Teck Trail Operations

Lower Columbia River

Aquatic Effects Monitoring Program

2021 Data Collection and Interpretation Report









Prepared By:
Ecoscape Environmental Consultants Ltd.

Prepared For:
Teck Trail Operations
Trail, B.C.

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LIST OF ACRONYMS

µS	microSiemens
AFDW	Ash Free Wet weight (Volatile Solids)
Al	Aluminum
AEMP	Aquatic Effects Monitoring Program (formerly Aquatic Receiving Environment Monitoring Program; AREMP)
AOI	Area of Interest represents the Lower Columbia River from the confluence of the Kootenay River downstream to Waneta – including both reference and exposure areas (downstream of the smelter) assessed within the AREMP.
ALS	ALS Environmental Laboratories, Burnaby BC
As	Arsenic
BIR	Birchbank
BC Hydro	British Columbia Hydro and Power Authority
BC ENV	British Columbia Ministry of Environment and Climate Change Strategy
BOD_5	5-day Biological Oxygen Demand
Ca	Calcium
CABIN	Canadian Aquatic Biomonitoring Network
Caro Labs	Caro Environmental Laboratories (Kelowna, BC)
CCME	Canadian Council of Ministers of the Environment
CII	Teck Metals Ltd. Trail Smelter combined effluent Outfall II
CIII	Teck Metals Ltd. Trail Smelter combined effluent Outfall III
CIV	Teck Metals Ltd. Trail Smelter combined effluent Outfall IV (fertilizer outfall on right bank at Stoney Creek)
Cl	Chlorine
Cd	Cadmium
CRIEMP	Columbia River Integrated Environmental Monitoring Program
Chl-a	Chlorophyll-a
Co	Cobalt
CRH	Torrent Sculpin (*Cottus rhotheus*)
CSR	Contaminated Sites Regulations
Cu	Copper
DDI	Double Deionized Water
DEP	Depositional area sample site
DEP-EXP	Depositional area sample site situated downstream of the smelter
DEP-REF	Depositional area sample site situated upstream of the smelter
Didymo	*Didymosphenia geminata*
DO	Dissolved Oxygen
EPT	Ephemeroptera, Plecoptera, Tricoptera
ER	Exposure Ratio
ERA	Ecological Risk Assessment
ERO	Erosional area sample site
ERO-EXP	Erosional exposure area sample site situated downstream of the smelter
ERO-REF	Erosional reference area sample site situated upstream of the smelter
EXP	Indicates sample sites/areas situated downstream of the smelter. These represent exposure area samples.
Fe	Iron
g	Gram
GIS	Geographic Information Systems
GPS	Global Positioning System
GSI	Gonadosomatic Index
HBI	Hilsenhoff Biotic Index

Hg	Mercury
HLK	Hugh L. Keenleyside
HSD	Honest Significant Difference
HSI	Hepatosomatic Index
HSS	Site-specific water hardness (mg/L $CaCO_3$)
ICP-MS	Inductively-Coupled Mass Spectrometry
IDZ	Initial dilution (mixing) zone of effluent receiving waters extending downstream from the TML Trail Smelter to Old Trail Bridge.
ISQG	Interim Sediment Quality Guideline
K	Potassium
k	Fulton's Condition Factor
kcfs	Thousands of Cubic Feet Per Second
kg	Kilogram
km	Kilometer
L	Liter
LCR	Lower Columbia River
m ASL	Meters Above Sea Level
m	Meter
max	Maximum Value
MCR	Middle Columbia River from below the Revelstoke Reservoir downstream to Upper Arrow Lake
Mg	Magnesium
mg	Milligram
min	Minimum Value
mm	Millimeter
Mn	Manganese
Mo	Molybdenum
MW	Mountain Whitefish (*Prosopium williamsoni*)
N	Nitrogen
n	Sample Size
Na	Sodium
NaCl	Sodium Chloride
NMDS	Non-metric Multidimensional Scaling
NTU	Nephelometric Turbidity Units
Pb	Lead
PCA	Principal Component Analysis
PCOC (PMOC)	Potential Contaminant of Concern (equates to Potential Metal of Concern herein)
PEL	Probable Effects Level (lower limit usually associated with the potential for adverse effects)
POM	Particulate Organic Material
ppm	Parts per Million
QA/QC	Quality Assurance and Quality Control
RB	Rainbow Trout (*Oncorhynchus mykiss*)
REF	Indicates sample sites/areas situated upstream of the smelter. These represent reference area samples.
SALM	Strong Acid Leachable Metals
SD	Standard Deviation
Se	Selenium
Si	Silicon
SO_4	Sulphate
TDS	Total Dissolved Solids
Tl	Thallium

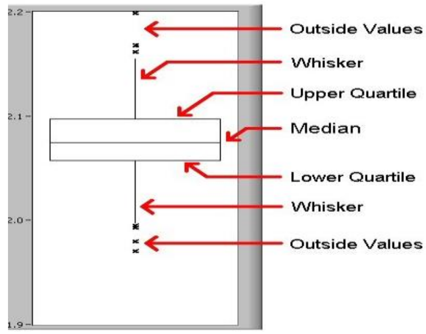
T-P	Total Phosphorus
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TML	Teck Metals Limited
TOC	Total Organic Carbon
TRO	Tissue Residue Objectives
TSS	Total Suspended Solids
TTS	Teck Trail Smelter
UBC	University of British Columbia
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VIF	Variance Inflation Factors
WP	Walleye (*Sander vitreus*)
WQIS	Water Quality Index Station
WUP CC	Columbia River Water Use Plan Consultative Committee
Zn	Zinc

DEFINITIONS

The following terms are briefly defined as they are used in this report. For a fuller explanation, please refer to scientific literature.

Term	Definition
Anoxic	Devoid of oxygen.
Benthic	Organisms that dwell in or are associated with the sediments.
Benthic production	The production within the benthos originating from both periphyton and benthic invertebrates.
Bioaccumulation	Removal of materials from solution by organisms via adsorption, metabolism.
Bioavailable	Available for use by plants or animals.
Biomagnification	A marked increase in a material of interest through successively higher levels of a food chain.
Catastrophic flow	Flow events that have aquatic population-level consequences of >50% mortality.
Cyanobacteria	Bacteria-like algae having cyanochrome as the main photosynthetic pigment.
Diatoms	Algae that have hard, silica-based "shells" frustules.
Effective Dilution	Ratio of the effluent concentration to the plume concentration
Eutrophic	Nutrient-rich, biologically productive water body.
Exposure Area	The Columbia River within the Initial Dilution Zone and areas downstream of the smelter effluent discharges (to Waneta).
Flow	The instantaneous volume of water flowing at any given time (e.g., 1200 m^3/s).
Functional Feeding group	(FFG) Benthic invertebrates can be classified by mechanism by which they forage, referred to as functional feeding or foraging groups.
Inflow plume	An inflow seeks the layer of matching relative density in the receiving water, diffusing as it travels; High TSS, TDS and low temperature increase water density.
Left Bank	Left bank (river left) when looking downstream.
Light attenuation	Reduction of sunlight strength during transmission through water.
Limitation, nutrient	A nutrient can limit or control the potential growth of organisms e.g., P or N.
Macronutrient	The major constituents of cells: nitrogen, phosphorus, carbon, sulphate, H.
Metal of Interest	In previous studies/reports metals of interest were referred to as Potential Contaminants of Concern (PCOC).
Micronutrient	Small amounts are required for growth; Si, Mn, Fe, Co, Zn, Cu, Mo etc.
Microflora	The sum of algae, bacteria, fungi, *Actinomycetes,* etc., in water or biofilms.
Myxotrophic	Organisms that can be photosynthetic or can absorb organic materials directly from the environment as needed.
Nano plankton	Minute algae that are less than 5 microns in their largest dimension.
Near-field	Near-field mixing is the immediate mixing upon release from the diffuser and its interaction with ambient river water.
Pico plankton	Minute algae that are less than 2 microns in their largest dimension.
PPB or µg/L	1 part per billion (e.g., $1/6^{th}$ of an aspirin tablet in 1 rail car of water (16,000 gal).
Peak biomass	The highest density, biovolume or chl-a attained in a set time on a substrate.
Periphyton	Microflora that are attached to aquatic plants or solid substrates.
Phytoplankton	Algae that float, drift or swim in water columns of reservoirs and lakes.
Redox	The reduction (-ve) or oxidation (+ve) potential of a solution.
Reducing environment	Devoid of oxygen with reducing conditions (-ve redox) e.g., water-covered organic sediments. Negative redox is usually driven by bacterial activity.
Reference Area	The Columbia River within the AOI upstream of Stoney Creek and smelter effluent discharges.
Right Bank	Right bank (river right) when looking downstream.
Riparian	The interface between land and a stream or lake.
Zooplankton	Minute animals that graze algae, bacteria and detritus from a water column.

HOW TO INTERPRET A BOXPLOT



The lower (first) quartile (Q_1) is defined as the middle number between the smallest number and the median *of the data set. The second quartile (Q_2) is the median of the data. The upper (third) quartile (Q_3) is the middle value between the median and the highest value of the data set.*

An outlier (outside) value is generally defined as any value that is 1.5 times the lower (Q1) and upper (Q3) quartile values (i.e., the whiskers on the above figure). Outlier values can be due to real variability in the sample population, heavy-tailed distributions, or due to errors in sampling equipment or transcription.

WATER QUALITY, SEDIMENT AND TISSUE GUIDELINES

Generalized Water Quality Guidelines and Objectives					
Selected Analytes	Units	LCR Water Quality Objectives		BC	
Water Quality General		Short-term	Long-term	Short-term acute	Long-term chronic
pH		6.5 - 8.5	-	6.5 - 9.0	-
Dissolved oxygen	mg/L	5.5 - 9.5	-	5 - 9 (min)	8 - 11 (min)
Total organic carbon	mg/L	-	-	-	± 20% of 30-day median background concentration
Suspended solids	mg/L	-	-	± 25	± 5
Turbidity	NTU	-	-	± 8	± 2
Metals					
Aluminum – dissolved[1]	mg/L	-	-	0.1	0.05
Arsenic – total	mg/L	-	0.005	0.005	-
Cadmium – dissolved	mg/L	-	-	Cd calc	Cd calc
Chromium – total	mg/L	-	0.001	-	-
Chromium III ion	mg/L	-	-	-	0.0089
Chromium VI ion	mg/L	-	-	-	0.001 (working)
Copper – total	mg/L	0.00717	0.002	BLM Model	BLM Model
Iron – total	mg/L	-	-	1.0	-
Iron – dissolved	mg/L	-	-	0.35	-
Lead – total	mg/L	0.0379	0.0048	Pb calc	Pb calc
Mercury – total inorganic	mg/L	-	-	0.0001	0.00002
Nickel – total	mg/L	0.0025 - 0.150	-	-	Ni calc (working)
Selenium – total	mg/L	-	-	0.002	0.001
Sodium – total	mg/L	-	-	-	-
Silver – total	mg/L	-	-	(0.0001 if hardness <100mg/L) - 0.003	0.00005 (hard <100 mg/L) - 0.0015
Thallium – total	mg/L	-	0.0008	-	0.0008 (working)
Zinc – total	mg/L	0.033	0.0075	Zn calc	Zn calc
Nutrients					
Ammonia as N	mg/L	-	0.102 - 2.08 temp/pH table	0.752 - 27.7 temp/pH table	0.102 - 2.08 temp/pH table
Nitrate-N as N	mg/L	-	-	32.8	3.0
Nitrite-N as N	mg/L	-	-	0.06	0.02
Total phosphorus as P	mg/L	-	-	0.005 - 0.015 for lakes	-
Sulphate	mg/L	-	-		218 (hardness of 70 mg/L)

Parameter/Analyte mg/L	Calculation
Cd short-term (dissolved)	$e^{1.03 * (\ln(Hss) – 5.274)}/1000$
Cd long-term (dissolved)	$e^{0.736 * (\ln(Hss) – 4.943}/1000$
Cu total	BC Biological Ligand Model (2019)
Ni long-term	When hardness >60 to <180 mg/L = $e^{(0.76[\ln(Hss)]+1.06)}/1000$
Pb short-term	$e^{1.273 * (\ln(Hss)-1.46)}/1000$
Pb long-term	$3.31 + e^{(1.273 \ln(\text{mean hardness}) - 4.705)}/1000$
SO_4 (proposed 2013)	Hardness(mg/L) soft (0-30)=128 mg/L SO_4 | moderate (31-75)=218 mg/L SO_4 | hard(76-180) =309 mg/L SO_4 | very hard(181-250)=429 mg/L SO_4
Zn short-term	(33+0.75(hardness-90))/1000
Zn long-term	(7.5+0.75(hardness-90))/1000

Water Quality Guideline References

LCR Objectives: Lower Columbia River from Birchbank to the International Border: Water quality Assessment and Recommended Objectives, MacDonald Envi Services Ltd. 1997

LCR Objectives: Ambient Water Quality Assessment and Objectives for the Lower Columbia River – Birchbank to the US Border. Overview Report. 2000.

BC Water Quality Guidelines. 2019. https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines

[1.] In 2022, Environment and Climate Change Canada (ECCC) published an updated Federal Water Quality Guideline (FWQG) for Al for the protection of freshwater aquatic life. B.C. has adopted this guideline with the addition of an assessment factor to account for the sources of uncertainty. This new guideline was established after the initial report date.

Sediment quality guidelines

Total Metals	Units (Dry wt.)	LCR Sediment Objective	BC Working Guidelines 2006		CCME	
			ISQG	PEL	ISQG	PEL
Arsenic	mg/kg	5.7	5.9	17	5.9	17
Cadmium	mg/kg	0.6	0.6	3.5	0.6	3.5
Chromium	mg/kg	36.4	37.3	90	37.3	90
Copper	mg/kg	35.1	35.7	197	35.7	197
Iron	mg/kg	-	21,200 (2%)	43,766 (4%)	-	-
Lead	mg/kg	33.4	35	91.3	35	91.3
Manganese	mg/kg	-	460	1100	-	-
Mercury	mg/kg	0.16	0.174	0.486	0.17	0.486
Nickel	mg/kg	-	16	75	-	-
Selenium	mg/kg	-	2	-	-	-
Silver	mg/kg	-	0.5 (Ontario)	-	-	-
Thallium	mg/kg	-	-	-	-	-
Zinc	mg/kg	120	123	315	123	315
ISQG = interim sediment quality guideline			(mg/kg = µg/g)			

PEL = probable effects level

NOTE: the Objectives cited here are more stringent than the Contaminated Sites Regulations (CSR) Schedule 9 standards for sediment

According to the 2009 BC Lab Manual for sediment samples, the < 2 mm fraction is analyzed.

Sediment Guideline References

LCR Objectives: Lower Columbia River from Birchbank to the International Border: Water quality Assessment and Recommended Objectives, MacDonald Envi Services Ltd. 1997

BC Sediment Quality Guidelines https://www.for.gov.bc.ca/hfd/library/ffip/Nagpal_NK2001.pdf

CCME Canadian Council of Ministers of the Environment http://www.ccme.ca/

Tissue metals guidelines for consumers of fish

Analyte	Human Health[1]	LCR TRO[2]	CCME[4]	BCMOE
	µg/g (ww)	µg/g (ww)	µg/g (ww)	µg/g (ww)
Arsenic	3.5	0.47		
Cadmium		0.9		
Chromium		0.94		
Lead	0.5	0.16		0.08
Mercury	0.5	0.1	0.033	0.033
Selenium[3]	High intake = 1.8 Moderate intake = 3.6 Low intake = 18.7			Egg/ovary = 2.75 Whole body = 1 Muscle/fillet (*Interim*) = 1

1. Canadian guidelines for chemical contaminants and toxins in fish and fish products. Based on fish protein (mussel) concentration (Ammend.no.11, 2011). (Can.Food.Insp.Agency 2011)
2. LCR tissue residue objectives (TRO): Lower Columbia River from Birchbank to the International Border: Water quality Assessment and Recommended Objectives (MacDonald Envi Services Ltd. 1997)
3. BCMOE. 2014. Ambient water quality guidelines for Selenium Technical Report Update. Water Protection and Sustainability Branch Environmental Sustainability and Strategic Policy Division British Columbia Ministry of Environment. 270pp.
4. CCME tissue guideline is for methyl mercury and based on the most stringent avian receptor.

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EXECUTIVE SUMMARY

Introduction

Ecoscape Environmental Consultants Ltd. (Ecoscape) was retained by Teck Metals Ltd., Trail Operations (Teck) to carry out an aquatic effects monitoring program (AEMP) on the Lower Columbia River (LCR) as per section 3.2.1 of Effluent Permit PE02753. The purpose of this program is to conduct effluent receiving environment monitoring in the LCR to assess the potential impacts of current operations on the Columbia River.

The Trail smelter has three permitted outfalls (CII, CIII, and CIV) into the Columbia River. The requirement to carry out an AEMP was assigned to Teck by the BC Ministry of Environment and Climate Change Strategy (BC ENV) in 2011. Methods for the AEMP data collection and interpretation adapt the Proposed Study Design for Teck Trail Smelter Aquatic Receiving Environment Monitoring Program (AREMP) (Golder 2012a).

This report follows the fourth data collection cycle (2021) and includes evaluation of water quality, sediment quality, periphyton communities, benthic invertebrate communities, and small and large-bodied fish condition and tissue metals analysis.

The primary study area is the LCR from Stoney Creek to Old Trail Bridge, the initial dilution zone (IDZ) for the permitted outfalls. Downstream of the smelter and beyond the IDZ, monitoring extends to immediately upstream of the confluence with the Pend Oreille River and north of the international border at Waneta. Reference study areas upstream of the smelter extend from the Hugh L Keenleyside (HLK) and Brilliant Dams downstream to Stoney Creek.

Background

The potential influence of the smelter effluent discharge on the aquatic receiving environment was monitored initially by Teck and then through the Columbia River Integrated Environmental Monitoring Program (CRIEMP) which implemented a Lower Columbia River Water Quality Objectives Monitoring Program from 1997-2005 (Hatfield 2008).

From 2000 through 2008, Teck conducted a large-scale Ecological Risk Assessment (ERA) in the Trail area (Golder 2010). The aquatic ERA Area of Interest (AOI) encompassed the LCR and its tributaries from downstream of the HLK and Brilliant Dams downstream to Waneta. The ERA concluded that risk management objectives were being met for fish, and that additional evaluation was required with respect to periphyton and benthic invertebrates at specific sites downstream where non-smelter related stressors are also present. Tributary systems did not have strong evidence to indicate risks from smelter-related stressors. The ERA findings formed the basis of the study design for AEMP.

In addition to the smelter outfalls, smelter-related influences include Stoney Creek, which discharges just upstream of the smelter and contributes metals to the LCR (Teck Cominco 1998), Trail Creek, which discharges downstream of the smelter adjacent to downtown Trail, and historically impacted groundwater discharges to the LCR in the vicinity of the smelter (Golder 2012).

Non-smelter-related stressors in the LCR include contaminants in urban stormwater and municipal wastewater treatment facility discharges, as well as elevated metals in tributaries resulting from other anthropogenic sources such as forestry, historical mining and run-off from agricultural and urban areas (Golder 2007).

BC Hydro dam flow regulation from HLK and Brilliant Dams is the major determinant of LCR condition. River flow is an important driver of benthic community development in all flowing waters. This is because flow determines dilution, as well as several important co-variate parameters, including substrate submergence or stranding, velocity, turbulence, sediment transport, and light penetration.

Sources other than permitted smelter discharges have a potential influence on the health of the aquatic receiving environment. Due to the integrating nature of the LCR, any impacts from these sources could not be assessed separately from those potentially associated with the effluent discharge, and the AEMP will measure parameters reflecting all influences on the river, not only the Trail Smelter effluent discharge.

Water quality

The water quality program is a long-term monitoring program designed to evaluate potential effects of Teck's permitted effluent discharges on the LCR. Water quality samples are collected in spring, summer, and fall. The spring and fall sampling events are designed to target a low flow period, when metal concentrations in the water column should be the least diluted. However, the LCR is a regulated river, and flows were higher during some of the sampling events and years.

Water quality data were compared to BC long-term and short-term water quality guidelines and LCR Water Quality Objectives and to data from previous years (2011-2020). The long-term average concentration was determined by calculating the mean from 5 samples collected within 30 days from right shallow locations (R-sh) during spring low flow. The R-sh locations were used because the effluent plume hugs the right bank and diffuses outward moving downstream.

There were no exceedances of the short-term acute or long-term chronic Water Quality Guidelines or LCR Objectives for any metals of interest downstream of the IDZ in 2021. Within the IDZ, the spring 2021 30-day average dissolved cadmium and dissolved copper concentrations exceeded the long-term chronic WQG at New Trail Bridge R-sh. Nutrient concentrations in the LCR below the IDZ were not significantly altered by the effluent discharges.

Significant trends in concentrations have become increasingly apparent since the previous trend analysis conducted in 2018 (Larratt et al. 2019) as an additional three years of data are available. In general, decreasing trends in metals concentrations predominate through the IDZ and downstream of the smelter. Parameters with increasing trends in concentrations (e.g., selenium and sulfate) are also increasing to a similar degree in background levels at the upstream Birchbank reference location.

Water quality in the study area varied spatially and temporally. Spatial variation is influenced by the smelter, non-smelter sources, and river hydrodynamics. The intra-annual temporal variation was affected by flows. The AEMP transect water quality sampling showed spatial variation in water quality within the IDZ but not at Waneta where full mixing is evident. The effluent plume hugs the right bank (~1/3 channel width or approximately 60 m) through to the downstream end of the IDZ. 2021 Spatial mapping of specific conductance during LCR low flows illustrates plume geometry related to diffusion and dilution through the IDZ.

The AEMP water quality monitoring study, conducted from 2011-2021, is appropriate for evaluating temporal and spatial variation in water quality related to smelter influence in the LCR. It focusses on lower flow periods when mixing and dilution are reduced, and water quality impacts are expected to be greatest. Existing parameters and their reportable detection limits are appropriate for this study.

Depositional habitat

The depositional habitat component of the AEMP is designed to assess potential effects of Teck's permitted effluent discharges on depositional habitat by comparing periphyton and benthic invertebrate community structure and composition between areas upstream (reference) and downstream (exposure) of the smelter.

Hydrodynamics of the LCR study area create conditions where long-term depositional zones are rare (Golder, 2003). Depositional habitat was estimated at 0.1% of the total sediment habitat within the AOI (Golder 2007c). The rarity of depositional habitats make them an important component of the LCR ecosystem. Furthermore, depositional habitats support benthic invertebrate and periphyton communities that differ from erosional sites because of structural habitat differences like flow and substrate size. The unique communities present within depositional sites contribute to the overall biodiversity of the LCR.

Depositional sites are dynamic, and each site has its own character in contrast to the comparatively uniform erosional habitats. The character of individual sites can change over time, and this must be considered when interpreting sediment and benthic community results collected in this study.

Sediment chemistry of the small LCR depositional areas was distinct from erosional cobble substrates. Sand dominated in all depositional sites within the AOI. Depositional sediments developed lower dissolved oxygen, lower redox, and elevated organic components compared to erosional habitats. These sediment conditions induced unique microflora communities dominated by decomposers.

The 2012, 2015, 2018, and 2021 AEMP data show that metal concentrations in depositional sediments downstream of the smelter (exposure sites) were higher than reference sites. This is consistent with the results of earlier studies (Golder 2007, Hatfield 2008). Depositional area size and substrate stability (influenced by local hydrodynamics) are important factors. Distance from the smelter was also a factor in sediment metal distribution but had a non-linear relationship. None of the sediment metals of interest consistently decreased with distance from smelter in 2021. The non-linear pattern of sediment exceedances as distance from the smelter increases suggests there continue to be site-specific effects which may include influences of river flow dynamics along with other sources of metals such as naturally occurring metal concentrations, historical mining and milling, municipal effluent and/or stormwater. The highly variable nature of the small depositional areas that account for only about 0.1% of the AOI in the LCR was evident in these results.

Sediment metals that exceeded guideline PEL concentrations in 2021 were limited to Cu, Pb, and Zn in the <2mm fraction. Metals concentrations were higher in the <63 µm fraction resulting in more exceedances of the PEL for As, Cd, Cu, Pb, Hg, and Zn. The <63 µm sediment fraction is expected to have a greater proportion of fine silts and organic matter, which more readily adsorb metals. Metals in both sediment fractions followed similar distribution patterns at the sample sites.

Background reference concentrations of PCOCs have been increasing in both sediment size fractions analyzed. In 2021 LCR Objectives were exceeded for Cadmium and Zinc in the 63 µm fraction at all 3 background locations. Sediment trends are difficult to determine and rely on due to the dynamic and transient nature of LCR sediment, but in general, exposure site metals concentrations appear to be stable or decreasing with less guideline exceedances noted in 2021 in comparison to previous years. The exception to this being Casino results, which were generally higher in 2021 than in previous years.

The length of time that deposited materials remain in depositional areas is important. Larger depositional sites such as Genelle Eddy (Dep-Ref-2), Casino Eddy (Dep-Exp-3), and Waneta Eddy (Dep-Exp-7) can be expected to have longer storage than small depositional sites, thus they may take longer to return to a natural state than adjacent erosional sites. The dynamic and transient nature of the smaller depositional sites is illustrated by the Maglios and Airport Bar sites having been scoured and new sites being established in 2018, which were re-sampled in 2021. Fines that accumulated during low flows are frequently scoured and re-sorted during high flows (Parametrix et al. 2010).

Depositional periphyton analysis found significant differences in community metrics between sample sites in the LCR AOI. Community metrics, including species richness, diversity, and evenness were significantly higher in depositional reference sites than in exposure sites when all years were analyzed together. This difference is likely due to the size and structure of depositional reference sites in comparison to exposure sites. No significant differences were detected in periphyton growth metrics between samples from reference and exposure depositional sites. Linear models showed that the influence of the smelter outfall on depositional periphyton metrics was less important than the effect of year-to-year influences in the LCR, led by flow-related drivers.

In addition to physical and chemical characteristics of the sediment, a critical part of the depositional habitat component is assessment of benthic community structure to evaluate whether elevated metals in sediment result in impairment of the benthic communities and their role as nutrition for certain higher trophic level consumers. Abundance, species diversity, and species composition were measured and differences between exposure and references sites were assessed graphically and statistically. Physical elements of the habitat formed an important component of this assessment. While variations in habitat between deposition sites are evident, the differences did not indicate detectable impacts from sediment metal concentrations or from current effluent discharges on depositional periphyton or benthic invertebrate community structure.

In benthic invertebrate communities there was no significant difference in the total abundance, chironomid composition, EPT composition, or effective species when reference and exposure sites were grouped by year. Benthic invertebrate community metrics varied with site, and no discernible pattern emerged among sites. In 2021, total abundance was high overall, and was highest at Kootenay Eddy reference area, yet biomass was highest at Casino Eddy exposure area. Taxa richness and effective species number (diversity) were highest at Birchbank reference area.

Total benthic invertebrate abundance was significantly higher in 2021 than 2015 or 2012, and effective species was also higher in 2021 than 2018 or 2012. However, there were no significant differences between reference and exposure sites. There was no significant difference in community structure between all areas sampled within 2021. Community structure differed significantly between areas across all study years, which continues to highlight the natural seasonal and annual variability that occurs in benthic communities.

Differences in LCR benthic communities among sites and years were detected, but benthic communities in depositional habitats did not differ between reference and exposure sites. Observed differences did not suggest adverse effects or impairment of benthic communities or an impact on upper trophic consumers linked to current smelter influences.

Erosional Habitat

The primary objectives of the erosional habitat sampling components are to assess potential effects of effluent discharges on benthic invertebrate and periphyton communities in these habitats. Two upstream reference areas were identified as Reference Area 1 (ERO-REF-1) (left bank opposite Stoney Creek and CIV outfall) and Reference Area 2 (ERO-REF-2) (Birchbank). Five downstream exposure areas were sampled at sites identified as downstream Exposure Area 1 through Exposure Area 5 (ERO-EXP-1 to ERO-EXP-5). Exposure areas were further divided into near-field sites along the right bank of the IDZ (IDZ RB), and far-field sites that occur beyond the extent of the effluent plume and downstream of the IDZ where the effluent is more thoroughly mixed with the LCR.

Relative effects of metals concentrations and habitat on periphyton and benthic communities in the LCR were assessed using various response variables.

Most periphyton growth metrics from 2012 through 2021 do not differ significantly between upstream reference sites and downstream exposure sites, which were broken into near-field exposure sites (Initial Dilution Zone Right Bank (IDZ RB)), and far-field exposure sites. This indicates that erosional periphyton growth is not significantly impacted by exposure to smelter effluents. However, periphyton diversity was significantly different in the near-field exposure sites (IDZ RB) compared to reference and far-field sites, likely driven by the increased water temperature from the CIII outfall that supported increased cyanobacteria growth compared to other sites. Periphyton community structure also differed significantly between reference, near-field IDZ RB, and far-field sites in 2021, and when all years were analyzed together. Near-field taxonomic results and productivity metrics from 2021 also suggest that the influence of the smelter on periphyton in the AOI is diminishing. Detected differences in periphyton communities appear to be primarily driven by flow-related variables and channel features. Environmental variables with the strongest effect on community structure differences were substrate size (D50), water velocity, and water temperature.

In 2021, there was no significant difference in benthic invertebrate total abundance between reference, near-field IDZ RB, and far-field areas, but invertebrate biomass was higher in near-field IDZ RB sites than in reference sites, and lower in far-field sites than reference sites. Benthic invertebrate biomass and abundances were higher in 2021 than previous years.

Most benthic invertebrate community metrics remained consistent between reference, near-field IDZ RB, and far-field sites, including taxa richness, Shannon's evenness, and percent of the population that was chironomids. However, near-field IDZ RB sites had significantly higher EPT taxa richness and percentage EPT taxa in the community than reference sites. Other site category combinations for 2021 did not differ significantly. This community variation between sites is likely due to differences in water velocity and substrate size in different habitats. Swifter water velocities and larger substrates are common in the IDZ RB sites, and these factors are favored by EPT taxa.

Mixed effects models indicated that water velocity and substrate size (D50) were the most important variables influencing benthic invertebrate communities in erosional habitats. Velocity was an important variable for explaining benthic macroinvertebrate abundance, EPT composition, taxa richness, and Shannon evenness, a measure of diversity. Sites with higher water velocity and larger substrate size had higher abundances and higher EPT composition. EPT richness was significantly higher in near-field IDZ RB sites and far-field sites than in reference sites. EPT richness was strongly influenced by water velocity and substrate size, and lower velocity sites had lower EPT richness. Many reference sites had lower velocities, thus the difference in EPT richness between treatment types was likely due to differences in habitat attributes, and not an influence from the smelter.

Periphyton and benthic metric trends over time were driven by flow regime, natural annual variation (e.g., climate conditions), and substrate size. Increased water temperature in the side channel (ERO-EXP-2) below the CIII outfall created a localized increase in periphyton productivity, and a unique periphyton community with more cyanobacteria than other sites. Although different, we can't conclude that the aquatic community in the side channel (immediately downstream of CIII) is lower condition, since EPT taxa richness was significantly higher in near-field IDZ sites than reference sites.

Small-bodied Fish

An effects-based design was adapted to measure biological variables in small-bodied fish (Sculpins). The overall objective of this study was to determine what effect (positive, negative, or neutral) effluent discharges may have on fish tissue metals concentrations, body condition, and overall growth characteristics by comparing small fish collected from upstream reference sites to downstream exposure sites. Specifically, collection targeted the Torrent Sculpin, as they are relatively abundant, sedentary, and have high site fidelity, so they are likely to stay in one site within the study area.

Arsenic, cadmium, and thallium fish tissue concentrations were significantly higher in fish caught in the IDZ Right Bank exposure areas but did not exceed guidelines. Iron and zinc concentrations did not differ significantly between reference and exposure sites. Copper concentrations were significantly lower in exposure areas than reference areas.

Lead, selenium, and mercury concentrations in small-bodied fish tissues were significantly higher in exposure areas than reference areas, and there were exceedances of applicable guidelines for these metals in 2021, the majority of which were in exposure areas within the IDZ.

Overall, small-bodied fish tissue concentrations of metals have either declined or remained consistent with levels observed in 2013. As, Pb, Hg, and Zn tissue metal concentrations were significantly lower in 2021 than in 2013. Whereas concentrations of Cd, Fe, Se, and Tl did not differ significantly between 2021 and 2013.

Sculpins downstream of the IDZ had significantly lower body condition (Fulton's condition k) than sculpins in the reference area. There were no significant differences in sculpin body condition between other exposure areas in the IDZ and reference areas. Liver weight (hepatosomatic index; HSI) was significantly higher in fish in the IDZ Right Bank exposure area than reference areas. The liver works to store glycogen, decompose red blood cells, produce hormones, and detoxify the blood. An elevated HSI may be a response to elevated metals in the system, or due to hormonal production during gonadal maturation (Hismayasari et al. 2015).

Overall, tissue concentrations of metals decreased with increased distance from the smelter. Lead concentrations are about 30 times lower at the Downstream end of the IDZ than near New Trail Bridge. Mercury concentrations follow a similar pattern. The highest metal exposure from the effluent is in ERO-EXP-2, just downstream of the CIII outfall on the right bank. This area and ERO-EXP-1 show the highest concentrations, and concentrations decrease downstream as the effluent plume mixes and dilutes.

Large-bodied Fish

The primary objectives of this component are to assess potential effects of effluent discharges, particularly metals concentrations, on large-bodied fish tissues (measured in fillets, whole fish samples, and gut contents). Species used for this component of the AEMP were Mountain Whitefish, Rainbow Trout, and Walleye.

Mountain whitefish from reference areas had significantly higher gonadosomatic indices than those from exposure areas. Mountain whitefish spawn in the reference areas in the fall, so an increase in gonad weight is expected. Walleye body condition (k) was significantly higher in reference areas than exposure areas. Rainbow Trout condition indices did not differ between treatment areas.

All three large-bodied fish species sampled migrate long distances throughout river systems at different times of the year. The residency time in any given area in the LCR of an individual, and the distance it travelled are not known. Fish collected in an upstream reference area may have frequented downstream areas, and vice versa.

Cadmium, lead, and thallium concentrations in all sample types, and arsenic and copper concentrations in gut samples were significantly higher in exposure areas than reference areas in 2021.

There were no individual sample exceedances of the human consumption guideline for fillet concentrations of any metal in 2021, and no mean fillet metal concentrations exceeded their respective human consumption guideline. Mean mercury concentrations in fillet and whole fish samples of Walleye from both reference and exposure areas exceeded the TRO in 2021. There were some individual sample exceedances of the lead TRO, but mean lead concentrations remained below the TRO in exposure and reference areas in 2021. There were no exceedances of the TRO for arsenic, cadmium, or chromium in 2021.

We expected varying tissue metal concentrations among the three species due to their different life histories and feeding habits. Specifically, we expected Walleye to have higher concentrations of bioaccumulative substances because they are a top-level piscivorous predator. As expected, species had a significant effect on tissue metal concentrations, and Walleye had higher concentrations of mercury. However, Mountain Whitefish had higher concentrations of arsenic, cadmium, lead, selenium, and zinc than Rainbow Trout or Walleye. Copper concentrations differed significantly by species, but the species with the highest concentration varied dependent on tissue sample type.

Overall, most tissue metal concentrations have declined since 2000. Arsenic, cadmium, and lead were significantly lower in 2021 than early sample years. Declines in cadmium since 2004 may be because of better detection capabilities and sampling procedures have improved detection accuracy.

Chromium has also declined since 2000 and concentrations have remained below the TRO since 2005. Mercury concentrations have varied but have not changed significantly since 2000 and show no discernible trend.

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APPENDICES

1.0 INTRODUCTION

Ecoscape Environmental Consultants Ltd. (Ecoscape) was retained by Teck Metals Ltd., Trail Operations (Teck) to carry out an aquatic effects monitoring program (AEMP) on the Lower Columbia River (LCR) as per section 3.2.1 of Effluent Permit PE-2753. This report follows the fourth data collection cycle (2021) and includes evaluation of water quality, sediment quality, periphyton communities, benthic invertebrate communities, and small and large-bodied fish condition and tissue metals analysis.

The purpose of this work is to conduct effluent receiving environment monitoring in the LCR to assess the potential impacts of current operations on the Columbia River.

The Teck Trail Smelter is located adjacent to the right bank looking downstream on the LCR in Trail, BC, about 11 km due north of the International Border with the United States. The streamline distance from the smelter down to the border is about 18 km (Schedule A).

The smelter has three permitted outfalls (CII, CIII, and CIV) into the Columbia River. The requirement to carry out an AEMP was assigned to Teck by the BC Ministry of Environment and Climate Change Strategy (BC ENV) in 2011. Methods for the AEMP data collection and interpretation adapt the Proposed Study Design for Teck Trail Smelter AREMP (Golder 2012a). The study design addressed water quality, sediment quality, periphyton communities, benthic Invertebrate communities, and large-bodied fish condition and tissue metals. The small-bodied fish study design was not included in the initial workplan by Golder (Golder 2012a) and was developed by Ecoscape in 2012 with data collection initiated in the spring of 2013.

The primary study area is the LCR from Stoney Creek to Old Trail Bridge, the initial dilution zone (IDZ) for the permitted outfalls. Downstream of the smelter and beyond the IDZ, monitoring extends to immediately upstream of the confluence with the Pend Oreille River just north of the international border at Waneta. Reference study areas upstream of the smelter extend from the Hugh L Keenleyside (HLK) and Brilliant Dams downstream to Stoney Creek (Schedule A).

Sources other than permitted smelter discharges have a potential influence on the health of the aquatic receiving environment, but the evaluation of such influences is outside the scope of this AEMP. Due to the integrating nature of the LCR, any impacts from these sources could not be assessed separately from the effluent discharge; it is therefore acknowledged that the AEMP evaluates all influences on the river, not just the Trail Smelter effluent discharge. Potential contaminant sources in the LCR are discussed in more detail in section 2.2.

The structure of this report is based on the Proposed Study Design for Teck Trail Smelter AREMP (Golder 2012a) and on Recommendations to AREMP, 2015-2017 (Hawes et al. 2015). The following report describes project objectives and methods, and outlines management questions.

It is important to note that a comprehensive review of the effluent discharge limits under Effluent Permit PE-2753 is underway, and the final step in the process will be a review of the AEMP scope.

2.0 BACKGROUND INFORMATION

The LCR aquatic environment has been extensively studied, with data collected over the years by various organizations. Teck has commissioned numerous studies and reports on a wide range of potential effects of past and current smelter operations of the Trail Smelter. These efforts provide historical data and context for the present AEMP.

2.1 Summary of Historical Studies in the LCR AOI and Origin of AEMP

This section provides a brief summary of the historical studies and regulatory history that led to the development of AEMP as it currently stands as a requirement of Effluent Permit PE-2753.

2.1.1 Trail Area Ecological Risk Assessment

From 2000 through 2008, Teck conducted an Ecological Risk Assessment (ERA) in the Trail Area. The aquatic ERA (Golder 2007) Area of Interest (AOI) encompassed 56 km of the LCR and its tributaries from the Hugh L. Keenleyside Dam and the Brilliant Dam on the Kootenay River downstream to Waneta at the International Border. Assessment endpoints were defined for periphyton community composition, benthic invertebrate community composition, fish population and condition metrics as well as habitat quality.

The sequential assessment of lines of evidence (SALE) in the aquatic ERA concluded that aquatic impacts were localized and recommended that these be addressed via follow-up monitoring through the permitting process which became the Aquatic Receiving Environment Monitoring Program (AREMP). Specifically, the ERA found:

- Risk management objectives were being met for fish.
- Potential impacts to periphyton in near-field areas close to the smelter; and
- Potential impacts to benthic invertebrate community composition at two downstream depositional habitats (Maglios and Waneta).

The ERA recommended further investigation of periphyton and benthic invertebrate communities.

The terrestrial ERA (Intrinsik 2011) included evaluation of potential risks to birds and mammals associated with the aquatic environment. This evaluation was updated using monitoring data collected from the first cycle of AEMP (Intrinsik 2014). The overall conclusion from these reports is that there are no unacceptable risks to wildlife with aquatic-based diets.

2.1.2 Risk Assessment of Tributaries

Teck commissioned an assessment of the relative risk to tributaries from smelter emissions (Golder 2006). Cadmium, silver, and zinc concentrations exceeded water quality guidelines at both reference and exposure sites within tributaries to the lower Columbia River. The Aquatic ERA (Golder 2007) hypothesized that some elevated surface water concentrations of metals in tributaries may be explained by other anthropogenic sources, such as forestry, highway run-off, erosion from power and gas rights of way, old mining works and run-off from agricultural and urban areas (the later especially true for reference tributaries (Golder 2006)).

Sediment metals concentrations in tributaries were elevated from upstream reference sites downstream to Murphy Creek, with variable metals concentrations between the smelter and Beaver Creek, and high metals concentrations farther downstream at Sheppard Creek (Golder 2006).

Algal biovolume in tributaries was low at most sites, and the degree of variability between reference and exposure sites was within the standard error (Golder 2006). Golder (2006) concluded there was low risk to tributary systems from smelter discharges.

Differences in benthic invertebrate community composition were reported for tributaries in the area of influence (AOI) (Golder 2006). These differences reflected environmental variation relating to water quality and habitat (Golder 2006), with the variability in natural habitat features being the primary determinants of periphyton and benthic community composition (Golder 2012a).

2.1.3 Aquatic Receiving Environment Monitoring Program (AREMP)

The requirement to carry out a receiving environment monitoring program was assigned to Teck by BC ENV in 2011 after the Columbia River Integrated Environmental Monitoring Program (CRIEMP) ceased their annual Water Quality Objectives monitoring program in 2010. The AREMP scope was developed by Golder in consultation with Teck, Intrinsik, and BC ENV. In addition to water quality monitoring, the AREMP study design (Golder 2012a) addressed the outstanding issues from the Aquatic ERA, namely assessment of potential impacts to periphyton and benthic invertebrate communities downstream of the smelter. The study design included management questions for water quality, depositional and erosional habitats, and small and large bodied fish tissue monitoring.

Ecoscape was retained by Teck to complete AREMP monitoring with data collection beginning in the fall of 2012. The small-bodied fish study design had not been included in the initial workplan by Golder (Golder 2012a) and was developed by Ecoscape in 2012 and data collection initiated in the spring of 2013. Subsequent to the 2015 data collection cycle, the small and large-bodied fish collection frequency was shifted from every three years to every 6 years to reduce potential impacts on local populations associated with lethal sampling. The decision for this change was collectively agreed upon by Ecoscape, Teck, and BC ENV during a project reviewing meeting in April 2017.

The name of AREMP was changed to Aquatic Effects Monitoring Program (AEMP) in 2017 at the request of ENV. The AEMP study design included an evaluation of effluent outfalls and effluent plume behaviour to ensure appropriate sample locations. These evaluations are summarized in the following sections.

2.2 Sources of Potential Contaminants of Concern (PCOC) in the LCR Area of Interest

The focus of this study is to assess the potential impacts of current smelter operations on the LCR. Potential contaminant sources influenced by the smelter are outlined in sections 2.2.1 and 2.2.2. Non-smelter influences are outlined in section 2.2.2.6.

2.2.1 Permitted Outfalls

The Trail smelter has three permitted outfalls under PE 2753 (CII, CIII, and CIV).

- C-IV Outfall - Effluent from the Trail Fertilizer Operations (TFO) outfalls just upstream of the mouth of Stoney Creek via outfall C-IV. Permitted limits for this outfall include limits for flow, pH, total mercury, ammonia as total nitrogen and total zinc.
- CIII Outfall – Effluent from the CIII outfall discharges into the side-channel adjacent Teck Trail Operations. Permit limits for the C-III outfall include limits for flow, pH, total suspended solids (TSS) and various total metals (arsenic, zinc, lead, cadmium, mercury, copper, and thallium).
- CII Outfall – Effluent from the CII outfall discharges near the right-bank upstream of the New Trail Bridge. Permit limits for the C-II outfall (PE 2753) include limits for flow, pH and various total metals (cadmium, copper, mercury, lead and zinc).

2.2.1.1 Comprehensive Review of Effluent Permit PE-2753

In 2019, ENV outlined the requirement for the comprehensive review of the effluent discharge limits for each authorized discharge under Effluent Permit PE-2753. The purpose of the review is to examine the potential effects of potential contaminants of concern on the receiving environment of the LCR and to assess the need for revised effluent discharge limits. This comprehensive review was divided into two components referred to as Submission 1 and Submission 2. Submission 1 (Azimuth 2020) included development of a problem formulation based on monitoring data, an integrated summary of effects in the aquatic receiving environment, a source control evaluation and best achievable technology review, and a comprehensive characterization of source including permitted outfalls and legacy sources. Submission 2 is currently in progress and will build on Submission 1. It will include an updated conceptual site model, a review of water uses and values and a predictive effects assessment for the receiving environment. To support the predictive effects assessment, an updated mixing model is being generated to predict flows and expected concentrations of parameters in the receiving environment, including contribution from permitted outfalls and upstream and legacy inputs.

2.2.2 Other Sources

In addition to the permitted effluent outfalls, there are other smelter-related sources of PCOCs to the LCR.

2.2.2.1 Stoney Creek

Stoney Creek discharges to the LCR immediately downstream of CIV upstream of the smelter and contributes metals to the LCR (Teck Cominco 1998). The Stoney Creek watershed is affected by historical waste disposal and storage activities that contribute to metal drainage from seepage and surface runoff. The stream also receives runoff from an urban area and a historical municipal landfill. An assessment undertaken in Lower Stoney Creek as per the Final Remediation Plan (Golder 2012c) identified metals-impacted soil and sediment. A channel rehabilitation project was completed for a 90 m section of the creek bed to restore degraded areas, reduce transport of metals-impacted soils from the slopes and to minimize downstream transport of metals-impacted sediment (SNC Lavalin, 2015). Additional investigations to evaluate residual dissolved metals input to surface water are currently underway.

2.2.2.2 Trail Creek

Trail Creek discharges to the LCR immediately downstream of the smelter and CII outfall. The Trail Creek watershed is influenced by historical mining activities and contributes natural background concentrations of metals to the LCR. Groundwater inputs of PCOCs to Trail Creek include Haley Creek (a tributary to Trail Creek) and the Annable groundwater plume.

Metal inputs to Trail Creek from Haley Creek are sourced from two historical landfills in the Haley Creek gully which contribute dissolved metals via groundwater. Physical remediation has taken place, including installation of a permeable reactive barrier to minimize historical landfill inputs to Haley Creek.

A shallow groundwater plume in the Annable area originates from Trail Fertilizer Operations (TFO) and contains ammonia, sulphate, fluoride and cadmium above applicable groundwater standards. The Annable groundwater plume is interpreted to discharge to Trail Creek, and remediation efforts include a groundwater capture and treatment system.

2.2.2.3 Groundwater

Hydrogeological investigations have been conducted beneath the smelter and surrounding area over a period of more than 20 years and have identified impacted groundwater associated with historical practices. The main groundwater plume is characterized by elevated nitrogen, sulphate, fluoride, total dissolved solids, arsenic, cadmium, iron, lead, manganese, and zinc (Golder 2012c) and is present beneath the TFO and smelter. The main groundwater plume flows toward the south-southeast, with a minor flow component toward the south beneath TFO. Shallow portions of the main plume discharge to the LCR adjacent to the smelter; its shallow to intermediate portions upwell across the entire width of the river; and its deeper portions migrate beneath the LCR through the East Trail Aquifer before discharging into riverbed sediments along the left bank from around Old Trail Bridge to about 1.3 km downstream (Golder, 2012c).

Groundwater discharge to the river depends on river stage but is influenced more by the rate of change in stage rather than by absolute river level (Golder 2010). Falling river levels result in groundwater upwelling to the river whereas rising river levels contribute to recharge of the aquifer. Phase 1 of a hydraulic interception and treatment system to address the main groundwater plume as per the 2012 Final Remediation Plan (Golder 2012c) was commissioned in 2017. Phase 1 is estimated to intercept approximately 80% of the impacted groundwater and performance verification monitoring is underway to identify reduction in loading (Azimuth 2020).

2.2.2.4 Sediment - Historical Permitted Slag Discharge

Slag is a granulated by-product of the smelting process. It is a particle consisting primarily of silica, calcium, and iron, that contains small amounts of base metals including zinc, lead, copper, and cadmium (Golder 2007b). Although grain size is similar to sand (DeBrito and Saikia 2013), slag has a density of >2.9 g/cm^3 (Cox et al. 2005), while coarse sand is lighter, with an average density of 2.65 g/cm^3. Discharge of slag from the Trail Smelter to the river began in the early 1920s and was discontinued in 1995.

2.2.2.5 Sediment Metals

In this report, we considered all potential metals of interest, but focused on those most likely to have potential adverse effects and that could have originated in releases from the smelter, as defined in Golder (2007), including arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, thallium, and zinc. Several of the metals have other important drivers of their distributions. For example, iron and manganese are very common and are mobile in low redox sediments. Aluminum is naturally prevalent throughout the LCR as is mercury.

Elevated metals concentrations in exposure site sediments may also be influenced by inputs from tributary creeks such as Blueberry, Murphy, Hanna, and Topping Creek, where high elevation creek sediments have concentrations comparable to depositional sites downstream of the smelter for lead, copper, arsenic, and cadmium (Reyes et al. 2004). Thus, the elevated metal concentrations in sediments downstream of the smelter cannot be attributed to past or present smelter activity alone.

2.2.2.6 Non-Smelter Influences

There are many influences on water quality in the LCR. The Aquatic ERA identified non-smelter-related stressors in the vicinity of New Trail Bridge (adjacent downtown Trail) and the Maglios sites (at the confluence with Bear Creek and the Regional wastewater treatment facility; Golder 2007) (Table 2-1) summarizes permitted effluent discharges to the Lower Columbia River as of 2021.

Table 2-1: Active Permitted Effluent Discharges to the Lower Columbia River (2021).

Location	Permit #	Discharge Description	Approximate Discharge (m^3/day)
LCR – between HLK dam and Castlegar, BC	PE 1272	Zellstoff-Celgar Ltd Partnership - final industrial kraft pulpmill low rate activated sludge effluent	177,000
	PE 7622	Lion's Head Inn -private 2° treated domestic via small package treatment plant with extended aeration effluent	20
	PE 80	City of Castlegar – 2° treated effluent via aerated stabilization ponds, polishing lagoons, chlorination	2,728
	PE 4008	City of Castlegar - treated domestic effluent via activated sludge treatment plant, UV disinfection, sludge lagoons	1,600
	PE 141	Selkirk College- 2° treated domestic effluent via silver recovery system, rotating biochemical disk treatment plant	536
LCR – Trail, BC	PE 2753	Teck Smelter - industrial effluents, cooling water via various treatments including lime, Hg cleaning area, groundwater recapture	296,000
LCR – downstream of Trail, BC	PE 274	Kootenay Regional District - 2° treated effluent via bar screening, grit removal, sedimentation, sludge digestion, chlorination	13,600
	PE 71	Village of Montrose - 2° treated effluent	640
Castlegar	PE 103725	Arrowpoint Effluent Inc. – Sewage Treatment	na
Beaver Creek	PE 133	Village of Fruitvale - 2° treated effluent	910
	PE 2500	Village of Salmo - 2 ° treated effluent including infiltration	455

Source: BC ENV Nelson, 2006 (After Golder 2007); Opus Dayton Knight 2016, BC ENV Discharge website

Additionally, stormwater runoff is discharged into the LCR at numerous locations. Urban stormwater from Trail, Rossland, and Warfield discharges to the LCR via Trail Creek (Golder, 2007c). An unknown volume of runoff from highways, roads, railways, historical mine works, sawmills, pulp and paper mills, and transmission lines may also affect the LCR. Furthermore, runoff from other industries and agricultural developments can impact the LCR.

2.2.3 Operational Improvements

Teck has undertaken a series of facility improvements that have had a positive effect within the receiving environment. These include:

- 1981: effluent treatment plant
- 1981: stripped zinc electrolyte was routed to fertilizer plant instead of river discharge
- 1982: mercury removal plant constructed
- 1991: construction of a drainage control system to route wash water and stormwater to the effluent treatment plant

- 1993: Heat exchanger installed in lead smelter
- 1994: Phosphate-based fertilizer production was terminated
- 1995: cessation of slag discharge to the LCR
- 1997-98: installation completed and operation of KIVCET flash lead smelter commenced
- 1997-98: seepage collection system along Stoney Creek
- 2003: a closed industrial landfill adjacent to Stoney Creek was capped with an engineered membrane
- 2005: arsenic-containing wastes adjacent to Stoney Creek were consolidated in a permanent storage facility.
- 2013-2014: removal of metals-impacted sediment from a former iron-ore roaster residue discharge area on the LCR right bank south of Stoney Creek.
- 2015: mitigation of metals-impacted sediment on a 90 m section of Stoney Creek downstream of Highway 22.
- 2016: Mitigation on Haley Creek to control sediment transport to Trail Creek
- 2016: construction and commissioning of Phase 1 of the TMO groundwater remediation system to intercept groundwater discharge to the Columbia River adjacent to the smelter.
- 2019: commissioning of CIV outfall retention and holding reservoirs.
- 2020: construction and commissioning of CII Stormwater Management project.
- 2020: construction and seasonal operation of Phase 1 of the Annable groundwater remediation system to intercept a groundwater discharge to Trail Creek.
- 2021: construction of a permeable reactive barrier in Haley Gully to mitigate metals-impacted groundwater discharge to Haley Creek.

2.3 Flow Regulation and Dynamics of the LCR

Flow regulation by BC Hydro from the Hugh L. Keenleyside (HLK) and Brilliant Dams is a key determinant of LCR condition. Changing river flows influence water quality and affects a range of co-variate parameters including substrate submergence or stranding, velocity, turbulence, sediment transport, and light penetration, all of which were considered in the previous AREMP reports (Hawes et al., 2014 and Hawes et al., 2019), and further investigated herein. Consequently, river flow is an important driver of benthic community development in all running waters.

2.4 Effluent Plume Geometry

Distribution of effluent is governed by fluid dynamics in the LCR. A CORMIX plume delineation model was developed for Trail smelter effluent in 2012 (Golder 2012b) and subsequently evaluated by water quality sampling and spatial analysis (Hawes and Larratt 2014). The CORMIX model (Golder 2012b) predicted that metal concentrations in outfall plumes would be diluted to near upstream (background) concentrations within the distances outlined in Table 2-2.

A Rhodamine-B dye tracer study during low flows in April 1997 and a study by Hawes et al. (2015) both showed faster attainment of 1% dilution than the CORMIX model predicted. At Old Trail Bridge, water quality transect sampling indicated that the CII effluent plume at low flows was approximately 60 m wide as opposed to the predicted 35 m width. With increased plume diffusion, field measurements indicated a mixing ratio of about 200:1 (0.5% effective dilution) (Hawes et al. 2015).

Table 2-2: Teck Trail smelter estimated effluent plume dimensions during Columbia River low flow periods (Golder 2012b).

Discharge Name	Discharge Type under normal LCR Flows	Monitoring Parameters	CORMIX predicted plume dimensions at Low Flow 1% dilution
Combined CII	Multi-port diffuser	Cd, Cu, Hg, Pb, Zn, pH	1300 m long x 35 m wide
Combined CIII	Multi-port diffuser	TSS, Zn, As, Pb, Cd, Hg, Cu, Tl, pH	1700 m long x 20 m wide
Combined CIV	Multi-port diffuser	Hg, NH_3, Zn, pH	25 m long x 9 m wide
Stony Creek	Surface Discharge		130 m long x 8 m wide
Groundwater	Sub-surface plume		near CII and CIII discharges (see Schedule A for maps)

As noted in Section 2.2.1.1, a comprehensive review of effluent permit PE-2753 is underway and includes updated plume mapping and modelling. Plume delineation based on specific conductivity readings was carried out in 2021 during summer high LCR flow and fall low LCR flow conditions. For the purposes of the AEMP, the plume mapping results confirm that water quality and community sampling locations are appropriate. The effluent plume hugs the right bank (~1/3 channel width or approximately 60 m) through to the downstream end of the IDZ.

AEMP water quality sample locations were selected based on the modelled and field mapped plume geometry. Sample locations and AEMP scope will be re-evaluated as part of the ongoing Comprehensive Review of Permit 2753.

3.0 PROJECT SCOPE AND MANAGEMENT QUESTIONS

Methods for the AEMP data collection and interpretation adapt the Proposed Study Design for Teck Trail Smelter AREMP (Golder 2012a) with data collection beginning in fall 2012. Changes to the program recommended in 2014 were subsequently implemented.

Table 3-1: AEMP data collection schedule as per Permit 2753.

Report	Sampling Components	Frequency and Next Year of Sampling
Annual Report	Water quality sampling events: • Spring low-flow • Summer moderate to high-flow (between June 1-July 30) • Fall low-flow	Annual
AEMP 3-year Cycle	• Water quality sampling and trend analysis • Benthic invertebrate community analysis (in depositional and erosional habitats) • Sediment quality monitoring • Periphyton	3-year cycle: • 2021 • 2024
AEMP 6-year Cycle	• Water quality sampling and trend analysis • Benthic invertebrate community analysis (in depositional and erosional habitats) • Sediment quality monitoring • Periphyton • Small-bodied fish tissue analysis and condition assessment • Large-bodied fish tissue analysis	6-year cycle: • 2021 • 2027

This 2021 AEMP consists of five components plus data management (Table 3-2).

Table 3-2: Components of the Teck Aquatic Effects Monitoring Program.

Water Quality
Sediment quality of depositional areas
Periphyton
Depositional Habitats
Erosional Habitat
Benthic invertebrates
Depositional Habitats
Erosional Habitat
Small-bodied (sculpin) fish condition metrics and tissue metals
Large-bodied (Mountain whitefish, Rainbow Trout, Walleye) fish condition metrics and tissue metals

3.1 Water Quality

The water quality program component is a long-term monitoring program designed to evaluate potential effects of Teck's permitted effluent discharges on the LCR. The Columbia River Integrated Environmental Monitoring Program (CRIEMP) implemented a Lower Columbia River Water Quality Objectives Monitoring Program from 1997-2005 (Hatfield 2008). This program and the Aquatic ERA (Golder 2007) collected significant water quality data, and together with the AEMP, these efforts document LCR water quality over time, encompassing environmental improvements at the smelter, changing water quality objectives or guidelines, and water sample collection and analytical techniques.

Key water quality questions posed in Golder (2012a) and to be answered by the AEMP are:

Q1. Are Provincial Water Quality Objectives attained at the downstream end of the Initial Dilution Zone during low flows (less than 40 kfcs/1133 m^3/sec) as per long-term trend monitoring (e.g., CRIEMP, BC ENV)?

Q2. Does water quality in the study area vary spatially between locations in the LCR including point source and reference sites (both horizontal and vertical), and temporally between seasons and years as a result of Teck's point source effluent discharges and if so, describe the variances?

Q3. Are water quality parameters that are analyzed at the AEMP sites appropriate?

The AEMP study design recommended that water samples be collected near the shoreline as well as within the water column at specified transect locations, and. throughout different seasons within years and events between years. To help assess potential effects of smelter discharges, control sites upstream of any influences of the smelter effluent outfalls (e.g., Birchbank) were also included. Water quality sampling events are required to take place during the following seasonal flow conditions:

- Spring low-flow
- Summer moderate to high-flow (between June 1st and July 30th)
- Fall low-flow

3.2 Depositional Habitats

The objective of the AEMP depositional habitat component is to assess potential effects of Teck Trail Operations' permitted effluent discharges on depositional benthic communities by comparing benthic invertebrate structure and composition between areas upstream (reference) and downstream (exposure) of the smelter. Depositional areas may be affected by other metal sources in the LCR, and make up about 0.1% of the study area. Specific study questions for this component include:

Q1. What is the sediment quality in the depositional areas upstream and downstream of the smelter?

Q2. Are the benthic invertebrate communities in depositional sediments downstream of the smelter different from the upstream communities in terms of abundance, species diversity and/or species composition?

Q3. If differences in benthic communities exist, do these differences suggest adverse effects (i.e., impairment of benthic communities such that they provide poor habitat to upper trophic consumers) and is this linked to current permitted effluent discharges?

For purposes of this study, adverse effects were defined as statistically significant differences in abundance, species diversity and species composition to values outside the normal range such that periphyton and benthic communities may be impaired and provide poor nutrition to upper trophic consumers. The normal range was calculated as the variation among reference upstream sites plus/minus two standard deviations of the mean of multiple reference areas. Values outside of this normal range are, for purposes of this report, considered outside the range of natural variability and therefore indicative of potential effects on benthic communities. This definition of adverse effects aligns with earlier work (Golder 2012a).

Sediment quality for benthic invertebrates is a component of this program, and sediment quality was assessed at three reference and seven exposure sites.

Metals are known to have the potential to influence biological communities in riverine ecosystems (Jones and Bennett 1986; Solomon 2008, Luoma et al. 1997). Benthic invertebrates are often used as indicator species because their community structure and diversity are affected by substrate, water quality, velocity, desiccation/drying on regulated systems like the Columbia, distance downstream of a point discharge, etc.

3.3 Erosional Habitats

The primary objectives of the erosional habitat sampling are to assess effects of effluent discharges on benthic invertebrate and periphyton communities in these habitats. Specific study questions are:

Q1. What is the difference in periphyton communities in erosional habitats downstream of the smelter compared to the upstream communities in terms of periphyton community structure, composition, and standing crop biomass?

Q2. What is the difference in the benthic invertebrate communities in erosional habitats downstream of the smelter compared to the upstream communities in terms of community structure and composition?

Q3. On the basis of qualitative review, is there a trend in periphyton and benthic metrics over time?

This aspect of the work program is similar to the depositional habitat program and focuses on identifying potential impacts of effluent discharges by looking for observed changes in community structure and diversity in periphyton and benthic communities.

3.4 Small-bodied Fish

The small-bodied fish sampling program frequency was extended to a 6-year cycle from a 3-year cycle to reduce population burdens associated with lethal sampling for tissue analysis and condition metrics. The small-bodied fish program was developed by Ecoscape (2013) after the original AEMP study design. The following are the key questions and a brief summary of how the AEMP addresses them:

Q1. Is there a difference in tissue metals concentration in small-bodied fish between reference sites and exposure sites downstream of the smelter?

Q2. Do tissue metal concentrations decrease in small-bodied fish as the distance from the smelter effluent discharge increases?

Q3. Is there a difference in the length, weight, liver weight, gonad weight and condition of fish collected upstream of the smelter and downstream of the smelter?

Q4. What is the relationship between the distance from the effluent discharge and tissue metals, condition factor, liver weight (hepatosomatic index) and gonad weight (gonadosomatic index).

The study addresses differences in metal accumulation in small fish tissue based on species with short home ranges. Sample sites coincided with previous metals analysis work completed for the smelter including benthic analysis, water quality, and large bodied fish tissue analysis.

3.5 Large-bodied Fish

The large-bodied fish sampling program frequency was extended to a 6-year cycle from a 3-year cycle to reduce population burdens associated with lethal sampling for tissue analysis and condition metrics. Primary objectives of this component are to assess potential effects of effluent discharges, particularly metals concentrations, on fish tissues (measured in fillets, whole fish samples, and gut contents).

Specific study questions are:

Q1. How do the concentrations of metals in the tissues of three large-bodied fish species in 2021 compare to concentrations since 2000?

Q2. Do large-bodied fish tissue concentrations exceed relevant human consumption guidelines?

The tissue sampling program is intended to document the current tissue metal concentrations in large-bodied fish in the LCR. Fish aging and condition assessments are a key component of this work program and were completed as part of the Lower Columbia River Fish Indexing Program (Ford and Thorley, 2011).

4.0 WORKPLAN OVERVIEW

The data collection methods in 2021 repeated those followed in the previous AEMP cycles in 2012, 2015, and 2018. The workplan overview is summarized below. Samples sites for all components of the AEMP are shown in **Schedule A** (map sheets) and the **Technical Methods** for data collection and analysis are provided in **Appendix A**.

4.1 Water Quality

Metals of Interest for water quality are identified in Table 4-1. Three sampling programs were employed in the LCR in the spring, summer, and fall of 2021.

Spring sampling is intended to target low flow periods when there is a higher probability of BC Water Quality Guideline exceedances due to reduced dilution capacity of the river. This sampling allowed the calculation of 30-day averages from five weekly grab samples from the right bank sites and allowed comparison to BC WQG.

Summer high-flow sampling consists of grab samples from the right bank to demonstrate the effect of increased flows on dilution and to contrast with spring low flow concentrations.

Fall transect sampling across the river at each sample site during fall low flows monitors the spatial extents of the plume and aligns with the aquatic community sampling program.

Water quality monitoring sites include:

- Birchbank – upstream Reference Site (9.7 km upstream of smelter).
- Stoney Creek – 100 m downstream of Stoney Creek confluence and CIV outfall (within the IDZ near upstream end)
- New Trail Bridge – Beneath or as close to the Bailey Street bridge as safely practicable, within the IDZ (250 m downstream of the CII effluent outfall).
- Old Trail Bridge – 20 m upstream of the Old Trail Bridge, marks end of IDZ (1.1 km downstream of CII effluent outfall).
- Maglios – 4.2 km downstream of the IDZ. This site was added in the 2014 sampling program to demonstrate near to full mixing of the effluent plume by this location as opposed to Waneta, which is 10 km further downstream.
- Waneta – 15.8 km downstream of smelter, above Pend Oreille River confluence.

Both BC WQG (2021) and LCR Water Quality Objectives were used to evaluate water quality in this report. Guidelines are set at levels designed to result in negligible risk to biota, their functions, or any interactions that are integral to sustaining the health of ecosystems and the designated resource uses they support (CCME 2013; BC ENV 2021). Similarly, objectives are specific criterion adapted to protect the most sensitive designated water use at a specific location with an adequate degree of safety, taking local circumstances into account (BC ENV 2021). An exceedance of a water quality guideline or objective does not necessarily mean that there will be effects on aquatic species.

Analysis of trends was conducted using flow-weighted mean concentrations (FWMC) of the five spring R-sh samples from 2012-2021 (Appendix L).

Table 4-1: Matrix for Determining Water Quality Metals of Interest.

Metal	Metals of interest identified in previous reports	Near-field sites >> reference sites in earlier work (2011-14)	Near-field sites >> reference sites in recent 2015-16 work	Guideline exceedance during past 10 years in LCR AOI
Aluminum				✓
Arsenic	✓	✓		✓
Cadmium	✓	✓	✓	✓
Chromium	✓			✓
Copper	✓	✓		✓
Lead	✓	✓	✓	✓
Mercury	✓	✓	✓	✓
Nickel	✓			✓
Selenium		✓	✓	✓
Silver	✓			
Thallium	✓	✓	✓	
Zinc	✓	✓		✓

(Previous reports: Golder 2003, Hatfield 2008, Golder 2010)
>> signifies a difference of >50% this table uses new cadmium guideline

4.2 Sediment Quality Monitoring

Sediment samples and supporting parameters were collected at ten depositional sites, that included three reference sites, upstream of the smelter, and seven exposure sites downstream of the smelter (Schedule A: Maps, Appendix F). Samples from each site were analyzed for total metals in both the <2mm, and <63µm sediment fractions.

4.3 Periphyton Communities

To determine the effects of effluent discharges on primary production, community structure, and diversity, periphyton were sampled above and below the smelter in the AOI.

Depositional Habitats

In depositional habitats, periphyton were sampled at the same ten sites sampled for depositional sediment quality monitoring.

Erosional Habitats

Periphyton communities were sampled in erosional sites above and below the smelter to determine the influence of the smelter on periphyton communities and production. Sampling focused on cobble-sized substrates in sites that had similar water depth, flow, velocity, and substrate size, and the periphyton monitoring program was aligned with the benthic monitoring program for erosional sites, which included two reference areas and five exposures areas. Exposure areas were further divided into near-field sites along the right bank of the IDZ (IDZ RB), and far-field sites that occur beyond the extent of the effluent plume and downstream of the IDZ where the effluent is more thoroughly mixed with the LCR. Depositional sites were not categorized and analyzed this way because there are no depositional sites within the near-field IDZ RB.

4.4 Benthic Invertebrate Communities

The benthic invertebrate monitoring program focused on assessing impacts of effluent discharges on benthic invertebrate communities and their habitats. Benthic invertebrates were collected and identified and habitat attributes, such as substrate size and water velocity, were recorded.

Depositional Habitats

Ten depositional areas, three reference areas above the smelter effluent discharge and seven below, were sampled in 2021.

Erosional Habitats

Two reference areas upstream of the smelter and five exposure areas (further stratified as outlined in 4.3 above) downstream of the smelter were sampled for benthic invertebrates. Habitat attributes were also surveyed at each site.

4.5 Analysis of Periphyton and Benthic Invertebrate Community Response

The responses of periphyton and benthic invertebrate communities to exposure to the smelter effluent discharge were analyzed with multiple statistical approaches. Community metrics were modelled with chemical and physical variables, as well as year and treatment to determine changes in community over time. Modelling of habitat attributes helped determine factors influencing community compositions of periphyton and benthic invertebrates (Appendix A).

4.6 Small-bodied Fish Condition and Tissue Metals

To determine the effect of effluent discharges on small-bodied fish, tissue metal concentrations and condition indices were measured in sculpins from reference areas above and exposure areas below the smelter outfalls. Fish were sampled from the left and right banks of the river to determine the effects of plume dilution on tissue metals concentrations.

4.7 Large-Bodied Fish Condition and Tissue Metals

Rainbow Trout, Mountain Whitefish, and Walleye tissue metal concentrations and condition indices were measured to determine the impact, if any, of the smelter. Fish were sampled from reference areas above and exposure areas below the effluent discharge (Appendix A).

4.8 Analysis of Fish Condition Indices and Tissue Metals

Fish condition indices were modelled with treatment (reference and exposure) and distance to the outfall to determine the influence of the smelter on fish condition. Tissue metals concentrations of whole small-bodied fish and whole, fillet, and gut samples of large-bodied fish were analyzed. Small-bodied fish tissue conditions were modelled with treatment (reference and exposure) and year to determine smelter impact and changes over time. Large-bodied fish were modelled with treatment, year, and species to determine the effect of the smelter on fish metal tissue concentrations. Metal concentrations are presented with human consumption guidelines and TRO for wildlife consumers of fish.

5.0 RESULTS AND DISCUSSION

5.1 Water Quality

Five sampling events were conducted in the spring on March 11, March 12, March 17, March 18, and March 29, 2021. This sampling period allowed the calculation of long-term (30-day) and short-term allowable concentrations for the spring low flow period. A grab sample event during the summer high flow period was carried out on July 20-21, 2021. The fall low flow transect samples were collected on October 19-20, 2021.

Figure 5-1 illustrates the LCR hydrograph from 2021 to highlight the variability in flows during the sampling events. This figure also displays hydrographs and water quality sample events from the previous AEMP community sample years (2012, 2015, and 2018).

Table 5-1 highlights the sample dates and corresponding sites along with river flows (at Birchbank) on those days.

Table 5-1: 2021 water sample collection dates and corresponding sites.

Sample Date	LCR Flows (m^3/s (at Birchbank))	Sample Site
March 11	1,090	Right Bank Shallow (R-sh)
March 12	1,020	Right Bank Shallow (R-sh)
March 17	1,020	Right Bank Shallow (R-sh)
March 18	1,000	Right Bank Shallow (R-sh)
March 29	889	Right Bank Shallow (R-sh)
July 20-21	2,735	Right Bank Shallow (R-sh)
October 19-20	1,080	Full Transect

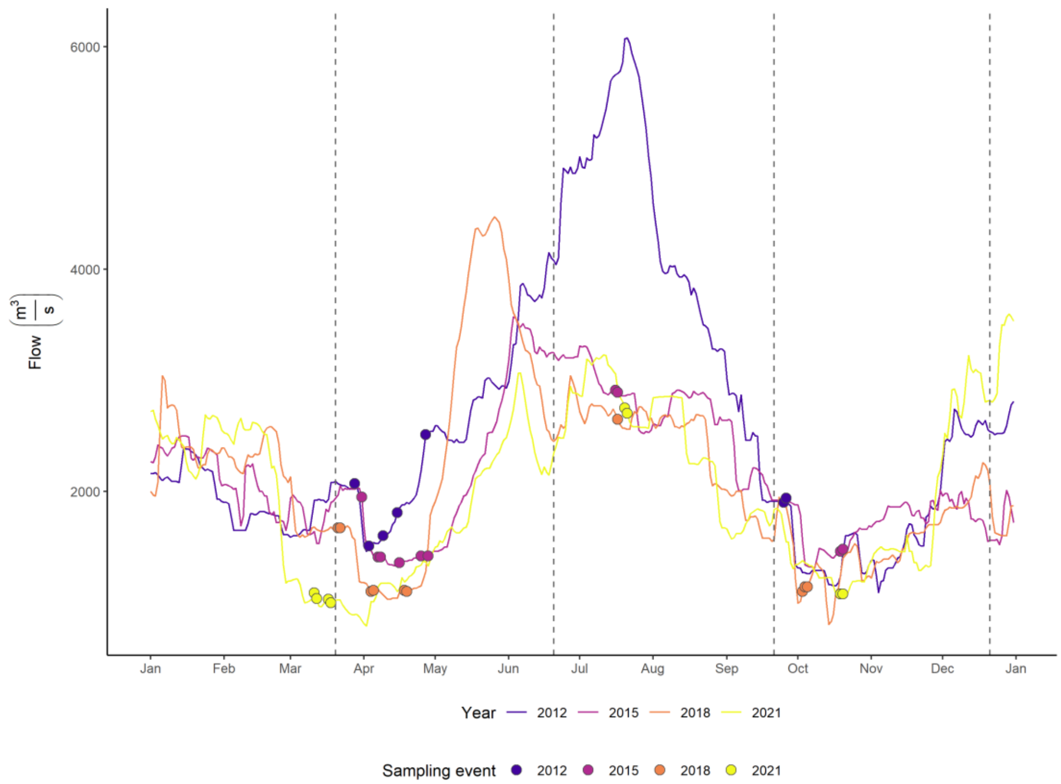


Figure 5-1: Lower Columbia River flows and the spring, summer and fall AEMP water sampling periods for 2021 as well as previous AEMP community sampling years. Flow data are based on Birchbank Station (08NE049) from Water Survey of Canada.

5.1.1 In-situ Water Quality Parameters

Field-measured parameters that were slightly elevated within the IDZ including temperature, conductivity, salinity, and TDS (Table 5-2). During summer high flows, increased dilution from the LCR results in smaller differences between in-situ parameters measured in the IDZ relative to background and downstream measurements. Overall, the in-situ water quality parameters measured in 2021 were within the typical range for the LCR both upstream and downstream of the IDZ (Larratt et al. 2013).

In both the IDZ and the entire AOI, none of the in-situ measured water quality parameters exceeded LCR Water Quality Objectives in the 2021 data.

Turbidity in samples collected in 2021 were all less than 2 Nephelometric Turbidity Units (NTU). Similarly, TSS concentrations in samples collected in 2021 were below the 3.0 mg/L field and laboratory detection limit.

There are no approved BC guidelines for the protection of aquatic life or LCR Objectives for specific conductivity or TDS. During low flows, New Trail Bridge and community sampling sites ERO-EXP-2-2 and ERO-EXP-2-3 had elevated TDS (115-116 mg/L) compared to TDS measured at the Birchbank reference site and sites downstream beyond the IDZ (99.4 and 100.4 mg/L respectively). Similarly, water temperature was about 1 degree warmer (14°C) at ERO-EXP-2-2, ERO-EXP-2-3, and ERO-EXP-3-1, compared to upstream reference sites that were around 13 °C. The mean and maximum water temperatures recorded at ERO-EXP-2 and ERO-EXP-3 sites did not exceed the BC maximum daily temperature guideline of 15°C for watercourses with Bull Trout (BC ENV 2001) during spring or fall sampling periods. Summer LCR water temperatures exceeded the daily temperature guideline for Bull Trout at all sites including the background.

Table 5-2. Average in-situ water quality parameters measured during spring low flow sampling. Samples were collected Mar 11, 12, 17, 18, and 29 at right bank shallow (R-sh) locations.

Parameter	Birchbank	Stoney Creek	New Trail Bridge	Old Trail Bridge	Maglios	Waneta
Temp (°C)	4.7	4.6	5.7	4.8	4.7	4.6
ODO (% Sat)	102.6	102.24	104.84	103.38	103.12	102.72
ODO (mg/L)	13.214	13.184	13.158	13.276	13.276	13.242
Sp.Cond (µS/cm)	153.12	153.62	177.86	157.14	154.44	154.52
Cond (µS/cm)	93.62	93.76	112.16	96.42	94.46	94.36
TDS (mg/L)	99.4	99.7	115.5	102.3	100.4	100.4
Sal (psu)	0.07	0.07	0.08	0.07	0.07	0.07
pH	7.05	7.32	7.31	7.26	7.27	7.31
ORP (mV)	249.42	273.36	255.15	268.64	270.36	266.54
Turbidity (FNU)	0.0	0.0	0.0	0.0	0.0	0.0

Table 5-3. In-situ water quality parameters during summer (July 20-21) high flow sampling at right bank shallow (R-sh) locations.

Parameter	Birchbank	Stoney Creek	New Trail Bridge	Old Trail Bridge	Maglios	Waneta
Temp (°C)	16.7	16.8	17.1	16.3	16.8	16.1
ODO (% Sat)	112.20	111.40	111.40	110.50	109.90	110.00
ODO (mg/L)	10.90	10.82	10.74	10.85	10.65	10.83
Sp. Cond (µS/cm)	129.40	129.50	132.40	130.50	128.60	129.70
Cond (µS/cm)	108.90	109.10	112.50	108.70	108.60	107.70
TDS (mg/L)	84.0	84.0	86.0	85.0	84.0	84.0
Sal (psu)	0.06	0.06	0.06	0.06	0.06	0.06
pH	8.31	8.34	8.44	8.27	8.42	8.25
ORP (mV)	156.80	134.80	67.10	68.10	67.70	59.10
Turbidity (FNU)	0	0	0	0	0	0

Table 5-4. In-situ water quality parameters during fall (Oct 19-20) low flow sampling at right bank shallow (R-sh) locations.

Parameter	Birchbank	Stoney Creek	New Trail Bridge	Old Trail Bridge	Maglios	Waneta
Temp (°C)	11.8	11.8	12.3	11.6	11.8	11.8
ODO (% Sat)	95.2	95.7	97.6	95.2	95.9	94
ODO (mg/L)	10.31	10.37	10.43	10.35	10.39	10.18
Sp. Cond (µS/cm)	125.2	125.8	142.6	128	126.7	127.1
Cond (µS/cm)	93.6	94	108.2	95.3	94.7	95
TDS (mg/L)	81	82	93	83	82	83
Sal (psu)	0.06	0.06	0.07	0.06	0.06	0.06
pH	7.89	7.82	7.72	7.85	7.88	7.85
ORP (mV)	83.9	86.1	85.7	76.9	86	92.7
Turbidity (FNU)	0	0	0	0	0	0

5.1.2 Nutrients

5.1.2.1 Inorganic Nitrogen

There are numerous sources of inorganic nitrogen within the LCR, including municipal effluents, lake fertilization programs in upstream reservoirs, and stormwater inflows (MacDonald 1997; Can-BC 2008). Nitrate and ammonia are key nutrients that are consumed, transformed, and released in a cycle as water travels downstream. Ammonia and nitrate account for most of the total nitrogen concentrations in the LCR AOI, with very low nitrite concentrations (Figure 5-2).

None of the 2011-2020 or 2021 samples approached inorganic nitrogen guidelines for aquatic life (3.0 mg/L nitrate as a long-term average; 0.02 mg/L nitrite; 0.7 mg/L ammonia) (Figure 5-2). In the LCR, the distribution of inorganic nitrogen species has been stable through the years (Olson-Russello et al. 2014). Inorganic nitrogen averages 86% nitrate and 14% ammonia. Nitrate concentrations are related to transport during high flows and ammonia concentrations are primarily donated by groundwater throughout the river, with increased donation during low flows (Larratt et al. 2013).

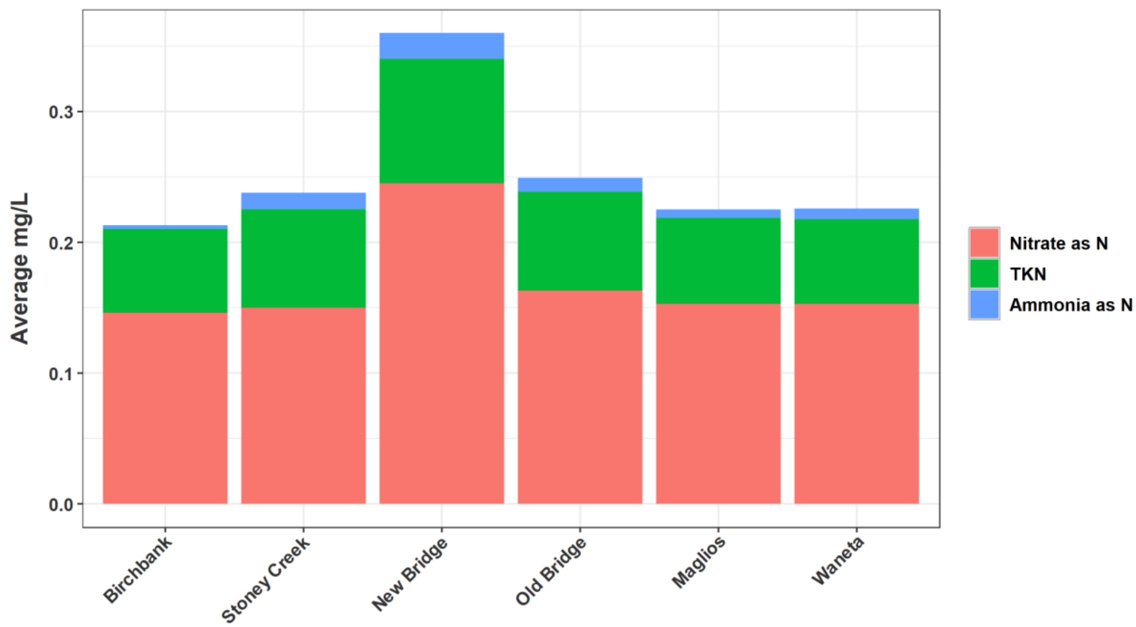


Figure 5-2: Average concentration of nitrogen forms for samples collected along the right bank shallow site of the LCR in 2021 during spring low flows.

Nitrate concentrations were elevated at New Trail Bridge but returned to near-background levels by Old Trail Bridge at the downstream end of the IDZ (Figure 5-3). The long-term average nitrate concentration from the right shallow samples at Birchbank reference site was 0.146 mg/L. At New Trail Bridge, nitrate concentrations increased to 0.245 mg/L and then dropped to 0.163 mg/L at Old Trail Bridge and down to 0.153 mg/L at Maglios and Waneta sites (Table 5-5; Figure 5-3). The maximum recorded nitrate concentration was at New Trail Bridge measuring 0.290 mg/L in the March 31, 2021 sample.

Nitrite is a transient form of inorganic nitrogen, explaining why 87% of the nitrite concentrations were below standard detection limits in 2021 during the spring low flow sampling. Nitrite was only detected in two New Trail Bridge samples, one Old Trail Bridge sample, and one Maglios sample (Figure 5-4). None of the concentrations were close to the short or long-term guidelines.

Elevated ammonia concentrations occurred within the IDZ in shallow samples from both banks (Appendix M) which may be a result of groundwater influence and/or CIII effluent discharge. Groundwater that is intercepted by Phase 1 of the Teck Trail Operations groundwater remediation system is treated to convert ammonia to nitrate prior to discharge through C-III.

Ammonia concentrations in shallow samples declined downstream of the IDZ, with a faster rate of decline in R-sh than L-sh samples. Transect ammonia samples were equivalent across the river at Maglios (Appendix M; Larratt et al. 2019). Ammonia guidelines were not exceeded at any sample sites and 23% of 2021 low flow water quality samples were below the limit of detection for ammonia (Table 5-5).

Contributions made by organic forms of nitrogen measured since 2014 have been small (Figure 5-6). They were measured as TKN that also includes ammonia. Elevated TKN in R-sh and L-sh low flow samples may be related to groundwater influence, likely in the ammonia component of TKN (Appendix M; Larratt et al. 2019). Organic nitrogen increased in the IDZ and remained elevated downstream, but the net change was small and unlikely to exert a secondary influence on water chemistry.

In 2021, average total nitrogen concentrations at New Trail Bridge R-sh were close to 1.6 times higher than the reference Birchbank R-sh site (Table 5-5). However, total nitrogen declined downstream of the IDZ. The increase in total nitrogen between Birchbank and Waneta was under 8%.

Table 5-5: Nutrient Concentrations at LCR Sample Sites, right bank shallow sample (2021).

Analyte	BC Guideline or LCR Objective (mg/L)	Results (mg/L)ǂ	Birchbank	Stoney Creek	New Trail Bridge	Old Trail Bridge	Maglios	Waneta
Nitrate (as N)	32.8 (max)	Maximum	0.152	0.159	0.29	0.166	0.155	0.156
	3.0 (average)	Long-term Ave.	0.1456	0.1498	0.2446	0.163	0.1528	0.1528
Nitrite (as N)	0.06	Maximum	0.0005	0.0005	0.0031	0.0013	0.0011	0.0005
	0.02 (average)	Long-term Ave.	0.0005	0.0005	0.00112	0.0006	0.00062	0.0005
Ammonia, Total (as N)	0.681 – 27.7	Maximum	0.0067	0.0212	0.0261	0.0124	0.0086	0.0104
	0.102 – 2.08	Long-term Ave.	0.0025	0.01268	0.02128	0.01098	0.0062	0.0082
Total Kjeldahl Nitrogen	--	Maximum	0.08	0.097	0.13	0.112	0.079	0.077
	--	Long-term Ave.	0.059	0.0782	0.093	0.0676	0.0636	0.0636
Phosphorus (P)-Total	--	Maximum	0.0049	0.0048	0.006	0.005	0.0046	0.0042
	--	Long-term Ave.	0.00296	0.00308	0.0032	0.00284	0.0029	0.00332
Potassium (K)-Total	--	Maximum	0.675	0.677	0.753	0.695	0.691	0.695
	--	Long-term Ave.	0.6328	0.64	0.7186	0.6486	0.6412	0.6426
Sulfate (SO4)	--	Maximum	13.4	13.8	23	15	14	13.9
	218	Long-term Ave.	13.24	13.44	22.18	14.84	13.84	13.82
Total Organic Carbon	--	Maximum	1.26	1.25	1.26	1.31	1.27	3.1
	--	Long-term Ave.	1.036	1.128	1.106	1.102	1.14	1.074

ǂ long term average based on the average of 5 samples collected within 30 days during spring low-flow sampling (Mar-Apr).

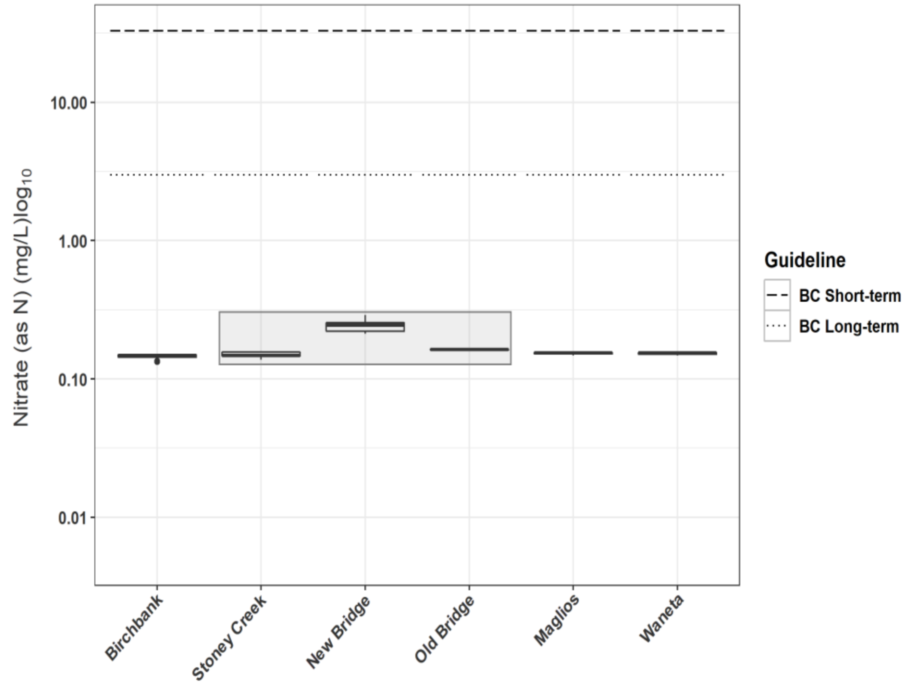


Figure 5-3: Box plots of total nitrate (as N) measured in R-sh position in March 2021. The grey box represents the Initial Dilution Zone. No samples were below the limit of detection for nitrate.

Note: See page vi for explanation of boxplots and guide for interpretation.

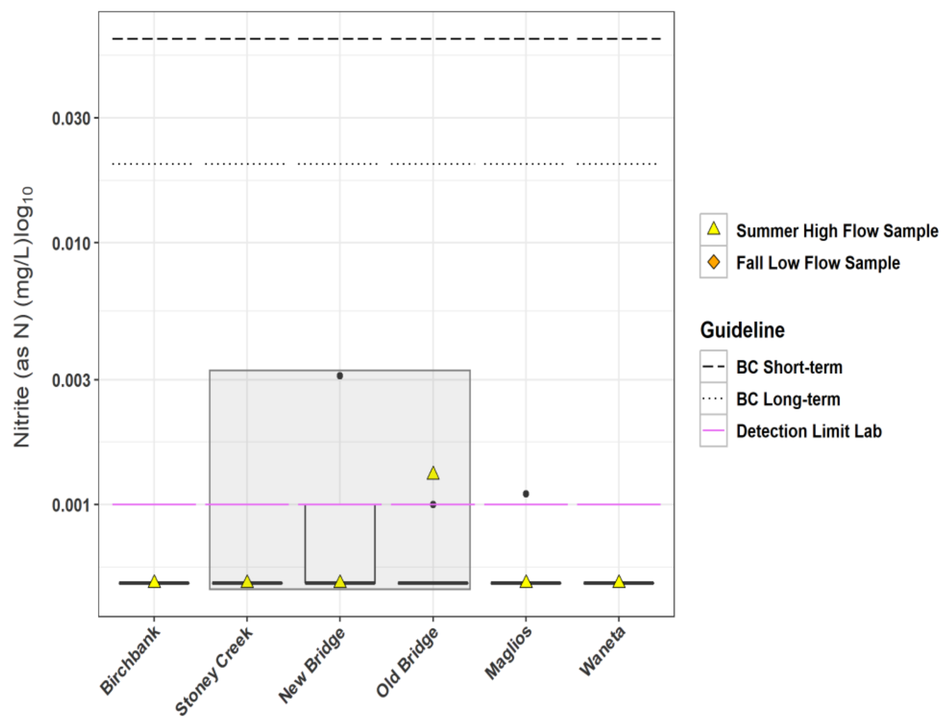


Figure 5-4: Box plots of total nitrite (as N) measured in R-sh position in March 2021. Points correspond to 2021 fall and summer R-sh samples. The grey box represents the Initial Dilution Zone. 87 percent of samples were below the detection limit for nitrite. Samples that were < lab detection limit (D.L.) are shown on the graph at concentrations that are ½ D.L. Fall samples were not analyzed for total nitrite.

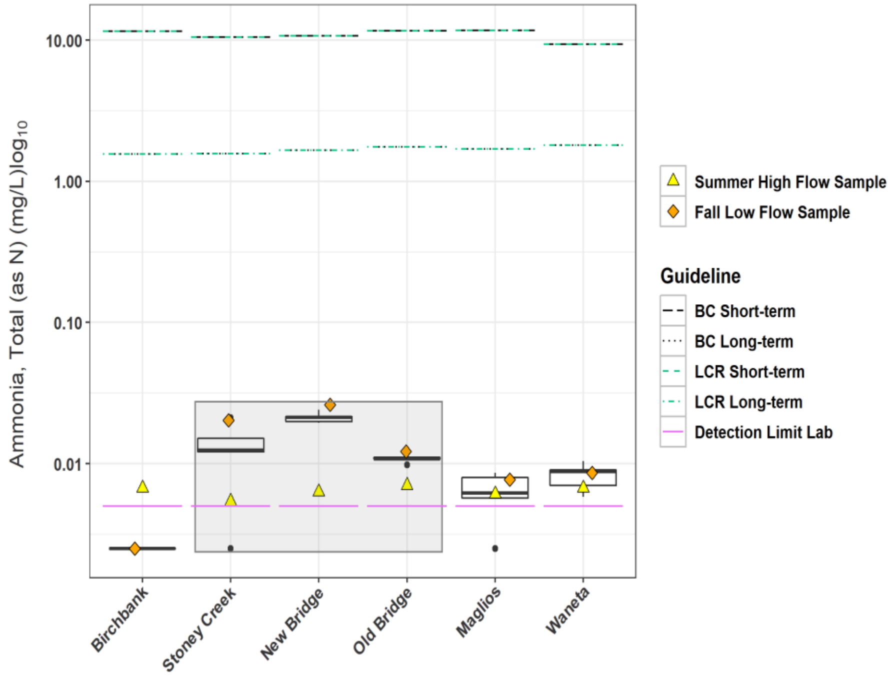


Figure 5-5: Box plots of ammonia (as N) measured in R-sh position in March 2021. Points correspond to 2021 fall and summer R-sh samples. The grey box represents the Initial Dilution Zone. 23 percent of spring low flow samples were below the limit of detection for ammonia. The Guideline varies at each location because it is a calculation based on pH and water temperature. Samples that were < lab detection limit (D.L.) are shown on the graph at concentrations that are ½ D.L.

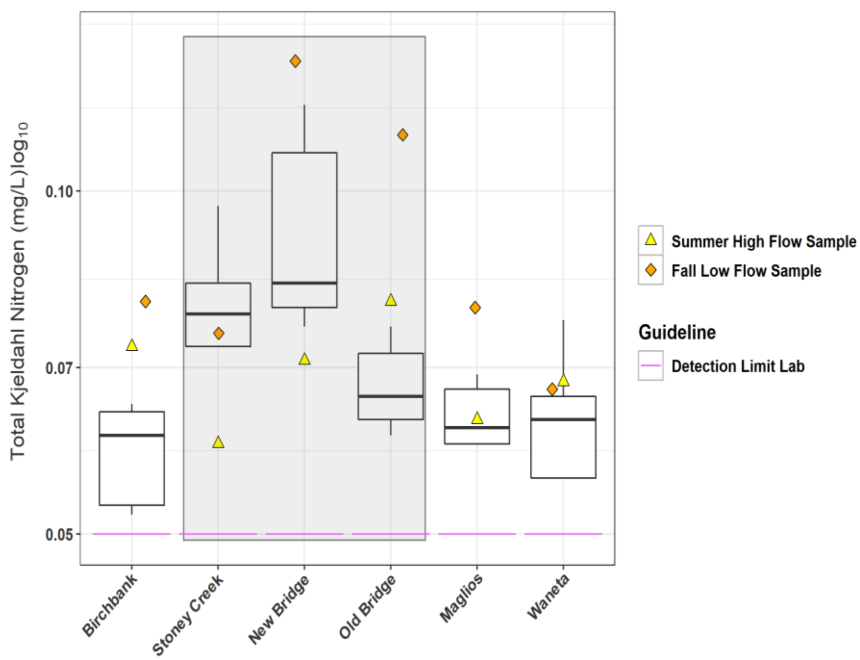


Figure 5-6: Box plots of TKN organic nitrogen measured in R-sh position in March 2021. Points correspond to 2021 fall and summer R-sh samples. The grey box represents the Initial Dilution Zone. There are no BC water quality guidelines or LCR water quality objectives for TKN.

5.1.2.2 Phosphorus

Phosphorus is a key nutrient that usually controls aquatic productivity. Total phosphorus (T-P) concentrations measured throughout the LCR follow a declining trend over the years, particularly during 1968 – 1978 (Holmes and Pommen 1999; Can.-BC 2008) as outfall water treatment improved throughout the LCR. Phosphorus is added annually as part of lake fertilization programs in upstream Hydro reservoirs.

There is no phosphorus objective set for the LCR, and no provincial guideline for total phosphorus concentrations in rivers. The guideline range for lakes (0.005 to 0.015 mg/L), where salmonids are the predominant fish species, was therefore considered as a qualitative reference point, although it has not been empirically verified as being suitable for rivers. No total phosphorous concentrations exceeded the BC total phosphorous Guideline for lakes minimum guideline (0.005-0.015 mg/L) in spring low flow samples collected in 2021 (Figure 5-7). While the Guidelines are not applicable to the LCR riverine environment, these values demonstrate that the smelter does not appear to adversely affect phosphorus concentrations. No net change in total phosphorus concentrations was detected between Birchbank and Waneta in most years.

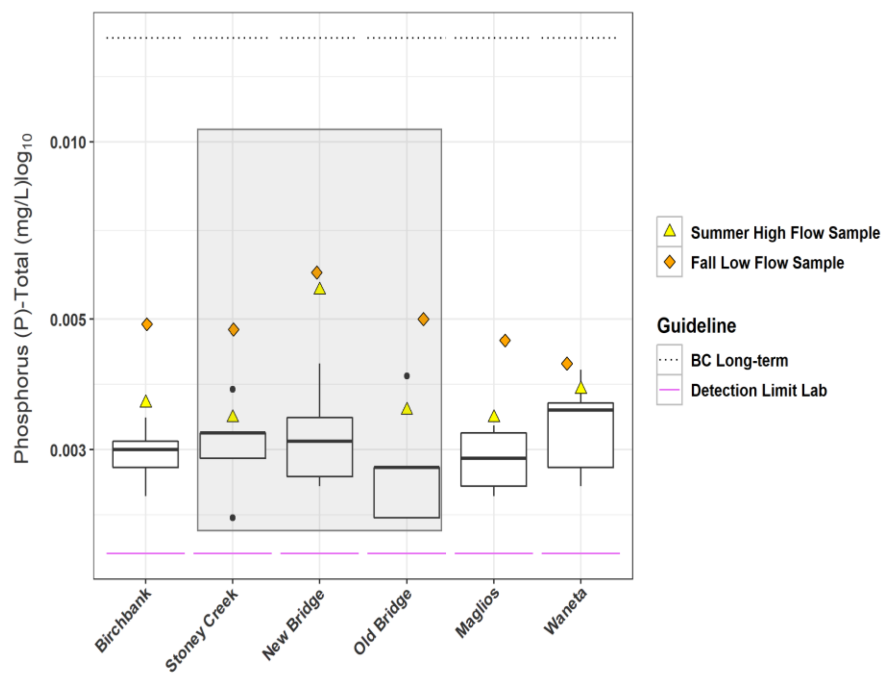


Figure 5-7: Box plot of total phosphorus concentrations measured in R-sh position in March 2021. Points correspond to 2021 fall and summer R-sh samples. The grey box represents the Initial Dilution Zone. No samples were below the limit of detection for total phosphorus.

5.1.2.3 Minor Nutrients

Potassium concentrations were elevated at New Trail Bridge R-sh and L-sh and may reflect a groundwater contribution (Appendix M; Larratt et al. 2019). There are no BC Guidelines or LCR Objectives established for potassium. Potassium samples from the end of the IDZ were similar to background reference concentrations. Stormwater and sewage effluent discharged below the smelter would also contribute to the increase in potassium observed in Maglios and Waneta samples.

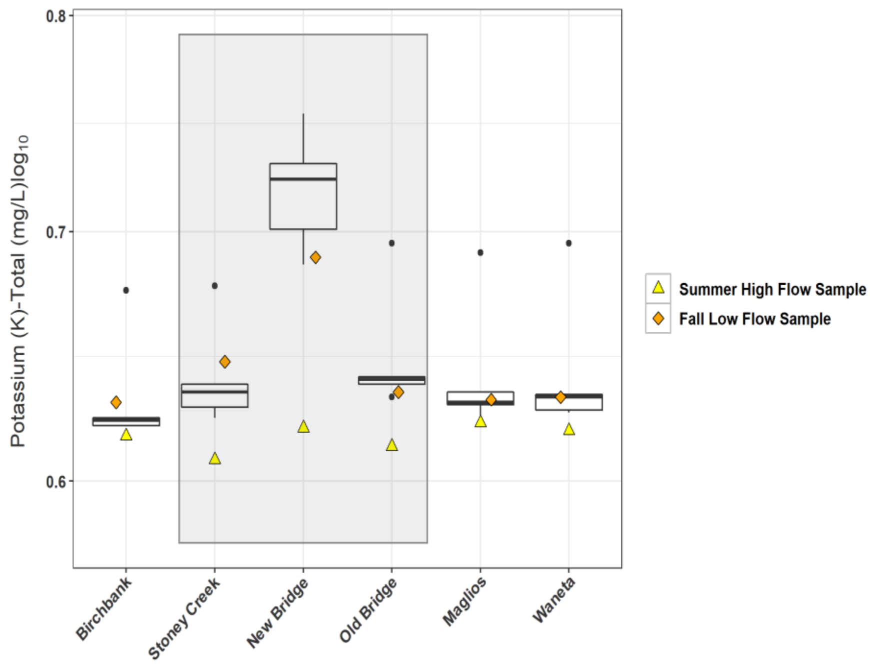


Figure 5-8: Box plots of potassium measured in R-sh position in March 2021. Points correspond to 2021 fall and summer R-sh samples. The grey box represents the Initial Dilution Zone. No samples were below the limit of detection for potassium.

Sulphate is utilized by some algae and bacteria in the periphyton (Wetzel 2001). Sulphate was the dominant anion in the AOI (Hawes et al. 2014) and is a notable parameter in the groundwater plume beneath the smelter (Golder 2010). The 30-day average guideline for the protection of aquatic life is 218 mg/L SO_4, in soft to moderately soft waters (31-75 mg/L as $CaCO_3$) typical of the lower Columbia River (Meays and Nordin 2013). This guideline was not exceeded in any 2015-2021 samples, (Appendix M). Sulphate 30-day average concentrations increased at New Trail Bridge along the right bank (avg. 22.18 mg/L SO_4) and returned to near reference concentrations (13.24 mg/L at Birchbank) by Maglios at 13.84 mg/L (Figure 5-9).

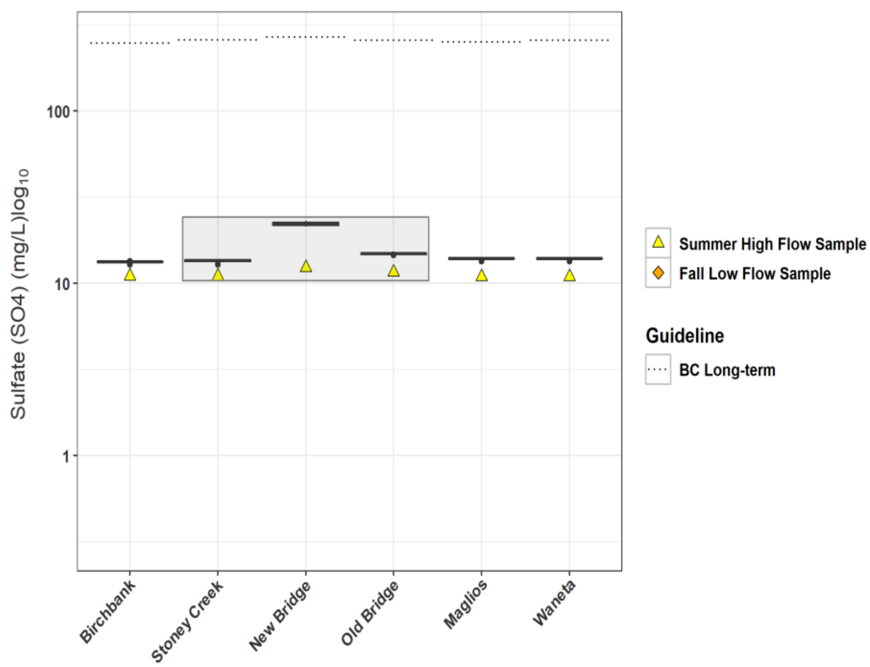


Figure 5-9: Box plots of sulphate concentrations measured in R-sh position in March 2021. Points correspond to 2021 summer R-sh samples. The grey box represents the Initial Dilution Zone. No samples were below the limit of detection for sulphate. Fall samples were not analyzed for sulfate.

Total organic carbon (TOC) provides an indication of organic material available for invertebrate food, and for sequestering metals. TOC is generally low in the LCR. The BC WQG prescribes a 30-day median within ±20% of the median background TOC concentration (MWLAP 2001), which was 1.07 mg/L at Birchbank in 2021. Based on this, the upper guideline concentration was 1.28 mg/L, and the lower guideline concentration was 0.86. mg/L.

The spring 30-day median values at all sites were within the BC WQG (Figure 5-10). TOC was not elevated in the effluent plume of the smelter, nor in the IDZ compared to sites outside the IDZ. Waneta had a fall low flow TOC concentration (3.10 mg/L) that was more than twice that measured through the IDZ or at Maglios. The reason for this singular elevated TOC concentration is not known.

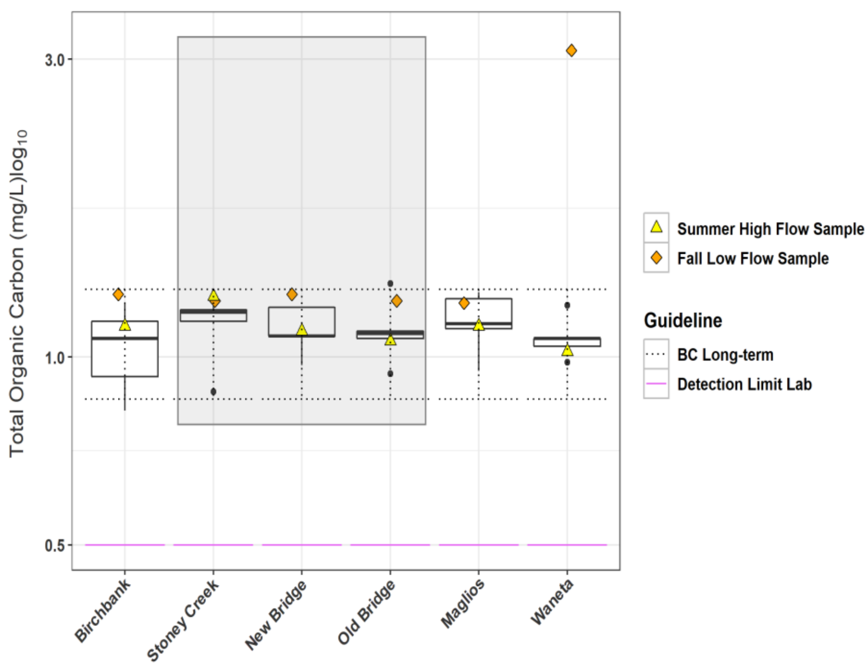


Figure 5-10: Box plots of TOC concentrations measured in R-sh position in March 2021. Points correspond to 2021 summer and fall R-sh samples. The grey box represents the Initial Dilution Zone. No samples were below the limit of detection for TOC.

5.1.3 Total and Dissolved Metal Concentrations

The following discussion of dissolved and total metals is focussed on metals of interest and discusses historical data and trends. Metals of interest were selected based on previous reports, and on significant differences between near-field and reference sites over the study years (Table 5-6). Complete water quality data are available in Appendix D. The box plots below present spring 2021 low flow sampling data.

Implementation of metals criteria is complex due to the site-specific nature of metals toxicity and variable metal behaviour. Canadian guidelines frequently use total metals, which is the sum of dissolved ions and metals associated with particulates or minerals, while the US EPA frequently uses dissolved metals. Studies have indicated that particulate metals appear to contribute to overall metal toxicity, but their contribution is substantially less than that of dissolved metals (US EPA MoU 1993).

Most figures in this report depict total metal concentrations (as opposed to dissolved metals) to align with BC WQG and LCR objectives; however, metals occurring mainly in particulate phases can frequently have lower potential toxicity. Numerous metals occurred predominantly in the dissolved form throughout the LCR (Table 5-6). Within the IDZ, cadmium and lead had an increased proportion of total concentrations in the dissolved phase.

Table 5-6: Percent of total analyte concentration accounted for by dissolved phase metals in the LCR in 2021 low flow samples. Missing values indicate that parameter concentrations were below the method detection limit.

	Average % dissolved metals in R-sh samples during low LCR flows					
Metal/Site	BB	SC	NB	OB	MA	WA
Aluminum	60%	56%	59%	52%	58%	57%
Arsenic	92%	95%	93%	88%	98%	94%
Cadmium	82%	75%	96%	84%	82%	81%
Copper	98%	100%	92%	96%	92%	96%
Lead	42%	19%	54%	30%	32%	34%
Mercury		59%	28%	16%	62%	85%
Selenium	87%	95%	92%	95%	91%	85%
Silver						
Thallium	100%	100%	100%	97%	97%	97%
Zinc	100%	100%	75%	84%	80%	76%

Legend: BB = Birchbank; SC = Stoney Creek; NB = New Trail Bridge; OB = Old Trail Bridge; MA = Maglios; WA = Waneta

5.1.3.1 Summary of Exceedances

No exceedances of the short-term acute or long-term chronic Water Quality Guidelines or LCR Objectives occurred for any metals of interest downstream of the IDZ in 2021. Within the IDZ, the spring 2021 30-day average dissolved cadmium and dissolved copper concentrations exceeded the long-term chronic WQG at New Trail Bridge R-sh (Table 5-7 and Figure 5-11). As these elevated concentrations were within the IDZ, they do not constitute non-attainment.

Table 5-7: Observed exceedances in the LCR 2021 water quality data for spring low flow samples at right bank shallow (R-sh) locations in the IDZ.

Site Name	Analyte	Measured 30-d Average (mg/L)	BC long-term Guideline (mg/L)	Exceed BC long-term Guideline
New Trail Bridge	(Cd)-Dissolved	0.000293	0.000178	1
New Trail Bridge	(Cu)-Dissolved	0.00082	0.00036	1
Old Trail Bridge	(Cu)-Dissolved	0.00036	0.00036	1

The highest number of BC long-term WQG exceedances was in 2016 (Hawes et al. 2019; Figure 5-11). Despite flows being about 100m^3/sec lower in 2021 compared to 2016, spring 2021 had fewer water quality exceedances (Figure 5-11).

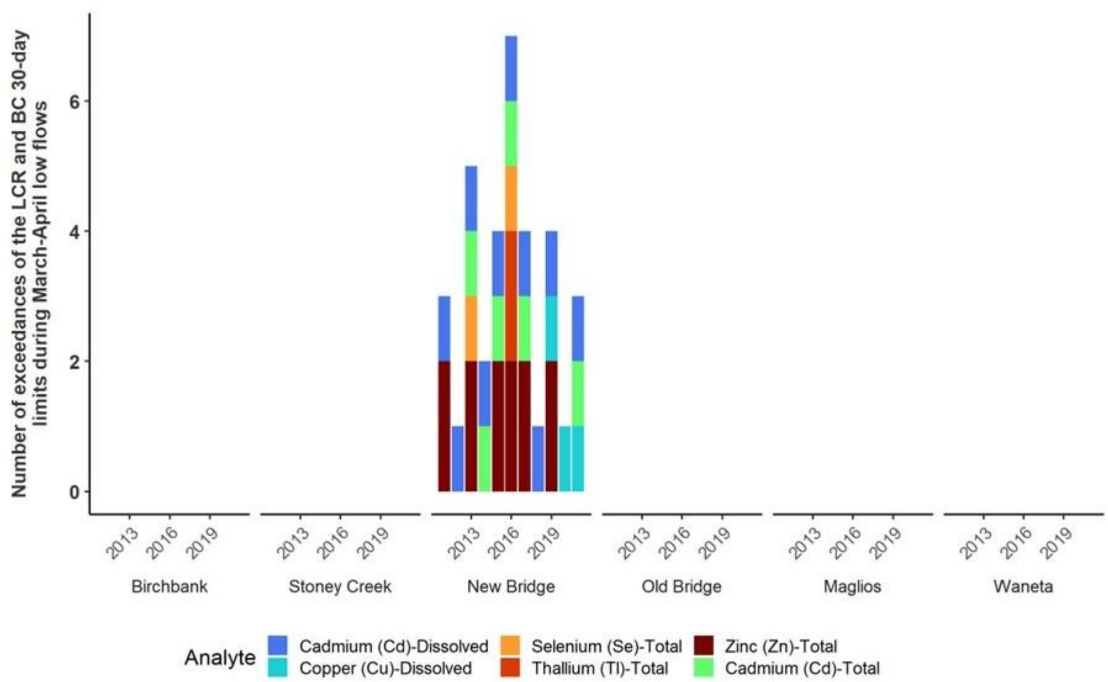


Figure 5-11: Total number of exceedances by metal of the BC long-term WQG and LCR Objectives for the March-April low flow periods from 2011 to 2021. Exceedances in the IDZ (Stoney Creek to Old Trail Bridge) do not constitute non-attainment of Water Quality Objectives.

5.1.3.2 Aluminum (Al)

Spring low flow dissolved Al concentrations did not exceed the BC long term average allowable concentration at any of the six sample sites (Figure 5-12). Similarly, no Al exceedances were detected in the 2021 fall transect sampling (Appendix M). All samples were above the limit of detection for D-Al.

A declining trend in Al concentrations has been detected throughout the LCR in data collected from 1983-2005 at Birchbank (Can. BC 2008), although a significant declining trend was not apparent in the 2012-2021 R-sh spring low flow data. The highest Al concentration during the spring low flow sampling occurred at the Birchbank upstream reference site, and the lowest at Waneta.

The highest aluminum concentrations were documented during the July high river flow periods. This is likely a result of increased aluminum being carried downstream by freshet flows in tributaries associated with increased erosion, channel scour, turbidity, and TDS. No influence of the smelter on aluminum concentrations has been detected in the 2011-2021 water quality data.

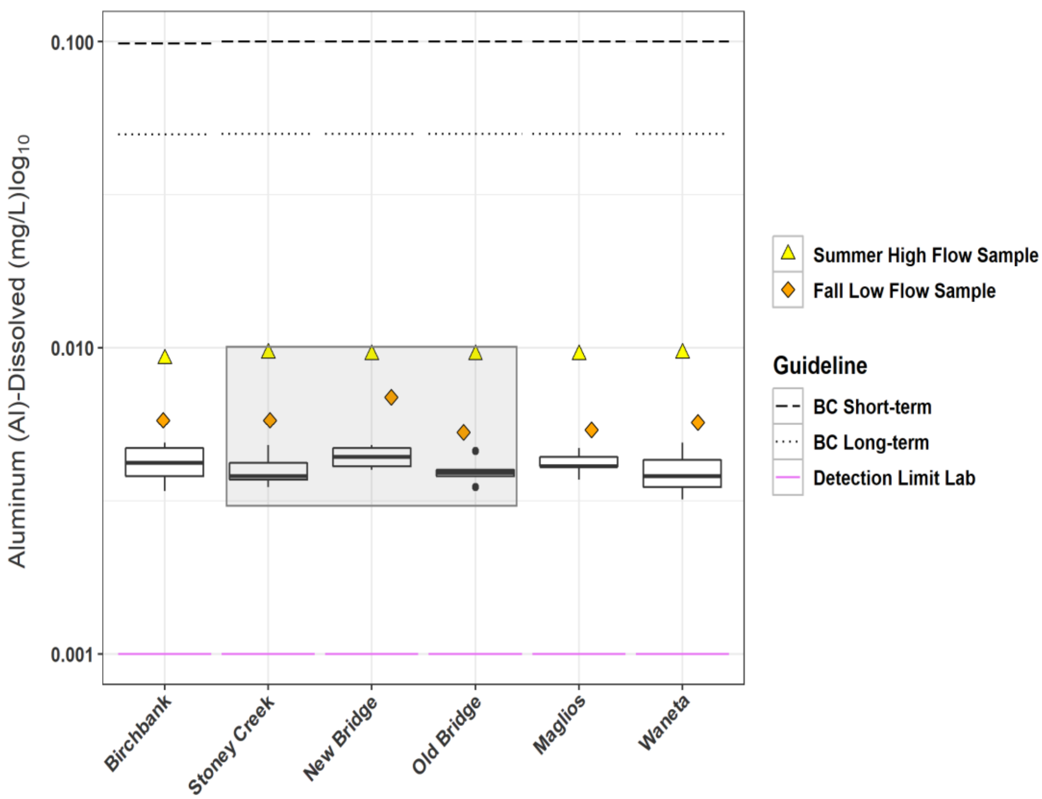


Figure 5-12: Box plots of D-Al measured in R-sh position in March 2021. Points correspond to 2021 fall and summer R-sh samples. The grey box represents the Initial Dilution Zone. All samples were above the limit of detection for D-Al.

5.1.3.3 Arsenic (As)

Both the 30-day average LCR Objective and the BC WQG short-term maximum concentration of arsenic has been set at 0.005 mg/L (5 µg/L) T-As to protect fish and aquatic life (BC ENV 2005). T-As within the IDZ, notably at the R-sh sites, was elevated above background concentrations and was attributable to smelter effluents and possibly groundwater inflows. No 2021 samples exceeded the Objective, even within the IDZ, as has been observed in previous years (Figure 5-13; Appendix M; Hawes et al. 2019). In 2021, arsenic concentrations were highest in the Stoney Creek and New Trail Bridge right shallow samples. Arsenic concentrations noted within the IDZ were fully mixed by Waneta and were within 3.0% of the average right shallow reference site concentrations by Maglios.

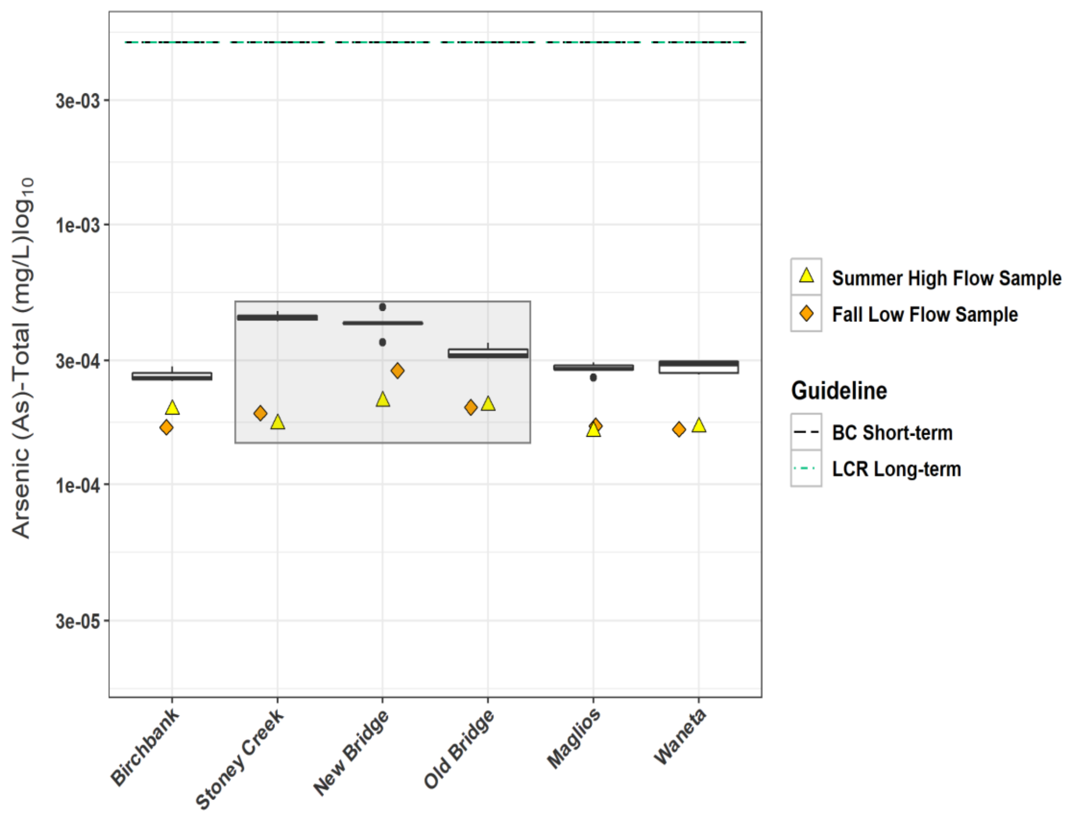


Figure 5-13: Box plots of T-As measured in R-sh position in March 2021. Points correspond to 2021 fall and summer R-sh samples. The grey box represents the Initial Dilution Zone. All samples were above the limit of detection for T-As. The dashed line displays the BC short-term maximum concentration of 0.005 mg/L for total As, which is also the 30-day average allowable LCR Objective.

5.1.3.4 Cadmium (Cd)

The formula-based dissolved cadmium (D-Cd) Guidelines (BC ENV 2015) were applied to 2021 water quality data (Figure 5-14). These formulae use measured total hardness to calculate the site-specific short and long-term D-Cd Guidelines. Since 2011, the measured total hardness at Birchbank (background) has averaged about 66 mg/L as $CaCO_3$. Applying this value, the long-term chronic guideline would be 1.56 E-04 mg/L and the short-term maximum would be 3.84 E-04 mg/L.

All New Trail Bridge R-sh samples collected during 2021 spring and fall low flows exceeded the BC long-term chronic concentration for dissolved Cd. However, no samples exceeded the BC short-term maximum Guideline. During summer high flows, the New Trail Bridge R-sh sample was below the long-term guideline. There were no sample exceedances of the short or long-term Guidelines at Old Trail Bridge or further downstream beyond the IDZ.

Since 2011, and including 2021, the highest dissolved Cd concentrations occur at New Trail Bridge right bank (R-sh) samples during spring low flows (Appendix D).

From 2011-2016 dissolved cadmium concentrations remained elevated from the IDZ along the right bank to Maglios (Larratt et al. 2019). However, in 2018 and 2021, spring and fall low-flow samples, D-Cd remained elevated above the reference Birchbank site concentrations at both Maglios and Waneta. Transect sampling across the river channel indicates that the mixing through the channel was close to, but not fully complete at the Maglios site while complete mixing was evident at Waneta (Larratt et al. 2019). Reasons for the slightly elevated D-Cd concentration at Waneta are not known at this time.

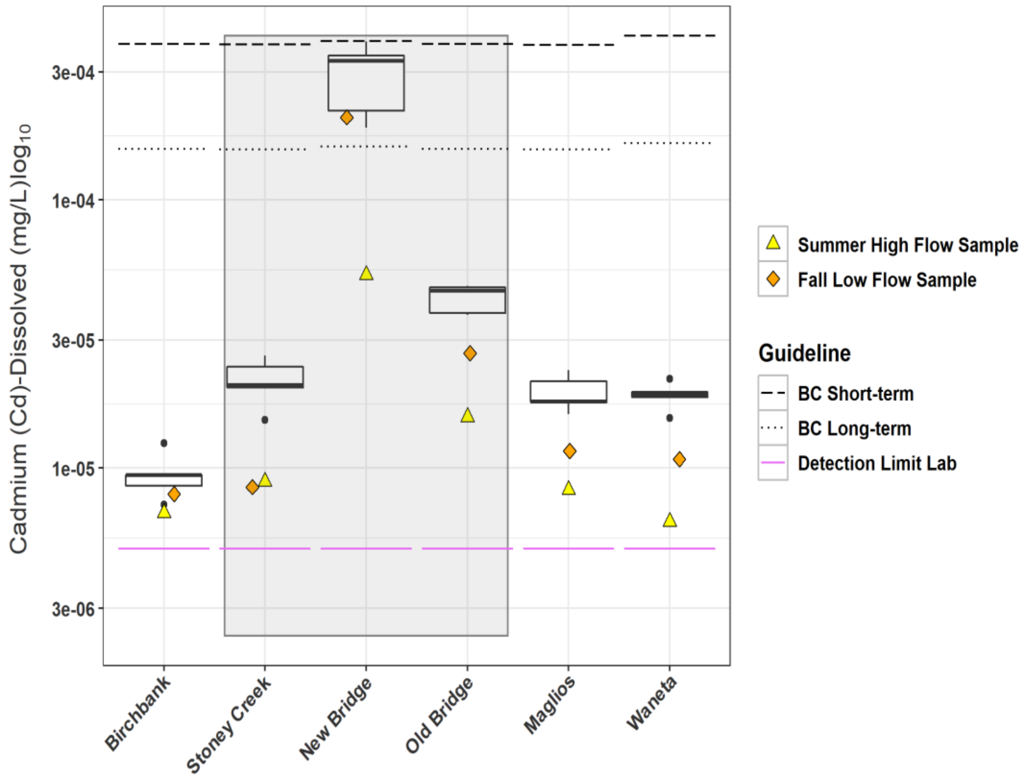


Figure 5-14: Box plots of D-Cd measured in R-sh position in March 2021. Points correspond to 2021 fall and summer R-sh samples. The grey box represents the Initial Dilution Zone. Dashed lines represent calculated guideline values.

5.1.3.5 Chromium (Cr)

Similar to previous years, only 3% of the 2021 water quality data was above the limit of detection for chromium. No exceedances of the Water Quality Guidelines for Cr occurred in any samples collected in 2021 (Figure 5-15). Since 2011, the only exceedance of T-Cr occurred mid-channel at the Birchbank reference site in July 2016 (Hawes et al. 2019).

A 30-day average LCR objective of 0.001 mg/L (1.0 µg/L) for total chromium was set for the protection of fish and aquatic life. No short-term water quality objective was established for Cr (BC ENV 1997).

Total chromium concentrations have declined in BC ENV data collected at Birchbank between 1983 and 2005 (Can.-BC 2008). Current Waneta T-Cr concentrations were lower than historical concentrations and were mostly below the limit of ultra-low metal detection of 0.0001 mg/L.

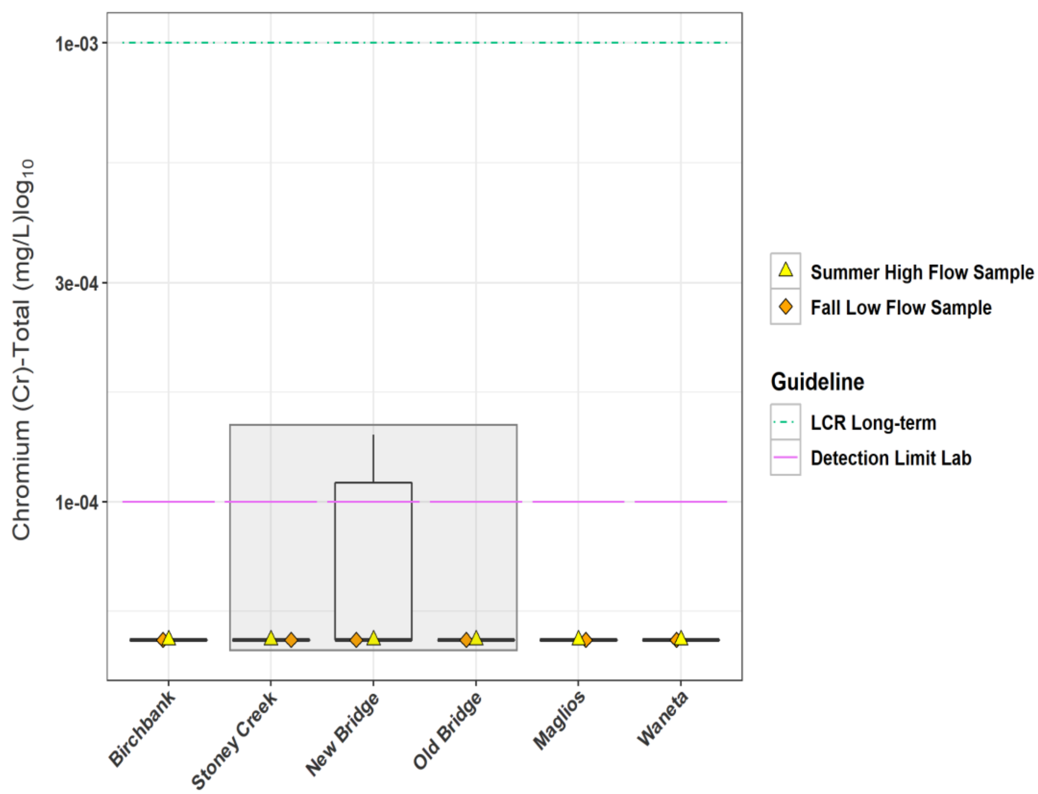


Figure 5-15: Box plots of T-Cr measured in R-sh position in March 2021. Points correspond to 2021 fall and summer R-sh samples. The grey box represents the Initial Dilution Zone. 97 percent of samples were below the ultra-low limit of detection for T-Cr. Dashed lines represent calculated guideline values. Samples that were < lab detection limit (D.L.) are shown on the graph at concentrations that are ½ D.L.

5.1.3.6 Copper (Cu)

The Biotic Ligand Model (BLM) was used to derive sample specific dissolved copper WQGs. The specific water chemistry conditions of a water body determine the proportions of the different bioavailable forms of dissolved Cu and therefore the toxicity of dissolved Cu. Since 2020, the BC BLM software has been used to derive sample-specific dissolved copper WQGs based on dissolved organic carbon, hardness, and pH levels at each sample location.

Copper occurs primarily in the dissolved form both above and below the smelter. Elevated copper concentrations have been measured on both sides of the river in the IDZ at New Trail Bridge suggesting groundwater influence in addition to smelter effluents (Hawes et al. 2019). Groundwater influence may be seen in right and left bank samples, but any effluent influence would be right bank only. Prior to adoption of the BLM to calculate WQG, there were no exceedances of the BC WQG for dissolved copper between 2011 and 2019.

Dissolved copper concentrations remain similar to previous years, but since the adoption of the more stringent BLM WQG in 2020 AEMP sampling, some exceedances of the long-term chronic WQG have occurred. In March 2021, 30-day average concentrations exceeded the long-term chronic WQG at New Trail Bridge (Figure 5-16). In addition, the single sample collected during fall low flows was elevated above the Long-term Guideline at New Trail Bridge. There were no exceedances of the long-term chronic WQG concentrations at Old Trail Bridge or downstream beyond the IDZ.

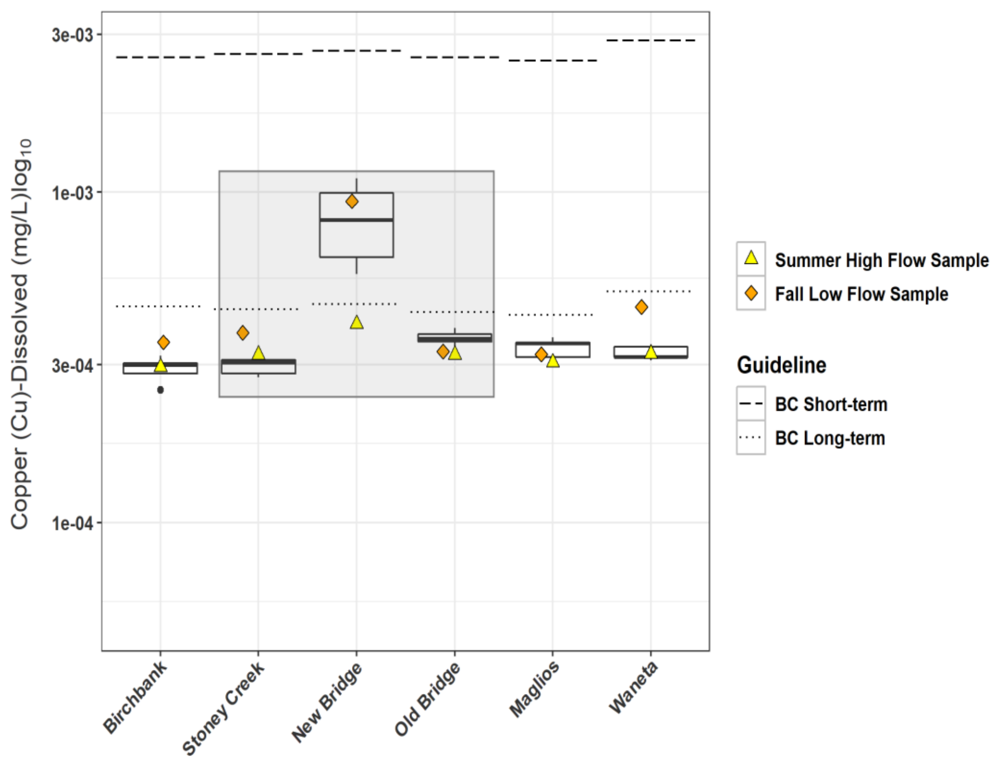


Figure 5-16: Box plots of D-Cu measured in R-sh position in March 2021. Points correspond to 2021 fall and summer R-sh samples. The grey box represents the Initial Dilution Zone. No samples were below the ultra-low limit of detection for D-Cu. Dashed lines represent calculated guideline values.

5.1.3.7 Lead (Pb)

No samples exceeded either the short-term or the long-term Water Quality Guideline for total lead (T-Pb) in the 2021 data. Elevated T-Pb concentrations above background were measured at Stoney Creek, New Trail Bridge, and Old Trail Bridge in 2021 and in earlier datasets (Hawes et al. 2019). Average concentrations downstream at Waneta remained about 66% higher than background levels, but still below the short and long term guidelines (Figure 5-17). This is consistent with 2011-2020 observations (Hawes et al. 2014; Larratt et al, 2019); where average lead concentrations remained slightly elevated at Waneta compared to the Birchbank reference site.

Water Quality Objectives for the LCR set a short-term allowable concentration of total lead at 0.0379 mg/L (37.9 µg/L) to protect fish and aquatic life. The long-term T-Pb Objective is 0.0048 mg/L. All AEMP water sampling to date (2011–2021) indicated the highest average lead concentrations occurred within the IDZ in right bank samples (Figure 5-17). Most of the lead occurred in the less bio-available particulate form with dissolved lead accounting for about 32% of total mean concentrations downstream of the IDZ.

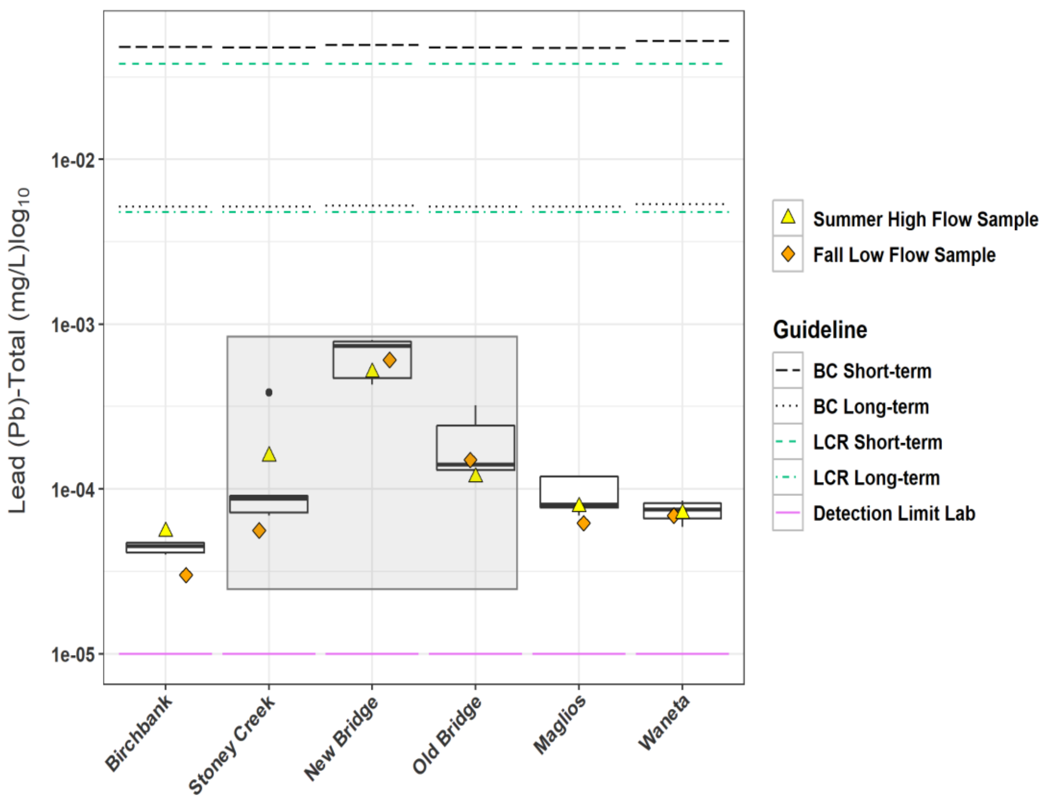


Figure 5-17: Box plots of T-Pb measured in R-sh position in March 2021. Points correspond to 2021 fall and summer R-sh samples. The grey box represents the Initial Dilution Zone. No samples were below the ultra-low limit of detection for T-Pb. Dashed lines represent calculated guideline values.

5.1.3.8 Mercury (Hg)

There were no exceedances of the short-term guideline for total mercury (T-Hg) at any sites and no exceedances of the long-term guidelines either within or outside of the IDZ (Figure 5-18). The BC short-term WQG for total mercury is 0.0001 mg/L (0.1 µg/L), with a long-term guideline of 0.00002 mg/L T-Hg (0.02 µg/L) when methylated Hg (MeHg) = 0.5% of T-Hg. No Water Quality Objective for mercury was set for the LCR.

There were no exceedances of the short or long-term WQGs in 2021 data. Like aluminum, historical mercury concentrations occasionally exceeded the BC short-term Guideline both above and below the smelter (Hawes et al. 2014; Hawes et al. 2019). Similar to 2011-2020 data, 2021 total mercury concentrations were elevated above reference levels inside the IDZ but returned to near background levels by Maglios (Figure 5-18; Appendix D). 60% of 2021 samples had non-detectable (<0.0005 µg/L) T-Hg concentrations, even with the ultra-low metal analyses.

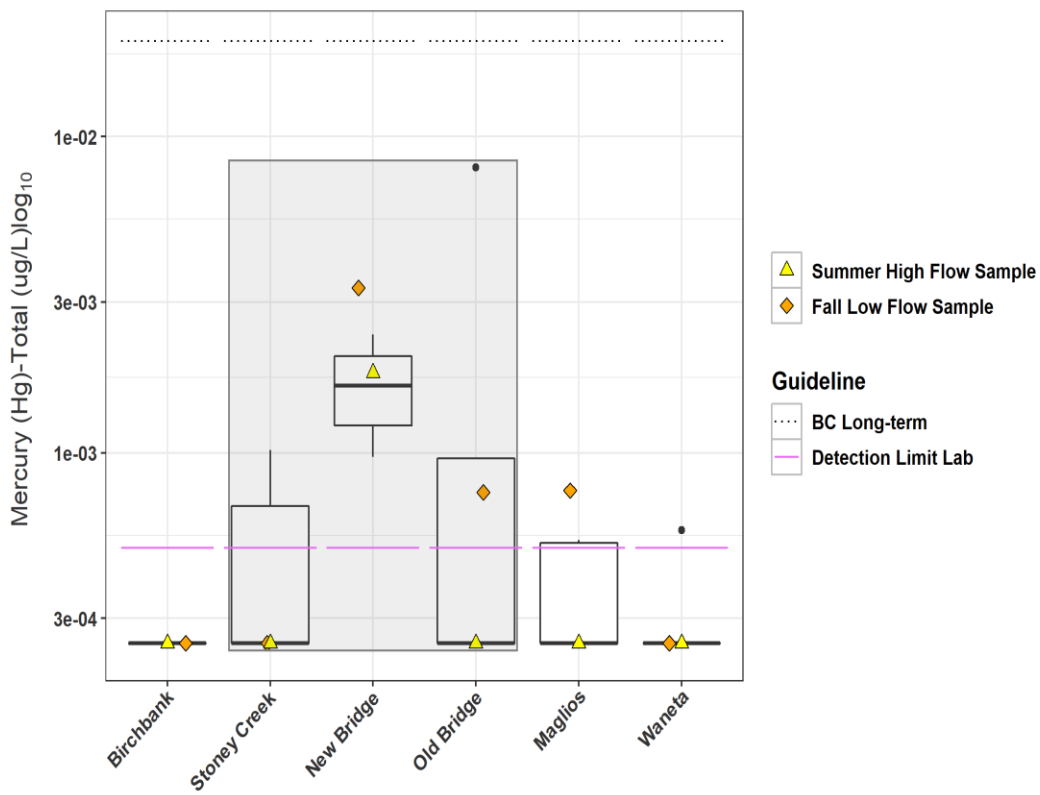


Figure 5-18: Box plots of T-Hg measured in R-sh position in March 2021. Points correspond to 2021 fall and summer R-sh samples. The grey box represents the Initial Dilution Zone. 60% of 2021 samples were below the ultra-low limit of detection for T-Hg. The dashed line displays the BC short-term allowable concentration of 0.0001 mg/L and the dotted line displays the BC long-term allowable concentration of 0.00002 mg/L for total Hg. Samples that were < lab detection limit (D.L.) are shown on the graph at concentrations that are ½ D.L.

5.1.3.9 Nickel (Ni)

No exceedances of total nickel (T-Ni) have been detected in any samples collected from the LCR AOI since 2011 including within the IDZ (Figure 5-19). The nickel short-term maximum LCR Objective was established for the protection of fish and aquatic life and ranges between 0.0025 - 0.150 mg/L T-Ni. The BC long-term WQG is a hardness-based calculation and is shown in (Figure 5-19).

Total nickel concentrations at Maglios were within about 4% of the reference Birchbank site in 2021, similar to earlier years of study. Most of the nickel in LCR samples is present in the dissolved form. Differences between nickel concentrations throughout the AOI were small in 2021 (Appendix D).

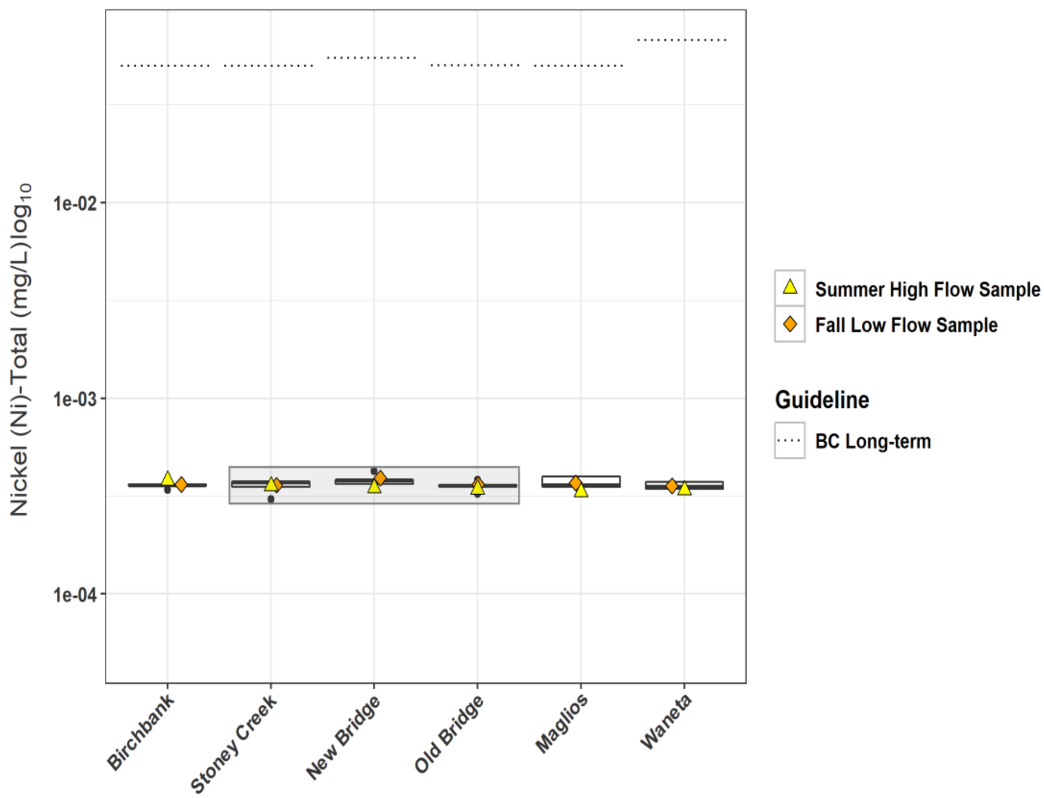


Figure 5-19: Box plots of T-Ni measured in R-sh position in March 2021 March-April. Points correspond to 2021 fall and summer R-sh samples. The grey box represents the Initial Dilution Zone. None of the 2018 samples were below the ultra-low limit of detection for T-Hg.

5.1.3.10 Selenium (Se)

The water quality guideline for the protection of aquatic life set the long-term (30-day average) chronic guideline for Se at 0.002 mg/L T-Se (2 µg/L) and a long-term alert level for aquatic life in sensitive ecosystems of 0.001 mg/L T-Se (1 µg/L) (BC MOE 2014). The alert level is more applicable to lentic habitats where enhanced SE accumulation and cycling from sediments can occur (BC MOE 2014). There is no short-term acute WQG for selenium.

In 2021, the 30-d average T-Se concentration at New Trail Bridge did not exceed the BC ENV long-term chronic T-Se Guideline (Figure 5-20). Only the 30-day average of the 5 samples is comparable to the long-term WQG. At New Trail Bridge and throughout the LCR, Se occurred mainly in the dissolved form.

At Waneta, where complete mixing of the effluent plume is achieved, T-Se averaged 0.000363 mg/L (24% higher than Birchbank). No exceedances of T-Se have occurred outside the IDZ in sampling to date (2011-2021).

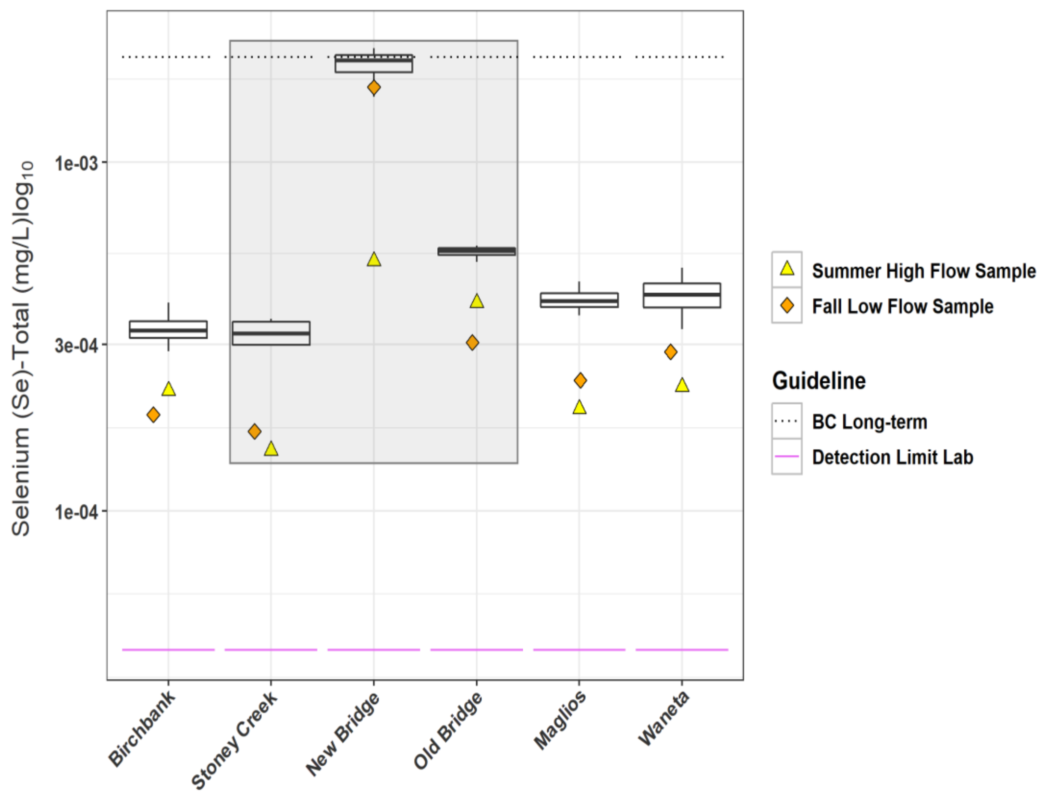


Figure 5-20: Box plots of T-Se measured in R-sh position in March 2021. Points correspond to 2021 fall and summer R-sh samples. The grey box represents the Initial Dilution Zone. None of the 2021 samples were below the ultra-low limit of detection for T-Se.

5.1.3.11 Silver (Ag)

None of the samples collected in 2021 had measurable silver (T-Ag) results (Figure 5-21) even when analyzed using ultra-low metal analyses (MDL=5.00E-06 mg/L).

The BC WQG for total silver is hardness dependent. For waters with hardness <100 mg [$CaCO_3$]/L, a short-term guideline of 0.0001 mg/L T-Ag (0.1 µg/L), and a long-term (30-day mean) of 0.00005 T-Ag (0.05 µg/L) was recommended by BC ENV (2017) for the protection of freshwater fish and aquatic life.

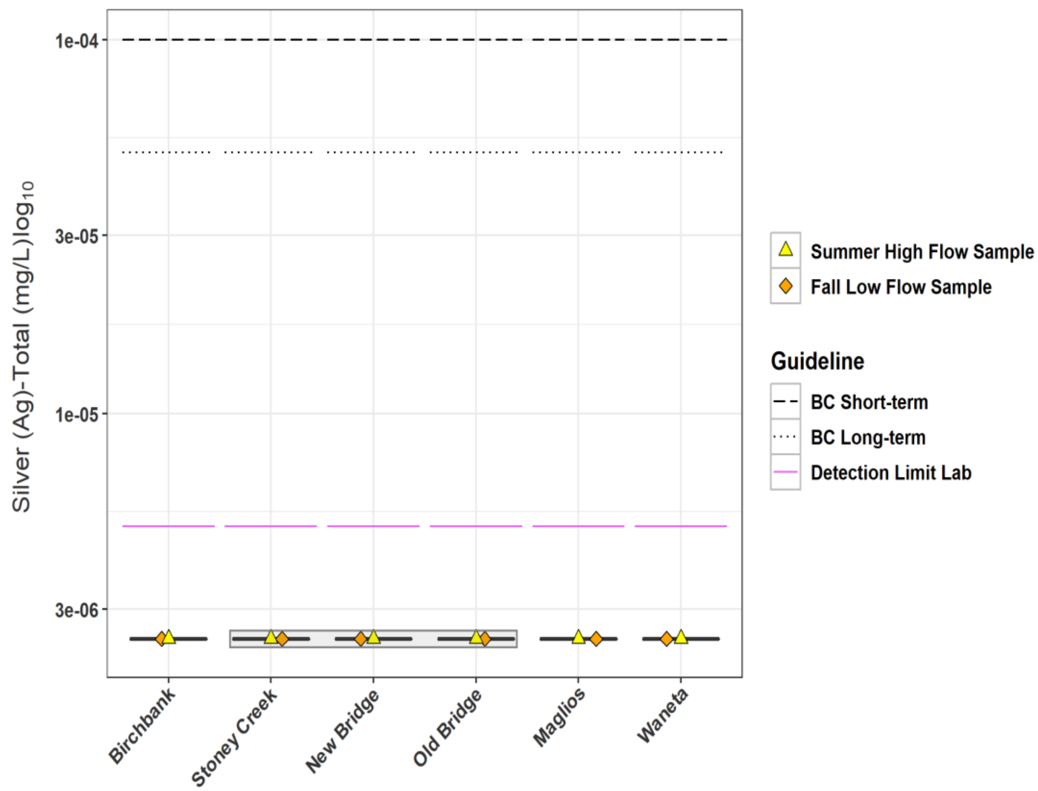


Figure 5-21: Box plots of T-Ag measured in R-sh position in March 2021. Points correspond to 2021 fall and summer R-sh samples. The grey box represents the Initial Dilution Zone. All of the 2021 samples were below the ultra-low limit of detection for T-Ag. Samples that were < lab detection limit (D.L.) are shown on the graph at concentrations that are ½ D.L.

5.1.3.12 Thallium (Tl)

There were no exceedances of the long-term chronic Guidelines for total thallium (T-Tl) at any sites during 2021 sampling (Figure 5-22). The provisional long-term LCR Water Quality Objective for total thallium of 0.0008 mg/L (0.8 µg/L) was recommended by BC ENV (1997) for the protection of fish and aquatic life. There is no short-term acute Objective for thallium.

Similar to 2011-2020 data, T-Tl concentrations were elevated (relative to background concentrations) at all sites from New Trail Bridge and downstream. The highest T-Tl concentrations were measured at New Trail Bridge in 2021. These studies have not shown exceedances of the long-term Objective for T-Tl (Appendix D). Tl was predominantly in the dissolved form.

The distribution of thallium concentrations across transects was similar in the 2011-2020 data and the 2021 data. These results all showed increased Tl in the effluent plume path, and effective but incomplete mixing by Maglios, and full mixing by Waneta.

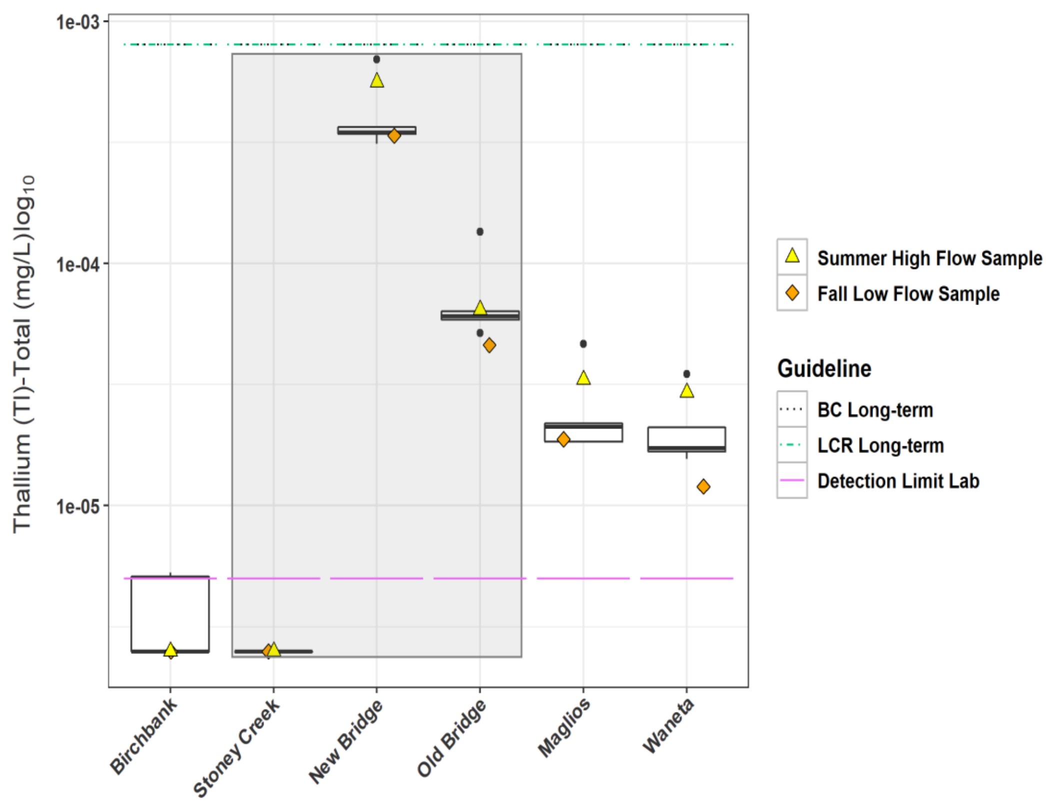


Figure 5-22: Box plots of total Tl measured in R-sh position in March 2021. Points correspond to 2021 fall and summer R-sh samples. The grey box represents the Initial Dilution Zone. No samples were below the limit of detection for Tl. The dotted line displays the working BC and LCR long-term allowable concentration of 0.0008 mg/L for total Tl. Samples that were < lab detection limit (D.L.) are shown on the graph at concentrations that are ½ D.L.

5.1.3.13 Zinc (Zn)

There were no exceedances of the long-term chronic Guideline for Zinc at any site in the 2021 sampling program. Elevated T-Zn concentrations were consistently measured along both the right bank and to a lesser extent, the left bank at New Trail Bridge and Old Trail Bridge. However, none of the values measured have exceeded the LCR long-term chronic, or the LCR short-term maximum concentration for total Zn. At New Trail Bridge (in the IDZ), one of the 5 spring samples used to calculate the 30-d average exceeded the BC long-term guideline. However, the average of the 5 samples was still below the long-term chronic Guideline (Figure 5-23; Appendix D). Average T-Zn concentrations during low LCR flows at Maglios were about 10% above the average values at the reference Birchbank site.

Water Quality Objectives for the LCR, set the short-term maximum concentration of total zinc (T-Zn) at 0.033 mg/L (33 µg/L) to protect fish and aquatic life and other water uses (BC ENV 2005). The long-term chronic Guideline is 0.0075 mg/L T-Zn. Throughout the LCR area of interest, zinc occurs primarily in the dissolved form.

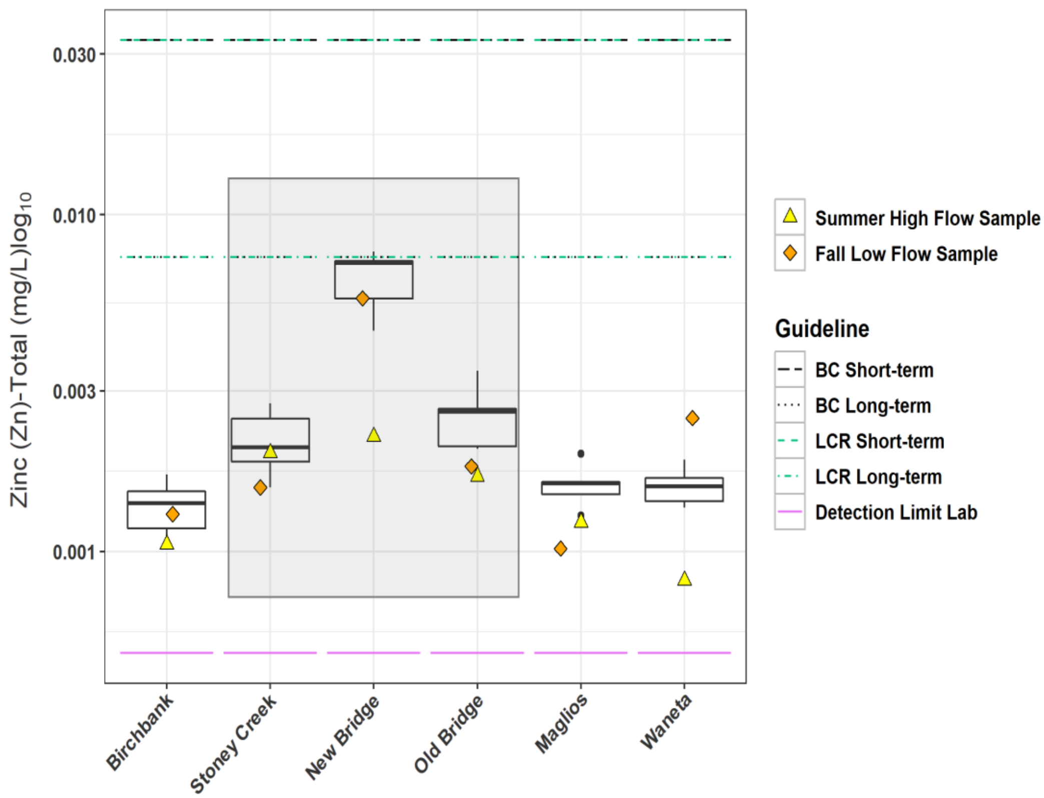


Figure 5-23: Box plots of T-Zn measured in R-sh position in March 2021. Points correspond to 2021 fall and summer R-sh samples. The grey box represents the Initial Dilution Zone. None of the 2021 samples were below the ultra-low limit of detection for T-Zn.

5.1.3.14 Relationship Between River Flow and Metals Concentrations

The spring sampling sessions are designed to target a low flow period for the LCR when effluent is expected to be least diluted over the year. However, the LCR is a regulated river and flows were higher during some of the sampling events and years. For example, all the 2017 spring sampling events occurred on days that had a mean daily discharge of >2000 m^3/s (Table 5-8). In 2021, river discharge was the lowest it has been during spring AEMP water quality sampling. Spring sampling events during higher river discharges can influence metal concentrations through increased dilution. Variations in discharge between sampling events make it difficult to compare annual differences and trends in spring metal concentrations.

Table 5-8: Birchbank flow summary for spring water quality sampling events (2012-2021).

Year	Mean ± Standard Deviation of Flow (m^3/s)
2012	1,874 ± 400.3
2013	1,540 ± 58.42
2014	1,635 ± 271.7
2015	1,523 ± 281.8
2016	1,108 ± 78.46
2017	2,185 ± 95.87
2018	1,108 ± 8.304
2019	1,035 ± 141.23
2020	1,216 ± 188.69
2021	1,004 ± 65.04

Multiple linear regression models were used to evaluate the relationship between background water quality parameters from the R-sh samples and flow using the Birchbank Reference Station. The period of record was from 2012-2021. This understanding (Figure 5-24 - Figure 5-33) is important as it illustrates how background metals concentrations change with river flow, which is key to establish flow weightings for subsequent analysis of trends with respect to effluent discharges and downstream metals concentrations.

Aluminum concentrations are positively correlated with river flow and background levels increase as flows increase. As explained previously, this is due to aluminum silicate clays that occur naturally in the watershed. Thus, with increased runoff and erosion during higher flows, more aluminum is transported into the LCR.

Concentrations of ammonia, As, Cd, Cu, Pb, Ni, Se, Ag, Tl, and Zn are negatively correlated with river flow and decrease as river flows increase. There was a minimal to no observed relationships between concentrations of Cr, Fe, and Hg, and mean daily flow at Birchbank. For Cr and Hg, this may be due to a large number of non-detects in samples.

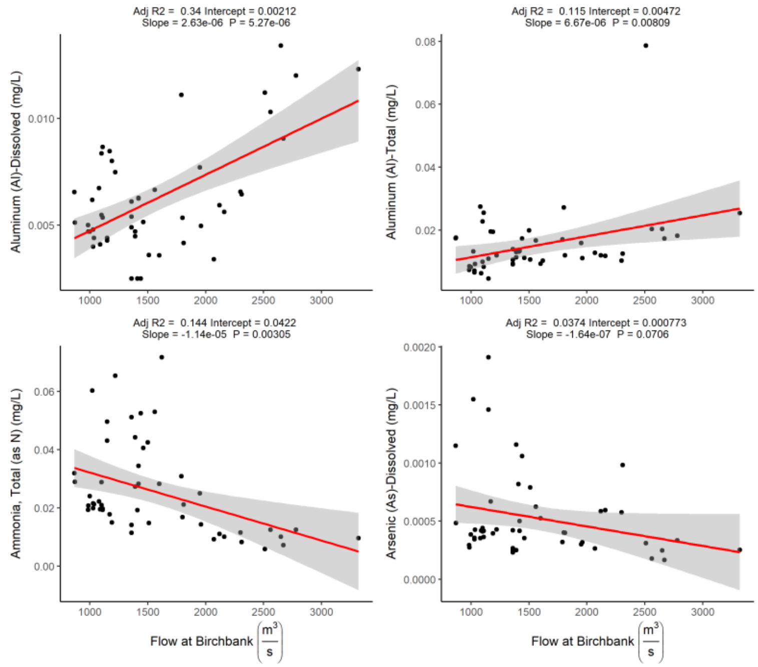


Figure 5-24: Scatter plots of Aluminum (Al)-Dissolved, Aluminum (Al)-Total, Ammonia, Total (as N) and Arsenic (As)-Dissolved concentrations at different flow rates as measured at the Birchbank site. Red line indicates least squares regression line.

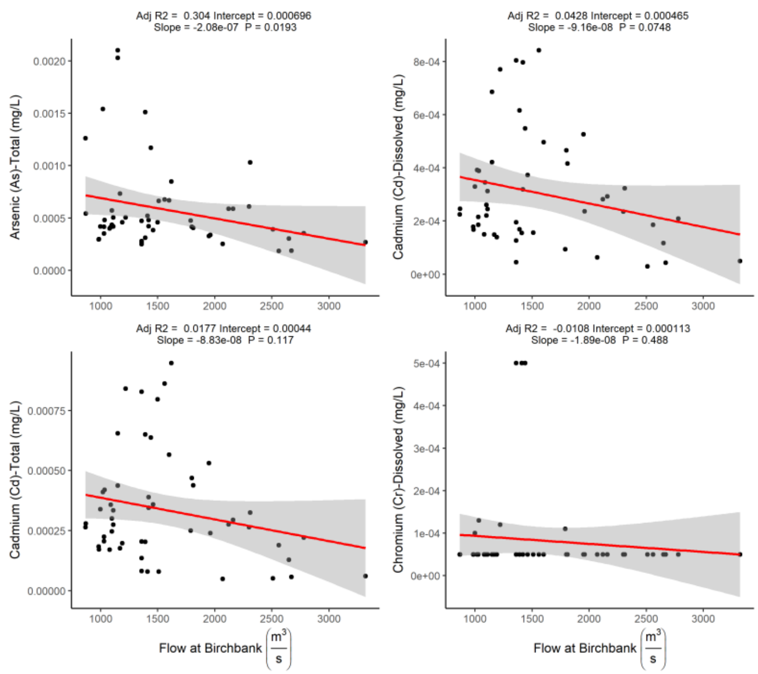


Figure 5-25: Scatter plots of Arsenic (As)-Total, Cadmium (Cd)-Dissolved, Cadmium (Cd)-Total and Chromium (Cr)-Dissolved concentrations at different flow rates as measured at the Birchbank site. Red line indicates least squares regression line.

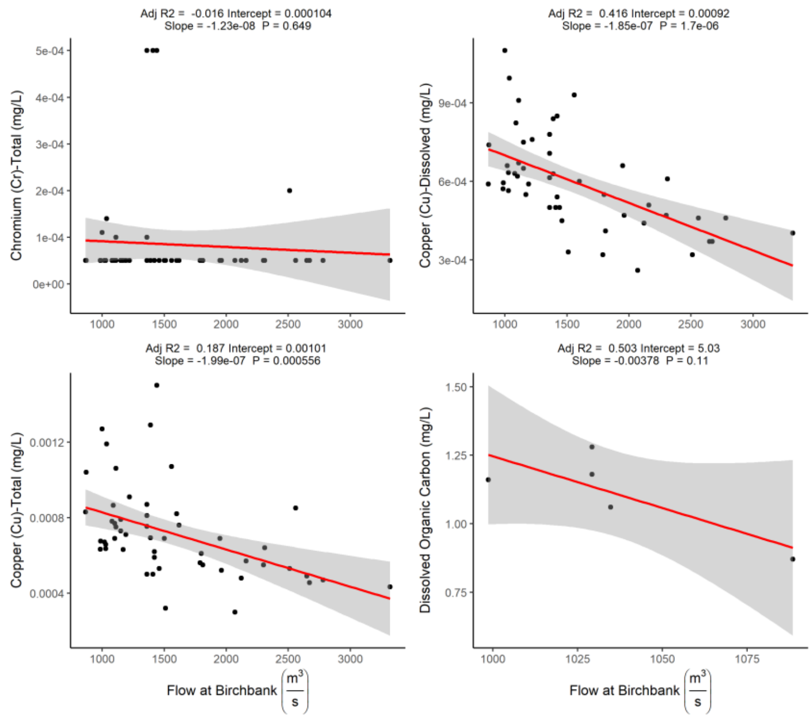


Figure 5-26: Scatter plots of Chromium (Cr)-Total, Copper (Cu)-Dissolved, Copper (Cu)-Total and Dissolved Organic Carbon concentrations at different flow rates as measured at the Birchbank site. Red line indicates least squares regression line.

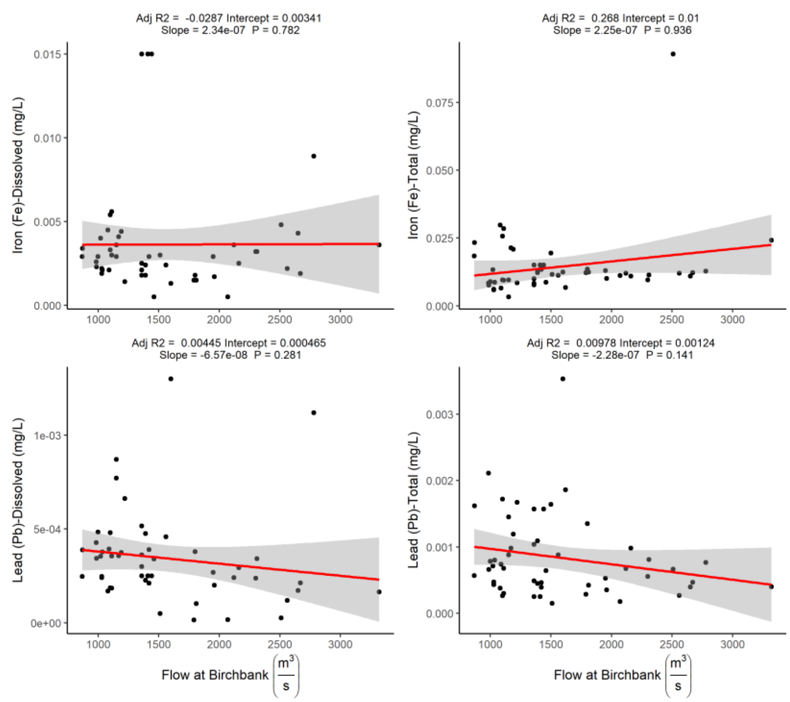


Figure 5-27: Scatter plots of Iron (Fe)-Dissolved, Iron (Fe)-Total, Lead (Pb)-Dissolved and Lead (Pb)-Total concentrations at different flow rates as measured at the Birchbank site. Red line indicates least squares regression line.

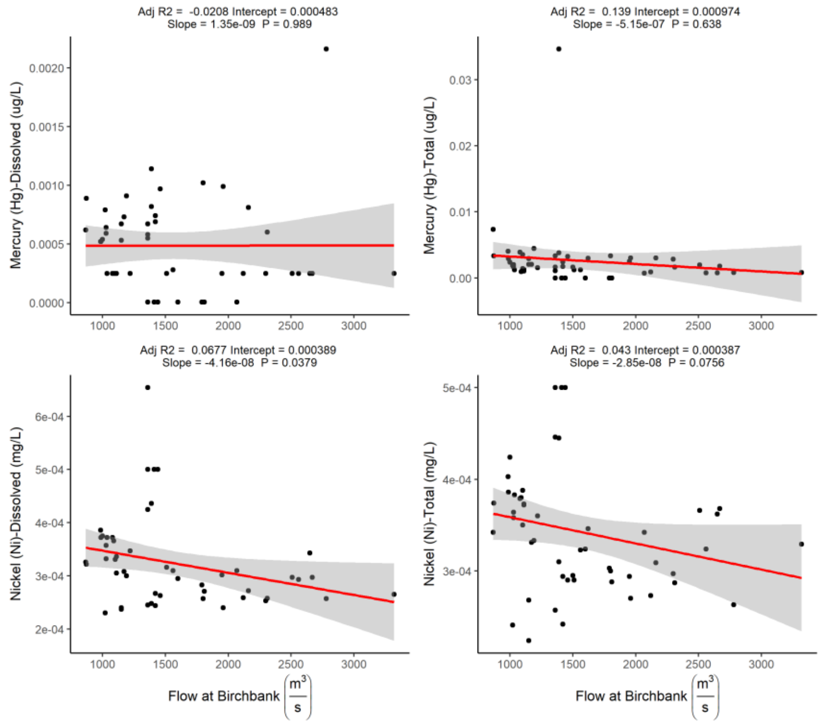


Figure 5-28: Scatter plots of Mercury (Hg)-Dissolved, Mercury (Hg)-Total, Nickel (Ni)-Dissolved and Nickel (Ni)-Total concentrations at different flow rates as measured at the Birchbank site. Red line indicates least squares regression line.

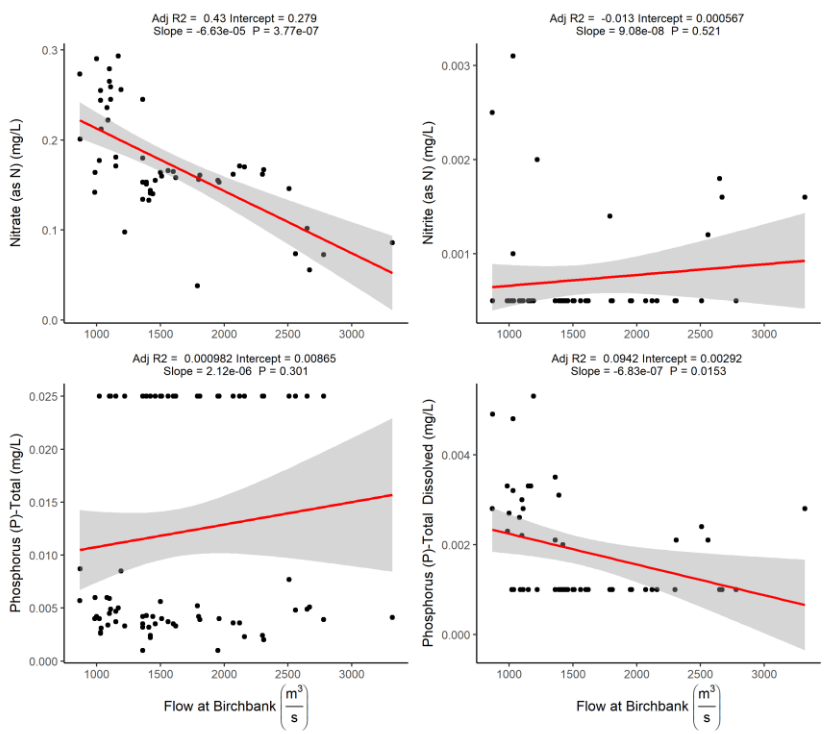


Figure 5-29: Scatter plots of Nitrate (as N), Nitrite (as N), Phosphorus (P)-Total and Phosphorus (P)-Total Dissolved concentrations at different flow rates as measured at the Birchbank site. Red line indicates least squares regression line.

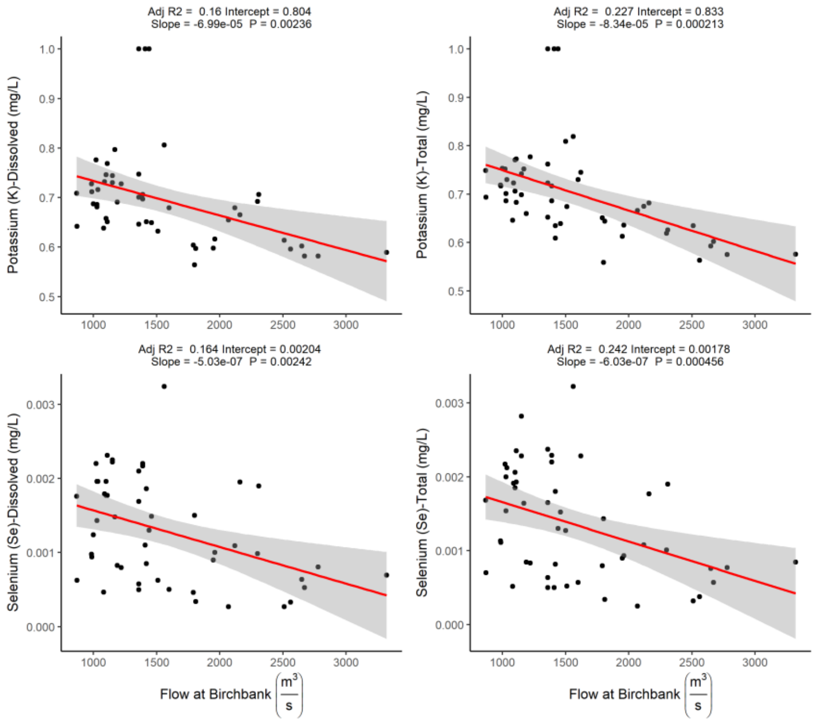


Figure 5-30: Scatter plots of Potassium (K)-Dissolved, Potassium (K)-Total, Selenium (Se)-Dissolved and Selenium (Se)-Total concentrations at different flow rates as measured at the Birchbank site. Red line indicates least squares regression line.

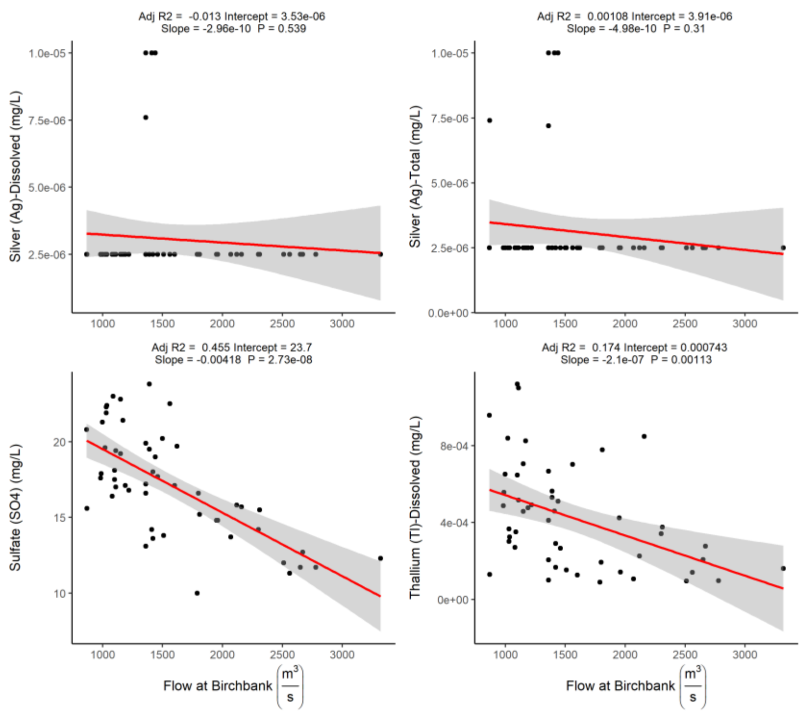


Figure 5-31: Scatter plots of Silver (Ag)-Dissolved, Silver (Ag)-Total, Sulfate (SO4) and Thallium (Tl)-Dissolved concentrations at different flow rates as measured at the Birchbank site. Red line indicates least squares regression line.

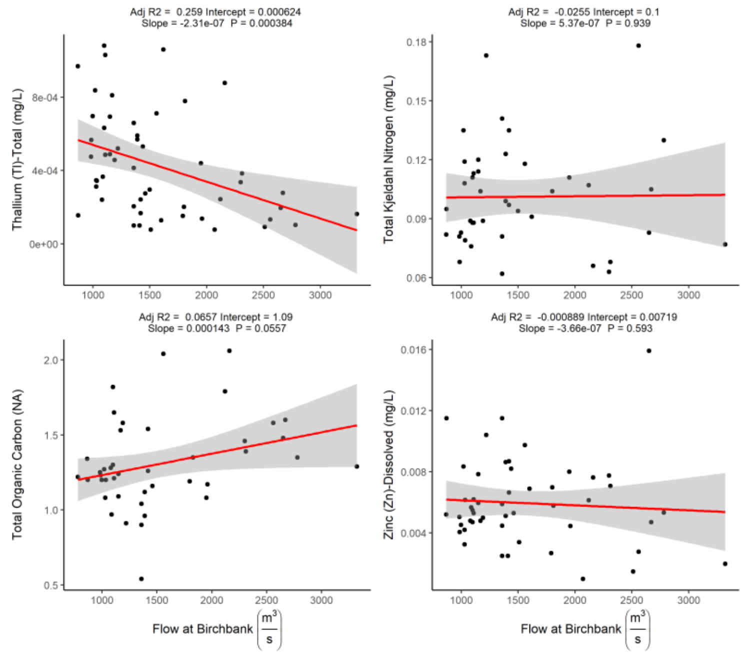


Figure 5-32: Scatter plots of Thallium (Tl)-Total, Total Kjeldahl Nitrogen, Total Organic Carbon and Zinc (Zn)-Dissolved concentrations at different flow rates as measured at the Birchbank site. Red line indicates least squares regression line.

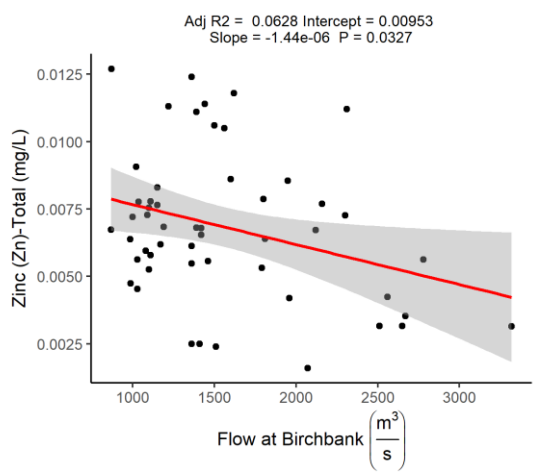


Figure 5-33: Scatter plot of Zinc (Zn)-Total concentrations at different flow rates as measured at the Birchbank site. Red line indicates least squares regression line.

5.1.3.15 Trends in Water Quality

The relationship between effluent loadings and metals concentrations at New Trail Bridge between 2012-2021 was evaluated through multiple linear regressions (Table A43).

Flow-weighted concentrations of spring and fall low flow samples from the right bank of the river (R-sh) were used for trend analysis. The mean for each season/year for right bank shallow samples was the focus of the trend analysis because there has been continuous sampling from 2011-2021. In addition, the effluent plume follows the right bank through the IDZ to Old Trail Bridge. To account for the effect of flow, flow-weighted concentrations were calculated for the low flow sampling events for the right shallow samples.

Significant trends detected by the Mann Kendall analysis are summarized in Table 5-9, with full analytical results presented in Appendix L. Results with a P-value < 0.05 indicate that there is (monotonic) trend. An increasing trend is indicated by a positive (+) Tau and a decreasing trend is indicated by a negative (-) Tau (Table 5-9).

Data from 2011 to 2018 showed only two metals with significant trends: total selenium and dissolved cadmium (Larratt et al. 2019) neither of which were attributed to Teck Trail Operations' effluent as similar trends were detected upstream at the Birchbank reference site.

Significant trends have become increasingly apparent since the 2018 analysis (Larratt et al. 2019). Overall, decreasing trends in metals concentrations predominate through the initial dilution zone and downstream of the smelter. Parameters that continue to show increasing trends and concentrations also exhibit these increasing trends in samples collected at Birchbank reference site.

Background concentrations measured at the Birchbank upstream reference site show significant increasing trends for dissolved copper, total selenium, sulfate, dissolved and total thallium, and total organic carbon. Decreasing trends were detected for total aluminum, total copper, and total lead (Table 5-9; Figure 5-34 - Figure 5-44).

Table 5-9: Significant Mann Kendall results for analytes in R-sh water quality samples based on flow-weighted concentrations for data collected since 2011.

Trend	Birchbank	LCR at Stoney Creek	New Trail Bridge	Old Trail Bridge	Maglios	Waneta
Increasing	D-Cu, T-Se, SO_4, T-Tl, D-Tl, TOC	T-NH4, D-Cu, T-P, D-P, SO_4	NO_3, NO_2, T-P, D-Se,	T-Ni	Ni, P, SO_4	T-Se, SO_4
Decreasing	Al, T-Cu, T-Pb	T-Tl	T-Al, D-Cd, T-Cd, T-Zn, D-Zn	D-Al, D-Cd, T-Cd	D-Cd, D-Cu, T-Ag, TKN	T-Cd, D-Cd, T-Pb

The LCR at Stoney Creek had significant increasing trends in total ammonia, dissolved copper, total and dissolved phosphorus, and sulfate. Total thallium showed a decreasing trend at Stony Creek (Table 5-9; Figure 5-34 - Figure 5-44).

New Trail Bridge shows increasing trends in nitrate and nitrite concentrations as well as total phosphorus, and dissolved selenium. Selenium concentrations have also increased in background levels at Birchbank. Decreasing flow-weighted trends are occurring for total aluminum, dissolved and total cadmium, and dissolved and total zinc (Table 5-9; Figure 5-34 - Figure 5-44).

At Old Trail Bridge, the downstream end of the IDZ, dissolved aluminum, dissolved cadmium, and total cadmium show decreasing trends since 2012. Whereas dissolved nickel shows an increasing trend in concentrations (Table 5-9; Figure 5-34 - Figure 5-44).

At Maglios, dissolved cadmium, dissolved copper, total silver, and total Kjeldahl nitrogen all have decreasing trends in concentrations. Dissolved and total nickel, total dissolved phosphorus, and sulfate have increasing trends apparent (Table 5-9; Figure 5-34 - Figure 5-44).

At Waneta, dissolved and total cadmium, and total lead have significant decreasing trends in concentrations. Total selenium and sulfate both have increasing trends at Waneta, but this trend is also evident in background levels at Birchbank (Table 5-9; Figure 5-34 - Figure 5-44).

The increasing selenium and sulfate concentration trends through the IDZ and downstream are also seen in the upstream reference location at Birchbank and therefore cannot be ascribed to the smelter. Further, the Effluent Comprehensive Review, Submission 1 (Azimuth 2020) indicates Se is declining at all three outfalls. In addition to Se, Cd and Cr are declining at all three outfalls.

Dissolved nickel had a small significant (p-Value=0.049) increasing trend in concentrations at Old Trail Bridge and Maglios that was not detected through the initial dilution zone at New Trail Bridge or Stoney Creek, or upstream background concentrations at Birchbank.

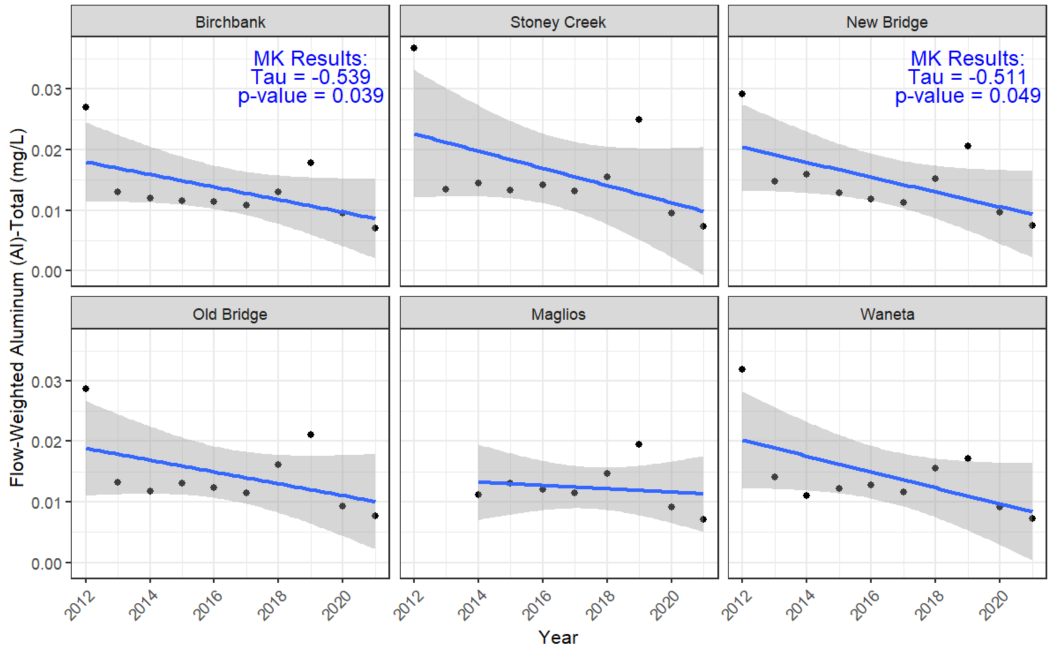


Figure 5-34: Spring flow-weighted concentrations of Aluminum (total) across sites. Sites with significant trends include the Mann-Kendall (MK) test results. Blue line represents a linear regression.

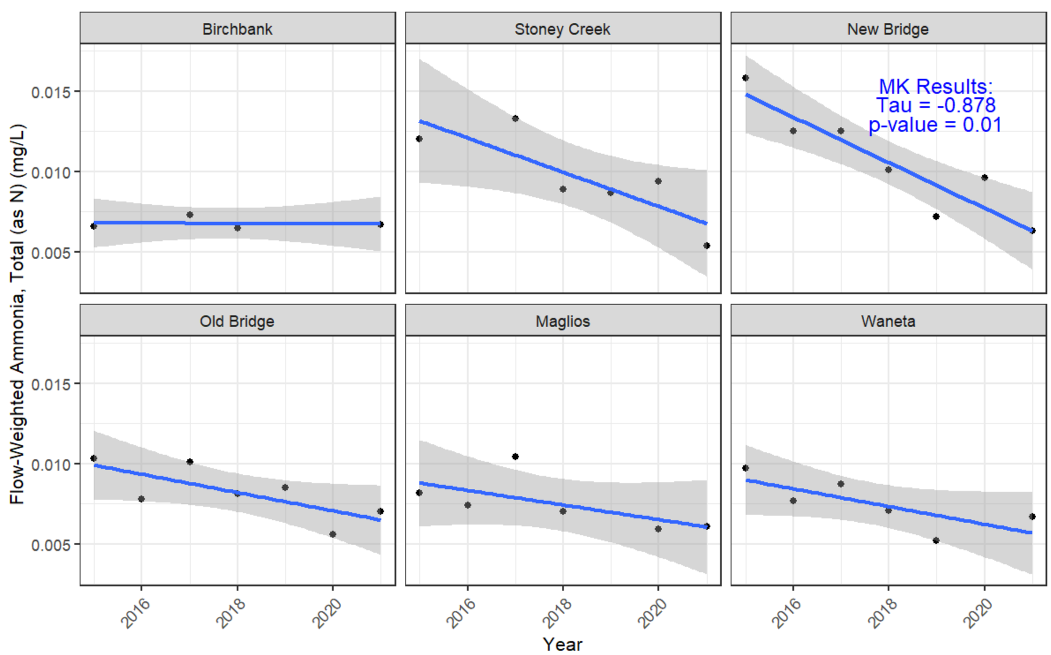


Figure 5-35: Summer flow-weighted concentrations of Ammonia (total) across sites. Sites with significant trends include the Mann-Kendall (MK) test results. Blue line represents a linear regression.

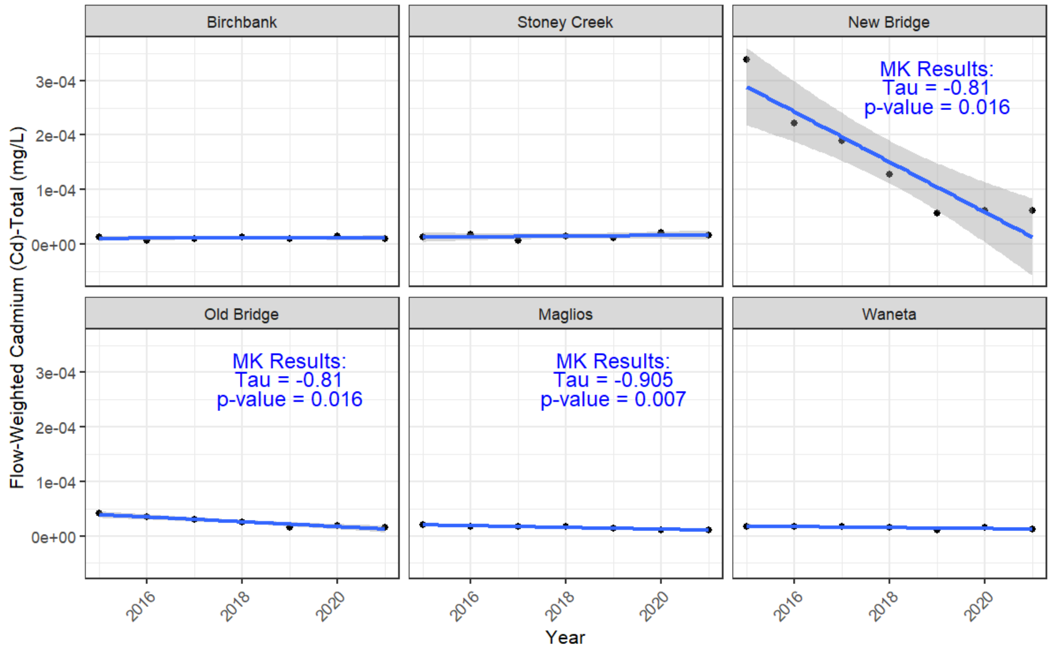


Figure 5-36: Summer flow-weighted concentrations of Cadmium (total) across sites. Sites with significant trends include the Mann-Kendall (MK) test results. Blue line represents a linear regression.

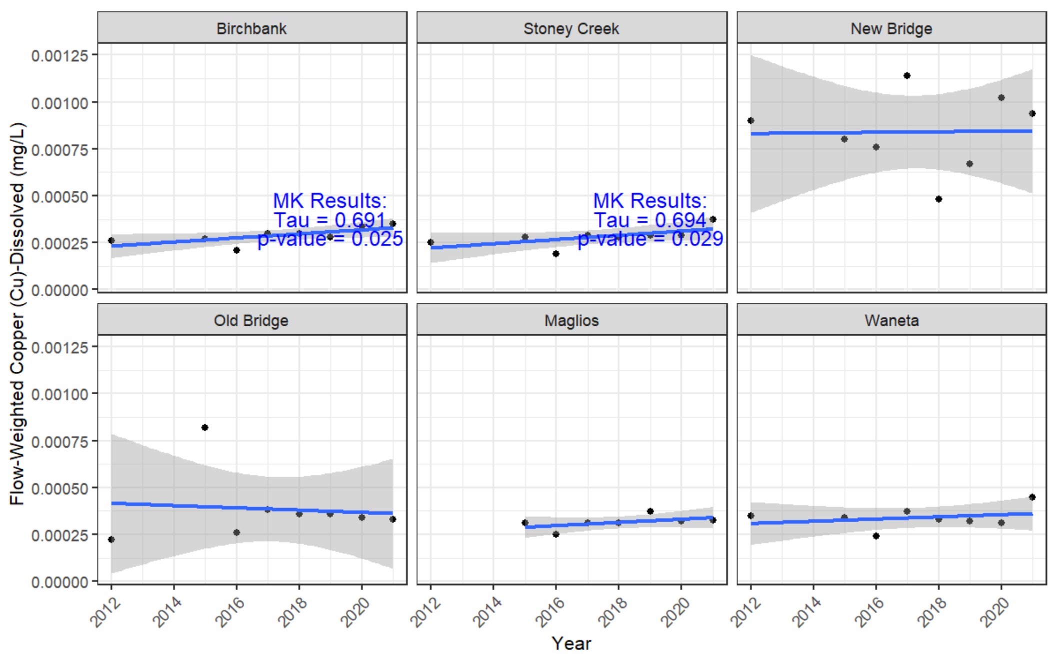


Figure 5-37: Fall flow-weighted concentrations of Copper (Dissolved) across sites. Sites with significant trends include the Mann-Kendall (MK) test results. Blue line represents a linear regression.

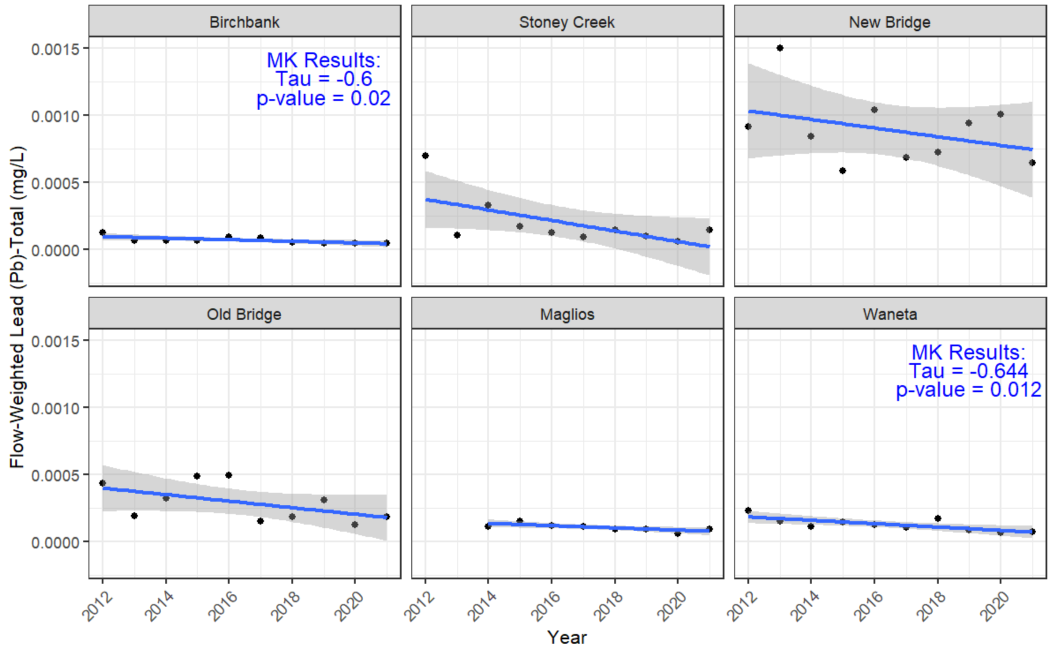


Figure 5-38: Spring flow-weighted concentrations of Lead (total) across sites. Sites with significant trends include the Mann-Kendall (MK) test results. Blue line represents a linear regression.

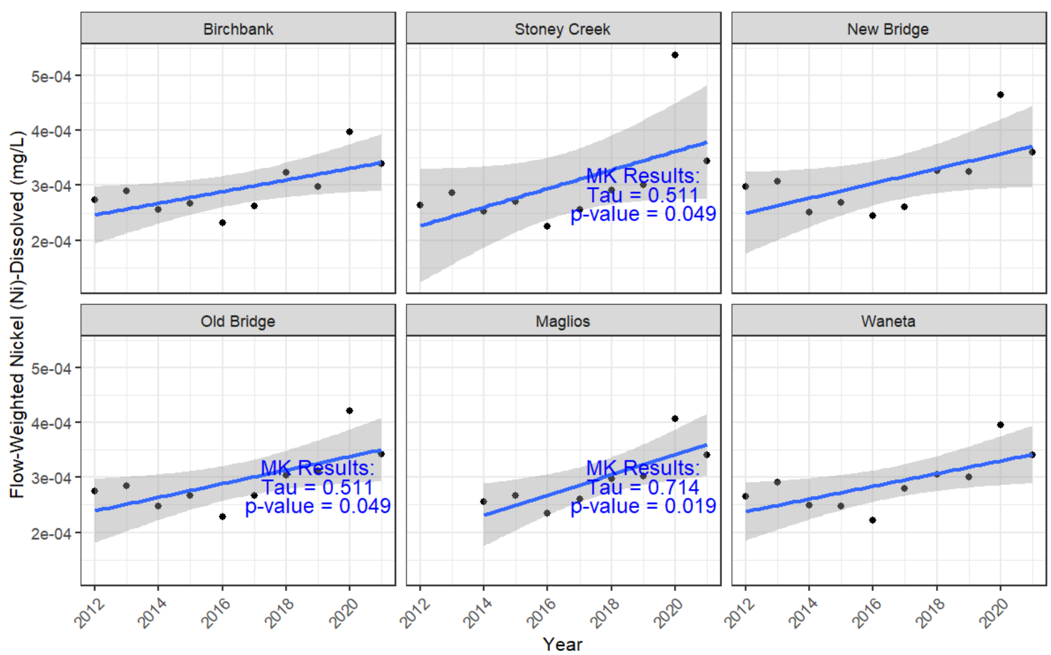


Figure 5-39: Spring flow-weighted concentrations of Nickel (Dissolved) across sites. Sites with significant trends include the Mann-Kendall (MK) test results. Blue line represents a linear regression.

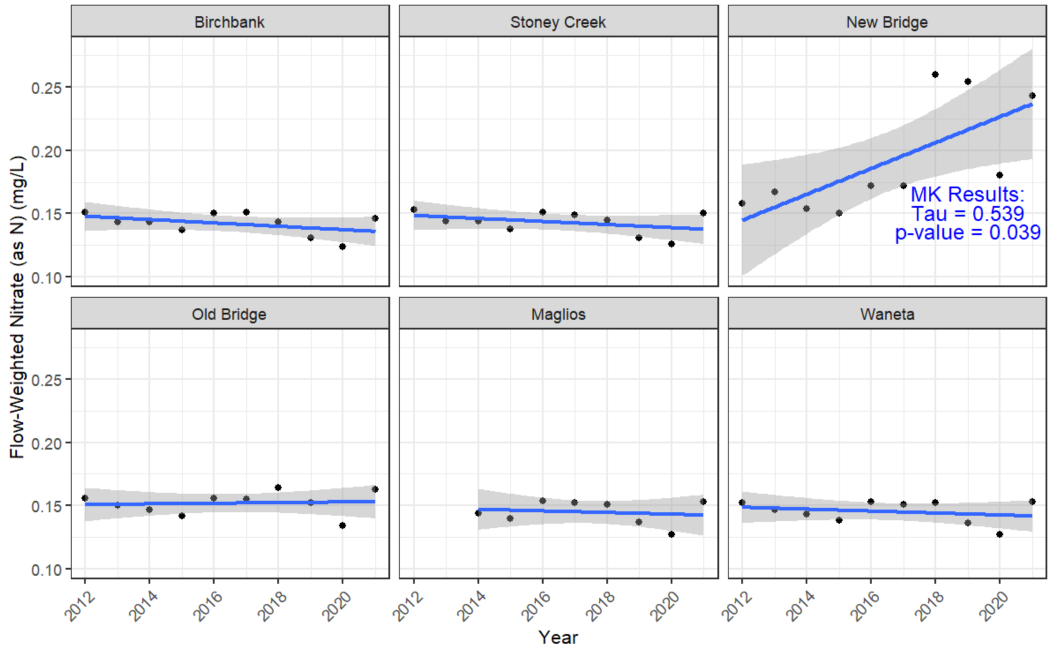


Figure 5-40: Spring flow-weighted concentrations of Nitrate (Total) across sites. Sites with significant trends include the Mann-Kendall (MK) test results. Blue line represents a linear regression.

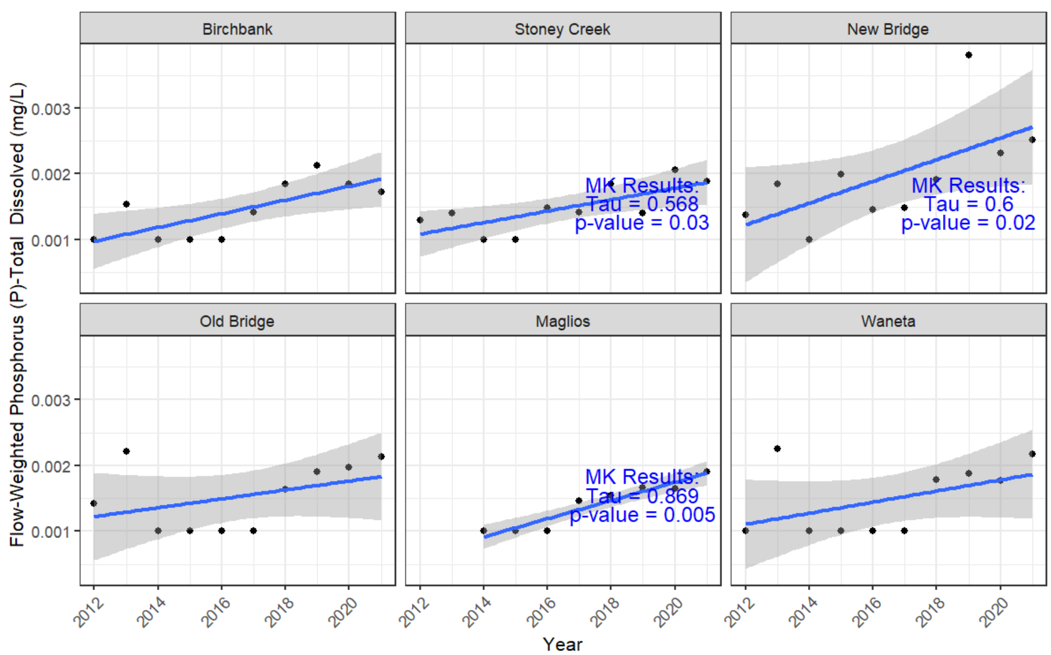


Figure 5-41: Spring flow-weighted concentrations of Phosphorus (Total) across sites. Sites with significant trends include the Mann-Kendall (MK) test results. Blue line represents a linear regression.

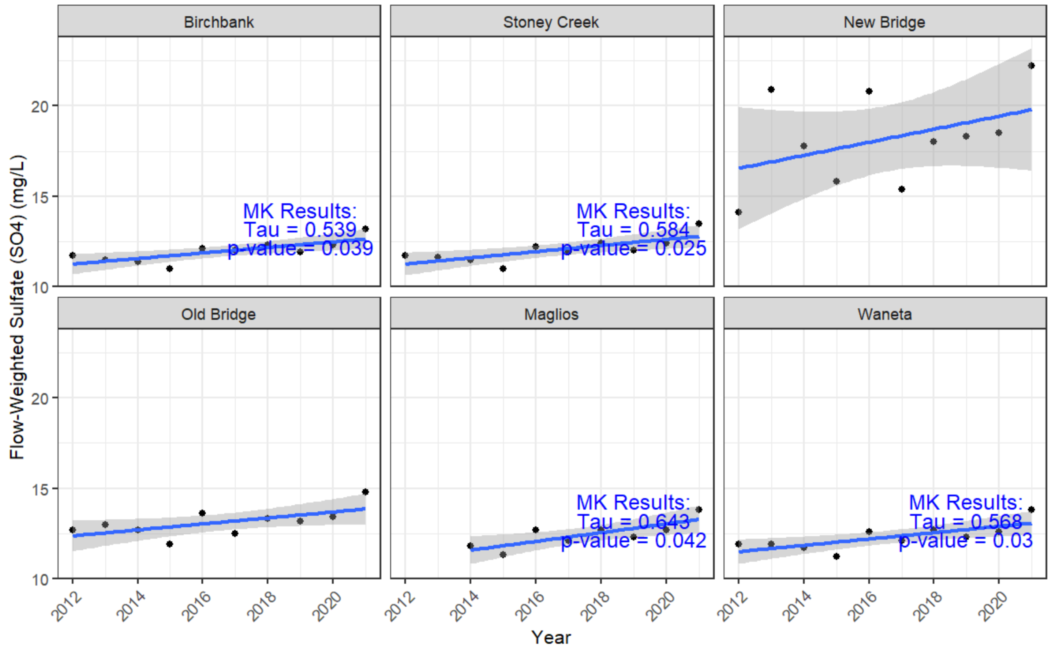


Figure 5-42: Spring flow-weighted concentrations of Sulfate (Total) across sites. Sites with significant trends include the Mann-Kendall (MK) test results. Blue line represents a linear regression.

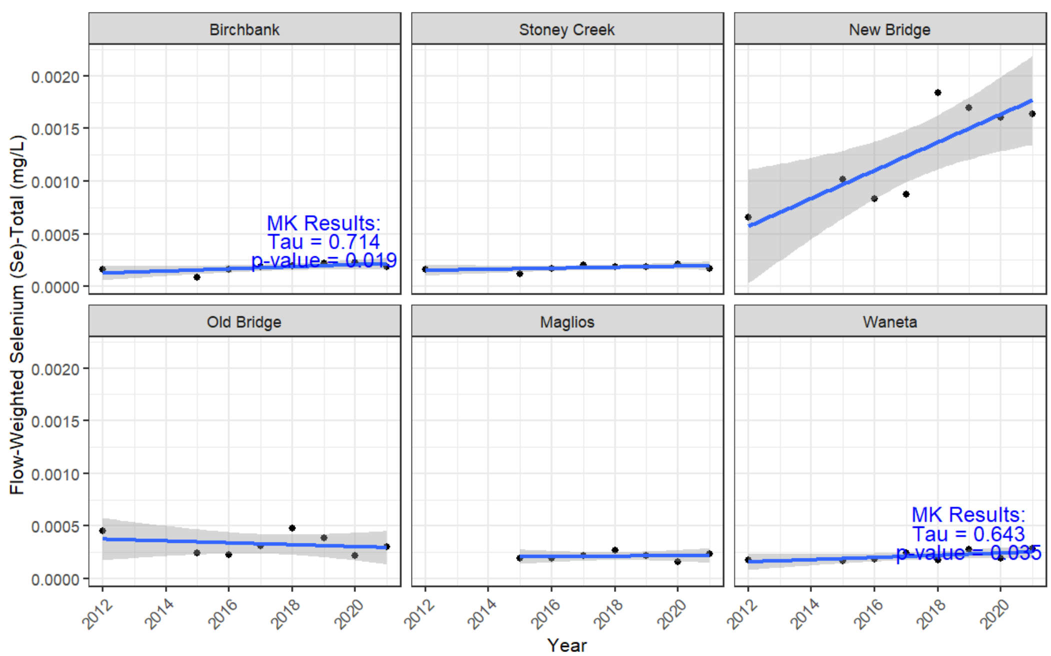


Figure 5-43: Fall flow-weighted concentrations of Selenium (Total) across sites. Sites with significant trends include the Mann-Kendall (MK) test results. Blue line represents a linear regression.

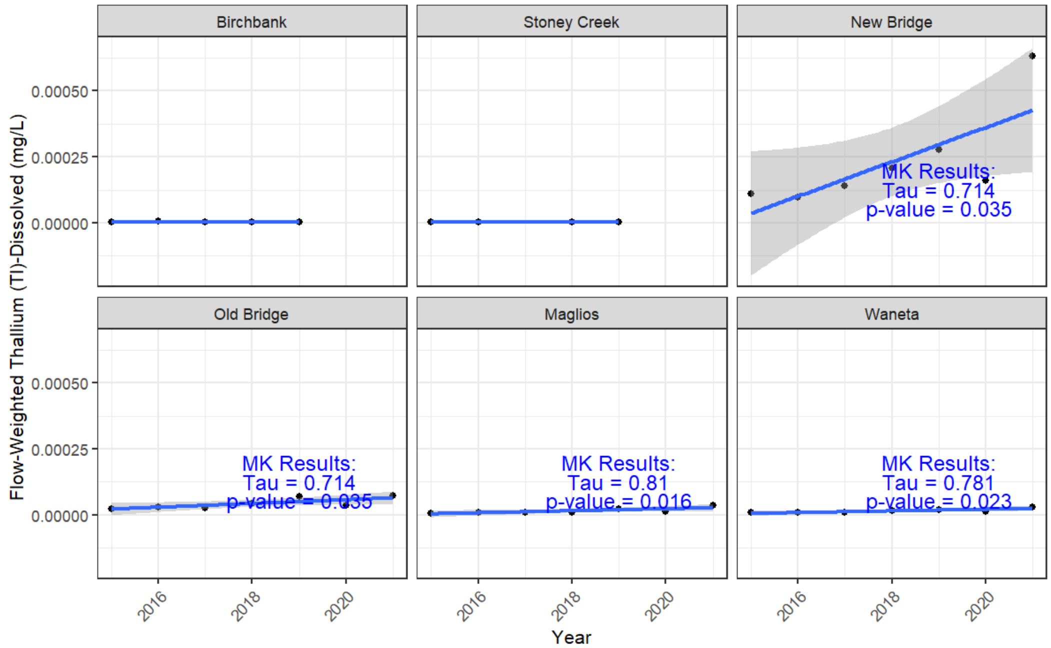


Figure 5-44: Summer flow-weighted concentrations of Thallium (Dissolved) across sites. Sites with significant trends include the Mann-Kendall (MK) test results. Blue line represents a linear regression.

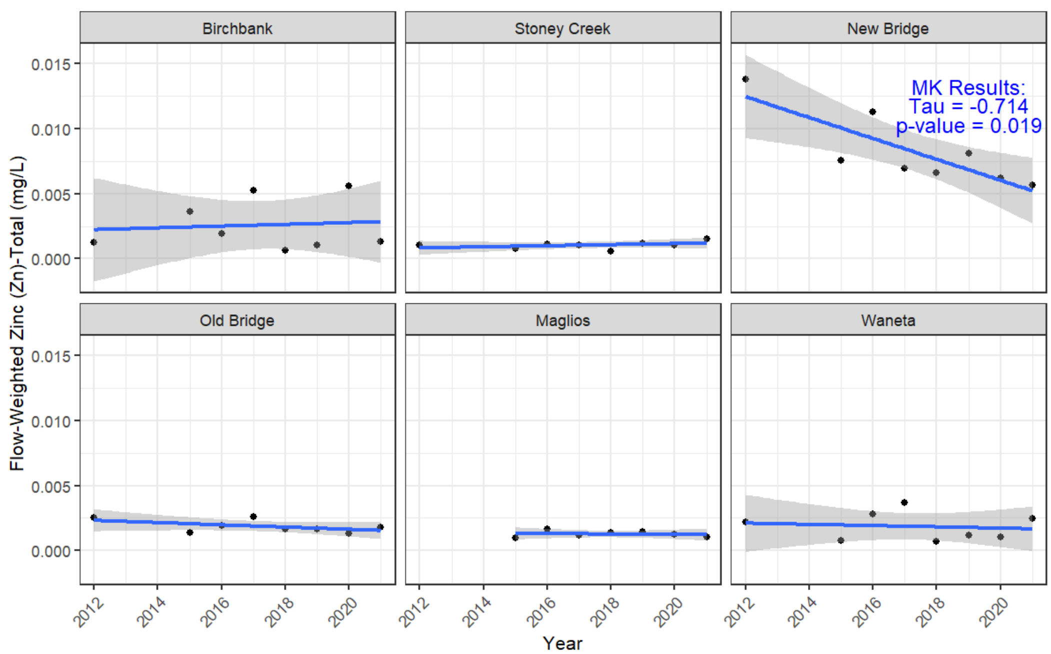


Figure 5-45: Fall flow-weighted concentrations of Zinc (Total) across sites. Sites with significant trends include the Mann-Kendall (MK) test results. Blue line represents a linear regression.

5.1.3.16 Quality Assurance and Quality Control

In ultra-low metals detection, a small discrepancy between duplicate samples causes a relatively large percentage difference that can exceed the QC assessment criterion of 50%. All samples with >50% RPD (reportable detection limit) had concentrations that were less than 5 times the method limit of detection and therefore below the practical calculated limit for RPD.

The resulting AEMP analytical values were suitable for addressing water quality objectives of this study. The residual analytical discrepancies did not interfere with data interpretation.

5.2 Depositional Area Sediment Quality

5.2.1 Sediment Condition and Composition

Depositional sediments are dynamic. Sediment composition measured at the same LCR sites is variable between years, almost certainly as a function of flow regime. The percentage of fines in depositional sites in the silt/clay fraction were generally low, ranging from 0.7 to 36% (Hatfield 2008), from 3 – 23 % (Golder 2003), and between <1 – 9% in 2012 (Hawes et al 2014). In all studies, the dominant material in the LCR depositional areas was sand (Hawes et al. 2019).

In sediment sampling, a strong correlation between decreasing grain size and increasing metal concentrations is expected, making comparison of samples dominated by a sand fraction with one dominated by a silt fraction inappropriate (Wisconsin DoNR 2003). Sediment samples collected from reference sites since 2012 contained >94% sand, and exposure sites contained >92% sand, therefore reference and exposure samples can be compared.

Microscope evaluation of depositional sediments in 2012 through 2018 confirmed that the contribution made to the biofilm by algae was small compared to erosional periphyton biofilms, while the contribution made by bacteria and organic debris was greater. Together, these depositional sediment components exert an influence on metal concentrations and bioavailability at these small LCR depositional pockets.

It was very difficult to definitively determine slag presence in the field and even with a microscope because differentiating between slag and other dark particulates is challenging; therefore, results should be interpreted with caution. Similarly, estimates of slag content made in earlier reports that were based only on visual inspection in the field should be interpreted with caution. Thus, estimates of residual slag in the LCR AOI, from field and microscopic identification are tentative. With these limitations in mind, field and microscope estimates of the percentage of slag in the depositional sediment samples has decreased since the last slag discharge in 1995. Field estimates from depositional areas were higher in 2003 than microscope estimates from 2012 and estimates were lower still in 2015 and restricted to 1 or 2 particles per sample viewed in 2018. In recent years (2018 and 2021), dark particulates that appeared to be a slag-type material were only noted in DEP-Exp-2, and to a lesser extent, DEP-Exp-3 samples.

5.2.2 2021 Sediment Metals Concentrations

There were no exceedances of any contaminants of potential concern at any of the reference depositional areas.

Arsenic exceeded the ISQG (5.9 mg/kg) at Casino and Trimac for the 2 mm sediment fraction (Table 5-10). In the 63 µm fraction, the PEL (17 mg/kg) for arsenic was also exceeded at Casino and Trimac, with values of 36.7 and 34.1 mg/kg respectively.

Cadmium exceeded the ISQG (0.6 mg/kg) at Casino, Trimac, and Waneta for the 2 mm sediment fraction (Table 5-10). In the 63 µm fraction, cadmium exceeded the ISQG at all seven exposure sites, with the PEL (3.5 mg/kg) being exceeded at Casino and Trimac. The highest cadmium concentration was at the Trimac site with a value of 9.29 mg/kg.

Chromium concentrations in the 2 mm sediment fraction exceeded the ISQG (37 mg/kg) at Casino only (Table 5-10). In the 63 µm fraction, chromium exceeded the ISQG at Casino, Trimac, Fort Shepherd, and Waneta.

In the 2 mm fraction, copper exceeded the ISQG (36 mg/kg) at all exposure sites with the exception of Korpac. Copper concentrations in the 2 mm fraction also exceeded the PEL (197 mg/kg) at Casino, Airport Bar, and Trimac, with concentrations of 738, 265, and 221 mg/kg respectively (Table 5-10). In the 63 µm fraction, copper concentrations also exceeded ISQGs at all exposure sites with the exception of Korpac. In addition, Casino and Trimac both had copper concentrations that exceeded the PEL at 1130 and 1,070 mg/kg respectively.

Lead concentrations exceeded the ISQG (35 mg/kg) at all exposure sites for both the 2 mm and 63 µm sediment fractions (Table 5-10). The PEL (91 mg/kg) was exceeded at Casino and Trimac for both size fractions as well as at Fort Shepherd and Waneta for the 63 µm fraction. Casino and Trimac had the highest lead concentrations in both sizes fractions.

There were no exceedances of mercury in the 2 mm sediment fraction at any of the reference or exposure sites. Casino exceeded the ISQG (0.2 mg/kg) for mercury in the 63 µm fraction and Trimac exceeded the PEL (0.5 mg/kg) for mercury in the 63 µm fraction.

There were no exceedances of nickel in the 2 mm sediment fraction at any of the reference or exposure sites. However, in the 63 µm fraction, nickel exceeded the ISQG (16 mg/kg) at all exposure sites with the exception of Korpac (Table 5-10).

In the 2 mm fraction, silver concentrations exceeded the LCR sediment guideline (0.5 mg/kg) at Maglios, Casino, Airport Bar, and Trimac (Table 5-10). In the 63 µm fraction, silver concentrations exceeded the LCR Guideline at Casino, Airport Bar, Trimac, Fort Shepherd, and Waneta.

Zinc concentrations in the 2 mm fraction exceeded the ISQG (123 mg/kg) at all exposure sites and exceeded the PEL (315 mg/kg) at all exposure sites except Korpac. The highest concentrations were in Casino and Trimac, with concentrations in the 63 µm fraction being 6,140 and 5,500 mg/kg respectively (Table 5-10).

Table 5-10: Sediment Data Summary for 2021 sampling denoting exceedances of BC/CCME ISQG and PEL Sediment Quality Guidelines.

		Reference Sites			Exposure Sites						
COPC	Size Fraction	Kootenay Dep-Ref-1	Genelle Dep-Ref-2	Birchbank Dep-Ref-3	Korpac Dep-Exp-1	Maglios Dep-Exp-2	Casino Dep-Exp-3	Airport Bar Dep-Exp-4	Trimac Dep-Exp-5	Ft Shep. Dep-Exp-6	Waneta Dep-Exp-7
Arsenic	2 mm	1.47	2.1	1.23	2.77	5.11	**9.19**	5.15	**6.44**	3.65	4.49
	63 um	2.94	3.53	3.44	3.89	4.5	**36.7**	3.99	**34.1**	**8.72**	**10.5**
Cadmium	2 mm	0.244	0.519	0.179	0.462	0.474	**0.947**	0.558	**1.35**	0.382	**0.617**
	63 um	**0.816**	**0.994**	**0.785**	**1.16**	**0.978**	**5.61**	**0.897**	**9.29**	**1.37**	**3.2**
Chromium	2 mm	18	20.3	14.9	14.3	22.6	**49.1**	26.6	27.6	23.8	27.6
	63 um	30.1	28.2	30.5	21.2	28	**62.1**	28.9	**79.6**	**44.2**	**51.9**
Copper	2 mm	6.47	9.12	5.75	17.8	**130**	**738**	**265**	**221**	**94.9**	**127**
	63 um	17.9	18.9	18.2	19.3	**54.1**	**1130**	**78.5**	**1070**	**189**	**195**
Lead	2 mm	7.68	12	6.39	**40.9**	**60.4**	**140**	**57.6**	**110**	**41**	**53.5**
	63 um	17.9	24.6	18.1	**45**	**55**	**533**	**49.8**	**788**	**109**	**164**
Mercury	2 mm	0.02	0.02	0.02	0.02	0.06	0.02	0.045	0.158	0.072	0.02
	63 um	0.02	0.02	0.02	0.06	0.129	**0.418**	0.141	**3.47**	0.112	0.157
Nickel	2 mm	10.9	15.1	10.2	10.5	11.2	10	11.3	12.3	14.2	14.1
	63 um	**20.8**	**19.8**	**20.4**	14.7	**16.6**	**19.9**	**16.1**	**32.3**	**24.7**	**26.7**
Silver	2 mm	0.29	0.05	0.05	0.05	**0.55**	**2.19**	**4.81**	**1.23**	0.44	0.38
	63 um	0.19	0.17	0.13	0.31	0.46	**16.3**	**1.16**	**7.03**	**3.18**	**2.23**
Zinc	2 mm	86.3	117	63.9	**176**	**934**	**8070**	**1440**	**1520**	**639**	**1030**
	63 um	**146**	**141**	**123**	**188**	**380**	**6140**	**593**	**5500**	**885**	**1370**

 # bold > LCR objective / ISQG

 # bold (shaded) > PEL and LCR objective /ISQG

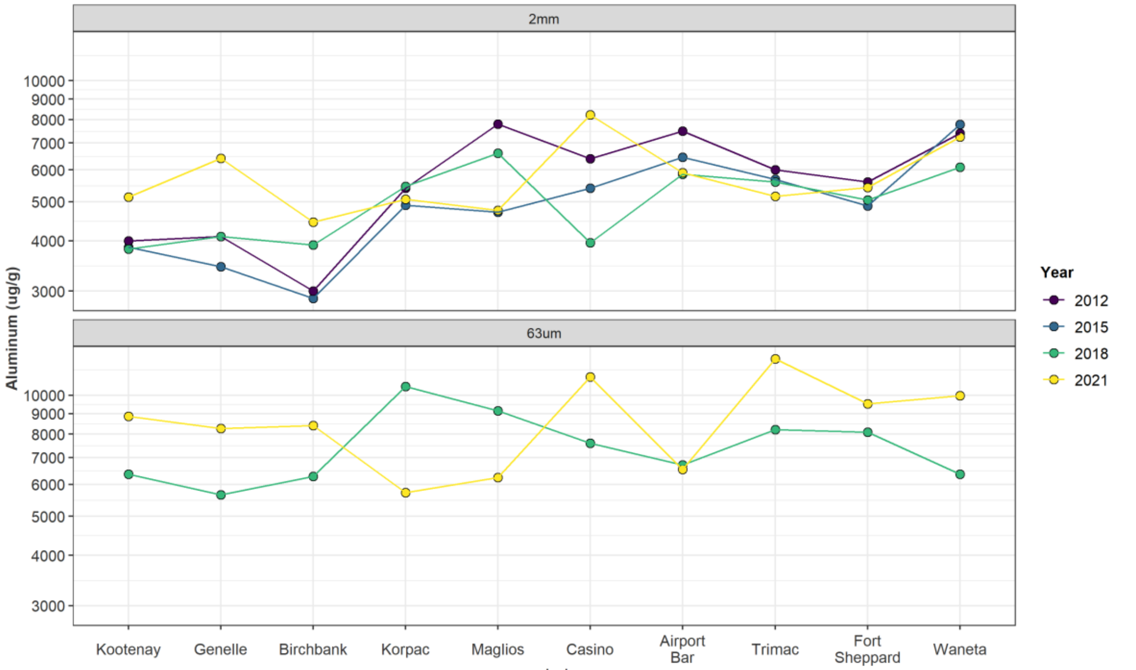
Note: the highest value among duplicate pairs is presented in this table

Table 5-11 provides a summary comparison of reference sites and exposure sites for both the <63 µm and the <2 mm sediment fractions. Concentrations of the metals of interest in depositional sediments were significantly higher at exposure sites than at reference sites in 2012, 2015, 2018, and 2021 (exposure site concentrations greater than two times the standard deviation of reference site concentration; Table 5-11).

Table 5-11: Average and standard deviation (n=3) for depositional sediment samples (2 mm fraction mg/kg dry) from upstream reference sites (n=3) and downstream exposure sites (n=7) collected in 2021.

Sediment Metal	DEP-EXP (63 um)	DEP-EXP (2 mm)	DEP-REF (63 um)	DEP-REF (2 mm)
Antimony	36.43 ± 46.33	16.40 ± 11.98	0.38 ± 0.11	0.17 ± 0.04
Arsenic	14.63 ± 14.43	5.26 ± 2.09	3.30 ± 0.32	1.60 ± 0.45
Cadmium	3.215 ± 3.179	0.684 ± 0.346	0.865 ± 0.113	0.314 ± 0.181
Chromium	45.1 ± 21.0	27.4 ± 10.6	29.6 ± 1.2	17.7 ± 2.7
Copper	390.8 ± 489.2	227.7 ± 239.2	18.3 ± 0.5	7.1 ± 1.8
Iron	38040 ± 25530	31360 ± 25090	18970 ± 251.7	12430 ± 1620
Lead	249.10 ± 293.50	71.91 ± 38.04	20.20 ± 3.81	8.69 ± 2.94
Manganese	475.6 ± 384.4	451.9 ± 459.6	218 ± 7.6	148.7 ± 21.6
Mercury	0.641 ± 1.253	0.056 ± 0.049	0.02 ± 0	0.02 ± 0
Nickel	21.6 ± 6.5	11.9 ± 1.7	20.3 ± 0.5	12.1 ± 2.7
Selenium	1.15 ± 1.56	0.39 ± 0.31	0.54 ± 0.11	0.1 ± 0
Silver	4.38 ± 5.74	1.38 ±1.67	0.16 ± 0.03	0.13 ± 0.14
Thallium	0.35 ± 0.40	0.15 ± 0.07	0.13 ± 0.01	0.08 ± 0.06
Tin	49.19 ± 62.71	23.07 ± 20.11	1.13 ± 0.09	0.47 ± 0.13
Zinc	2151 ± 2542	1973 ± 2728	136.7 ± 12.1	89.1 ± 26.7

Figure 5-46 to Figure 5-52 illustrate concentrations of metals of interest measured in sediments (2012-2021) collected from three reference sites (Kootenay Eddy, Genelle, and Birchbank), and from seven downstream exposure sites (Korpac, Maglios, Casino, Airport Bar, Trimac, Fort Shepherd Eddy, and Waneta). Where they exist, published guidelines are indicated on each figure to illustrate where exceedances may have occurred.



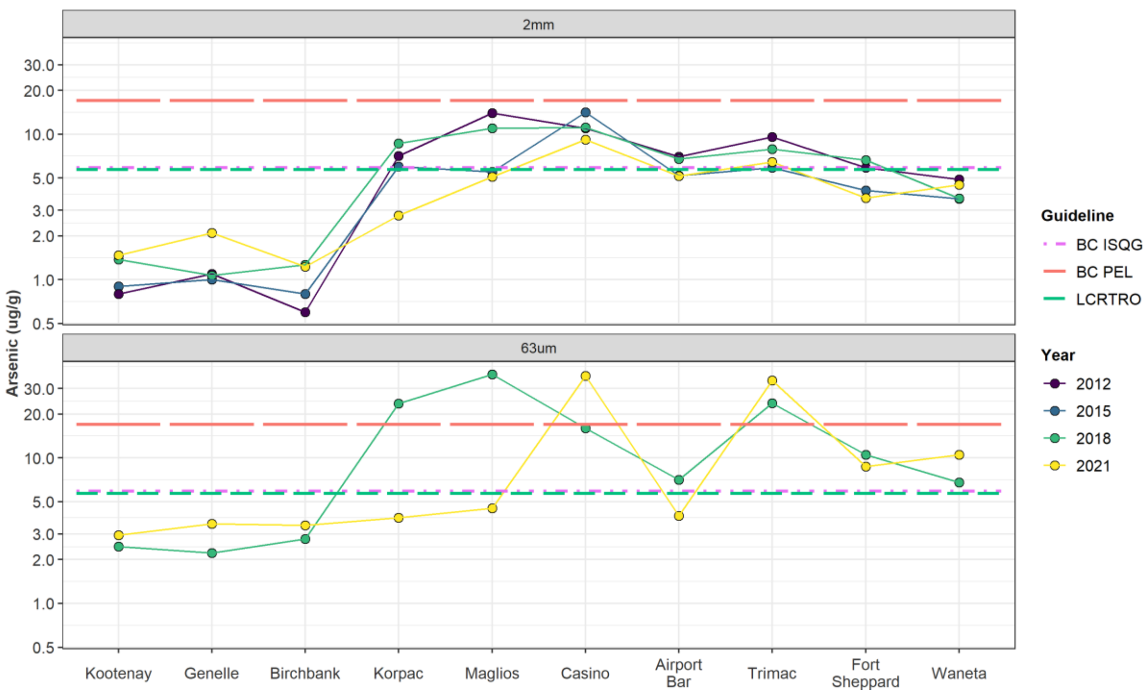
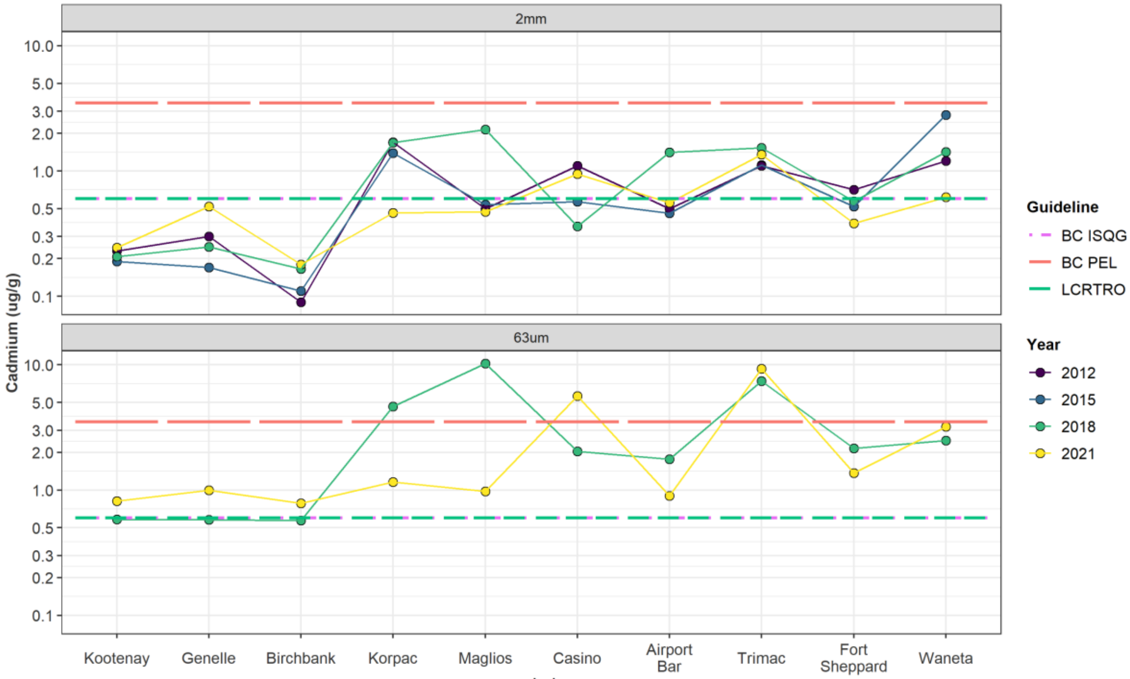


Figure 5-46: Distribution of aluminum and arsenic, concentrations in depositional sediments with distance from the TTS -Teck Trail Smelter. No applicable guidelines are defined for Al. The top pane presents data in the <2mm fraction and the lower pane presents data in the <63µm fraction.



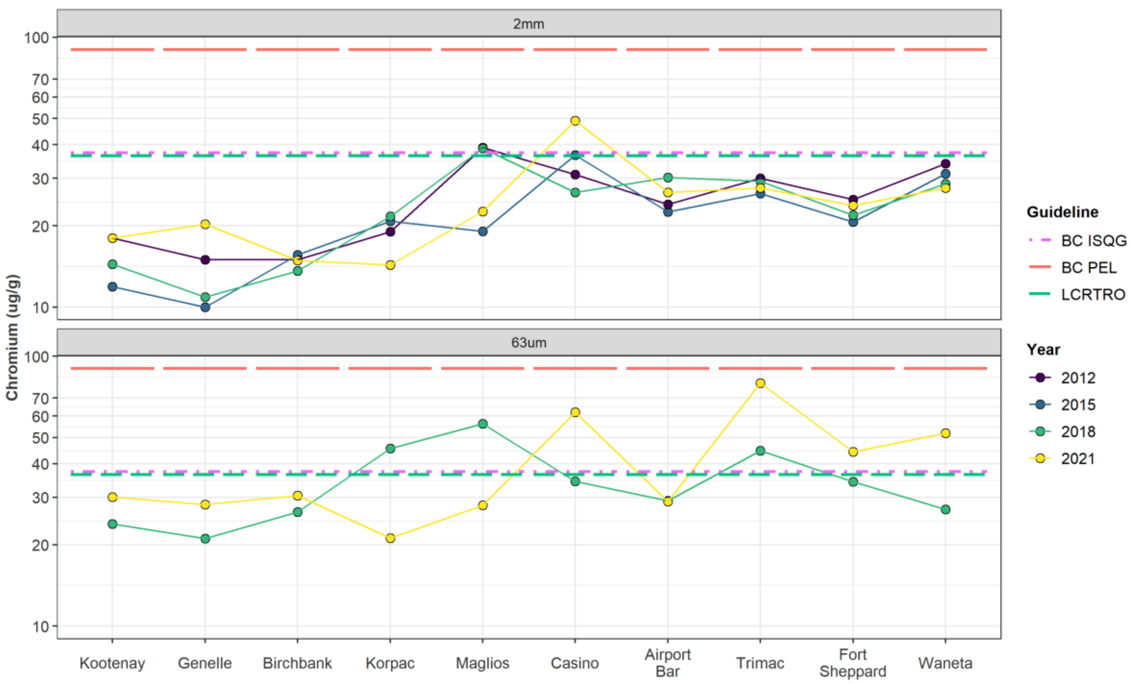


Figure 5-47: Distribution of cadmium and chromium concentrations in depositional sediments with distance from the smelter. The top pane presents data in the <2mm fraction and the lower pane presents data in the <63µm fraction.

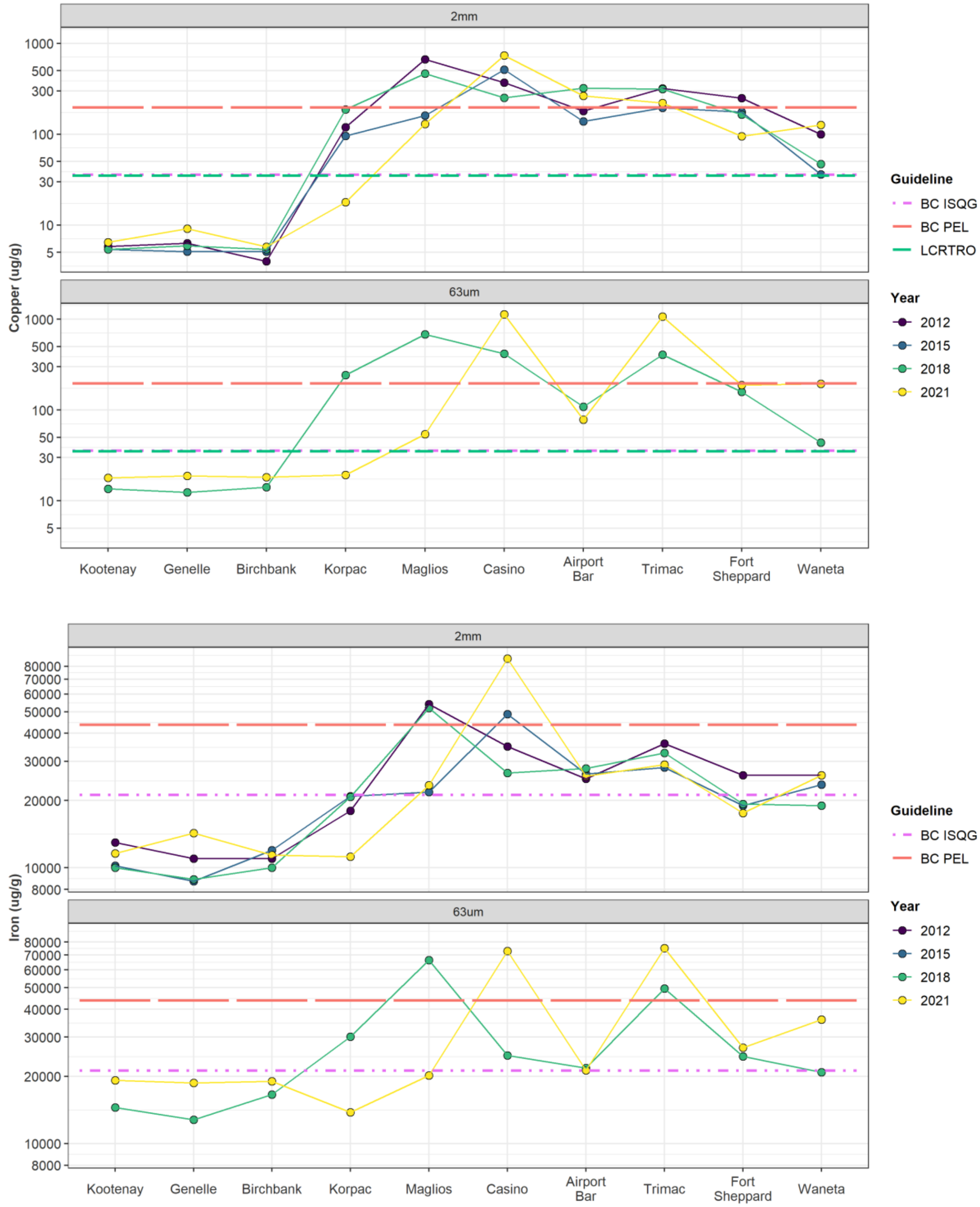


Figure 5-48: Distribution of copper and iron concentrations in depositional sediments with distance from the smelter. The top pane presents data in the <2mm fraction and the lower pane presents data in the <63µm fraction.

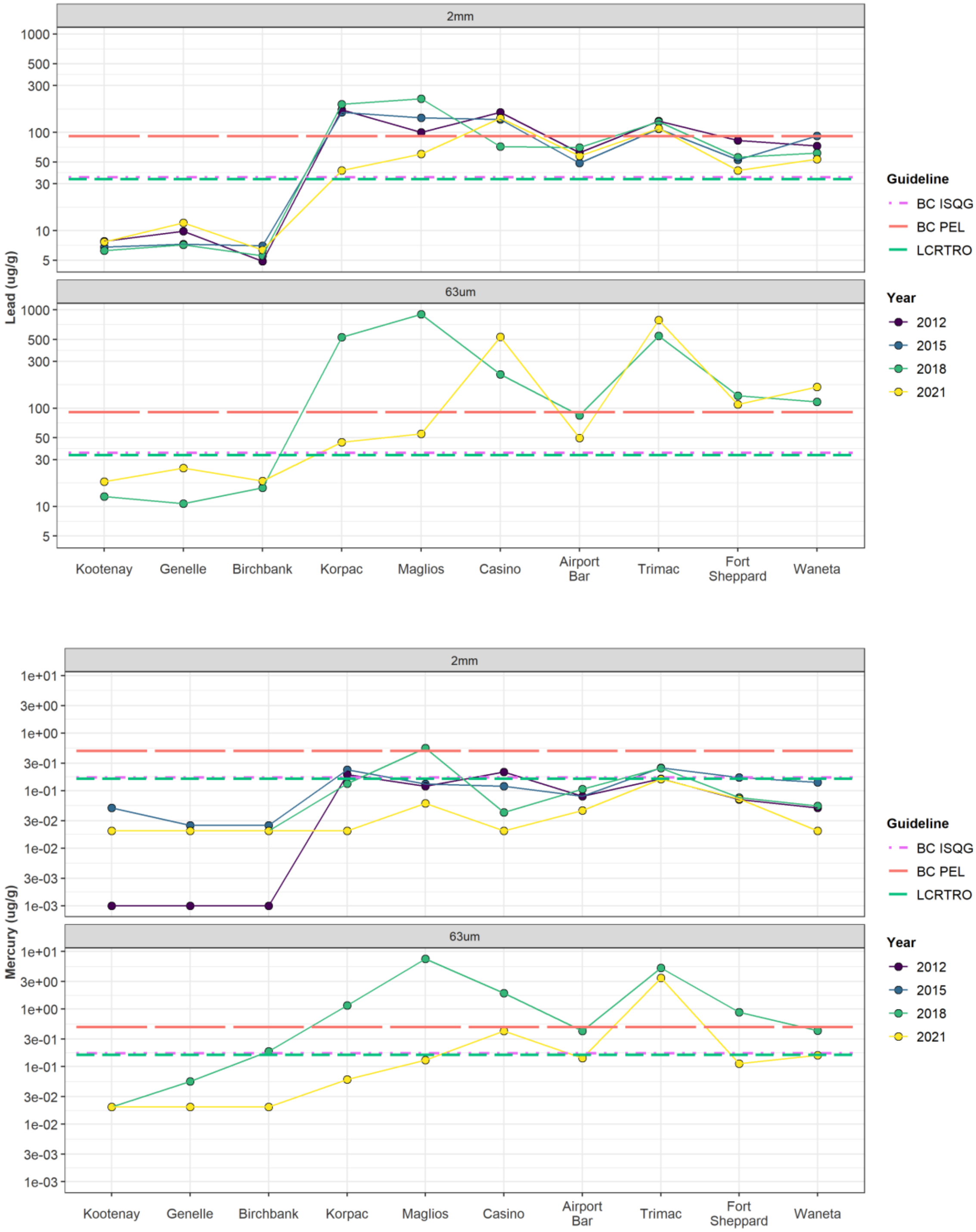
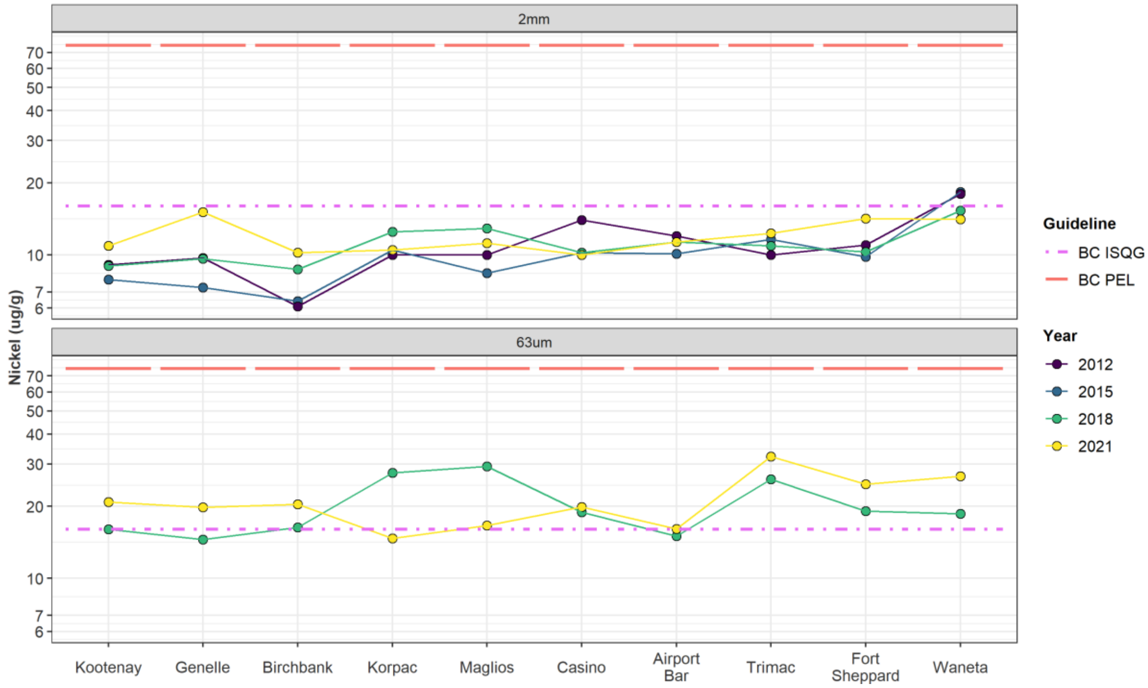


Figure 5-49: Distribution of lead and mercury concentrations in depositional sediments with distance from the smelter. The top pane presents data in the <2mm fraction and the lower pane presents data in the <63µm fraction.



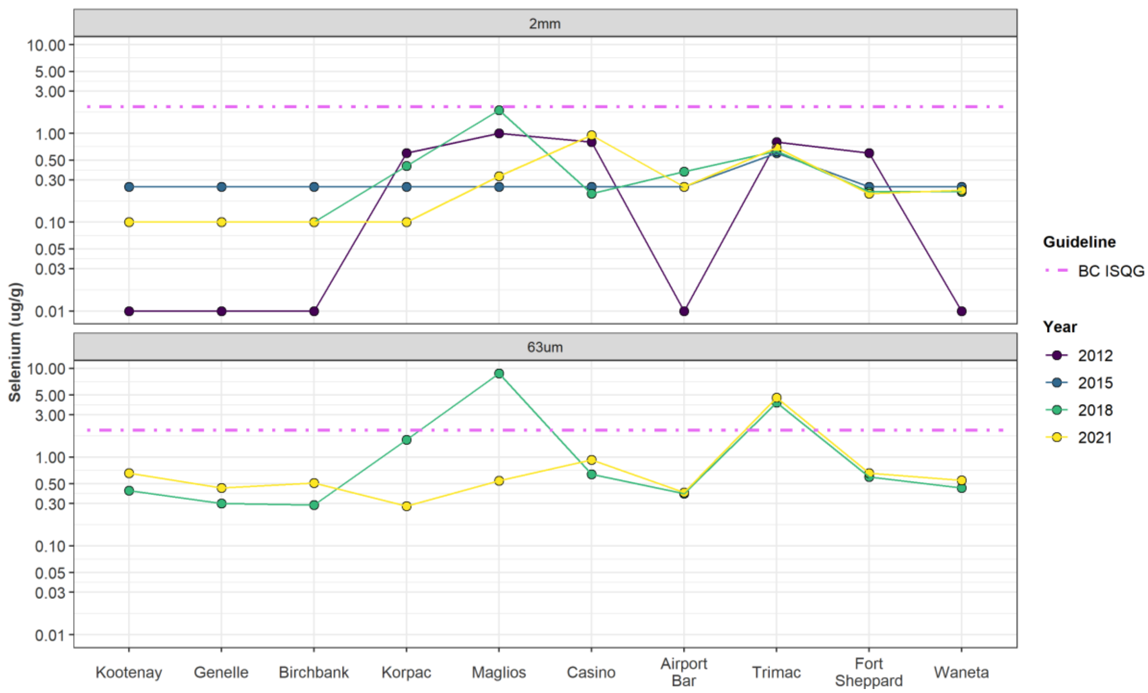
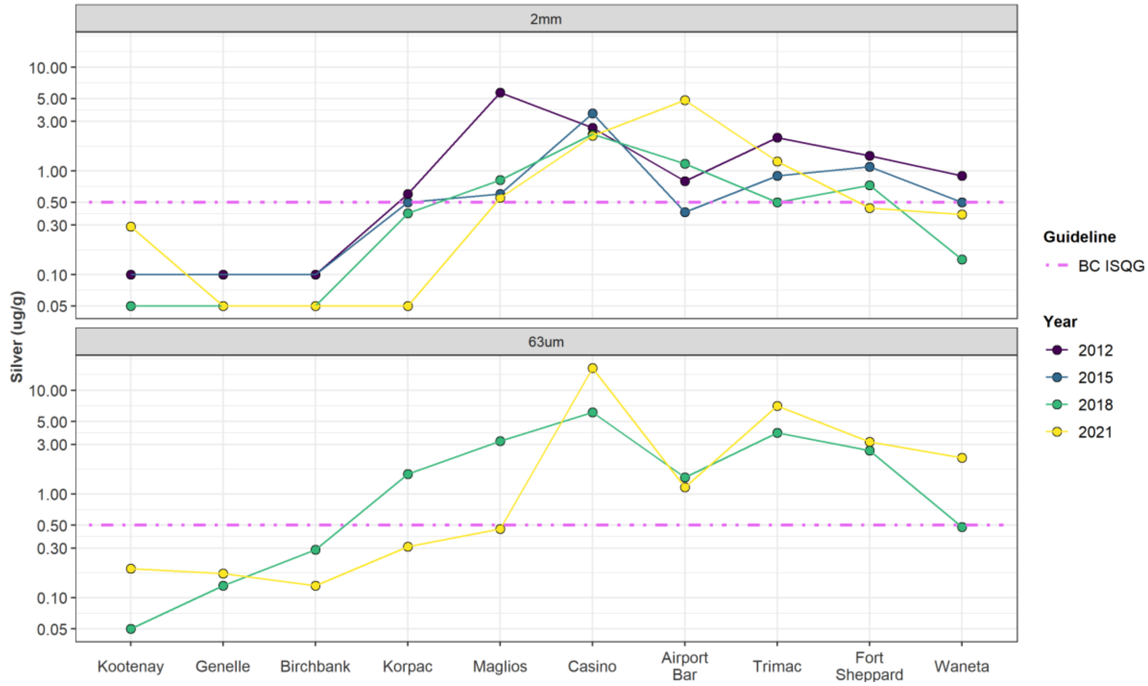


Figure 5-50: Distribution of nickel and selenium concentrations in depositional sediments with distance from the smelter. The top pane presents data in the <2mm fraction and the lower pane presents data in the <63µm fraction.



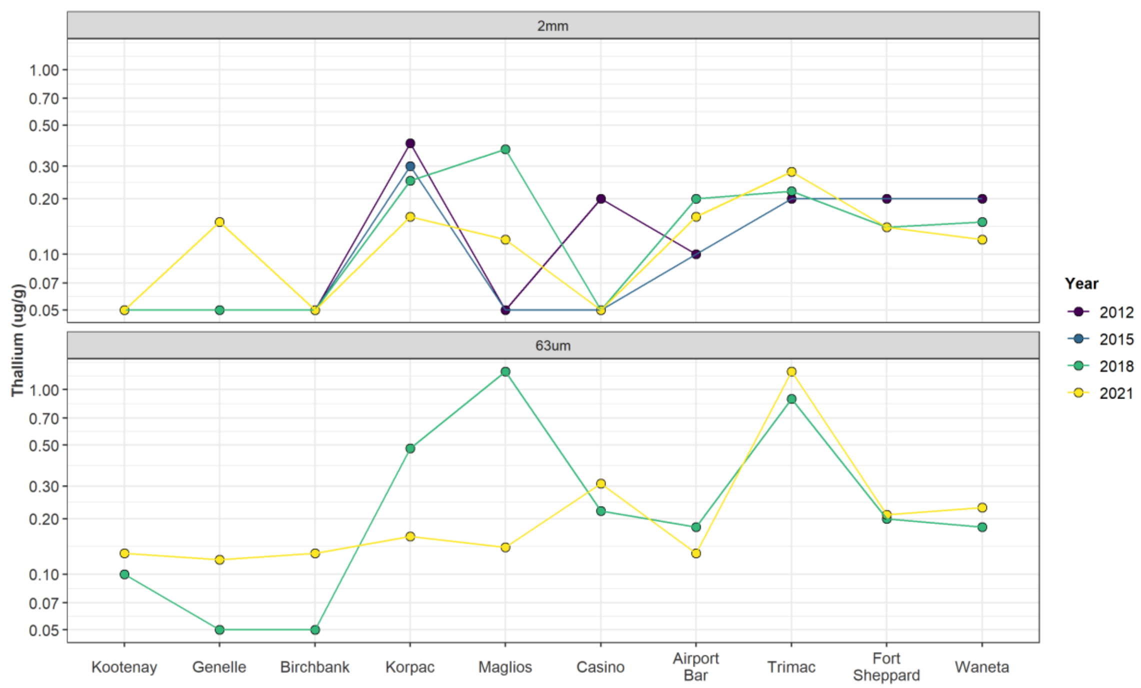


Figure 5-51: Distribution of silver and thallium concentrations in depositional sediments with distance from the smelter. The top pane presents data in the <2mm fraction and the lower pane presents data in the <63µm fraction.

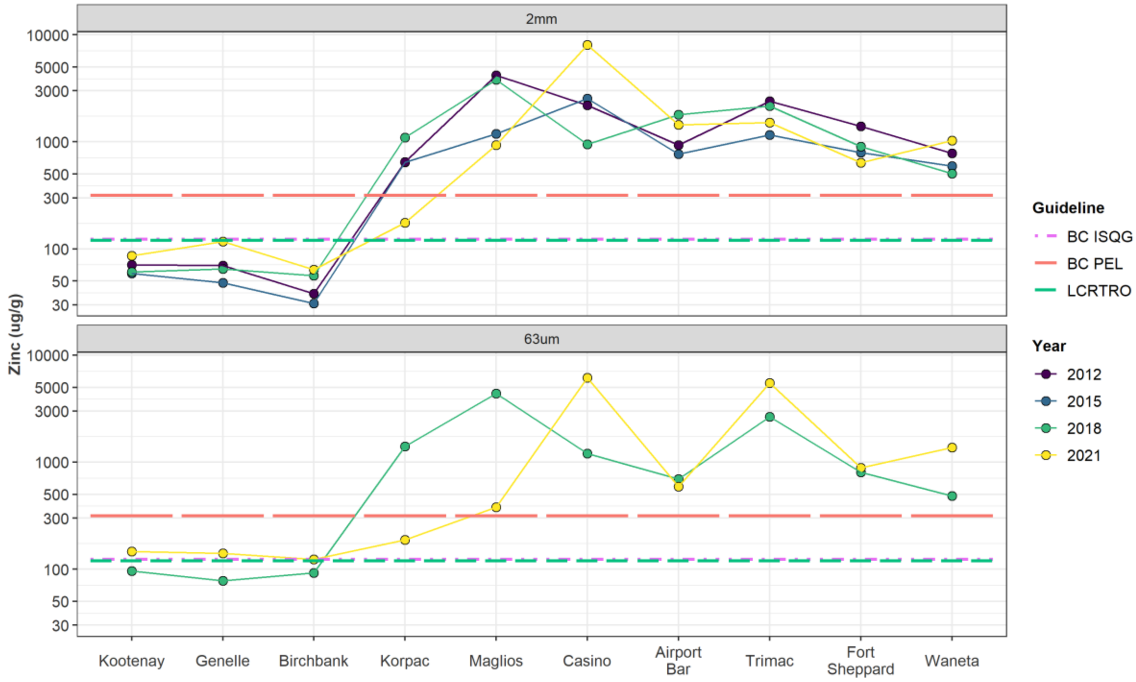


Figure 5-52: Distribution of zinc concentrations in depositional sediments with distance from the smelter. The top pane presents data in the <2mm fraction and the lower pane presents data in the <63µm fraction.

Distance from the smelter was a factor in sediment metal distribution but had a non-linear relationship to sediment metal distribution for: aluminum, arsenic, cadmium, chromium, copper, lead, and zinc (Figure 5-46 through Figure 5-52). No sediment metals of interest consistently decreased with distance from smelter in 2021. The non-linear pattern of sediment exceedances as distance from the smelter increases suggests there are site-specific effects which may include influences of river flow dynamics along with other sources of metals such as naturally occurring metal concentrations, historical mining and milling, municipal effluent and/or stormwater (Table 5-12).

Due to the dynamic nature of the LCR, the historical Maglios, Airport Bar, and Birchbank sites had been scoured by high flows and were no longer suitable depositional sites in 2018 and 2021. As a result, new sites were identified in the vicinity of the original sites and sampled in 2018 and repeated in 2021. Due to the new location of these sites in 2018, data from 2018 and 2021 are not directly comparable to historical data.

Temporal changes in sediment metal concentrations in these small depositional pockets will not only reflect environmental improvements (including the cessation of slag discharge along with other environmental improvements), but they will also reflect the dynamics of the river flow regime where high flows scour, and low flows allow deposition of organics. Due to the river flow dynamics and transient nature of some of the small sample sites, sediment metal trends are difficult to discern.

Table 5-12: Sediment Metal Exceedances (<2 mm and <63 µm fraction) of CCME ISQG in Depositional Exposure Sites 2003, 2012, 2015, 2018, and 2021.

Sites	2003 (<2mm)	2012 (<2mm)	2015 (<2mm)	2018		2021	
				<63	<2mm	<63	<2mm
Dep-Ref-1	0	0	0	0	0	8	0
Dep-Ref-2	0	0	0	0	0	3	0
Dep-Ref-3	0	0	0	2	0	3	0
Dep-Exp-1	6	7	6	10	5	3	2
Dep-Exp-2	7	8	5	12	10	5	5
Dep-Exp-3	7	9	7	10	6	11	9
Dep-Exp-4	7	6	4	8	8	7	5
Dep-Exp-5	8	8	7	12	8	12	7
Dep-Exp-6	6	6	4	9	5	9	3
Dep-Exp-7	7	7	6	7	4	9	5

5 sediment cores were collected at each site and combined to form a single sample in each year.

* New Maglios and Airport Bar sites sampled in 2018 and again in 2021 because the historical depositional sites no longer existed due to scour.

Sediment metal concentrations in the <2 mm fraction remained relatively steady in the 2012 to 2021 data, both in terms of concentration and number of guideline exceedances (Figure 5-53; Table 5-13). Some decline in concentrations is evident when the 2012-2021 data are compared to 2003 data. Inter-annual variability in sediment metals concentrations is expected due to the dynamic and mobile nature of LCR sediments. Sediment metals concentrations in 2021 were higher than in 2015 at several sites, notably Casino where 2021 concentrations were elevated (Table 5-13). This is interpreted to be a reflection of inter-annual variability due to the transient nature of the smaller depositional sites (e.g., Maglios and Airport Bar sample sites were new depositional areas in 2018 that were re-sampled in 2021).

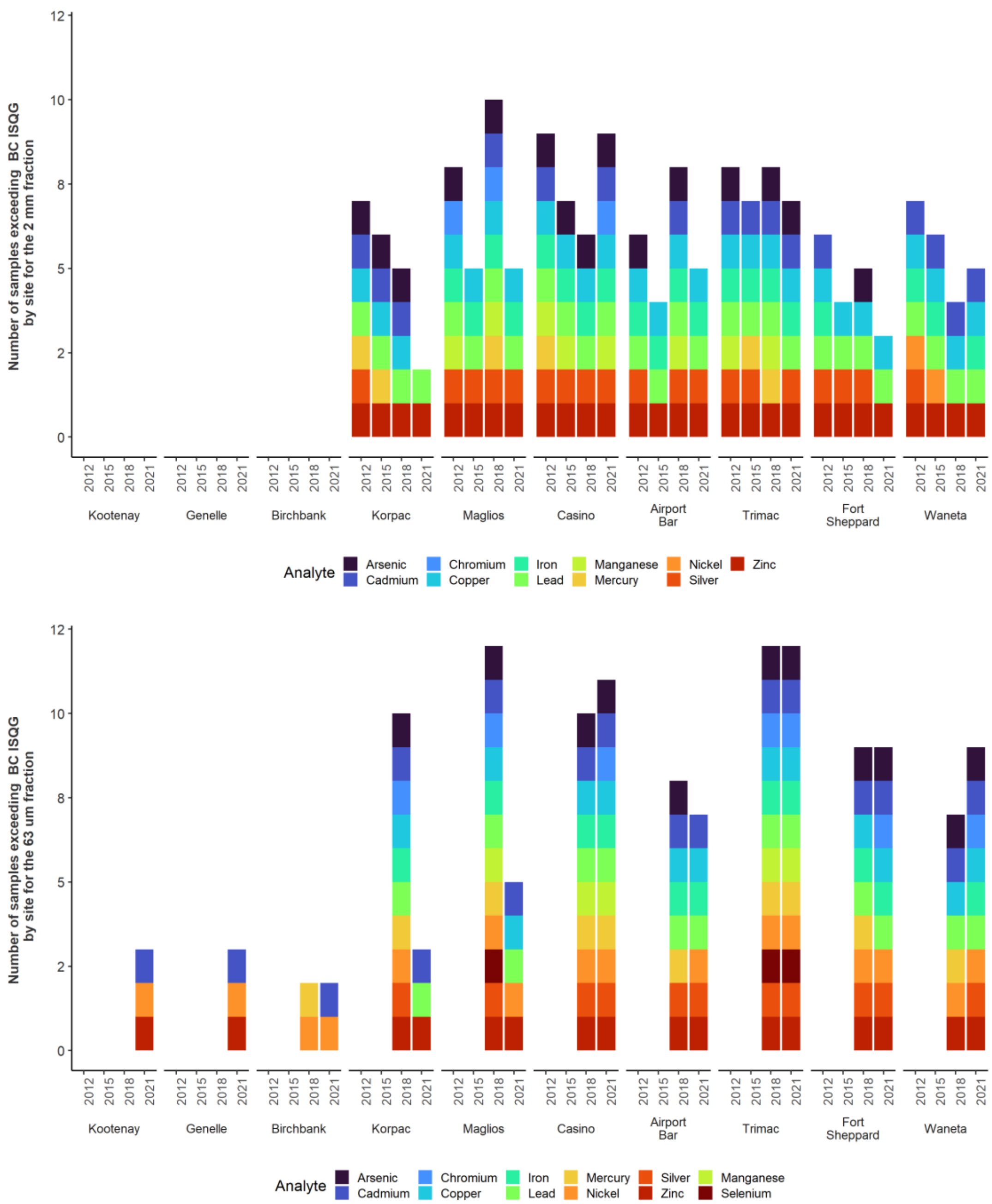


Figure 5-53: Number of sediment metal BC guideline exceedances at depositional sites in the LCR area of interest: 2003, 2012, 2015, 2018, and 2021. The top plot is based on the <2mm fraction and the bottom plot is based on the <63µm fraction.

The ecological importance of sediment guideline exceedances in the LCR is small relative to the context of the entire AOI, where the area of depositional habitat in the AOI is only about 0.1% (Golder 2007). Shifting conditions at these small depositional areas, with continual sediment influx from upstream sources and scouring to downstream mainstem sites caused variable results.

5.2.2.1 Sediment Metal Distributions and Trends

Sediment metal distributions are presented above (Figure 5-46 to Figure 5-52) as a function of distance from the smelter. The <63 µm fraction was analyzed only in 2018 and 2021, and biases metal concentrations high relative to the <2 mm fraction due to higher organic content. To assess trends between sampling years, only the <2 mm fraction results should be used.

A summary of all sediment data collected since 2003 is presented in Table 5-13. The number of <2 mm sediment samples that had metal concentrations below the lab reportable detection limits affects subsequent data analyses because with frequent non-detection, the data does not conform to a normal distribution. The 2012, 2015 2018, and 2021 sediment concentrations of As, Cd, Cr, Cu, Pb, and Zn were all above the limit of detection. Of the mercury sediment samples, 30%, 20%, 30%, and 60% were below the limit of detection in 2 mm fraction samples in 2012, 2015, 2018, and 2021 respectively. Selenium sediment samples were 50%, 90%, 30%, and 40% below detection limits in 2012, 2015, 2018, and 2021 respectively. For Tl, 40 to 50% of samples were below the limit of detection in 2012, 2015, and 2018, while 30% of samples were below the limit of detection in 2021.

Table 5-13: Sediment Data Summary (2003-2021) Denoting Exceedances of BC/CCME ISQG and PEL Sediment Quality Guidelines.

COPC	Sediment Quality Guideline: CCME ISQG	CCME PEL	BC ISQG	BC PEL	LCR Obj.	Year	Size Fraction Analyzed	Location: Reference Sites: Kootenay	Genelle	Birchbank*	Exposure Sites: Korpac	Maglios*	Casino	Airport Bar*	Trimac	Ft Shep.	Waneta
Arsenic	5.9	17	5.9	17	5.7	2003	2 mm	-	-	-	10.0	20.0	17.0	8.3	7.2	20.0	6.0
						2012	2 mm	0.8	1.1	0.6	7.1	14.0	11.0	7.0	9.6	5.9	4.9
						2015	2 mm	0.9	1	0.8	6	5.5	14.1	5.2	5.9	4.1	3.6
						2018	2 mm	1.38	1.07	1.27*	8.66	11.0*	11.1	6.76*	7.88	6.64	3.63
							63 um	2.46	2.22	2.78*	23.6	37.4*	16.5	7.05*	23.7	10.5	6.79
						2021	2 mm	1.47	2.1	1.23	2.77	5.11	9.19	5.15	6.44	3.65	4.49
							63 um	2.94	3.53	3.44	3.89	4.5	36.7	3.99	34.1	8.72	10.5
Cadmium	0.6	3.5	0.6	3.5	0.6	2003	2 mm	0.6	-	-	1.8	2.2	1.2	0.83	3.2	1.07	0.71
						2012	2 mm	0.23	0.3	0.09	1.7	0.5	1.1	0.6	1.1	0.71	1.2
						2015	2 mm	0.19	0.17	0.11	1.39	0.54	0.57	0.46	1.12	0.52	2.81
						2018	2 mm	0.208	0.248	0.165*	1.68	2.15*	0.49	1.41*	1.53	0.573	1.42
							63 um	0.584	0.580	0.572*	4.63	10.19*	2.42	1.76*	7.4	2.15	2.48
						2021	2 mm	0.244	0.519	0.179	0.462	0.474	0.947	0.558	1.35	0.382	0.617
							63 um	0.816	0.994	0.785	1.16	0.978	5.61	0.897	9.29	1.37	3.2
Chromium	37	90	37	90	36	2003	2 mm	-	-	-	-	56.0	-	-	-	-	80.0
						2012	2 mm	18	15	15	19.0	39.0	31.0	24.0	30.0	25.0	34.0
						2015	2 mm	11.9	10	15.6	20.8	19.1	36.6	22.5	26.3	20.7	31.2
						2018	2 mm	14.4	10.9	13.6*	21.7	38.7*	26.6	30.2*	29.3	21.9	28.6
							63 um	23.9	21.1	26.5*	45.5	56.2*	36.0	29.1*	44.7	34.29	27.1
						2021	2 mm	18	20.3	14.9	14.3	22.6	49.1	26.6	27.6	23.8	27.6
							63 um	30.1	28.2	30.5	21.2	28.0	62.1	28.9	79.6	44.2	51.9
Copper	36	197	36	197	35	2003	2 mm	-	-	-	415	1156	466	338	174	506	1685
						2012	2 mm	5.8	6.3	4	120	670	370	180	320	250	100
						2015	2 mm	5.4	5.1	5.1	95.9	161	514	139	196	176	36
						2018	2 mm	5.4	5.89	5.38*	188	467*	251	322*	315	165	46.9
							63 um	13.6	12.4	14.2*	243	681*	441	109*	408	158	43.8
						2021	2 mm	6.47	9.12	5.75	17.8	130	738	265	221	94.9	127
							63 um	17.9	18.9	18.2	19.3	54.1	1130	78.5	1070	189	195
Lead	35	91	35	91	33	2003	2 mm	-	-	-	173	335	142	122	150	193	126
						2012	2 mm	7.8	9.9	4.9	170	100	160	62.0	130	83.0	73.0
						2015	2 mm	6.8	7.3	7	160	141	136	48.9	109	52.8	91.9
						2018	2 mm	6.26	7.19	5.54*	194	220*	71.8	70.4*	129	56.0	61.9
							63 um	12.6	10.7	15.5*	526	900*	247	84.6*	543	134	116
						2021	2 mm	7.68	12	6.39	40.9	60.4	140	57.6	110	41	53.5
							63 um	17.9	24.6	18.1	45	55.0	533	49.8	788	109	164
Mercury	0.2	0.5	0.2	0.5	0.2	2003	2 mm	-	-	-	-	-	0.30	0.19	0.34	0.17	-
						2012	2 mm	<0.05	<0.05	<0.05	0.19	0.12	0.21	0.08	0.16	0.07	0.05
						2015	2 mm	0.05	<0.05	<0.05	0.23	0.13	0.12	0.08	0.25	0.17	0.14
						2018	2 mm	<0.040	<0.040	<0.040*	0.133	0.55*	0.042	0.106*	0.245	0.076	0.054
							63 um	<0.040	0.055	0.185*	1.149	7.41*	1.9	0.414*	5.21	0.879	0.422
						2021	2 mm	<0.040	<0.040	<0.040	<0.040	0.06	<0.040	0.045	0.158	0.072	<0.040
							63 um	<0.040	<0.040	<0.040	0.06	0.129	0.418	0.141	3.47	0.112	0.157
Nickel	n/a	n/a	16	75	n/a	2003	2 mm	-	-	-	-	-	-	-	18.0	-	-
						2012	2 mm	9.1	9.7	6.1	10.0	10.0	14.0	12.0	10.0	11.0	18.0
						2015	2 mm	7.9	7.3	6.4	10.5	8.4	10.2	10.1	11.6	9.8	18.3
						2018	2 mm	9.01	9.65	8.69*	12.5	12.9*	10.2	11.3*	10.9	10.3	15.3
							63 um	16	14.5	16.3*	27.6	29.3*	19.9	15.0*	25.9	19.1	18.6
						2021	2 mm	10.9	15.1	10.2	10.5	11.2	10.0	11.3	12.3	14.2	14.1
							63 um	20.8	19.8	20.4	14.7	16.6	19.9	16.1	32.3	24.7	26.7
Silver	n/a	n/a	n/a	n/a	0.5	2003	2 mm	-	-	-	108	5.2	10.0	1.8	1.5	3.4	1.2
						2012	2 mm	<0.2	<0.2	<0.2	0.6	5.7	2.6	0.8	2.1	1.4	0.9
						2015	2 mm	<0.2	<0.2	<0.2	0.5	0.6	3.6	0.4	0.9	1.1	0.5
						2018	2 mm	<0.10	<0.10	<0.10*	0.39	0.82*	2.26	1.17*	0.5	0.73	0.14
							63 um	<0.10	0.13	0.289*	1.56	3.24*	6.81	1.44*	3.89	2.62	0.48
						2021	2 mm	0.29	0.05	0.05	0.05	0.55	2.19	4.81	1.23	0.44	0.38
							63 um	0.19	0.17	0.13	0.31	0.46	16.3	1.16	7.03	3.18	2.23
Zinc	123	315	123	315	120	2003	2 mm	-	-	-	2455	7746	2276	1638	1067	3307	17925
						2012	2 mm	71	70	38	650	4200	2200	930	2400	1400	780
						2015	2 mm	59	48	31	645	1190	2550	770	1160	793	594
						2018	2 mm	60.8	64.9	56.2*	1100	3790*	1070	1800*	2160	902	506
							63 um	96.2	78.2	92.5*	1400	4380*	1280	697*	2660	803	482
						2021	2 mm	86.3	117	63.9	176	934	8070	1440	1520	639	1030
							63 um	146	141	123	188	380	6140	593	5500	885	1370

* location of sample site changed in 2018 due to lack of depositional sediment in previous location. These same sites were re-sampled in 2021.
"-" indicates no data available for that site or year.

 # bold > LCR objective / ISQG
 # bold (shaded) > PEL and LCR objective /ISQG
63 um fraction tested in 2018 and 2021. This smaller sediment fraction is expected to have a greater proportion of organic matter which more readily adsorbs metals. Results cannot be directly compared to data from 2mm fraction.
Note: the highest value among duplicate pairs is presented in this table

More historical sediment data were available for Waneta Eddy, the largest (and therefore more stable) depositional area downstream of the smelter within the LCR, than for the other exposure depositional sites. At the Waneta site, metals concentrations in sediment appeared to show a declining trend up to 2018. However, in 2021 concentrations of some key analytes were higher than in 2018, notably arsenic, copper, and zinc (Figure 5-54 and Figure 5-55).

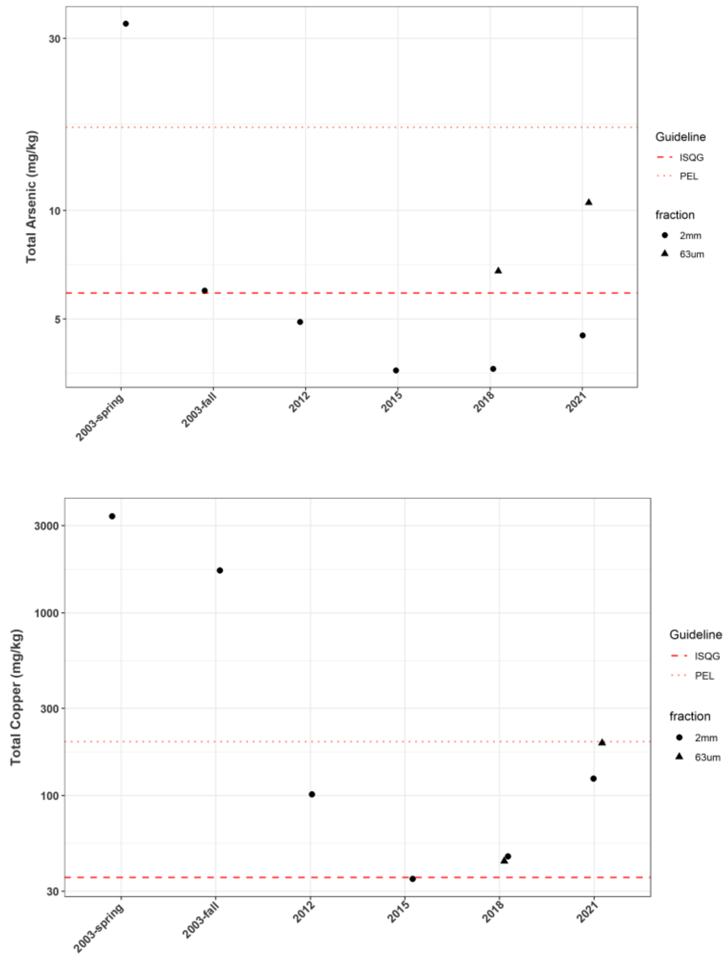


Figure 5-54: Concentrations of Arsenic and Copper at the Waneta Eddy for depositional sediment metals of interest from 2003 to 2021, compared to BC guidelines.

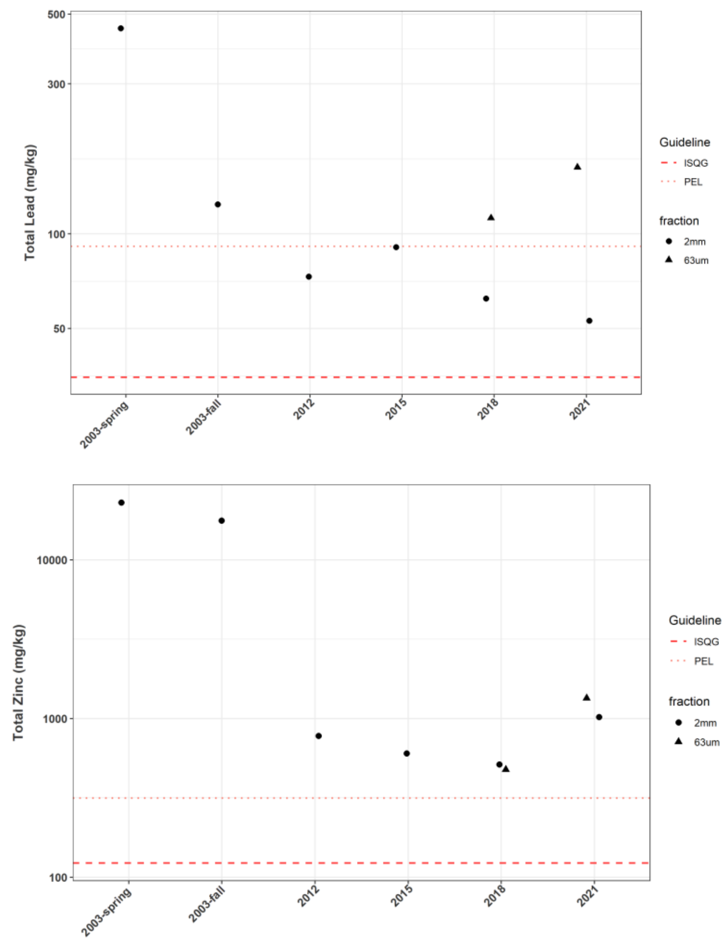


Figure 5-55: Concentrations for Lead and Zinc at the Waneta Eddy for depositional sediment metals of interest from 2003 to 2021, compared to BC guidelines.

5.2.2.2 Comparison of Sediment Size Fraction Results

Metal concentrations in the smaller <63 µm size fraction were greater than the <2 mm fraction samples for the following metals of interest: Ni, Cr, Ag, Cd, As, Fe, Pb, Tl (in order of greatest difference to least) (Table 4-16). This occurred at both exposure and reference sites. Arsenic, Cd, Hg, Pb and Se concentrations were higher in the <63 µm fraction compared to the <2 mm fraction at Maglios and Trimac. Phosphorus demonstrated the biggest difference between the two sediment fractions, indicating that organic materials were captured more with the smaller fraction (Table 4-16). All these metals are known to adsorb onto organics in the pH range found in the LCR, and many are also scavenged by carbonates and oxides (Forstner & Wittmann 1981; Sholkovitz and Copland 1981; Lin and Xhen 1998; Coquery and Wolborn 1995; Yang et al. 2010; Erhayem and Sohn 2014). The higher proportion of detectable metals in the <63 µm fraction samples are indicative of the greater inclusion of fine silts and clay particles and organics compared to the <2 mm results. Both sediment fractions followed similar distribution patterns at the sample sites with respect to metals concentrations.

5.2.2.3 Correlated Sediment Metals and Site Comparisons

A principal component analysis (PCA) was used to simplify sediment metals data before it was incorporated into mixed effects models for periphyton and benthic invertebrate community analysis (Sections 4.3 and 4.4) because multiple variables were correlated. The components accounting for the majority of data variability are referred to as the principal components. The purpose of the depositional sediment PCA is to understand which metals underpinned the most variation observed in the multivariate metal concentration data. The principal components are new variables that are constructed as linear combinations or mixtures of the initial variables (i.e., the correlated sediment metals). The first principal component (PC1) accounts for the largest possible variance and represents concentrations of As, Cr, Cu and Zn. The second principal component (PC2) represents concentrations of Cd, Pb, Hg, and Tl, is uncorrelated with the first principal component, and accounts for the next highest variance (Figure 5-56). Diagnostic plots that describe how much of the variance is described by PC1 and PC2 were output to identify how meaningful the PCA is (Appendix O).

The first two components of the PCA explained 86% of the variation in sediment metal concentrations in the <2 mm fraction. The first axis (PC1) explained the most variation at 54%, and the second axis (PC2) proportionally explained 46%. Positively correlated sediment metals in PC1 included As, Cr, Zn and Cu, while PC2 contained Cd, Pb, Hg, and Tl. Reference sites had lower PC1 loadings compared to exposure sites, indicating lower concentrations of As, Cr, Zn and Cu PC2 (Cd, Pb, Hg, and Tl) did not provide clear separation between reference and exposure sites. Many sediment metals were strongly correlated, particularly in the <63 µm fraction samples. Iron was highly correlated with Tl, Zn, Se, Hg, Cd and Sn (r >0.97). Zinc was also highly correlated with Sn, Se, Tl and Hg (r >0.97).

A cluster analysis using all years of data was subsequently performed to group the sites based on metals concentrations (Figure 5-57) to support analysis and interpretation of biological community responses (discussed in subsequent sections). The ordination grouped exposure site 1 (Dep-Exp-1) that is closest to the smelter, with the three upstream reference sites. Exposure sites 2, 4, 5, 6, and 7 were another cluster. Casino Eddy (Dep-Exp-3) was unique from other exposure sites based on metals concentrations and was its own cluster group (Figure 5-57).

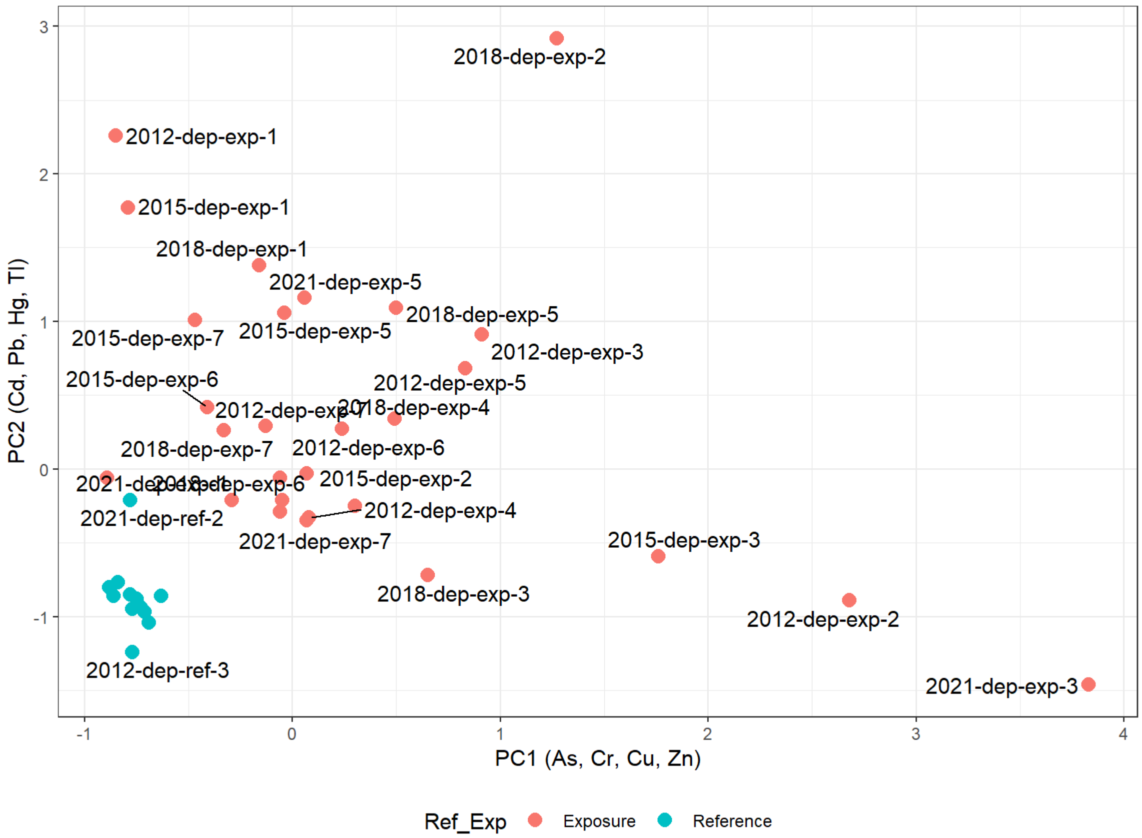


Figure 5-56: PCA sediment metals biplot of PCs for <2mm fraction for sediment samples. Only the first two axis are shown which explain 86% of the variation.

Table 5-14: Principal Component loadings for <2mm fraction analysis.

Analyte	PC1	PC2
Arsenic	0.757421	0.488193
Cadmium	0.360192	0.817757
Chromium	0.877124	0.287023
Copper	0.967359	0.176442
Lead	0.537066	0.768442
Mercury	0.28026	0.848174
Selenium	0.649159	0.555218
Thallium	-0.00489	0.955567
Zinc	0.954767	0.109963

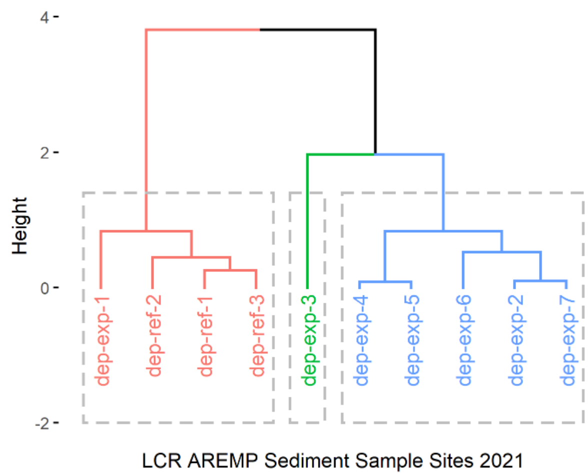
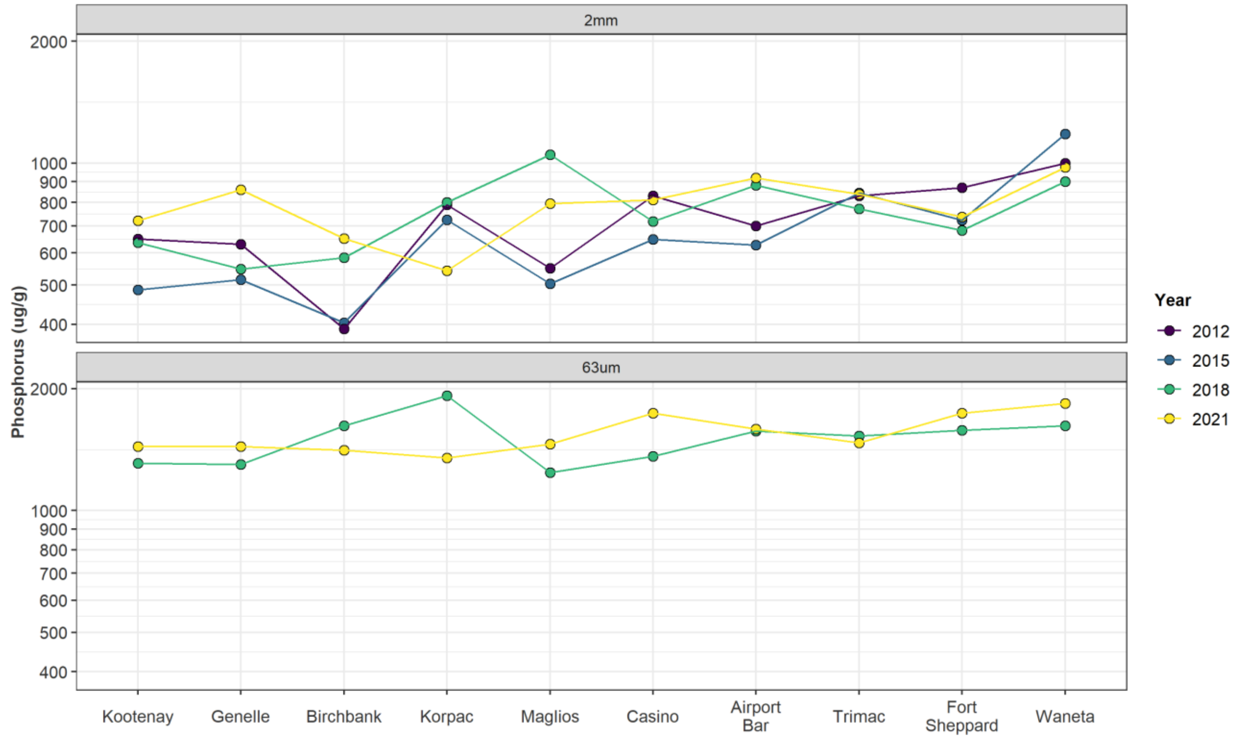


Figure 5-57: Cluster analysis of 2021 AEMP depositional sites.

5.2.2.4 Sediment Nutrients

Most sediment nutrients including phosphorus, ammonia and potassium were elevated downstream of the City of Trail, and likely contributed to the increased periphyton growth. This is a common occurrence in rivers receiving urban stormwater. The Regional District of Kootenay Boundary (RDKB) wastewater treatment outfall is located upstream of the Maglios depositional area (Schedule A, Mapsheet 7). Groundwater impacted by historical fertilizer manufacturing is another potential nutrient source. No nuisance algae growths were detected at depositional sites in 2012, 2015, 2018, or 2021. Plots showing the distribution of phosphorus and potassium concentrations in depositional sediments are show as Figure 5-58 below.



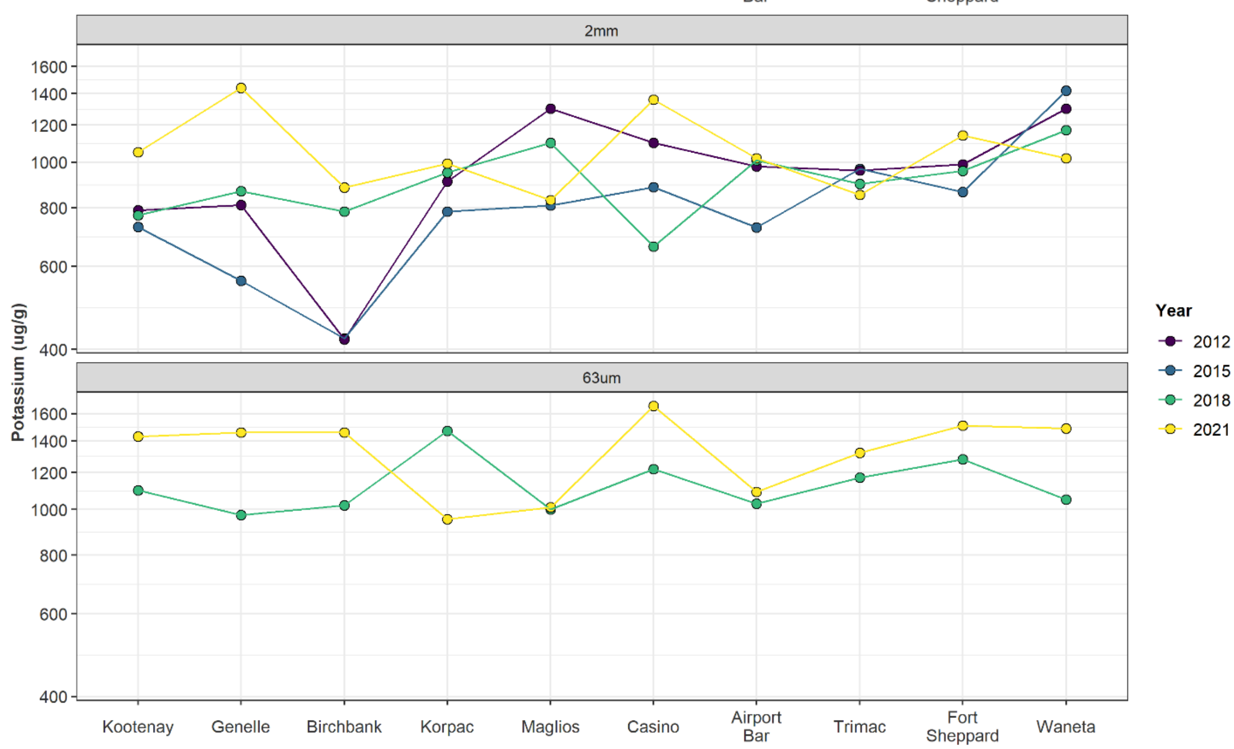


Figure 5-58: Distribution of phosphorus and potassium concentrations in depositional sediments with distance from the smelter. No applicable guidelines are defined for P and K. The top pane presents data in the <2mm fraction and the lower pane presents data in the <63µm fraction.

5.3 Periphyton

Periphytic algae are the main primary producers in freshwater environments. Periphyton biofilms in erosional LCR habitats are complex, layered assemblages of autotrophic (algae and photosynthetic bacteria) and heterotrophic (bacteria, fungi, yeasts, and protozoa) species, all embedded in a protective polymeric matrix (Wetzel 1993, Decho 1990, Drenner *et al.* 1993, Sobczack 1996). This biofilm supplies a large portion of the energy to higher trophic levels in the LCR as it does in all rivers (Azim 2009). Diatoms commonly constitute the dominant group of algae in river biofilms (Stevenson and Bahls 1999), as they did in every study of the LCR including this one.

Biomonitoring is a useful tool for assessing aquatic ecosystem health, and it complements physical and chemical analyses (Morin et al. 2008). Periphytic algae are very sensitive to systemic modifications in water quality and hydrologic regime (Smolar-Žvanut et al. 2013). After a high-flow period that scours the biofilm such as freshet, bacteria and small closely attached diatoms are among the rapid, early colonizers, while slower growing filamentous green algae are among the later arrivals. Diatoms arriving from upstream reservoirs that become trapped in the biofilm are important to the LCR periphyton (Larratt et al. 2013).

The depositional and erosional habitat periphyton sampling programs were designed to assess effects of the effluent discharge on periphyton communities in two different habitat types in terms of community structure, composition, and standing crop biomass, and to detect any trends over the years of study: 2012, 2015, 2018 and 2021.

5.3.1 Depositional Habitats

In the AOI (Birchbank to Waneta), isolated, small depositional sites account for only 0.1% of the total LCR area substrates (Golder 2007). There are no depositional sites in the near-field IDZ. The rarity of depositional sites is due to the erosional nature of the Columbia River in the AOI.

Depositional periphyton communities are usually distinct from their erosional counterparts. Depositional communities are physically smaller and are driven by unique site characteristics unlike the comparatively uniform mainstem erosional habitats. Additionally, depositional sediments can retain materials from historical discharges, making them inherently slower to demonstrate improved conditions than adjacent erosional habitats. All the 2021 depositional periphyton samples were dominated by fine silt substrates.

The growing conditions of depositional areas are determined by the interaction between substrate pore water and the overlying water, while the erosional areas are exposed to shifting velocities and water chemistry and are determined by flow-controlled variables. While depositional sediments are fine and moved at lower velocities, erosional substrates are larger and more stable, affording secure anchorage for slow growing periphyton taxa (Figure 5-59).

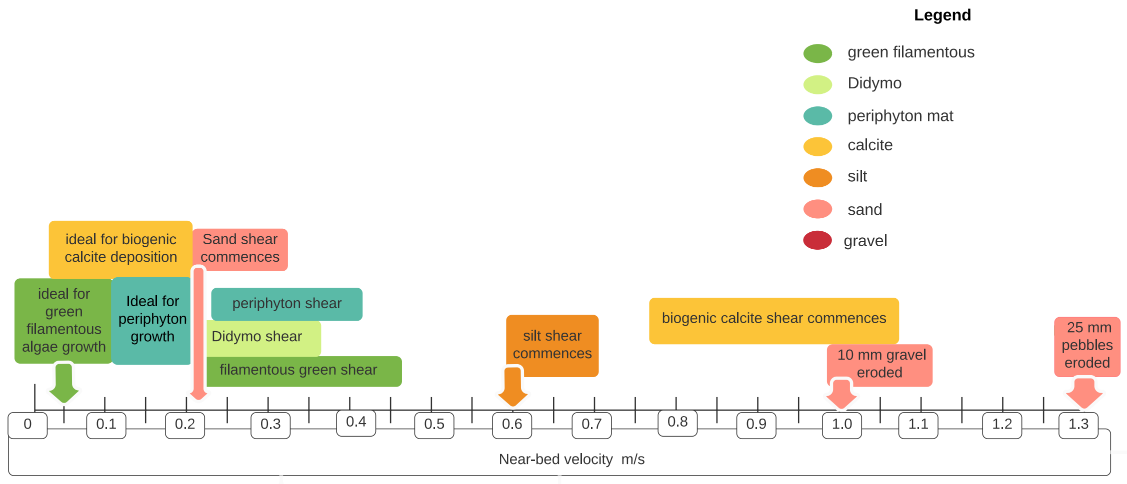


Figure 5-59: Typical shear velocities of periphyton and substrates in rivers

Depositional periphyton communities frequently generate about half of the erosional periphyton abundance per unit area because depositional sandy substrate does not allow slow-growing species to develop before substrate disruption by flow changes (Barbour, 1999, Wetzel, 2001). Further, they are subject to scour during high flows as happened in 2012's extreme flows throughout the LCR. However, if depositional areas are not scoured and offer macrophytes stable growth media, then depositional abundance can exceed that of erosional substrates as was observed in some depositional sites in 2015, 2018, and at many reference and exposure depositional sites in 2021.

In depositional habitats, the small, closely attached species so prevalent in high flow situations are absent. Instead, large and motile diatom guilds are prevalent at depositional sites, as well as large diatoms from upstream reservoirs that settle in the calm backwaters and eddies. These factors culminate in greater species richness and diversity in depositional sites versus erosional sites in all studies years including 2021 samples. Additionally, the contribution made by bacteria and organic debris to the depositional periphyton biofilm was much greater than it was in erosional periphyton biofilms in all years of study (Hawes et al. 2014).

Table 5-15: Summary statistics describing periphyton community productivity and diversity in depositional reference and exposure sites in samples collected during 2021.

Metric	Statistic	Exposure	Reference
Abundance cells/cm^2	Sample Size	7	3
	Mean (±SD)	2.80e+06±1.18e+06	1.07e+06±1.81e+05
	Median	2.94e+06	1.17e+06
	Minimum	1.17e+06	8.65e+05
	Maximum	4.45e+06	1.18e+06
Species Richness (# species)	Sample Size	7	3
	Mean (±SD)	46±7.98	53.33±1.53
	Median	48	53
	Minimum	32	52
	Maximum	53	55
Shannon EQ Index	Sample Size	7	3
	Mean (±SD)	0.73±0.04	0.75±0.07
	Median	0.72	0.79
	Minimum	0.69	0.67
	Maximum	0.82	0.79
Total Biovolume um^3/cm^2	Sample Size	7	3
	Mean (±SD)	1.55e+09±9.14e+08	6.95e+08±1.10e+08
	Median	1.27e+09	6.50e+08
	Minimum	5.84e+08	6.15e+08
	Maximum	2.94e+09	8.20e+08

5.3.1.1 Depositional Dominant Taxa

Consistent with 2012, 2015 and 2018 results, there was no evidence of periphyton species shifts reflecting smelter effects at depositional sites in 2021 (Table 5-16). In Fall 2021, the dominant periphyton were all diatoms in all depositional sites. Eight of the ten dominant taxa remained consistent between reference and exposure sites in 2021, and nine of the ten dominant taxa remained consistent between reference and exposure sites through all other study years. Depositional reference and exposure site periphyton had a similar community dominated by diatoms in all years of study (Appendix H).

Reservoir taxa such as *Cyclotella spp., Synedra ulna and Fragilaria crotonensis* accounted for a significant portion of the depositional periphyton over the years. *Fragilaria crotonensis* was prevalent in 2021 (Table 5-16).

Depositional samples in 2021 had diverse and high diatom densities, with very low filamentous cyanobacteria and flagellate populations at most sites. *Didymosphenia geminata* (Didymo) was present in all sites and was the dominant taxa by biovolume in depositional reference sites. Green filamentous algae were not encountered in these samples. Bacteria and organic detritus ranged from low to common in these samples. Freshwater sponge spicules were encountered in several reference samples and in Casino DEP-EXP-3.

Didymo is native to BC, but it can behave invasively. Didymo was a significant component of reference and exposure depositional sites in 2021 as it was in most studied years. It forms visible mats and is occasionally thick enough to foul sampling gear and coat low flow substrates with a layer several centimeters thick. If an environmental influence is causing the Didymo fluctuations, light, flows, and water temperature are common drivers (Canter-Lund & Lund, 1995; Kilroy et al., 2008, Whitton et al., 2008; Whitton et al., 2009). In the LCR, visible periphyton mats in stretches of the LCR are considered a natural occurrence rather than a symptom of stress (Columbia River Integrated Environmental Program 2005; Lindstrøm & Skulberg 2007; Whitton et al. 2009).

Table 5-16: Dominant periphyton species as defined by percent biovolume for depositional sites with upstream reference sites shown separately from downstream exposure sites in 2021.

Dominant Reference Taxa	Biovolume Ref (%)	Biovolume Exp (%)	Dominant Exposure Taxa
Didymosphenia geminata	19.15	11.63	Melosira undulata
Melosira undulata	13.44	11.07	Staurosira construens v ventor
Cymbella lanceolata	10.40	10.50	Pinnularia caudata
Staurosira construens v ventor	7.26	7.37	Didymosphenia geminata
Navicula spp.	3.43	4.50	Cymbella lanceolata
Fragilaria crotonensis	3.31	3.56	Anomoeoneis sphaerophora
Gomphonema gracile	3.25	3.54	Fragilaria crotonensis
Cocconeis placentula	3.06	3.01	Eucocconeis flexella
Eucocconeis flexella	2.92	2.94	Navicula spp.
Campylodiscus cf. hibernicus	2.77	2.64	Cocconeis placentula

5.3.1.2 Depositional Species Richness and Diversity

We used a two-way ANOVA and Tukey Post-Hoc procedure to evaluate potential differences between reference and exposure sites and sample year on periphyton diversity metrics.

Mean effective species number was significantly higher in reference than exposure sites when data from all years were analyzed together with an ANOVA (η = .12, F = 4.3, p = 0.046; Appendix H, Figure 5-60). The difference in effective species number between reference and exposure sites is likely a result of depositional site size and stability. The reference depositional sites are larger than the exposure depositional sites. Larger depositional sites have more macrophyte potential and can support more species variation than smaller sites. Significant differences in effective species number between years due to annual flow-related variables and weather were detected (η = 0.47, F = 9.46, p < 0.001; Appendix H). Effective species number was higher at most sites in October 2021 than in previous years, likely in response to stable low flows.

Species richness was significantly higher in reference sites than exposure sites when all years were analyzed (η = 0.13, F = 4.8, p = 0.035). Species richness in all study years was consistently low at Waneta DEP-EXP-7 (Figure 5-60). This is a deep site where light is expected to preclude the growth of some taxa. Species richness was also significantly different between years (η = 0.50, F = 11.0, p = < 0.001). This difference was driven mostly by samples from 2021, and 2021 differed significantly from all previous study years in species richness (Appendix H).

Shannon diversity index was significantly higher in reference sites than exposure sites (η = 0.13, F = 4.7. p = 0.037). Shannon diversity index also varied significantly by year (η = 0.49, F = 9.7, p < 0.001).

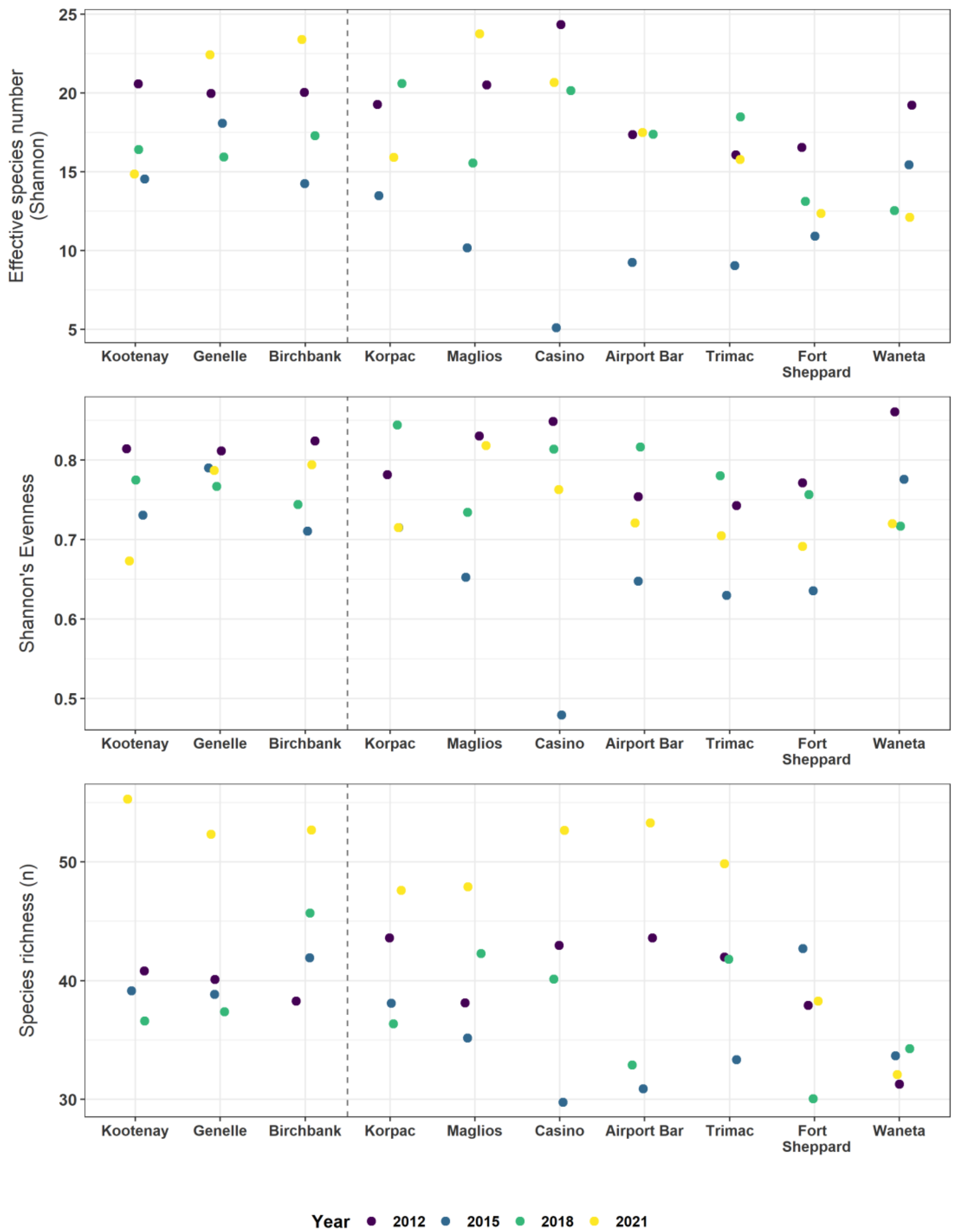


Figure 5-60: Periphyton community diversity in depositional sites for study years 2012, 2015, 2018, and 2021. The dashed line separates reference from exposure sites.

5.3.1.3 Depositional Productivity Metrics

The effect of site type and sample year on periphyton productivity metrics were tested with a two-way ANOVA and Tukey Post-Hoc procedure. Total abundance and total biovolume were log-transformed total abundance and total biovolume to satisfy the test assumptions.

Total abundance did not differ significantly between exposure and reference sites (η = 0.73, $F = 0.29$, $p = 0.591$) but differed significantly between years for all year-pairs except for 2018-2015 ($F = 30.00$, $p < 0.001$; Appendix H).

Total biovolume followed the same pattern, showing no significant difference between exposure and reference sites (η = 0.01, $F = 0.37$, $p = 0.55$) but differing significantly between years (η = 0.70, $F = 26.0$, $p < 0.001$, Appendix H).

Samples from 2021 were unusually productive compared to other years of this study, likely in response to stable low flows during drought conditions (Figure 5-61). The cumulative effect of flows, weather, and timing of sampling in relation to flow changes are reflected in the significant difference between years for abundance and biovolume (Appendix H).

In each study year, the range of periphyton productivity metrics varied within the 3 reference sites and within the 7 exposure sites (Figure 5-60). Reference and exposure depositional sites had similar growth metrics, yet exposure sites had a wider range. For example, the depositional reference site biovolume ranged from 18.5 - 25 cm^3/m^2 and the exposure sites ranged from 6 - 29 cm^3/m^2 in 2021 (Table 5-17; Figure 5-61). The reference depositional sites are larger than all but the Waneta exposure site. Shifting of sample locations at the small exposure sites has been necessary due to scouring and redeposition of substrates over the study period.

Algae taxa including diatoms have unique sensitivity to dissolved metals and varying requirements for trace metals as nutrients including the metals Mn, Fe, Co, Ni, Cu, Zn, and Cd (Medley and Clemens 1998). Depositional sediment metals that exceeded guideline PEL concentrations at exposure sites in 2021 were primarily Zn, Pb, and Cu. These three metals were identified by Golder (2007a; 2010) in tests of bioavailability which ranked depositional sites with the highest potential for effects as Maglios, Fort Shepherd, and Waneta, respectively. The 2021 sediment data indicated that Casino and Trimac showed the highest residual sediment metals concentrations. These two sites showed typical growth metrics relative to adjacent exposure sites in 2021 data. Overall, the depositional exposure sites showed comparable periphyton growth metrics to the reference sites.

No ash was identifiable by light microscope in these samples but wildfire ash nutrients and low stable flows prevalent during the hot 2021 drought months may have contributed to the overall increased periphyton productivity observed in 2021. Within the depositional habitats, sediment nutrients including phosphorus, ammonia and potassium were progressively elevated downstream of the City of Trail and may also contribute to increased periphyton growth. This is frequently observed in rivers receiving urban stormwater and treated wastewater.

Table 5-17: Average Periphyton growth metrics by depositional sample site for 2021 samples.

Metric	Korpac (exp-1)	Maglios (exp-2)	Casino (exp-3)	Airport (exp-4)	Trimac (exp-5)	Fort Sheppard (exp-6)	Waneta (exp-7)	Kootenay Eddy (ref-1)	Genelle (ref-2)	Birchbank (ref-3)
Abundance cells/cm^2	980,606	674,571	1,484,820	1,284,771	1,106,231	607,550	388,720	1,184,240	1,170,836	864,723
Species Richness (# species)	48	48	53	53	50	38	32	55	52	53
Total Biovolume ug/cm^2	1.27e+09	1.04e+09	2.37e+09	2.94e+09	2.04e+09	6.03e+08	5.84e+08	2.46e+09	1.95e+09	1.85e+09
Shannon EQ Index	0.71	0.82	0.76	0.72	0.71	0.69	0.72	0.67	0.79	0.79

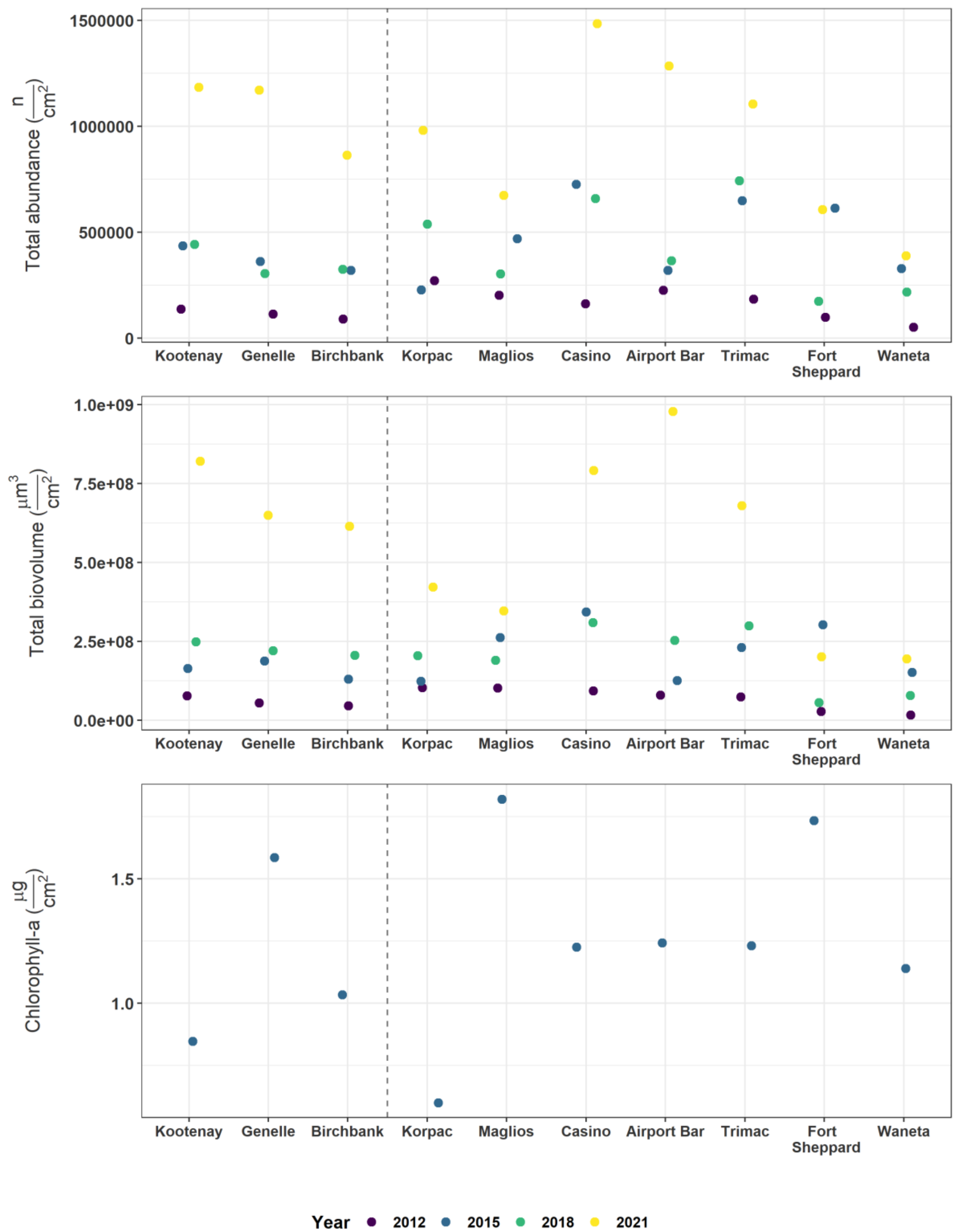


Figure 5-61: Plots of 2012, 2015, 2018 and 2021 periphyton community productivity in depositional sites. Dashed line separates reference from exposure sites. *Chl-a was only measured in 2015 from depositional sites.*

Phytotoxic copper concentrations at exposure sites did not have significant correlations with productivity or community composition metrics in any year of this study, including 2021 (Table 5-18).

Large depositional sites such as downstream Waneta and upstream Genelle eddies often had lower periphyton abundance and biovolume than smaller depositional sites (Figure 5-61). Large depositional sites likely have other influences restricting periphyton productivity unrelated to the smelter, such as increased water depth and increased density of invertebrate consumers.

Taken together, these results indicate that the algicidal effects of copper or other metals did not reduce periphyton growth. Sediment metals may contribute to differences in relative concentrations of dominant taxa.

Table 5-18: Pearson's r correlation coefficients comparing copper (mg/kg) and available measures of depositional periphyton productivity and biodiversity in exposure sites.

Measure	Pearson's r	p Value
Effective Species	0.215	0.272
Shannon's H	0.113	0.567
Shannon's Equitability	0.020	0.921
Species Richness	0.232	0.235
Total Abundance	0.262	0.178
Total Biovolume	0.289	0.136

5.3.1.4 Depositional Community Composition

A NMDS using periphyton abundance by species and subsequent PERMANOVA was performed on the distance of sites from the smelter did not detect significant differences between reference and exposure sites ($r^2 = 0.02$, $F = 0.87$, $p = 0.519$). The NMDS plot of year-to-year differences indicates a distinct grouping of 2021 data (Figure 5-62), which was statistically supported by a PERMANOVA showing a significant difference in the year-to-year distances ($r^2 = 0.27$, $F = 14.30$, $p = 0.001$).

Diatoms accounted for 93% to 100% of the total periphyton biovolume in 2012, 2015, 2018 and 2021 in depositional surface sediments (Table 5-19). All 10 dominant taxa were diatoms at reference and exposure depositional sites (Table 5-16). The many taxa that occurred in both reference and exposure sites helps explain why the NMDS of depositional sites does not show any major periphyton community differences attributable to effluent exposure (Figure 5-62). Diatoms that dominated the depositional communities were either motile, require warm water with elevated organic content, or were tolerant of dissolved metals (Schmidt et al. 2004). The diversity of metal-tolerant taxa is indicative of moderate concentrations of metals. The depositional sediment metals were not present in concentrations that are known to adversely affect periphyton communities (Hawes et al. 2014; Medley and Clements 1998). Further, depositional sediment metal concentrations have declined or remained stable since 2003 at most locations (Hawes et al. 2014; Larratt et al. 2019).

Table 5-19: Percent contribution of major algae groups to depositional periphyton biovolume by site for 2021.

Algae Type	Kootenay Eddy (ref-1)	Genelle (ref-2)	Birchbank (ref-3)	Korpac (exp-1)	Maglios (exp-2)	Casino (exp-3)	Airport (exp-4)	Trimac (exp-5)	Fort Sheppard (exp-6)	Waneta (exp-7)
Diatoms	99.7	99.9	99.9	99.3	100	99.9	100	93.0	99.4	99.3
Green algae	0.1	0.0	0.0	0.2	0	0.0	0	6.8	0.0	0.1
Flagellates	0.1	0.1	0.1	0.4	0	0.1	0	0.2	0.6	0.1
Cyanobacteria	0.1	0.0	0.0	0.1	0	0.0	0	0.0	0.0	0.6
Dinoflagellates	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0.0	0.0
Red algae	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0.0	0.0

No spatial trend in the depositional community structure with distance downstream of the smelter was evident in 2012, 2015, 2018 or 2021 (Table 5-19). Periphyton community data was collected during fall low flows, when the potential to generate a downstream spatial trend is expected to be the greatest. In 2012, Waneta had unusually high densities of flagellated algae, a group known for their metal tolerance. In 2015, flagellates were still common, but they were rare or not detected in subsequent years. Periphyton samples from DEP–EXP-3 (Casino) had a community structure that may be driven by hyporheic flows at this site. Protozoa were regularly encountered in Casino samples, and among the bacteria, low amounts of possible filamentous iron-related bacteria (IRB) were encountered.

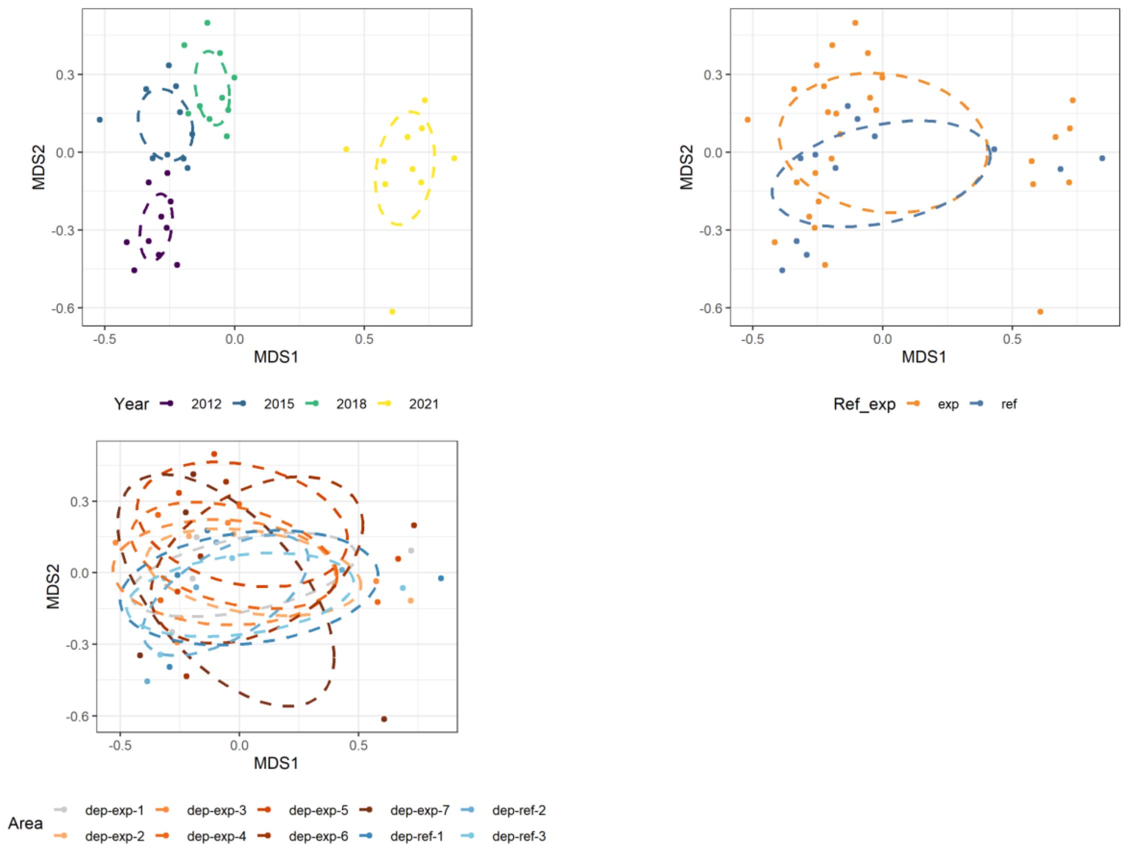


Figure 5-62: NMDS of depositional periphyton abundance at the species level grouped by year (top left panel), exposure (EXP) and reference (REF) sites (top right panel), and individual sites (bottom panel). The stress value was 0.14.

5.3.2 Erosional Habitat

Erosional substrates consisting of pebble, cobble, and boulder account for approximately 1,517 ha, or 98%, of the total area of the LCR between HLK Dam and the Canada - US border. In the AOI (Birchbank to Waneta), erosional areas account for 99.9% of substrates (Golder 2007).

Five replicate sub-samples taken from each erosional site were combined to avoid pseudo replication in statistical tests. We then grouped erosional sample sites into categories by type and distance from smelter to help control for variation between exposure sites while still evaluating differences between reference sites and all exposure sites (Table 5-20). The sites were grouped into reference, near-field sites along the right bank of the IDZ (IDZ RB) in the effluent plume, and far-field sites that occur beyond the extent of the effluent plume and downstream of the IDZ where the effluent is more thoroughly mixed with the LCR. Depositional sites were not categorized and analyzed this way because there are no depositional sites within the IDZ RB.

Table 5-20: LCR AEMP sample areas and corresponding sample site categories used for analysis.

Area	Description	Site	Site Category
ERO-REF-1	Left bank opposite Stoney Creek	ERO-REF-1-1	Reference
		ERO-REF-1-2	
		ERO-REF-1-3	
		ERO-REF-1-4	
		ERO-REF-1-5	
ERO-REF-2	Birchbank	ERO-REF-2-1	
		ERO-REF-2-2	
		ERO-REF-2-3	
		ERO-REF-2-4	
		ERO-REF-2-5	
ERO-EXP-1	Right bank from Stoney Creek to top of CIII side channel	ERO-EXP-1-1	Initial Dilution Zone along the right bank (IDZ RB) and within known extents of the TTS effluent plume
		ERO-EXP-1-2	
		ERO-EXP-1-3	
		ERO-EXP-1-4	
		ERO-EXP-1-5	
ERO-EXP-2	Side channel from CIII outfall to CII outfall	ERO-EXP-2-1	
		ERO-EXP-2-2	
		ERO-EXP-2-3	
		ERO-EXP-2-4	
		ERO-EXP-2-5	
		ERO-EXP-2-3	
		ERO-EXP-2-4	
		ERO-EXP-2-5	
ERO-EXP-3	CII outfall downstream to Korpac	ERO-EXP-3-1	
		ERO-EXP-3-2	
		ERO-EXP-3-3	
		ERO-EXP-3-4[1]	Far-field – Beyond IDZ or beyond known extents of the TTS effluent plume
		ERO-EXP-3-5[1]	
ERO-EXP-4	Korpac to Maglios	ERO-EXP-4-1	
		ERO-EXP-4-2	
		ERO-EXP-4-3	
		ERO-EXP-4-4	
		ERO-EXP-4-5	
ERO-EXP-5	Maglios to Waneta	ERO-EXP-5-1	
		ERO-EXP-5-2	
		ERO-EXP-5-3	
		ERO-EXP-5-4	
		ERO-EXP-5-5	

[1]ERO-EXP-3-4 and ERO-EXP-3-5 occur along the left bank of the LCR and, while being in the IDZ as defined by the initial AEMP study design (Golder 2012a), they are outside of the known extents of the TTS effluent plume. They were therefore included in far-field site grouping.

Although stable low flows preceding the October 2021 periphyton sampling led to high productivity, summary statistics from 2021 align with earlier AEMP studies. When 2021 data are compared to other large rivers including the LCR above the AOI, most metrics place the AOI in the typical large river category, with small differences between years and between the AOI and upstream LCR Reach 2 (Table 5-21).

Table 5-21: Summary of typical range of LCR periphyton metrics from all study years, with comparison to oligotrophic, typical, and productive large rivers and LCR area of interest.

Metric	Oligo-trophic or stressed	Typical large rivers	Eutrophic or productive	LCR-upstream Reach 2*	Exposure Erosional AOI of LCR 2012	Exposure Erosional AOI of LCR 2015	Exposure Erosional AOI of LCR 2018	Exposure Erosional AOI of LCR 2021
Number of taxa (live & dead)	<20 – 40	25 - 60	Variable	8 – 60	23 – 48	22 – 44	21 – 49	35-51
Chlorophyll-a µg/cm²	<2	2 – 5 (7)	>7 – 10 (30+)	0.04 – 15.3	0.37 – 3.50	0.23 – 0.99	0.15 – 4.67	0.46 – 4.76
Algae density cells/cm²	<0.2 x10⁶	1 - 4 x10⁶	>10 x10⁶	0.03 – 3.9 x10⁶	0.05 – 0.73x10⁶	0.05 – 0.29x10⁶	0.04 – 0.73 x10⁶	0.25 –3.59 x10⁶
Algae biovolume cm³/m²	<0.5	0.5 – 5	20 - 80	0.1 – 25	0.15 – 0.93	0.18 – 1.46	0.22 – 5.66	0.94-17.27
Diatom density frustules/cm²	<0.15 x10⁶	1 - 2 x10⁶	>20 x10⁶	0.4 – 2.3 x10⁶	0.07 – 0.28 x10⁶	0.04 – 0.55 x10⁶	0.26-0.47 x10⁶	1.39-4.60x10⁶
Biomass – AFDW mg/cm²	<0.5	0.5 - 2	>3	0.35 – 7.1	Not sampled	Not sampled	Not sampled	Not sampled
Biomass – dry wt mg/cm²	<1	1 – 5	>10	3.1	Not sampled	Not sampled	Not sampled	Not sampled
Bacteria sed. HTPC CFU/cm²	<4 -10 x10⁶	0.4 – 50 ×10⁶	>50×10⁶ – >10¹⁰	1.5 - >5 x 10⁶	0.36 – >2 x 10⁶	Not re-sampled	Not re-sampled	Not re-sampled
Fungal count CFU/cm²	<50	50 – 200	>200	8 - 1830	<200 – 1000	Not re-sampled	Not re-sampled	Not re-sampled

Comparison data obtained from Flinders and Hart 2009; Biggs 1996; Peterson and Porter 2000; Freese et al. 2006; Durr and Thomason 2009; Romani 2009; Biggs and Close 2006. Dodds et al, 1998
*Artificial substrate samples, tends to inflate growth metrics compared to natural substrates

5.3.2.1 Erosional Dominant Taxa

Diatoms are the dominant algae class in most large rivers and were dominant in the LCR AOI (Table 5-16). Dominant taxa by biovolume in October 2021 were similar between reference and far-field exposure sites, although near-field exposure (IDZ RB) sites had some unique taxa that stood out. The small diatom *Achnanthidium minutissima* was dominant by abundance at erosional sites. However, when the dominant taxa are ranked by their biovolume contributions to standing crop, a variety of dominant diatoms emerge.

The filament-forming diatom Didymo was the top dominant species in reference, IDZ RB, and far-field sites in 2021, and has occurred in the dominant taxa lists in every year of study. Field observations reported that Didymo had bloomed throughout the LCR in 2021 and was heavier upstream of the AOI.

Near-field (IDZ RB) sites had a different assemblage of dominant taxa than reference and far-field sites. IDZ RB sites shared 5 of the 10 dominant taxa present in reference or far-field sites, while the far-field sites were more similar to reference sites, sharing 7 out of 10 dominant taxa (Table 5-22).

IDZ RB sites had higher proportions of cyanobacteria than reference or far-field sites, driven primarily by higher biovolumes at ERO-EXP-2, and lower proportions of diatoms (Table 5-23). Unique dominants occurring only at the IDZ RB exposure sites in 2021 were all filamentous taxa that display strong water velocity and nutrient (filamentous green) or water temperature and nutrient (*Phormidium*) preferences.

Filamentous green algae (*Cladophora fracta*; *Stigeoclonium sp.*) have been important contributors to periphyton biovolume at both reference and exposure erosional sites (Appendix H). In 2021 results, *Cladophora* sp. were more prominent in the IDZ RB near-field exposure sites compared to the reference and far-field exposure sites, and *Stigeoclonium* sp. were more common in far-field sites than IDZ RB or reference sites (Table 5-22).

Large numbers of filamentous cyanobacteria *Phormidium autumnale* were common in the CIII side channel (ERO-EXP-2) within the IDZ RB throughout this study, including 2021. This is likely because of the increased water temperature of the side channel from the CIII outfall. *Phormidium autumnale* was the third dominant species in the IDZ RB site category and was not in the top ten dominant taxa in the reference or far-field sites, setting the IDZ RB dominant taxa apart from other erosional sites. Another filamentous cyanobacteria, *Lyngbya*, was prevalent only in reference sites (Table 5-22).

Sites with heavy loads of metal pollution are known to have Diatom frustule abnormality levels of more than 3.5 to 10% of the population (Guasch et al 2012). Diatom abnormalities were extremely rare (<1 in 500) in the 2012 through 2021 results and were distributed between reference and exposure sites. No sample exceeded 0.2% frustule abnormalities in the LCR AOI.

Table 5-22: Dominant periphyton species as defined by percent biovolume for erosional habitats in reference, near-field IDZ RB, and far-field site categories in 2021.

Reference Taxa	Percentage of Reference Biovolume	IDZ Taxa	Percentage of IDZ Biovolume	Far-Field Taxa	Percentage of Far-Field Biovolume
Didymosphenia geminata	31.86	Didymosphenia geminata	39.21	Didymosphenia geminata	32.43
Gomphonema gracile	24.81	Gomphonema gracile	19.12	Gomphonema gracile	29.97
Gomphoneis minuta	5.84	Phormidium autumnale (colony)	10.39	Gomphoneis minuta	6.64
Achnanthidium minutissima	3.50	Cladophora fracta	7.89	Stigeoclonium sp.	2.92
Gomphonema ovilaceaides	3.49	Synedra ulna	2.47	Synedra ulna	2.82
Synedra ulna	2.85	Achnanthidium minutissima	2.44	Achnanthidium minutissima	2.29
Cocconeis placentula	2.27	Gomphonema ovilaceaides	1.82	Gomphonema ovilaceaides	2.25
Lyngbya sp.	2.18	Cyclotella bodanica	0.88	Navicula cinta	1.66
Fragilaria crotonensis	1.66	Navicula gregaria	0.85	Cocconeis placentula	1.58
Staurosira construens v ventor	1.59	Achnanthidium linearis = Rossithidium	0.80	Diatoma tenue var elongatum	1.39

Table 5-23: Percent contribution of the major algae groups to periphyton biovolume by erosional site in 2021.

Algae Type	ero-ref-1	ero-ref-2	ero-exp-1	ero-exp-2	ero-exp-3	ero-exp-4	ero-exp-5
Diatoms	97.6	89.2	83.0	69.7	95.2	95.1	88.7
Green algae	1.2	0.1	13.9	8.0	1.7	0.0	5.8
Flagellates	0.2	2.4	1.3	0.8	1.3	1.6	1.1
Cyanobacteria	1.0	7.5	1.9	21.5	1.6	3.2	4.2
Dinoflagellates	0.0	0.1	0.0	0.0	0.1	0.1	0.1
Red algae	0.0	0.7	0.0	0.0	0.0	0.0	0.0

Table 5-24: Distribution of filamentous periphyton (biovolume cm^3/m^2) at erosional sites in 2021.

Algae Group	Taxa	ero-ref-1	ero-ref-2	ero-exp-1	ero-exp-2	ero-exp-3	ero-exp-4	ero-exp-5
Green algae	*Bulbochaete* sp.	ND	ND	ND	ND	ND	ND	0.02
	Cladophora fracta	ND	ND	3.16	4.07	ND	ND	ND
	Mougeotia sp.	ND	ND	0.60	ND	ND	ND	ND
	Stigeoclonium sp.	ND	ND	0.18	ND	0.35	ND	0.61
	Ulothirx sp. *(zonata)*	0.21	ND	ND	ND	ND	ND	ND
Cyanobacteria	*Homeothrix* sp. *(colony)*	ND	ND	ND	0.73	0.06	ND	ND
	Lyngbya birgei	ND	ND	0.10	0.10	ND	ND	ND
	Lyngbya sp.	0.08	0.51	0.24	0.06	0.19	0.16	0.14
	Oscillatoria cf. tenuis	0.01	ND	0.01	0.14	ND	ND	ND
	Phormidium autumnale (colony)	ND	ND	ND	9.52	ND	ND	ND
	Planktolyngbya limnetica (colony)	<0.01	0.02	0.01	0.08	0.01	0.01	ND
Red algae	*Audouinella* sp.	ND	0.05	ND	ND	ND	ND	ND

ND = Not detected

5.3.2.2 Erosional Productivity Metrics

Linear mixed effects models of periphyton productivity metrics and site categories followed by model averaging showed site as an important predictor of chl-a productivity across all sample years (Figure 5-67;RVI = 1). In comparison to reference sites, far-field sites had less chl-a productivity when all years were modelled together (relative effect size = -0.05, lower CI = -0.49, upper CI = 0.40). Conversely, IDZ RB sites had higher chl-a productivity (relative effect size = 0.60, lower CI = 0.15, upper CI = 1.05). In 2021, IDZ RB sites had significantly higher chl-a productivity than far-field sites (relative effect size = 1.08, p = 0.04), but did not differ significantly from reference sites (p = 0.18).

In 2021, a few subsamples reached the eutrophic category at ERO-EXP-2 within the IDZ RB site category (Appendix H). Stable low flows near 1300 m^3/s preceding the 2021 sampling allowed greater periphyton productivity at reference and exposure sites in comparison to previous years. The mixed effects models confirmed that 2021 showed increased chl-a productivity in comparison to other years (relative effect size = 1.09, RVI = 1, lower CI = 0.54, upper CI = 1.63). Most chlorophyll-a samples from the LCR AOI were in the oligotrophic category for periphyton growth in 2003 results (Golder, 2007b). Four chlorophyll-a samples reached the mesotrophic 2 – 5 µg/cm^2 chl-a range in the near-field during 2012, none in 2015, three in 2018, and two from the near-field in 2021.

Sample site category was an important predictor of periphyton biovolume (RVI = 0.92). The IDZ RB sites had a slight positive effect on biovolume when all years were modelled together (relative effect size = 0.23, lower CI = -0.1, upper CI = 0.56). In 2021 data alone, reference sites had significantly lower biovolume than IDZ RB sites (relative effect size = -0.47, p = 0.02). IDZ RB sites also had significantly higher biovolume than far-field sites in 2021 (relative effect size = 0.40, p = 0.03).

The elevated biovolume of the IDZ RB is likely due to the increased prevalence of the filamentous cyanobacteria *Phormidium* at ERO-EXP-2 in the CIII side channel where warm temperatures from the effluent outfall have created preferable growing conditions. Cyanobacteria are also known for their metal tolerance (Fiore and Trevors 1994).

Cyanobacteria provide poor food quality for zooplankton and invertebrates compared to other periphyton taxa, and their dominance in ERO-EXP-2 may indicate a degradation in habitat immediately below the CIII outfall (Ger et al. 2016). However, the prevalence of cyanobacteria is not widespread throughout the IDZ, and the impact is localized just downstream of the CIII outfall in the side channel.

In 2021, ERO-EXP 1 also had high biovolume resulting from the high amount of green algae *Cladophora* and *Mougeotia*, both indicators of stable flows with abundant nutrients. The stable low flows prior to and during the sampling period would increase the relative contribution of groundwater with its elevated nutrient concentrations. This is particularly true of ERO-EXP-1 where a significant increasing trend in total dissolved phosphorous (TDP) was strongest in the fall (Tau 0.65; p = 0.05). An increasing phosphorus trend was also detected at New Trail Bridge (Tau 0.60; p = 0.02) and Maglios (Tau 0.95; p = 0.002), reflective of the multiple nutrient sources in the AOI.

Abundance did not differ significantly between reference sites, IDZ RB sites (relative effect size = 0.13, RVI = 0.41, lower CI = -0.04, upper CI = 0.29) or far-field sites (relative effect size = 0.02, lower CI = -0.15, upper CI = 0.18). Periphyton abundance had declined from 2003 to 2018, likely in response to declining nutrients. However, mean periphyton abundance increased to 1.04e+06 ± 4.61e+05 cells/cm^2 at reference sites, 1.44e+06 ± 8.66e+05 cells/cm^2 at IDZ RB sites, and 7.46e+ 05 ± 3.92e+05 cells/cm^2 at far-field sites during Fall 2021 low flow conditions.

Table 5-25: Periphyton growth and community metrics by erosional sample site and site category, 2021.

Metric	statistic	Ref Site 2 (ERO-REF-2)	Ref Site 1 (ERO-REF-1)	IDZ Right Bank Site 1 (ERO-EXP-1)	IDZ Right Bank Site 2 (ERO-EXP-2)	IDZ Right Bank Site 3 (ERO-EXP-3)	Far-Field Site 3 (ERO-EXP-3 left bank sites)	Far-Field Site 4 (ERO-EXP-4)	Far-Field Site 5 (ERO-EXP-5)
Abundance cells/cm2	Sample Size	5	5	5	5	3	2	5	5
	Mean (±SD)	1.3e+06 ± 5.0e+05	7.4e+05 ± 1.2e+05	1.0e+06 ± 2.9e+05	2.2e+06 ± 9.1e+05	8.7e+05 ± 3.7e+05	1.3e+06 ± 3.8e+05	6.9e+05 ± 3.0e+05	5.7e+05 ± 3.0e+05
	Median	1.4e+06	7.0e+05	1.0e+06	2.2e+06	7.7e+05	1.3e+06	5.9e+05	4.2e+05
	Minimum	7.9e+05	6.2e+05	6.4e+05	1.1e+06	5.6e+05	1.1e+06	4.0e+05	2.6e+05
	Maximum	2.1e+06	9.3e+05	1.3e+06	3.6e+06	1.3e+06	1.6e+06	1.1e+06	9.8e+05
Species Richness (# species)	Sample Size	5	5	5	5	3	2	5	5
	Mean (±SD)	43 ± 3.16	44.2 ± 6.14	45.8 ± 4.55	47.6 ± 4.22	41.67 ± 10.26	49.5 ± 0.71	35 ± 8.86	35.2 ± 3.7
	Median	44	45	47	46	39	49.5	31	35
	Minimum	38	35	39	45	33	49	26	32
	Maximum	46	51	51	55	53	50	45	41
Shannon Evenness	Sample Size	5	5	5	5	3	2	5	5
	Mean (±SD)	0.49 ± 0.15	0.74 ± 0.05	0.6 ± 0.09	0.58 ± 0.11	0.67 ± 0.03	0.66 ± 0.01	0.67 ± 0.05	0.69 ± 0.09
	Median	0.47	0.75	0.64	0.6	0.68	0.66	0.64	0.71
	Minimum	0.29	0.66	0.5	0.4	0.63	0.65	0.62	0.54
	Maximum	0.7	0.78	0.69	0.7	0.69	0.67	0.72	0.76
Total Biovolume um3/cm2	Sample Size	5	5	5	5	3	2	5	5
	Mean (±SD)	1.5e+08 ± 3.7e+07	3.9e+08 ± 2.0e+08	5.7e+08 ± 2.2e+08	1.0e+09 ± 6.7e+08	3.9e+08 ± 8.8e+07	4.7e+08 ± 4.5e+08	2.5e+08 ± 1.4e+08	2.2e+08 ± 9.0e+07
	Median	1.6e+08	3.2e+08	5.0e+08	1.1e+09	3.5e+08	4.7e+08	2.2e+08	2.0e+08
	Minimum	9.4e+07	1.9e+08	3.0e+08	3.0e+08	3.3e+08	1.5e+08	1.2e+08	9.4e+07
	Maximum	1.9e+08	7.2e+08	8.4e+08	1.7e+09	4.9e+08	7.9e+08	4.4e+08	3.4e+08
Chlorophyll-a ug/cm2	Sample Size	5	5	5	5	3	2	5	5
	Mean (±SD)	1.76 ± 0.99	2.26 ± 1.04	2.19 ± 0.62	3.76 ± 0.92	1.43 ± 0.77	1.76 ± 0.46	1.46 ± 0.82	1.65 ± 1.25
	Median	1.93	1.76	2.14	3.48	1.11	1.76	1.2	1.16
	Minimum	0.3	1.33	1.58	2.58	0.88	1.44	0.95	0.46
	Maximum	3.02	3.96	3.11	4.76	2.31	2.09	2.90	3.16

In studies before the AEMP, the Old Trail Bridge area (ERO-EXP-3) was a distinctive community with more chrysophyte (golden flagellated algae) and higher green algae densities (Golder 2003), which often indicates organic or nutrient enrichment (Felisberto et al. 2011; Wetzel 2001). From 2012 to 2021, these algae were no longer prevalent at this site. These near-field taxonomic results from 2021 confirm productivity metrics from recent years, suggesting that the influence of the smelter on the AOI is diminishing.

Far-field areas ERO-EXP-4 and ERO-EXP-5 showed low productivity in all years of this AEMP study (far-field sites 4 and 5). The smelter effluent plume is dilute and well-mixed at these locations, while other important influences on this area include lower velocities over more embedded substrates with more fines, and Ryan Creek inflows.

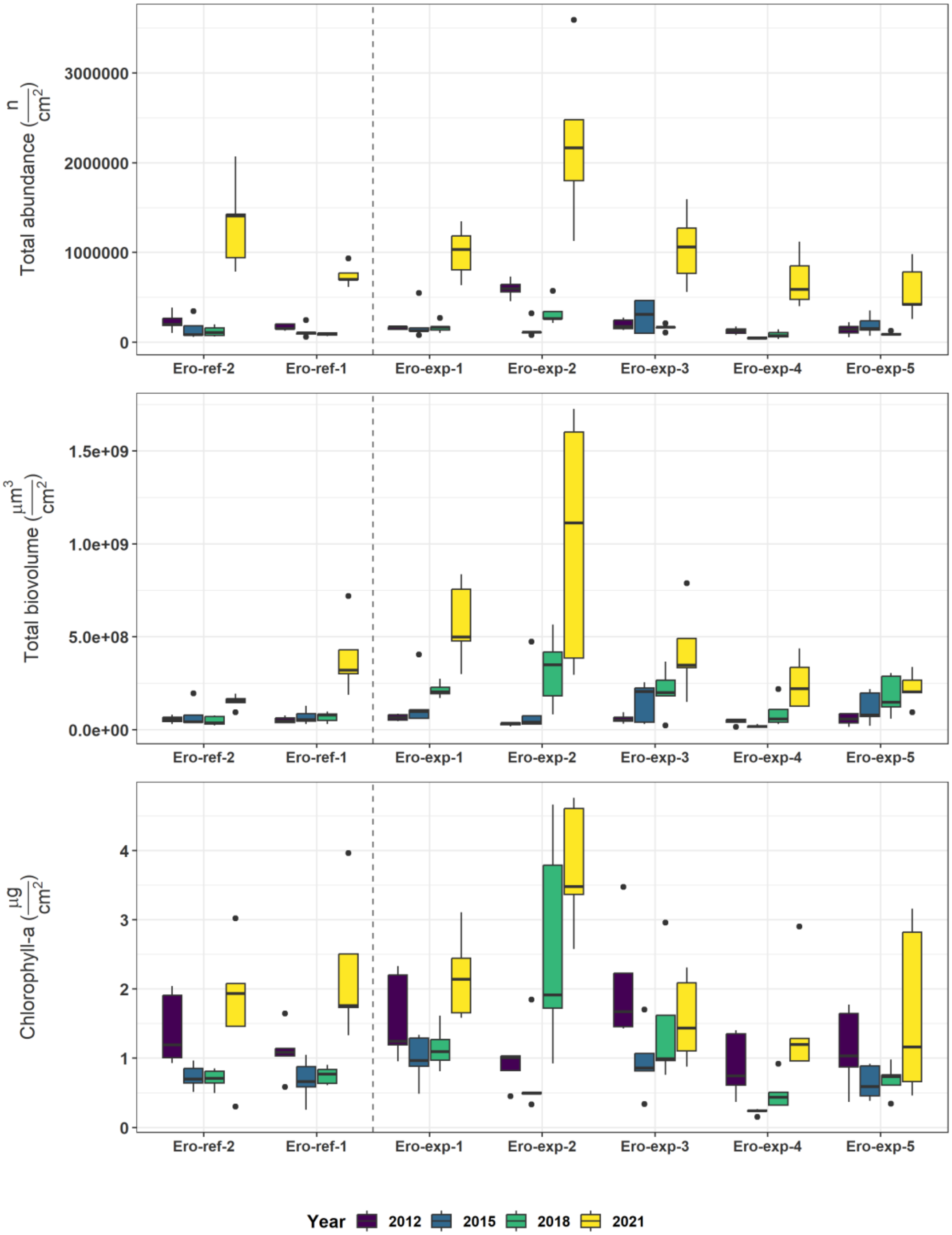


Figure 5-63: Abundance, biovolume and Chl-a of 2012, 2015, 2018 and 2021 periphyton community productivity in erosional sites. Exp = exposure, Ref = reference.

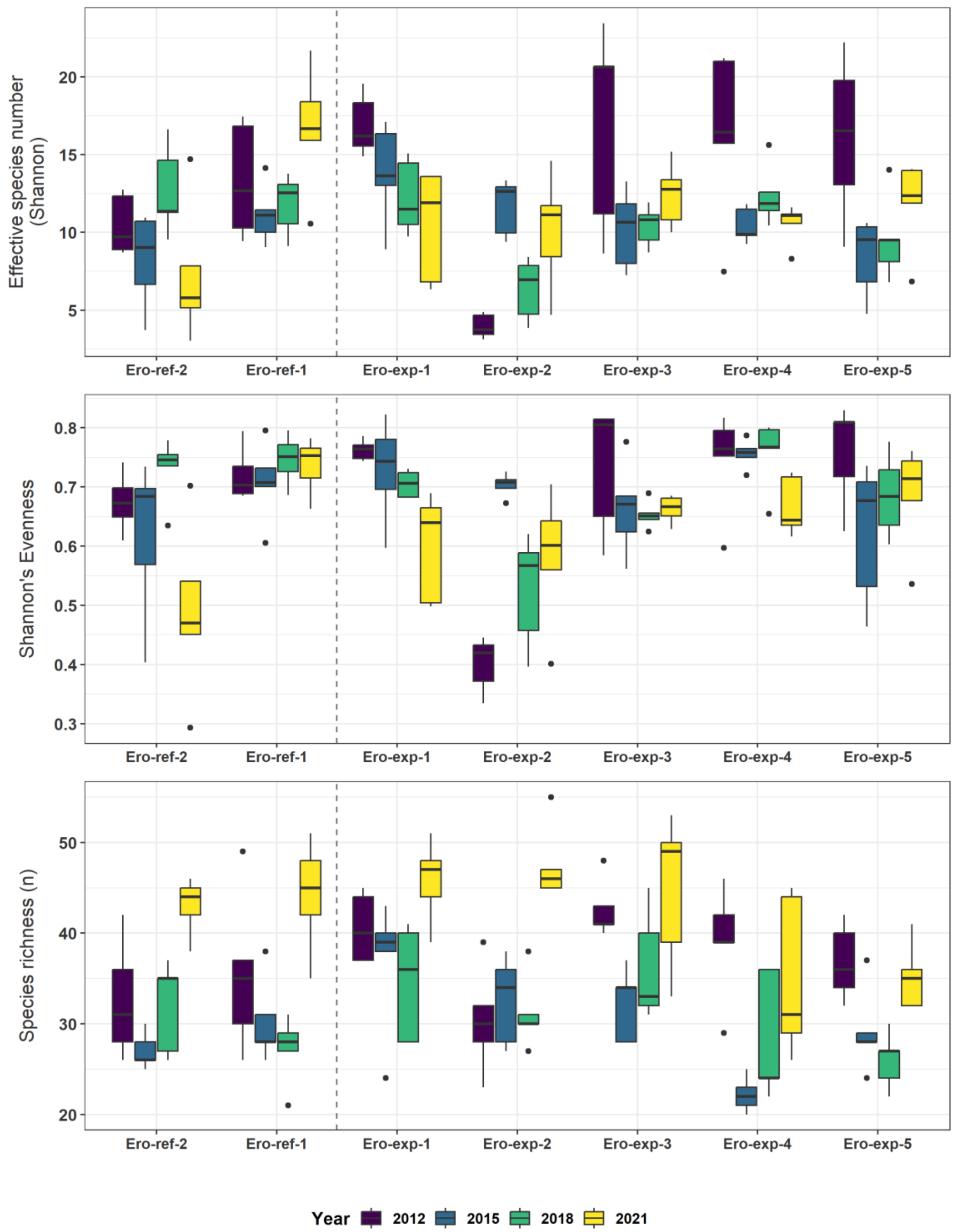


Figure 5-64: Effective species number, Shannon's Evenness and species richness of 2012, 2015, 2018 and 2021 periphyton community in erosional sites. Exp = exposure, Ref = reference.

5.3.2.3 Erosional Community Metrics

Linear mixed effects models and subsequent model averaging showed some differences in periphyton community metrics between site categories.

Species richness was higher in 2021 across all sample sites, indicating more stable growth conditions in the weeks prior to sampling (relative effect size = 6.86, RVI = 1, lower CI = 2.84, upper CI = 10.88). Reference areas had a mean species richness of 43.6 ± 4.65 taxa, and IDZ RB exposure area samples had a mean of 45.54 ± 5.99 taxa in 2021 (Table 5-26). Didymo was found in clumps throughout the reference and exposure sites. Where Didymo occurred, diatom cell density increased, likely because of the increased surface area for diatom attachment created by the Didymo filaments.

Species richness did not differ significantly between sample site category pairs in 2021 alone. However, species richness was impacted by sample site category when all years were modelled together (RVI = 0.77). IDZ RB sites had higher species richness compared to reference sites (relative effect size = 3.92, lower CI = 0.25, upper CI = 7.60). This was likely driven primarily by the relatively high species richness in the CIII side channel. However, there were no significant differences between site category pairs within 2021 data alone.

While studies previous to the AEMP measured between 63 and 84 species per site in the LCR AOI (Golder 2003, 2007), 2021 samples showed 26 – 55 species per site. Because reduced periphyton species richness is universally found at sites receiving metal effluent, identifying lower diversity areas in the LCR is important (Guasch et al. 2012; Morin et al. 2008).

The Shannon evenness index considers the number of taxa (richness) and their relative abundance (evenness). Sample site category did not have an effect on Shannon evenness (RVI = 0.16).

Table 5-26: Summary statistics describing periphyton community productivity and diversity in erosional reference, IDZ RB, and far-field sites in samples collected during 2021.

Metric	Statistic	Reference	IDZ RB	Far-Field
Abundance cells/cm^2	Sample Size	10	13	12
	Mean (±SD)	1.04e+06 ± 4.61e+05	1.44e+06 ± 8.66e+05	7.46e+05 ± 3.92e+05
	Median	8.59e+05	1.19e+06	6.85e+05
	Minimum	6.16e+05	5.62e+05	2.59e+05
	Maximum	2.07e+06	3.59e+06	1.59e+06
Species Richness (# species)	Sample Size	10	13	12
	Mean (±SD)	43.6 ± 4.65	45.54 ± 5.99	37.5 ± 8.06
	Median	44.5	46	35.5
	Minimum	35	33	26
	Maximum	51	55	50
Shannon Evenness	Sample Size	10	13	12
	Mean (±SD)	0.61 ± 0.17	0.61 ± 0.09	0.67 ± 0.06
	Median	0.68	0.64	0.67
	Minimum	0.29	0.4	0.54
	Maximum	0.78	0.7	0.76

Table 5-26: Summary statistics describing periphyton community productivity and diversity in erosional reference, IDZ RB, and far-field sites in samples collected during 2021.

Metric	Statistic	Reference	IDZ RB	Far-Field
Total Biovolume um^3/cm^2	Sample Size	10	13	12
	Mean (±SD)	2.72e+08 ± 1.86e+08	7.05e+08 ± 4.90e+08	2.74e+08 ± 1.92e+08
	Median	1.91e+08	4.92e+08	2.13e+08
	Minimum	9.42e+07	2.96e+08	9.38e+07
	Maximum	7.19e+08	1.73e+09	7.90e+08
Chlorophyll-a ug/cm^2	Sample Size	10	13	12
	Mean (±SD)	2.01 ± 1	2.62 ± 1.22	1.59 ± 0.92
	Median	1.85	2.44	1.24
	Minimum	0.3	0.88	0.46
	Maximum	3.96	4.76	3.16

5.3.2.4 Erosional Community Composition

When 2021 periphyton community composition were evaluated alone with an NMDS and a PERMANOVA test of the NMDS distances, there were significant differences in community structure between reference, IDZ RB, and far-field sites ($R^2 = 0.13$, $F = 2.31$, $p = 0.007$; Figure 5-65). There were also significant differences in community structure between all sample sites ($R^2 = 0.40$, $F = 3.05$, $p = 0.001$).

PERMANOVA testing of the NMDS distances also found significant differences in community composition between the site categories of reference, IDZ RB, and far-field sites when all years were evaluated together ($R^2 = 0.04$, $F = 2.71$, $p = 0.001$; Figure 5-66). These analyses were completed using species abundances and excluded rare species present at fewer than 4 sample sites.

A PERMANOVA of the NMDS distances indicates the erosional periphyton community varies significantly with sample year ($R^2 = 0.16$, $F = 27.22$, $p = 0.001$). Species data from 2021 stood out as a distinct cluster (Figure 5-66). Annual fluctuations in community composition between years have been identified throughout the Lower and Middle Columbia River and are caused by annual variations in flow-related variables (Olsen-Russello et al. 2014; Hawes et al. 2019). The community clusters from 2021 were unique compared to other sample years, and drove the significant differences detected when data from all years was evaluated together. The stable low flows that were experienced prior to the 2021 sampling likely influenced the difference in community structure from previous years.

When environmental variables were evaluated with the NMDS and community structure, PERMANOVA testing found that water temperature was a significant variable in determining community structures ($R^2 = 0.35$, $p = 0.001$). Distance from the CII outfall was also a significant variable ($R^2 = 0.34$, $p = 0.001$).

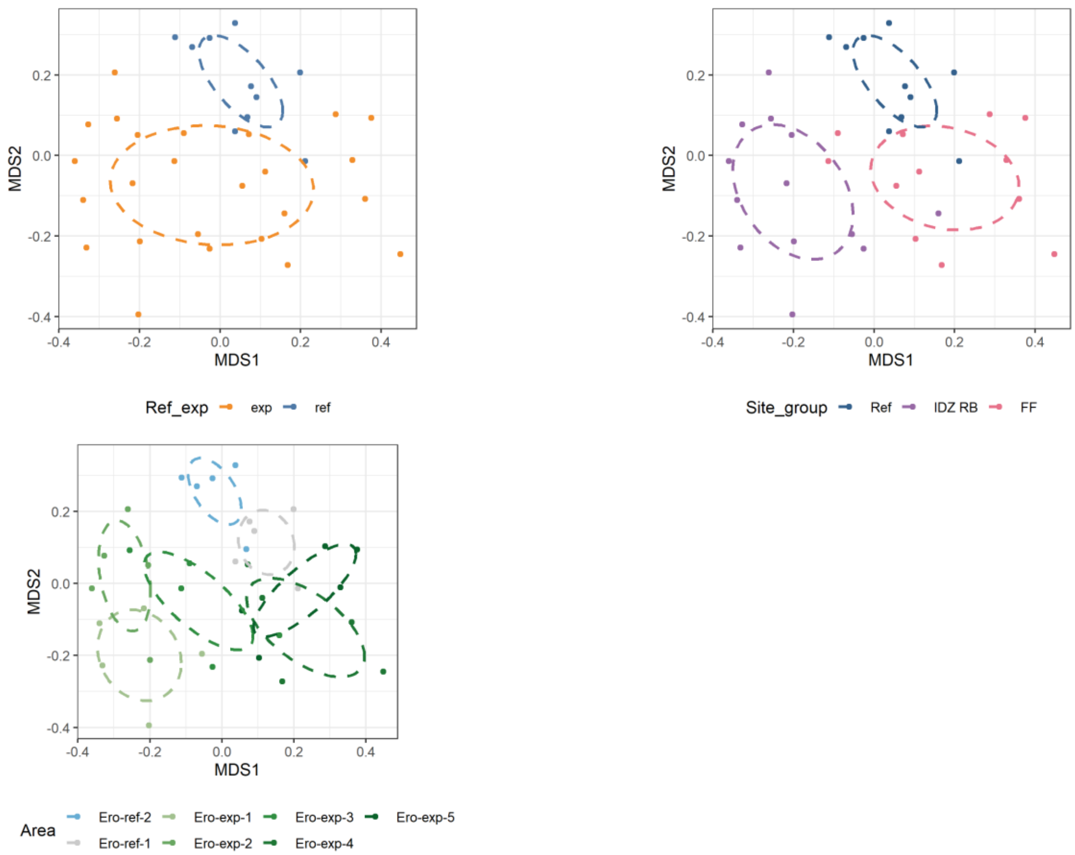


Figure 5-65: NMDS of erosional habitat periphyton abundance at the species level for 2021 alone grouped by reference and exposure sites (top left panel), exposure category (top right panel), and by site (bottom left panel). The stress value was 0.23.

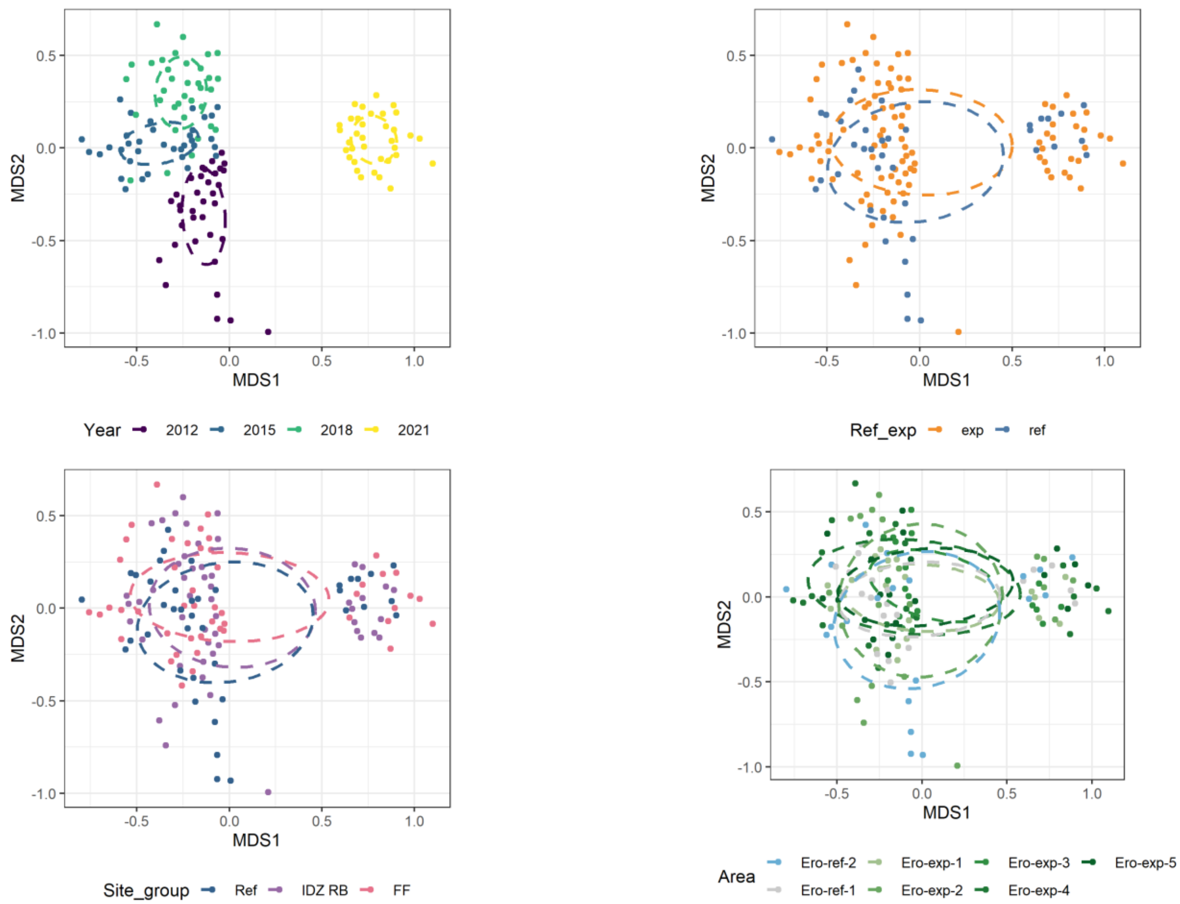


Figure 5-66: NMDS of erosional periphyton abundance at the species level by year (top left panel), site location (top right panel), site category (bottom left), and site (bottom right). The stress value was 0.21.

Attempts to find periphyton species whose distributions were correlated to metals of interest in the AOI and could serve as indicator taxa were largely unsuccessful and contradictory (G3 1999, Golder 2003, Golder 2007). Other more important driving forces on periphyton included overall river flows, localized water velocities, irradiance, nutrient concentrations, and benthic invertebrate grazing pressure.

5.3.2.5 Environmental Variable Models

Environmental variables that may impact periphyton communities and productivity were evaluated using linear mixed effects models and model averaging.

Substrate size (D50) was the physical factor with the strongest effect on abundance (relative effect size = 0.12, RVI = 0.98, lower CI = 0.04, upper CI = 0.20; (Figure 5-67; Figure 5-69). Similarly, the proportion of cobble substrate had a large positive effect on chl-a (relative effect size = 0.48, RVI = 1, lower CI = 0.20, upper CI = 0.76), biovolume (relative effect size = 0.17, RVI = 0.97, lower CI = 0.05, upper CI = 0.29), and species richness (relative effect size = 3.35, RVI = 0.99, lower CI = 1.03, upper CI = 5.67; Figure 5-70 - Figure 5-72).

The positive relationship between large substrates and growth metrics occurs because large substrates have large, stable surfaces available for periphyton growth.

Water velocity was positively associated with periphyton abundance (relative effect size = 0.08, RVI = 0.73, lower CI = - 0.002, upper CI = 0.15; Figure 5-73) and negatively associated with Shannon evenness (Figure 5-74), a measure of species diversity (relative effect size = -0.04, RVI = 0.95, lower CI = -0.07, upper CI = -0.01). High velocities reduce periphyton diversity because they shear off high profile taxa (Passy 2007).

Water temperature had a negative effect on Shannon evenness (relative effect size = -0.05, RVI = 0.82, lower CI = -0.10, upper CI = -0.0004; Figure 5-75). This effect is likely driven by the CIII side channel, where warm temperatures from the effluent increased the amount of filamentous cyanobacteria changing the species diversity in comparison to other sites.

Dissolved oxygen was positively associated with Shannon evenness (relative effect size = 0.04, RVI = 0.61, lower CI = -0.01, upper CI = 0.10; Figure 5-76).

Earlier research in the LCR AOI, prior to the AEMP, reported adverse effects of metals on periphyton growth within the near-field prior to 2003 (G3 2001, Suter and Tsao, 1996, Golder 2010). Suter and Tsao (1996) identified chronic effects values were possibly exceeded for Cd, Cu, and Zn, and later reports suggested Pb, Tl and Cu negatively correlated with periphyton growth in the IDZ (Golder 2010). The results of the linear mixed effects models suggest that conditions in the LCR AOI may be improving. Substrate composition, water velocity, and water temperature have been shown as the variables with the strongest effect on periphyton communities and productivity in the AEMP. The relative importance of treatment (i.e., the position of sample sites relative to the smelter effluent and potential metal effects) on periphyton communities and productivity is lower.

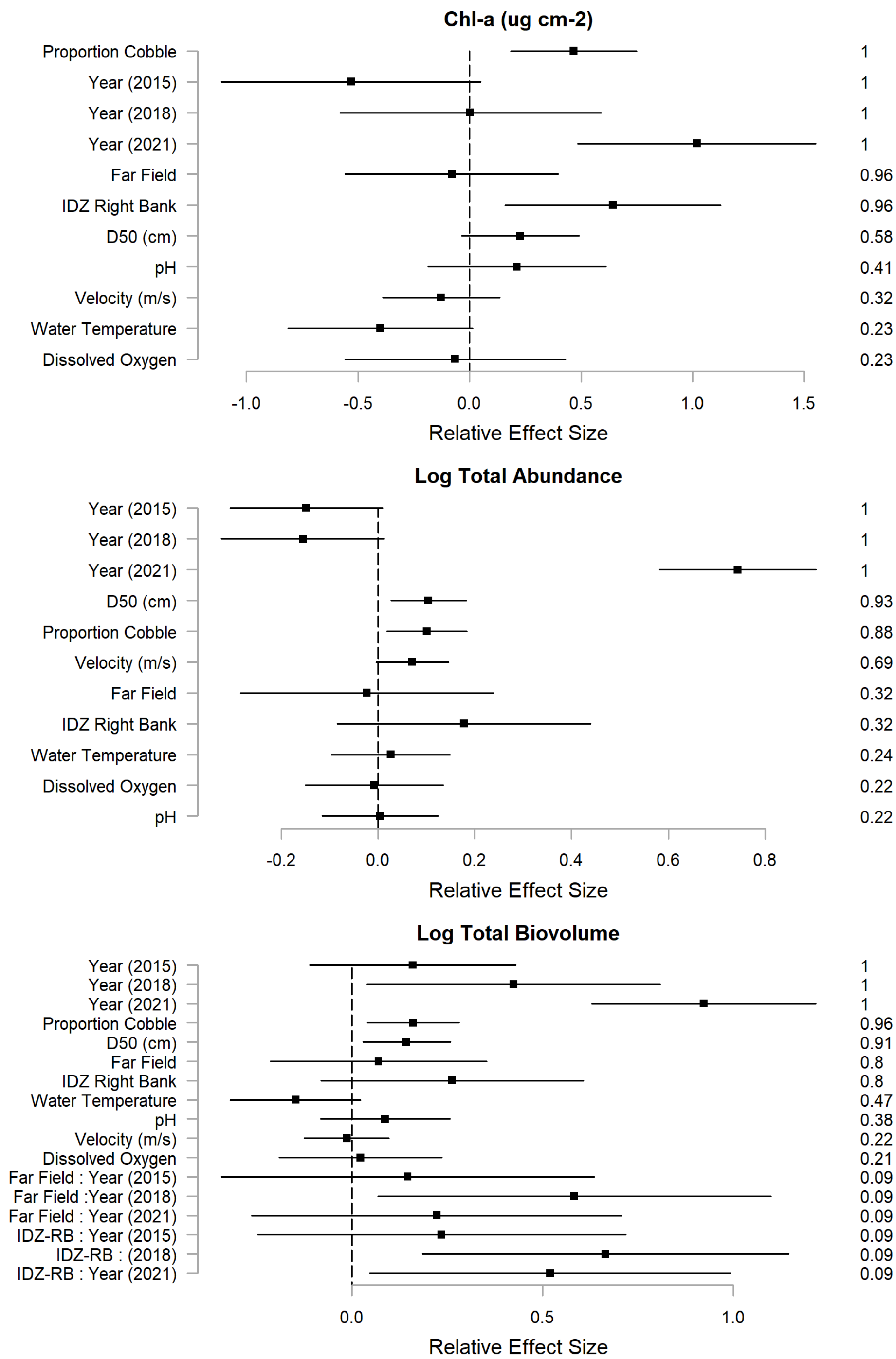


Figure 5-67: The coefficients and their 95% CLs of standardized explanatory variables of erosional periphyton samples. Periphyton responses include chl-a (log), abundance (log), and total biovolume (log). Explanatory variables include D50 (substrate), velocity, water temperature, year sampled and treatment (reference or exposure). Environmental variables' coefficients were standardized to allow comparisons of the direction and size of effects, noting that variables with CLs that do not cross zero influence the response variables. CLs that cross zero can still have some influence even if it is not 'statistically' shown. Key explanatory variables are those that have a relative variable importance (RVI) of greater than 0.6-0.7 and the RVI is shown on the right-hand side of each figure.

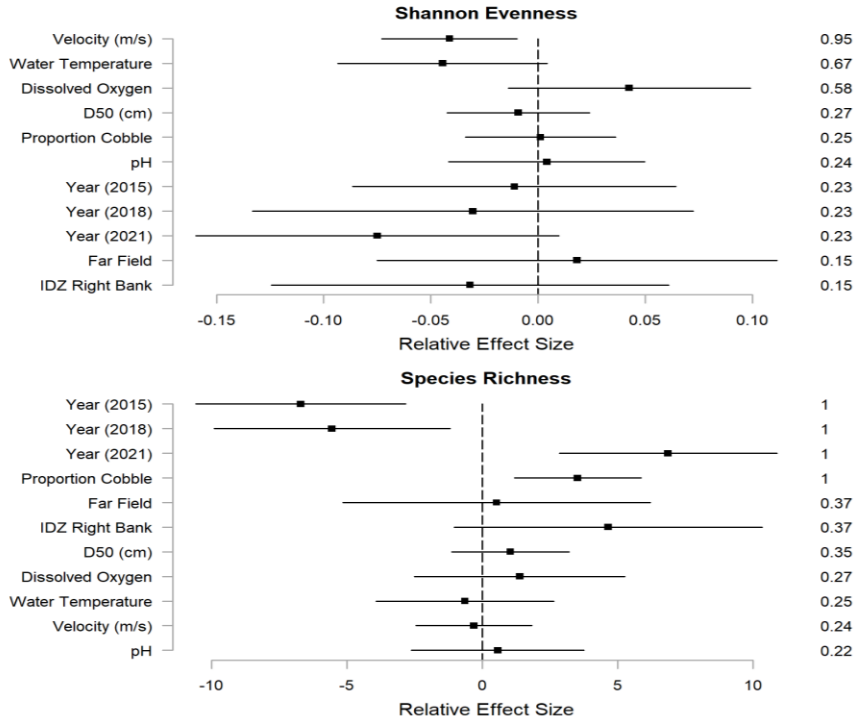


Figure 5-68: The coefficients and their 95% CLs of standardized explanatory variables of erosional periphyton samples. Periphyton responses include Shannon evenness and species richness. Explanatory variables include D50 (substrate), velocity, water temperature, year sampled and treatment (reference or exposure). Environmental variable's coefficients were standardized to allow comparisons of the direction and size of effects. Variables with CLs that do not cross zero influence the response variable. CLs that cross zero can still have some influence even if it is not 'statistically' shown. Key explanatory variables are those that have a relative variable importance (RVI) of greater than 0.6-0.7 and the RVI is shown on the right-hand side of each figure.

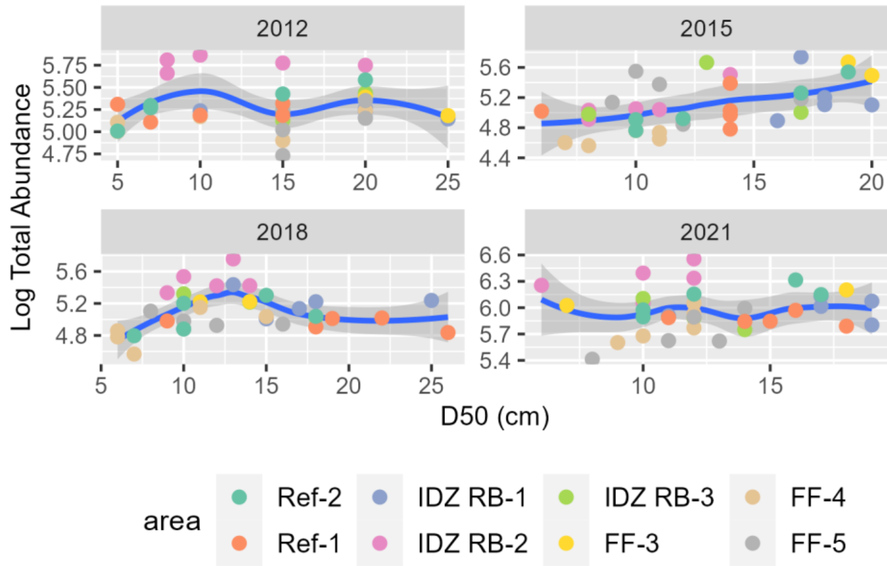


Figure 5-69: Substrate size (D50) and log total abundance grouped by site in each year.

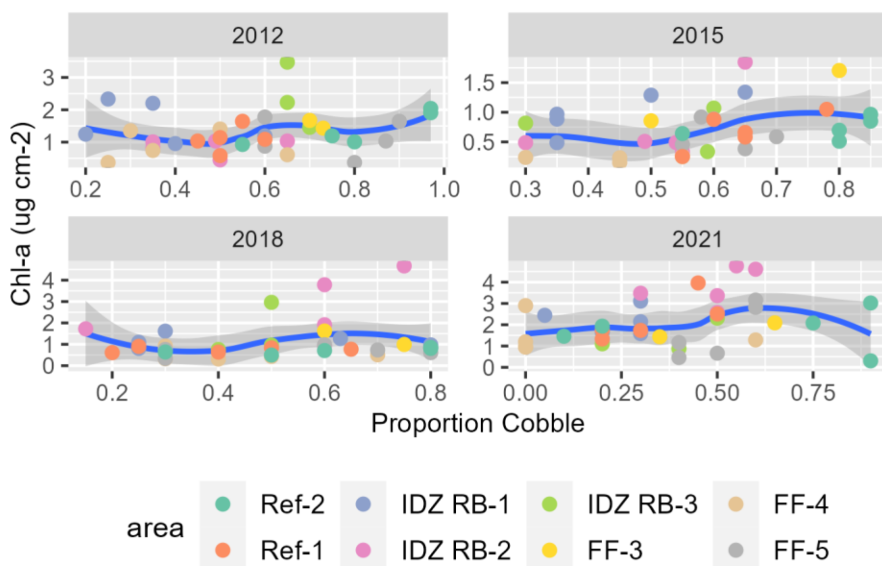


Figure 5-70: Chl-a and proportion cobble grouped by site in each year.

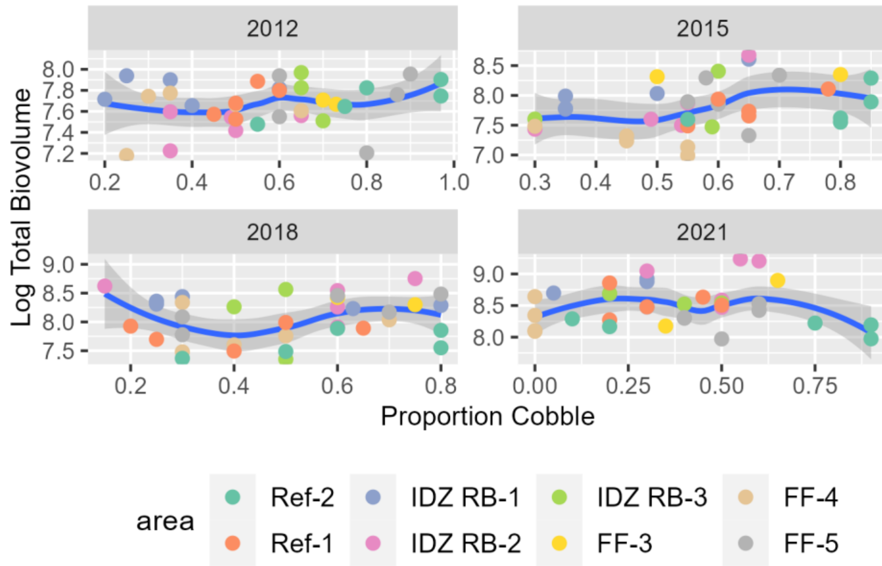


Figure 5-71: Log of total biovolume and proportion cobble grouped by site in each year.

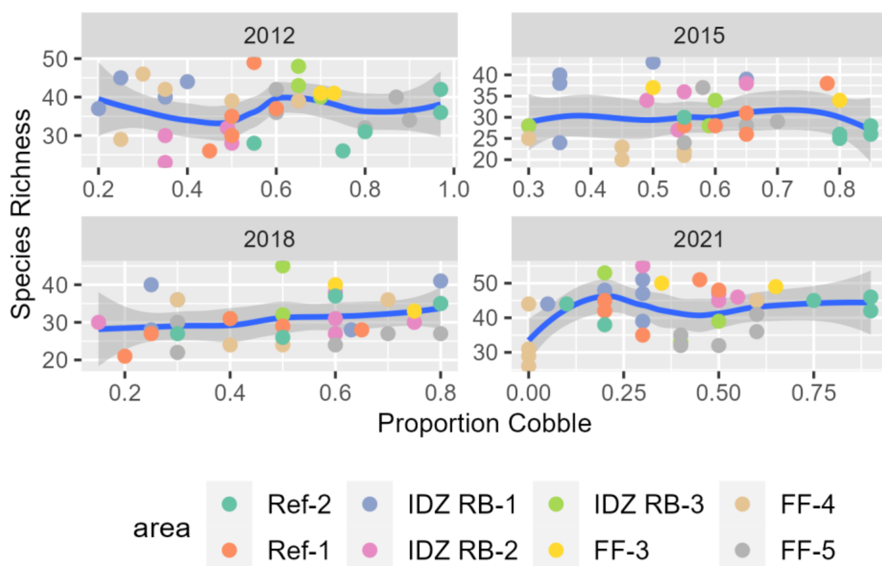


Figure 5-72: Periphyton species richness and proportion cobble grouped by site in each year.

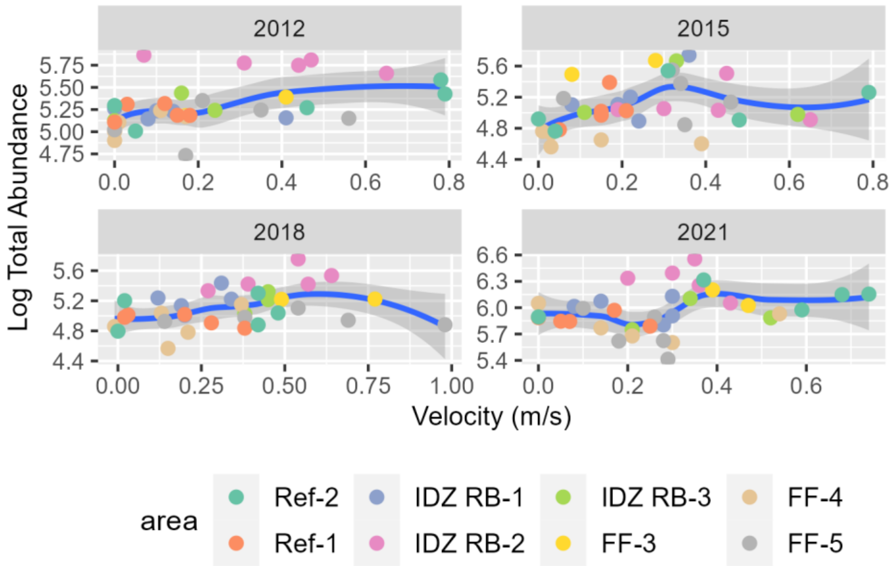


Figure 5-73: Log of total abundance and water velocity grouped by site in each year.

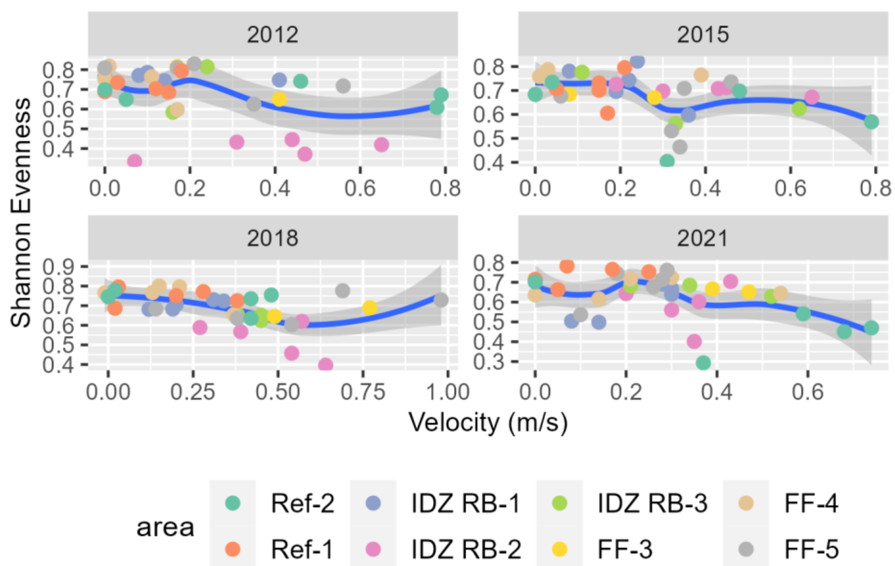


Figure 5-74: Shannon evenness and water velocity grouped by site in each year.

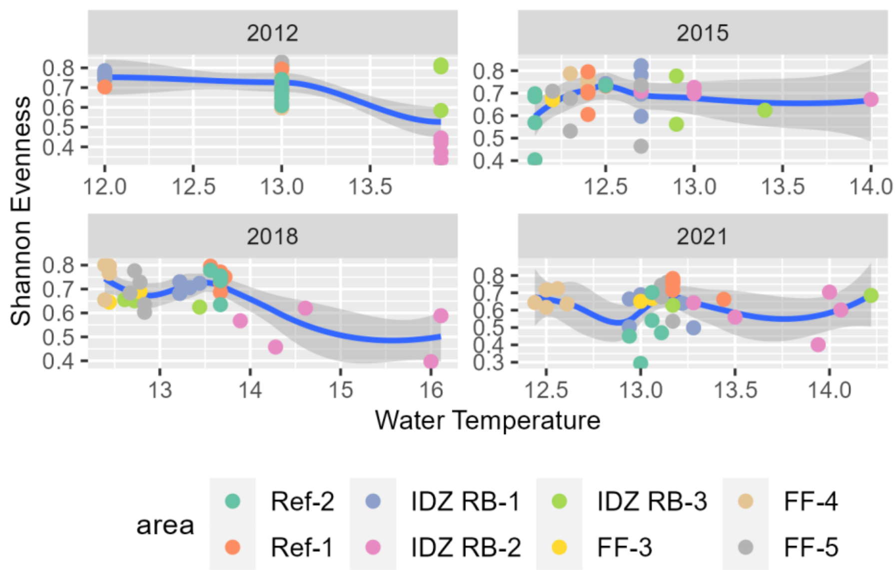


Figure 5-75: Shannon evenness and water temperature grouped by site in each year.

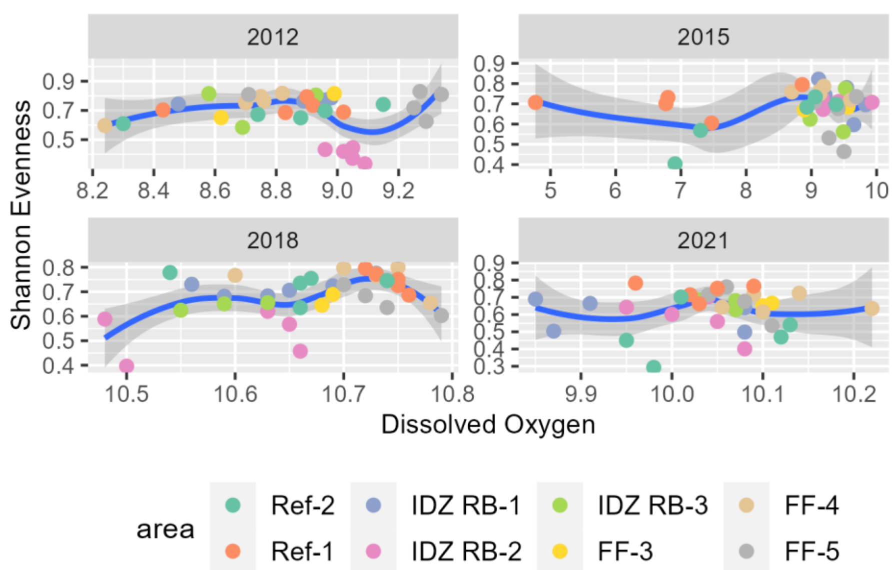


Figure 5-76: Shannon evenness and dissolved oxygen grouped by site in each year.

5.4 Benthic Invertebrates

5.4.1 Depositional Habitats

5.4.1.1 Dominant Taxa

In 2021, detritus worms (Naididae) were the dominant family in all depositional exposure sites, and in two of the three depositional reference sites, Genelle (DEP-REF-2) and Birchbank (DEP-REF-3) (Figure 5-77). Isopods were the dominant family at Kootenay Eddy (DEP-REF-1).

Figure 5-77: Proportional abundance by family for depositional sites by year. Kootenay, Birchbank, and Genelle are reference sites, and the rest are exposure sites.

Table 5-27: Dominant taxa represented in depositional habitats for 2021 samples.

Class	Order	Family	Dominant Taxa*	Common Name	Functional Feeding Group
Arachnida	Trombidiformes	Hygrobatidae	*Hygrobates*	water mite	Predator
		Lebertiidae	*Lebertia*	water mite	Predator
Bivalvia	Veneroida	Pisidiidae	*Pisidiidae*	pill clam	Collector - Filterer
			Pisidium	pill clam	Collector - Filterer
	Unionida	Margaritiferidae		pearl mussel	Collector - Filterer
Gastropoda	Basommatophora	Lymnaeidae	*Lymnaeidae*	pond snail	Scraper
		Physidae	*Physa*	bladder snail	Scraper
		Planorbidae	*Planorbidae*	ramshorn snail	Scraper
	Heterostropha	Valvatidae	*Valvata*	valve snail	Scraper
			Valvata tricarinata	valve snail	Scraper
	Hypsogastropoda	Hydrobiidae	*Hydrobiidae*	mud snail	Scraper
Insecta	Diptera	Chironomidae	*Cryptochironomus*	chironomid	Predator
			Microtendipes pedellus group	chironomid	Collector-Gatherer
			Polypedilum sp.	chironomid	Collector-Gatherer
			Procladius	chironomid	Predator
			Rheotanytarsus	chironomid	Collector-Filterer
			Robackia demeijerei	chironomid	Collector-Gatherer
			Tanytarsus	chironomid	Collector-Filterer
	Ephemeroptera	Ephemerellidae	*Ephemerellidae*	spiny crawler mayfly	Collector-Gatherer
	Trichoptera	Leptoceridae	*Mystacides*	black dancer caddisfly	Omnivore
		Leptoceridae	*Oecetis*	brown caddisfly	Predator
		Hydropsychidae		net-spinning caddisfly	Collector-Filterer
	Hemiptera	Corixidae		water boatman	Predator
Malacostraca	Amphipoda	Crangonyctidae	*Crangonyx*	amphipod	Collector-Gatherer
		Hyalellidae	*Hyalella*	amphipod	Collector-Gatherer
	Isopoda	Asellidae	*Caecidotea*	isopod	Collector-Gatherer
Maxillopoda	Pygophora	Lithoglyptidae			Unclassified
Oligochaeta	Lumbriculida	Lumbriculidae	*Lumbriculidae*	aquatic worm	Collector-Gatherer
	Tubificida	Enchytraeidae	*Enchytraeus*	white worm	Collector-Gatherer
		Naididae	*Naididae*	detritus worm	Collector-Gatherer

*Based on metric data provided by Cordillera Consulting (2019)

5.4.1.2 Community Metrics

We tested the effect of treatment (reference vs. exposure area) and year on benthic invertebrate community metrics that quantify community composition in depositional sites using a two-way ANOVA.

Effective species number did not differ significantly between reference and exposure sites but was significantly higher in 2018 than in 2012 (η = F = 4.40, p = 0.006). Mean effective species number was 13.85 ± 1.17 in reference areas in 2021. Effective species number (diversity) and Shannon's evenness among depositional reference sites were greatest at Birchbank (DEP-REF-3), closely followed by Kootenay Eddy (DEP-REF-1) and were lowest at Genelle (DEP-REF-2; Figure 5 71). In 2021, mean effective species number was 8.37 ± 3.70 for exposure sites, lower than most previous years. Korpac had the highest effective species number (diversity) of the depositional exposure sites. Casino had the second highest effective species number, followed by Fort Sheppard (DEP-EXP-6; Figure 5 71). Shannon's evenness was also highest at Korpac, followed by Casino and then Fort Sheppard.

Taxa richness did not differ significantly between reference and exposure sites (η = 0.05, F = 1.6, p = 0.21). Taxa richness was highest in depositional reference sites at Birchbank (DEP-REF-3) with 67 taxa. Genelle (DEP-REF-2) had 49 taxa, and Kootenay Eddy (DEP-REF-1) had 44 taxa (Figure 5-78). Taxa richness was greatest among exposure sites at Korpac with 61 taxa documented. Waneta (DEP-EXP-7) had the second highest taxa richness among depositional exposure sites with 53 taxa, and Casino had 46 taxa (Figure 5-78). Taxa richness varied significantly by year (η = 0.62, F = 18.0, p < 0.001).

Percent EPT did not differ significantly between years or reference and exposure sites (η = 0.038, F = 1.3, p = 0.26, Appendix J). Kootenay Eddy had the highest relative abundance of EPT (3.7%). Birchbank had 2.9% and Genelle had 1.1% EPT abundance (Figure 5 71). Percent EPT did not differ significantly by year (η = 0.12, F = 1.5, p = 0.23).

EPT richness was not significantly different between reference and exposure areas (η = 0.00, F = 0.14, p = 0.71). EPT richness was highest in depositional reference sites at Birchbank (DEP-REF-3) with 15 taxa. Genelle and Kootenay Eddy both had 5 EPT taxa. EPT richness was highest among the exposure sites at Waneta with 14 EPT taxa. Korpac had 11 EPT taxa, followed by Fort Sheppard with 8 (Figure 5 71). Mean EPT richness was 8.33 ± 5.77 in reference sites in 2021. Mean EPT richness for exposure sites in 2021 was 7 ± 4.32 in 2021. EPT richness varied by year (η = 0.24, F = 3.70, p = 0.021). Only 2021 and 2012 differed significantly in EPT richness among year pairs (p = 0.04).

Percent Chironomidae did not differ significantly between years (η = 0.11, F = 1.3, p = 0.28) or between reference and exposure sites (η = 0.00, F = 0.06, p = 0.8). Mean Chironomid relative abundance in reference areas was 13.95 ± 5.82 in 2021. Chironomid relative abundance was highest among depositional reference sites at Genelle (DEP-REF-2) and accounted for 17.8% of the sample. Birchbank (DEP-REF-3) had the second highest Chironomid relative abundance with 16.9%, and Kootenay Eddy (DEP-REF-1) was 7.25% (Figure 5 72). Mean Chironomid abundance was 9.66 ± 9.12 in exposure sites in 2021, lower than previous study years. Chironomid relative abundance was highest in the Casino Eddy exposure area (DEP-EXP-3) accounting for 27.4% of the sample. Korpac and Airport Bar had 15.8% and 9.65% Chironomidae abundance respectively.

Oligochaeta relative abundance was greatest among depositional reference areas at Genelle (DEP-REF-2) accounting for 44.1% of the community sample followed by Birchbank (DEP-REF-3) and Kootenay Eddy (DEP-REF-1) with 42% and 17.1% Oligochaeta respectively (Figure 5-80). Oligochaeta relative abundance among exposure sites was greatest at Trimac with 78.1% of the sample consisting of Oligochaeta. Trimac was followed by Maglios with 60.6% and Airport Bar with 56.4% (Figure 5-80).

5.4.1.3 Productivity Metrics

Total abundance did not differ significantly between reference and exposure sites (η = 0.058, F = 2.1, p = 0.16). However, total abundance varied by year and was significantly higher in 2021 than 2015 (η = 0.28, F = 4.36, p = 0.04) and 2012 (p = 0.01). Mean abundance in 2021 reference sites was higher than previous years with 29,691.85 ± 12,632.40 organisms/m^2. Of the three depositional reference sites sampled in 2021, Kootenay Eddy (DEP-REF-1) had the highest total abundance with 5,049 organisms (raw), equivalent to about 45,000 organisms/m^2 (Figure 5-78). In 2021, mean abundance was 23,969.52 ± 8,665.55 organisms/m^2 in depositional exposure areas, higher than previous years.

Total biomass did not differ significantly between reference and exposure sites (η = 0.95, F = 0.64, p = 0.43). Among depositional exposure sites in 2021, total biomass was highest at Airport Bar (DEP-EXP-4) with 35,288.9 organisms/m^2 (Figure 5-78). Maglios (DEP-EXP-2) had the second highest biomass with 30,123.3 organisms/m^2, and Trimac (DEP-EXP-5) had 29,928.9 organisms/m^2. Biomass differed significantly by year (η = 0.53, F = 0.14, $p < 0.001$). Biomass in depositional sites in 2021 was significantly higher than in 2015 ($p < 0.001$), and in 2018 (p = 0.006).

Mean biomass across reference sites in 2021 was 7,387.57 ± 2,965.49 mg/m^2. Total biomass was highest in 2021 at Kootenay Eddy (DEP-REF-1) with 1,208.18 mg/m^2, followed by Genelle (DEP-REF-2) with 710.81 mg/m^2 and Birchbank with 574.31 mg/m^2 (Figure 5-78). Mean biomass in exposure sites was 9,472.59 ± 4,848.01 organisms/m^2 in 2021, higher than previous years. Total biomass was highest among exposure sites at Casino (DEP-EXP-3) with 19,236 mg/m^2. The presence of pearl mussels (Margaritiferidae) in the sample, along with a high abundance of detritus worms (Naididae) and Chironomids contributed to the large total biomass at Casino, despite its relatively low total abundance compared to other depositional exposure sites. Casino was followed by Korpac (DEP-EXP-1) and Airport Bar (DEP-EXP-4) with 14,165.6 mg/m^2 and 11,733.2 mg/m^2, respectively (Figure 5-78).

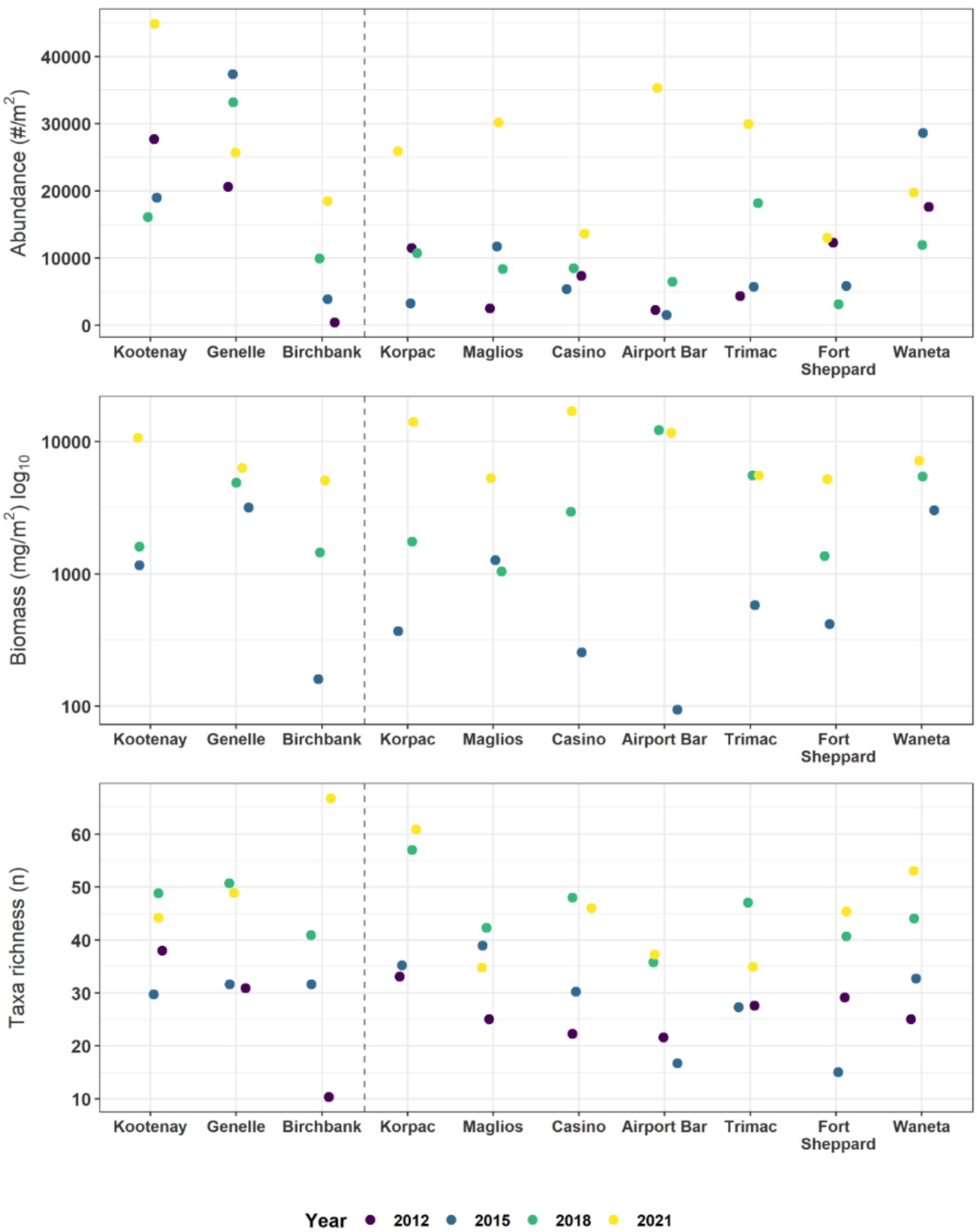


Figure 5-78: Abundance, biomass, and taxa richness for 2012, 2015, 2018, and 2021 benthic invertebrate community productivity and diversity metrics at depositional reference and exposure sites. The vertical dashed line separates reference (left) and exposure (right) sites.

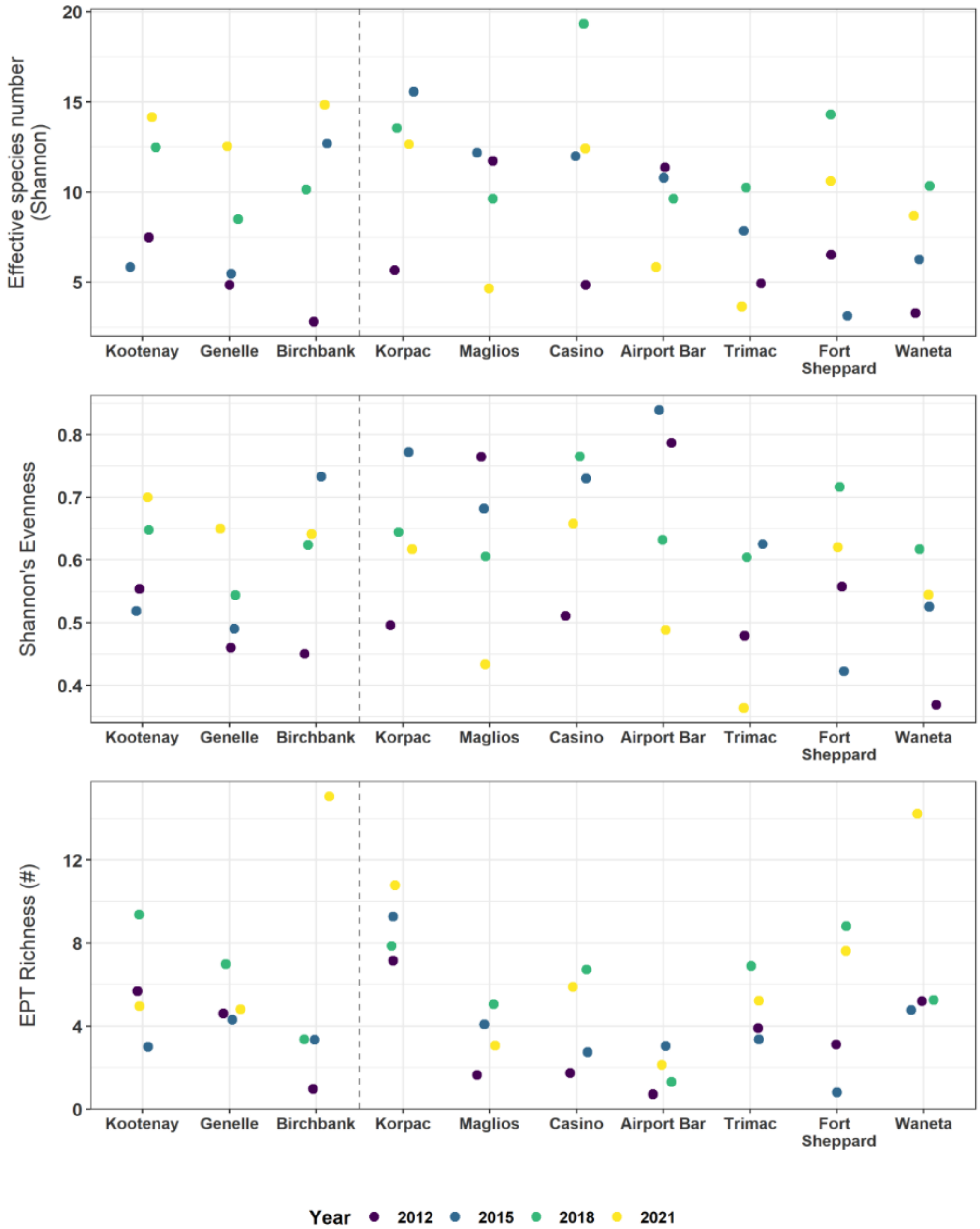


Figure 5-79: Effective species number, Shannon's evenness, and EPT Richness for 2012, 2015, 2018, and 2021 of benthic invertebrates at depositional reference and exposure sites. The vertical dashed line separates reference (left) and exposure (right) sites.

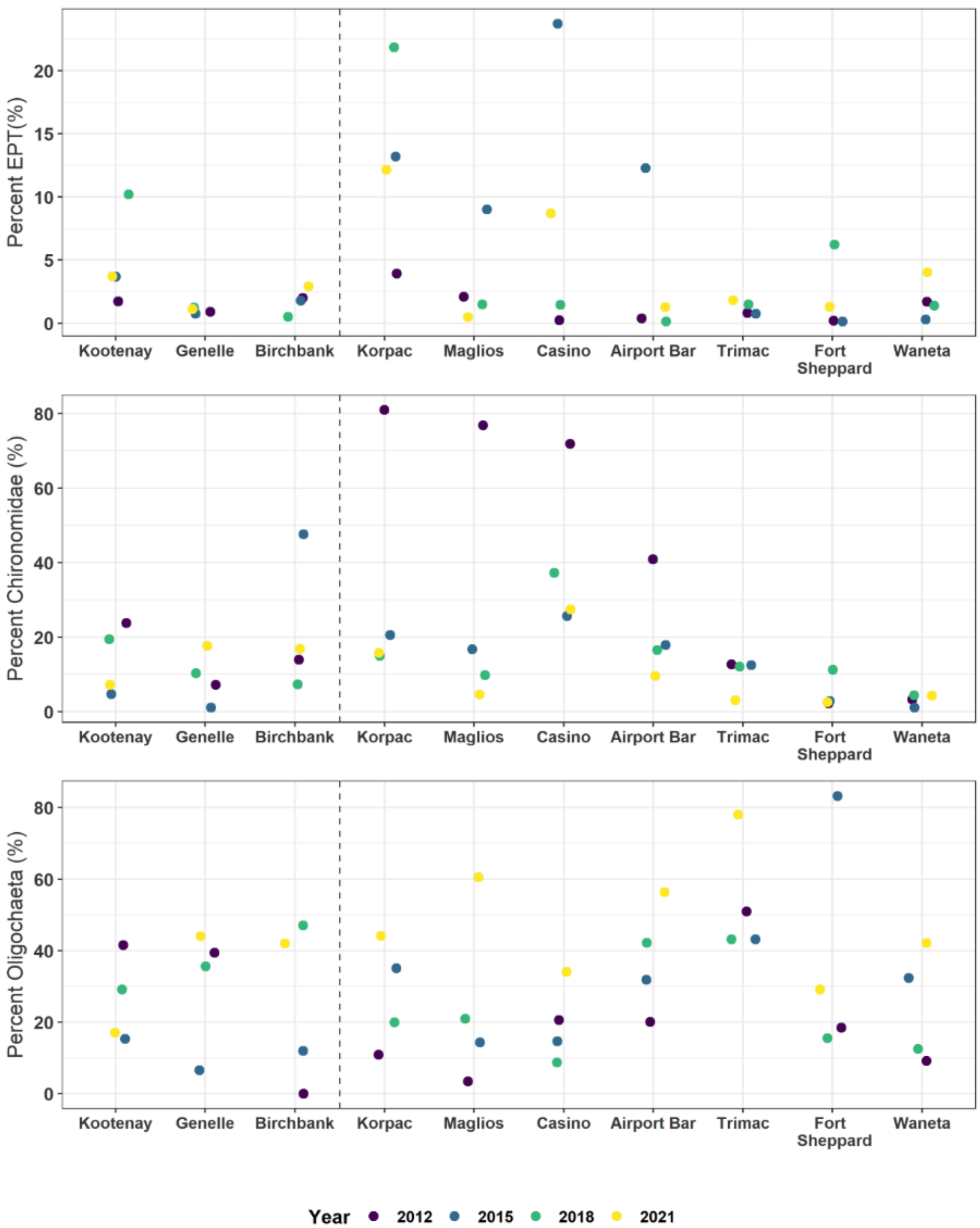


Figure 5-80: Proportions of EPT, Chironomidae, and Oligochaeta in the benthic invertebrate community for 2012, 2015, 2018, and 2021 at depositional reference and exposure sites. The vertical dashed line separates reference (left) and exposure (right) sites.

5.4.1.4 Community Composition

The NMDS for depositional areas across all years provided an adequate representation of the community (stress index = 0.24). The NMDS for 2021 community composition alone provided a good representation (stress index = 0.13).

The NMDS for 2021 alone did not show a difference between reference and exposure sites, and this was supported by the PERMANOVA analysis (F = 1.18, R^2 = 0.13, p = 0.34). Between depositional site clusters in 2021, Naididae, Asellidae, Crangonyctidae, Chironomidae, and Planorbidae were the most influential families in setting sites apart from one another, although sites did not differ significantly.

A PERMANOVA of the main vectors of the NMDS showed there was a significant difference in benthic community composition for depositional habitats between reference and exposure areas when all years were modelled (F = 2.48, R^2 = 0.06, p = 0.017; Figure 5-82). NMDS illustrated a distinct cluster in benthic community composition between years, which was supported by the PERMANOVA analysis of the NMDS vectors (F = 5.47, R^2 = 0.13, p = 0.001). Community composition appears to vary less between sites within 2018 and 2021 than in 2015 and 2012. Community composition also differed significantly between sites (PERMANOVA, F = 1.66, R^2 = 0.33, p = 0.006). Two exposure areas (Casino and Fort Sheppard) and two reference areas (Genelle and Kootenay Eddy) occurred to the right of 0.0 on the first axis (MDS1), with Genelle and Kootenay Eddy loading most strongly to the right. Hydrobiidae and Hygrobatidae loaded strongly to the left of 0 on the first axis. Valvatidae (valve snails), Planorbidae (ramshorn snails), and Naididae (detritus worms) loaded more strongly on the right of 0 on the first axis and are families that favor lower velocity sites.

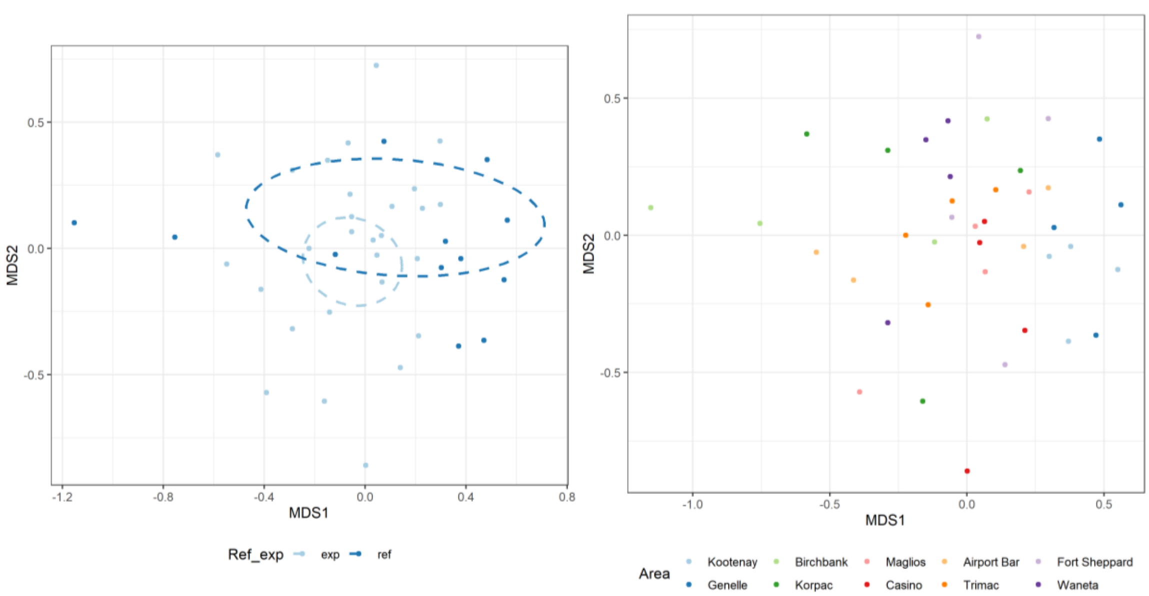


Figure 5-81. NMDS of depositional habitat benthic invertebrate communities in 2021 at the family level grouped by reference and exposure (right), and site (left).

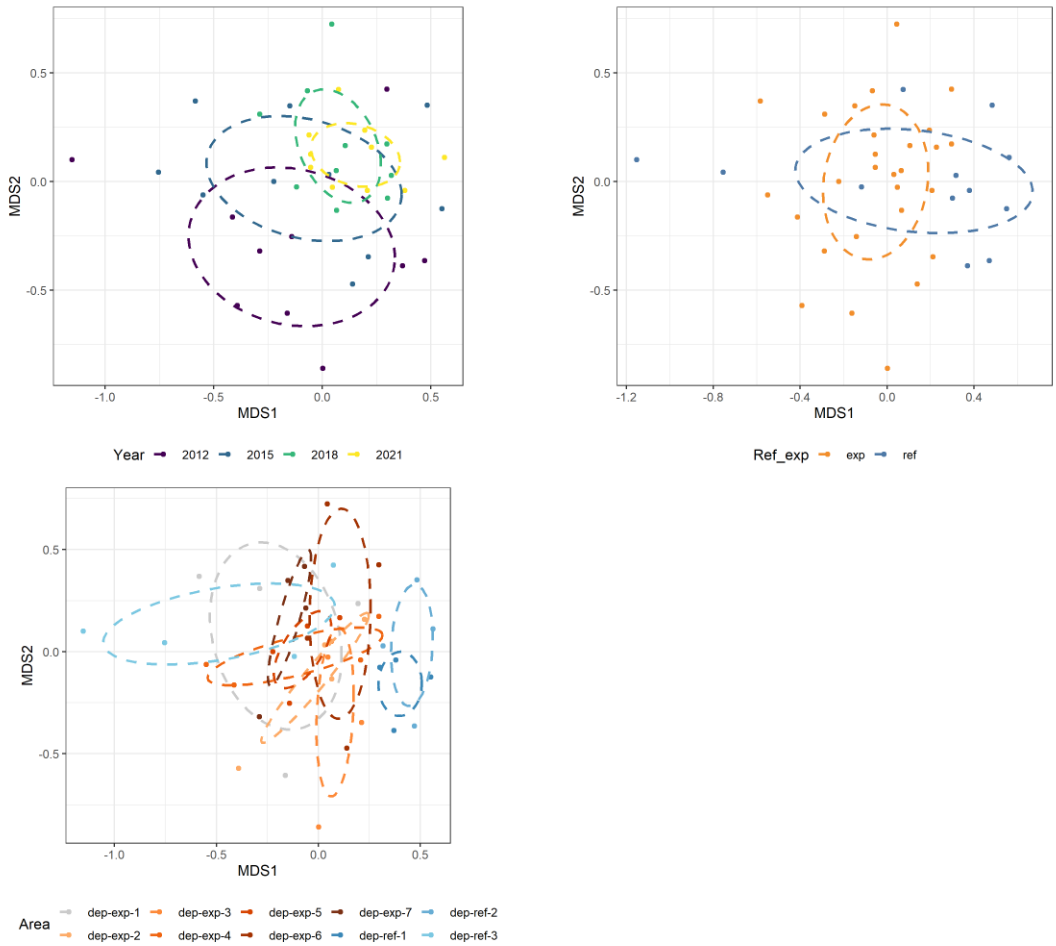


Figure 5-82. NMDS of depositional habitat benthic invertebrate communities at the family level grouped by year (left), reference and exposure (right), and site (bottom).

5.4.2 Erosional Habitats

Erosional habitats were grouped and analyzed by category to help control for variation between near-field and far-field exposure sites while still evaluating differences between reference sites and all exposure areas (Table 5-20). The erosional sites were grouped into reference, Initial Dilution Zone Right Bank (IDZ RB) and far-field categories. The near-field IDZ RB sites are within the effluent plume where the highest risk of effluent exposure occurs. The far-field sites occur beyond the extent of the effluent plume and downstream of the IDZ where the effluent is more thoroughly mixed with the LCR.

Benthic productivity and community metrics and the physical, spatial, and temporal variables that influence them were modelled using linear mixed effects models. The models were evaluated with model averaging to determine which variables had the strongest effects on benthic invertebrate metrics. Community structure in erosional habitats was also analyzed using NMDS ordination analysis and subsequent PERMANOVA models.

The structure of benthic invertebrate communities showed little to no difference between reference, near-field IDZ RB, and far-field exposure areas for erosional habitats. Community structure between the reference, IDZ RB, and far-field groups differed significantly between years (2012, 2015, 2018, and 2021), but the most important variables influencing communities in LCR erosional habitats are water velocity, annual variation, and to a lesser extent, substrate size.

Within the AOI, at both the upstream reference and downstream exposure sites, benthic invertebrate abundance and diversity can vary by an order of magnitude among sites of the same type. However, species assemblages and distributions observed within this study were comparable to those sampled in other productivity studies carried out in the LCR upstream of the AEMP study area (Larratt et al. 2013).

5.4.2.1 Dominant Taxa

Dominant taxa in erosional reference habitats were consistent and EPT taxa dominated all area communities (Figure 5-83 – Figure 5-85). Net-spinning caddisflies (Hydropsychidae) dominated all reference and exposure areas in 2021. Within far-field Exposure Areas 4 and 5, two individual sites (ERO-EXP-4-1 and ERO-EXP-5-4) were dominated by Chironomidae. The IDZ RB sites and far-field sites had the same top three dominant taxa across sample sites, except for IDZ RB site 2 and far-field site 3, which had Brachycentridae as their third dominant taxa rather than Chironomidae (Figure 5-84).

Within Reference Areas 1 and 2, individual sites with low water velocities (ERO-REF-1-2 and ERO-REF-1-5) were dominated by Chironomidae, and ERO-REF-2-4 was dominated by ramshorn snails (Planorbidae). The shift in taxonomic structure in these sites was likely influenced by low current velocities. Water velocity is the most important variable explaining community composition and there are correlations between community diversity and water velocities (Nelson and Lieberman 2002; Degani et al. 1993; Tien Nguyen et al. 2018). Flow can strongly affect habitat characteristics, dispersal, resource acquisition, competition, and predation (Hart and Finelli 1990).

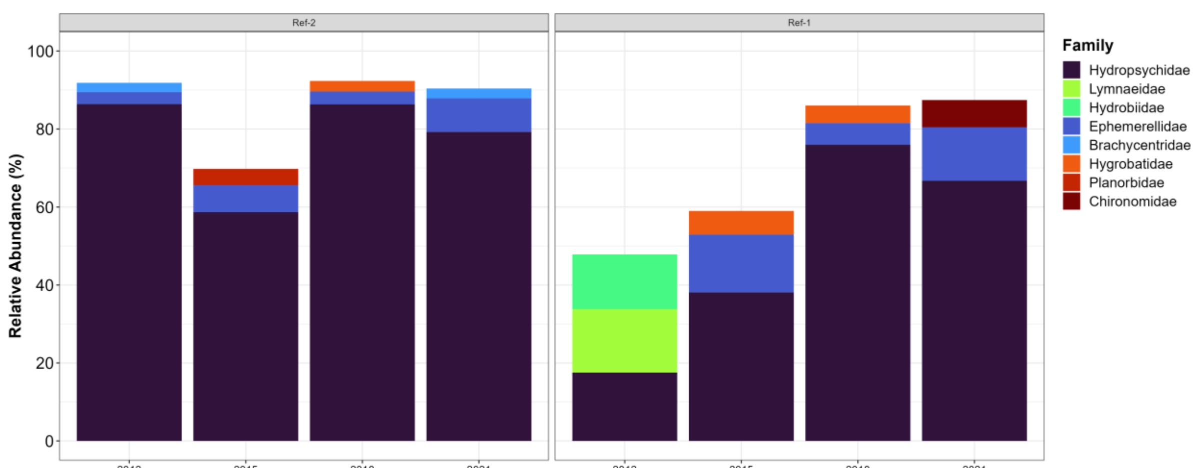


Figure 5-83: Benthic invertebrate proportional abundance at the family level by year among reference sample area sites.

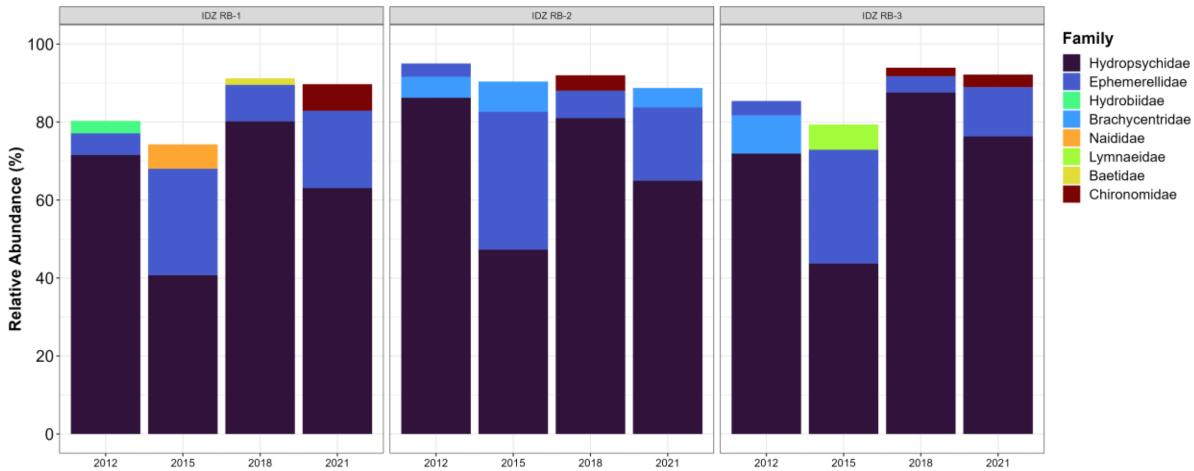


Figure 5-84: Benthic invertebrate proportional abundance at the family level by year among IDZ RB sample area sites.

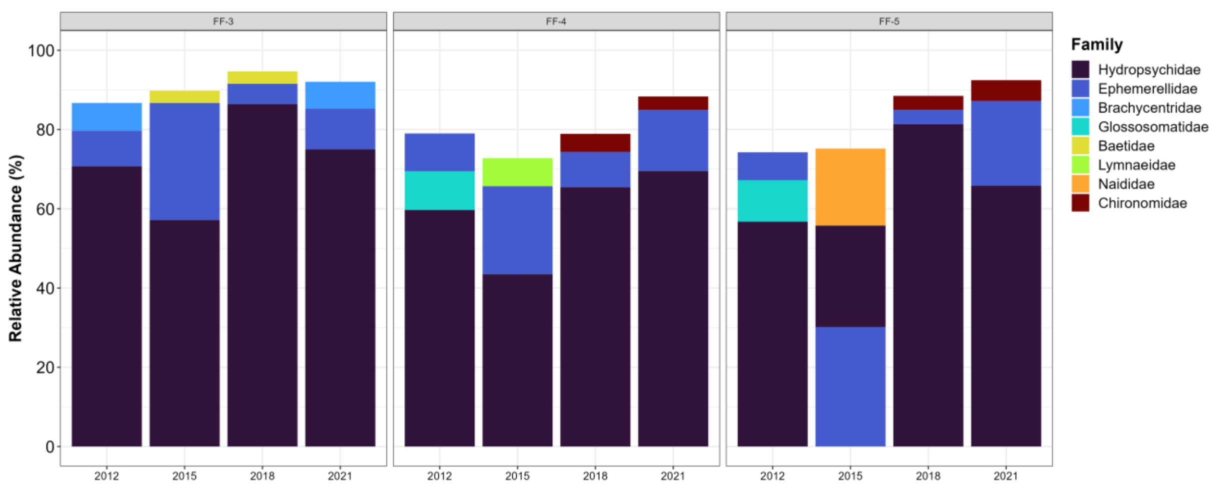


Figure 5-85: Benthic invertebrate proportional abundance at the family level by year among far-field sample area sites.

5.4.2.2 Productivity Metrics

Productivity metrics for benthic invertebrates consisting of abundance and biomass were analyzed with linear mixed effects models and model averaging to determine which variables had an effect on productivity metrics.

Substrate (D50) composition and velocity were the most important factors influencing benthic invertebrate total abundance (RVI = 1). Site category did not have a significant effect on benthic abundance, meaning there was no difference in total abundance between reference, IDZ RB, and far-field sites (RVI = 0.3, Figure 5-86, Appendix K). Of the three site categories, the IDZ RB group had the highest mean abundance in 2021 of 3,346.07 ± 1,865.50 organisms/m^2. Of the individual sites, ERO-EXP-2 had the highest abundance with 4,350 ± 1,854.83 organisms/m^2 (Figure 5-88). ERO-EXP-2 is the side channel into which the CIII outfall discharges and higher water velocities and slightly higher water temperatures are common. ERO-EXP-3 had the second highest abundance with 4,137.1 organisms/m^2. The Birchbank reference sites (ERO-REF-2) had the highest abundance among reference areas with 3,384.6 ± 1,602.66 organisms/m^2.

Abundances were higher in 2021 than previous years, and annual variation was an important factor in determining abundance (relative effect size = 0.33, RVI = 1, lower CI = 0.13, upper CI = 0.52). Abundances did not differ significantly between site categories in 2021 data alone.

Year was the most important factor influencing benthic invertebrate biomass (RVI = 1). Biomass was relatively high in 2021 (relative effect size = 0.50, lower CI =0.25, upper CI = 0.76). Velocity was also an important factor influencing benthic invertebrate biomass (RVI= 0.97)

Sample site category had an effect on invertebrate biomass when all years were modelled together (RVI = 0.72; Figure 5-86). Far-field sites had a slightly negative effect on biomass in comparison to reference sites (relative effect size = -0.23, lower CI = -0.59, upper CI = 0.12). IDZ RB sites had slightly higher biomass relative to reference sites (relative effect size = 0.20, lower CI = -0.15, upper CI = 0.55). However, in pairwise comparisons between site category in 2021 data alone, biomass did not differ significantly by site category. Despite its lower abundance, ERO-REF-1 had the highest biomass with 15,605.9 mg/m^2. This high biomass is likely due to the presence of signal crayfish (*Pacifastacus leniusculus*) in the sample that are frequently observed in the large interstitial spaces of the boulder-dominated substrates along ERO-REF-1. Species with large bodies, such as crayfish, increase total biomass while contributing relatively little to abundance. Biomass was second highest at ERO-EXP-1, with 6,315.9 organisms/m^2, followed by ERO-EXP-4 with 5,500.9 organisms/m^2 (Figure 5-88).

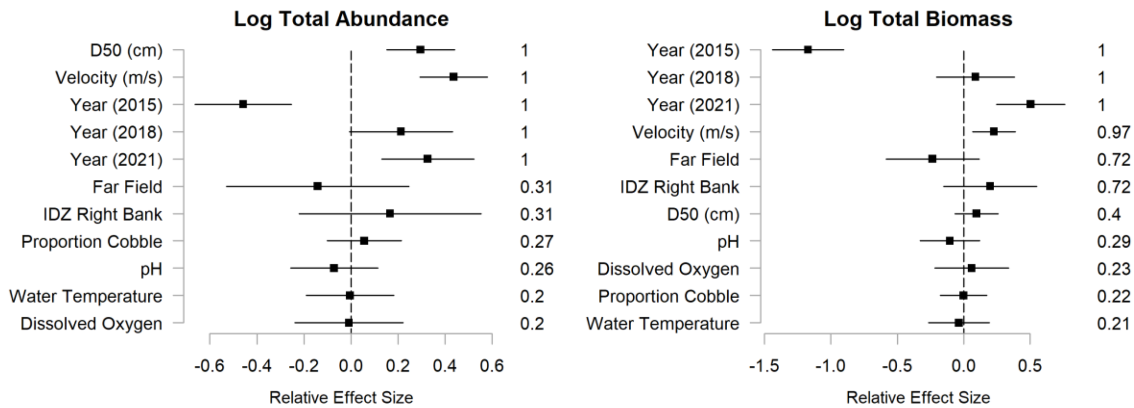


Figure 5-86: Linear mixed effects model effect sizes for variables influencing total abundance and total biomass in 2012, 2015, 2018, and 2021 samples at erosional sites. Coefficients were standardized to allow comparisons of the direction and size of effects. Variables with CLs that do not cross zero influence the response variable. Key explanatory variables are those that have a relative variable importance (RVI) of or greater than 0.6-0.7. RVI is shown on the right-hand side of each figure.

5.4.2.3 Community Metrics

Community metrics for benthic invertebrates in erosional sites and the variables that may influence them were evaluated using linear mixed effects models and model averaging. A summary of benthic invertebrate community metrics for erosional habitats sampled in 2012, 2015, 2018, and 2021 can be found in Appendix K.

Site category did not have an effect on taxa richness (RVI = 0.03). Among individual sites, ERO-EXP-5 had the highest taxa richness with a mean of 31.2, ERO-REF-1 had 30.8 taxa, followed by ERO-EXP-4 with 28.2. Taxa richness fluctuated with year (RVI = 0.84). The low abundance of Ephemerellidae in 2012 and 2018 is likely due to annual variation. For instance, a large emergence (hatch) may have occurred in the days that preceded sampling.

Shannon's evenness was not significantly different between site categories (RVI = 0.10) or sample years (RVI = 0.38; Figure 5-89).

Within 2021 data alone, reference sites had significantly lower EPT richness than near-field IDZ RB sites (relative effect size = -1.88, p = 0.05). Other site category combinations for 2021 did not differ significantly.

Site category was the strongest factor influencing EPT richness when all years were modelled together (RVI = 0.91; Figure 5-87). Near-field IDZ RB sites had higher EPT richness than reference sites (relative effect size = 1.93, lower CI = 0.66, upper CI = 3.20). Far-field sites also had higher EPT richness than reference sites (relative effect size = 1.84, lower CI = 0.62, upper CI = 3.06). Sample year was also an important factor influencing EPT richness (RVI = 0.79). However, 2021 conditions did not have a strong effect on EPT richness in comparison to other years (relative effect size = 1.19, lower CI = -0.19, upper CI = 2.57).

Most EPT taxa are classified as metal sensitive species. EPT richness was highest among exposure sites at ERO-EXP-4 and ERO-EXP-2 with 13.8 and 13.6, respectively. ERO-REF-1 had a mean of 11.8 EPT taxa for EPT richness and ERO-REF-2 had a mean of 11.6 taxa. High EPT richness is a good indicator of a healthy benthic invertebrate community.

Substrate (D50) composition and velocity were the most important factors influencing the amount of the benthic community consisting of EPT taxa, or percent EPT (RVI = 1). Site category was also an important factor influencing percent EPT (RVI = 0.85; Figure 5-87). Near-field IDZ RB sites had a higher percent EPT than reference sites (relative effect size = 19.98, lower CI = 6.74, upper CI = 33.21). Far-field sites also had a higher percent EPT than reference sites (relative effect size = 11.78, lower CI = -1.51, upper CI = 25.08). Among individual sites, percent EPT was highest at ERO-EXP-3 with 95.1% and was second highest at ERO-EXP-2 with 92.1% (Figure 5-89). EPT richness and percent EPT are likely higher at these near-field IDZ RB sites because of increased water velocity and substrate size relative to the reference sites.

Although EPT richness and proportion differed between reference and both exposure site categories, site category did not have a strong effect on the percentage of Chironomids in the benthic invertebrate population (RVI = 0.14).

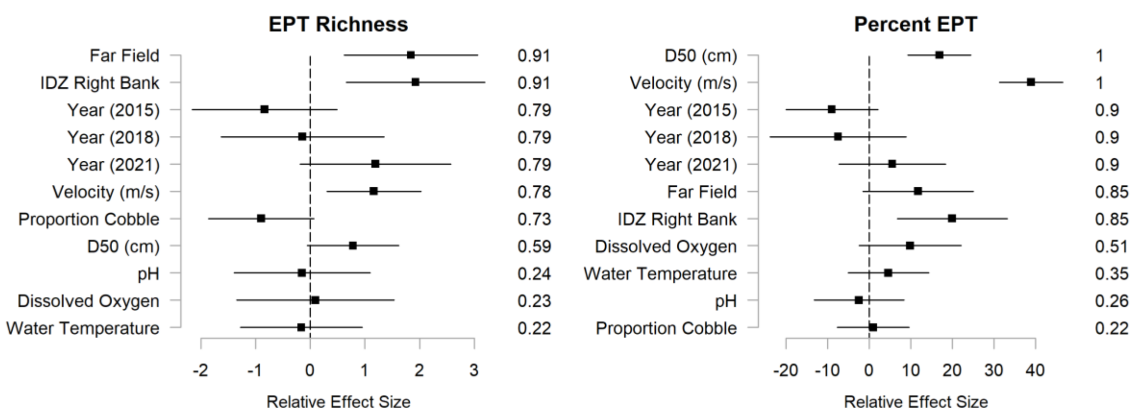


Figure 5-87: Linear mixed effects model effect sizes for variables influencing EPT richness and percent EPT in 2012, 2015, 2018, and 2021 samples at erosional sites. Coefficients were standardized to allow comparisons of the direction and size of effects. Variables with CLs that do not cross zero influence the response variable. Key explanatory variables are those that have a relative variable importance (RVI) of or greater than 0.6-0.7. RVI is shown on the right-hand side of each figure.

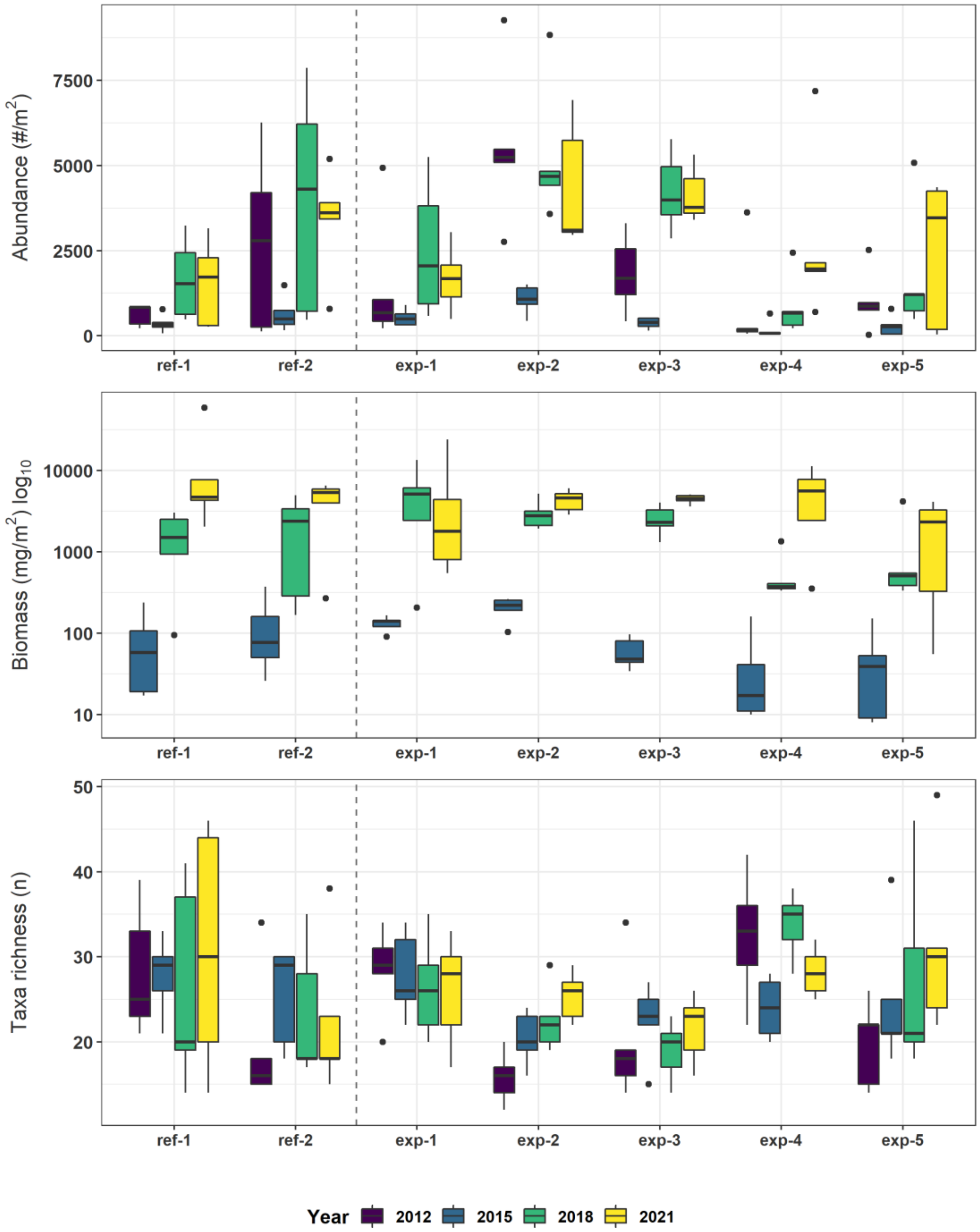


Figure 5-88: Abundance, biomass, and taxa richness for 2012, 2015, 2018, and 2021 benthic invertebrate community productivity and diversity at erosional sites above and below smelter outflow.

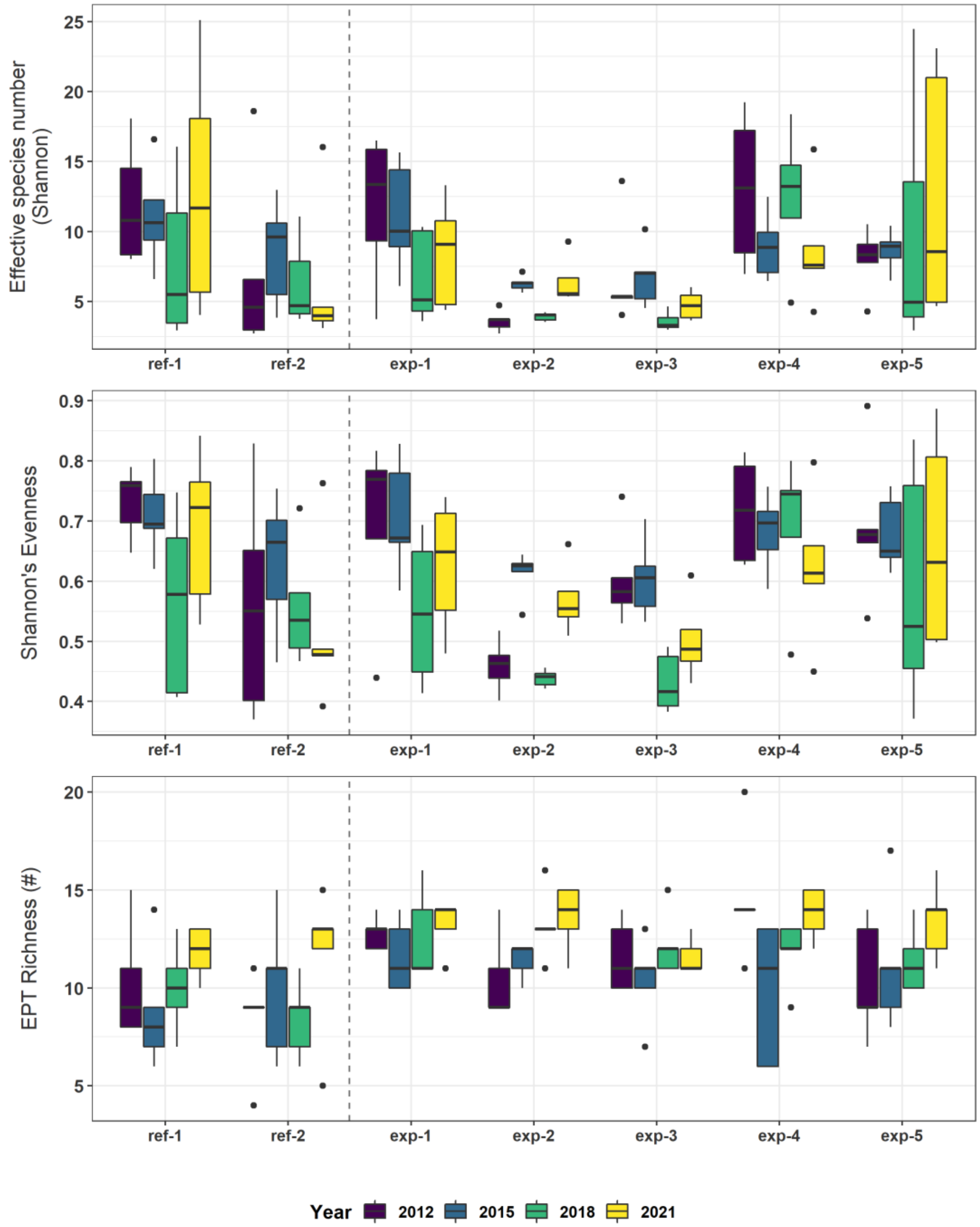


Figure 5-89: Effective species number, Shannon's evenness, and EPT Richness for 2012, 2015, 2018, and 2021 benthic invertebrate community productivity and diversity at erosional sites above and below smelter outflow.

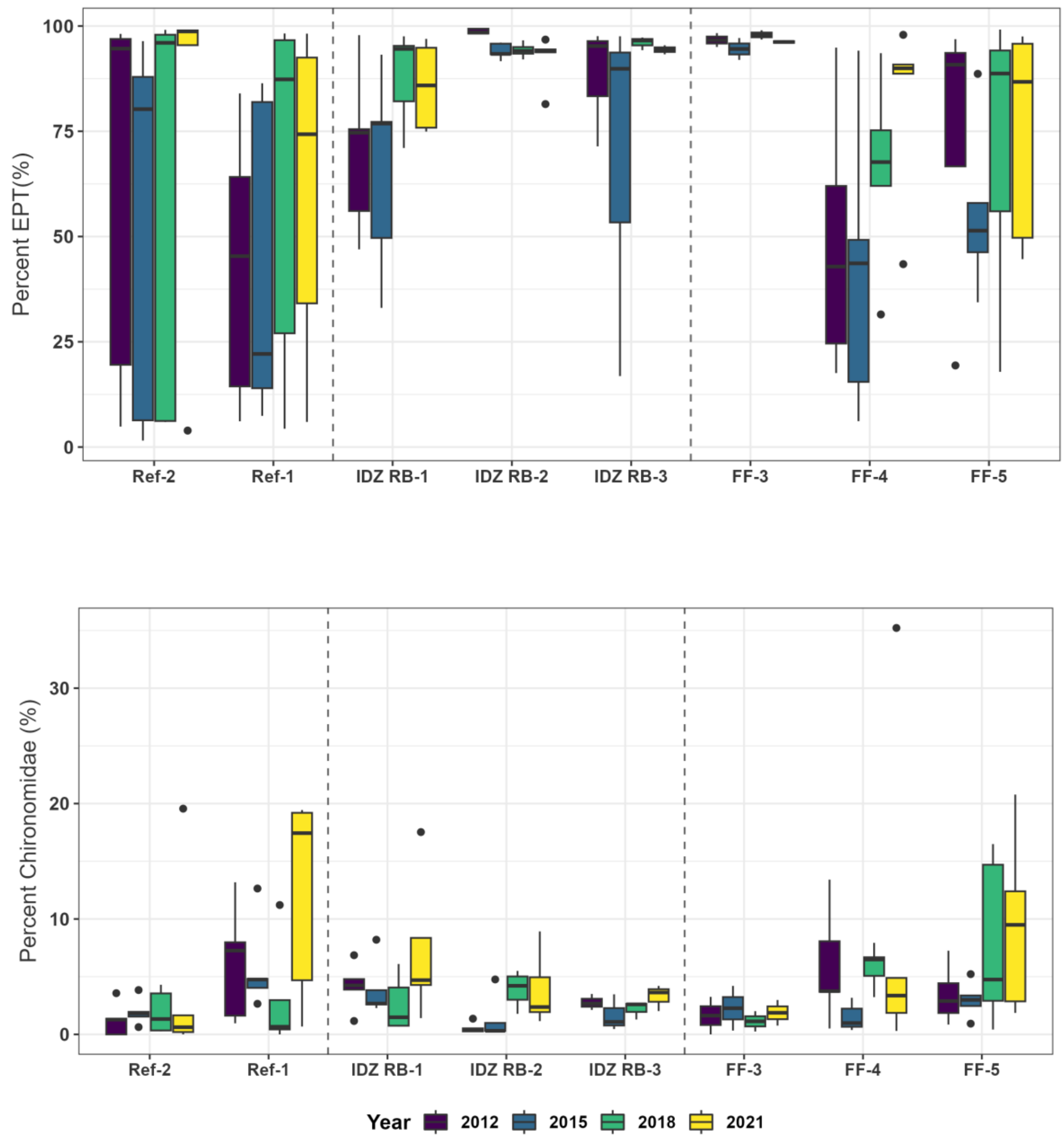


Figure 5-90: Percent EPT and percent Chironomidae, for 2012, 2015, 2018, and 2021 benthic invertebrate community productivity and diversity at erosional sites above and below smelter outflow.

5.4.2.4 Functional Feeding Groups

Distribution and relative abundance of the various functional feeding groups in both reference and exposure areas were typical for a river of the order and hydrologic character of the LCR. The River Continuum Concept (RCC) predicts that community functional composition changes with habitat size and structure. For example, shredders (detritivores) should be relatively abundant in upper headwater reaches and then decrease downstream as the relative importance of coarse detritus declines. With a more open canopy and increased primary production, scrapers that graze algae and fine particles become more dominant in lower, larger reaches of rivers (Bottorff & Knight 1988, Uwadiae 2010).

Functional feeding groups were modelled with linear mixed effects models using site categories and years as variables. Erosional site categories did not have a strong effect on the relative abundance of Collector Filterers (RVI = 0.25), Collector Gatherers (RVI = 0.04), and Predators (RVI = 0.55).

However, site category did have an effect on the percentage of Scrapers among benthic functional feeder groups when all years were modelled together (RVI = 0.60). Near-field IDZ RB sites had a negative effect on the percentage of scrapers in the community compared to reference sites (relative effect size = -9.96, lower CI = -18.56, upper CI = -1.36). Far-field sites did not differ strongly from reference sites in percentage of Scrapers (relative effect size = -3.93, lower CI = -12.55, upper CI = 4.68). Annual fluctuation, or year, had a strong effect on percentage of Scrapers (RVI = 1). Sample year 2021 had a negative effect on percentage of Scrapers (relative effect size = -16.12, lower CI = -24.88, upper CI = -7.37).

Percentage of omnivores differed significantly between site categories when all years were modelled together (RVI = 0.60; Appendix K). Near-field IDZ RB sites had higher percentages of omnivores than reference sites (relative effect size = 2.34, lower CI = 0.21, upper CI = 4.46). This difference in community was likely primarily driven by the benthic community at ERO-EXP-2, although far-field sites also differed slightly from reference sites in percentage omnivores (relative effect size = 1.39, lower CI = -0.74, upper CI = 3.52). ERO-REF-1 had a lower percentage of omnivores in the population than ERO-EXP-2. Between exposure sites, percent omnivores in the population were higher in ERO-EXP-2 than in ERO-EXP-1 and ERO-EXP-4. The higher number of Chironomids and ramshorn snails in the lower velocity sites of ERO-REF-1 explains this difference. These organisms are grazers and scrapers that specialize to feed on the biofilm layers versus the net-spinning caddisfly that dominates ERO-EXP-2 and catches algae, detritus, and smaller invertebrates in their woven nets.

Percentage of omnivores was more effected by annual fluctuations than any other variable (RVI = 1). Percentage of omnivores was negatively affected by conditions in 2021 in comparison to 2012 (relative effect size = -4.27, lower CI = -6.75, upper CI = -1.79).

Observed shifts in dominant functional feeding groups and altered insect community composition in some sites within erosional areas is tied to differences in instream habitat structure (Slavik et al 2004). This difference is particularly evident in the sites that had lower velocities.

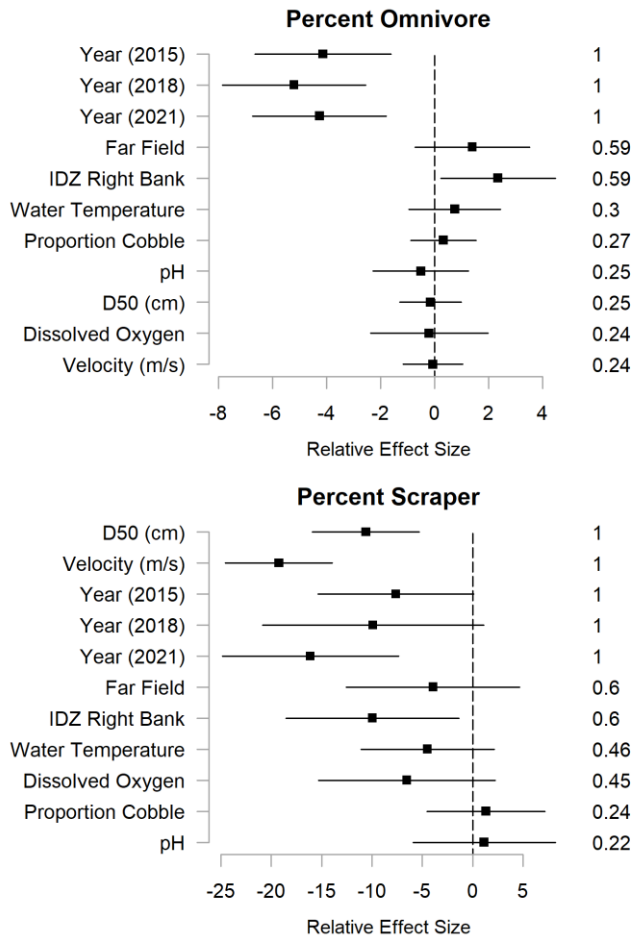


Figure 5-91: Linear mixed effects model effect sizes for variables influencing the percentage of omnivores and scrapers in 2012, 2015, 2018, and 2021 samples at erosional sites. Coefficients were standardized to allow comparisons of the direction and size of effects. Variables with CLs that do not cross zero influence the response variable. Key explanatory variables are those that have a relative variable importance (RVI) of or greater than 0.6-0.7. RVI is shown on the right-hand side of each figure.

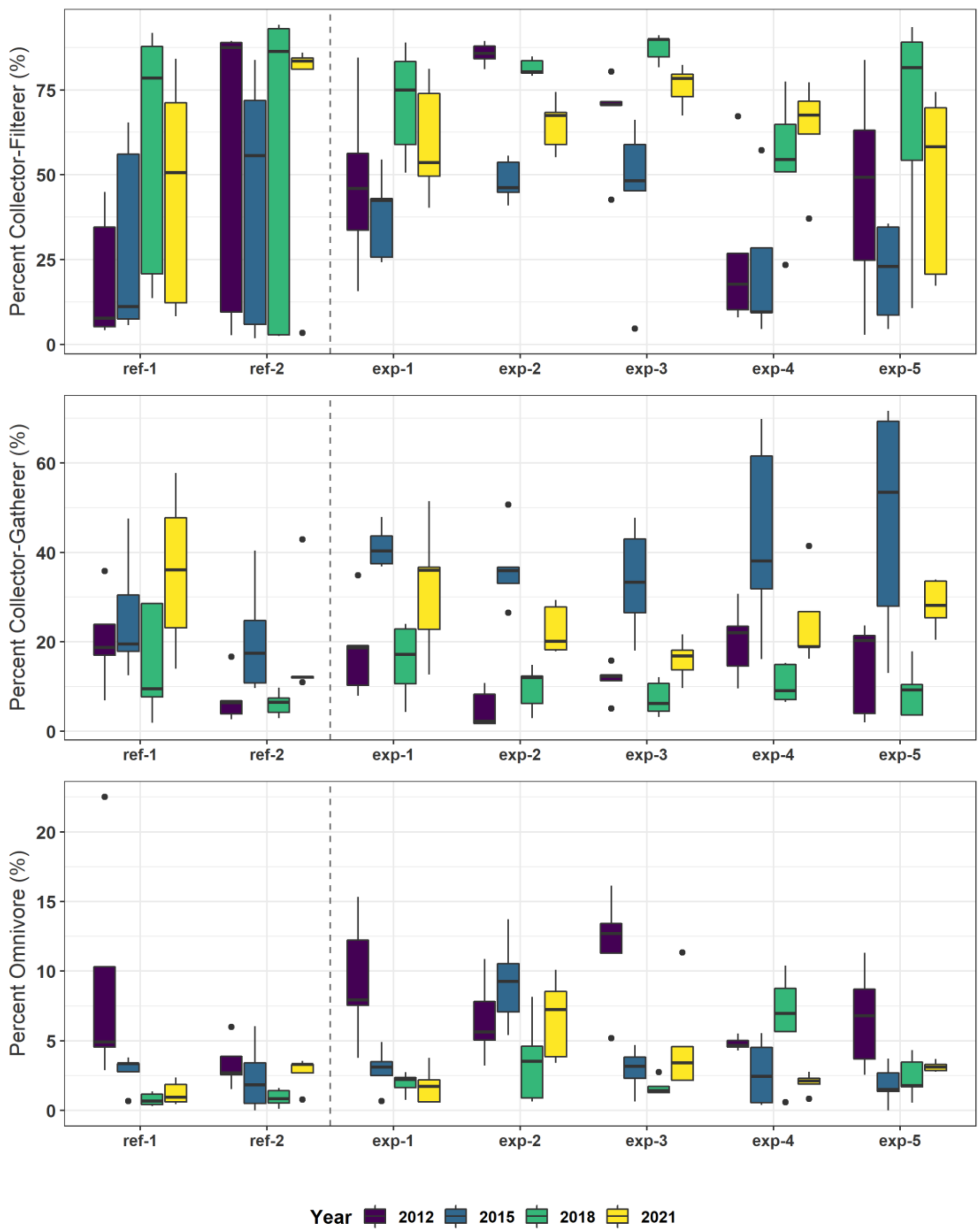


Figure 5-92: Percent Collector Filterer, percent Collector Gatherer and percent Omnivore for 2012, 2015, 2018, and 2021 samples at erosional sites above and below smelter outflow.

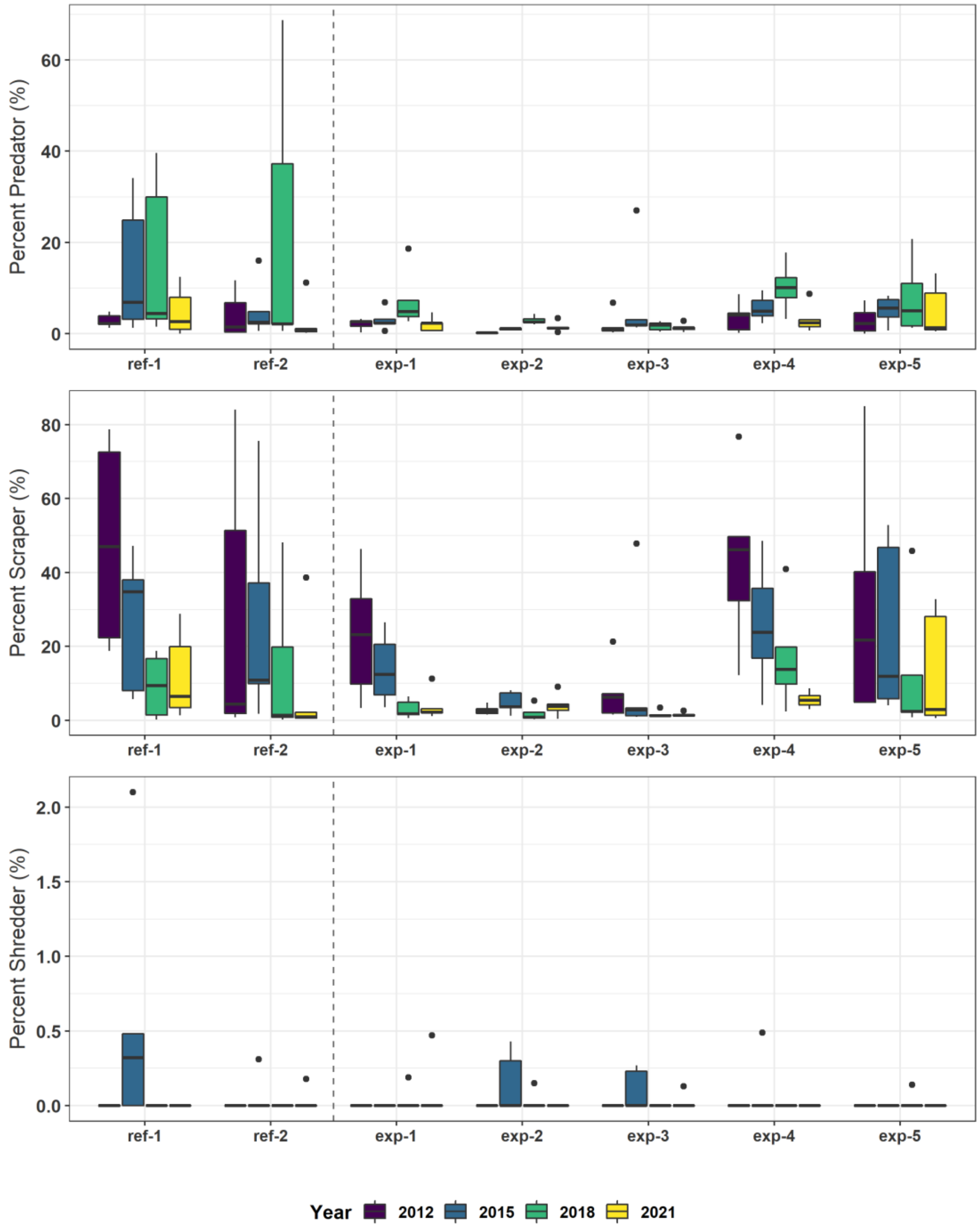


Figure 5-93: Percent Predator, percent Scraper and percent Shredder for 2012, 2015, 2018, and 2021 samples at erosional sites above and below smelter outflow.

5.4.2.5 Community Composition

The NMDS for 2021 community composition alone also provided a good representation (stress index = 0.15).

NMDS for 2021 alone showed no significant difference in community composition between the site categories of reference, IDZ RB, and far-field (F = 0.86, R^2 = 0.05, p = 0.52). There was no significant difference between individual sample sites (F = 1.55, R^2 = 0.25, p = 0.068; Figure 5-94). In 2021, Hydropsychidae and Ephemerellidae drove most of the differences between clusters.

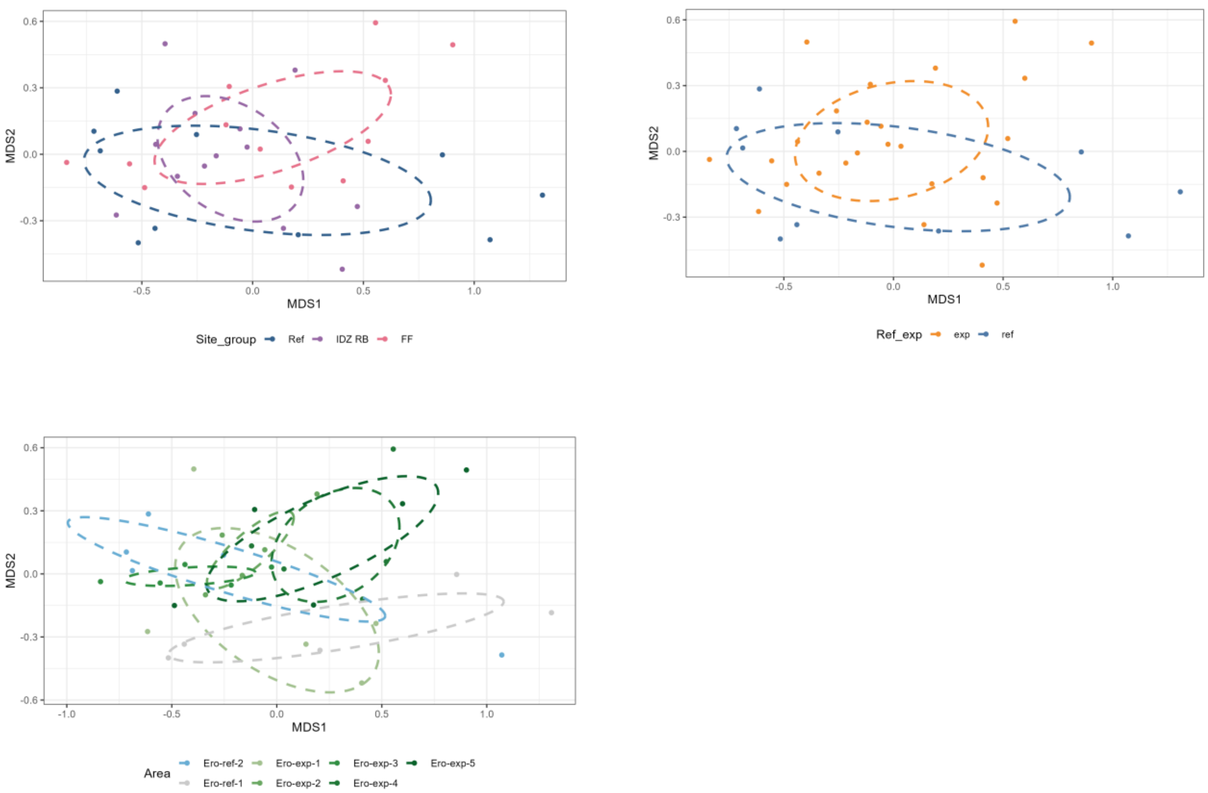


Figure 5-94: NMDS of erosional habitat benthic invertebrate communities in 2021 at the family level grouped by site category (top left), reference and exposure (top right), and site (bottom).

The NMDS for erosional sites across all years provided a good representation of the community (stress index = 0.18). A PERMANOVA of the NMDS community variation showed benthic community composition differed significantly between reference and exposure areas when all years were modelled (F = 3.19, R^2 = 0.02, p = 0.012; Figure 5-95). Community also differed significantly between site categories (F = 3.84, R^2 = 0.05, p = 0.003).

The PERMANOVA illustrated a significant difference in benthic community composition between years (F = 8.95, R^2 = 0.06, p = 0.001). While composition varied between years, it did not follow a discernable directional trend. Community composition also differed significantly between all sites (PERMANOVA, F = 3.58, R^2 = 0.14, p = 0.001).

When grouped by treatment, ERO-EXP-2 and ERO-EXP-3 occurred to the right of 0.0 on the first axis (MDS1). Sites within these areas generally had higher velocities, which would result in different community compositions from lower velocity sites. Caddisflies (Hydrospychidae and Brachycentridae) and mayflies of the family Baetidae load strongly on the first axis. In contrast, Planorbidae (ramshorn snail) occurred to the right of 0 on the first axis and was more common in the reference sites, which had lower velocities.

When 2021 taxa were modeled with environmental variables that may influence community structure, a PERMANOVA of the NMDS distances showed that velocity was the only significant variable ($R^2 = 0.57$, $p = 0.001$).

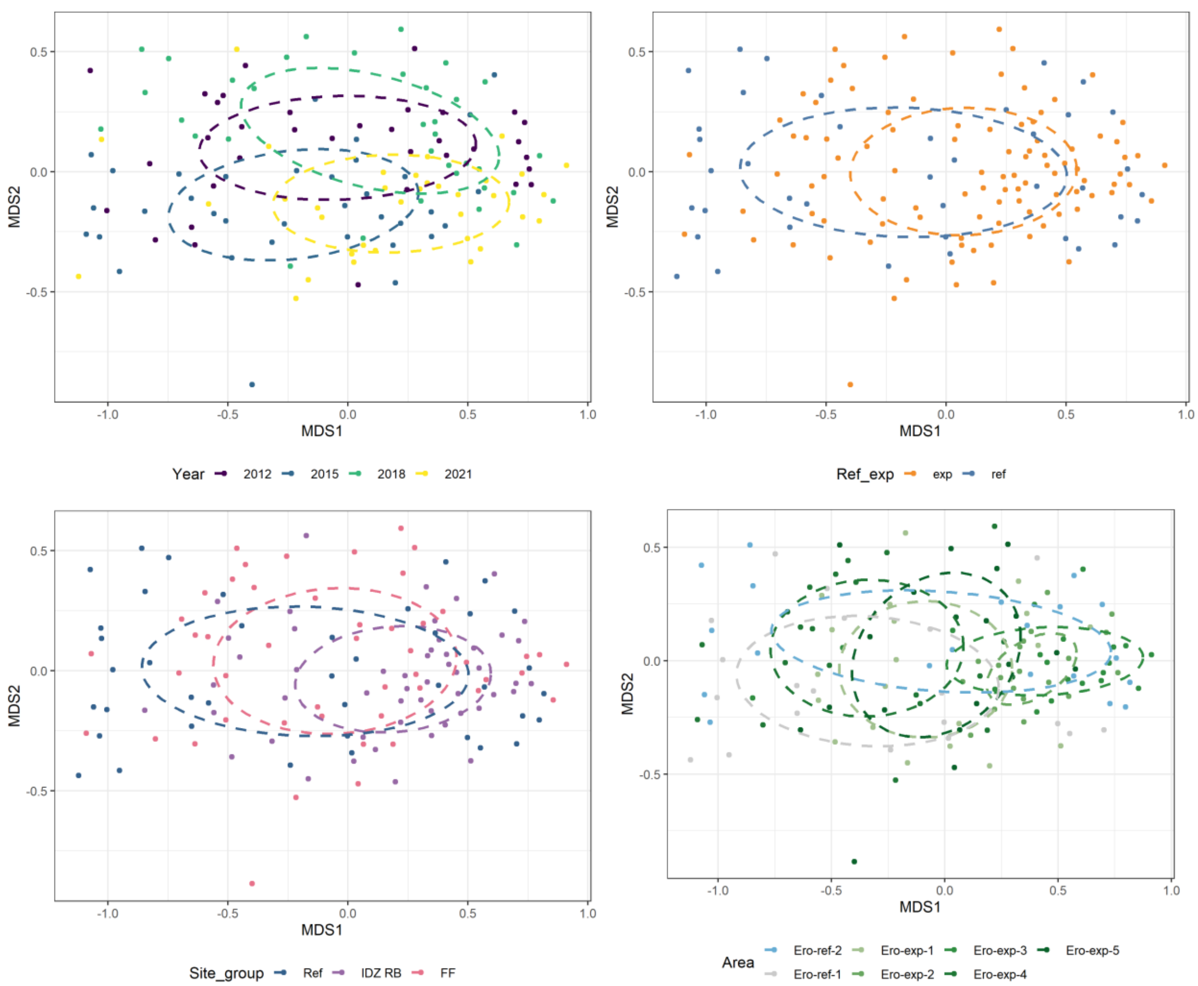


Figure 5-95: NMDS of erosional habitat benthic invertebrate communities at the family level grouped by year (top left), reference and exposure (top right), site category (bottom left), and individual site (bottom right).

5.4.2.6 Community Response to Explanatory Variables

Linear mixed effects models were used to evaluate the effects of environmental variables and annual variation that may influence benthic invertebrate communities and productivity.

Model averaging of the linear mixed effects models showed that erosional sites with higher velocities and larger substrate size had greater benthic macroinvertebrate abundance and biomass and were dominated by EPT taxa in 2021. This remains consistent with 2012, 2015, and 2018 AREMP results (Hawes et al. 2014 and Hawes et al. 2019), and previous studies by Larratt et al. (2013). Water velocity had a strong negative effect on taxa richness, percent Chironomidae, and Shannon evenness. Combined 2021 model results indicated that smelter effluent discharges did not have a negative effect on erosional habitat benthic invertebrate communities, and differences in community and productivity were due to variations in habitat and annual fluctuations.

Water velocity was the most important variable influencing benthic taxa richness in erosional habitats (RVI = 1; Figure 5-96). Velocity had a strong negative effect on taxa richness, indicating that sites with higher velocities had fewer total taxa (relative effect size = -8.59, lower CI = -10.81, upper CI = -6.37). The high velocity sites (e.g., ERO-EXP-2) have been strongly dominated by Hydropsychidae in 2012, 2018, and 2021, but in 2015, Hydropsychidae was codominant with Ephemerellidae along with low numbers of other taxa.

Substrate size had a negative effect on taxa richness (relative effect size = -2.73, RVI = 0.93, lower CI = -4.84, upper CI = -0.62; Figure 5-107). Water temperature was also an important variable that influenced benthic invertebrate taxa richness (RVI = 0.81). Water temperature had a negative effect on taxa richness (relative effect size = -2.68, lower CI = -5.10, upper CI = -0.25).

Total abundance was strongly positively correlated with substrate size (D50; relative effect size = 0.30, RVI = 1, lower CI = 0.15, upper CI = 0.44; Figure 5-105) and water velocity (relative effect size = 0.44, RVI = 1, lower CI = 0.29, upper CI = 0.58; Figure 5-96). Sites with higher water velocity and larger substrate size had higher overall abundances (Figure 5-99, Figure 5-105).

Water velocity had a strong positive effect on invertebrate biomass (relative effect size = 0.23, RVI = 0.97, lower CI = 0.07, upper CI = 0.39; Figure 5-101). Substrate size was not a significant factor in determining biomass (RVI = 0.40).

Shannon evenness was negatively affected by water velocity (relative effect size = -0.16, RVI = 1, lower CI = -0.19, upper CI = -0.12), substrate size (relative effect size = -0.04, RVI = 0.92, lower CI = -0.08, upper CI = -0.01), and water temperature (relative effect size = -0.05, RVI = 0.87, lower CI = -0.10, upper CI = -0.01; Figure 5-109).

EPT richness was strongly impacted by water velocity, with higher velocities correlated to higher EPT richness (Figure 5-102). A greater proportion of reference sites (ERO-REF-1-2; ERO-REF-1-5; ERO-REF-2-4; ERO-REF-2-5) had lower water velocities and increased abundance of gastropod snails, pill clams, and detritus worms. In 2018 and 2021 sampling, higher velocity microhabitats within the larger low velocity areas were targeted to help reduce the effect of physical habitat variability. In some situations, Hydropsychidae were more dominant in these areas and sites than in previous years (e.g., ERO-REF-1).

Percent EPT in the community was strongly positively correlated with substrate size (D50; relative effect size = 16.92, RVI = 1, lower CI = 9.34, upper CI = 24.50; Figure 5-108) and water velocity (relative effect size = 38.90, RVI = 1, lower CI = 31.30, upper CI = 46.51; Figure 5-97). Sites with higher velocities and substrate sizes had more EPT taxa in their benthic communities.

Percent Chironomidae was negatively affected by water velocity (relative effect size = -4.05, RVI = 1, lower CI = -5.74, upper CI = -2.35).

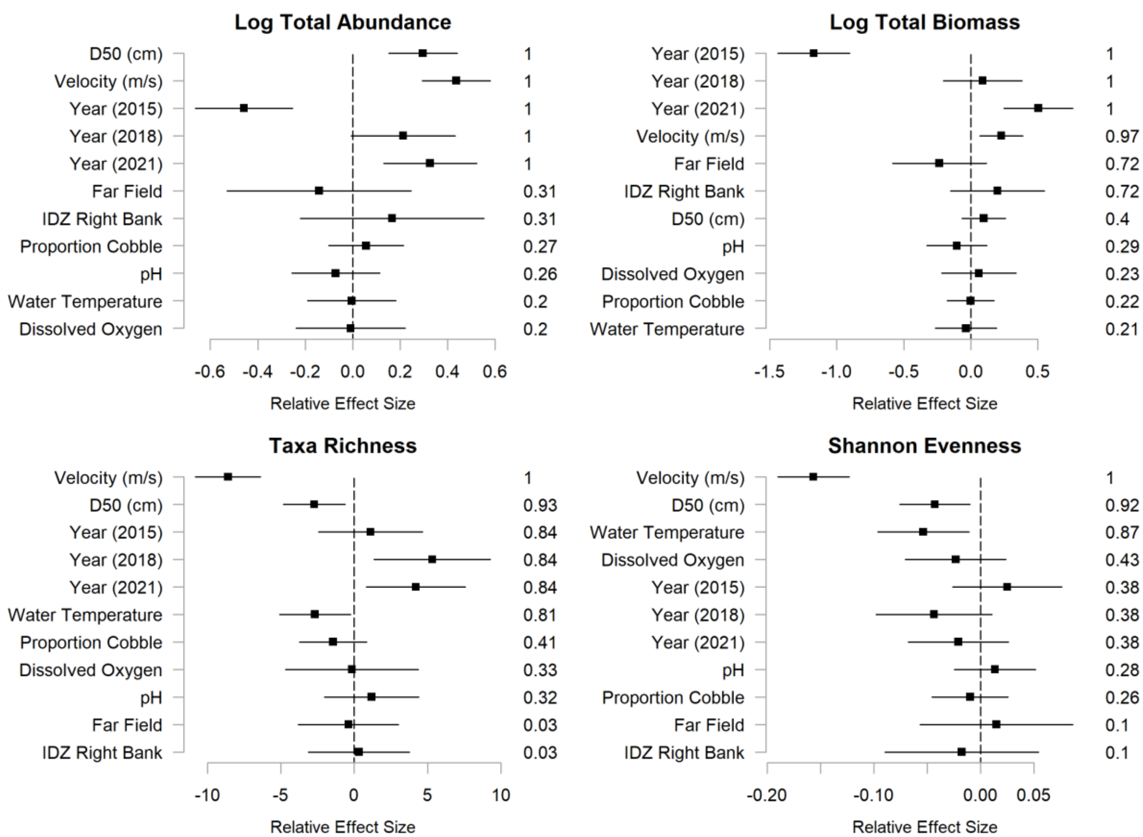


Figure 5-96: The coefficients and their 95% CLs of standardized explanatory variables of invertebrate erosional samples. Invertebrate responses included log of total abundance, log of total biomass, taxa (family) richness, and Shannon evenness. Explanatory variables included D50 (substrate), velocity, water temperature, year sampled and sample site category. Coefficients were standardized to allow comparisons of the direction and size of effects. Variables with CLs that do not cross zero influence the response variable. Key explanatory variables are those that have a relative variable importance (RVI) of or greater than 0.6-0.7. RVI is shown on the right-hand side of each figure.

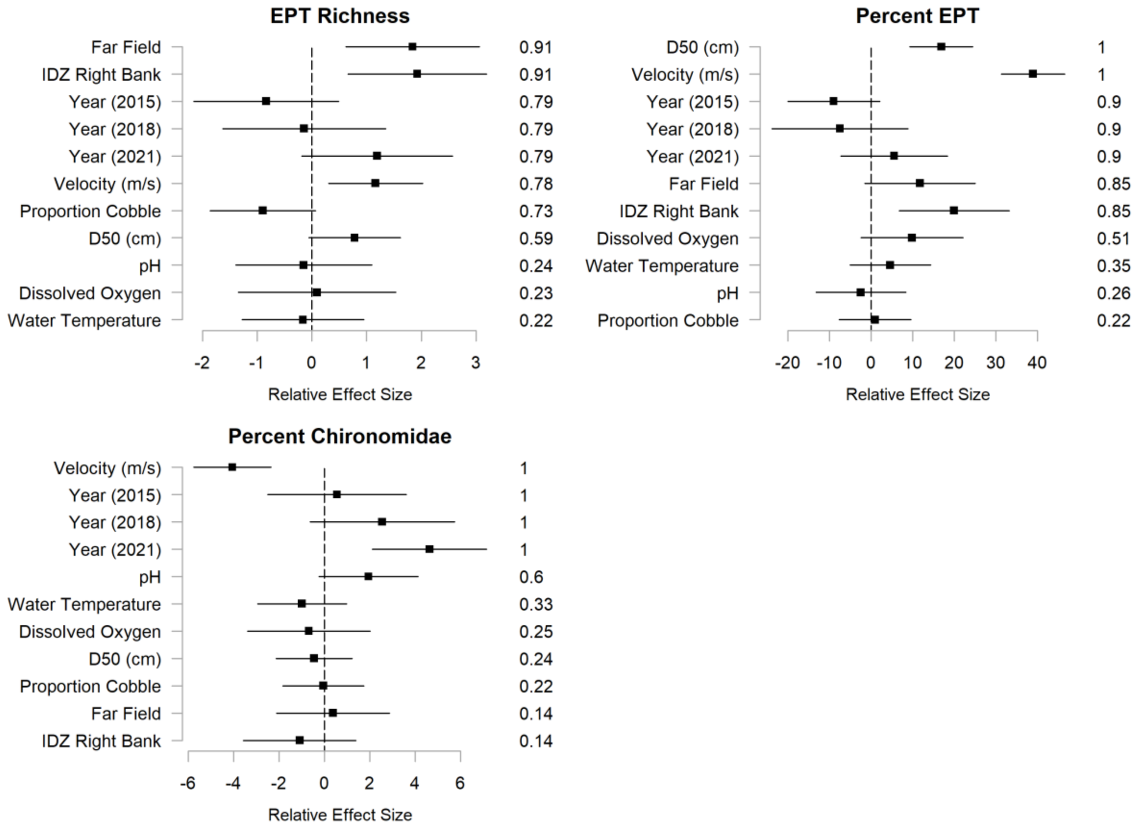


Figure 5-97: The coefficients and their 95% CLs of standardized explanatory variables of invertebrate erosional samples. Invertebrate responses included EPT richness, percent EPT, and percent Chironomidae. Explanatory variables included D50 (substrate), velocity, water temperature, year sampled and sample site category. Coefficients were standardized to allow comparisons of the direction and size of effects. Variables with CLs that do not cross zero influence the response variable. Key explanatory variables are those that have a relative variable importance (RVI) of or greater than 0.6-0.7. RVI is shown on the right-hand side of each figure.

Current velocity and substrate size are the most important physical predictors affecting macroinvertebrate community structure in the Lower Columbia River (Figure 5-98). Differences in community structure and shifts in dominant taxa were observed at some sites. However, there was no overall significant difference in communities and numerous metrics (e.g., total abundance, species richness etc.) between reference and exposure areas sampled.

Sites with low current velocities had apparent differences in community structure. There was a higher percentage of reference sites that had lower current velocities than exposure sites. Specifically, sites within Reference Area 1, Reference Area 2, and Exposure Area 4 had the lowest measured current velocities and had lower total abundances (Figure 5-99).

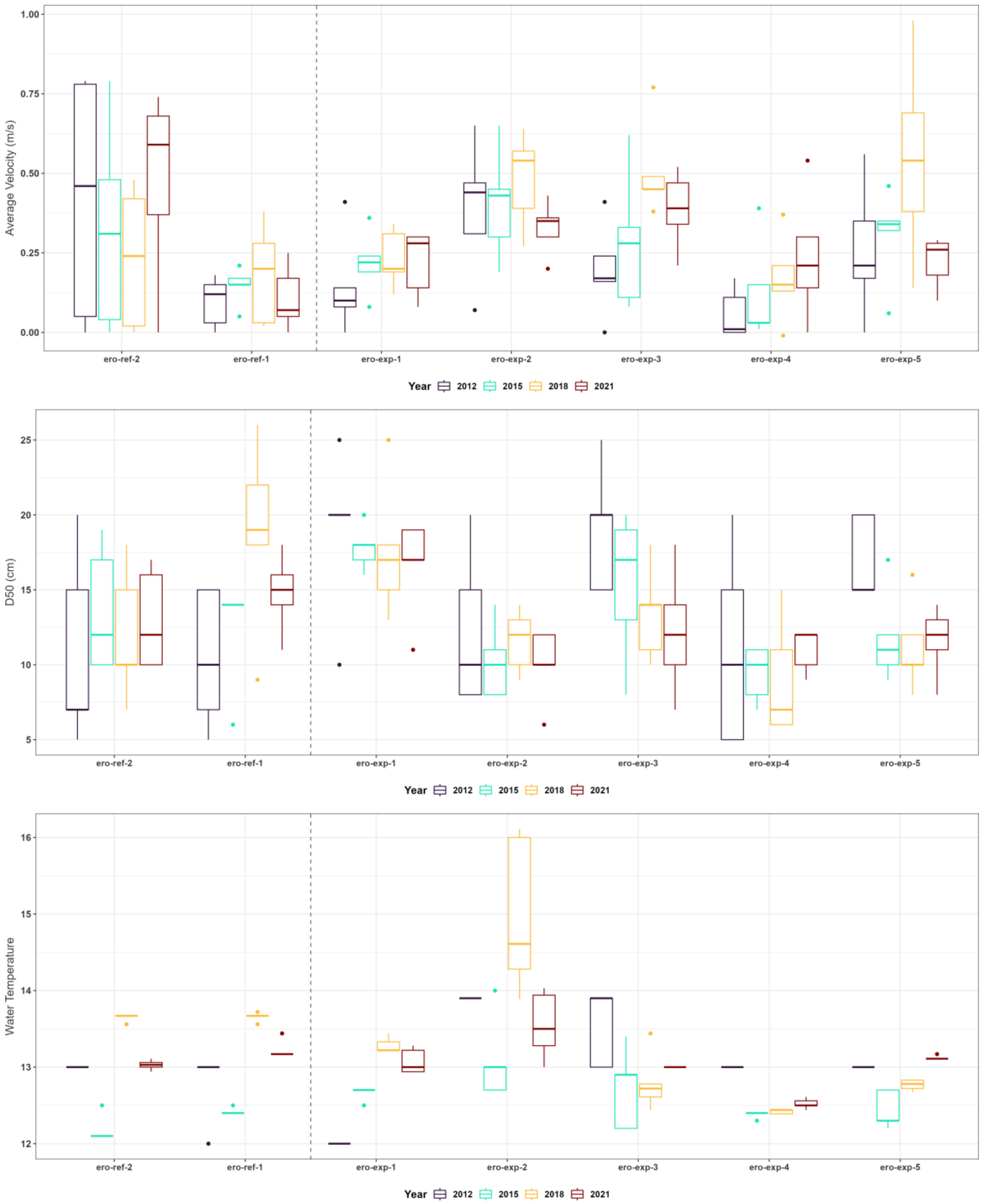


Figure 5-98: Key physical predictors influencing benthic community structure in erosional areas including water velocity, D50, and water te*mperature*.

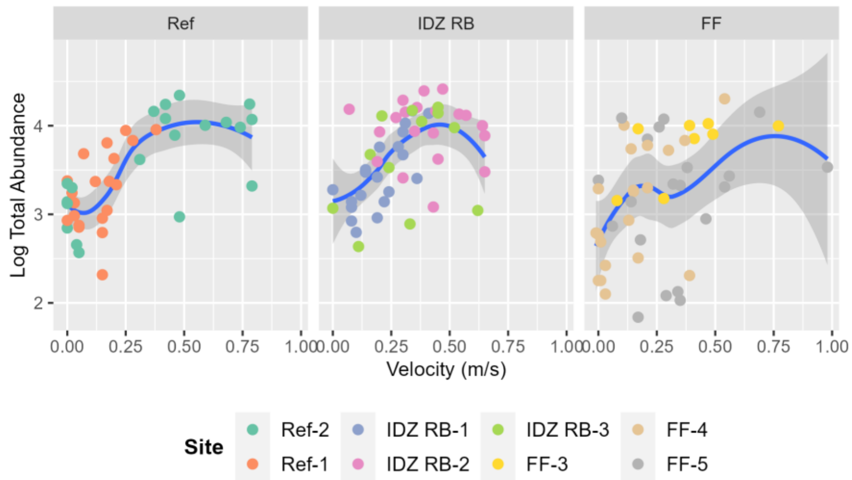


Figure 5-99: Current velocity and log total abundance grouped by site across all years.

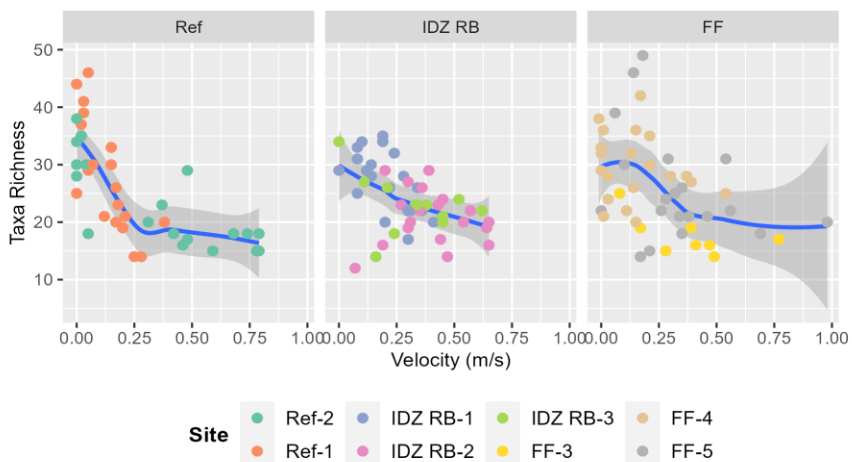


Figure 5-100: Current velocity and taxa richness grouped by site across all years.

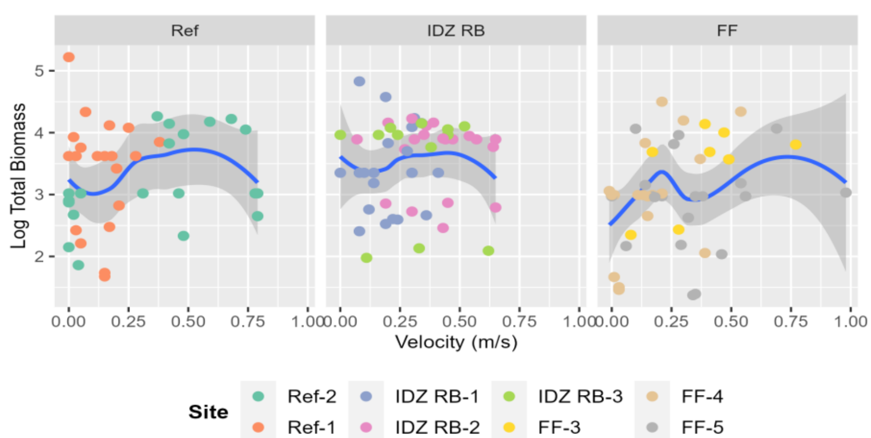


Figure 5-101: Current velocity and biomass grouped by site across all years .

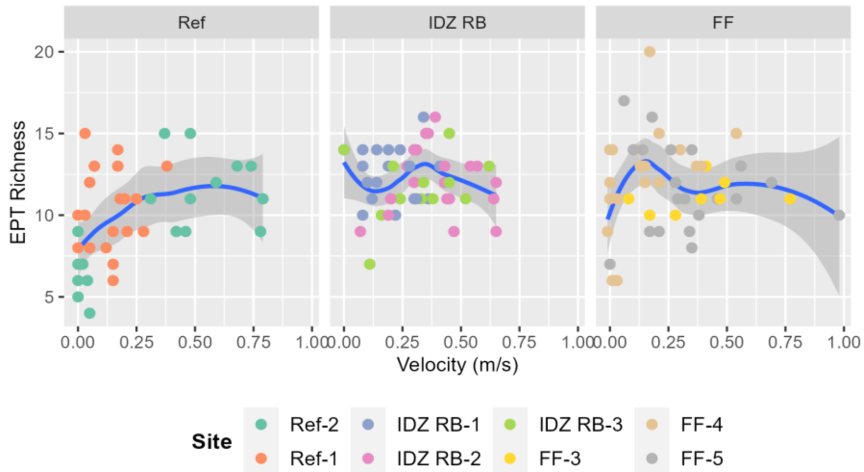


Figure 5-102: Current velocity and EPT richness grouped by site across all years .

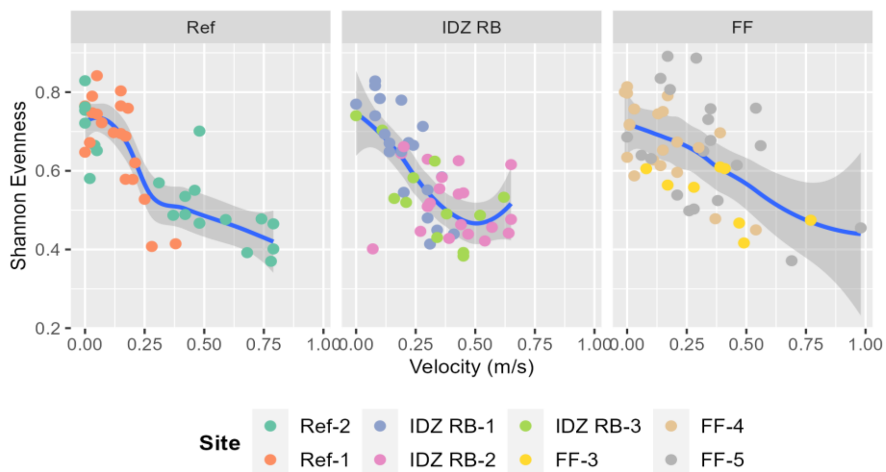


Figure 5-103: Current velocity and Shannon evenness grouped by site across all years.

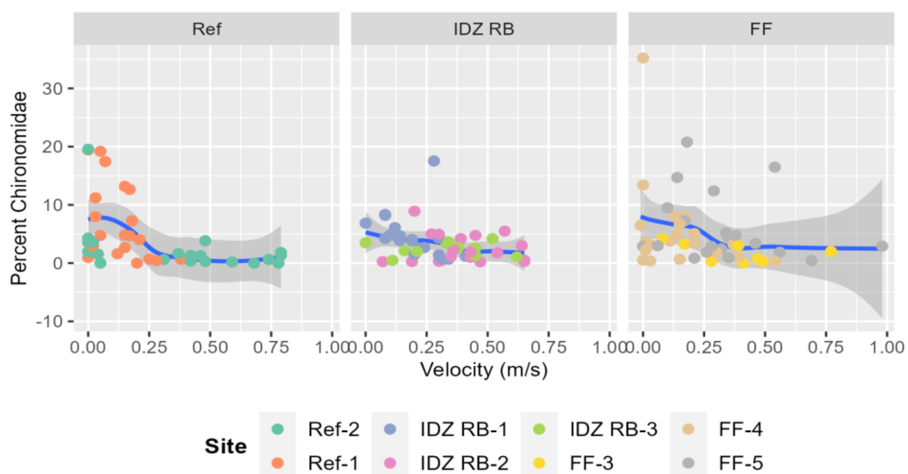


Figure 5-104: Current velocity and percent Chironomidae grouped by site across all years.

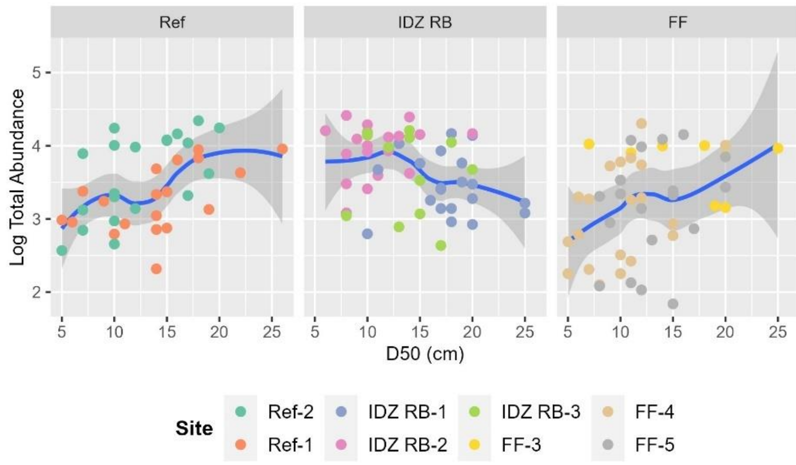


Figure 5-105: D50 and log total abundance grouped by site across all years.

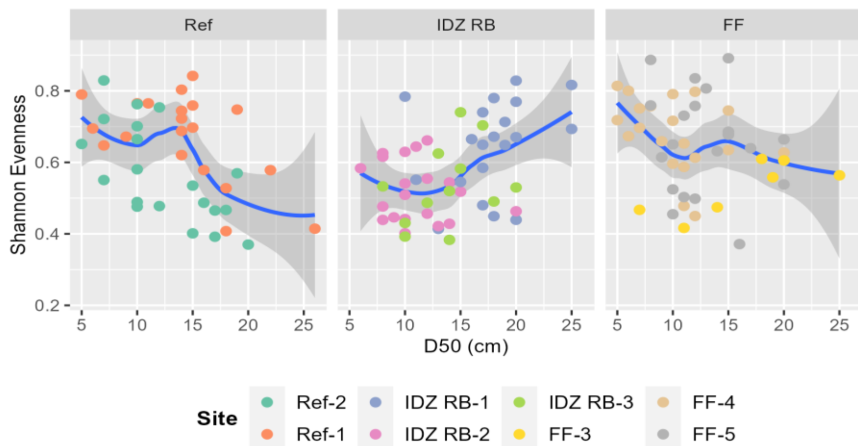


Figure 5-106: D50 and Shannon evenness grouped by site across all years.

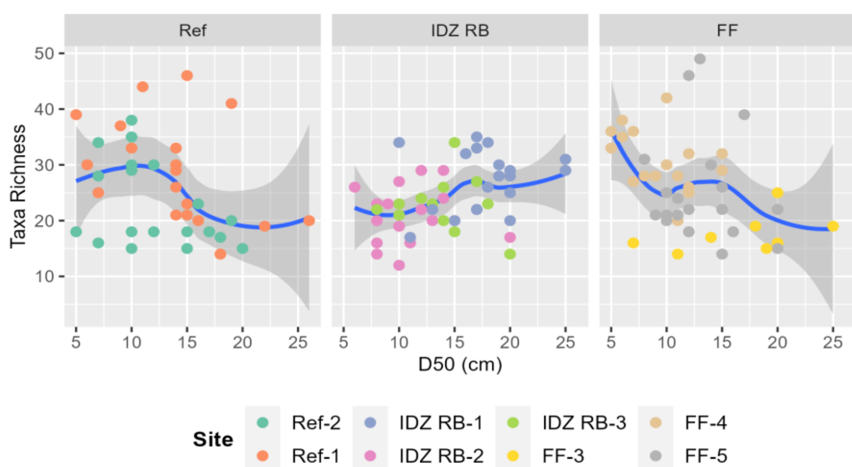


Figure 5-107: D50 and taxa richness grouped by site across all years.

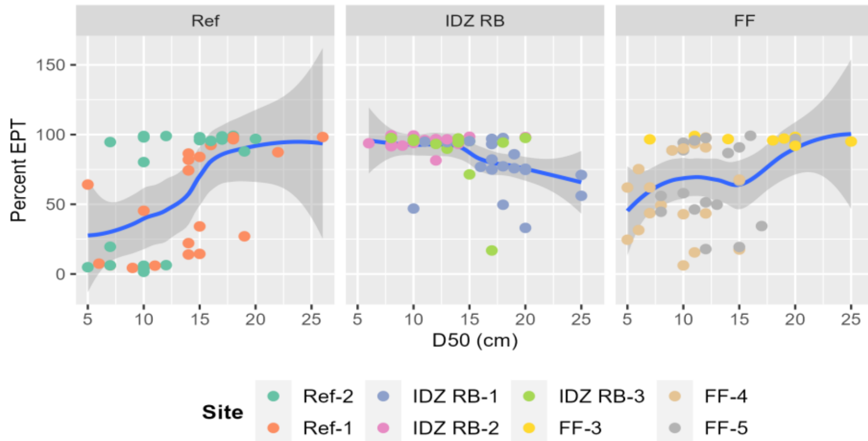


Figure 5-108: D50 and percent EPT grouped by site across all years.

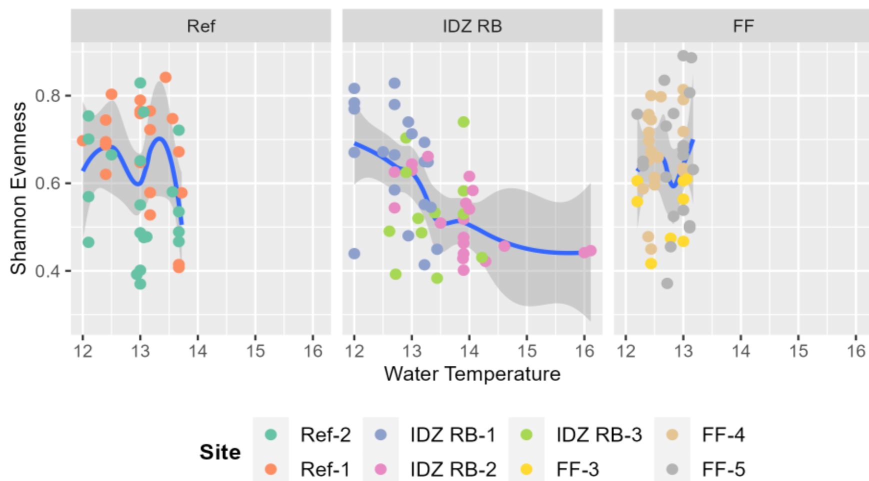


Figure 5-109: Water temperature and Shannon evenness grouped by site across all years.

5.4.2.7 Species At Risk

The shortface lanx (*Fisherola nuttallii*) is a small limpet-shaped freshwater snail that requires flowing, well-oxygenated waters. In British Columbia, the shortface lanx has a list rank of Red, indicating that it is a candidate for either extirpated, endangered, or threatened status in BC. It is restricted to the Columbia River drainage in Canada and has only been documented in an area extending about 14 km upstream and 6 km downstream of the City of Trail. Increased periphyton abundance on rock surfaces increases detection success for this species. However, the sampling approach employed in the AEMP would collect this species regardless of the degree of periphyton present since the rocks are washed and the contents collected in a downstream receiving net.

The shortface lanx was collected from erosional reference habitats in ERO-REF-2 situated along the river left bank across from Stoney Creek during the 2012 AEMP data collection. However, it was not documented in any of the samples from 2015, 2018, or 2021 AEMP data collection cycles.

5.5 Small-bodied Fish

Sampling was carried out between April 19th-23rd, 2021 when river flows were still low, between 1,180 and 1,350 m^3/s. During this time female sculpin were notably gravid. Sentinel species targeted during sampling included: Torrent Sculpin (*Cottus rhotheus*), and Columbia Mottled Sculpin (*Cottus hubbsi*) under Scientific Collection Permit No. CB21-619612.

Figure 5-110: Sculpins collected during spring sampling programs. From left to right: Torrent Sculpin, Columbia Sculpin, Shorthead Sculpin.

A total of 592 small-bodied fish were collected over the 5-day period (Table 5-28). Columbia Sculpins (*Cottus bairdi hubbsi*) were captured most frequently and were 54% of the total catch, with 321 individuals. *Cottus bairdi hubbsi* is Blue-listed[1] in British Columbia. Its range includes the Columbia River system in British Columbia, Idaho, Washington, Oregon, and Nevada; and the Harney basin in Oregon (McPhail 2007).

Table 5-28: Small-bodied fish collection summary.

Species	Catch	% Catch
Coarsescale Sucker (*Ptychocheilus oregonensis)*	2	0.3
Rainbow Trout (Oncorhynchus mykiss)	5	0.8
Longnose Dace (*Rhinichthys cataractae*)	11	1.9
Prickly Sculpin (*Cottus asper*)	14	2.4
Torrent Sculpin (*Cottus rhotheus*)	103	17.4
Shorthead Sculpin (*Cottus confuses*)	136	23.0
Columbia Mottled Sculpin (*Cottus bairdi hubbsi*)	321	54.2
Total	592	

C. Confusus was the second most abundant sculpin species collected and made up 23% of the total sculpins collected (n = 136). *Cottus confuses* is also Blue-listed and its habitat includes fast riffles of cold headwaters, creeks, and small to large rivers (McPhail 2007), also sometimes large rivers with slow-moving water (e.g., along shorelines, in backwaters). It is generally found in more upstream habitats relative to *C. bairdi hubbsi*.

[1] Blue list Includes any native species or subspecies considered to be of Special Concern (formerly Vulnerable) in British Columbia. Taxa of Special Concern have characteristics that make them particularly sensitive or vulnerable to human activities or natural events. Blue-listed taxa are at risk, but are not Extirpated, Endangered or Threatened.

There were 294 sculpins retained for analysis of tissue metals and health assessments. A total of 87 individuals were collected from reference areas and 207 individuals were from exposure areas (Table 5-29).

Table 5-29: Summary of sculpins retained for tissue metals and health assessments for exposure and reference areas in 2021.

Species		Exposure		Reference		Total	
Prickly Sculpin		**0**		**2**		**2**	
	Female				1		1
	Unknown				1		1
Columbia Sculpin		**192**		**24**		**216**	
	Female		90		16		106
	Male		92		7		99
	Unknown		10		1		11
Shorthead Sculpin		**1**		**0**		**1**	
	Female		1				1
Torrent Sculpin		**14**		**61**		**75**	
	Female		2		23		25
	Male		5		17		22
	Unknown		7		21		28
Total		**207**		**87**		**294**	

5.5.1 Condition Metrics

Sculpins from near Waneta had significantly lower body weight corrected for fish length (Fulton's condition *k*) than sculpins in Reference areas ($R^2 = 0.09$, $p < 0.001$). There were no significant differences in body condition between other exposure areas in the IDZ and reference areas.

Liver weight corrected for total fish weight (hepatosomatic index) was significantly higher in fish from the IDZ Right Bank than reference sites ($R^2 = 0.09$, $p = 0.04$). The liver plays a major role in metabolism and performs the functions of glycogen storage, decomposition of red blood cells, plasma protein synthesis, hormone production, and detoxification. Elevated HSI may indicate a response to elevated metals concentrations or other environmental factors in the effluent plume along the right bank of the IDZ, or may also be related to gonadal (i.e., ovary) maturation (Hismayasari et al. 2015).

There was no significant difference between reference and exposure areas for fish gonad weight corrected for total body weight in 2021 ($R^2 = 0.51$, $p > 0.05$ for all). Males had significantly lower gonadosomatic indices than females ($p < 0.001$), which is expected.

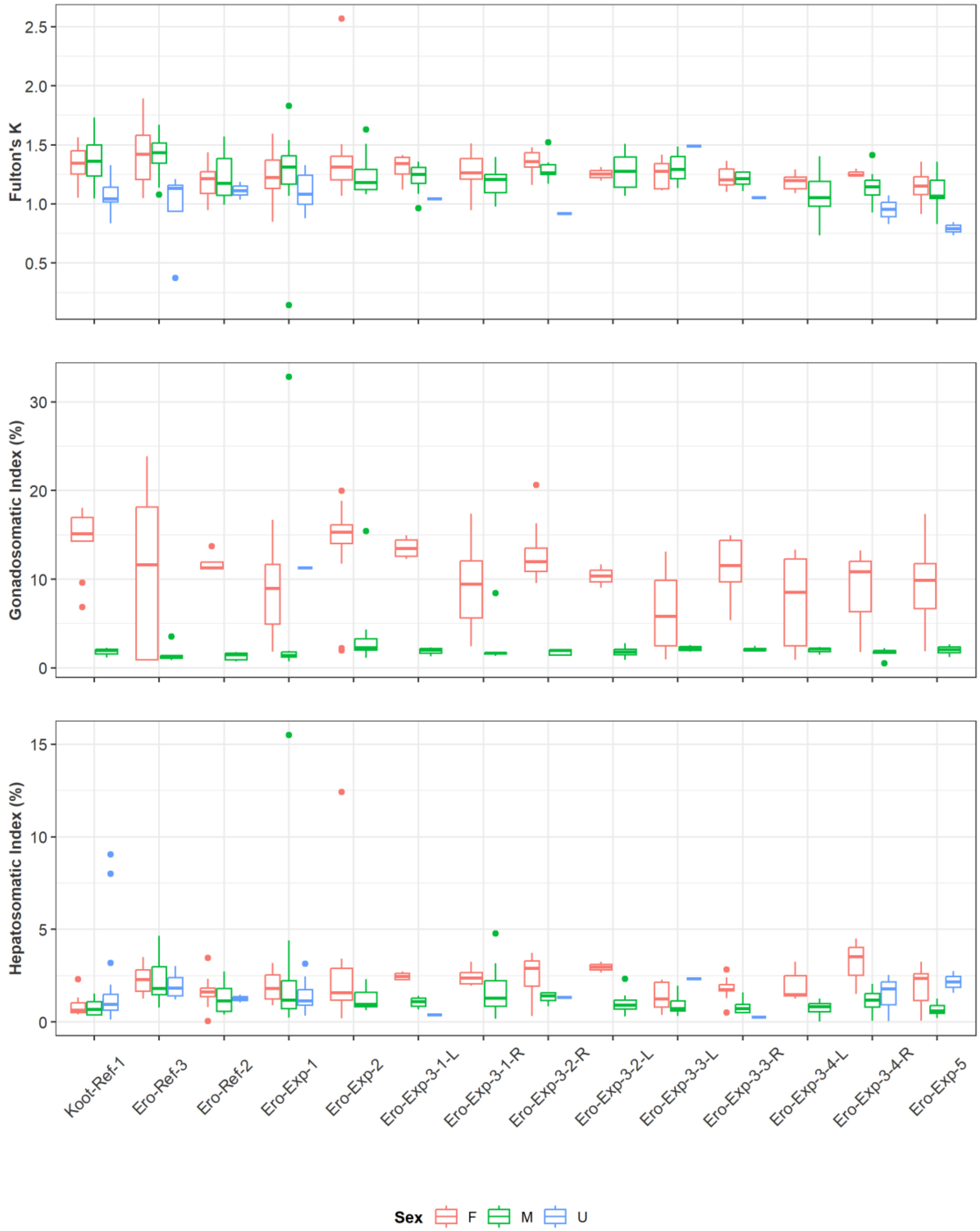


Figure 5-111: April 2021 sculpin body condition metrics by sex and sample capture location. Fulton's k (FK), gonadosomatic index (GSI), and hepatosomatic index (HSI) are shown.

5.5.2 Tissue Metals

Overall, tissue concentrations of most metals drop with increasing distance downstream from New Trail Bridge. Sculpins collected from the right bank adjacent downtown Trail (ERO-EXP-3-2-R) had average lead concentrations that were more than four times lower than fish collected just 300 m further upstream from ERO-EXP-3-1-R (Table 5-30). Tissue lead and mercury concentrations decrease with distance downstream to a point where they are about 30 times lower in ERO-EXP-5 near Waneta than average concentrations measured at fish from New Trail Bridge. Mean lead tissue concentrations do not return to equal levels measured in reference sites within the scope of the study area and remain elevated above reference site levels at ERO-EXP-5 the most downstream site surveyed, which is approximate 16 km downstream of the CII outfall. Mean mercury tissue concentrations return to reference site levels with some variability between sites ERO-EXP-3-1 and ERO-EXP-5.

Figure 5-112 illustrates the spatial extents of the effluent plume and relative intensity based on specific conductance measured through the IDZ. Small-bodied fish sample sites are shown to highlight the varying exposure of these fish to the effluent plume. The highest exposure to metals from the effluent is in ERO-EXP-2, which is the right bank side channel downstream of the CIII outfall. Fish along the right bank in the IDZ continue to be exposed to the plume at decreasing concentrations moving downstream, while those on the left bank of the IDZ are outside of the extents of the effluent plume.

Tissue metal concentrations were modelled by treatment area (Reference, IDZ Right Bank, IDZ Left Bank, and Downstream of IDZ) with the distance of each sample to the CII outfall included as a quadratic factor. Year was also modelled as a factor with treatment area and distance as a quadratic factor.

Table 5-30: LCR TRO exceedances for sculpin whole body lead and mercury concentrations by location. Concentrations are given in wet weight.

Site	Location	Total lead exceedances	Mean Pb Conc. (mg/kg)	Total mercury exceedances	Mean Hg Conc. (mg/kg)
Koot-Ref-1	Reference	4	0.11	0	0.01
Ero-Ref-2	Reference	8	0.14	0	0.02
Ero-Ref-3	Reference	1	0.08	0	0.02
Ero-Exp-1	IDZ right bank	27	1.02	1	0.03
Ero-Exp-2	IDZ right bank	10	4.44	3	0.05
Ero-Exp-3-1-L	IDZ left bank	3	0.16	0	0.02
Ero-Exp-3-1-R	IDZ right bank	15	6.34	0	0.02
Ero-Exp-3-2-R	IDZ right bank	17	1.51	0	0.03
Ero-Exp-3-2-L	IDZ left bank	13	0.42	0	0.02
Ero-Exp-3-3-L	IDZ left bank	16	0.43	0	0.02
Ero-Exp-3-3-R	Downstream of IDZ	15	0.38	0	0.02
Ero-Exp-3-4-L	Downstream of IDZ	14	0.56	0	0.03
Ero-Exp-3-4-R	Downstream of IDZ	14	0.45	0	0.01
Ero-Exp-5	Downstream of IDZ	19	0.20	0	0.02

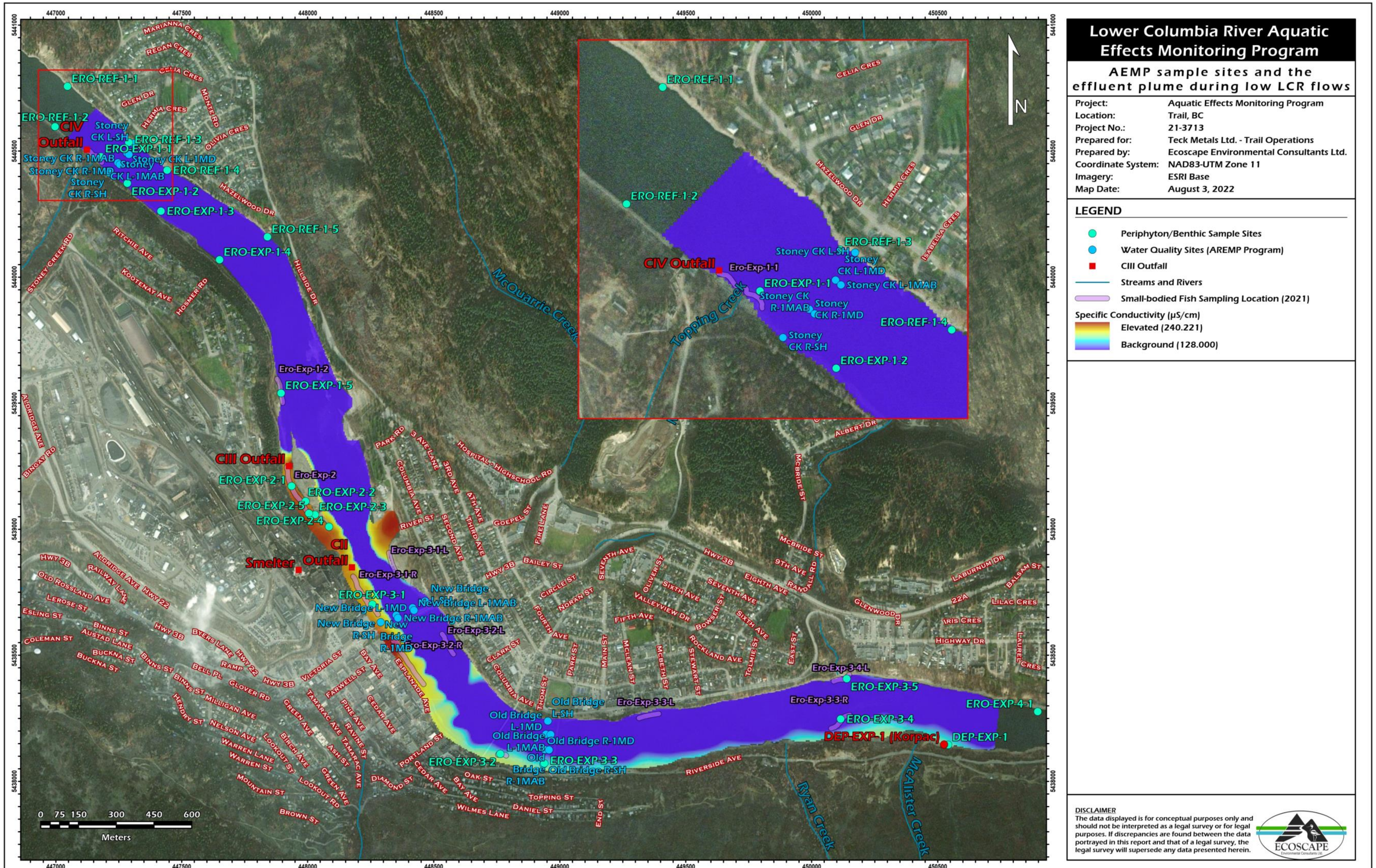


Figure 5-112: Position of small-bodied fish and other AEMP sample sites relative to the effluent plume through the IDZ.

5.5.2.1 Arsenic (As)

Arsenic concentrations were significantly higher in in the exposure area IDZ Right Bank than in reference areas ($R^2 = 0.31$, $p < 0.001$), but did not differ between other exposure areas and reference areas (Figure 5-113). Arsenic tissue metal concentrations were significantly higher in 2013 than in 2021 ($R^2 = 0.26$, $p < 0.001$).

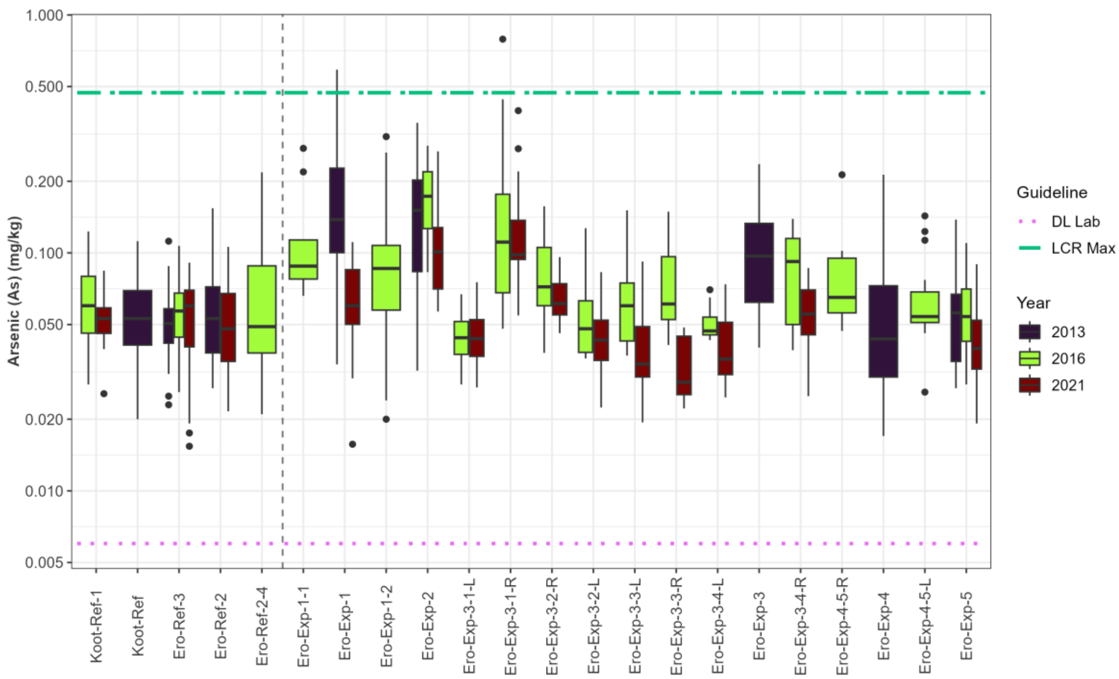


Figure 5-113: Concentrations of arsenic (mg/kg wet weight) in whole body sculpin samples in reference and exposure by sample site and year.

5.5.2.2 Cadmium (Cd)

Cadmium concentrations were also significantly higher in the IDZ Right Bank area than reference area (R^2 = 0.43, p < 0.001). Cadmium concentrations in small-bodied fish tissue did not differ significantly between 2021 and 2013 and were significantly higher in 2016 than in 2013 (R^2 = 0.39, p = 0.003). While they differed between exposure and reference sites, cadmium concentrations did not exceed the TRO in 2021.

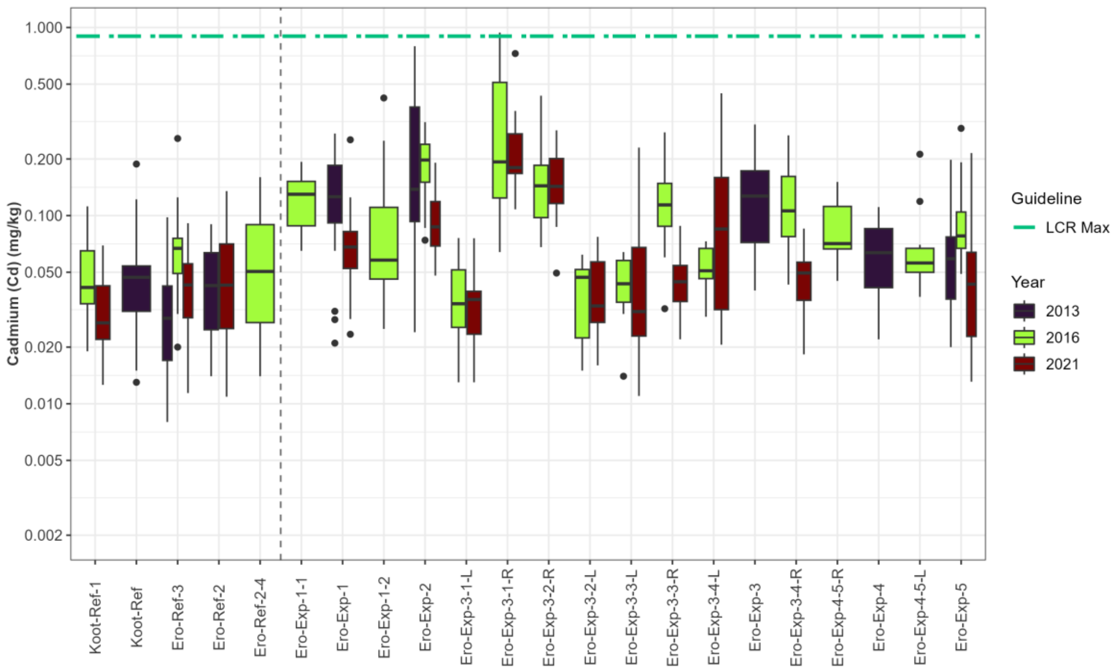


Figure 5-114: Concentrations of cadmium (mg/kg wet weight) in whole body sculpin samples in reference and exposure by sample site and year.

5.5.2.3 Chromium (Cr)

There were no exceedances of the TRO for Cr in 2021 (Figure 5-115). Chromium was not modelled between sites and year since the majority of sample concentrations were below the limit of detection (DL), which has varied over the years. In 2013 and 2015, the DL was 0.01 mg/kg and in 2021, the DL was 0.04 mg/kg. In 2015, 72% of sampled fish had Cr concentrations that were below the DL. In 2021, 53% of sampled fish had Cr concentrations that were below the DL. The varying DL between years and the high number of values below the DL in each year confound the results and the ability to compare concentrations between year.

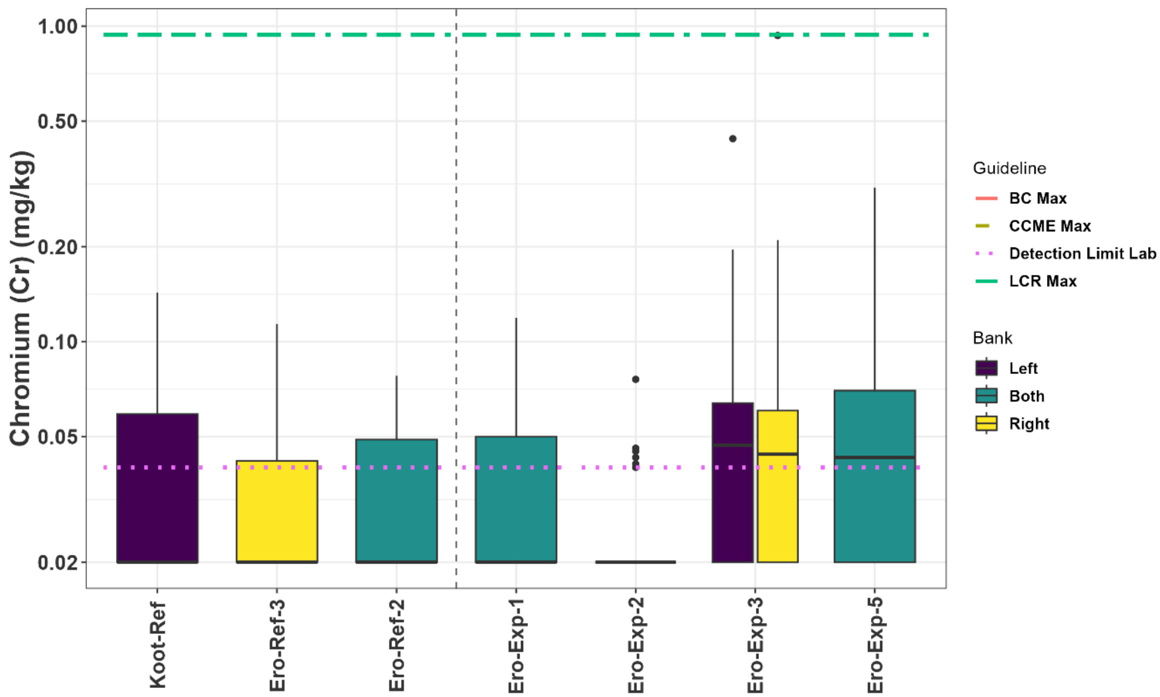


Figure 5-115: Concentrations of chromium (mg/kg wet weight) in whole body sculpin samples in reference and exposure sites for 2021.

5.5.2.4 Copper (Cu)

Copper concentrations were significantly lower in the IDZ Left Bank (p = 0.002) and Downstream IDZ than in reference areas ($R2 = 0.20$, $p = 0.007$; Figure 5-116). Copper concentrations were significantly lower in 2021 than in 2013 ($R2 = 0.1$, $p < 0.001$).

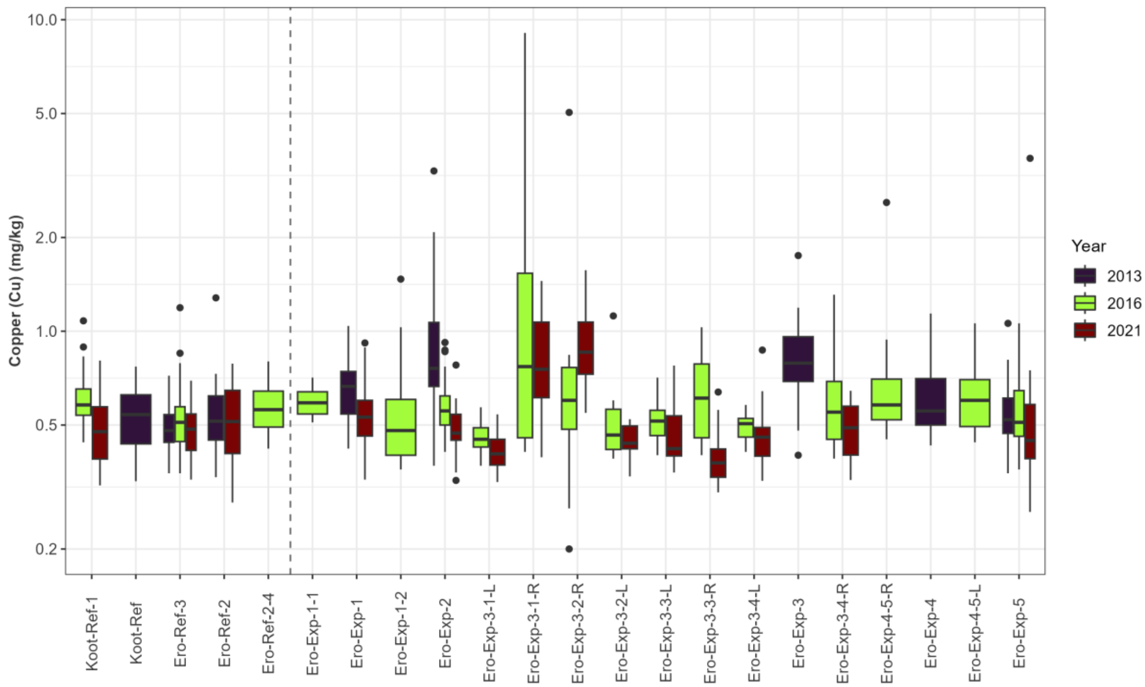


Figure 5-116: Concentrations of copper (mg/kg wet weight) in whole body sculpin samples in reference and exposure by sample site and year.

5.5.2.5 Iron (Fe)

Iron concentrations did not differ between reference and exposure sites. Iron concentrations in fish tissue were significantly lower in 2016 than in 2013 (R2 = 0.08, p < 0.001) and did not differ significantly between 2021 and 2013.

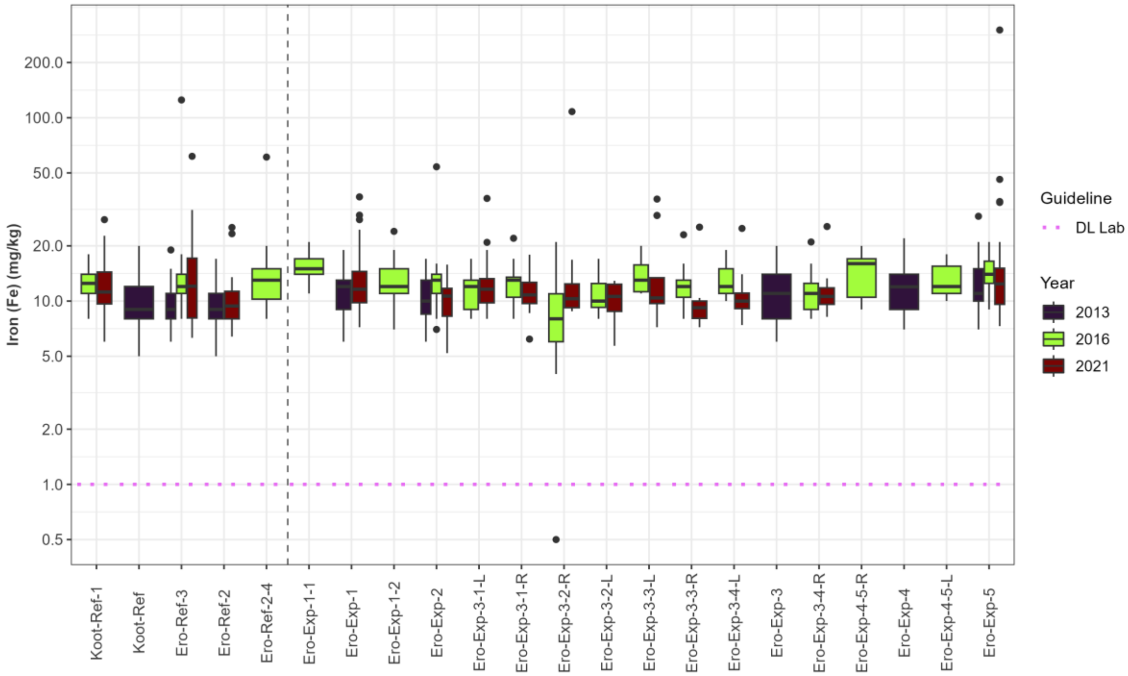


Figure 5-117: Concentrations of iron (mg/kg wet weight) in whole body sculpin samples in reference and exposure by sample site and year.

5.5.2.6 Lead (Pb)

There were exceedances of the Lower Columbia River TRO guidelines in 2021. Mean lead (Pb) concentrations for all exposure sites exceeded the TRO guidelines (Figure 5-118). Exceedances were most common in fish from near-field sites just downstream of the CIV outfall in ERO-EXP-1 and below the CIII outfall in ERO-EXP-2 (Figure 5-113 - Figure 5-122). ERO-EXP-1 Right Bank had a mean lead concentration of 6.34 mg Pb/kg wet weight, and ERO-EXP-2 Right Bank had a mean of 1.51 mg Pb/kg wet weight: both well above the TRO guideline of 0.16 mg Pb/kg wet weight. All sculpin samples from ERO-EXP-1 and ERO-EXP-2 exceeded the TRO for lead. Lead concentrations at all exposure sites were significantly higher than concentrations at reference sites (R^2 = 0.66, p < 0.001 for all). Tissue lead concentrations were significantly lower in 2021 than in 2013 (R^2 = 0.48, p < 0.001).

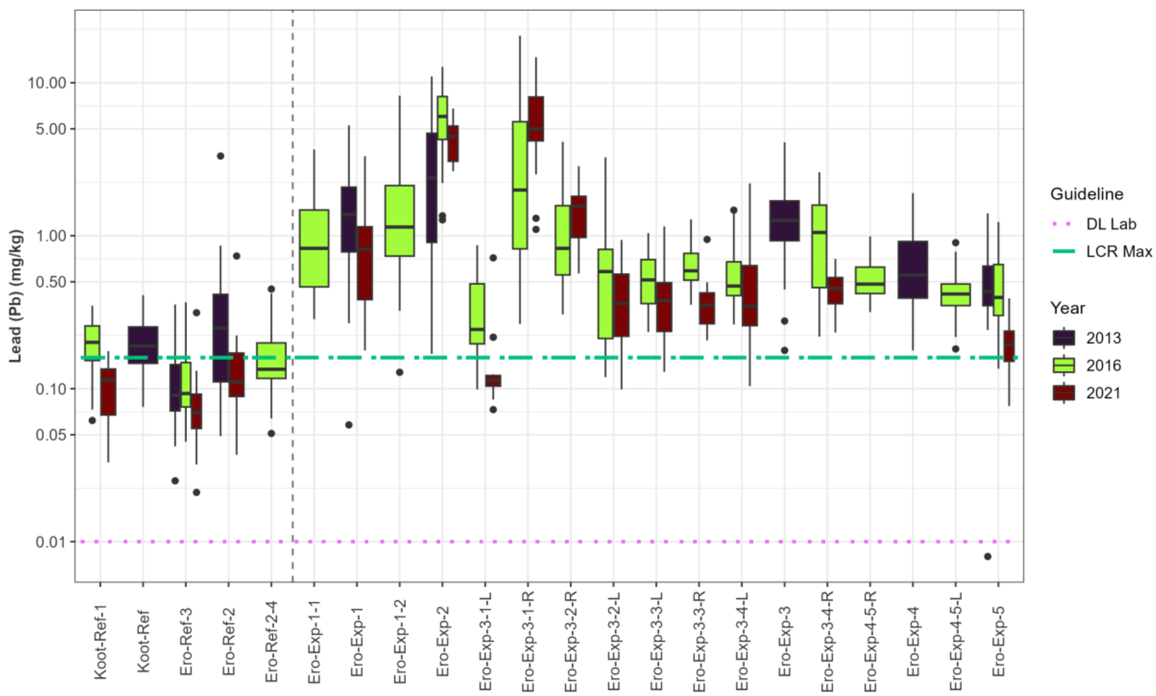


Figure 5-118: Concentrations of lead (mg/kg wet weight) in whole body sculpin samples in reference and exposure by sample site and year.

5.5.2.7 Mercury (Hg)

ERO-EXP-2 also had higher mercury levels when compared to other sites, with a mean of 0.05 mg Hg/kg wet weight, exceeding the CCME guideline of 0.03 mg Hg/kg (Figure 5-119). Three samples from ERO-EXP-2 and one sample from ERO-EXP-1 exceeded the TRO mercury guideline of 0.1 mg Hg/kg wet weight. Mercury exceedances of the BC and CCME guidelines also occurred in all other exposure sites, and there were three exceedances of the BC and CCME mercury guidelines in reference sites. Concentrations of mercury were significantly higher in the IDZ Right Bank area than in reference areas ($R^2 = 0.32$, $p < 0.001$). Concentrations of mercury in small-bodied fish tissue were significantly lower in 2021 than in 2013 ($R^2 = 0.21$, $p < 0.001$).

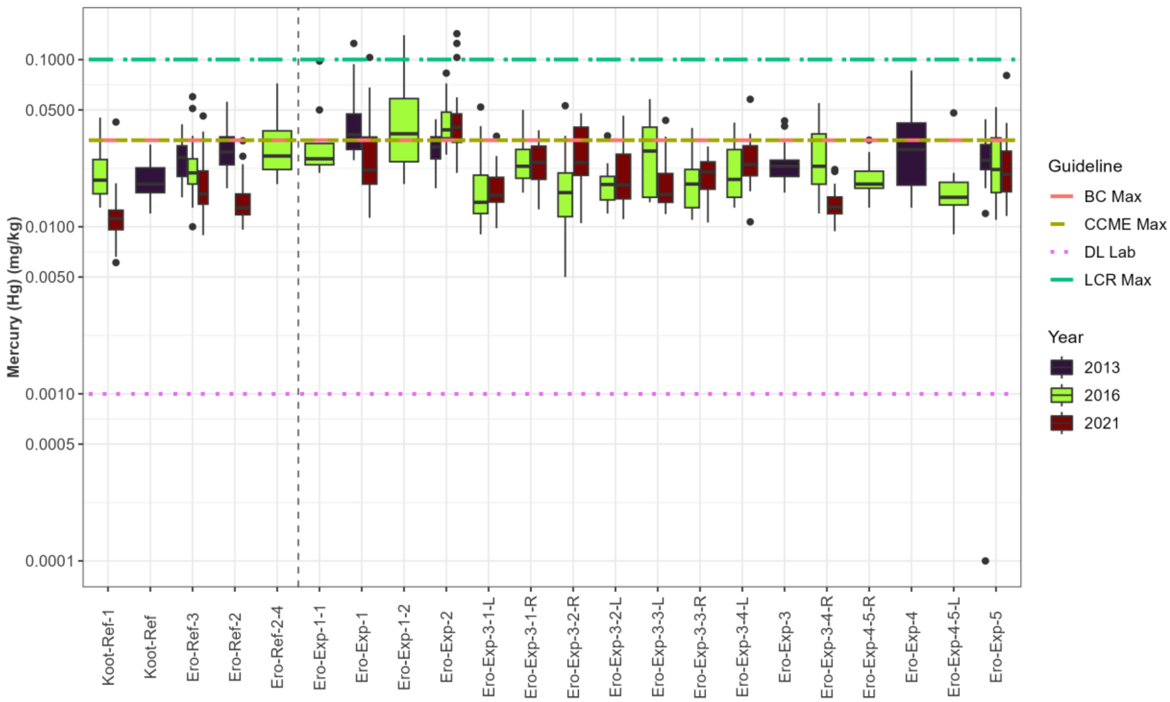


Figure 5-119: Concentrations of mercury (mg/kg wet weight) in whole body sculpin samples in reference and exposure by sample site and year.

5.5.2.8 Selenium (Se)

Selenium concentrations were significantly higher in all exposure areas than reference areas (R^2 = 0.34, $p < 0.001$ for IDZ Left and Right banks, $p = 0.006$) (Figure 5-120). Selenium concentrations did not differ significantly between 2021 and 2013 (R^2 = 0.36, $p = 0.71$), but were significantly higher in 2016 than 2013 ($p < 0.001$). The average Se concentration was below the BC wildlife guideline of 1 mg Se/kg (wet weight) at all sites in 2021. However, individual samples from several areas exceeded this value. There were three exceedances for Se concentrations from reference areas, and 15 exceedances from exposure areas. All exceedances in exposure areas occurred in the IDZ Right Bank zone and 12 of the 15 were in ERO-EXP-2, just downstream of the CIII outfall. Two exceedances came from ERO-EXP-3, and one from ERO-EXP-1.

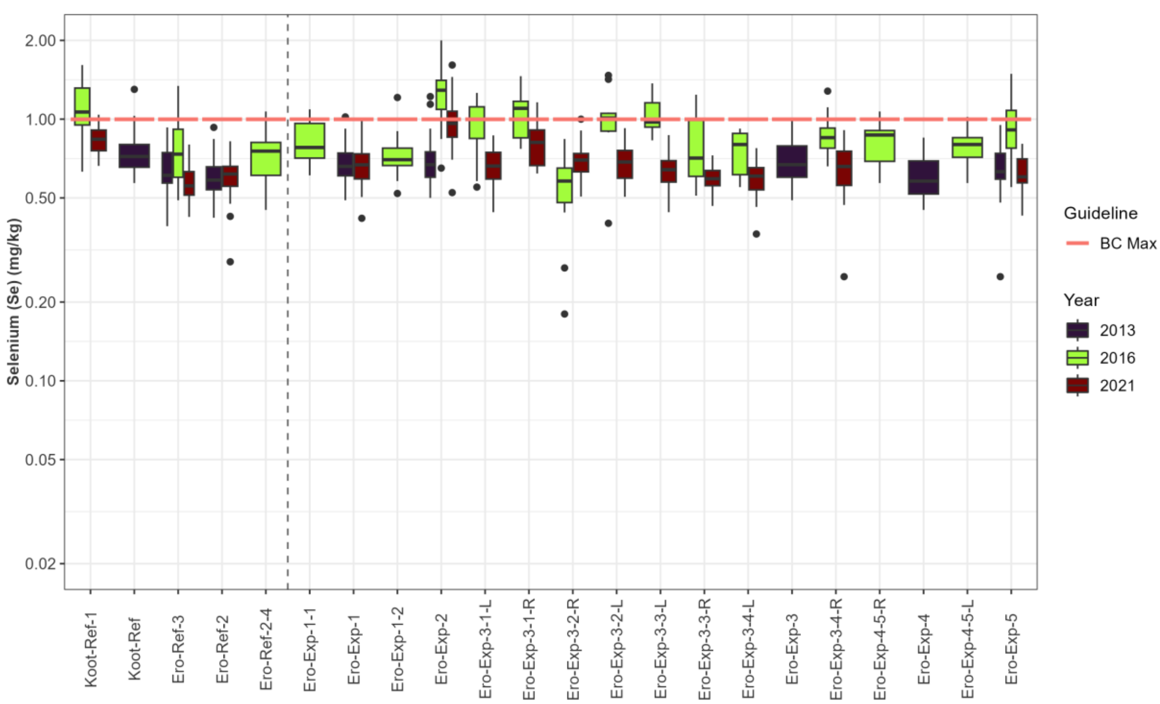


Figure 5-120: Concentrations of selenium (mg/kg wet weight) in whole body sculpin samples in reference and exposure by sample site and year.

5.5.2.9 Thallium (Tl)

Thallium was significantly higher in the IDZ Right Bank ($p < 0.001$), particularly ERO-EXP-2, and Downstream of the IDZ ($p = 0.005$) than in reference areas ($R2 = 0.41$; Figure 4 109). Thallium concentrations in tissue did not differ significantly between 2021 and 2013 but were significantly higher in 2016 than in 2013 ($R2 = 0.39$, $p = 0.02$).

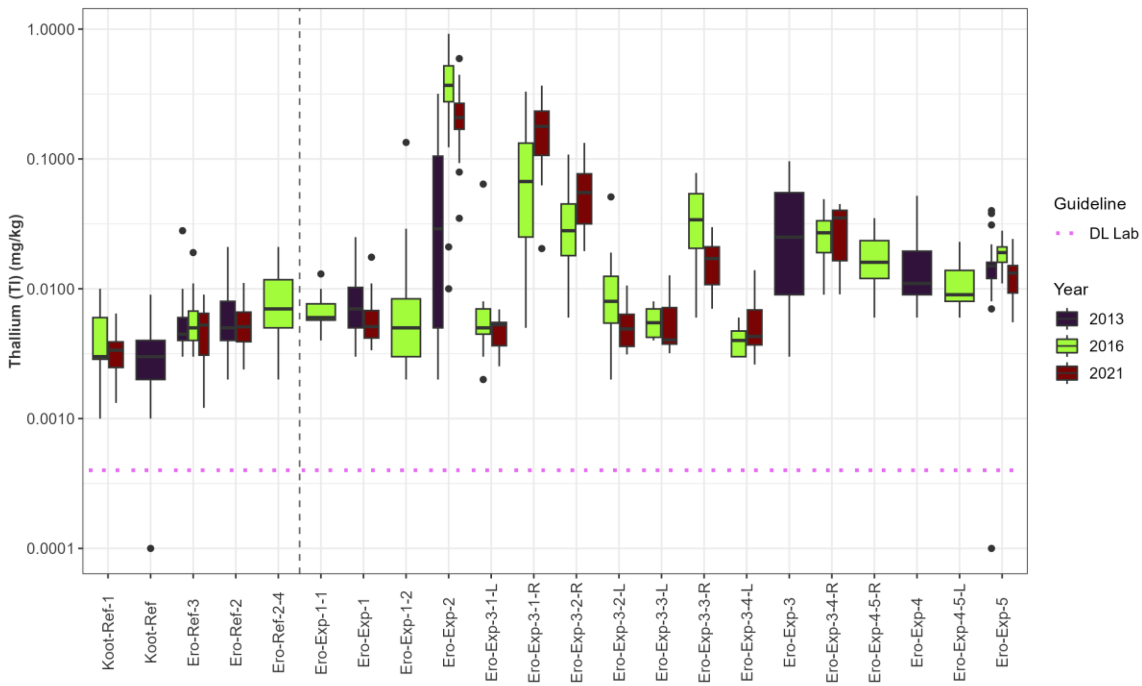


Figure 5-121: Concentrations of thallium (mg/kg wet weight) in whole body sculpin samples in reference and exposure by sample site and year.

5.5.2.10 Zinc (Zn)

Zinc concentrations did not differ significantly between reference and exposure sites (Figure 5-122). Concentrations of zinc in small-bodied fish tissue was significantly lower in 2021 than in 2013 ($R^2 = 0.16$, $p < 0.001$), and did not differ significantly between 2016 and 2013 ($p = 0.62$).

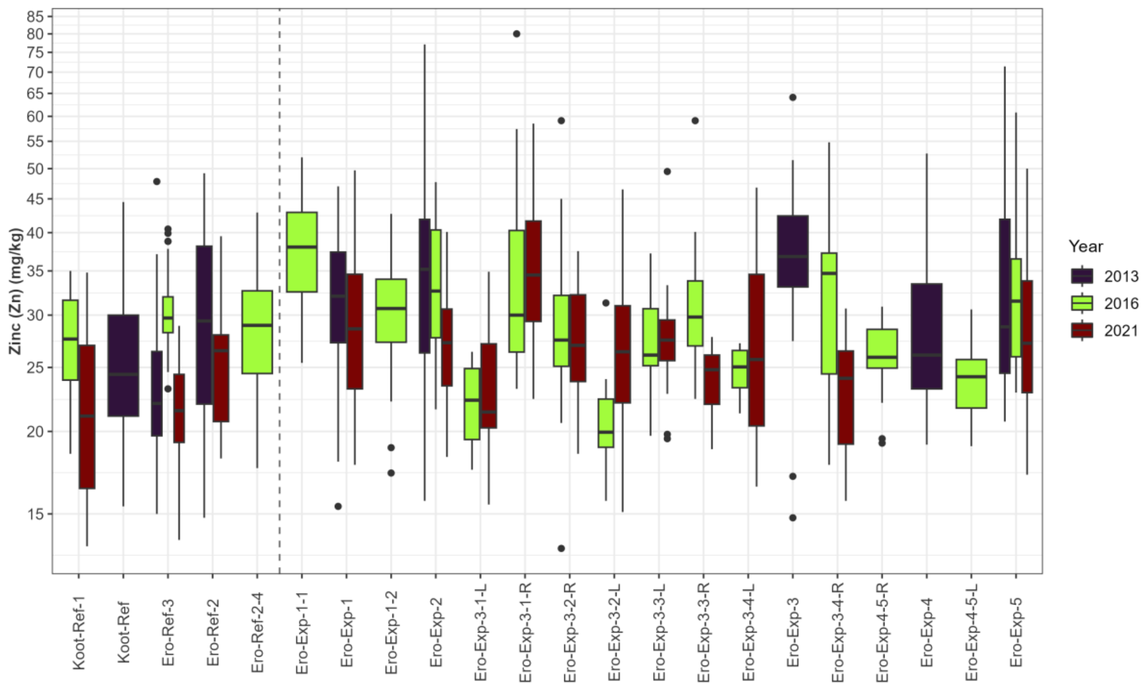


Figure 5-122: Concentrations of zinc (mg/kg wet weight) in whole body sculpin samples in reference and exposure by sample site and year.

5.6 Large-bodied Fish

A total of 101 adult fish (Mountain Whitefish, Rainbow Trout, and Walleye) were collected from two sites in the study area. We sampled 34 Mountain Whitefish, 40 Rainbow Trout, and 27 Walleye in 2021. A total of 60 fish were collected from the reference area (HLK Dam downstream to Robson Bridge) and 41 were collected from the exposure area. In 2021, no fish were caught near Waneta and the other far-field sites, so the actual 2021 exposure sample area was from Beaver Creek to Maglios.

Within the reference area, we collected 20 of each of the three focal species. We collected 14 Mountain Whitefish, 20 Rainbow Trout, and 7 Walleye from the exposure area. Sampling focused on obtaining fish of catchable size (>200 mm) that would be sought by anglers. Thus, lower age class fish were generally excluded from sampling, with the exception of one Mountain Whitefish under 200 mm in length.

5.6.1 Condition Metrics

Mountain Whitefish caught in the reference area had significantly higher gonadosomatic indices than those caught in exposure areas ($R^2 = 0.16$, $p = 0.02$; Figure 5-123). Condition (k) and hepatosomatic index did not differ for Mountain Whitefish between reference and exposure areas. Walleye condition (k) was significantly higher in reference sites than in exposure sites ($R^2 = 0.12$, $p = 0.018$). Walleye hepatosomatic index was significantly higher in exposure sites than reference sites ($R^2 = 0.18$, $p = 0.037$). Gonadosomatic indices did not differ between walleye caught in the reference area upstream of the smelter and those caught in the exposure area. Rainbow Trout condition indices did not differ significantly between exposure and reference areas.

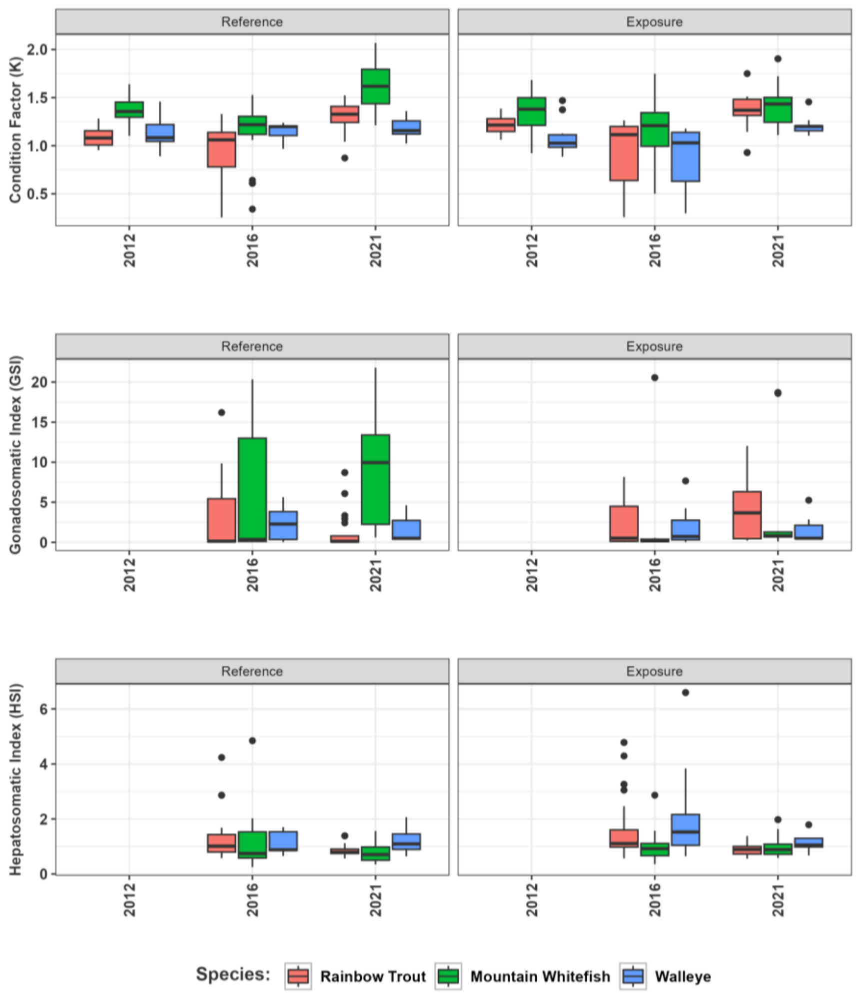


Figure 5-123: Mountain Whitefish, Rainbow Trout, and Walleye condition metrics sampled in 2021 from reference (upstream of smelter) and exposure (downstream of smelter) areas in the LCR.

5.6.2 Tissue Metals

Concentrations measured from fish caught in 2021 were compared to Canadian guidelines for chemical contaminants and toxins in fish for human consumption (Canadian Food Inspection Agency 2011), BC Ministry of Environment guidelines, and the LCR TRO for wildlife (1997). Model R^2 values are given where significant results are reported.

Tissue metals concentrations were reported by the lab in mg/kg dry weight in 2021 and converted to wet weight to compare with historical data (2012 and 2015) that was also reported in wet weight. Mean percentage moisture of sampled fillets was 73.5% ± 3.83. Whole fish sample mean percentage moisture was 70.9% ± 3.7, and mean percentage moisture of gut samples was 65.6% ± 11.1.

5.6.2.1 Arsenic (As)

Arsenic concentrations in fillet tissues are very unlikely to pose a risk to human health or wildlife consumers of fish, as there were no tissue arsenic concentration exceedances of the human consumption guideline or the TRO (Figure 5-124).

Gut arsenic concentrations were significantly higher in exposure areas than in reference areas in 2021 ($R^2 = 0.28$, $p < 0.001$). The elevated metal concentrations in the gut are related to solid metals associated with sediments that are passed through the fish and not absorbed or assimilated into the fish tissue. Arsenic concentrations did not differ significantly between reference and exposure areas in fillet ($R^2 = 0.20$ $p = 0.54$) or whole fish samples ($R^2 = 0.62$, $p = 0.24$) in 2021.

When samples from 2012, 2016, and 2021 were modeled together, Mountain Whitefish has significantly higher fillet arsenic concentrations than Rainbow Trout ($R^2 = 0.25$, $p = 0.025$) and Walleye ($p = 0.09$). Arsenic concentrations were significantly higher in gut ($R^2 = 0.15$, $p = 0.007$) and fillet samples ($p = 0.004$) of fish with larger fork lengths, but this trend did not show in whole fish samples.

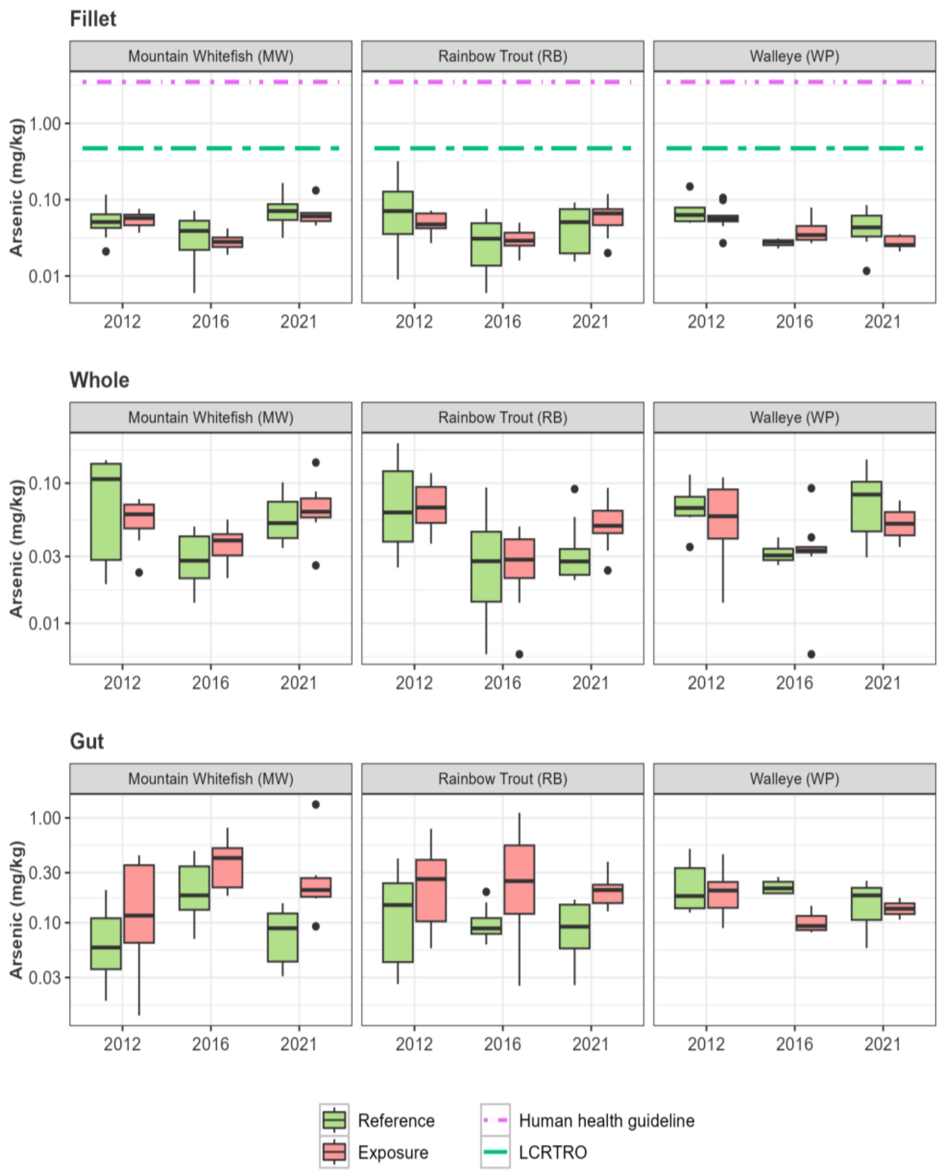


Figure 5-124: Concentrations of Arsenic (mg/kg wet weight) in fillet, whole body, and gut samples from Mountain White fish (MW), Rainbow Trout (RB), and Walleye (WP) collected from reference and exposure areas upstream and downstream of the smelter respectively. Human consumption and wildlife guidelines are included as horizontal lines where they fall within observed metal concentration ranges.

5.6.2.2 Cadmium (Cd)

Cadmium concentrations in muscle tissue and whole fish are very unlikely to pose health risk concerns to wildlife. Mean and maximum muscle tissue and whole fish Cd concentrations were well below the TRO (0.9 mg Cd/kg wet weight) (Figure 5-125). There is no guideline set for human consumption.

Concentrations of cadmium were significantly higher in exposure sites than reference sites in fillet samples ($R^2 = 0.45$, $p = 0.003$), gut samples ($R^2 = 0.43$, $p < 0.001$), and whole samples ($R^2 = 0.36$, $p < 0.001$) in 2021.

When 2012, 2016, and 2021 samples were modelled together, cadmium concentrations were significantly higher in fillet samples of Mountain Whitefish relative to other species ($R^2 = 0.47$, $p < 0.001$ for Rainbow Trout, $p < 0.001$ for Walleye). Whole samples showed the same trend of significantly higher cadmium concentrations in Mountain Whitefish than in Rainbow Trout ($R^2 = 0.31$, $p < 0.001$) and Walleye ($p = 0.005$). Cadmium tissue concentrations decreased marginally with larger fork lengths, but this difference was only apparent in gut samples ($R^2 = 0.41$, $p = 0.002$).

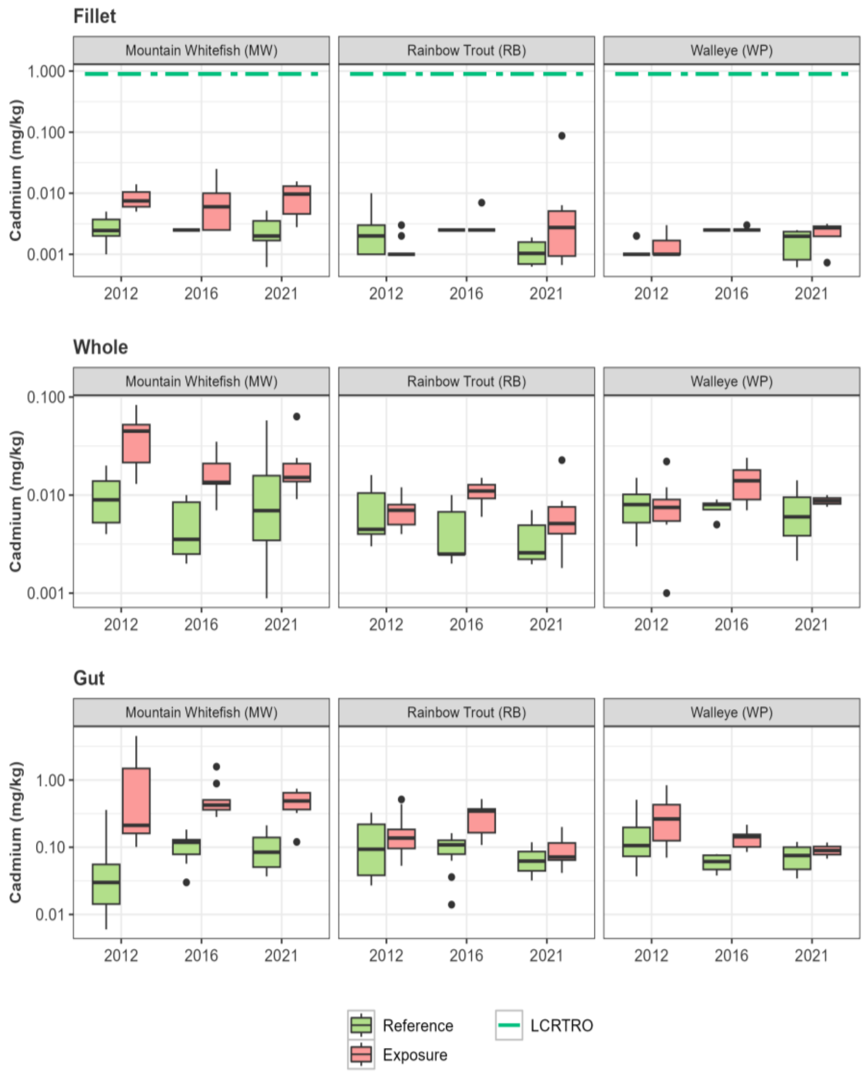


Figure 5-125: Concentrations of Cadmium (mg/kg wet weight) in fillet, whole body, and gut samples from Mountain White fish (MW), Rainbow Trout (RB), and Walleye (WP) collected from reference and exposure areas upstream and downstream of the smelter respectively. The LCR TRO is shown.

5.6.2.3 Chromium (Cr)

Fillet chromium concentrations are very unlikely to pose health risk concerns to wildlife consumers of fish. Maximum fillet and whole fish Cr concentrations were 0.14 and 0.02 mg/kg wet weight respectively, which are below the 0.94 mg Cr/kg wet weight TRO.

Sixty percent of fish had Cr concentrations that were below the DL. Most detectable samples were from the gut analysis, with only 4 fish having fillet concentrations of Cr above the DL. There is no guideline for human consumption for chromium in fish tissue.

Due to the large number of non-detectable chromium results, comparisons could not be tested statistically. However, exposure and reference areas, species, and sample type can be compared visually using Figure 5-126. Concentrations of Cr do not appear to differ between reference and exposure sites. Gut Cr concentrations were higher than other tissue types in all 2021 samples at both reference and exposure sites.

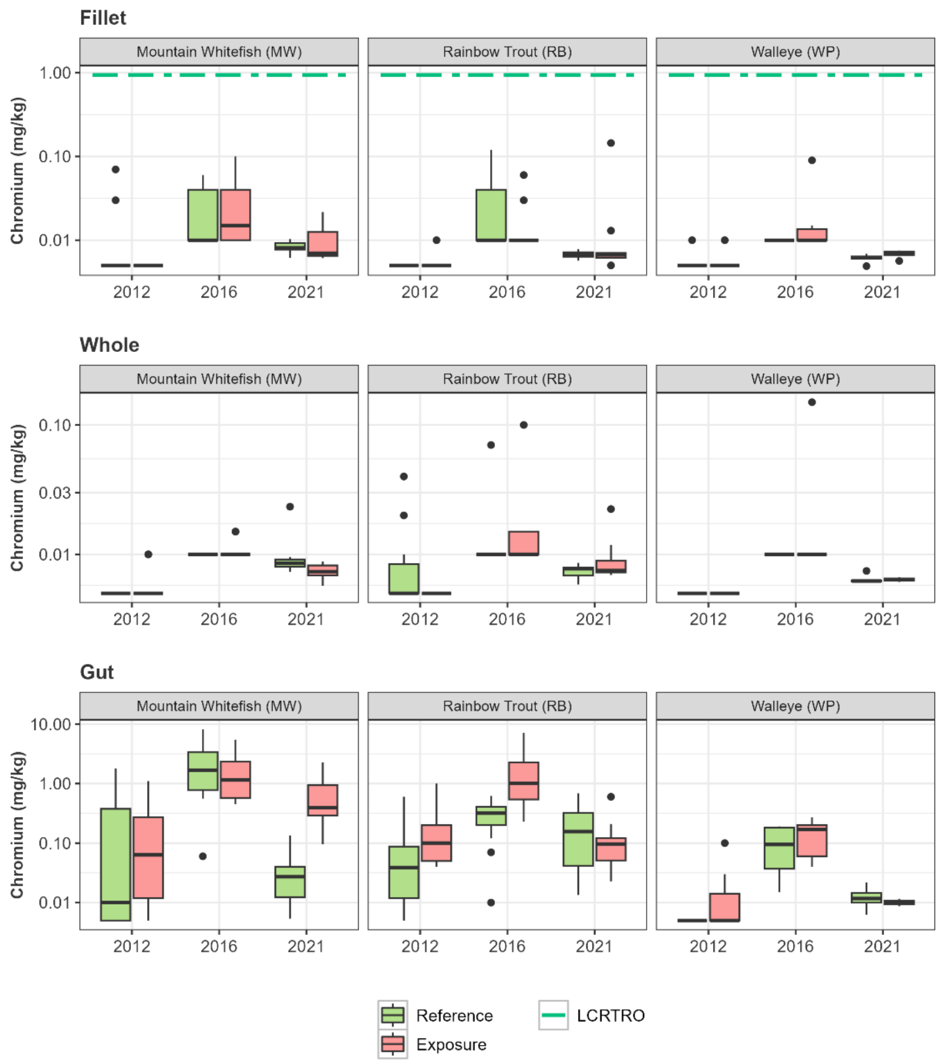


Figure 5-126: Concentrations of Chromium (mg/kg wet weight) in fillet, whole body, and gut samples from Mountain White fish (MW), Rainbow Trout (RB), and Walleye (WP) collected from reference and exposure areas upstream and downstream of the smelter, respectively. The LCR TRO is included.

5.6.2.4 Copper (Cu)

There are no tissue guidelines available for copper. Copper concentrations in gut samples were significantly lower in reference sites than in exposure sites in 2021 ($R^2 = 0.75$, $p < 0.001$; Figure 5-127). Copper concentrations did not differ significantly between reference and exposure in other tissue types (fillet $R^2 = 0.56$, $p = 0.27$, whole $R^2 = 0.67$, $p = 0.55$). When samples from 2012, 2016, and 2021 were modelled together, Mountain Whitefish had significantly higher copper concentrations in all sample types than Walleye (fillet $R^2 = 0.66$, $p < 0.001$, gut $R^2 = 0.55$, $p = 0.001$, whole $R^2 = 0.54$, $p < 0.001$). Rainbow Trout had significantly higher copper concentrations than Mountain Whitefish in gut and whole fish samples ($p < 0.001$ for both). However, in fillet samples, Rainbow Trout had significantly lower copper concentrations than Mountain Whitefish ($p < 0.001$). In fillet samples, copper concentrations were significantly lower in 2012 than in 2016 ($p = 0.008$) or 2021 ($p < 0.001$). Fillet samples from 2021 had significantly higher copper concentrations than in 2016 ($p < 0.001$). Higher fork lengths had lower concentrations of copper in gut samples ($p = 0.005$), but this trend did not show in other sample types.

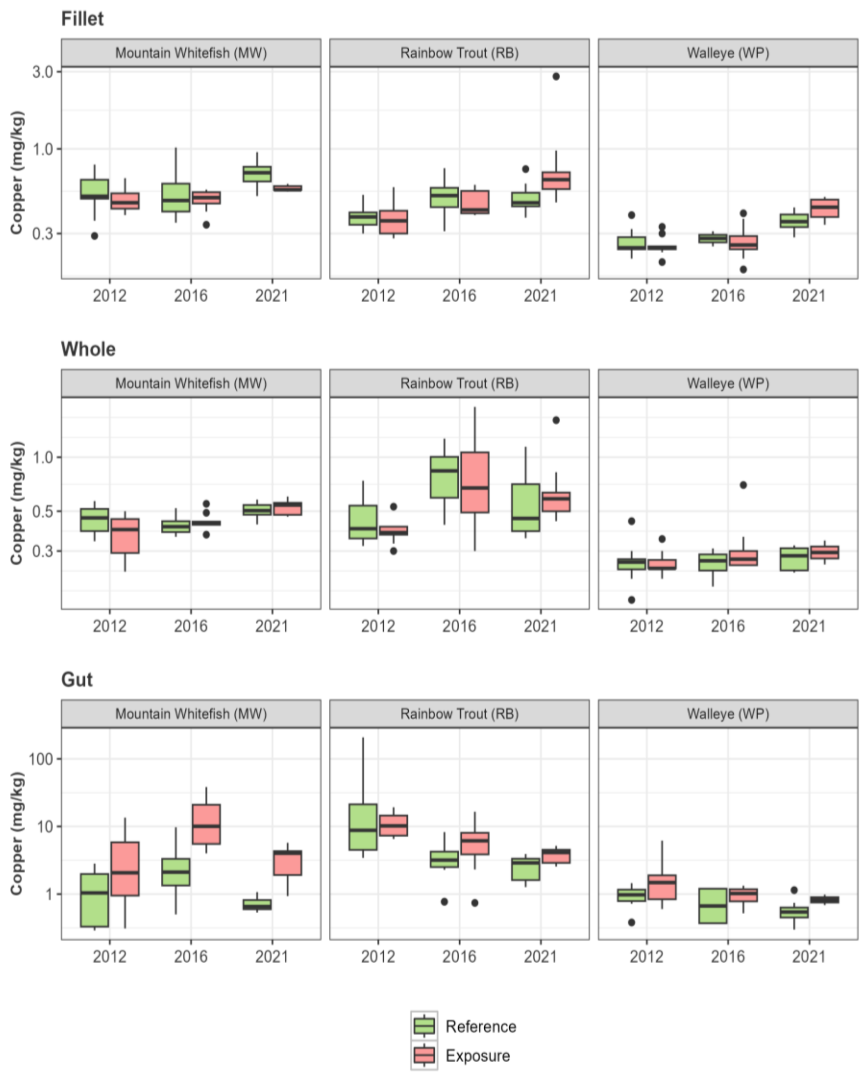


Figure 5-127: Concentrations of Copper (mg/kg wet weight) in fillet, whole body, and gut samples from Mountain White fish (MW), Rainbow Trout (RB), and Walleye (WP) collected from reference and exposure areas upstream and downstream of the smelter respectively.

5.6.2.5 Lead (Pb)

Mean lead concentrations of all species' fillet samples in exposure and reference areas were below the human consumption guideline (0.5 mg Pb/kg wet weight), and there were no individual fillet sample exceedances of the human consumption guideline in 2021.

Mean lead concentrations in fillet and whole fish samples of Mountain Whitefish and Rainbow Trout from exposure areas were below the LCR TRO for wildlife (0.16 mg Pb/kg wet weight in 2021. No samples from any species exceeded the TRO in reference areas. In exposure areas, 29% of fillet samples of Mountain Whitefish and 9% of Rainbow Trout fillets exceeded the LCR TRO (Figure 5-128). No Walleye samples in exposure sites exceeded the TRO. While the TRO was intended to be compared to mean concentrations, it is important to understand the individual variance of samples and total sample exceedances.

Lead concentrations were significantly higher in fillet (R^2 = 0.40, $p < 0.001$), gut (R^2 = 0.72, $p < 0.001$), and whole fish samples (R^2 = 0.38, $p = 0.003$) from exposure areas than reference areas in 2021. When 2012, 2016, and 2021 samples were modelled together, Mountain Whitefish had higher lead concentrations than Walleye in fillet (R^2 = 0.47, $p < 0.001$), gut (R^2 = 0.69, $p < 0.001$), and whole fish samples (R^2 = 0.38, $p < 0.001$). Mountain Whitefish also had significantly higher lead concentrations than Rainbow Trout in fillet ($p = 0.004$) and whole fish samples ($p = 0.017$). Lead concentrations increased with increased fork length, but this trend was only apparent in fillet ($p < 0.001$) and whole fish samples ($p = 0.007$). Lead concentrations showed the opposite trend in gut samples, with lead concentrations decreasing marginally with increased fork length ($p < 0.001$).

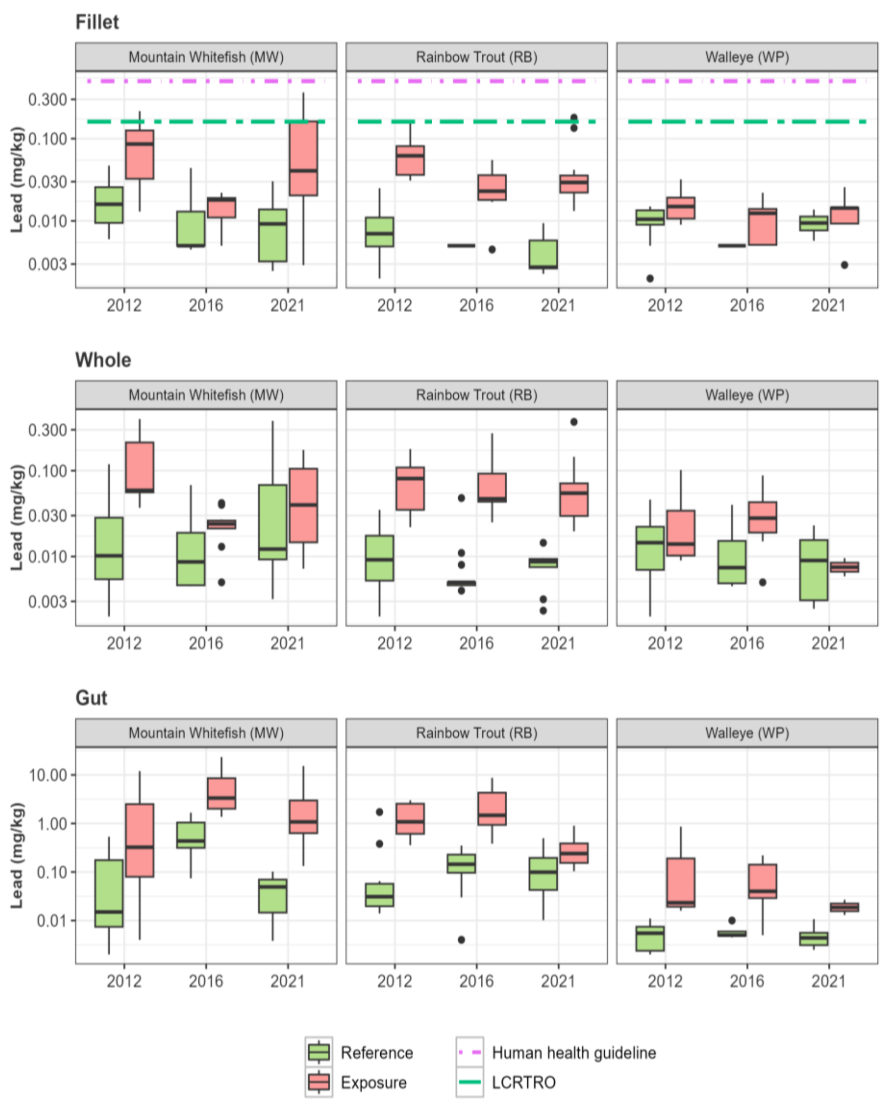


Figure 5-128: Concentrations of lead (mg/kg wet weight) in fillet, whole body, and gut samples from Mountain White fish (MW), Rainbow Trout (RB), and Walleye (WP) collected from reference and exposure areas upstream and downstream of the smelter respectively. Human consumption and wildlife guidelines are included as horizontal lines where they fall within observed metal concentrations.

5.6.2.6 Mercury (Hg)

Mean mercury concentrations of all fillet samples from reference and exposure areas were below the Canadian guidelines for human consumption (0.5 mg Hg/kg wet weight) in 2021. There were no individual sample exceedances of the human consumption guideline.

In reference areas, 90% of Walleye fillet samples exceeded the TRO (0.1 mg Hg/kg wet weight). Two (20%) Rainbow Trout fillets from reference areas also exceeded the TRO. In exposure areas, 60% of Walleye fillets, 14% of Mountain Whitefish fillets, and no Rainbow Trout fillets exceeded the TRO. Mean mercury concentrations in fillet and whole fish samples of Walleye from both reference and exposure areas exceeded the TRO in 2021, ranging from 0.12 mg Hg/kg wet weight in exposure fillet samples to 0.17 mg Hg/kg wet weight in reference whole fish samples.

In exposure areas, 86% of Mountain Whitefish fillets, 27% of Rainbow Trout fillets, and all Walleye fillets exceeded the CCME and BC MOE wildlife mercury guideline of 0.033 mg Hg/kg wet weight in 2021. All Walleye fillet samples, 40% of whole Mountain Whitefish samples, and 90% of Rainbow Trout samples in reference areas also exceeded the guidelines. Mean mercury concentrations in whole and fillet samples from all species in exposure and reference sites exceeded the CCME guideline and BC wildlife guideline, except for fillets of Rainbow Trout from exposure areas and whole Rainbow Trout from reference areas.

Mercury concentrations did not differ significantly between reference and exposure areas for any sample type in 2021 (fillet $R^2 = 0.51$, $p = 0.18$; gut $R^2 = 0.27$, $p = 0.15$; whole $R^2 = 0.72$ $p = 0.13$).

When samples from 2012, 2016, and 2021 were modelled together, mercury concentrations in fish from reference areas were significantly higher than in exposure areas for fillet ($R^2 = 0.77$, $p < 0.001$) and whole body ($R^2 = 0.75$, $p = 0.046$) samples. Walleye had significantly higher mercury concentrations than Mountain Whitefish in whole body and fillet samples ($p < 0.001$ for both; Figure 5-129). Walleye also had higher mercury concentrations than Rainbow Trout in whole body and fillet samples ($p < 0.001$ for both). Mercury concentrations increased with increased fork length in fillet ($p < 0.001$), gut ($R^2 = 0.25$ $p < 0.001$), and whole fish samples ($p < 0.001$).

Among large-bodied fish sampled for metal concentrations in other studies, Walleye frequently have the highest mean mercury concentrations of between 0.08 – 0.65 mg Hg/kg wet weight, followed by Rainbow Trout (0.04 – 0.21 mg Hg/kg dry) and then Mountain Whitefish (0.05 – 0.17 mg Hg/kg dry) (Hatfield 2008). Methylated mercury is one of the few metals with demonstrated biomagnification in aquatic food chains. As a top piscivorous predator, Walleye have a higher Hg burden because they live longer and feed at a higher level in the food chain. Thus, they have longer to accumulate mercury, and consume other species that can also accumulate mercury from their own diets.

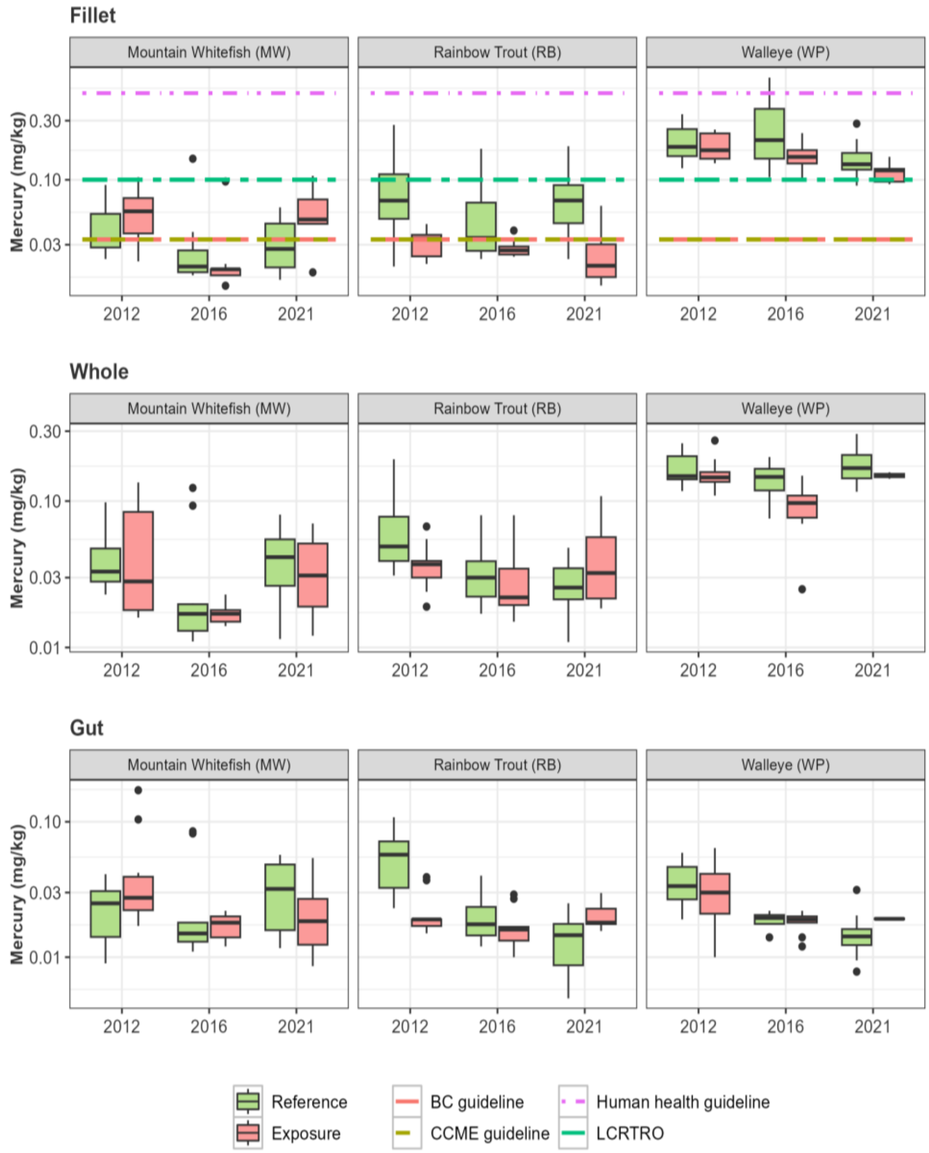


Figure 5-129: Concentrations of mercury (mg/kg wet weight) in fillet, whole body, and gut samples from Mountain White fish (MW), Rainbow Trout (RB), and Walleye (WP) collected from reference and exposure areas upstream and downstream of the smelter respectively. Human consumption and wildlife guidelines are included as horizontal lines.

5.6.2.7 Selenium (Se)

No fillet samples from reference or exposure areas exceeded the human consumption guideline (Figure 5-130). There were no exceedances of the BC wildlife guideline of 1 mg Se/kg wet weight, in any fillet samples for all species. Whole and gut samples were not evaluated by the BC wildlife guideline. Comparing the whole-body or gut samples to the wildlife guideline is not a valid comparison because of how the different tissues accumulate and store selenium. For instance, Sato et al. (1980) found that selenium accumulations in fish kidneys, livers, gall bladders and gills were large, while those in heart, bone and muscle were small.

Selenium concentrations did not differ between reference and exposure sites for any sample type in 2021 (fillet $R^2 = 0.28$, $p = 0.51$; gut $R^2 = 0.67$, $p = 0.87$; whole $R^2 = 0.23$ $p = 0.91$). When samples from 2012, 2016, and 2021 were modelled together, selenium concentrations were significantly higher in exposure areas than in reference areas for all sample types (fillet $R^2 = 0.35$, $p < 0.001$; gut $R^2 = 0.64$, $p < 0.001$; whole $R^2 = 0.39$, $p = 0.006$).

Mountain Whitefish had significantly higher selenium concentrations than Walleye (fillet $p = 0.01$, gut and whole $p < 0.001$) or Rainbow Trout ($p < 0.001$) for all sample types. Selenium concentrations were significantly higher in 2012 than in 2016 in fillet samples ($p = 0.007$) and gut samples ($p < 0.001$). Selenium concentrations were also significantly higher in 2012 than in 2021 in both fillet and gut samples ($p < 0.001$ for both). However, when whole tissue samples were considered, concentrations from 2012 were significantly lower than in 2016 ($p = 0.002$). Selenium concentrations did not vary significantly with fork length for any sample type ($p > 0.32$ for all).

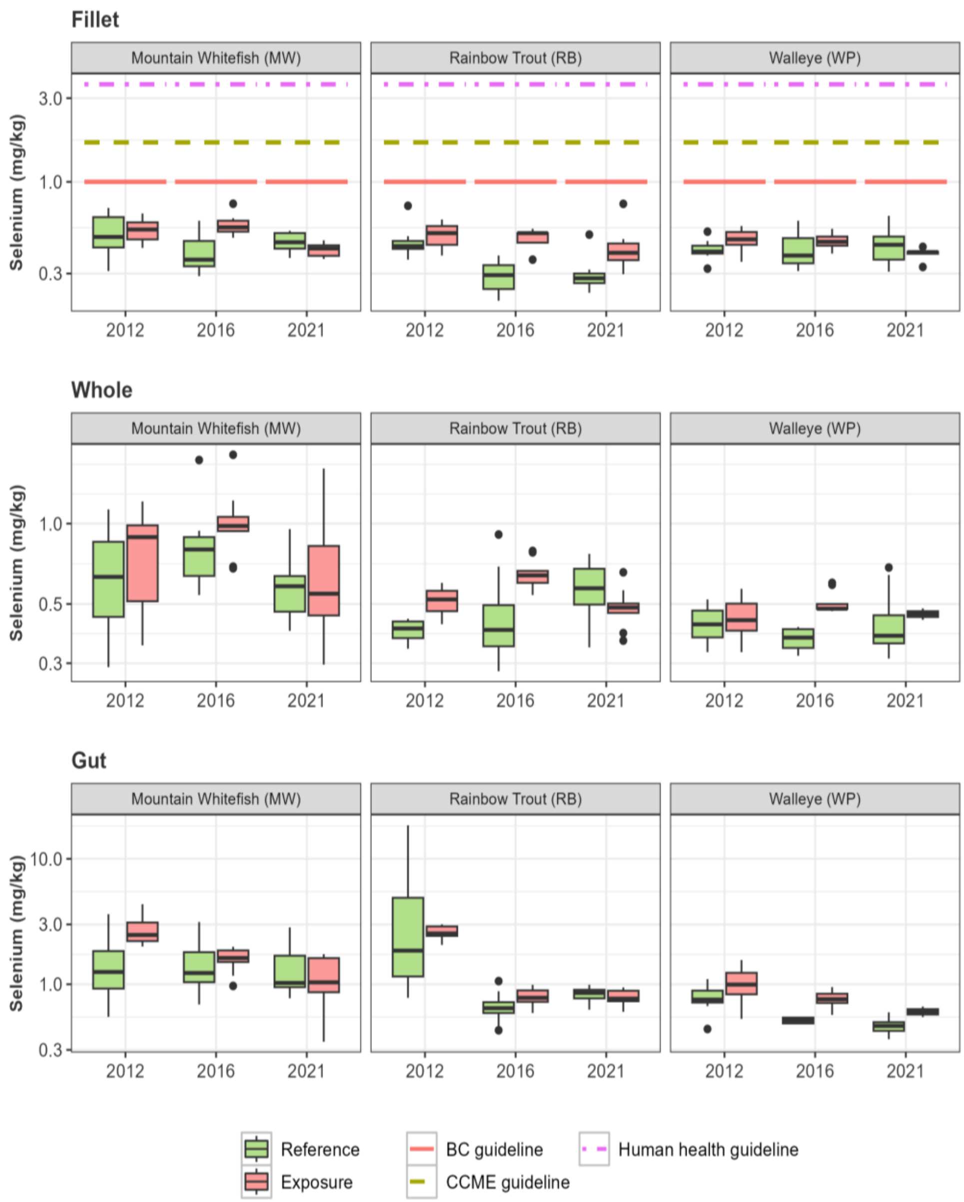


Figure 5-130: Concentrations of selenium (mg/kg wet weight) in fillet, whole body, and gut samples from Mountain White fish (MW), Rainbow Trout (RB), and Walleye (WP) collected from reference and exposure areas upstream and downstream of the smelter respectively.

5.6.2.8 Thallium (Tl)

There is no guideline for thallium in fish tissues for wildlife or human consumption. Reference areas had significantly lower thallium concentrations than exposure areas in fillet (R^2 = 0.56), gut (R^2 = 0.63), and whole fish (R^2 = 0.61) samples in 2021 ($p < 0.001$ for all; Figure 5-131).

When samples from 2012, 2016, and 2021 were modelled together, Thallium concentrations were significantly lower in reference areas than in exposure areas in fillet (R^2 = 0.44, $p < 0.001$), gut (R^2 = 0.35, $p < 0.001$), and whole fish samples (R^2 = 0.50, $p < 0.001$). Mountain Whitefish fillet and whole samples had significantly lower Thallium concentrations than Rainbow Trout ($p < 0.001$ for both). Mountain Whitefish also had significantly lower thallium concentrations than Walleye in fillet and whole fish samples ($P < 0.001$ for both). Thallium concentrations did not differ significantly between years.

Increased fork length had a negative effect on thallium concentrations in gut and whole fish samples ($p < 0.001$ for both), but not in fillet samples ($p = 0.28$).

Although thallium was significantly higher in fillets from exposure areas than from reference areas, there are no expected effects on fish health. Fillet and whole body concentrations of thallium in 2021 rarely exceeded 0.1 mg Tl/kg wet weight, which is below the literature-derived benchmark of 0.66 mg Tl/kg wet weight (Lapointe and Couture 2010).

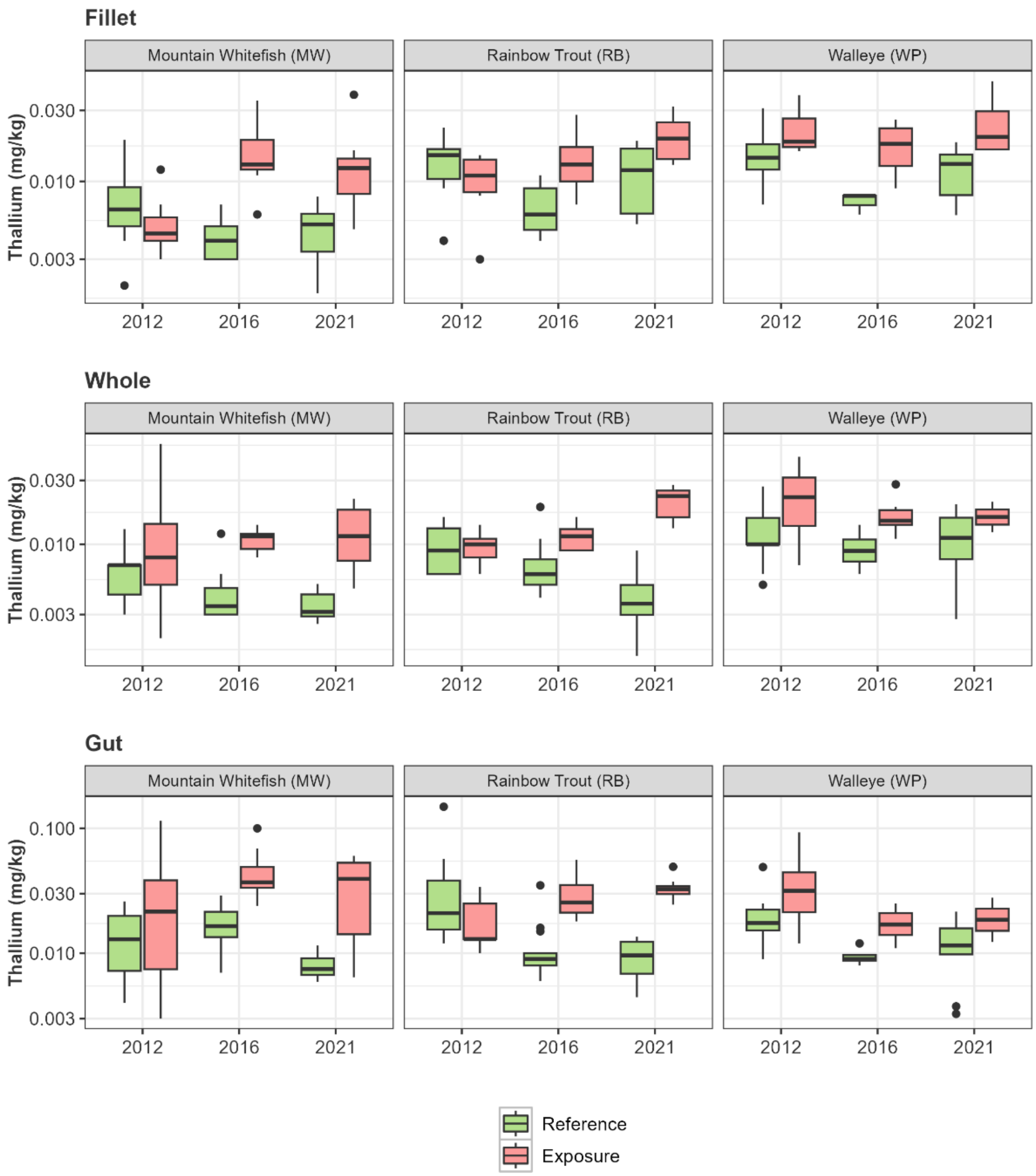


Figure 5-131: Concentrations of thallium (mg/kg wet weight) in fillet, whole body, and stomach content samples from Mountain White fish (MW), Rainbow Trout (RB), and Walleye (WP) collected from reference and exposure areas upstream and downstream of the smelter respectively.

5.6.2.9 Zinc (Zn)

There is no guideline for zinc in fish tissues for wildlife or human consumption. Zinc concentrations did not differ significantly between reference and exposure areas in gut (R^2 = 0.90), fillet (R^2 = 0.09), and whole fish (R^2 = 0.08) samples in 2021 ($p > 0.36$ for all; Figure 5-132). When 2012, 2016, and 2021 samples were modelled together, zinc concentrations were significantly higher in exposure areas than reference areas in gut samples (R^2 = 0.73, p = 0.03). However, zinc concentrations were significantly higher in reference than exposure areas in whole fish samples (R^2 = 0.18, p = 0.01), and concentrations did not differ significantly between treatments in fillet samples (R^2 = 0.20, p = 0.75). Mountain Whitefish had significantly higher zinc concentrations in gut samples than Walleye ($p < 0.001$). Rainbow Trout had significantly higher gut zinc concentrations than Mountain Whitefish (p = 0.03). Zinc concentrations were significantly higher in 2021 than 2012 in fillet ($p < 0.001$) and gut samples ($p < 0.001$), but not in whole fish samples (p = 0.71). Concentrations did not differ between 2012 and 2016. Higher fork lengths had significantly lower zinc concentrations in whole fish samples (p = 0.002), but this pattern did not show in other sample types.

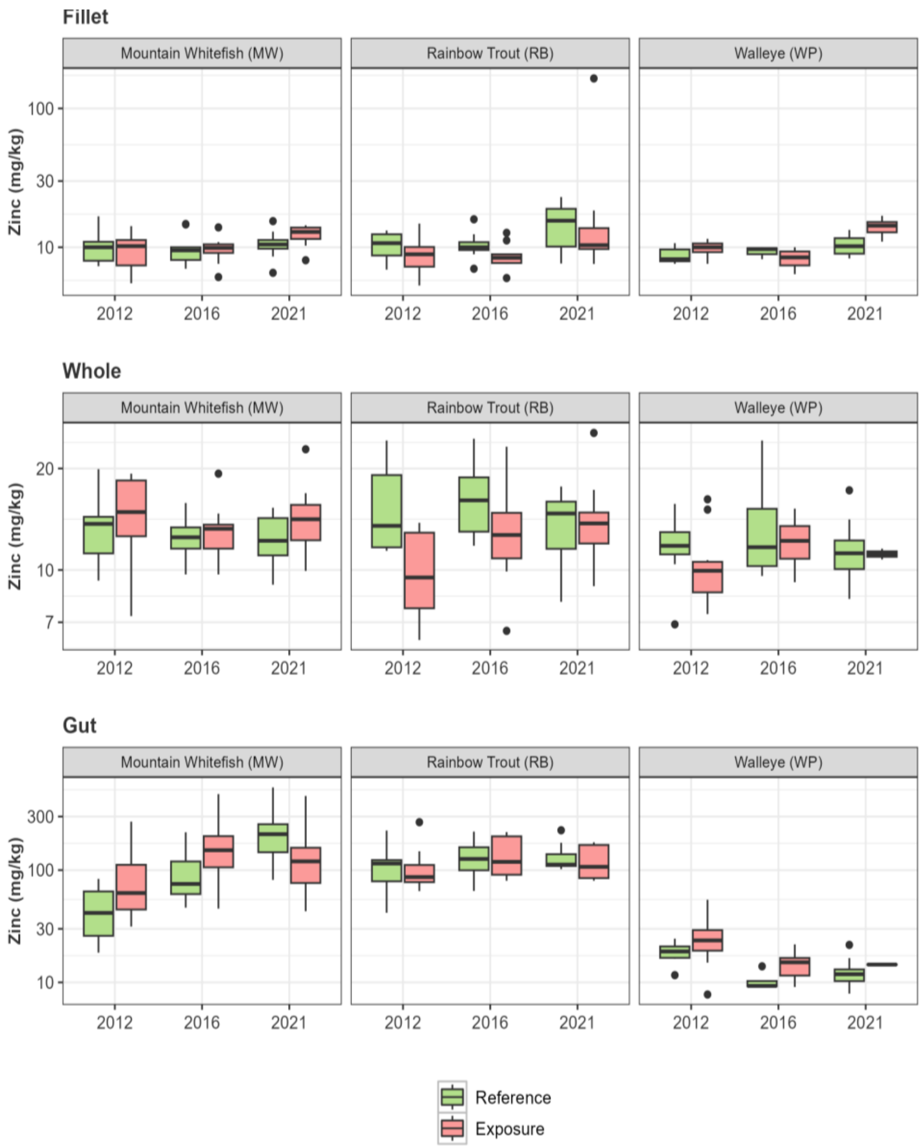


Figure 5-132: Concentrations of zinc (mg/kg wet weight) in fillet, whole body, and stomach content samples from Mountain White fish (MW), Rainbow Trout (RB), and Walleye (WP) collected from reference (Ref) and exposure (Exp) areas upstream and downstream of the smelter respectively.

5.6.3 Tissue Metals Concentration Trends from 2000-2021

Mean arsenic concentration in fillet samples differed significantly by year in reference sites ($F = 93.75$, $p < 0.001$) and exposure sites ($F = 56.09$, $p < 0.001$; Figure 5-133). Arsenic concentrations in fillet samples decreased from 2000 through 2021 in all species in both reference and exposure sites. Mean arsenic concentrations were significantly lower in 2021 than most early study years, including 2003, 2004 ($p < 0.001$ for both), and 2005 ($p = 0.01$).

Detection capabilities for cadmium have improved since 2004. Trends show a significant decline in cadmium concentrations since 2000 for all species in both exposure and reference sites, with the greatest decline after 2005 (Figure 5-134). There was a significant difference in cadmium concentrations in fillet samples between years in reference ($F = 31.67$, $p < 0.001$) and exposure areas ($F = 7.99$, $p = 0.002$). Cadmium concentrations were significantly higher in earlier years than in later years but did not differ significantly between later samples years. For example, cadmium tissue concentrations were significantly lower in 2021 than in 2000 – 2004 ($p < 0.001$ except for 2002 $p = 0.002$), but there were no significant differences between combinations of sample years after 2012.

Chromium concentrations in fillet samples differed significantly by year in reference areas ($F = 14.62$, $p < 0.001$) and exposure areas ($F = 39.71$, $p < 0.001$). In general, earlier study years had significantly higher chromium concentrations than later years, declining significantly since 2004. However, varying lab detection limits from 2012-2021 confound the results and ability to illustrate potential trends, where the majority of samples were below the detection limit in 2015 and 2021.

Lead concentrations differed significantly by year in reference areas ($F = 57.23$, $p < 0.001$) and exposure areas ($F = 9.05$ $p = 0.001$) and have decreased since early study years (Figure 5-135). Mean lead concentrations in fillet samples were significantly lower in 2021 than all years between 2000 and 2004 in reference sites ($p < 0.001$ for all except 2002 $p = 0.002$). In exposure sites, lead concentrations in 2021 were also significantly lower than in 2000 ($p = 0.008$) or 2001 ($p = 0.047$).

Mercury concentrations did not differ significantly between years in reference ($F = 0.87$, $p = 0.57$) or exposure areas ($F = 0.96$, $p = 0.51$; Figure 5-136). Mercury concentrations in fillet tissues have been variable since early study years but show no discernible trend.

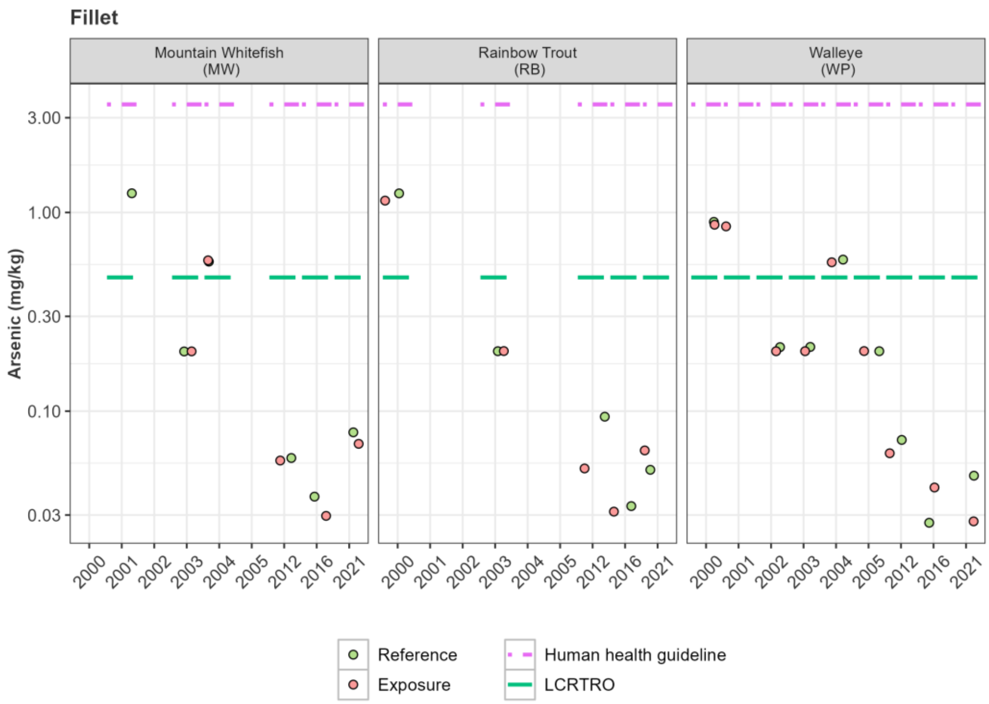


Figure 5-133. Mean arsenic concentrations (mg/kg wet weight) of large-bodied fish fillet samples through survey years in reference and exposure areas by species. The human health guideline and LCR TRO guideline are shown.

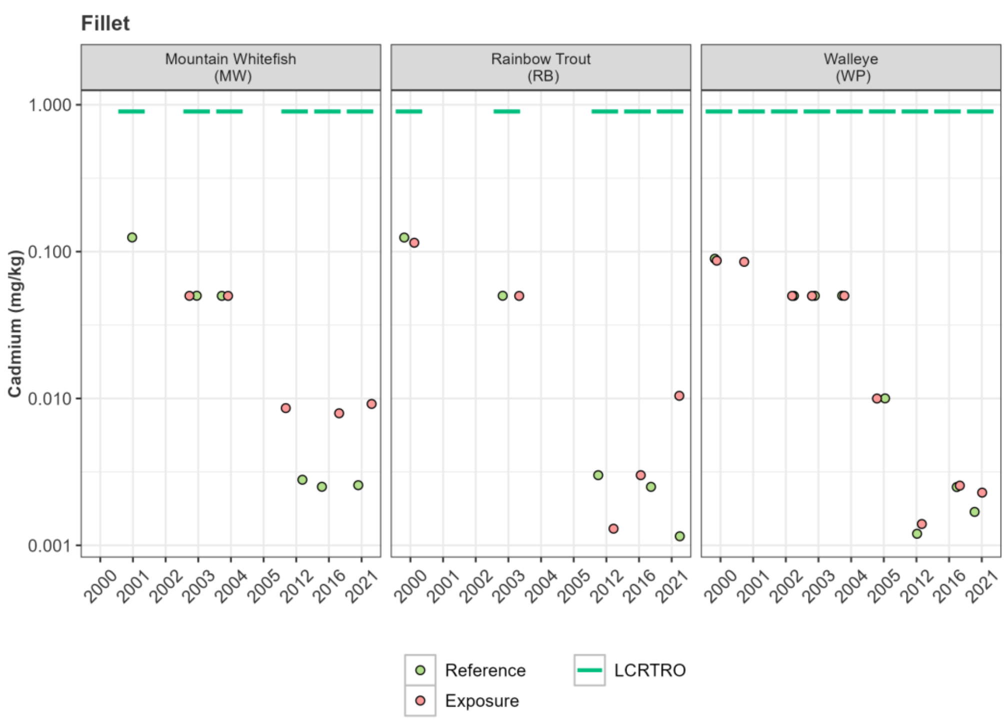


Figure 5-134. Mean cadmium concentrations (mg/kg wet weight) of large-bodied fish fillet samples through survey years in reference and exposure areas by species. The LCR TRO guideline is shown.

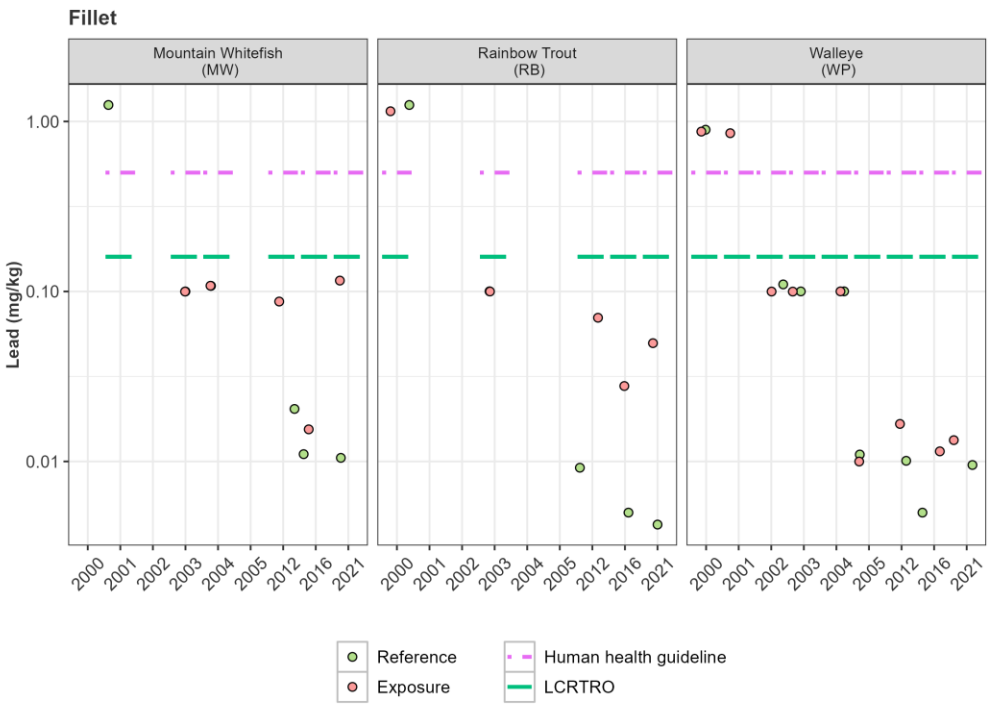


Figure 5-135. Mean lead concentrations (mg/kg wet weight) of large-bodied fish fillet samples through survey years in reference and exposure areas by species. The human health guideline and LCR TRO guideline are shown.

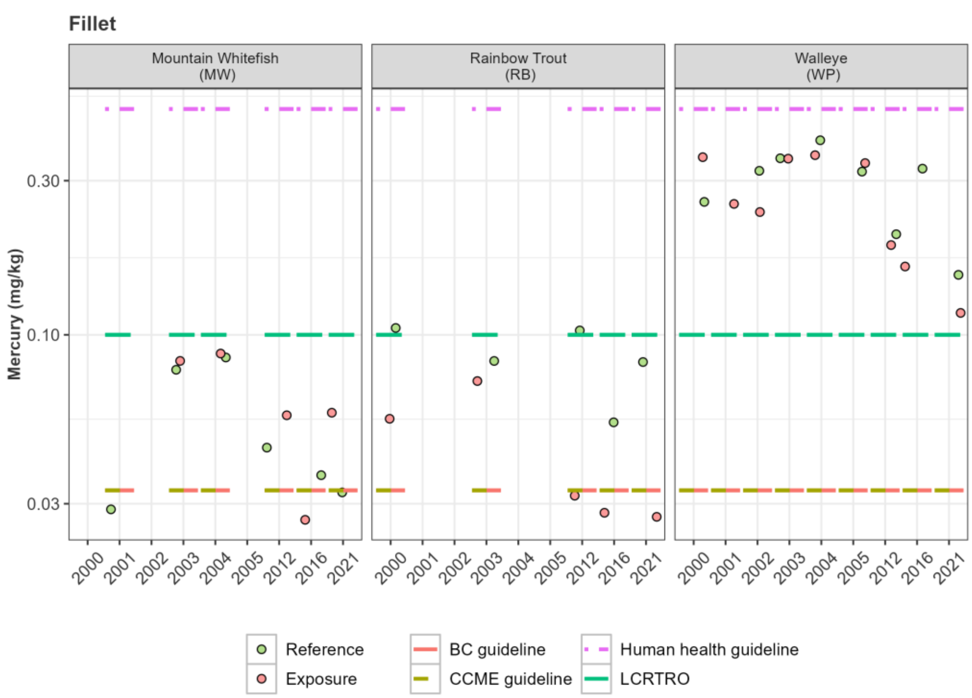


Figure 5-136. Mean mercury concentrations (mg/kg wet weight) of large-bodied fish fillet samples through survey years in reference and exposure areas by species. The human health guideline, LCR TRO, BC ministry of Environment guideline, and CCME guideline are shown.

6.0 SUMMARY AND CONCLUSIONS

The following section provides summary responses to the key management questions of the AEMP.

6.1 Water quality

The water quality program is a long-term monitoring program designed to evaluate potential effects of Teck's permitted effluent discharges on the LCR.

6.1.1 Management Question 1.

Are Provincial Water Quality Objectives attained at the downstream end of the Initial Dilution Zone during low flows (less than 40 kfcs/1133 m^3/sec) as per long-term trend monitoring (e.g., CRIEMP, BC ENV)?

Yes, Provincial Water Quality Objectives were attained at the downstream end of the IDZ. There were no exceedances of the short-term acute or long-term chronic Water Quality Guidelines or LCR Objectives for any metals of interest at the downstream end of the IDZ in 2021.

Within the IDZ, the spring 2021 30-day average dissolved cadmium and dissolved copper concentrations exceeded the long-term chronic WQG at New Trail Bridge R-sh. Nutrient concentrations in the LCR below the IDZ were not significantly altered by the effluent discharges.

Significant trends in concentrations have become increasingly apparent with the additional years of data since the previous trend analysis in 2018 (Larratt et al. 2019).

Overall, decreasing trends in metals concentrations predominate through the IDZ and downstream of the smelter. Parameters that continue to show increasing trends in concentrations (e.g., selenium and sulfate) are also increasing in background levels at the Birchbank reference site.

6.1.2 Management Question 2.

Does water quality in the study area vary spatially between locations in the LCR including point source and reference sites (both horizontal and vertical), and temporally between seasons and years as a result of Teck's point source effluent discharges and if so, describe the variances?

Water quality in the study area varied spatially and temporally but the variability was not solely a result of the smelter's point source effluent discharges. Spatial variation was affected by non-point groundwater discharge and other non-smelter discharges. Temporal variation was affected by flows in the Columbia River and associated with other sources. The AEMP transect water quality sampling showed spatial variation in water quality within the IDZ but not at Waneta where full mixing is evident. The effluent plume hugs the right bank

(~1/3 channel width or approximately 60 m) through to the downstream end of the IDZ. Spatial mapping in 2021 of specific conductance during low LCR illustrates the plume geometry relating to diffusion and dilution through the IDZ.

6.1.3 Management Question 3.

Are water quality parameters that are analyzed at the AEMP sites appropriate?

The AEMP water quality monitoring study, conducted from 2011-2021, is appropriate for evaluating temporal and spatial variation in water quality related to smelter influence in the LCR. It focusses on lower flow periods when mixing and dilution are reduced, and water quality impacts are expected to be greatest. Existing parameters and their reportable detection limits are appropriate for this study.

6.2 Depositional habitat

The depositional habitat component of the AEMP is designed to assess potential effects of Teck Trail Operations' permitted effluent discharges on depositional habitat by comparing periphyton and benthic invertebrate community structure and composition between areas upstream (reference) and downstream (exposure) of the smelter.

Hydrodynamics of the Columbia River in the study area create conditions where long-term depositional zones are rare (Golder, 2003). There are no depositional habitats in the near-field IDZ RB area affected by the effluent plume and these habitats are estimated at only 0.1% of the total sediment habitat within the AOI (Golder 2007c). The rarity of depositional habitats make them an important component of the LCR ecosystem because they support benthic invertebrate and periphyton communities that differ from erosional sites because of structural habitat differences like flow and substrate size. The unique communities present within depositional sites contribute to the overall biodiversity of the LCR.

Depositional sites are dynamic, and each site has its own character in contrast to the comparatively uniform erosional habitats. The character of individual sites can change over time, and this must be considered when interpreting sediment and benthic community results collected in this study.

6.2.1 Management Question 1.

What is the sediment quality in the depositional areas upstream and downstream of the smelter?

The 2012, 2015, 2018, and 2021 AEMP data show that metal concentrations in depositional sediments downstream of the smelter (exposure sites) were higher than reference sites. This is consistent with the results of earlier studies (Golder 2007, Hatfield 2008). Distance from the smelter was a factor in sediment metal distribution but had a non-linear relationship. None of the sediment metals of interest consistently decreased with distance from smelter in 2021. The non-linear pattern of metal concentration exceedances in sediment as distance from the smelter increases suggests there are other localized influences which may include influences of river flow dynamics along with other sources of metals such as naturally occurring metal concentrations, historical mining and milling in tributaries, municipal effluent and/or stormwater. Estimates of percent slag in this study were lower in recent years than in earlier studies (Golder 2003; 2007).

The small depositional areas that account for about 0.1% of the AOI in the LCR are highly variable. Sediment metals that exceeded guideline PEL concentrations in 2021 were limited to Cu, Pb, and Zn in the <2 mm fraction. Metals concentrations were higher in the <63 µm fraction resulting in more exceedances of the PEL for As, Cd, Cu, Pb, Hg, and Zn (Table 5-13). The <63 µm sediment fraction is expected to have a greater proportion of fine silts, clays, and organic matter which more readily adsorb metals.

The <63 µm samples had higher concentrations of metals than the <2 mm fraction, interpreted to result from metals adsorption on organics which are proportionately higher in the <63 µm fraction. Metals in both sediment fractions followed similar distribution patterns at the sample sites.

6.2.2 Management Question 2.

Are the benthic invertebrate communities in depositional sediments downstream of the smelter different from the upstream communities in terms of abundance, species diversity and species composition?

While variations in habitat between depositional sites are evident, the differences did not indicate detectable impacts on depositional periphyton or benthic invertebrate community structure from exposure to sediment metals or from current effluent discharges.

In 2021, no significant difference in the total abundance, chironomid composition, EPT composition, or effective species was evident when reference and exposure sites were grouped by year. Benthic invertebrate community metrics varied with site, and no discernible pattern emerged among sites. In 2021, total abundance was highest at Kootenay Eddy reference area, yet biomass was highest at Casino Eddy exposure area. Taxa richness and effective species number (diversity) were highest at Birchbank reference area.

Total abundance was significantly higher in 2021 than 2015 or 2012, and effective species was also higher in 2021 than 2018 or 2012. However, there were no significant differences between reference and exposure sites. There was no significant difference in community structure between all areas within 2021. Community structure differed significantly between areas across all study years, which continues to highlight the natural seasonal and annual variability that occurs in benthic communities.

6.2.3 Management Question 3.

If differences in benthic communities exist, do these differences suggest adverse effects (i.e., impairment of benthic communities such that they provide poor habitat to upper trophic consumers) and is this linked to current permitted effluent discharges?

Differences in LCR benthic communities among sites and years were detected, but depositional benthic communities did not differ between treatments. Observed differences did not suggest adverse effects or impairment of benthic communities or an impact on upper trophic consumers. We detected no impairment linked to current effluent discharges.

6.3 Erosional Habitat

The primary objectives of the erosional habitat sampling are to assess effects of effluent discharges on periphyton and benthic invertebrate communities. Two upstream reference areas were identified as Reference Area 1 (ERO-REF-1) (left bank opposite Stoney Creek and CIV outfall) and Reference Area 2 (ERO-REF-2) (Birchbank). Five downstream exposure areas were sampled at sites identified as downstream Exposure Area 1 through Exposure Area 5 (ERO-EXP-1 to ERO-EXP-5). Exposure areas were further divided into near-field sites along the right bank of the IDZ (IDZ RB), and far-field sites that occur beyond the extent of the effluent plume and downstream of the IDZ where the effluent is more thoroughly mixed with the LCR.

6.3.1 Management Question 1.

<u>What is the difference in periphyton communities in erosional habitats downstream of the smelter compared to the upstream communities in terms of periphyton community structure, composition, and standing crop biomass?</u>

Periphyton community structure was significantly different between reference, near-field (IDZ RB), and far-field erosional sites in 2021, and when all years were evaluated together. Chl-a productivity and biomass were significantly higher in near-field exposure sites (IDZ RB) than in reference or far-field sites. IDZ RB sites had significantly different community structures from reference and far-field sites, including more cyanobacteria taxa and higher abundance. This difference was driven mainly by samples located in the warmer side channel below the CIII outfall. Near-field taxonomic results and productivity metrics from 2021 suggest that the influence of the smelter on periphyton in the AOI is diminishing over time. Differences in periphyton growth appear to be primarily driven by flow-related variables, water temperatures, and channel features. Although different, we can't conclude that the aquatic community in the side channel is lower condition, since benthic invertebrate EPT taxa richness was significantly higher in near-field IDZ sites than reference sites.

6.3.2 Management Question 2

<u>What is the difference in the erosional benthic invertebrate communities in erosional habitat downstream of the smelter compared to the upstream communities in terms of community structure and composition?</u>

In 2021, there was no significant difference in benthic invertebrate total abundance between reference, IDZ RB sites, and far-field sites. Total abundance was highest in ERO-EXP-2, the side channel receiving CIII discharges. Biomass was significantly higher in IDZ RB sites than reference sites, but significantly lower in far-field sites than reference sites. The NMDS analysis and modelling showed a significant difference in benthic invertebrate communities between reference and exposure areas when all years were modelled, but no differences within 2021 alone. This community variation between sites is likely due to a difference in habitat variables and annual variation.

Water velocity and substrate size (D50) were the most important variables influencing communities in erosional habitats. Velocity was an important variable for explaining benthic macroinvertebrate abundance, EPT composition, and taxa richness. Sites with higher water velocity and larger substrate size had higher abundances and higher EPT composition. EPT richness was significantly lower in reference sites than near-field IDZ RB or far-field sites. EPT richness was strongly influenced by water velocity and substrate size, and lower velocity sites had lower EPT richness. Many reference sites had lower velocities than IDZ RB sites, thus the difference in EPT richness between site categories was likely due to differences in habitat attributes, and not an influence from the smelter.

The smelter did not exert an adverse influence on benthic invertebrate community composition in 2021. Although some differences within sites were observed, they were driven by physical variables, including current velocity and associated substrate size.

6.3.3 Management Question 3

On the basis of qualitative review, is there a trend in periphyton and benthic metrics over time?

Periphyton and benthic metric trends over time were driven by factors other than smelter influence. These include flow regime (velocity), substrates size, and natural annual variation (e.g., climate conditions). In other words, there are no apparent trends in periphyton and benthic invertebrate metrics that are driven by smelter influences.

6.4 Small-bodied Fish

6.4.1 Management Question 1

Is there a difference in tissue metals composition and concentration in small-bodied fish between reference sites and exposure sites upstream downstream of the smelter respectively?

Lead, selenium, and mercury concentrations were significantly higher in exposure areas than reference areas, and there were exceedances of applicable guidelines for these metals in 2021, the majority of which occurred within the IDZ along the right bank.

Arsenic, cadmium, and thallium fish tissue concentrations were significantly higher in the IDZ Right Bank exposure areas but did not exceed guidelines. Iron and zinc concentrations did not differ significantly between reference and exposure sites. Copper concentrations were significantly lower in exposure areas than reference areas.

6.4.2 Management Question 2

Do tissue metal concentrations decrease in small-bodied fish as the distance from the smelter effluent discharge increases?

Overall, tissue concentrations of metals decreased with increased distance from the smelter. Lead concentrations decreased with distance downstream, and concentrations are about 30 times lower in the Downstream end of the IDZ than near New Trail Bridge. Mercury concentrations follow a similar pattern. The highest metal exposure from the effluent is in ERO-EXP-2, just downstream of the CIII outfall on the right bank. This area and ERO-EXP-1 show the highest concentrations, and concentrations decrease downstream as the effluent plume mixes and dilutes.

6.4.3 Management Question 3

Is there a difference in the length, weight, liver weight, gonad weight and condition of fish collected upstream of the smelter and downstream of the smelter?

Sculpins in the Downstream IDZ had significantly lower body condition (Fulton's condition k) than sculpins in the reference area. Liver weight (hepatosomatic index) was significantly higher in fish in the IDZ Right Bank exposure area than reference areas. The liver works to store glycogen, decompose red blood cells, produce hormones, and detoxify the blood. An elevated HSI may be a response to elevated metals in the system, or due to hormonal production during gonadal maturation (Hismayasari et al. 2015).

6.4.4 Management Question 4

What is the relationship between the distance from the effluent discharges and tissue metals, condition factor, liver weight (hepatosomatic index) and gonad weight (gonadosomatic index)?

The tissue concentrations of most metals in sculpins decrease with distance from the effluent discharge. Body condition was lower in exposure areas than reference areas, and hepatosomatic index was elevated in exposure areas compared to reference areas. Gonadosomatic index showed no difference between treatment types but varied by sex. Low body condition metrics and elevated HIS may indicate stress in small-bodied fish.

6.5 Large-bodied Fish

6.5.1 Management Question 1

How do the concentrations of metals in the tissues of large-bodied fish species in 2021 compare to concentrations since 2000?

Overall, most tissue metal concentrations have declined since 2000. Arsenic, cadmium, and lead were significantly lower in 2021 than early sample years. Declines in cadmium since

2004 may be because of better detection capabilities and sampling procedures have improved detection accuracy.

Chromium has also declined since 2000 and concentrations have remained below the TRO since 2005. Mercury concentrations have varied but have not changed significantly since 2000 and show no discernible trend.

6.5.2 Management Question 2

<u>Do large-bodied fish tissue concentrations exceed relevant human consumption guidelines?</u>

Mean large-bodied fish tissue concentrations do not exceed human consumption guidelines in either reference or exposure areas. There were no exceedances of the human consumption guideline of arsenic, lead, selenium, or mercury.

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SCHEDULE - A

MAP SHEETS

Lower Columbia River Aquatic Effects Monitoring Program

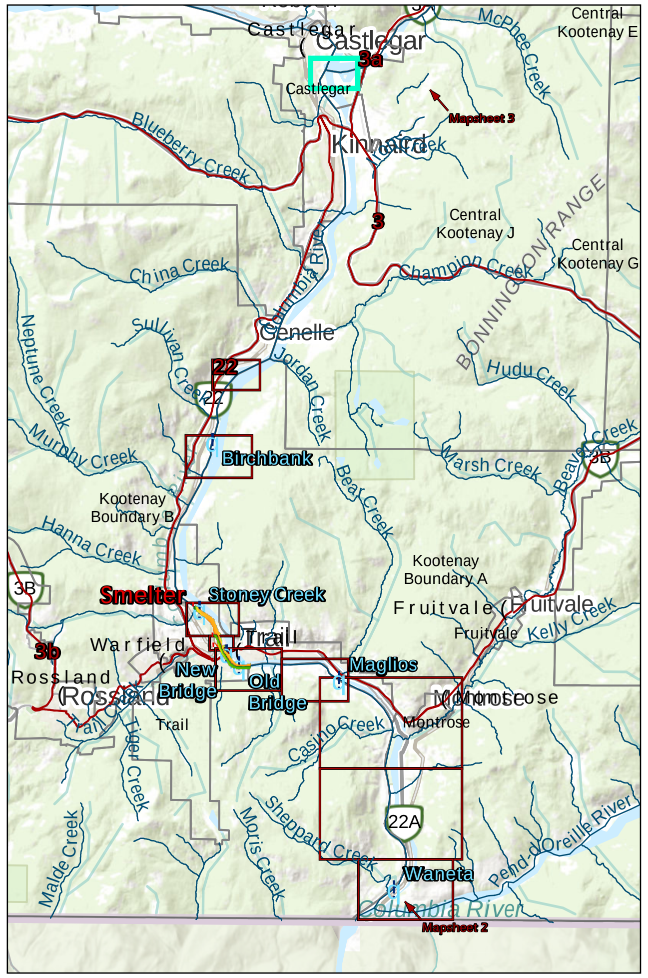
Mapsheet 1

Project:	Aquatic Effects Monitoring Program
Location:	Trail, BC
Project No.:	21-3713
Prepared for:	Teck Metals Ltd. - Trail Operations
Prepared by:	Ecoscape Environmental Consultants Ltd.
Coordinate System:	NAD83-UTM Zone 11
Imagery:	ESRI Base
Map Date:	August 3, 2022

LEGEND

- Periphyton/Benthic Sample Sites
- Water Quality Sites (AREMP Program)
- Sediment Sample Sites
- Outfall
- Streams and Rivers
- Small-bodied Fish Sampling Location (2021)
- Large-bodied Fish Exposure Area Sampling
- Large-bodied Fish Reference Area Sampling
- Initial Dilution Zone

Regional Location of the Sampling Site



Lower Columbia River Aquatic Effects Monitoring Program

Mapsheet 2

Project:	Aquatic Effects Monitoring Program
Location:	Trail, BC
Project No.:	21-3713
Prepared for:	Teck Metals Ltd. - Trail Operations
Prepared by:	Ecoscape Environmental Consultants Ltd.
Coordinate System:	NAD83-UTM Zone 11
Imagery:	ESRI Base
Map Date:	August 4, 2022

LEGEND

- Periphyton/Benthic Sample Sites
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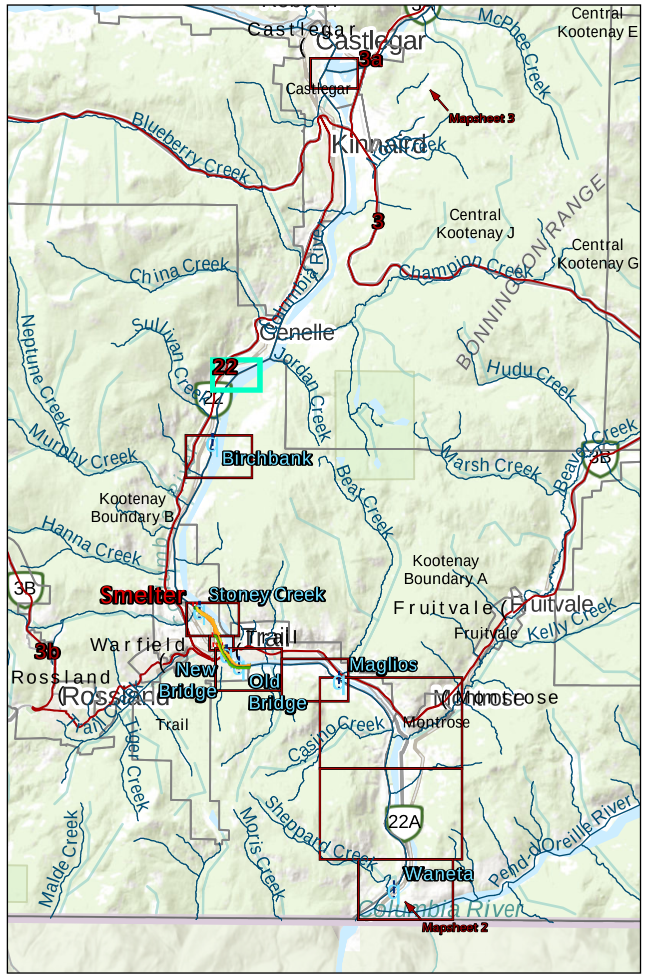
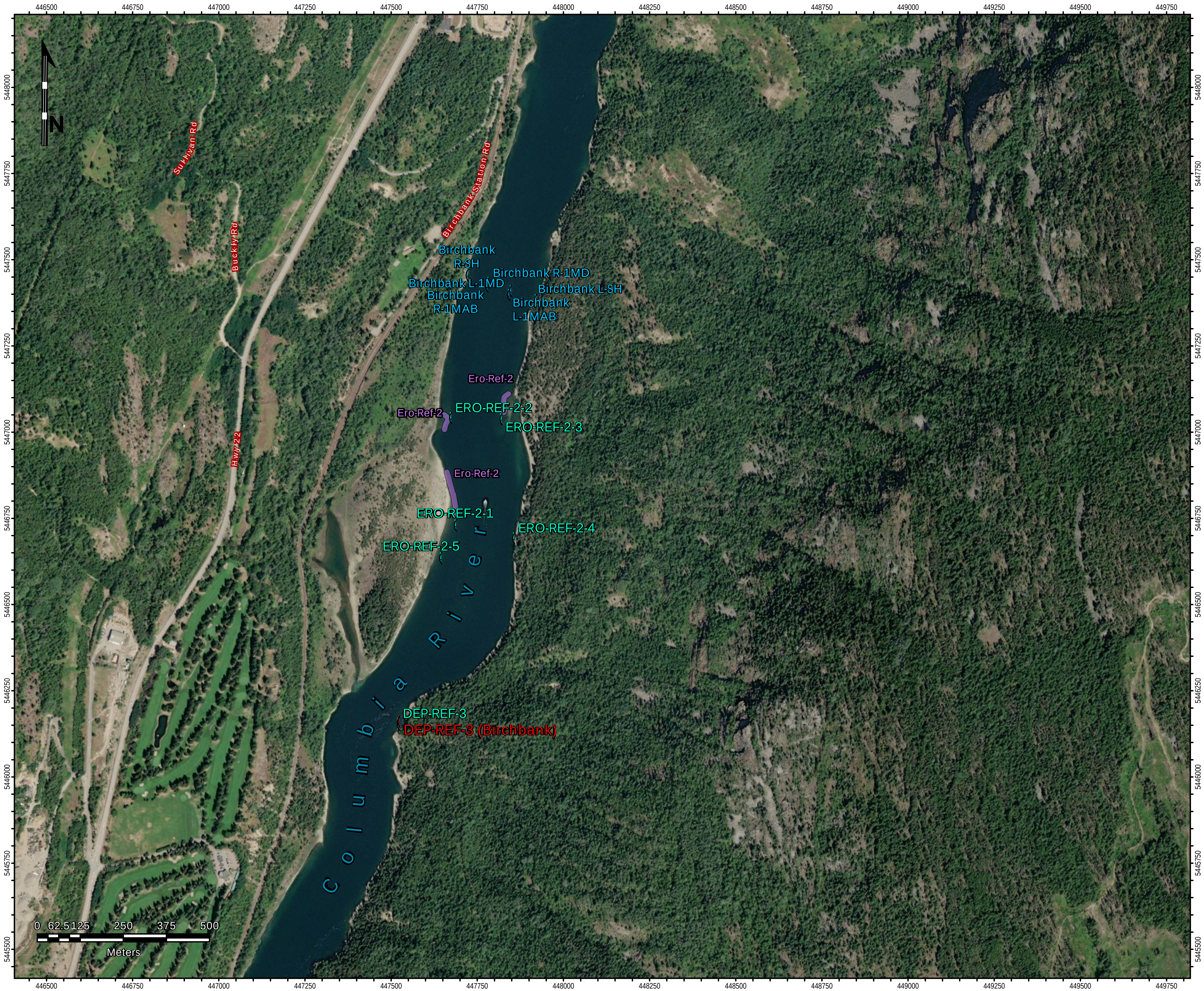
- Initial Dilution Zone

Regional Location of the Sampling Site



DISCLAIMER
The data displayed is for conceptual purposes only and should not be interpreted as a legal survey or for legal purposes. If discrepancies are found between the data portrayed in this report and that of a legal survey, the legal survey will supersede any data presented herein.

ECOSCAPE Environmental Consultants Ltd.



Lower Columbia River Aquatic Effects Monitoring Program

Mapsheet 3

Project:	Aquatic Effects Monitoring Program
Location:	Trail, BC
Project No.:	21-3713
Prepared for:	Teck Metals Ltd. - Trail Operations
Prepared by:	Ecoscape Environmental Consultants Ltd.
Coordinate System:	NAD83-UTM Zone 11
Imagery:	ESRI Base
Map Date:	August 4, 2022

LEGEND

- Periphyton/Benthic Sample Sites
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- Outfall
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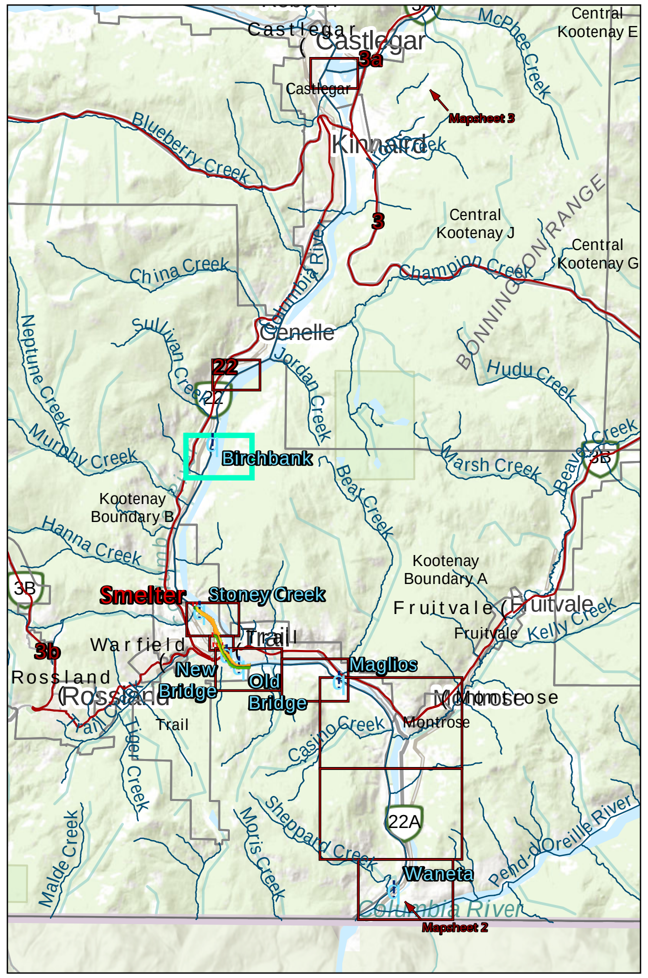
- Small-bodied Fish Sampling Location (2021)
- Large-bodied Fish Exposure Area Sampling
- Large-bodied Fish Reference Area Sampling
- Initial Dilution Zone

Regional Location of the Sampling Site



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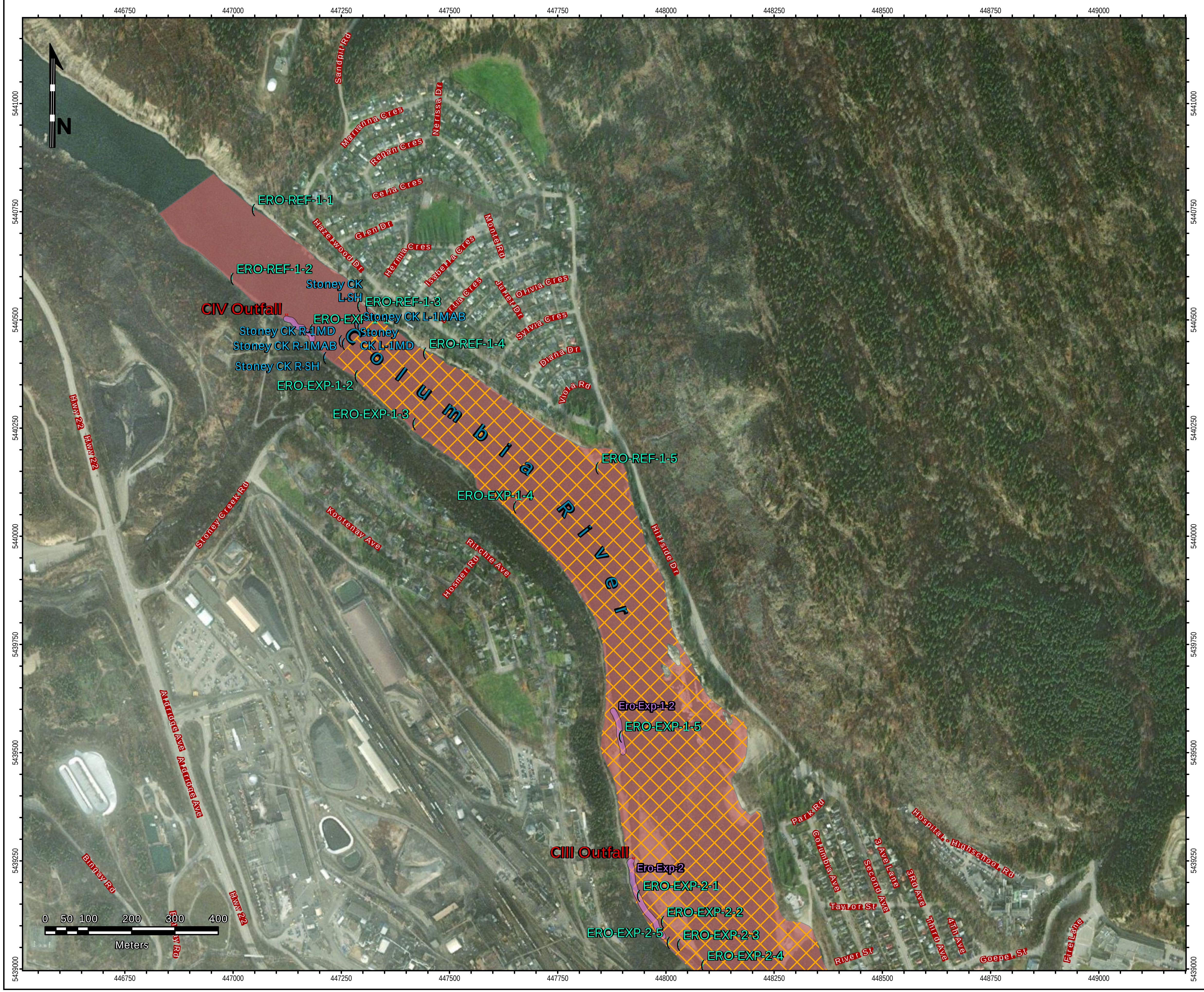


Lower Columbia River Aquatic Effects Monitoring Program

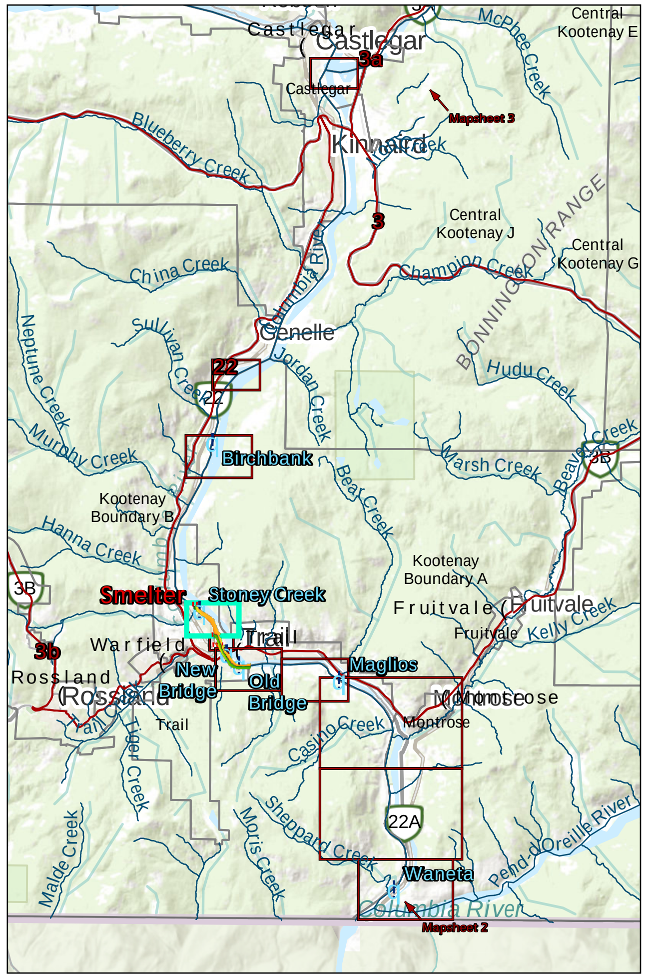
Mapsheet 4

Project:	Aquatic Effects Monitoring Program
Location:	Trail, BC
Project No.:	21-3713
Prepared for:	Teck Metals Ltd. - Trail Operations
Prepared by:	Ecoscape Environmental Consultants Ltd.
Coordinate System:	NAD83-UTM Zone 11
Imagery:	ESRI Base
Map Date:	August 4, 2022

LEGEND

- Periphyton/Benthic Sample Sites
- Water Quality Sites (AREMP Program)
- Sediment Sample Sites
- Outfall
- Streams and Rivers
- Small-bodied Fish Sampling Location (2021)
- Large-bodied Fish Exposure Area Sampling
- Large-bodied Fish Reference Area Sampling
- Initial Dilution Zone

Regional Location of the Sampling Site



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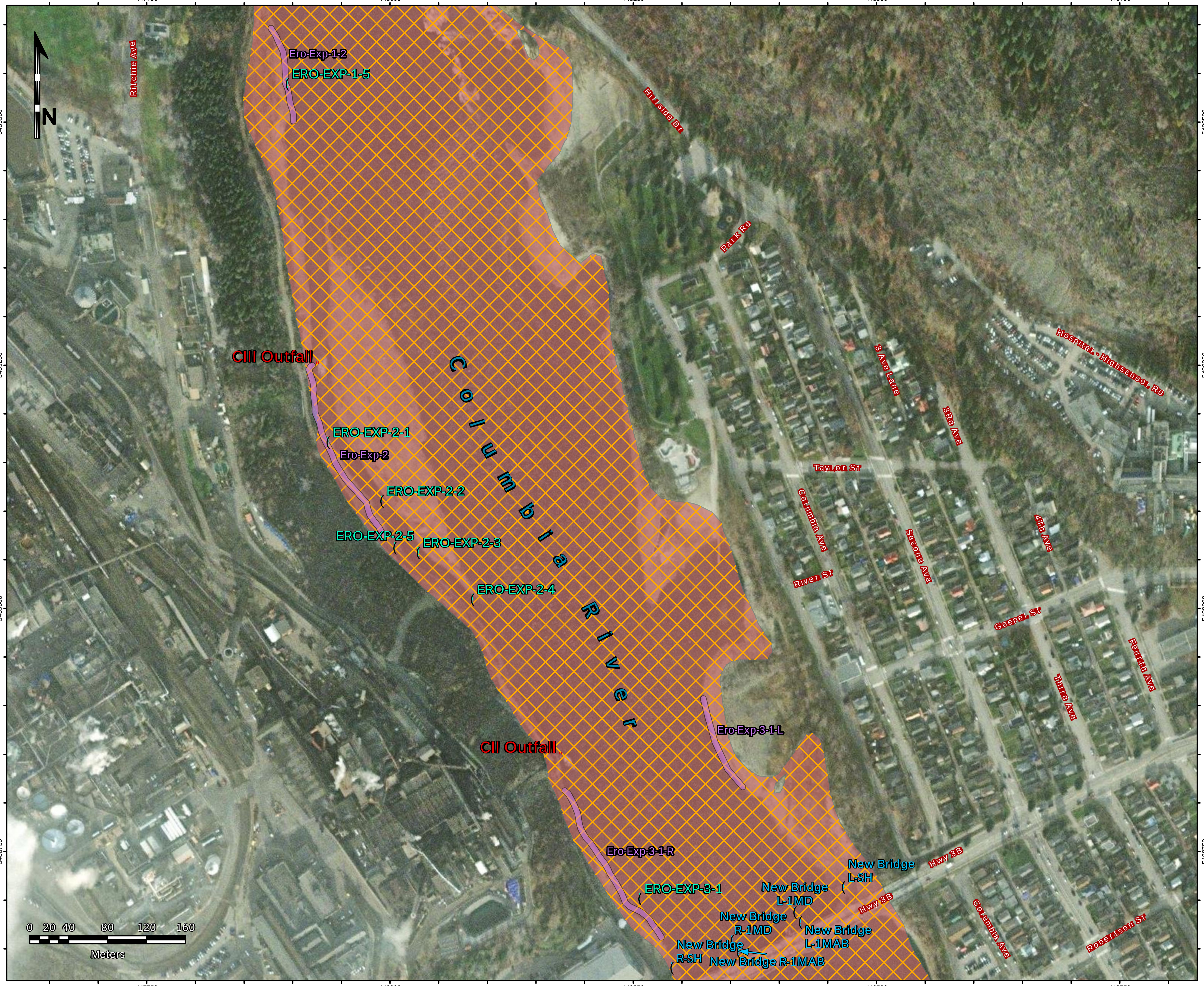
Environmental Consultants Ltd.



Lower Columbia River Aquatic Effects Monitoring Program

Mapsheet 5

Project:	Aquatic Effects Monitoring Program
Location:	Trail, BC
Project No.:	21-3713
Prepared for:	Teck Metals Ltd. - Trail Operations
Prepared by:	Ecoscape Environmental Consultants Ltd.
Coordinate System:	NAD83-UTM Zone 11
Imagery:	ESRI Base
Map Date:	August 4, 2022

LEGEND

- Periphyton/Benthic Sample Sites
- Water Quality Sites (AREMP Program)
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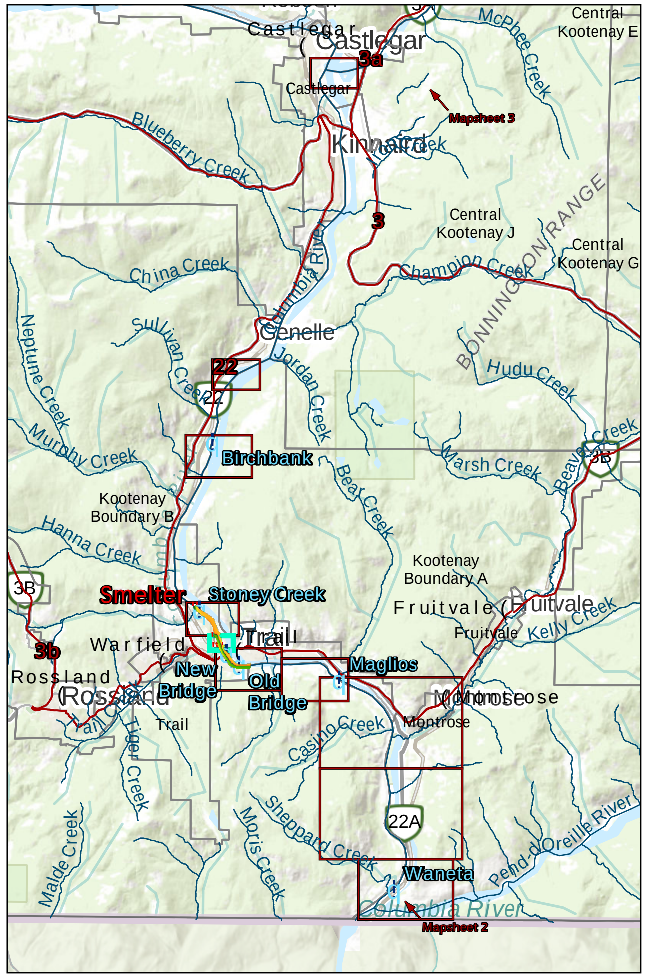
- Streams and Rivers
- Small-bodied Fish Sampling Location (2021)
- Large-bodied Fish Exposure Area Sampling
- Large-bodied Fish Reference Area Sampling
- Initial Dilution Zone

Regional Location of the Sampling Site



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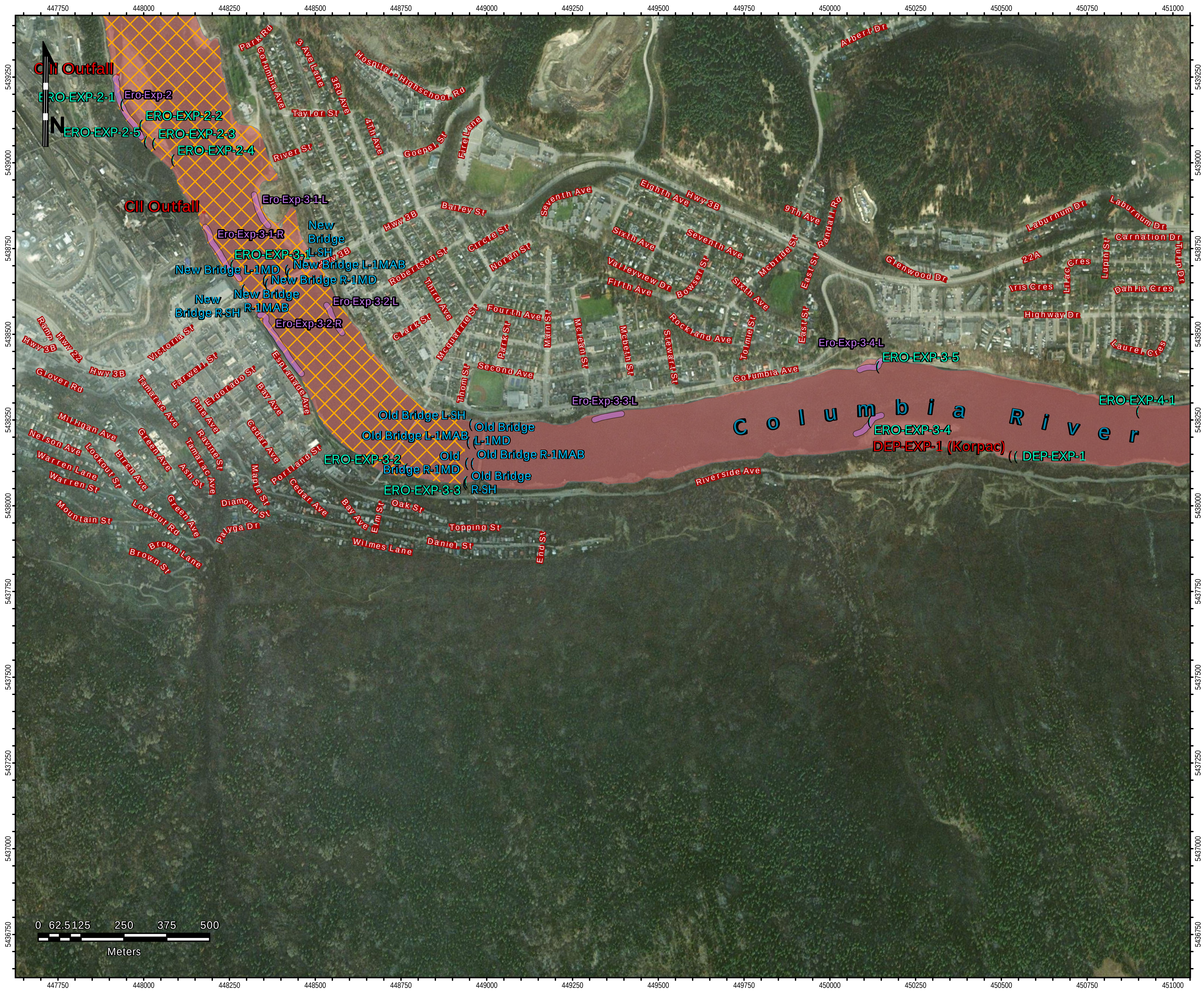
ECOSCAPE Environmental Consultants Ltd.



Lower Columbia River Aquatic Effects Monitoring Program

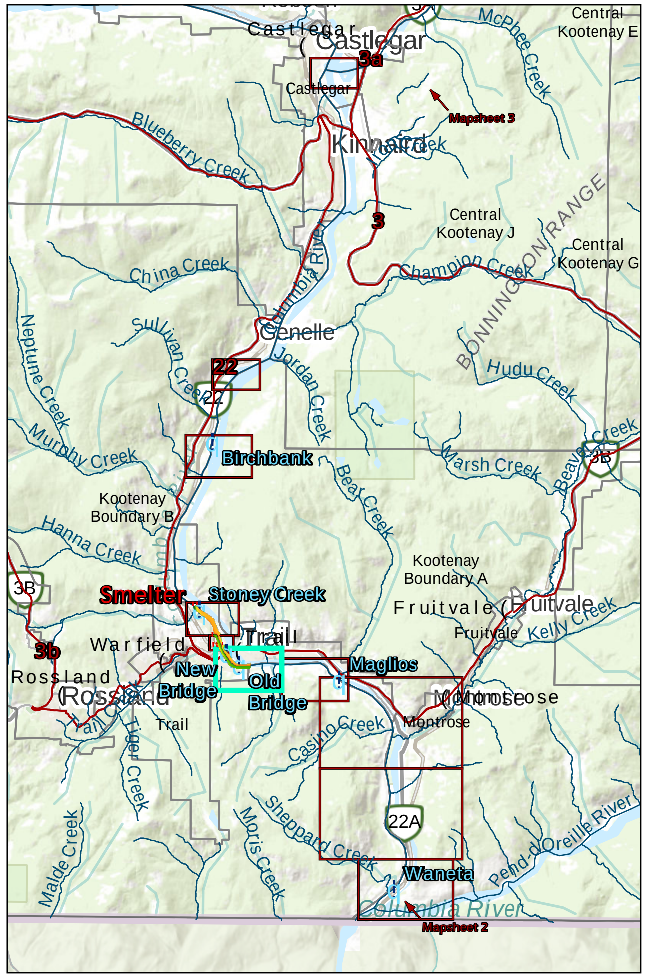
Mapsheet 6

Project:	Aquatic Effects Monitoring Program
Location:	Trail, BC
Project No.:	21-3713
Prepared for:	Teck Metals Ltd. - Trail Operations
Prepared by:	Ecoscape Environmental Consultants Ltd.
Coordinate System:	NAD83-UTM Zone 11
Imagery:	ESRI Base
Map Date:	August 4, 2022

LEGEND

- Periphyton/Benthic Sample Sites
- Water Quality Sites (AREMP Program)
- Sediment Sample Sites
- Outfall
- Streams and Rivers
- Small-bodied Fish Sampling Location (2021)
- Large-bodied Fish Exposure Area Sampling
- Large-bodied Fish Reference Area Sampling
- Initial Dilution Zone

Regional Location of the Sampling Site



DISCLAIMER
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ECOSCAPE Environmental Consultants Ltd.

Lower Columbia River Aquatic Effects Monitoring Program

Mapsheet 7

Project: Aquatic Effects Monitoring Program
Location: Trail, BC
Project No.: 21-3713
Prepared for: Teck Metals Ltd. - Trail Operations
Prepared by: Ecoscape Environmental Consultants Ltd.
Coordinate System: NAD83-UTM Zone 11
Imagery: ESRI Base
Map Date: August 4, 2022

LEGEND

- Periphyton/Benthic Sample Sites
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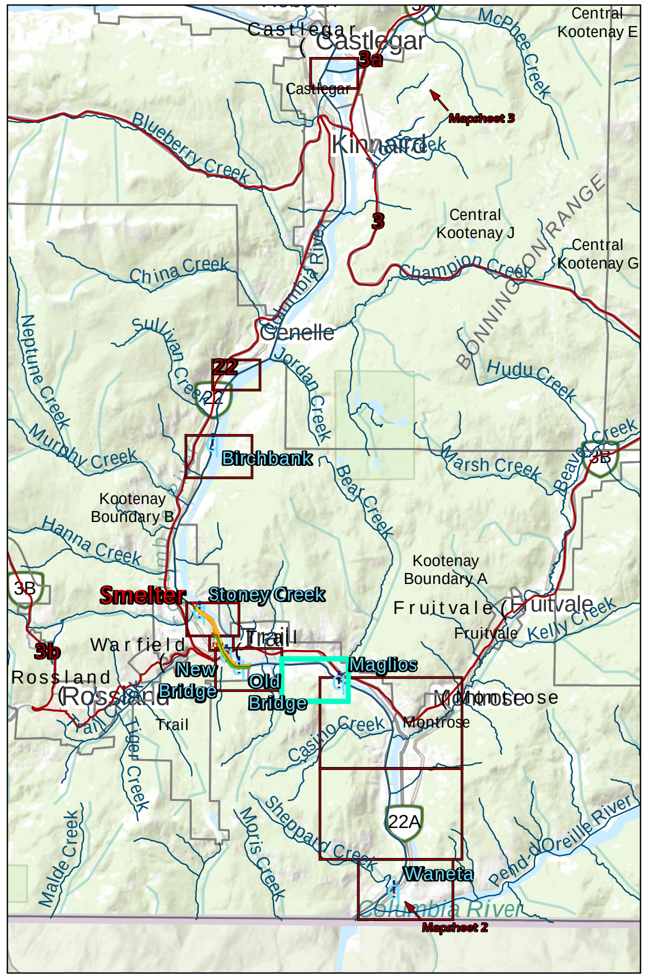
Regional Location of the Sampling Site



DISCLAIMER
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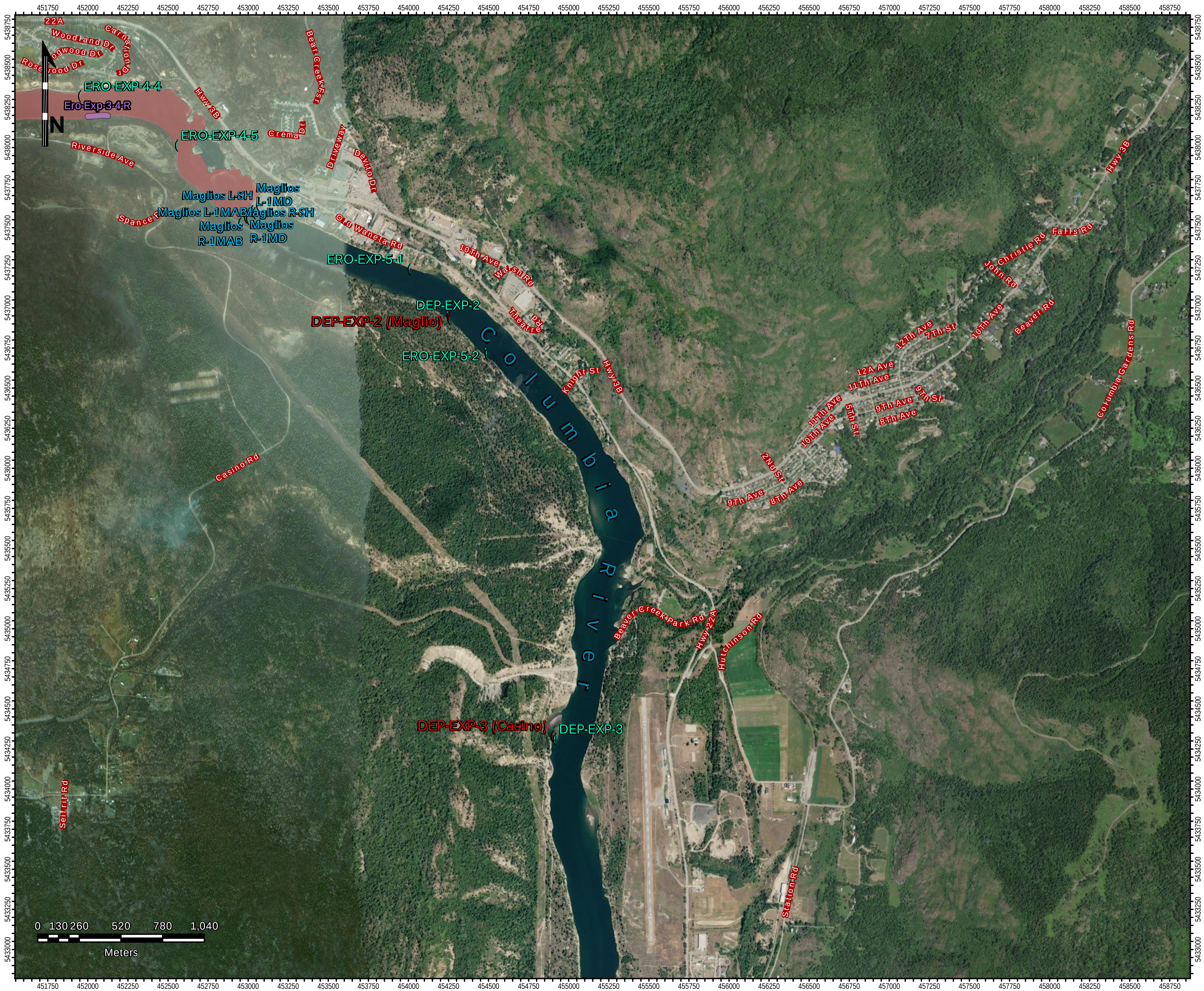
ECOSCAPE Environmental Consultants Ltd.

Lower Columbia River Aquatic Effects Monitoring Program

Mapsheet 8



Project:	Aquatic Effects Monitoring Program
Location:	Trail, BC
Project No.:	21-3713
Prepared for:	Teck Metals Ltd. - Trail Operations
Prepared by:	Ecoscape Environmental Consultants Ltd.
Coordinate System:	NAD83-UTM Zone 11
Imagery:	ESRI Base
Map Date:	August 4, 2022

LEGEND

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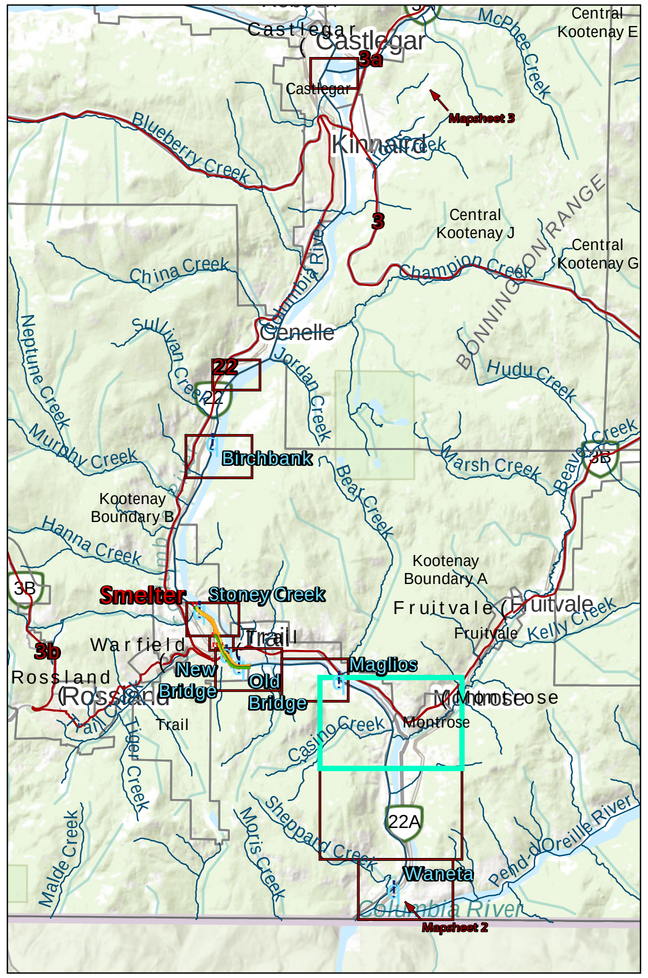
Regional Location of the Sampling Site



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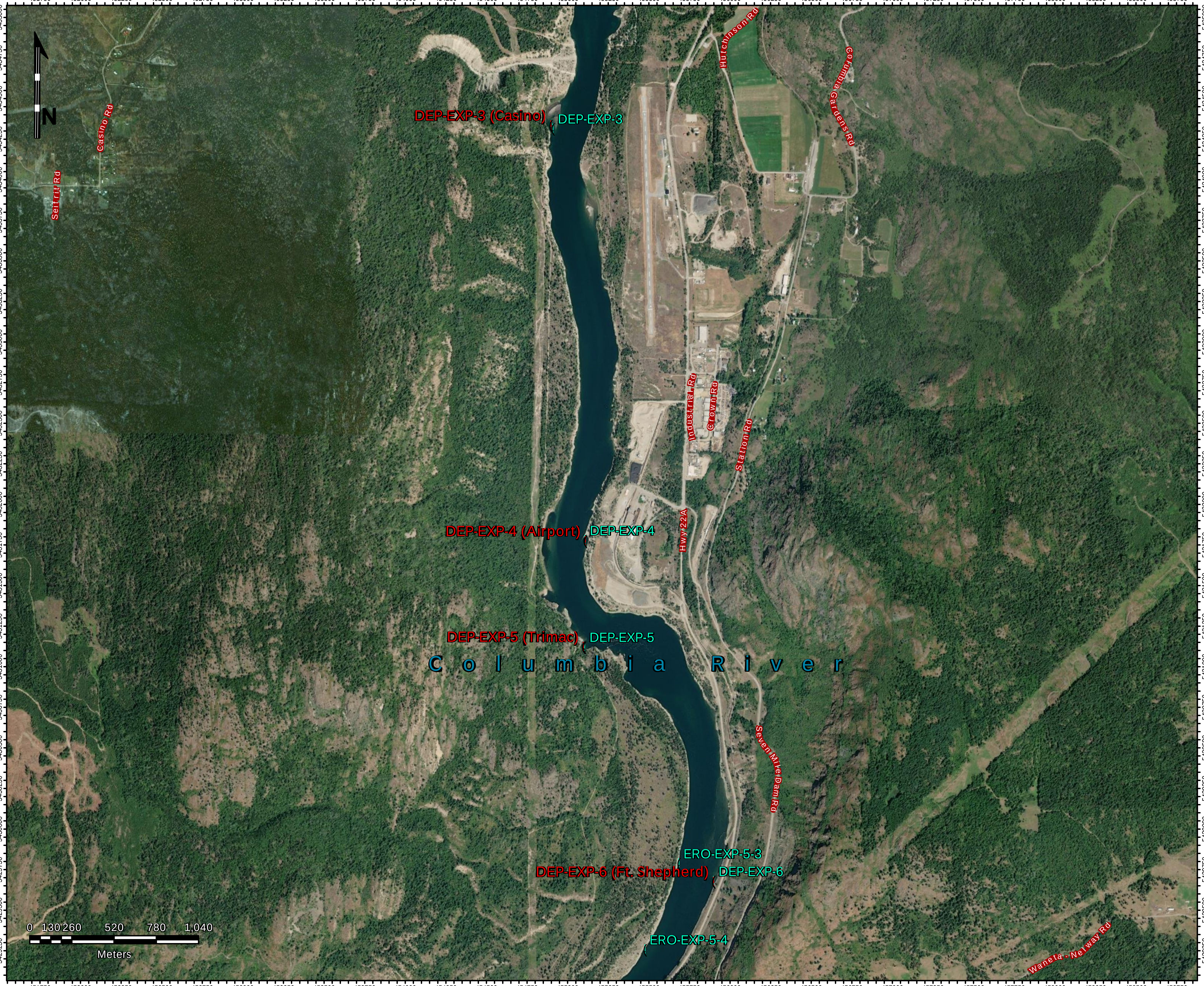
ECOSCAPE Environmental Consultants Ltd.



Lower Columbia River Aquatic Effects Monitoring Program

Mapsheet 9

Project:	Aquatic Effects Monitoring Program
Location:	Trail, BC
Project No.:	21-3713
Prepared for:	Teck Metals Ltd. - Trail Operations
Prepared by:	Ecoscape Environmental Consultants Ltd.
Coordinate System:	NAD83-UTM Zone 11
Imagery:	ESRI Base
Map Date:	August 4, 2022

LEGEND

- Periphyton/Benthic Sample Sites
- Water Quality Sites (AREMP Program)
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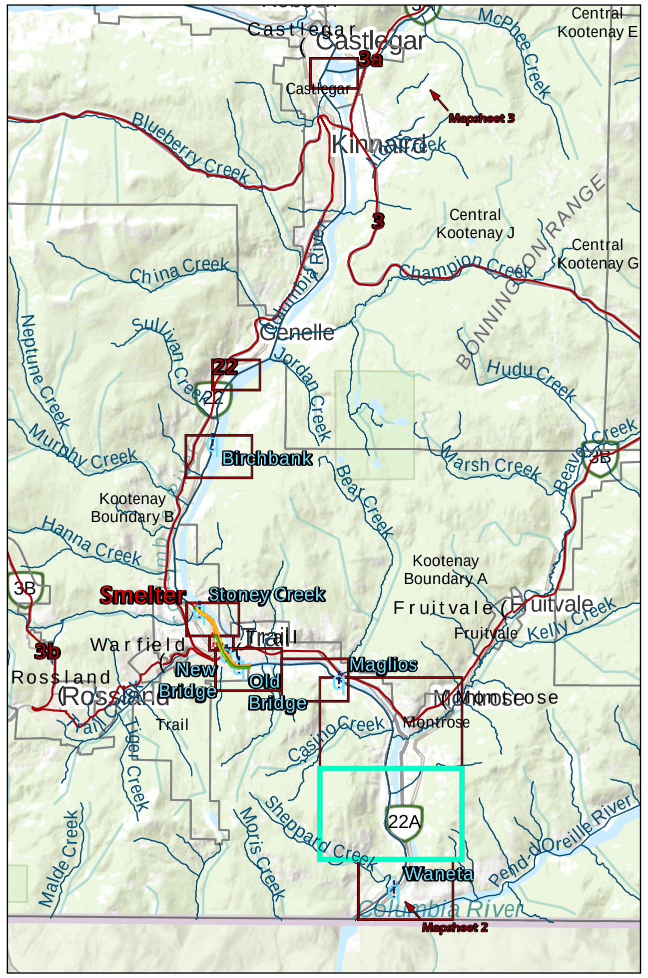
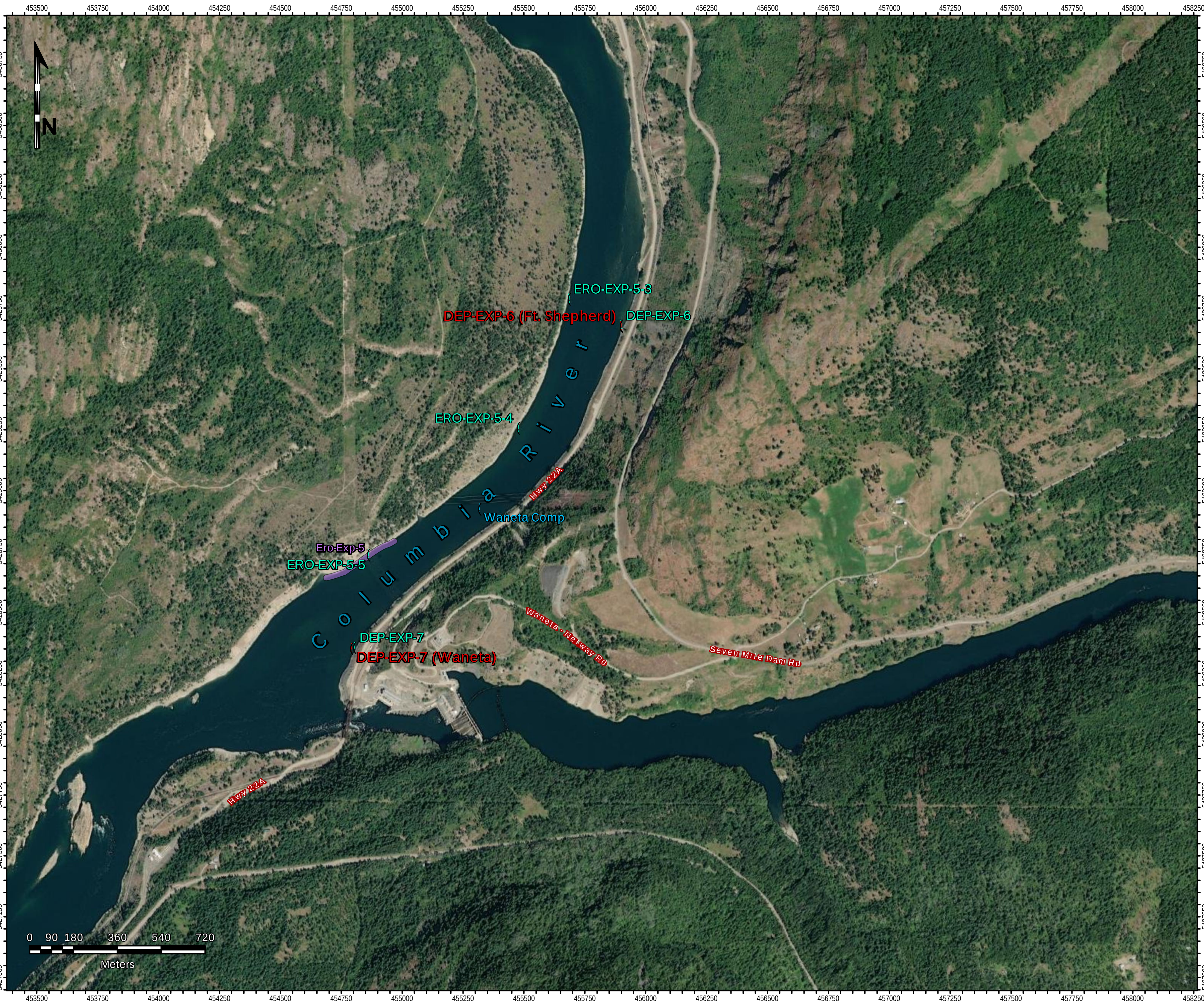
Regional Location of the Sampling Site



ECOSCAPE



Lower Columbia River Aquatic Effects Monitoring Program

Mapsheet 10

Project:	Aquatic Effects Monitoring Program
Location:	Trail, BC
Project No.:	21-3713
Prepared for:	Teck Metals Ltd. - Trail Operations
Prepared by:	Ecoscape Environmental Consultants Ltd.
Coordinate System:	NAD83-UTM Zone 11
Imagery:	ESRI Base
Map Date:	August 4, 2022

LEGEND

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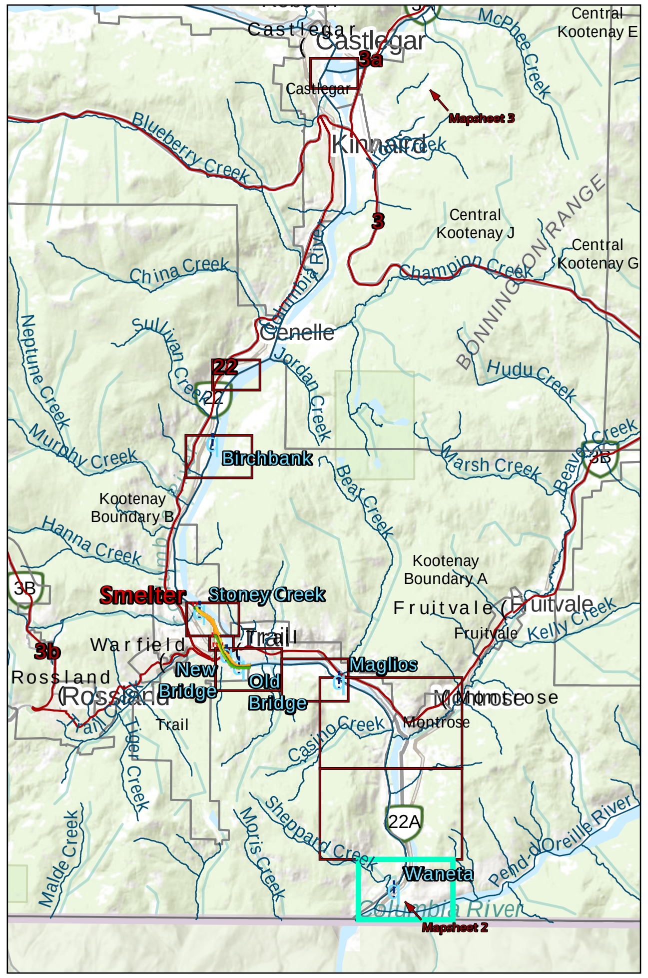
Regional Location of the Sampling Site



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APPENDICES TABLE OF CONTENTS

APPENDIX A TECHNICAL METHODS

Water Quality

The study area for the water quality sampling component of the AEMP includes the mainstem Lower Columbia River from Birchbank to the Waneta monitoring station just upstream of the Pend Oreille River confluence. Monitoring sites are shown in Figure 1 and are consistent with previous monitoring programs (Hawes et al. 2014). The water quality program was developed to evaluate the effects of the permitted effluent discharges by the smelter on the LCR. For this reason, sampling efforts are concentrated in the spring low flow period to gather data when dilution of effluents is minimized, and when measured parameters are at their highest.

Water quality monitoring sites include:

- Birchbank – upstream Reference Site (9.7 km upstream of smelter).
- Stoney Creek – 100 m downstream of Stoney Creek confluence and CIV outfall (within the IDZ near upstream end).
- New Trail Bridge – Beneath or as close to the Bailey Street bridge as safely practicable, within the IDZ (0.25 km downstream of the CII effluent outfall).
- Old Trail Bridge – 1.1 km downstream of CII outfall, marks the end of the IDZ (Noting that the monitoring site was found 20 m upstream of the Old Bridge location and therefore still within the IDZ).
- Maglios – 4.2 km downstream of the IDZ. This site was added in the 2014 sampling program to demonstrate near to full mixing of the effluent plume by this location as opposed to Waneta, which is 10 km further downstream.
- Waneta – 15.8 km downstream of smelter, above Pend Oreille River confluence.

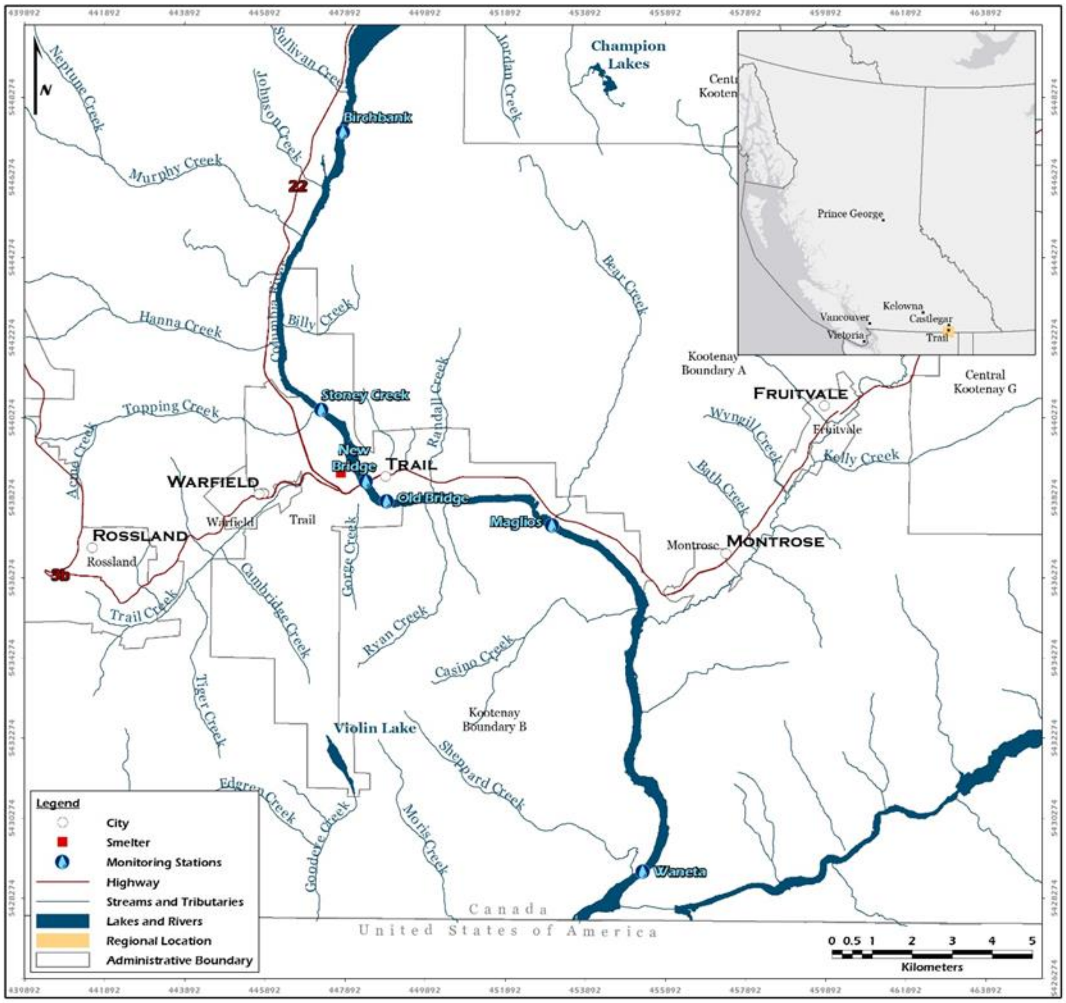


Figure 1: Study Area and Sample Sites - Surface Water Quality.

All water samples were collected using a Van Dorn bottle - Type Beta Plus designed for sampling trace metals and organics. There were two water quality sampling level intensities: transect and right shallow grab. The purpose of the transect sampling was to evaluate spatial heterogeneity across the river channel. For transect sampling, a series of six samples was collected with two near-shore grab samples, and four mid-channel samples (Figure 2). A composite sample at Waneta was collected over the six separate samples since previous analysis indicated concentration homogeneity across the river channel at this location (Hawes et al. 2014). The Waneta composite was obtained by combining 3 samples collected evenly across the channel at ½ the wetted depth. For transect sampling, a total of 30 samples plus 3 samples for quality assurance and quality control (QA/QC) were collected during each sampling event. Grab sample events involved the collection of a single sample from the right bank in a wetted depth of about 1 m. Water quality sampling was conducted from March to October each year.

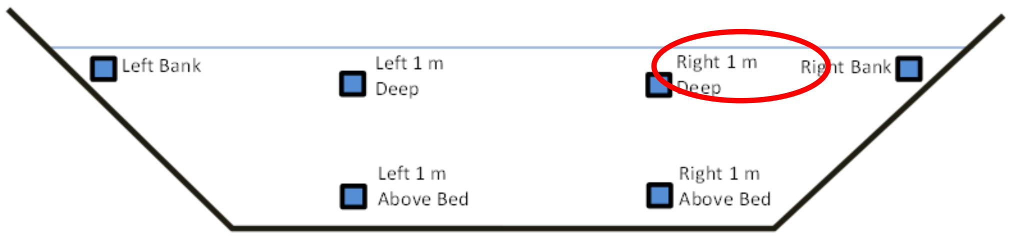


Figure 2: Schematic of transect water sample locations across the Columbia River channel (Perspective: Looking downstream). Transects were completed at Birchbank (reference site), Stony Creek, New Bridge, Old Bridge, Maglios, and Waneta. Grab sample events collected a sample from the right bank position (circled red). The short forms for the channel position designations are L-sh left-shallow, L-1md left 1 m deep, L-1mab left 1 meter above bed, and the same for Right.

Water Quality Field Parameters and Laboratory Analyses

Water quality field parameters were measured with a pre-calibrated Hanna HI 9828 (2015) and a YSI Pro DSS multimeter (2016 -2021) by lowering the sonde to the prescribed depth upstream of the sample site, then allowing the boat to drift until the sonde cable was vertical and on-site before the reading was recorded. Parameters included: GPS location, temperature, dissolved oxygen, percent dissolved oxygen saturation, pH, conductivity, total dissolved solids, and salinity. Data were downloaded from the meter computer to a stand-alone computer at the end of every sample collection session. Water depths were measured with a boat-mounted Lowrance HDS 7 chartplotter. Back-up field meters included a Hanna HI 9025C multi-meter, a Eutech Instruments pHTestr-20 for pH verification, and a Hanna conductivity meter.

Water quality samples were collected and submitted to a certified analytical lab and are a critical component of this monitoring program.

Lab parameters included:

- Specific conductivity, total alkalinity, hardness, pH, TSS, TDS, BOD5, TOC, turbidity;
- Major ions Ca, Mg, K, Na, Br, Cl, F, SO4;
- Nutrients including ammonia, nitrate, nitrite, TKN, total phosphorus, dissolved phosphorus;
- Total (not filtered) and dissolved (field-filtered) ultra-low metals scans with method detection limits 5 times lower than the BC ENV water quality guideline for the protection of aquatic life - using Inductively-Coupled Mass Spectrometry (ICP-MS).

Water Quality Data Analysis

Water quality data were evaluated using a variety of techniques that aligned with methods used in earlier reports (Hawes et al. 2014; Hawes et al. 2019). Data exploration with descriptive statistics (mean, minimum, maximum, standard deviation, etc.) were used to compare reference sites to exposure sites. Data from 2021 were plotted to illustrate the range of measured parameter concentrations at each site relative to established Water Quality Objectives and Guidelines. Box plots were then prepared from the data sampled during low flow periods (March, April, and October) and data sampled during the July high flow period and each was displayed as points.

Water quality data were compared to applicable guidelines and LCR Water Quality Objectives in the Reference areas (Birchbank), the IDZ (Stoney Creek, New Bridge, and Old Bridge), and the downstream areas (Maglios and Waneta). The number of exceedances of the applicable guidelines was calculated for BC long-term and short-term averages. Exceedances of the BC long-term averages were determined by calculating the mean from 5 samples collected from right shallow (R-sh) and comparing the mean to the BC long-term average. Spatial and temporal variations were subsequently described. Non-detectable results are common in metal detection samples. These were treated as half of the detection limit as per Huston and Juarez-Colunga (2009) and Technical Guidance 4; Environmental Management Act Authorizations (January 2016).

River flows during each of the water quality sample events were highly variable. This variability can affect the concentration of metals and nutrients. Therefore, the effect of river flow on metal concentrations associated with smelter effluent was tested by multiple linear regression with analyte concentrations (mg/L) at New Bridge R-sh as the response variable, as predicted by the product discharge at Birchbank and the sum of loadings from all for effluent outflows. The sum of daily loadings from CIV, Stoney Creek, CIII, and CII was calculated for each analyte of interest (Ag, Al, As, Cd, Cu, Fe, Hg, K, NH3, Ni, NO2, NO3, P, Pb, Se, SO4, TKN, Tl, TOC, Zn).

Trend Analysis was conducted on the flow-weighted mean concentrations (FWMC) of the five spring R-sh samples from 2012-2021; 2011 data were not included in the analysis because detection limits were higher.

The FWMC was calculated as:

$$FWMC = \frac{\sum_{1}^{n}(c_i * t_i * q_i)}{\sum_{1}^{n}(t_i * q_i)}$$

With this equation, the concentration in each sample (ci = collected from the right shallow location) was weighted by both the time (ti = 24h) and the flow (qi = average daily LCR flow measured at Birchbank) that accompanied it. The FWMC represents the total load for the time period divided by the total discharge for the time period.

Mann-Kendall tests were used to determine if water quality parameters showed trends from 2012-2021. Tests were performed using the “Kendall” package version 2.2 in R (McLeod, 2011).

Quality Assurance / Quality Control for Water Samples

Quality assurance is a critical aspect of any monitoring program on trace metals because the ultra-low analyte concentrations make them susceptible to contamination. QA/QC reports from the labs can be found in Appendix C with the water quality data.

Field Quality Assurance

Prior to transect sampling, sample bottles were pre-labeled and stored in large resealable plastic bags, organized by site. The sampling boat and associated gear were pressure-washed prior to launching at Trail to remove road grime that could affect sampling, and to limit the potential for accidental transport of invasive species. Sampling began at reference sites and progressed downstream. Samples were collected from prescribed depths and sites in a cleaned, low metals Van Dorn bottle sampler. Sample bottles were provided by ALS Environmental Laboratories (ALS) and with the appropriate preservatives pre-measured in vials. Sample bottle caps, syringes and filters were triple-rinsed as needed with sample water to minimize contamination from atmospheric deposition. Metals sample bottles were triple-rinsed and immediately field-filtered using rinsed, prescribed syringe filters. All field sample preservation methods prescribed by ALS were observed. Clear un-powdered vinyl gloves were worn for all sample handling except Hg samples, when nitrile gloves were worn. Filled sample bottles were immediately placed on chipped ice and couriered to ALS Labs in Burnaby, B.C. within 48 hours of collection.

Duplicate instruments were used for field parameters where calibration is prone to drift, such as pH. Where agreement was within instrument tolerances, the Hanna multi-meter data were taken as correct. When agreement was not within tolerances, the multi-meter was re-calibrated. Data were downloaded from the multi-meter computer to a stand-alone computer at the end of every sample collection session.

Lab Quality Assurance

Standard water quality sampling methods were employed (BC ENV 2013), as well as all instructions from ALS, Vancouver.

Every sampling event QA/QC involved 1 travel blank (lab double de-ionized water (DDI) travels unopened), 1 field blank (Lab DDI water handled as sample water) and up to 3 duplicate samples (labels did not tell the lab which samples they duplicate). The minimum number of QA/QC samples was 3 per transect sampling event (10% of samples). Lab reports were checked on receipt of data and queries or requests for sample re-analysis were sent as soon as possible and within sample hold times. Requests for re-analysis were based on differences between sample duplicates that exceeded accepted tolerances, generally 20 - 50% difference due to the ultra-low concentrations, or an outlier result that exceeded the range of standard deviation for the applicable results to date. The lab was also directed to retain samples until they were notified that they could dispose of them or until the hold times specified in Standard Methods had expired.

The lab was asked to report the data electronically in Microsoft Excel and portable document format.

Sediment Quality Monitoring

Sediment samples and supporting parameters were collected at 10 depositional sites (Schedule A: Maps 1-10). Each of the sites were identified in the sediment quality triad (Golder 2007). All samples were collected following sampling procedures outlined in Clarke (2003) and other standardized, acceptable scientific techniques (Cavanagh et al. N.D.). Sample sites included:

- Three reference areas at Kootenay Eddy (DEP-REF- 1), Genelle Eddy (DEP-REF-2), and Birchbank Eddy (DEP-REF-3).

- Seven exposure sample sites were established at Korpac (DEP-EXP-1), Maglios (DEP-EXP-2), Casino (DEP-EXP-3), Airport Bar (DEP-EXP-4), Trimac (DEP-EXP-5), Fort Shephard Eddy (DEP-EXP-6), and Waneta (DEP-EXP-7).

Sediment samples were collected by pushing 4.35 cm diameter clear acrylic corers into the substrate to a depth of 15 cm and the 200 cm3 core was transferred to a large resealable plastic bag. Five cores were added to each bag to create a composite sample from a variety of sub-sample locations within the designated sample site. The sediment sample was mixed thoroughly and a 500 cm3 sediment subsample was retained and stored in a cooler on ice and delivered to Caro Analytical Labs, Kelowna for processing.

Supporting data collected at each sediment sample site included:

- Substrates were assessed using a GIS approach at all 10 sediment sites. Each habitat unit sampled was mapped in GIS. The percentage cover of each type of substrate was developed. This GIS approach allows long-term tracking of sediment erosion and deposition in the river and facilitates documentation of habitat change over time.
- Water velocity, channel morphology (run, riffle pool, etc.), bankfull width, and sample depth was collected at each site. Velocity at each sample site was collected using a Marsh McBirny or a Swoffer flow meter depending upon water depth. Velocity was collected at the 40% column depth.
- The percentage of cover of aquatic macrophyte was estimated visually at each sample site.
- The distance from the point of discharge was determined using GIS as measured from the centerline of the channel to the sample site. This data was useful in assessing potential gradients that may exist from the point of smelter discharge.
- Data were collected in a spatial framework using GIS and stored in standard data formats (e.g., Microsoft Excel).

In the Larratt Aquatic lab, both wet and dry sediment samples were examined for presence of slag in white sorting trays and photographed with a macro lens. Sediment samples were compared to slag samples obtained from the smelter. The samples were mixed with distilled water and reviewed under 400 power on an inverted microscope fitted with a second high-intensity lamp as a side light. Several microscope photographs were taken from each sample as an archived record to corroborate observations. Records were kept of dark silt, possible slag, organic debris, protozoa, small invertebrates, bacteria, fungi, Didymo tubes, algae, vascular debris, pollen, etc.

In the Caro Analytical lab, the strong acid leachable metals (SALM) soil procedure was followed, according to the British Columbia Environmental Laboratory Manual 2015 procedure for total sediment metals. Sub-sampling was done using approximately 50 g of sample for drying. In accordance with the 2015 BC Lab Manual method, the sample was dried, then disaggregated and split into two subsamples. One sample was sieved to <2 mm (BC ENV, 2015) and the second was sieved to <63 µm. Slag was identified as an interest in the Aquatic ERA (Golder 2007). Stones, rocks, debris, and possibly large slag particles exceeding the 2 mm sieve size were excluded from the analyzed samples, per the sample preparation procedure for the analysis of total metals, as referenced within the BC Contaminated Sites Regulations and BC Environmental Lab Manual. The SALM method achieves near-complete recoveries of some important metals, but many others are only partially recovered, such as aluminum, barium, beryllium, chromium, strontium, titanium, thallium, and vanadium. Metals not dissolved with this method are unlikely to be of environmental consequence (British Columbia Environmental Laboratory Manual: 2015). The SALM method is applicable to the following total metals and parameters:

Aluminum Al, Iron Fe, Silver Ag, Antimony Sb, Lead Pb, Sodium Na, Arsenic As, Lithium Li, Strontium Sr, Barium Ba, Magnesium Mg, Sulfur S, Beryllium Be, Manganese Mn, Thallium Tl, Boron B, Mercury Hg, Thorium Th, Cadmium Cd, Molybdenum Mo, Tin Sn, Calcium Ca, Nickel Ni, Titanium Ti, Chromium Cr, Phosphorus T, Uranium U, Cobalt Co, Potassium K, Vanadium V, Copper Cu, Selenium Se, and Zinc Zn.

Duplicate samples of the entire 2021 sediment sample set were analysed from the <63 µm fraction and evaluated as above. Differences in sediment metal concentrations between the <63 µm fraction and the <2 mm fraction were determined using a paired Wilcoxon signed-rank test.

Correlations between sediment metals were determined using Pearson's correlation coefficient and Principal Component Analysis. Pearson's correlation coefficient were calculated for pairs of sediment metal concentrations at exposure sites for 2012, 2015, 2018, and 2021 data. In addition, Pearson's correlation coefficient were also calculated separately for the 2018 sediment metal concentration in the <63 µm fraction and <2 mm fraction. Principal Component Analysis (PCA) was used to help understand potential variation in sediment concentrations between sites and years. Sediment metal concentrations of As, Cd, Cr, Cu, Pb, Hg, Se, Tl and Zn from the <2 mm fraction 2012, 2015, 2018, and 2021 samples were included in the PCA. Cd was log10-transformed, and Cr was square root transformed to satisfy model assumptions. All sediment metal concentrations were standardized by converting concentrations to z-scores. The first two components explained 88% of the variation of sediment metals.

Statistical analysis of variable sediment data was restricted because there was only one composite sample from each depositional area collected and three years of sampling. Data analysis relied on comparison to guidelines and to historical values using percent difference. Where statistics were used (for example Pearson's correlation coefficient), ½ of the detection limit was used where concentrations were below the method detection limit.

Periphyton Monitoring

Depositional Habitats

Objectives of this assessment were to determine effects of effluent discharges on depositional habitat, and periphyton community structure and diversity. Periphyton samples were collected from the same ten depositional sites that were used in the depositional sediment sampling component.

Depositional areas with approximately 20-40 cm of water were sampled for periphyton using the petri dish sampling method outlined in Barbour et al. (1999). Briefly, sand or silt substrate samples are collected by inverting a large 8.85 cm diameter petri dish, sliding a flat spatula under the dish, and lifting the surface sediment sample. The 55.4 cm^3 sample was agitated in a plastic sample bottle with 500 mL of 0.45 micron filtered river water, and a 250 mL sample promptly decanted into a pre-labeled sample jar. This was repeated three times to get three replicate samples from each depositional area.

For periphyton taxonomy, each 250 mL sample was transferred to a triple-rinsed 600 mL beaker and agitated with a stick blender for 30 seconds before a 10 mL subsample was extracted and allowed to settle in a 22 cm^2 settling chamber for 24 hours (periphyton identification description, section 3.3.5) at the LAC lab.

Erosional Habitats

Cobble-size substrates were selected using stratified random techniques (Schachter, N.D.; CCME 2011) from undisturbed sample areas that had been continuously submerged for at least 10 weeks so that they had well developed periphyton communities. The 10-week minimum period of inundation prior to sampling has been based on our understanding of the time required for periphyton to attain peak biomass in the LCR (Larratt et al. 2013). The LCR hydrograph was closely monitored prior to the initiation of fall data collection to ensure that sampling occurred only after the prominent decline in discharge such that LCR flows had not been lower since May or earlier. This would mean the substrates being sampled had been inundated for at least 20 weeks. Although sampling in the spring prior to the increasing freshet hydrograph was historically sampled (Golder 2012a), fall sampling was selected. This period is the optimal time for sampling benthic macroinvertebrates since most taxa are in an aquatic life stage at that time of year and are in a later stage of development to permit taxonomic resolution required. In addition, fall sampling is synchronized to occur when LCR flows drop to a level that permits sampling of stable substrates and benthic communities that are permanently wetted. Thus, the periphyton program was aligned with the benthic monitoring program.

Sample areas were selected that had similar water depth, flow, velocity, substrate size, macrophyte cover and shading. Adapting the Generalized Random Tessellation Stratified Spatially-Balanced Survey Design (Stevens and Olsen 2004), five randomly chosen near-shore cobbles were obtained from wadeable areas within each of the five exposed sample sites and two upstream reference sites for a total of 35 samples. Additional 'oversamples' were also collected if required.

Each sample was composed of five subsamples collected from the top of each cobble surface. To minimize natural variation, samples were collected from the apex surface (parallel to the water surface) of smooth cobbles 20-50 cm in diameter. This process was repeated to collect three individual replicate samples, using methods found in the USEPA Rapid Bioassessment Protocol for Periphyton (Barbour et al. 1999).

Fifteen smooth cobbles (100-200 mm in diameter) were selected and placed on 3 plastic trays (5 rocks /tray) at the river's edge to minimize drying. Each tray was sampled separately for replicate samples from each site. A standard 2" ABS cylinder (inside diameter 50.8 mm) was fitted with a flexible rubber gasket and held firmly on the top of the cobble (Figure 3 4). A scalpel, modified toothbrush, and a squirt bottle filled with filtered river water were used to remove all the periphyton within the sampler diameter (20.26 cm^2). The rock and funnel were rinsed into a beaker to a total volume of 100 mL. Coarser sand and predators were noted but not added to the sample. This was repeated for all 5 rocks of a given sample to give a final volume of 500 mL per replicate. Samples were chilled with ice to 2°C prior to shipping.

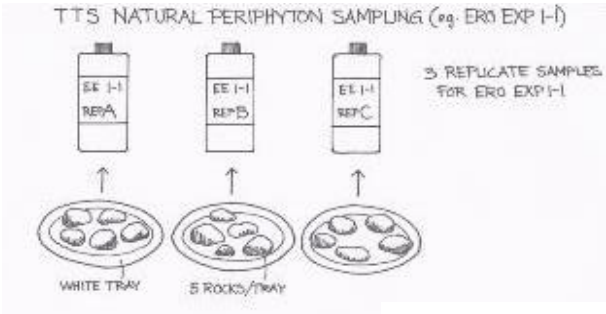


Figure 3-4a

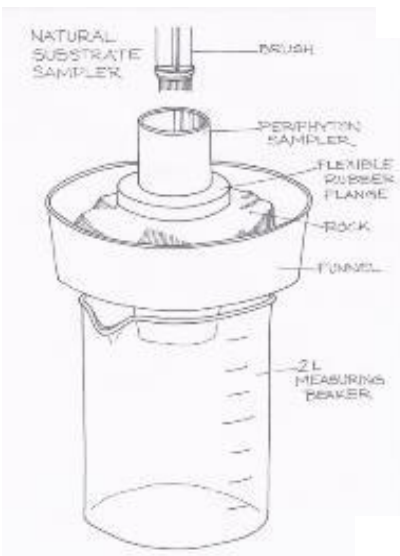


Figure 3-4b

Figure 3-4a. Natural periphyton sampling from cobble substrate and 3-4b periphyton sample processing.

Periphyton Identification, Enumeration and Measurements

Periphyton sorting and identification methods are consistent with those currently used in similar studies of the Mid and Lower Columbia River for BC Hydro, to allow comparison of Columbia River periphyton studies (e.g., Olsen-Russello et al. 2014).

1. Samples were settled in counting chambers for 24 hours. Cells were counted along mid-section transects examined at 400× - 800× magnification under a phase contrast inverted microscope.
2. Intact cells containing cytoplasm were counted as live, and cells without cytoplasm were counted as dead.
3. Counts continued until 300-500 cells were counted and taxa relative abundance stabilized (no new taxa encountered, dominant taxa stable at +-20% of count, (Barbour et al. 1999, Chpt 6). Counting continued if taxa relative abundance had not stabilized. Vigorous shaking

of the sample did not always break up algae clumps before the subsample was withdrawn, allowing a clumped distribution of large taxa to persist. Cells of filamentous and colonial taxa were separated from counts of unicellular taxa because of their clumped distribution.

4. Microscope photographs of typical assemblages were taken from each sample and archived.
5. Algae cell dimensions were measured to allow for the calculation of biovolumes. Algal cell biovolumes were calculated using published geometric formulae (Hildebrandt et al., 1999; Diaina, et al., 2006). Twenty specimens from each taxa were measured to the nearest 0.1-micron using ScopePhoto 3.0 image processing software. Median measurements were used to calculate cell biovolumes. Calculated biovolumes were compared to the range of sizes reported in published literature as a QA/QC step.
6. All parts of microflora were evaluated from the settled samples, noting prevalence of detritus, vascular debris, bacteria, fungi, yeasts, and micro-grazers (protozoa) to estimate productivity.
7. While diatoms usually dominate LCR periphyton, the inclusion of very small members of the periphyton biofilm in the taxa counts, including nano-periphyton (<2 – 20 microns), and pico-periphyton (>0.2 – 2 microns) bacteria and fungi facilitates estimates of productivity as they usually form a significant component of the overall periphyton community (Stockner 1991; Wetzel, 2001). High power (600 – 900×) magnification was used for visual identification of species. Dr. J. Stockner's (formerly of UBC) verified the taxonomy of these small, difficult to identify species.
8. All data were recorded in Microsoft Excel spreadsheets.
9. In lieu of preserved diatom reference samples that have short shelf life, microscope photographs of typical LCR periphyton assemblages were archived from each taxonomic sample. These photos provide a record that is usable at least to the genus level and includes non-diatom components of the periphyton.
10. About 20% of these samples were selected for taxonomic verification by Dr. J. Stockner. Dr. Stockner used a variety of microscopes to verify identifications, particularly for the nano- and pico-periphyton. Any taxonomic corrections/ nomenclature variations from existing data were clearly identified. All other taxonomic evaluations were performed by H. Larratt, Larratt Aquatic Consulting Ltd.

Phycologist Dr. J. Stockner also compiled a master species list for the Columbia System using current taxonomic nomenclature. In addition to his master-list, keys used during this work include:

References:

Patrick and Reimer; The Diatoms of the United States
Wehr and Sheath Freshwater Algae of North America
Canter-Lund and Lund Freshwater Algae; Their Microscopic World Explored
Prescott; Algae of the Western Great Lakes
Cyanobacteria Image Gallery; http://www-cyanosite.bio.purdue.edu/images/images.html
River Diatoms: a multi-access key; http://craticula.ncl.ac.uk/EADiatomKey/html/taxa.html

Academy of Natural Sciences ANSP Algae Image Database;
http://diatom.ansp.org/AlgaeImage/SearchCriteria.asp

Periphyton data were entered in Microsoft Excel spreadsheets and continuously backed up to an off-site server. Replicate preserved samples were refrigerated at Larratt Aquatic's office as back-up samples and discarded after six months.

Environmental Impact Prevention

Didymo (Didymosphenia geminata) is present in the LCR and can spread readily through transport of sampling gear. Nuisance blooms have been reported in rivers worldwide (BBC 2014). However, evidence indicates that blooms are probably not caused by introductions but, rather, by environmental conditions that promote excessive stalk production (Bothwell et al. 2014).

Regardless of factors affecting the spread and proliferation of Didymo, all wader boots used by Ecoscape were soaked for 1 minute in a salt solution containing 70 g NaCl/L and dried in the sun for several days or frozen for a week (Matheson et al. 2007).

Periphyton Quality Assurance/Quality Control

H. Larratt performed taxonomic investigations on all samples, with about 20% of periphyton samples going out to Dr. J. Stockner for taxonomic verification in 2021 as part of our QA/QC program. The following four steps were incorporated in taxonomic investigations for this AEMP:

1. Documenting live:dead ratios of diatoms prevents an overestimation of the standing crop and provide insights into the nutritional value of the periphyton.
2. Inclusion of very small members of periphyton biofilm in the taxa count, including nano-periphyton (<2 – 20 microns), pico-periphyton (>0.2 – 2 microns) bacteria and fungi prevents a significant under-estimate of productivity. Generation time of these small simple forms is a matter of hours, and they are usually a significant component of the overall periphyton community (Stockner 1991; Wetzel, 2001).
3. Algae cell dimensions were measured to allow for the calculation of biovolumes. Biovolume accounts for the difference in cell size among algae types and allows the estimation of standing crop.
4. A microscope photo of a typical field was archived from each sample for future reference.

Benthic Invertebrate Monitoring

The benthic invertebrate monitoring program was focused on assessing impacts of permitted effluent discharges on the quality of benthic habitats, together with the resultant benthic communities. Physical elements of the habitat formed an important component of this assessment.

Depositional Habitat Sampling

A total of five benthic invertebrate samples were collected from each of thirteen depositional areas using an Eckman dredge (sample area = 0.0225 m^2). Dredge sampling positions were randomly selected by blind deployment of the apparatus such that substrates and bottom conditions were not visibly assessed prior to deployment. Previous assessments determined that a sample size of 5 is sufficient to describe variability (Golder, 2007c). Samples were sieved in a wash bucket with 400-micron mesh (Env.Can. 2012) and transferred into a labeled sample bottle. The five dredge samples were not combined but were sent to the lab as replicates for each area.

Some depositional areas are more dynamic than others because they are less sheltered by prominent landforms and/or bedrock. As a result, the depositional areas of Birchbank Reference Area, Maglios Exposure Area and Airport Bar Exposure Area previously sampled in 2012 and 2015 were not sampled and were replaced by other depositional habitats identified nearby for 2018 and 2021 sampling (Schedule A Maps). We chose new depositional areas that contained suitable depositional attributes (i.e., fine depositional substrates) and occurred as close as possible (upstream or downstream) to the old areas.

There were **three depositional reference areas**. Kootenay Eddy (Dep-REF-1) was located on the right bank near the confluence of the Kootenay River. Genelle (DEP-REF-2) was a large backwater depositional site located on the right bank. The Birchbank Reference Area (DEP-REF-3) sampled in previous years was exclusively medium to coarse-grained sand substrates and not a representative depositional habitat. The new DEP-REF-3 was relocated about 675 m downstream on the left bank.

Seven depositional exposure areas were located downstream of the smelter labelled DEP-EXP-1 through DEP-EXP-7. There are no depositional habitats in the IDZ, thus all depositional exposure sites are far field sites. The Maglios Exposure Area (DEP-EXP-2) occurred in a backwater area just downstream of the Bear Creek fan on the left bank of the Columbia River. This depositional area was isolated by a gravel bar from river surface waters and nearly dry during the 2018 data collection. This area was therefore not sampled in 2018 or 2021 and DEP-EXP-2 was moved downstream about 1,200 m to the right bank of the river. Airport Bar (DEP- EXP-4) was also relocated about 1,200 m downstream on the left bank since the medium to coarse-grained sandy substrates of the original site were not representative of the predominantly silty substrates of other backwaters and eddies.

Erosional Habitat Sampling

Sampling was carried out in upstream reference and downstream exposure areas as outlined in the AEMP study plan (Golder 2012a), and an attempt was made to standardize field conditions at each site, including substrate size, water velocity, etc. Study areas and sample sites are shown in Map sheets 1-10 (Schedule A). All benthic invertebrate sampling was completed in natural substrates at wadable depths during low flows.

Two reference sites were located upstream of the exposure area and were identified as Reference Area 1 (ERO-REF-1) (left bank opposite Stoney Creek and CIV outfall) and Reference Area 2 (ERO-REF-2) (Birchbank).

There were **five downstream exposure sites**: Exposure Area 1 through Exposure Area 5 (ERO-EXP-1 to ERO- EXP-5). In 2021 these sites were further classified as being inside the Initial Dilution Zone Right Bank (IDZ – RB) and Far Field (FF). Sites within each of the upstream and downstream areas were randomly chosen using ArcGIS spatial tools. No additional sample sites were added as oversamples because all designated areas were effectively sampled. The exposure area sample sites are summarized as follows:

- ERO-EXP-1 (IDZ-RB) occurs exclusively along the right bank of the river extending about 1,300 m downstream from Stoney Creek and the CIV effluent outfall.
- ERO-EXP-2 (IDZ-RB) occurs in the right bank side channel downstream of the CIII effluent outfall, entirely within the CIII plume. The total length of this area is only about 315 m.
- ERO-EXP-3 (IDZ-RB and FF) was identified in the original study design as a single area that spans the width of the river beginning just below the right bank side channel, next to the smelter, and extending downstream about 3,000 m. As the understanding of both the effluent plume and groundwater plume has improved over the years, sampling within ERO-EXP-3 was further stratified into left (FF) and right bank (IDZ-RB) subsamples such that future analysis can begin to evaluate the left and right bank communities separately. The left bank is sampled at ERO-EXP-3 to assess the potential for groundwater plume effects in this area. Flowing downstream through ERO-EXP-3, the effluent plume diffuses outward from the CII outfall and the right bank and is diluted to about 0.5% of the initial CII outfall concentrations (Hawes and Larratt 2014) by Old Bridge (Schedule A).
- ERO-EXP-4 (FF) encompasses both the left and right bank of the river downstream beyond the effluent plume where diffusion and mixing is becoming more complete. The total length of this area is about 2,500 m.
- ERO-EXP-5 (FF) encompasses both the left and right bank of the river beginning downstream of the Rock Islands and Bear Creek confluence where full mixing of the plume has occurred. ERO-EXP-5 extends to the Pend d'Oreille river Confluence and is about 12,000 m in length.

At each sample site, a series of 5 area-based samples (Figure 3-5) were collected from undisturbed riverbed while moving upstream. All benthic sampling was completed in permanently wet natural substrates at wadable depths during low flows. The sample net had a mesh size of 400 microns in accordance with standard CABIN protocols (Env.Can. 2012). The sampler quadrat was 0.56 m^2. Thus, once combined, the total area sampled at each site was 2.8 m^2. Biophysical field information recorded for each site included:

- Substrate composition (general) – percent composition of each substrate type (e.g., boulder, cobble, gravel, sand etc.).
- Water velocity - velocity measurements were collected using a Swoffer 2100.
- 2100 flow meter or Marsh-McBirney Flo-Mate) at the 40% column depth.
- Sample depth and broader channel morphology (run, riffle pool, etc.).
- In situ water quality – Using an YSI Pro DSS (temperature, dissolved oxygen, total dissolved solids, turbidity, pH, specific conductivity, salinity, redox).

- Distance from smelter effluent outfalls (CII, CIII, and CIV) was determined using GIS as measured from the centerline of the channel to the sample site.

Figure 4: Sampling benthic invertebrates using an area-based approach with a modified surber/CABIN kicknet sampler (devised for area-based sampling in large river system with coarse substrates). The area shown is in Ero-Exp-3 situated on the right bank within the initial dilution zone.

Substrate Characteristics

The composition of stream bed material characterizes the type of habitat available to aquatic organisms. In addition, substrate composition is integral to understanding hydrological characteristics of that site.

The standard CABIN (Env.Can. 2012) pebble count was used to characterize substrate size and composition at each sample site. Substrate measurements within a sampling area were taken once all other sampling components were complete. While zigzagging through the sample area, substrates (i.e., boulder, cobble, pebble, gravel) were randomly selected every two steps following CABIN (Env.Can. 2012). If possible, the substrate material was extracted from the water and its intermediate axis (diameter perpendicular to the longest axis) was measured. If the substrate could not be dislodged, it was measured in place. The fraction of embeddedness for all rocks measured was also recorded.

Benthic Taxonomy

Benthic invertebrate samples were field processed by filtering samples and storing them in 70% ethanol. Fixed benthic invertebrate samples were transported to Cordillera Consulting in Summerland BC for processing and identification. Benthic invertebrate identification and biomass calculations followed standard CABIN procedures (Martens et al 2020). Field samples had organic portions removed and rough estimates of invertebrate density were calculated to determine if sub-sampling was required. Samples were then sorted, and macro-invertebrates were identified to the genus – species level where possible following the Standard Taxonomic Effort lists compiled by the Southwest Association of Freshwater Invertebrate Taxonomists (2011). A reference sample was kept for each representative taxon found. A sampling efficiency of 95% was used for benthic invertebrate identification and was determined through independent sampling.

Numerous metrics of benthic community structure including diversity, richness, community representation, and foraging guild were compiled (Appendix K).

Quality Assurance / Quality Control for Benthic Invertebrates

Lab reports on sediment and benthic samples were reviewed within two working days of receipt, and requests for re-analysis made if results were outside the 99th percentile without apparent cause. Lab reports were compared to all relevant standards and guidelines, with unusual results flagged.

Analysis of Periphyton and Benthic Invertebrate Community Response

The response of periphyton and benthic invertebrate communities to measured chemical (i.e., water and sediment quality), geographical, and physical variables were analyzed using multiple approaches summarized in the following subsections.

Response Variables

Relative effects of habitat characteristics on periphyton and benthic communities in the LCR were assessed using productivity and diversity response variables.

Periphyton response variables included: 1) abundance, 2) biovolume, 3) effective number of species, 4) Shannon evenness, 5) species richness, and 6) chlorophyll-a production. Additionally, the algal composition by category was analyzed.

Benthic invertebrate response variables included: 1) richness of Ephemeroptera, Plecoptera, and Trichoptera taxa (EPT richness), 2) abundance, 3) percent EPT taxa (% EPT), 4) percent Chironomid taxa (% Chironomidae), 5) effective number of species, 6) Shannon Evenness, and 8) t otal biomass. Additionally, invertebrate functional feeding groups composition was analyzed.

Explanatory variables included: sample site category (i.e., reference, initial dilution zone (IDZ), and far field (FF)), water temperature, pH, DO, water velocity, percent of cobble substrate, and substrate size (D50). The substrate metric D50 is the median substrate diameter, 50th percentile.

Descriptive Statistics

Basic descriptive statistics and plots of response and site attributes are presented to have an initial assessment of the behaviour of the variables of interest.

Community Composition

Non-metric multidimensional scaling (NMDS) using Bray-Curtis dissimilarity was used to explore variation in periphyton and benthic invertebrate community composition in both depositional and erosional sites. A separate NMDS analysis was conducted for erosional and depositional sites to allow taxonomic differences within a given habitat type to be tested and to take advantage of the differences in sample sizes. To eliminate effects of rare taxa, taxa that occurred a threshold of presence was used for analysis. NMDS was performed at the family taxonomic level for benthic invertebrates and the species level for periphyton to investigate effects of small and large-scale taxonomic community differences. PERMANOVA was used to evaluate the effect of individual site factors on the ordination results. Finally, taxa and sites were modelled against the ordination to assess their influence and differences in community composition by fitting them to ordination as factors using *envfit* function from package *vegan* version 2.6-4 (Oksanen et al., 2022). This allows us to describe the most influential taxa in the observed variation between sites and if sites are different. Additionally, cluster analysis was used to group sites across years according to their dissimilarity. SIMPER analysis was used to also extract the taxa that explain most of the difference among groups.

Ordination was done aggregating data across years. When data allowed, ordination analysis was also performed on a per-year basis.

Depositional Periphyton and Benthic Invertebrate Models

For the depositional sites, invertebrate and periphyton metrics were calculated by aggregating all five samples collected at each site. Periphyton metrics of effective number of species, total abundance and total biovolume were compared using a two-way ANOVA with year (2012, 2015, 2018, 2021) and treatment (reference and exposure) along with the interaction term. Levene's test was performed to determine if variances of each variable were normal within sites. Variables with significantly different variances were not included in the ANOVA as they would violate model assumptions. If the ANOVA determined there were significant differences among areas, the Tukey's Honest Significant Difference (HSD) test was used to identify areas that had different periphyton productivity or benthic invertebrate community composition.

Mixed-effects modeling of depositional communities was not undertaken due to the small size of sites and lack of independent replication, which would violate model assumptions. Benthic invertebrate metrics of total abundance, percent EPT, percent chironomids and effective species numbers were compared between years and treatment using a two-way ANOVA. Prior to modeling, the normality of each metric was tested using a Shapiro-Wilks test. To prioritize homogeneity of variance and rely on the robust nature of ANOVA to model departures from normality, total abundance, and percent Chironomidae were log-transformed. Percent EPT and effective species were not transformed after exploration of the data showed variance appeared homogenous.

To determine if elevated copper (a well-known algicide) concentration in sediment had adverse effects on periphyton, the correlation between periphyton metrics and sediment concentrations of copper at exposure depositional sites was tested using Pearson's correlation coefficient.

Erosional Site Analysis Methods

Productivity and diversity metrics associated with periphyton and invertebrate analyses from sites from 2012, 2015, 2018, and 2021 were included in linear mixed-effects models that used maximum likelihood fitting (Zuur et al. 2009). The fixed effects for all models included velocity, water temperature, pH, DO, percent cobble, substrate size (D50), sample site category, and year. In all models, an interaction term of year and site was included. Random effects of sample site category (e.g., reference or IDZ) and year were tested for each productivity and community composition response variable model.

Candidate models were compared through Akaike Information Criterion corrected for small sample size (AICc) based on Δ AICc values and AICc weights (w_i) which ranks models based upon the principle of parsimony, balancing model fit with complexity, in which the best models have the lowest Δ AICc and highest w_i. This way, we determined the overall relative model performance, rather than assessing the significance of individual parameters or models through p-values. Because numerous models performed similarly based on these criteria, we also assessed the relative support for the effects of different explanatory variables using multi-model averaging (Burnham and Anderson 2002; Anderson 2008). In this latter approach, model averaged parameter estimates with 95% confidence intervals (direction, variability, and size of effects) and relative variable importance (RVI: sum of w_i for all models containing a variable of interest) were calculated for each explanatory variable from 95% confidence sets of models (Burnham and Anderson 2002; Grueber et al. 2011).

Variables with 95% confidence intervals that did not span zero, and with RVI values > 0.5, were viewed as important in describing variation in response variables (e.g., Burnham and Anderson 2002). We also calculated pseudo R^2 for high-ranking models (derived from regressions of the observed data versus fitted values), which gives an indication of the proportion of the variance in response variables explained by an individual model (Cox and Snell 1989; Magee 1990; Nagelkerke 1991; Piñeiro et al. 2008).

To interpret and compare parameters which varied widely in scale, we standardized continuous explanatory variables by subtracting global means from each value (centering) and dividing by two times the SD (scaling) (Gelman 2008). Total abundance for both periphyton and benthic invertebrates, total biomass, and total biovolume in erosional and depositional sites were also log-transformed to meet model assumption of normality.

Erosional Periphyton and Benthic Invertebrate Models

Linear mixed-effects modeling of periphyton and benthic communities (Appendix H and Appendix M) were done in the *lmer* package, and competed and averaged using the *MuMIn* package version 1.43.6 (Barton, 2019), both implemented in R. While these models generally followed assumptions of multiple linear mixed-effects models, and many performed well, individual relationships among response and explanatory variables were not always linear based on scatter plots of the data. Therefore, interpretations of effects should be limited to general direction and size, but not shape of relationships. Following this, these models are not appropriate for predictive use.

For erosional areas, site and site-year interaction were the random effects and the fixed effects were current velocity, water temperature, pH, DO, percent cobble, substrate size (D50), sample site category, and year.

Erosional Periphyton Models

The same basic model structure of fixed and random terms was used for all response variables. Total abundance and biomass were log- transformed to improve meeting model assumptions. The best linear mixed-effect models (Delta <3) and model averaging were used to assess periphyton productivity and community metrics.

Erosional Benthic Invertebrate Models

As in periphyton modelling, the same model structure was kept across response variables. Site category and year were used as the random effect with site attributes as fixed terms. Abundance and biomass were log-transformed.

Small and Large-bodied Fish Monitoring

Small Bodied Fish Condition and Tissue Metals Monitoring

An effects-based design was adapted to measure biological variables in small-bodied fish (Sculpins). The overall objective of this study was to determine what effect (positive, negative, or neutral) effluent discharges may have on fish tissue metals concentrations, condition, and overall growth characteristics by comparing small fish collected from upstream reference sites to downstream exposure sites.

Arciszewski et al. (2010) discusses the importance of selecting suitable species as ecosystem sentinels, including the following characteristics: abundant, sedentary, high site fidelity and measurable life history characteristics relevant for the assessment. Based on this, the approach adapted for the AREMP small-bodied fish study contained the following key assumptions: 1) The species is representative of the receiving environment; 2) the species does not migrate between reference and exposure areas; and 3) there are minimal habitat differences between reference and exposure areas.

The objective of small-bodied fish monitoring was to assess nearfield biological responses with respect to distance downstream from the outfalls and to investigate differences in small-bodied fish responses between the right and left bank. Our intent was to explore the relationships between plume dilution, periphyton and benthic invertebrate metal uptake, and small fish tissue metal concentrations. To accomplish this, three reference areas and five exposure areas were sampled and are identified in Schedule 1 map sheets. Five sub-areas were sampled in Exposure Area 3 and 4 that were further divided by left and right banks (Table 1). When choosing reference sites, we looked for sites with comparable substrate and water flow to exposure habitats, and sites that were free from the influence of the effluent or other potential sources of stressors or metal pollution sources. Reference and exposure sites also had similar fish species compositions (Env. Can. 2012).

Table 1. Target samples and areas for small-bodied fish body condition and metal concentration sampling.

Treatment	Area	Sample Plan Overview	No. Fish
Reference	Area 1 – Kootenay River	Fish collected from gravel bar along backwater	30
	Area 2 - Birchbank	Fish collected from gravel bar along both left and right banks	30
	Area 3 – Genelle	Fish collected from gravel bar along both left and right banks	30
Exposure	Area 1 – CIV to CIII Outfall	Fish collected from right bank only downstream of CIV outfall	30
	Area 2 – CIII to CII Outfall	Fish collected from right bank only in side channel between CIII and CII outfalls	30

Area 3 – 4 – left bank from CII d/s to Maglios	Subdivided into 5 sections and 10 fish collected from each subsection	50
Area 3 – 4 – right bank from CII d/s to Maglios	Subdivided into 5 sections and 10 fish collected from each subsection	50
Area 5 – Maglios to Waneta	Fish collected from both left and right banks	30

Species Selection

Torrent Sculpin (C. rhotheus) were the target species for condition assessments and whole fish metals analysis. This species possesses ideal characteristics for a sentinel species in that they are abundant, sedentary, have high site fidelity, and have measurable life history characteristics.

Sample Timing

Timing of fish capture or sampling is determined by a number of factors including migratory behavior, gonadal development and flow conditions (Environment Canada 2013). Since gonad weights were to be used as a test parameter, sample timing was focused on when species are sexually mature. General spawning for sculpin in the Lower Columbia River has been estimated by AMEC (2012) to range from the end of May to late July when daily average water temperatures are between 9°C to 15°C. Therefore, optimal timing to sample for both mature males and females would be early to mid-May just prior to spawning. In 2021, sampling was carried out April 19th to 23rd. River flow ranged between 1,180 and 1,350 m^3/s.

Sampling Methods

Small-bodied fish were sampled under the Provincial Collection Permit: CB21-619612. Fish capture was completed along the riverbank (depths of 0.1 - 1.0 m) with use of a backpack electrofisher and pole seine to collect stunned fish being carried downstream by the current. Electrofishing start/end time, electrofishing seconds, electrofisher settings, and length and width of the area electrofished were recorded during sampling. These data were used to calculate a catch-per- unit-effort (CPUE). Each site was sampled until samplers retained enough of the target species, torrent sculpin, to meet the sampling goal for each location, if possible (Table 1).

Figure 5: Collection of sculpins with backpack electrofisher during spring 2016 small-bodied fish data collection program.

Field personnel referred to various species identification keys but relied primarily on one that was developed specifically for sculpins and dace of the lower Columbia River (adapted from McPhail 2007). This modified key identifies several key diagnostic features that greatly improves sculpin species identification in the field.

Fish were placed in a holding bucket where they were anesthetized using Tricaine mesylate (TMS) as per the Canadian Council on Animal Care's guidelines for the Care and Use of Fish in Research, Teaching and Testing (CCAC 2005).

Processing and Endpoint Analysis

Sculpins retained for tissue metals analysis and condition assessments had the following parameters measured:

- Total Length (mm)
- Weight (± 0.001 g)
- Age
- Sex
- Gonad Weight
- Liver Weight
- Fulton Condition (k)
- Gonadosomatic index (GSI)
- Hepatosomatic index (HSI)
- Tissue Metals
- General external and internal condition (i.e., presence of tumors etc.)

Fish were examined externally and internally for the presence of abnormalities, lesions, tumors, and parasites. Fish were weighed (± 0.001 g) and measured for total length (mm). The sex of individuals was determined externally by the presence of genital papilla (on mature males) and confirmed during dissection.

High-carbon stainless steel filleting knives and stainless high carbon steel utensils (scissors, forceps etc.) were used for processing fish. Instruments and cutting boards were washed with soap (critical cleaning liquid detergent) and then rinsed thoroughly with de-ionized water between each fish. Non-powdered vinyl gloves were worn by all personnel handling fish, and utensils to minimize contamination of samples.

The sampling process is outlined below:

1. The processor put on a clean pair of non-powdered vinyl gloves prior to handing the fish. New gloves were used for each fish to minimize cross contamination.
2. The thawed fish was removed from the bag and irrigated using de-ionized water to remove dirt and debris that may have been introduced during fish collection.
3. The clean fish was placed on a fresh sheet of wax paper on a cleaned vinyl cutting board. The head was crosscut (using surgical scissors) vertically posterior to the eye to expose the brain case and otoliths were extracted using tweezers and placed into a scale envelope labeled with fish catalog number and capture date for subsequent aging.

1. 4. The liver, gonads, and guts were extracted and weighed (± 0.001 g) and examined for abnormalities. The guts were subsequently preserved separately in labeled vials containing an alcohol fixative.

4. The liver, gonads, and whole fish were placed together in a new sterile plastic bag, labeled, and frozen on dry ice for subsequent tissue metals analysis by Caro Analytical Kelowna, BC. Fish samples were homogenized by Caro and subsequently analyzed for percent moisture, total lipids, trace metals, and major ions.

Calculation of Sculpin Condition

Physiological responses to stress in fish can be assessed by calculating the ratio of body weight to length, as well as that of the weight of certain organs relative to the total body weight or length. Declines in these indices of condition may indicate decreased energy storage, metabolism, feeding activity, or reproduction associated with environmental stressors (Barton et al. 2002). Although these indices are insensitive to short-term changes, they can be useful in the detection of long-term trends in fish exposed to chronic stressors. We considered three such condition indices:

Fulton-type condition factor (k) is the relationship between body weight and body length that is commonly used to infer physical condition of fish, and can be calculated using the following formula:

- Condition (k) = (105 × body weight (g))/length (mm)3

The gonadosomatic index and hepatosomatic index are calculations of the respective organ mass as a proportion of the total body mass and infer reproductive output and energy storage respectfully. Respective formulae are as follows:

- Gonadosomatic index = 100 × (gonad weight/gutted lab weight)
- Hepatosomatic index = 100 × (liver weight/gutted lab weight)

Fish Aging

Darren Filipic, R.P. Bio, completed fish aging. Otolith aging was conducted using a dissecting microscope. Age structures were interpreted using John Casselman's quantitative approach to fish aging:

- O, +, or ++ are assigned based on the observation of otolith growth or not
- since the last annulus was formed.
- 0 is assigned when the annulus is not quite complete
- + is less than half a year’s growth (relative to previous year)
- ++ is more than half a year’s growth (relative to previous year)

Large-Bodied Fish Tissue Monitoring

The AREMP Study Design (Golder 2012) specified the species, sample size, and types of tissue analyzed, and method of interpretation. Rainbow, Mountain Whitefish, and Walleye were used to stay consistent with historical data collection and because they are the most commonly caught and consumed by anglers (Golder 2012).

Field Data Collection

Fish for the large-bodied fish tissue monitoring program were obtained in coordination with the BC Hydro Lower Columbia Fish Indexing program (consistent with the 2012 AREMP). Fish collection was carried out by the Okanagan Nation Alliance and Golder Associates using a boat electrofisher from October 25th through 27th and November 2nd and 4th, 2021. Collection was completed under a Provincial Collection Permit (Permit number CB21-657143).

Collected fish were pooled into 'upper' and 'lower' areas. The upper areas captured reference areas upstream of the smelter outfall and extended from the Hugh L. Keenleyside Dam downstream to Castlegar above the Tin Cup Rapids. The lower areas were exposure areas below the outfall and extended from Beaver Creek to Waneta (Figure 3-8). Target species included Mountain Whitefish (*Prosopium williamsoni*), Rainbow Trout (*Oncorhynchus mykiss*), and Walleye (*Sander vitreus*).

The target sample size was 20 fish per species per sample area, for a total of 60 fish per area, and 120 fish in all. Adult-size fish (i.e., those targeted by anglers) were targeted for analysis since one of the primary objectives was to assess the concentrations of tissue metals relevant to human consumption guidelines. Therefore, sampling was biased toward obtaining catchable-size fish (>200 mm).

At the time of fish collection, fish condition was documented and included: Presence of physical abnormalities or parasites, fork length (mm), total length (mm), total body weight (g), age class, and sex.

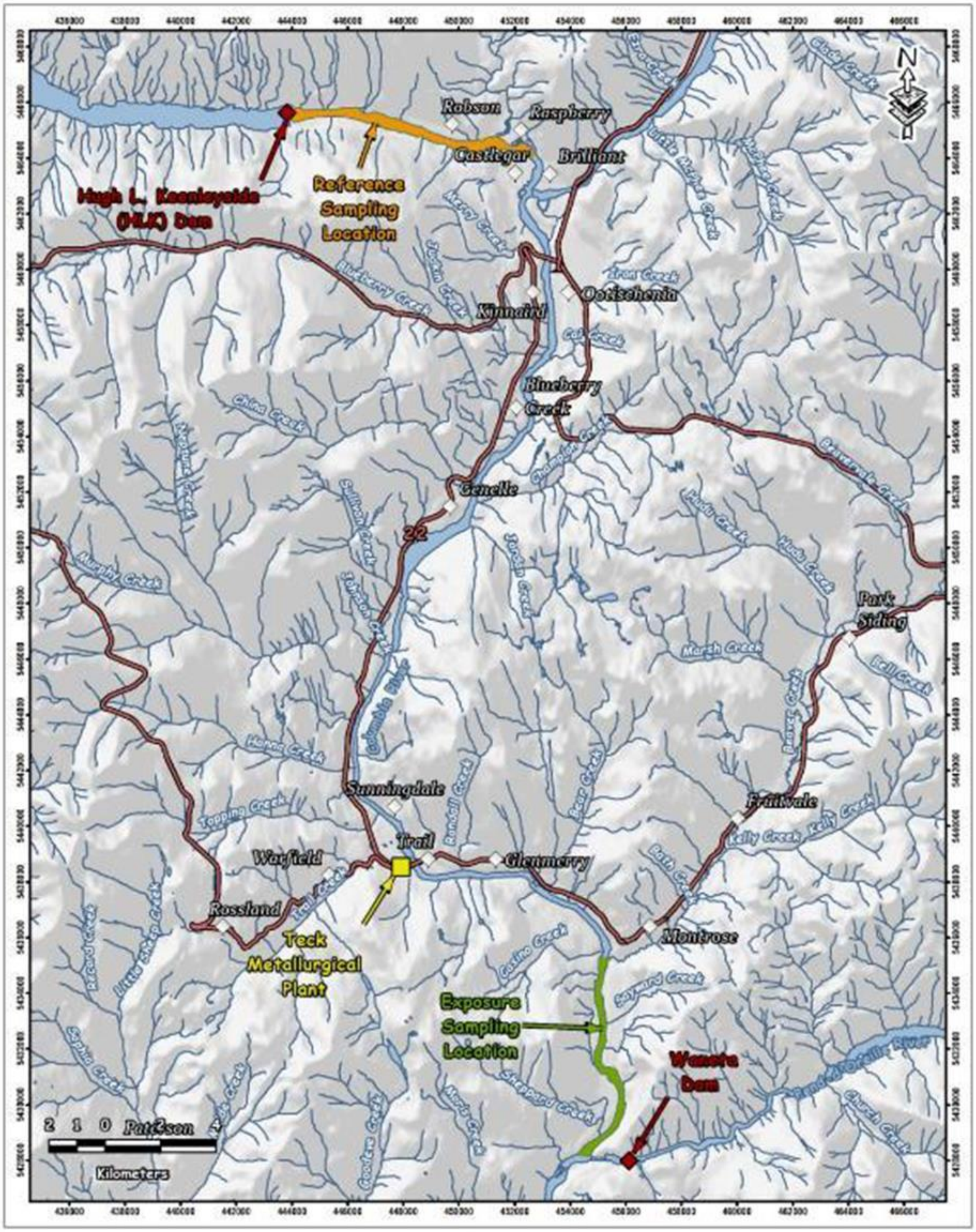


Figure 6. Large-bodied fish reference and exposure collection areas. Fish collection was carried out by Okanagan Nation Alliance and Golder Associates as part of Lower Columbia River Fish Indexing Project.

Each fish was assigned a catalog number and photographed. Physical abnormalities were noted when observed and additional close-up photos were taken. The fork length of each fish was measured, and the weight of the fish was documented.

Fish were placed in individual bags and euthanized in the bag to prevent potential tissue contamination. Fish were then placed on ice and transferred to a deep freezer upon returning to shore after each evening of sampling.

Large-Bodied Fish Processing

Frozen fish were transported to Kelowna and processed at Ecoscape, where a clean process room was prepared to minimize the risk of contamination from extraneous metal sources during tissue preparation. Frozen fish were thawed prior to dissections. Only as many fish as could be processed on a given occasion were thawed.

Of the 101 fish collected, 52 were analyzed as skin-on fillets. The other 49 were analyzed as whole fish with guts removed (Table 3-5). The guts were then analyzed separately. The selection of fish for whole samples and fillet sampling was done randomly prior to initiation of processing.

Table 2. Large-bodied fish collection and processing summary.

			Tissue metals analysis		
Collection Area	Species	Total collected	Fillets	Whole fish (guts removed)	Gut contents
Reference	Mountain Whitefish	20	10	10	10
	Rainbow Trout	20	10	10	10
	Walleye	20	10	10	10
Exposure	Mountain Whitefish	14	7	7	7
	Rainbow Trout	10	10	10	10
	Walleye	7	5	2	2
Total sample size		101			

Sampling methods were consistent with previous studies (Golder 2007) and British Columbia Field Sampling Manual: for Continuous Monitoring and Collection of Air, Air-emission, Water, Wastewater, Soil, Sediment and Biological Sampling (Clarke et al. 2003).
The following parameters were included in the endpoint analysis:

- Fork Length (mm)
- Weight (± 0.001 g)
- Age
- Sex
- Gonad Weight
- Liver Weight
- Fulton Condition (k)
- Gonadosomatic index (GSI)
- Hepatosomatic index (HSI)
- Tissue Metals
- General external and internal condition (i.e., presence of tumors etc.)

Fish were examined externally and internally for the presence of abnormalities, lesions, tumors, and parasites.

High-carbon stainless steel filleting knives and stainless high carbon steel utensils (i.e., scissors, forceps etc.) were used for processing fish. Instruments and cutting boards were washed with soap (critical cleaning liquid detergent) and then rinsed thoroughly with de-ionized water between each fish. Non-powdered vinyl gloves were worn by all personnel handling fish, and utensils to minimize contamination of samples.

The sampling process is outlined below:

1. The processor put on a clean pair of non-powdered vinyl gloves prior to handing the fish. New gloves were used for each fish to minimize cross contamination.
2. The thawed fish was removed from the bag and irrigated using de-ionized water to remove dirt and debris that may have been introduced during fish collection.
3. The clean fish was placed on a fresh sheet of wax paper on a cleaned vinyl cutting board. The head was crosscut vertically posterior to the eye to expose the brain case and otoliths were extracted using tweezers and placed into a scale envelope labeled with fish catalog number and capture date for subsequent aging.
4. The liver, gonads, and guts were extracted and weighed (± 0.001 g) and examined for abnormalities.
5. For fish designated as fillet samples: A single fillet was removed (skin on), weighed (± 0.001 g), and placed in a new, clean, pre-labeled sealable plastic bag. Each bag was labeled with the fish catalog number, date and analysis type.
6. For fish designated as whole samples: The liver, gonads, and whole fish were placed together in one new sterile plastic bag and the guts placed in a separate bag. Each bag was labeled with the fish catalog number, date and analysis type.
7. All samples were frozen on dry ice for subsequent tissue metals analysis by Caro Analytical (Kelowna, BC). Fish samples were homogenized by Caro and subsequently analyzed for percent moisture, total lipids, trace metals, and major ions.

Figure 7. Rainbow Trou prior to processing (left); processing gravid female Mountain Whitefish (right).

Quality Assurance / Quality Control for Large-bodied Fish Analysis

To ensure precision in metals testing, 10% of the fillet samples were analyzed in duplicate. Duplicates were submitted to the lab as blind samples. When evaluating the results, duplicates needed to be 5 times the detection limit for acceptability criteria to apply (USEPA 2000). If the relative percent difference for duplicates were within 20% of each other they were accepted. If the calculated relative percent differences were greater than 50%, a quantification problem was suspected, which may have included possible contamination or lack of sample representativeness. In such instances, the lab was notified of the discrepancy and data were re-checked and samples re-run if necessary. Relative percent difference was calculated as follows:

- (sample result - duplicate result) *100 (sample result + duplicate result)/2
- The accuracy of data entry was assessed with a second person checking a minimum of 10% of the data for completeness, data entry errors, transcription error and invalid data. If errors were found, then all data underwent a zero tolerance quality assurance check.

Fish Aging

Fish aging was undertaken by Darren Filipic, R.P.Bio. Otolith aging was conducted using a dissecting microscope.

Age structures were interpreted using John Casselman's quantitative approach to fish aging:

- O, +, or ++ are assigned based on the observation of otolith growth or not
- since the last annulus was formed.
- 0 is assigned when the annulus is not quite complete
- is less than half a year’s growth (relative to previous year)
- ++ is more than half a year’s growth (relative to previous year)

Large and small-bodied Analysis of tissue metals and condition Indices

Concentrations of arsenic, cadmium, chromium, copper, iron, lead, mercury, selenium, thallium, and zinc in large body fish tissues were plotted for each tissue (muscle/whole body/gut) according to year sampled, treatment, and species (Rainbow Trout, Mountain Whitefish, and Walleye) combination. Small-bodied fish (sculpin) whole body samples were plotted in downstream order according to site and riverbank.

For large-bodied fish, an analysis of covariance (ANCOVA) was used to assess the effects of exposure (above or below CIII outfall), species, year, and fish fork length on metal concentrations. For 2021 data, another ANCOVA was run with only treatment (reference and exposure) and species to assess the effects of exposure for 2021 alone. Because the range and level of metal concentrations differed considerably in gut samples relative to muscle and whole body, these analyses were conducted for each tissue type separately. Large-bodied fish metal concentrations below the limit of detection were included in analysis by taking the minimum limit of detection for the analyte (metal) and dividing by 2.

For small-bodied fish, body condition indices were compared between treatment areas using an ANCOVA and sex as a covariate term. Whole body sculpin concentrations of arsenic, cadmium, chromium, copper, iron, lead, mercury, selenium, thallium, and zinc were compared using a linear model by treatment group. Treatment groups were determined by exposure area and bank combination because right and left banks have a different level of exposure to the smelter outfall (Table 1). A polynomial quadratic factor of distance to CII outfall was included to account for the non-linear response of metal concentrations to distance from the smelter, which improved model fit.

In all cases tissue metal concentrations were log transformed and outliers were removed from data to meet model assumptions of normally distributed residuals. The results of the ANCOVA models with all samples and ANCOVA models with outliers excluded were compared. However, all results reported are of the ANCOVA models with outliers included. Some metals did not meet model assumptions primarily because of the large number of samples below the metal concentration limit of detection, and thus these metals were not modeled. In the interpretation of ANCOVA results, significance of overall models and individual parameters within them were determined through p-values at a 0.05 significance level, and direction of explanatory variable effects are determined from model parameter estimates.

Table 3. Small-bodied fish sample sites and treatment groups used for analysis.

Treatment Group	Site
Reference	Ero-Ref-2
Reference	Ero-Ref-3
Reference	Koot-Ref-1
IDZ Right Bank	Ero-Exp-1
IDZ Right Bank	Ero-Exp-2
IDZ Right Bank	Ero-Exp-3-1-R
IDZ Right Bank	Ero-Exp-3-2-R
IDZ Left Bank	Ero-Exp-3-1-L
IDZ Left Bank	Ero-Exp-3-2-L
IDZ Left Bank	Ero-Exp-3-3-L
Downstream IDZ	Ero-Exp-3-3-R
Downstream IDZ	Ero-Exp-3-4-L

Downstream IDZ	Ero-Exp-3-4-R
Downstream IDZ	Ero-Exp-5

References

Richards, A. B., & Rogers, D. C. (2011). List of freshwater macroinvertebrate taxa from California and adjacent states including standard taxonomic effort levels (p. 266). Southwest Association of Freshwater Invertebrate Taxonomists. http://www.safit.org/ste.html

Martens, A., Strachan, S., Pascoe, T., & Baird, D. (2020). CABIN laboratory methods: Processing, taxonomy, and quality control of benthic macroinvertebrate samples.: En84-86/2021E-PDF - Government of Canada Publications - Canada.ca. Environment and Climate Change Canada. https://publications.gc.ca/site/eng/9.895039/publication.html

APPENDIX B AQUATIC COMMUNITY SAMPLING SITE ORGANIZATION

Table 4. AEMP erosional habitat sampling areas, sites, and analyses-specific labels.

Area	Description	Area-Site	Bank	Periphyton Community	Benthic Community	Small-Bodied Fish Tissue Tissue
KOOT-REF-1	Erosional habitat on left bank of Kootenay River	KOOT-REF-1	L			KOOT-REF-1
ERO-REF-1	Left bank opposite Stoney Creek	ERO-REF-1-1	L	ERO-REF-1-1A ERO-REF-1-1B ERO-REF-1-1C	ERO-REF-1-1	
		ERO-REF-1-2	L	ERO-REF-1-2A ERO-REF-1-2B ERO-REF-1-2C	ERO-REF-1-2	
		ERO-REF-1-3	L	ERO-REF-1-3A ERO-REF-1-3B ERO-REF-1-3C	ERO-REF-1-3	
		ERO-REF-1-4	L	ERO-REF-1-4A ERO-REF-1-4B ERO-REF-1-4C	ERO-REF-1-4	
		ERO-REF-1-5	L	ERO-REF-1-5A ERO-REF-1-5B ERO-REF-1-5C	ERO-REF-1-5	
ERO-REF-2	Birchbank	ERO-REF-2-1	B	ERO-REF-2-1A ERO-REF-2-1B ERO-REF-2-1C	ERO-REF-2-1	ERO-REF-2
		ERO-REF-2-2	B	ERO-REF-2-2A ERO-REF-2-2B ERO-REF-2-2C	ERO-REF-2-2	
		ERO-REF-2-3	B	ERO-REF-2-3A ERO-REF-2-3B ERO-REF-2-3C	ERO-REF-2-3	
		ERO-REF-2-4	B	ERO-REF-2-4A ERO-REF-2-4B ERO-REF-2-4C	ERO-REF-2-4	
		ERO-REF-2-5	B	ERO-REF-2-5A ERO-REF-2-5B ERO-REF-2-5C	ERO-REF-2-5	
ERO-REF-3	Gennelle		B			ERO-REF-3
ERO-EXP-1	Right bank from Stoney Creek to side channel	ERO-EXP-1-1	R	ERO-EXP-1-1A ERO-EXP-1-1B ERO-EXP-1-1C	ERO-EXP-1-1	ERO-EXP-1
		ERO-EXP-1-2	R	ERO-EXP-1-2A ERO-EXP-1-2B ERO-EXP-1-2C	ERO-EXP-1-2	
		ERO-EXP-1-3	R	ERO-EXP-1-3A ERO-EXP-1-3B	ERO-EXP-1-3	

Area	Description	Area-Site	Bank	Periphyton Community	Benthic Community	Small-Bodied Fish Tissue Tissue
				ERO-EXP-1-3C		
		ERO-EXP-1-4	R	ERO-EXP-1-4A ERO-EXP-1-4B ERO-EXP-1-4C	ERO-EXP-1-4	
		ERO-EXP-1-5	R	ERO-EXP-1-5A ERO-EXP-1-5B ERO-EXP-1-5C	ERO-EXP-1-5	
		ERO-EXP-2-1	R	ERO-EXP-2-1A ERO-EXP-2-1B ERO-EXP-2-1C	ERO-EXP-2-1	
		ERO-EXP-2-2	R	ERO-EXP-2-2A ERO-EXP-2-2B ERO-EXP-2-2C	ERO-EXP-2-2	
ERO-EXP-2	Side channel from CIII outfall down to CII Outfall	ERO-EXP-2-3	R	ERO-EXP-2-3A ERO-EXP-2-3B ERO-EXP-2-3C	ERO-EXP-2-3	ERO-EXP-2
		ERO-EXP-2-4	R	ERO-EXP-2-4A ERO-EXP-2-4B ERO-EXP-2-4C	ERO-EXP-2-4	
		ERO-EXP-2-5	R	ERO-EXP-2-5A ERO-EXP-2-5B ERO-EXP-2-5C	ERO-EXP-2-5	
		ERO-EXP-3-1	R	ERO-EXP-3-1A ERO-EXP-3-1B ERO-EXP-3-1C	ERO-EXP-3-1	ERO-EXP-3-1-R
		ERO-EXP-3-1-L	L			ERO-EXP-3-1-L
		ERO-EXP-3-2	R	ERO-EXP-3-2A ERO-EXP-3-2B ERO-EXP-3-2C	ERO-EXP-3-2	
		ERO-EXP-3-2-L	L			ERO-EXP-3-2-L
ERO-EXP-3	CII Outfall downstream to Korpac	ERO-EXP-3-3	L	ERO-EXP-3-3A ERO-EXP-3-3B ERO-EXP-3-3C	ERO-EXP-3-3	ERO-EXP-3-3-L
		ERO-EXP-3-4	R	ERO-EXP-3-4A ERO-EXP-3-4B ERO-EXP-3-4C	ERO-EXP-3-4	ERO-EXP-3-4-R
		ERO-EXP-3-5	L	ERO-EXP-3-5A ERO-EXP-3-5B ERO-EXP-3-5C	ERO-EXP-3-5	ERO-EXP-3-4-L
		ERO-EXP-3-6	R			ERO-EXP-3-3-R
				ERO-CRADT-3-5B ERO-CRADT-3-5C		
ERO-EXP-4	Korpac downstream to below Maglios	ERO-EXP-4-1	L	ERO-EXP-4-1A ERO-EXP-4-1B ERO-EXP-4-1C	ERO-EXP-4-1	
		ERO-EXP-4-2	L	ERO-EXP-4-2A ERO-EXP-4-2B ERO-EXP-4-2C	ERO-EXP-4-2	
		ERO-EXP-4-3	L	ERO-EXP-4-3A	ERO-EXP-4-3	

Area	Description	Area-Site	Bank	Periphyton Community	Benthic Community	Small-Bodied Fish Tissue Tissue
		ERO-EXP-4-4	L	ERO-EXP-4-3B ERO-EXP-4-3C ERO-EXP-4-4A ERO-EXP-4-4B ERO-EXP-4-4C	ERO-EXP-4-4	
		ERO-EXP-4-5	R	ERO-EXP-4-5A ERO-EXP-4-5B ERO-EXP-4-5C	ERO-EXP-4-5	
		ERO-EXP-4-7	R			
		ERO-EXP-4-8	R			
		ERO-EXP-4-9	R			ERO-EXP-4-5-R
			L			ERO-EXP-4-5-L
ERO-EXP-5	Maglios downstream to Waneta	ERO-EXP-5-1	L	ERO-EXP-5-1A ERO-EXP-5-1B ERO-EXP-5-1C	ERO-EXP-5-1	
		ERO-EXP-5-2	R	ERO-EXP-5-2A ERO-EXP-5-2B ERO-EXP-5-2C	ERO-EXP-5-2	
		ERO-EXP-5-3	R	ERO-EXP-5-3A ERO-EXP-5-3B ERO-EXP-5-3C	ERO-EXP-5-3	
		ERO-EXP-5-4	R	ERO-EXP-5-4A ERO-EXP-5-4B ERO-EXP-5-4C	ERO-EXP-5-4	
		ERO-EXP-5-5	R	ERO-EXP-5-5A ERO-EXP-5-5B ERO-EXP-5-5C	ERO-EXP-5-5	
		ERO-EXP-5-6	R			ERO-EXP-5

Table 5. AEMP depositional habitat sampling areas, sites, and analyses-specific labels.

Area	Description	Area-Site	Bank	Periphyton Community	Benthic Community
DEP-REF-1	Kootenay Eddy	DEP-REF-1	R	DEP-REF- KE-1 DEP-REF- KE-2 DEP-REF- KE-3	DEP-REF-1-1 DEP-REF-1-2 DEP-REF-1-3 DEP-REF-1-4 DEP-REF-1-5
DEP-REF-2	Genelle	DEP-REF-2	R	DEP-REF- GE-1 DEP-REF- GE-2 DEP-REF- GE-3	DEP-REF-2-1 DEP-REF-2-2 DEP-REF-2-3 DEP-REF-2-4 DEP-REF-2-5
DEP-REF-3	Birchbank	DEP-REF-3	L	DEP-REF- BB-1 DEP-REF- BB-2 DEP-REF- BB-3	DEP-REF-3-1 DEP-REF-3-2 DEP-REF-3-3 DEP-REF-3-4 DEP-REF-3-5
DEP-EXP-1	Korpac	DEP-EXP-1	R	DEP-EXP- KO-1 DEP-EXP- KO-2 DEP-EXP- KO-3	DEP-EXP-1-1 DEP-EXP-1-2 DEP-EXP-1-3 DEP-EXP-1-4 DEP-EXP-1-5
DEP-EXP-2	Maglios	DEP-EXP-2	L	DEP-EXP- MG-1 DEP-EXP- MG-2 DEP-EXP- MG-3	DEP-EXP-2-1 DEP-EXP-2-2 DEP-EXP-2-3 DEP-EXP-2-4 DEP-EXP-2-5
DEP-EXP-3	Casino Eddy	DEP-EXP-3	R	DEP-EXP- C-1 DEP-EXP- C-2 DEP-EXP- C-3	DEP-EXP-3-1 DEP-EXP-3-2 DEP-EXP-3-3 DEP-EXP-3-4 DEP-EXP-3-5
DEP-EXP-4	Airport Bar	DEP-EXP-4	L	DEP-EXP-AB-1 DEP-EXP-AB-2 DEP-EXP-AB-3	DEP-EXP-4-1 DEP-EXP-4-2 DEP-EXP-4-3 DEP-EXP-4-4 DEP-EXP-4-5
DEP-EXP-5	Trimac	DEP-EXP-5	R	DEP-EXP- TR-1 DEP-EXP- TR-2 DEP-EXP- TR-3	DEP-EXP-5-1 DEP-EXP-5-2 DEP-EXP-5-3 DEP-EXP-5-4 DEP-EXP-5-5
DEP-EXP-6	Fort Shepherd	DEP-EXP-6	L	DEP-EXP- FS-1 DEP-EXP- FS-2 DEP-EXP- FS-3	DEP-EXP-6-1 DEP-EXP-6-2 DEP-EXP-6-3 DEP-EXP-6-4 DEP-EXP-6-5
DEP-EXP-7	Waneta	DEP-EXP-7	L	DEP-EXP- WA-1 DEP-EXP- WA-2 DEP-EXP- WA-3	DEP-EXP-7-1 DEP-EXP-7-2 DEP-EXP-7-3 DEP-EXP-7-4 DEP-EXP-7-5

APPENDIX C AEMP SAMPLE SITES PHYSICAL DATA

Table 6. Erosional site physical habitat parameters by percentage of site cover surveyed in 2021.

Site ID	River Bank	Sub Comp Bedrock	Sub Comp Boulder	Sub Comp Large Cobble	Sub Comp Small Cobble	Sub Comp Large Pebble	Sub Comp Small Pebble	Sub Comp Gravel	Sub Comp Coarse Sand	Sub Comp Fine Sand
ERO-REF-1-1	L	0	40	40	5	5	0	0	0	10
ERO-REF-1-2	R	0	30	50	0	5	5	5	0	5
ERO-REF-1-3	L	0	70	20	0	0	5	5	0	0
ERO-REF-1-4	L	0	70	10	10	5	5	0	0	0
ERO-REF-1-5	L	60	0	30	0	5	0	0	0	5
ERO-REF-2-1	R	0	70	20	0	5	0	5	0	0
ERO-REF-2-2	R	80	0	10	0	5	5	0	0	0
ERO-REF-2-3	L	0	5	75	0	8	0	2	0	0
ERO-REF-2-4	R	0	0	90	0	3	0	2	0	5
ERO-REF-2-5	L	0	0	90	0	10	0	0	0	0
ERO-EXP-1-1	R	0	40	20	0	20	10	10	0	0
ERO-EXP-1-2	R	0	0	30	0	5	5	0	0	0
ERO-EXP-1-3	R	0	75	5	0	5	5	5	5	0
ERO-EXP-1-4	R	0	50	20	10	10	5	5	0	0
ERO-EXP-1-5	R	0	60	20	10	5	0	5	0	0
ERO-EXP-2-1	R	0	20	35	20	15	2.5	2.5	0	0
ERO-EXP-2-2	R	2.5	0	20	10	25	30	10	0	2.5
ERO-EXP-2-3	R	0	0	30	20	25	15	10	0	0
ERO-EXP-2-4	R	0	0	30	20	20	5	5	0	0
ERO-EXP-2-5	R	0	10	30	30	25	0	5	0	0
ERO-EXP-3-1	R	0	5	20	0	30	0	10	0	5
ERO-EXP-3-2	R	0	20	50	0	20	0	10	0	0
ERO-EXP-3-3	R	0	40	40	0	10	10	0	0	0
ERO-EXP-3-4	R	0	30	60	5	5	0	0	0	0
ERO-EXP-3-5	L	0	0	5	30	40	20	5	0	0
ERO-EXP-4-5	R	0	20	30	30	10	5	0	5	0
ERO-EXP-5-1	L	0	30	30	30	5	0	5	0	0
ERO-EXP-5-2	R	0	30	40	20	5	5	0	0	0
ERO-EXP-5-3	R	0	10	30	10	30	10	10	0	0
ERO-EXP-5-4	R	0	20	40	0	20	10	10	0	0
ERO-EXP-5-5	R	0	5	20	30	30	10	5	0	0

APPENDIX D WATER QUALITY DATA AND STATISTICAL OUTPUTS

Table 7: Water quality Alkalinity, Total (as CaCO3) results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Alkalinity, Total (as CaCO3)	03-11	62.5	62.5	63.2	62.5	63.0	63.2
Alkalinity, Total (as CaCO3)	03-12	62.2	62.5	62.3	62.6	62.5	62.6
Alkalinity, Total (as CaCO3)	03-17	63.1	61.9	62.5	62.4	63.3	61.9
Alkalinity, Total (as CaCO3)	03-18	62.8	61.9	63.3	62.7	62.9	62.3
Alkalinity, Total (as CaCO3)	03-29	60.1	59.5	60.6	60.0	60.3	59.9
Alkalinity, Total (as CaCO3)	07-(20_21)	54.3	53.7	53.6	54.0	53.5	53.7
Alkalinity, Total (as CaCO3)	10-(19_20)	51.8	52.2	53.0	52.4	52.0	52.2

Table 8: Water quality Aluminum (Al)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Aluminum (Al)-Dissolved	03-11	0.0042	0.0038	0.0041	0.0038	0.0041	0.0049
Aluminum (Al)-Dissolved	03-12	0.0047	0.0037	0.0044	0.0039	0.0041	0.0035
Aluminum (Al)-Dissolved	03-17	0.0038	0.0042	0.0048	0.0040	0.0044	0.0038
Aluminum (Al)-Dissolved	03-18	0.0034	0.0035	0.0040	0.0035	0.0037	0.0032
Aluminum (Al)-Dissolved	03-29	0.0049	0.0048	0.0047	0.0046	0.0047	0.0043
Aluminum (Al)-Dissolved	07-(20_21)	0.0092	0.0096	0.0095	0.0095	0.0095	0.0096
Aluminum (Al)-Dissolved	10-(19_20)	0.0058	0.0058	0.0069	0.0053	0.0054	0.0057

Table 9: Water quality Aluminum (Al)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Aluminum (Al)-Total	03-11	0.0065	0.0084	0.0063	0.0075	0.0065	0.0063
Aluminum (Al)-Total	03-12	0.0071	0.0067	0.0092	0.0064	0.0071	0.0070
Aluminum (Al)-Total	03-17	0.0066	0.0068	0.0065	0.0087	0.0073	0.0082
Aluminum (Al)-Total	03-18	0.0074	0.0064	0.0071	0.0079	0.0067	0.0078
Aluminum (Al)-Total	03-29	0.0077	0.0085	0.0082	0.0079	0.0078	0.0072
Aluminum (Al)-Total	07-(20_21)	0.0154	0.0165	0.0173	0.0177	0.0167	0.0161
Aluminum (Al)-Total	10-(19_20)	0.0093	0.0098	0.0104	0.0102	0.0093	0.0092

Table 10: Water quality Ammonia, Total (as N) results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Ammonia, Total (as N)	03-11	<0.0050	0.0212	0.0195	0.0098	0.0057	0.0058
Ammonia, Total (as N)	03-12	<0.0050	0.0125	0.0213	0.0108	<0.0050	0.0104
Ammonia, Total (as N)	03-17	<0.0050	0.0121	0.0199	0.0108	0.0062	0.0070
Ammonia, Total (as N)	03-18	<0.0050	0.0151	0.0216	0.0111	0.0080	0.0090
Ammonia, Total (as N)	03-29	<0.0050	<0.0050	0.0241	0.0124	0.0086	0.0088
Ammonia, Total (as N)	07-(20_21)	0.0067	0.0054	0.0063	0.0070	0.0061	0.0067
Ammonia, Total (as N)	10-(19_20)	<0.0050	0.0203	0.0261	0.0122	0.0077	0.0086

Table 11: Water quality Antimony (Sb)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Antimony (Sb)-Dissolved	03-11	0.000035	0.000050	0.00220	0.000376	0.000146	0.000135
Antimony (Sb)-Dissolved	03-12	0.000044	0.000048	0.00400	0.000610	0.000258	0.000204
Antimony (Sb)-Dissolved	03-17	0.000041	0.000046	0.00217	0.000425	0.000142	0.000136
Antimony (Sb)-Dissolved	03-18	0.000037	0.000049	0.00250	0.000490	0.000194	0.000182
Antimony (Sb)-Dissolved	03-29	0.000041	0.000061	0.000952	0.000211	0.000107	0.000098
Antimony (Sb)-Dissolved	07-(20_21)	0.000030	0.000030	0.000901	0.000241	0.000076	0.000076
Antimony (Sb)-Dissolved	10-(19_20)	0.000027	0.000033	0.00188	0.000352	0.000119	0.000086

Table 12: Water quality Antimony (Sb)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Antimony (Sb)-Total	03-11	0.000037	0.000091	0.00240	0.000403	0.000156	0.000141
Antimony (Sb)-Total	03-12	0.000047	0.000053	0.00429	0.000664	0.000288	0.000216
Antimony (Sb)-Total	03-17	0.000041	0.000049	0.00226	0.000445	0.000154	0.000145
Antimony (Sb)-Total	03-18	0.000040	0.000054	0.00273	0.000524	0.000210	0.000190
Antimony (Sb)-Total	03-29	0.000042	0.000064	0.00101	0.000229	0.000115	0.000103
Antimony (Sb)-Total	07-(20_21)	0.000031	0.000035	0.000869	0.000234	0.000071	0.000074
Antimony (Sb)-Total	10-(19_20)	0.000028	0.000032	0.00190	0.000355	0.000122	0.000089

Table 13: Water quality Arsenic (As)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Arsenic (As)-Dissolved	03-11	0.000238	0.000409	0.000420	0.000272	0.000281	0.000263
Arsenic (As)-Dissolved	03-12	0.000252	0.000384	0.000426	0.000260	0.000299	0.000271
Arsenic (As)-Dissolved	03-17	0.000232	0.000382	0.000356	0.000300	0.000248	0.000241
Arsenic (As)-Dissolved	03-18	0.000253	0.000447	0.000344	0.000312	0.000306	0.000290
Arsenic (As)-Dissolved	03-29	0.000228	0.000454	0.000385	0.000283	0.000250	0.000255
Arsenic (As)-Dissolved	07-(20_21)	0.000155	0.000174	0.000194	0.000175	0.000153	0.000158
Arsenic (As)-Dissolved	10-(19_20)	0.000176	0.000183	0.000259	0.000163	0.000154	0.000169

Table 14: Water quality Arsenic (As)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Arsenic (As)-Total	03-11	0.000253	0.000433	0.000414	0.000313	0.000295	0.000298
Arsenic (As)-Total	03-12	0.000268	0.000424	0.000481	0.000308	0.000278	0.000297
Arsenic (As)-Total	03-17	0.000256	0.000429	0.000352	0.000330	0.000276	0.000265
Arsenic (As)-Total	03-18	0.000284	0.000446	0.000416	0.000351	0.000287	0.000289
Arsenic (As)-Total	03-29	0.000250	0.000463	0.000418	0.000305	0.000257	0.000268
Arsenic (As)-Total	07-(20_21)	0.000194	0.000171	0.000209	0.000201	0.000160	0.000166
Arsenic (As)-Total	10-(19_20)	0.000166	0.000188	0.000274	0.000198	0.000168	0.000163

Table 15: Water quality Barium (Ba)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Barium (Ba)-Dissolved	03-11	0.0222	0.0221	0.0220	0.0216	0.0223	0.0218
Barium (Ba)-Dissolved	03-12	0.0211	0.0215	0.0220	0.0215	0.0217	0.0221
Barium (Ba)-Dissolved	03-17	0.0223	0.0215	0.0214	0.0213	0.0221	0.0222
Barium (Ba)-Dissolved	03-18	0.0217	0.0228	0.0216	0.0219	0.0225	0.0222
Barium (Ba)-Dissolved	03-29	0.0222	0.0219	0.0225	0.0220	0.0223	0.0221
Barium (Ba)-Dissolved	07-(20_21)	0.0191	0.0194	0.0192	0.0195	0.0187	0.0192
Barium (Ba)-Dissolved	10-(19_20)	0.0177	0.0178	0.0178	0.0174	0.0174	0.0170

Table Error! No text of specified style in document.16: Water quality Barium (Ba)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Barium (Ba)-Total	03-11	0.0232	0.0226	0.0233	0.0218	0.0224	0.0226
Barium (Ba)-Total	03-12	0.0222	0.0225	0.0227	0.0223	0.0233	0.0218
Barium (Ba)-Total	03-17	0.0229	0.0224	0.0233	0.0232	0.0227	0.0227
Barium (Ba)-Total	03-18	0.0232	0.0232	0.0238	0.0229	0.0239	0.0238
Barium (Ba)-Total	03-29	0.0243	0.0242	0.0248	0.0242	0.0242	0.0240
Barium (Ba)-Total	07-(20_21)	0.0189	0.0187	0.0188	0.0184	0.0188	0.0186
Barium (Ba)-Total	10-(19_20)	0.0177	0.0179	0.0174	0.0174	0.0174	0.0176

Table 17: Water quality Beryllium (Be)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Beryllium (Be)-Dissolved	03-11	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Beryllium (Be)-Dissolved	03-12	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Beryllium (Be)-Dissolved	03-17	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Beryllium (Be)-Dissolved	03-18	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Beryllium (Be)-Dissolved	03-29	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Beryllium (Be)-Dissolved	07-(20_21)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Beryllium (Be)-Dissolved	10-(19_20)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050

Table 18: Water quality Beryllium (Be)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Beryllium (Be)-Total	03-11	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Beryllium (Be)-Total	03-12	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Beryllium (Be)-Total	03-17	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Beryllium (Be)-Total	03-18	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Beryllium (Be)-Total	03-29	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Beryllium (Be)-Total	07-(20_21)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Beryllium (Be)-Total	10-(19_20)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050

Table 19: Water quality Bismuth (Bi)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Bismuth (Bi)-Dissolved	03-11	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)-Dissolved	03-12	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)-Dissolved	03-17	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)-Dissolved	03-18	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)-Dissolved	03-29	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)-Dissolved	07-(20_21)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)-Dissolved	10-(19_20)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050

Table 20: Water quality Bismuth (Bi)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Bismuth (Bi)-Total	03-11	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)-Total	03-12	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)-Total	03-17	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)-Total	03-18	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)-Total	03-29	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)-Total	07-(20_21)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)-Total	10-(19_20)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050

Table 21: Water quality BOD results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
BOD	03-11	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
BOD	03-12	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
BOD	03-17	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
BOD	03-18	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
BOD	03-29	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
BOD	07-(20_21)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
BOD	10-(19_20)	<2.0	<2.0	<2.0	<2.0	<2.0	4.4

Table 22: Water quality Boron (B)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Boron (B)-Dissolved	03-11	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Boron (B)-Dissolved	03-12	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Boron (B)-Dissolved	03-17	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Boron (B)-Dissolved	03-18	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Boron (B)-Dissolved	03-29	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Boron (B)-Dissolved	07-(20_21)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Boron (B)-Dissolved	10-(19_20)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Table 23: Water quality Boron (B)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Boron (B)-Total	03-11	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Boron (B)-Total	03-12	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Boron (B)-Total	03-17	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Boron (B)-Total	03-18	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Boron (B)-Total	03-29	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Boron (B)-Total	07-(20_21)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Boron (B)-Total	10-(19_20)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Table 24: Water quality Bromide (Br) results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Bromide (Br)	03-11	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Bromide (Br)	03-12	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Bromide (Br)	03-17	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Bromide (Br)	03-18	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Bromide (Br)	03-29	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Bromide (Br)	07-(20_21)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050

Table 25: Water quality Cadmium (Cd)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Cadmium (Cd)-Dissolved	03-11	0.0000073	0.0000204	0.000345	0.0000478	0.0000176	0.0000192
Cadmium (Cd)-Dissolved	03-12	0.0000124	0.0000151	0.000389	0.0000472	0.0000232	0.0000154
Cadmium (Cd)-Dissolved	03-17	0.0000086	0.0000200	0.000186	0.0000378	0.0000177	0.0000188
Cadmium (Cd)-Dissolved	03-18	0.0000094	0.0000239	0.000215	0.0000372	0.0000159	0.0000215
Cadmium (Cd)-Dissolved	03-29	0.0000094	0.0000263	0.000330	0.0000458	0.0000211	0.0000184
Cadmium (Cd)-Dissolved	07-(20_21)	0.0000068	0.0000089	0.0000524	0.0000155	0.0000083	0.0000063
Cadmium (Cd)-Dissolved	10-(19_20)	0.0000080	0.0000085	0.000203	0.0000268	0.0000116	0.0000108

Table 26: Water quality Cadmium (Cd)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Cadmium (Cd)-Total	03-11	0.0000102	0.0000245	0.000358	0.0000537	0.0000199	0.0000193
Cadmium (Cd)-Total	03-12	0.0000144	0.0000225	0.000420	0.0000574	0.0000281	0.0000224
Cadmium (Cd)-Total	03-17	0.0000109	0.0000287	0.000206	0.0000453	0.0000213	0.0000196
Cadmium (Cd)-Total	03-18	0.0000098	0.0000265	0.000224	0.0000411	0.0000207	0.0000243
Cadmium (Cd)-Total	03-29	0.0000128	0.0000370	0.000339	0.0000595	0.0000250	0.0000243
Cadmium (Cd)-Total	07-(20_21)	0.0000092	0.0000162	0.0000605	0.0000162	0.0000110	0.0000126
Cadmium (Cd)-Total	10-(19_20)	0.0000079	0.0000080	0.000191	0.0000328	0.0000144	0.0000137

Table 27: Water quality Calcium (Ca)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Calcium (Ca)-Dissolved	03-11	19.8	20.4	21.0	21.3	20.6	19.2
Calcium (Ca)-Dissolved	03-12	19.6	20.8	20.9	20.0	20.3	20.4
Calcium (Ca)-Dissolved	03-17	22.3	21.7	23.5	21.8	21.1	21.7
Calcium (Ca)-Dissolved	03-18	21.6	22.2	23.3	21.6	21.8	21.8
Calcium (Ca)-Dissolved	03-29	19.6	19.5	21.5	19.8	19.6	19.4
Calcium (Ca)-Dissolved	07-(20_21)	16.5	17.3	16.8	16.9	16.4	16.4
Calcium (Ca)-Dissolved	10-(19_20)	17.2	16.6	18.6	17.0	17.3	17.0

Table 28: Water quality Calcium (Ca)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Calcium (Ca)-Total	03-11	20.4	21.2	22.0	21.0	20.9	21.4
Calcium (Ca)-Total	03-12	20.8	21.1	22.3	21.0	20.7	19.7
Calcium (Ca)-Total	03-17	21.4	22.4	23.3	22.0	22.1	21.4
Calcium (Ca)-Total	03-18	21.7	21.1	23.2	21.7	21.4	21.4
Calcium (Ca)-Total	03-29	21.2	20.7	23.3	21.3	21.1	21.4
Calcium (Ca)-Total	07-(20_21)	18.4	17.9	18.3	17.8	17.9	17.5
Calcium (Ca)-Total	10-(19_20)	17.1	16.9	18.1	17.0	16.8	16.5

Table 29: Water quality Cesium (Cs)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Cesium (Cs)-Dissolved	03-11	0.0000129	0.0000124	0.000307	0.0000511	0.0000253	0.0000209
Cesium (Cs)-Dissolved	03-12	0.0000153	0.0000128	0.000260	0.0000453	0.0000221	0.0000206
Cesium (Cs)-Dissolved	03-17	0.0000146	0.0000127	0.000266	0.0000616	0.0000299	0.0000265
Cesium (Cs)-Dissolved	03-18	0.0000156	0.0000133	0.000219	0.0000410	0.0000227	0.0000245
Cesium (Cs)-Dissolved	03-29	0.0000145	0.0000132	0.000165	0.0000379	0.0000206	0.0000217
Cesium (Cs)-Dissolved	07-(20_21)	0.0000130	0.0000123	0.0000209	0.0000319	0.0000130	0.0000128
Cesium (Cs)-Dissolved	10-(19_20)	0.0000136	0.0000124	0.000179	0.0000150	0.0000258	0.0000217

Table 30: Water quality Cesium (Cs)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Cesium (Cs)-Total	03-11	0.0000136	0.0000131	0.000329	0.0000522	0.0000251	0.0000220
Cesium (Cs)-Total	03-12	0.0000154	0.0000139	0.000270	0.0000516	0.0000248	0.0000236
Cesium (Cs)-Total	03-17	0.0000156	0.0000148	0.000264	0.0000622	0.0000305	0.0000270
Cesium (Cs)-Total	03-18	0.0000162	0.0000135	0.000170	0.0000434	0.0000219	0.0000276
Cesium (Cs)-Total	03-29	0.0000153	0.0000142	0.000167	0.0000402	0.0000238	0.0000217
Cesium (Cs)-Total	07-(20_21)	0.0000142	0.0000140	0.0000202	0.0000299	0.0000140	0.0000130
Cesium (Cs)-Total	10-(19_20)	0.0000154	0.0000144	0.000184	0.0000156	0.0000275	0.0000209

Table 31: Water quality Chloride (Cl) results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Chloride (Cl)	03-11	0.87	1.01	1.29	0.96	0.90	0.91
Chloride (Cl)	03-12	0.86	1.00	1.29	0.94	0.89	0.91
Chloride (Cl)	03-17	0.83	0.89	1.22	0.94	0.87	0.88
Chloride (Cl)	03-18	0.86	0.94	1.17	0.96	0.90	0.91
Chloride (Cl)	03-29	1.52	0.92	1.45	0.94	0.85	0.88
Chloride (Cl)	07-(20_21)	0.58	0.56	0.71	0.61	0.54	0.55

Table 32: Water quality Chromium (Cr)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Chromium (Cr)-Dissolved	03-11	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium (Cr)-Dissolved	03-12	<0.00010	<0.00010	0.00013	<0.00010	<0.00010	<0.00010
Chromium (Cr)-Dissolved	03-17	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium (Cr)-Dissolved	03-18	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium (Cr)-Dissolved	03-29	<0.00010	<0.00010	0.00010	<0.00010	<0.00010	<0.00010
Chromium (Cr)-Dissolved	07-(20_21)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium (Cr)-Dissolved	10-(19_20)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010

Table 33: Water quality Chromium (Cr)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Chromium (Cr)-Total	03-11	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium (Cr)-Total	03-12	<0.00010	<0.00010	0.00014	<0.00010	<0.00010	<0.00010
Chromium (Cr)-Total	03-17	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium (Cr)-Total	03-18	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium (Cr)-Total	03-29	<0.00010	<0.00010	0.00011	<0.00010	<0.00010	<0.00010
Chromium (Cr)-Total	07-(20_21)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium (Cr)-Total	10-(19_20)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010

Table 34: Water quality Cobalt (Co)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Cobalt (Co)-Dissolved	03-11	0.0000068	0.0000067	0.0000122	0.0000051	0.0000080	0.0000077
Cobalt (Co)-Dissolved	03-12	0.0000074	0.0000076	0.0000110	0.0000087	0.0000074	0.0000072
Cobalt (Co)-Dissolved	03-17	0.0000074	<0.0000050	0.0000106	<0.0000050	0.0000090	0.0000058
Cobalt (Co)-Dissolved	03-18	0.0000077	0.0000080	0.0000107	0.0000074	0.0000058	0.0000070
Cobalt (Co)-Dissolved	03-29	0.0000088	0.0000078	0.0000137	0.0000085	0.0000088	0.0000074
Cobalt (Co)-Dissolved	07-(20_21)	0.0000079	0.0000098	0.0000076	0.0000079	0.0000076	0.0000086
Cobalt (Co)-Dissolved	10-(19_20)	0.0000056	0.0000064	0.0000135	0.0000081	0.0000063	0.0000067

Table 35: Water quality Cobalt (Co)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Cobalt (Co)-Total	03-11	0.0000109	0.0000125	0.0000105	0.0000083	0.0000099	0.0000117
Cobalt (Co)-Total	03-12	0.0000115	0.0000087	0.0000193	0.0000109	0.0000116	0.0000102
Cobalt (Co)-Total	03-17	0.0000092	0.0000083	0.0000105	0.0000075	0.0000092	0.0000138
Cobalt (Co)-Total	03-18	0.0000118	0.0000100	0.0000239	0.0000115	0.0000113	0.0000117
Cobalt (Co)-Total	03-29	0.0000113	0.0000121	0.0000192	0.0000125	0.0000129	0.0000114
Cobalt (Co)-Total	07-(20_21)	0.0000139	0.0000134	0.0000154	0.0000124	0.0000104	0.0000138
Cobalt (Co)-Total	10-(19_20)	0.0000082	0.0000081	0.0000213	0.0000124	0.0000101	0.0000075

Table 36: Water quality COD results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
COD	03-11	<20	<20	<20	<20	<20	<20
COD	03-12	<20	<20	<20	<20	<20	<20
COD	03-17	<20	<20	<20	<20	<20	<20
COD	03-18	<20	<20	<20	<20	<20	<20
COD	03-29	<20	22	<20	<20	<20	<20
COD	07-(20_21)	<20	<20	<20	<20	<20	<20
COD	10-(19_20)	<20	<20	<20	<20	<20	<20

Table 37: Water quality Conductivity results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Conductivity	03-11	153	155	178	156	155	156
Conductivity	03-12	156	155	173	156	153	155
Conductivity	03-17	154	153	176	158	155	155
Conductivity	03-18	154	155	176	159	156	158
Conductivity	03-29	155	149	174	156	151	152
Conductivity	07-(20_21)	129	131	133	133	130	129
Conductivity	10-(19_20)	126	128	150	129	127	127

Table 38: Water quality Copper (Cu)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Copper (Cu)-Dissolved	03-11	0.000299	0.000304	0.000823	0.000372	0.000363	0.000309
Copper (Cu)-Dissolved	03-12	0.000303	0.000282	0.000995	0.000352	0.000350	0.000340
Copper (Cu)-Dissolved	03-17	0.000282	0.000275	0.000565	0.000331	0.000297	0.000317
Copper (Cu)-Dissolved	03-18	0.000252	0.000310	0.000634	0.000360	0.000316	0.000317
Copper (Cu)-Dissolved	03-29	0.000320	0.000322	0.00110	0.000388	0.000348	0.000346
Copper (Cu)-Dissolved	07-(20_21)	0.000295	0.000322	0.000399	0.000322	0.000305	0.000324
Copper (Cu)-Dissolved	10-(19_20)	0.000351	0.000375	0.000938	0.000329	0.000323	0.000449

Table 39: Water quality Copper (Cu)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Copper (Cu)-Total	03-11	0.000321	0.000309	0.000865	0.000383	0.000380	0.000342
Copper (Cu)-Total	03-12	0.000313	0.000313	0.00119	0.000376	0.000418	0.000361
Copper (Cu)-Total	03-17	0.000310	0.000312	0.000636	0.000332	0.000326	0.000325
Copper (Cu)-Total	03-18	0.000286	0.000297	0.000658	0.000366	0.000336	0.000341
Copper (Cu)-Total	03-29	0.000321	0.000331	0.00127	0.000436	0.000410	0.000377
Copper (Cu)-Total	07-(20_21)	0.000332	0.000306	0.000438	0.000309	0.000330	0.000316
Copper (Cu)-Total	10-(19_20)	0.000270	0.000293	0.000850	0.000359	0.000313	0.000452

Table 40: Water quality Dissolved Organic Carbon results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Dissolved Organic Carbon	03-11	0.87	0.97	0.87	0.88	0.97	0.94
Dissolved Organic Carbon	03-12	0.93	1.27	1.06	1.08	1.09	1.28
Dissolved Organic Carbon	03-17	1.20	1.26	1.28	1.17	1.16	1.21
Dissolved Organic Carbon	03-18	1.24	1.17	1.18	1.16	1.26	1.32
Dissolved Organic Carbon	03-29	1.22	1.22	1.16	1.24	1.10	1.46
Dissolved Organic Carbon	07-(20_21)	1.23	0.86	1.14	1.18	1.07	1.02
Dissolved Organic Carbon	10-(19_20)	1.18	1.18	1.25	1.24	1.20	2.87

Table 41: Water quality Fluoride (F) results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Fluoride (F)	03-11	0.070	0.082	0.157	0.086	0.074	0.076
Fluoride (F)	03-12	0.071	0.086	0.160	0.088	0.074	0.072
Fluoride (F)	03-17	0.071	0.071	0.148	0.084	0.075	0.075
Fluoride (F)	03-18	0.069	0.074	0.148	0.086	0.075	0.078
Fluoride (F)	03-29	0.069	0.070	0.155	0.087	0.075	0.076
Fluoride (F)	07-(20_21)	0.068	0.067	0.091	0.075	0.065	0.066

Table 42: Water quality Gallium (Ga)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Gallium (Ga)-Dissolved	03-11	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Gallium (Ga)-Dissolved	03-12	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Gallium (Ga)-Dissolved	03-17	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Gallium (Ga)-Dissolved	03-18	<0.000050	<0.000050	0.000052	<0.000050	<0.000050	<0.000050
Gallium (Ga)-Dissolved	03-29	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Gallium (Ga)-Dissolved	07-(20_21)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Gallium (Ga)-Dissolved	10-(19_20)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050

Table 43: Water quality Gallium (Ga)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Gallium (Ga)-Total	03-11	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Gallium (Ga)-Total	03-12	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Gallium (Ga)-Total	03-17	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Gallium (Ga)-Total	03-18	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Gallium (Ga)-Total	03-29	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Gallium (Ga)-Total	07-(20_21)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Gallium (Ga)-Total	10-(19_20)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050

Table 44: Water quality Hardness (as CaCO3) results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Hardness (as CaCO3)	03-11	72.4	73.8	74.6	74.6	74.0	69.8
Hardness (as CaCO3)	03-12	70.4	73.6	74.4	72.7	72.8	73.2
Hardness (as CaCO3)	03-17	76.9	75.3	80.2	75.9	74.0	75.9
Hardness (as CaCO3)	03-18	75.5	76.4	80.0	75.2	76.0	75.8
Hardness (as CaCO3)	03-29	68.8	68.2	74.2	69.0	68.7	68.0
Hardness (as CaCO3)	07-(20_21)	57.3	59.7	57.6	58.2	56.5	56.8
Hardness (as CaCO3)	10-(19_20)	59.1	57.3	62.8	58.1	59.0	58.4

Table 45: Water quality Iron (Fe)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Iron (Fe)-Dissolved	03-11	0.0021	0.0019	0.0021	0.0019	0.0020	0.0025
Iron (Fe)-Dissolved	03-12	0.0021	0.0019	0.0021	0.0019	0.0019	0.0018
Iron (Fe)-Dissolved	03-17	0.0015	0.0016	0.0022	0.0018	0.0017	0.0018
Iron (Fe)-Dissolved	03-18	0.0017	0.0019	0.0019	0.0019	0.0020	0.0020
Iron (Fe)-Dissolved	03-29	0.0030	0.0030	0.0029	0.0030	0.0029	0.0030
Iron (Fe)-Dissolved	07-(20_21)	0.0019	0.0022	0.0021	0.0020	0.0020	0.0023
Iron (Fe)-Dissolved	10-(19_20)	0.0022	0.0022	0.0022	0.0022	0.0020	0.0020

Table 46: Water quality Iron (Fe)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Iron (Fe)-Total	03-11	0.0065	0.0094	0.0065	0.0061	0.0064	0.0060
Iron (Fe)-Total	03-12	0.0071	0.0077	0.0087	0.0067	0.0070	0.0064
Iron (Fe)-Total	03-17	0.0066	0.0057	0.0059	0.0060	0.0063	0.0058
Iron (Fe)-Total	03-18	0.0060	0.0067	0.0061	0.0064	0.0057	0.0062
Iron (Fe)-Total	03-29	0.0084	0.0095	0.0089	0.0097	0.0102	0.0090
Iron (Fe)-Total	07-(20_21)	0.0094	0.0095	0.0110	0.0092	0.0092	0.0091
Iron (Fe)-Total	10-(19_20)	0.0078	0.0086	0.0096	0.0091	0.0076	0.0078

Table 47: Water quality Lanthanum (La)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Lanthanum (La)-Dissolved	03-11	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Lanthanum (La)-Dissolved	03-12	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Lanthanum (La)-Dissolved	03-17	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Lanthanum (La)-Dissolved	03-18	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Lanthanum (La)-Dissolved	03-29	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Lanthanum (La)-Dissolved	07-(20_21)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Lanthanum (La)-Dissolved	10-(19_20)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010

Table 48: Water quality Lanthanum (La)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Lanthanum (La)-Total	03-11	0.000015	0.000025	0.000014	0.000013	0.000013	0.000012
Lanthanum (La)-Total	03-12	0.000014	0.000016	0.000016	0.000014	0.000015	0.000012
Lanthanum (La)-Total	03-17	0.000014	0.000014	0.000014	0.000012	0.000015	0.000012
Lanthanum (La)-Total	03-18	0.000015	0.000014	0.000012	0.000015	0.000032	0.000013
Lanthanum (La)-Total	03-29	0.000015	0.000018	0.000016	0.000017	0.000019	0.000015
Lanthanum (La)-Total	07-(20_21)	0.000023	0.000018	0.000020	0.000021	0.000021	0.000018
Lanthanum (La)-Total	10-(19_20)	0.000012	0.000014	0.000012	0.000013	0.000015	0.000013

Table 49: Water quality Lead (Pb)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Lead (Pb)-Dissolved	03-11	0.000017	0.000039	0.000394	0.000053	0.000027	0.000029
Lead (Pb)-Dissolved	03-12	0.000024	0.000021	0.000378	0.000050	0.000033	0.000025
Lead (Pb)-Dissolved	03-17	0.000012	0.000018	0.000241	0.000049	0.000022	0.000019
Lead (Pb)-Dissolved	03-18	0.000013	0.000021	0.000247	0.000039	0.000023	0.000024
Lead (Pb)-Dissolved	03-29	0.000013	0.000021	0.000484	0.000074	0.000026	0.000028
Lead (Pb)-Dissolved	07-(20_21)	0.000036	0.000042	0.000291	0.000061	0.000036	0.000029
Lead (Pb)-Dissolved	10-(19_20)	0.000012	0.000015	0.000286	0.000038	0.000024	0.000018

Table 50: Water quality Lead (Pb)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Lead (Pb)-Total	03-11	0.000040	0.000384	0.000737	0.000140	0.000077	0.000075
Lead (Pb)-Total	03-12	0.000047	0.000069	0.000802	0.000130	0.000119	0.000059
Lead (Pb)-Total	03-17	0.000045	0.000072	0.000469	0.000242	0.000069	0.000066
Lead (Pb)-Total	03-18	0.000047	0.000091	0.000431	0.000113	0.000080	0.000082
Lead (Pb)-Total	03-29	0.000041	0.000087	0.000784	0.000322	0.000119	0.000085
Lead (Pb)-Total	07-(20_21)	0.000055	0.000158	0.000509	0.000118	0.000078	0.000071
Lead (Pb)-Total	10-(19_20)	0.000030	0.000056	0.000606	0.000150	0.000062	0.000069

Table 51: Water quality Lithium (Li)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Lithium (Li)-Dissolved	03-11	0.00125	0.00134	0.00131	0.00134	0.00127	0.00125
Lithium (Li)-Dissolved	03-12	0.00125	0.00125	0.00131	0.00128	0.00123	0.00127
Lithium (Li)-Dissolved	03-17	0.00135	0.00133	0.00140	0.00135	0.00132	0.00132
Lithium (Li)-Dissolved	03-18	0.00134	0.00134	0.00142	0.00134	0.00135	0.00134
Lithium (Li)-Dissolved	03-29	0.00132	0.00132	0.00147	0.00135	0.00136	0.00134
Lithium (Li)-Dissolved	07-(20_21)	0.00104	0.00100	0.00102	0.00105	0.00104	0.00106
Lithium (Li)-Dissolved	10-(19_20)	0.00110	0.00107	0.00113	0.00105	0.00108	0.00107

Table 52: Water quality Lithium (Li)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Lithium (Li)-Total	03-11	0.00132	0.00135	0.00138	0.00133	0.00133	0.00135
Lithium (Li)-Total	03-12	0.00129	0.00137	0.00143	0.00129	0.00129	0.00132
Lithium (Li)-Total	03-17	0.00140	0.00135	0.00142	0.00136	0.00135	0.00134
Lithium (Li)-Total	03-18	0.00135	0.00134	0.00143	0.00140	0.00137	0.00137
Lithium (Li)-Total	03-29	0.00130	0.00130	0.00140	0.00136	0.00131	0.00132
Lithium (Li)-Total	07-(20_21)	0.00110	0.00109	0.00108	0.00107	0.00107	0.00105
Lithium (Li)-Total	10-(19_20)	0.00109	0.00106	0.00115	0.00108	0.00107	0.00103

Table 53: Water quality Magnesium (Mg)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Magnesium (Mg)-Dissolved	03-11	5.58	5.56	5.38	5.19	5.48	5.30
Magnesium (Mg)-Dissolved	03-12	5.22	5.26	5.40	5.52	5.38	5.42
Magnesium (Mg)-Dissolved	03-17	5.15	5.12	5.23	5.21	5.19	5.27
Magnesium (Mg)-Dissolved	03-18	5.24	5.09	5.31	5.17	5.25	5.20
Magnesium (Mg)-Dissolved	03-29	4.83	4.75	4.97	4.76	4.81	4.76
Magnesium (Mg)-Dissolved	07-(20_21)	3.91	4.00	3.81	3.90	3.78	3.86
Magnesium (Mg)-Dissolved	10-(19_20)	3.92	3.86	3.98	3.80	3.84	3.88

Table 54: Water quality Magnesium (Mg)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Magnesium (Mg)-Total	03-11	5.48	5.37	5.48	5.35	5.56	5.61
Magnesium (Mg)-Total	03-12	5.38	5.55	5.53	5.61	5.55	5.27
Magnesium (Mg)-Total	03-17	5.35	5.46	5.32	5.23	5.22	5.29
Magnesium (Mg)-Total	03-18	5.42	5.31	5.45	5.40	5.30	5.32
Magnesium (Mg)-Total	03-29	4.93	4.86	5.11	4.95	5.15	4.99
Magnesium (Mg)-Total	07-(20_21)	4.61	4.48	4.36	4.47	4.51	4.48
Magnesium (Mg)-Total	10-(19_20)	3.93	3.88	3.90	3.84	3.95	3.86

Table 55: Water quality Manganese (Mn)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Manganese (Mn)-Dissolved	03-11	0.000909	0.000979	0.00188	0.00114	0.00108	0.00107
Manganese (Mn)-Dissolved	03-12	0.000875	0.000865	0.00211	0.00117	0.00102	0.00105
Manganese (Mn)-Dissolved	03-17	0.000812	0.000845	0.00205	0.00112	0.00101	0.000994
Manganese (Mn)-Dissolved	03-18	0.000846	0.000864	0.00211	0.00115	0.00107	0.00104
Manganese (Mn)-Dissolved	03-29	0.000906	0.000916	0.00224	0.00127	0.00116	0.00113
Manganese (Mn)-Dissolved	07-(20_21)	0.000338	0.000329	0.000341	0.000378	0.000256	0.000282
Manganese (Mn)-Dissolved	10-(19_20)	0.000461	0.000434	0.00384	0.000933	0.000690	0.000635

Table 56: Water quality Manganese (Mn)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Manganese (Mn)-Total	03-11	0.00160	0.00193	0.00270	0.00185	0.00173	0.00177
Manganese (Mn)-Total	03-12	0.00167	0.00175	0.00320	0.00188	0.00187	0.00179
Manganese (Mn)-Total	03-17	0.00164	0.00161	0.00282	0.00190	0.00178	0.00172
Manganese (Mn)-Total	03-18	0.00156	0.00163	0.00308	0.00202	0.00182	0.00182
Manganese (Mn)-Total	03-29	0.00194	0.00205	0.00377	0.00254	0.00250	0.00228
Manganese (Mn)-Total	07-(20_21)	0.00151	0.00142	0.00160	0.00152	0.00146	0.00145
Manganese (Mn)-Total	10-(19_20)	0.00135	0.00134	0.00502	0.00209	0.00156	0.00158

Table 57: Water quality Mercury (Hg)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Mercury (Hg)-Dissolved	03-11	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Mercury (Hg)-Dissolved	03-12	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Mercury (Hg)-Dissolved	03-17	<0.50	<0.50	0.64	<0.50	<0.50	<0.50
Mercury (Hg)-Dissolved	03-18	<0.50	<0.50	0.59	<0.50	<0.50	<0.50
Mercury (Hg)-Dissolved	03-29	<0.50	<0.50	0.54	<0.50	<0.50	<0.50
Mercury (Hg)-Dissolved	07-(20_21)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Mercury (Hg)-Dissolved	10-(19_20)	<0.50	<0.50	1.21	<0.50	<0.50	<0.50

Table 58: Water quality Mercury (Hg)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Mercury (Hg)-Total	03-11	<0.50	1.02	0.97	<0.50	<0.50	<0.50
Mercury (Hg)-Total	03-12	<0.50	<0.50	1.22	<0.50	0.52	<0.50
Mercury (Hg)-Total	03-17	<0.50	<0.50	2.02	7.98	<0.50	<0.50
Mercury (Hg)-Total	03-18	<0.50	<0.50	1.63	<0.50	<0.50	<0.50
Mercury (Hg)-Total	03-29	<0.50	0.68	2.37	0.96	0.53	0.57
Mercury (Hg)-Total	07-(20_21)	<0.50	<0.50	1.79	<0.50	<0.50	<0.50
Mercury (Hg)-Total	10-(19_20)	<0.50	<0.50	3.32	0.75	0.76	<0.50

Table 59: Water quality Molybdenum (Mo)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Molybdenum (Mo)-Dissolved	03-11	0.000527	0.000561	0.000552	0.000519	0.000479	0.000530
Molybdenum (Mo)-Dissolved	03-12	0.000535	0.000547	0.000577	0.000526	0.000512	0.000516
Molybdenum (Mo)-Dissolved	03-17	0.000501	0.000505	0.000618	0.000553	0.000529	0.000541
Molybdenum (Mo)-Dissolved	03-18	0.000535	0.000558	0.000642	0.000560	0.000528	0.000548
Molybdenum (Mo)-Dissolved	03-29	0.000546	0.000549	0.000620	0.000553	0.000542	0.000547
Molybdenum (Mo)-Dissolved	07-(20_21)	0.000483	0.000512	0.000503	0.000497	0.000492	0.000496
Molybdenum (Mo)-Dissolved	10-(19_20)	0.000539	0.000535	0.000707	0.000553	0.000530	0.000511

Table 60: Water quality Molybdenum (Mo)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Molybdenum (Mo)-Total	03-11	0.000511	0.000539	0.000614	0.000542	0.000529	0.000510
Molybdenum (Mo)-Total	03-12	0.000523	0.000542	0.000616	0.000565	0.000542	0.000512
Molybdenum (Mo)-Total	03-17	0.000546	0.000523	0.000622	0.000546	0.000535	0.000529
Molybdenum (Mo)-Total	03-18	0.000577	0.000558	0.000642	0.000582	0.000550	0.000560
Molybdenum (Mo)-Total	03-29	0.000586	0.000588	0.000674	0.000605	0.000602	0.000607
Molybdenum (Mo)-Total	07-(20_21)	0.000514	0.000506	0.000511	0.000509	0.000491	0.000523
Molybdenum (Mo)-Total	10-(19_20)	0.000531	0.000504	0.000723	0.000532	0.000541	0.000539

Table 61: Water quality Nickel (Ni)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Nickel (Ni)-Dissolved	03-11	0.000375	0.000355	0.000366	0.000331	0.000346	0.000344
Nickel (Ni)-Dissolved	03-12	0.000341	0.000349	0.000372	0.000367	0.000354	0.000355
Nickel (Ni)-Dissolved	03-17	0.000336	0.000339	0.000357	0.000332	0.000320	0.000364
Nickel (Ni)-Dissolved	03-18	0.000301	0.000320	0.000332	0.000328	0.000340	0.000308
Nickel (Ni)-Dissolved	03-29	0.000347	0.000360	0.000375	0.000362	0.000339	0.000334
Nickel (Ni)-Dissolved	07-(20_21)	0.000363	0.000374	0.000343	0.000353	0.000332	0.000358
Nickel (Ni)-Dissolved	10-(19_20)	0.000372	0.000402	0.000381	0.000353	0.000342	0.000333

Table 62: Water quality Nickel (Ni)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Nickel (Ni)-Total	03-11	0.000358	0.000353	0.000380	0.000355	0.000359	0.000344
Nickel (Ni)-Total	03-12	0.000363	0.000376	0.000383	0.000357	0.000397	0.000331
Nickel (Ni)-Total	03-17	0.000340	0.000381	0.000358	0.000325	0.000352	0.000352
Nickel (Ni)-Total	03-18	0.000359	0.000304	0.000364	0.000360	0.000338	0.000373
Nickel (Ni)-Total	03-29	0.000371	0.000371	0.000424	0.000383	0.000397	0.000378
Nickel (Ni)-Total	07-(20_21)	0.000380	0.000355	0.000347	0.000342	0.000331	0.000339
Nickel (Ni)-Total	10-(19_20)	0.000363	0.000359	0.000391	0.000362	0.000369	0.000356

Table 63: Water quality Niobium (Nb)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Niobium (Nb)-Dissolved	03-11	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Niobium (Nb)-Dissolved	03-12	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Niobium (Nb)-Dissolved	03-17	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Niobium (Nb)-Dissolved	03-18	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Niobium (Nb)-Dissolved	03-29	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Niobium (Nb)-Dissolved	07-(20_21)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Niobium (Nb)-Dissolved	10-(19_20)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010

Table 64: Water quality Niobium (Nb)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Niobium (Nb)-Total	03-11	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Niobium (Nb)-Total	03-12	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Niobium (Nb)-Total	03-17	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Niobium (Nb)-Total	03-18	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Niobium (Nb)-Total	03-29	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Niobium (Nb)-Total	07-(20_21)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Niobium (Nb)-Total	10-(19_20)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010

Table 65: Water quality Nitrate (as N) results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Nitrate (as N)	03-11	0.152	0.157	0.222	0.160	0.152	0.154
Nitrate (as N)	03-12	0.150	0.159	0.212	0.163	0.155	0.156
Nitrate (as N)	03-17	0.144	0.147	0.255	0.166	0.155	0.151
Nitrate (as N)	03-18	0.148	0.148	0.244	0.162	0.154	0.155
Nitrate (as N)	03-29	0.134	0.138	0.290	0.164	0.148	0.148

Table 66: Water quality Nitrite (as N) results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Nitrite (as N)	03-11	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Nitrite (as N)	03-12	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Nitrite (as N)	03-17	<0.0010	<0.0010	0.0010	<0.0010	<0.0010	<0.0010
Nitrite (as N)	03-18	<0.0010	<0.0010	0.0031	0.0010	0.0011	<0.0010
Nitrite (as N)	03-29	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Nitrite (as N)	07-(20_21)	<0.0010	<0.0010	<0.0010	0.0013	<0.0010	<0.0010

Table 67: Water quality pH results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
pH	03-17	8.08	8.09	8.11	8.10	8.09	8.09
pH	03-18	8.07	8.07	8.09	8.10	8.09	8.09
pH	03-29	7.99	8.01	8.02	8.00	7.98	8.01
pH	07-(20_21)	8.05	8.04	8.07	8.06	8.07	8.06

Table 68: Water quality Phosphorus (P)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Phosphorus (P)-Total	03-11	0.0030	0.0032	0.0034	0.0028	0.0033	0.0035
Phosphorus (P)-Total	03-12	0.0031	0.0032	0.0031	0.0023	0.0029	0.0036
Phosphorus (P)-Total	03-17	0.0028	0.0023	0.0027	0.0028	0.0025	0.0028
Phosphorus (P)-Total	03-18	0.0025	0.0029	0.0026	0.0023	0.0026	0.0026
Phosphorus (P)-Total	03-29	0.0034	0.0038	0.0042	0.0040	0.0032	0.0041
Phosphorus (P)-Total	07-(20_21)	0.0036	0.0034	0.0056	0.0035	0.0034	0.0038
Phosphorus (P)-Total	10-(19_20)	0.0049	0.0048	0.0060	0.0050	0.0046	0.0042

Table 69: Water quality Phosphorus (P)-Total Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Phosphorus (P)-Total Dissolved	03-11	<0.0020	<0.0020	<0.0020	0.0025	<0.0020	<0.0020
Phosphorus (P)-Total Dissolved	03-12	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Phosphorus (P)-Total Dissolved	03-17	0.0027	0.0032	0.0048	0.0034	0.0031	0.0033
Phosphorus (P)-Total Dissolved	03-18	0.0029	0.0032	0.0032	0.0026	0.0034	0.0030
Phosphorus (P)-Total Dissolved	03-29	<0.0020	<0.0020	0.0027	<0.0020	<0.0020	0.0028
Phosphorus (P)-Total Dissolved	07-(20_21)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Phosphorus (P)-Total Dissolved	10-(19_20)	<0.0020	0.0026	0.0037	0.0025	0.0031	0.0039

Table 70: Water quality Potassium (K)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Potassium (K)-Dissolved	03-11	0.631	0.635	0.732	0.636	0.628	0.623
Potassium (K)-Dissolved	03-12	0.626	0.632	0.716	0.644	0.620	0.644
Potassium (K)-Dissolved	03-17	0.600	0.609	0.686	0.637	0.611	0.622
Potassium (K)-Dissolved	03-18	0.608	0.605	0.681	0.614	0.613	0.614
Potassium (K)-Dissolved	03-29	0.621	0.623	0.687	0.639	0.620	0.628
Potassium (K)-Dissolved	07-(20_21)	0.568	0.600	0.565	0.586	0.568	0.574
Potassium (K)-Dissolved	10-(19_20)	0.637	0.615	0.701	0.620	0.628	0.622

Table 71: Water quality Potassium (K)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Potassium (K)-Total	03-11	0.623	0.628	0.723	0.637	0.622	0.626
Potassium (K)-Total	03-12	0.621	0.637	0.730	0.640	0.634	0.633
Potassium (K)-Total	03-17	0.621	0.634	0.701	0.632	0.630	0.627
Potassium (K)-Total	03-18	0.624	0.624	0.686	0.639	0.629	0.632
Potassium (K)-Total	03-29	0.675	0.677	0.753	0.695	0.691	0.695
Potassium (K)-Total	07-(20_21)	0.617	0.608	0.620	0.613	0.622	0.619
Potassium (K)-Total	10-(19_20)	0.630	0.646	0.689	0.634	0.631	0.632

Table 72: Water quality Rhenium (Re)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Rhenium (Re)-Dissolved	03-11	<0.0000050	<0.0000050	0.0000274	<0.0000050	<0.0000050	<0.0000050
Rhenium (Re)-Dissolved	03-12	<0.0000050	<0.0000050	0.0000247	0.0000050	<0.0000050	<0.0000050
Rhenium (Re)-Dissolved	03-17	<0.0000050	<0.0000050	0.0000203	<0.0000050	<0.0000050	<0.0000050
Rhenium (Re)-Dissolved	03-18	<0.0000050	<0.0000050	0.0000227	<0.0000050	<0.0000050	<0.0000050
Rhenium (Re)-Dissolved	03-29	<0.0000050	<0.0000050	0.0000149	<0.0000050	<0.0000050	<0.0000050
Rhenium (Re)-Dissolved	07-(20_21)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Rhenium (Re)-Dissolved	10-(19_20)	<0.0000050	<0.0000050	0.0000106	<0.0000050	<0.0000050	<0.0000050

Table 73: Water quality Rhenium (Re)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Rhenium (Re)-Total	03-11	<0.0000050	<0.0000050	0.0000255	<0.0000050	<0.0000050	<0.0000050
Rhenium (Re)-Total	03-12	<0.0000050	<0.0000050	0.0000238	<0.0000050	<0.0000050	<0.0000050
Rhenium (Re)-Total	03-17	<0.0000050	<0.0000050	0.0000216	<0.0000050	<0.0000050	<0.0000050
Rhenium (Re)-Total	03-18	<0.0000050	<0.0000050	0.0000182	<0.0000050	<0.0000050	<0.0000050
Rhenium (Re)-Total	03-29	<0.0000050	<0.0000050	0.0000172	<0.0000050	<0.0000050	<0.0000050
Rhenium (Re)-Total	07-(20_21)	<0.0000050	<0.0000050	0.0000054	<0.0000050	<0.0000050	<0.0000050
Rhenium (Re)-Total	10-(19_20)	<0.0000050	<0.0000050	0.0000109	<0.0000050	<0.0000050	<0.0000050

Table 74: Water quality Rubidium (Rb)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Rubidium (Rb)-Dissolved	03-11	0.000993	0.000982	0.00186	0.00108	0.00101	0.00102
Rubidium (Rb)-Dissolved	03-12	0.00101	0.00101	0.00170	0.00108	0.00102	0.00106
Rubidium (Rb)-Dissolved	03-17	0.000997	0.000956	0.00160	0.00110	0.00102	0.00100
Rubidium (Rb)-Dissolved	03-18	0.000968	0.000931	0.00154	0.000976	0.00101	0.00101
Rubidium (Rb)-Dissolved	03-29	0.00102	0.00100	0.00142	0.00106	0.00103	0.00103
Rubidium (Rb)-Dissolved	07-(20_21)	0.00106	0.00111	0.00108	0.00111	0.00104	0.00106
Rubidium (Rb)-Dissolved	10-(19_20)	0.00115	0.00112	0.00159	0.00116	0.00116	0.00115

Table 75: Water quality Rubidium (Rb)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Rubidium (Rb)-Total	03-11	0.00101	0.000994	0.00185	0.00114	0.00102	0.000997
Rubidium (Rb)-Total	03-12	0.00101	0.00104	0.00176	0.00113	0.00105	0.00106
Rubidium (Rb)-Total	03-17	0.00100	0.00100	0.00165	0.00113	0.00102	0.00103
Rubidium (Rb)-Total	03-18	0.00100	0.000982	0.00140	0.00105	0.00102	0.000986
Rubidium (Rb)-Total	03-29	0.00111	0.00110	0.00155	0.00119	0.00115	0.00114
Rubidium (Rb)-Total	07-(20_21)	0.00110	0.00107	0.00112	0.00111	0.00108	0.00111
Rubidium (Rb)-Total	10-(19_20)	0.00116	0.00118	0.00156	0.00115	0.00115	0.00118

Table 76: Water quality Selenium (Se)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Selenium (Se)-Dissolved	03-11	0.000298	0.000276	0.00179	0.000535	0.000363	0.000371
Selenium (Se)-Dissolved	03-12	0.000296	0.000278	0.00196	0.000531	0.000379	0.000356
Selenium (Se)-Dissolved	03-17	0.000300	0.000261	0.00143	0.000447	0.000343	0.000314
Selenium (Se)-Dissolved	03-18	0.000263	0.000334	0.00196	0.000596	0.000369	0.000361
Selenium (Se)-Dissolved	03-29	0.000275	0.000272	0.00124	0.000474	0.000324	0.000333
Selenium (Se)-Dissolved	07-(20_21)	0.000170	0.000175	0.000461	0.000325	0.000184	0.000187
Selenium (Se)-Dissolved	10-(19_20)	0.000166	0.000204	0.00157	0.000301	0.000227	0.000238

Table 77: Water quality Selenium (Se)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Selenium (Se)-Total	03-11	0.000396	0.000297	0.00191	0.000576	0.000364	0.000332
Selenium (Se)-Total	03-12	0.000287	0.000355	0.00212	0.000550	0.000391	0.000434
Selenium (Se)-Total	03-17	0.000323	0.000347	0.00154	0.000518	0.000409	0.000401
Selenium (Se)-Total	03-18	0.000335	0.000300	0.00200	0.000563	0.000455	0.000498
Selenium (Se)-Total	07-(20_21)	0.000221	0.000149	0.000521	0.000395	0.000196	0.000227
Selenium (Se)-Total	10-(19_20)	0.000189	0.000169	0.00164	0.000304	0.000237	0.000286

Table 78: Water quality Silicon (Si)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Silicon (Si)-Dissolved	03-11	2.06	2.15	2.05	2.09	2.05	2.06
Silicon (Si)-Dissolved	03-12	1.99	2.12	2.08	2.01	2.01	2.04
Silicon (Si)-Dissolved	03-17	2.07	2.05	2.02	2.10	1.97	2.01
Silicon (Si)-Dissolved	03-18	2.04	2.16	2.16	2.05	2.09	2.08
Silicon (Si)-Dissolved	03-29	2.02	2.15	2.07	2.05	2.03	2.06
Silicon (Si)-Dissolved	07-(20_21)	1.36	1.38	1.33	1.38	1.32	1.31
Silicon (Si)-Dissolved	10-(19_20)	1.47	1.50	1.47	1.46	1.51	1.47

Table 79: Water quality Silicon (Si)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Silicon (Si)-Total	03-11	2.16	2.18	2.11	2.18	2.12	2.18
Silicon (Si)-Total	03-12	2.13	2.16	2.15	2.13	2.12	2.10
Silicon (Si)-Total	03-17	2.10	2.18	2.13	2.11	2.15	2.06
Silicon (Si)-Total	03-18	2.20	2.22	2.15	2.24	2.20	2.16
Silicon (Si)-Total	03-29	2.10	2.26	2.16	2.21	2.08	2.21
Silicon (Si)-Total	07-(20_21)	1.58	1.52	1.52	1.59	1.47	1.53
Silicon (Si)-Total	10-(19_20)	1.49	1.48	1.67	1.46	1.49	1.49

Table 80: Water quality Silver (Ag)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Silver (Ag)-Dissolved	03-11	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Silver (Ag)-Dissolved	03-12	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Silver (Ag)-Dissolved	03-17	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Silver (Ag)-Dissolved	03-18	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Silver (Ag)-Dissolved	03-29	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Silver (Ag)-Dissolved	07-(20_21)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Silver (Ag)-Dissolved	10-(19_20)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050

Table 81: Water quality Silver (Ag)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Silver (Ag)-Total	03-11	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Silver (Ag)-Total	03-12	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Silver (Ag)-Total	03-17	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Silver (Ag)-Total	03-18	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Silver (Ag)-Total	03-29	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Silver (Ag)-Total	07-(20_21)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Silver (Ag)-Total	10-(19_20)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050

Table 82: Water quality Sodium (Na)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Sodium (Na)-Dissolved	03-11	1.60	1.69	4.98	2.10	1.71	1.73
Sodium (Na)-Dissolved	03-12	1.60	1.67	4.78	2.20	1.71	1.81
Sodium (Na)-Dissolved	03-17	1.43	1.48	4.69	2.05	1.65	1.67
Sodium (Na)-Dissolved	03-18	1.50	1.52	4.98	1.96	1.68	1.69
Sodium (Na)-Dissolved	03-29	1.45	1.52	3.75	1.82	1.58	1.62
Sodium (Na)-Dissolved	07-(20_21)	1.16	1.20	1.33	1.37	1.14	1.16
Sodium (Na)-Dissolved	10-(19_20)	1.48	1.46	3.97	1.68	1.59	1.56

Table 83: Water quality Sodium (Na)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Sodium (Na)-Total	03-11	1.60	1.69	5.04	2.07	1.77	1.72
Sodium (Na)-Total	03-12	1.61	1.73	4.59	2.11	1.75	1.77
Sodium (Na)-Total	03-17	1.50	1.56	4.90	2.05	1.70	1.69
Sodium (Na)-Total	03-18	1.55	1.56	4.43	2.02	1.69	1.74
Sodium (Na)-Total	03-29	1.50	1.58	3.92	1.91	1.67	1.72
Sodium (Na)-Total	07-(20_21)	1.28	1.28	1.46	1.54	1.28	1.28
Sodium (Na)-Total	10-(19_20)	1.46	1.48	3.88	1.72	1.61	1.63

Table 84: Water quality Strontium (Sr)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Strontium (Sr)-Dissolved	03-11	0.116	0.120	0.118	0.120	0.116	0.122
Strontium (Sr)-Dissolved	03-12	0.117	0.119	0.120	0.118	0.115	0.119
Strontium (Sr)-Dissolved	03-17	0.126	0.122	0.129	0.129	0.124	0.126
Strontium (Sr)-Dissolved	03-18	0.128	0.124	0.125	0.130	0.122	0.129
Strontium (Sr)-Dissolved	03-29	0.122	0.122	0.127	0.121	0.121	0.121
Strontium (Sr)-Dissolved	07-(20_21)	0.121	0.126	0.119	0.122	0.118	0.121
Strontium (Sr)-Dissolved	10-(19_20)	0.104	0.102	0.109	0.102	0.100	0.101

Table 85: Water quality Strontium (Sr)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Strontium (Sr)-Total	03-11	0.124	0.124	0.126	0.121	0.120	0.123
Strontium (Sr)-Total	03-12	0.125	0.120	0.126	0.121	0.126	0.123
Strontium (Sr)-Total	03-17	0.127	0.126	0.129	0.126	0.128	0.125
Strontium (Sr)-Total	03-18	0.122	0.125	0.130	0.129	0.125	0.126
Strontium (Sr)-Total	03-29	0.134	0.134	0.142	0.137	0.136	0.134
Strontium (Sr)-Total	07-(20_21)	0.133	0.132	0.129	0.129	0.129	0.130
Strontium (Sr)-Total	10-(19_20)	0.106	0.102	0.108	0.104	0.103	0.105

Table 86: Water quality Sulfate (SO4) results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Sulfate (SO4)	03-11	13.3	13.8	23.0	14.9	13.9	13.9
Sulfate (SO4)	03-12	13.4	13.7	22.4	14.8	13.9	13.9
Sulfate (SO4)	03-17	13.3	13.4	22.3	15.0	14.0	13.9
Sulfate (SO4)	03-18	13.3	13.4	21.9	14.9	13.9	13.9
Sulfate (SO4)	03-29	12.9	12.9	21.3	14.6	13.5	13.5
Sulfate (SO4)	07-(20_21)	11.0	11.0	12.3	11.6	10.9	10.9

Table 87: Water quality Sulfur (S)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Sulfur (S)-Dissolved	03-11	4.80	4.97	8.27	5.44	4.89	4.87
Sulfur (S)-Dissolved	03-12	4.84	4.92	8.28	5.15	4.99	4.95
Sulfur (S)-Dissolved	03-17	4.78	4.88	7.98	5.23	5.00	5.08
Sulfur (S)-Dissolved	03-18	4.74	4.70	8.41	5.36	5.28	4.84
Sulfur (S)-Dissolved	03-29	4.57	4.55	7.55	5.07	4.66	4.70
Sulfur (S)-Dissolved	07-(20_21)	3.60	3.70	4.10	3.83	3.60	3.61
Sulfur (S)-Dissolved	10-(19_20)	3.67	3.78	6.24	3.90	3.79	3.73

Table 88: Water quality Sulfur (S)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Sulfur (S)-Total	03-11	4.79	4.99	8.26	6.01	5.19	4.94
Sulfur (S)-Total	03-12	5.01	4.95	8.60	5.77	5.16	4.74
Sulfur (S)-Total	03-17	5.24	5.05	8.50	5.63	5.22	5.12
Sulfur (S)-Total	03-18	5.11	5.00	8.17	5.96	5.65	5.47
Sulfur (S)-Total	03-29	4.73	4.77	8.40	5.38	4.81	5.04
Sulfur (S)-Total	07-(20_21)	4.00	3.96	4.54	4.30	3.73	4.27
Sulfur (S)-Total	10-(19_20)	3.93	3.59	6.92	3.96	3.90	3.97

Table 89: Water quality Tantalum (Ta)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Tantalum (Ta)-Dissolved	03-11	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tantalum (Ta)-Dissolved	03-12	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tantalum (Ta)-Dissolved	03-17	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tantalum (Ta)-Dissolved	03-18	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tantalum (Ta)-Dissolved	03-29	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tantalum (Ta)-Dissolved	07-(20_21)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tantalum (Ta)-Dissolved	10-(19_20)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010

Table 90: Water quality Tantalum (Ta)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Tantalum (Ta)-Total	03-11	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tantalum (Ta)-Total	03-12	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tantalum (Ta)-Total	03-17	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tantalum (Ta)-Total	03-18	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tantalum (Ta)-Total	03-29	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tantalum (Ta)-Total	07-(20_21)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tantalum (Ta)-Total	10-(19_20)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010

Table 91: Water quality Tellurium (Te)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Tellurium (Te)-Dissolved	03-11	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tellurium (Te)-Dissolved	03-12	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tellurium (Te)-Dissolved	03-17	0.000026	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tellurium (Te)-Dissolved	03-18	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tellurium (Te)-Dissolved	03-29	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tellurium (Te)-Dissolved	07-(20_21)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tellurium (Te)-Dissolved	10-(19_20)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020

Table 92: Water quality Tellurium (Te)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Tellurium (Te)-Total	03-11	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tellurium (Te)-Total	03-12	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tellurium (Te)-Total	03-17	0.000029	<0.000020	<0.000020	<0.000020	0.000024	<0.000020
Tellurium (Te)-Total	03-18	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tellurium (Te)-Total	03-29	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tellurium (Te)-Total	07-(20_21)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tellurium (Te)-Total	10-(19_20)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020

Table 93: Water quality Thallium (Tl)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Thallium (Tl)-Dissolved	03-11	<0.0000050	<0.0000050	0.000351	0.0000560	0.0000176	0.0000149
Thallium (Tl)-Dissolved	03-12	0.0000055	<0.0000050	0.000324	0.0000486	0.0000173	0.0000161
Thallium (Tl)-Dissolved	03-17	<0.0000050	<0.0000050	0.000302	0.0000576	0.0000203	0.0000166
Thallium (Tl)-Dissolved	03-18	<0.0000050	<0.0000050	0.000366	0.0000600	0.0000206	0.0000198
Thallium (Tl)-Dissolved	03-29	0.0000052	<0.0000050	0.000652	0.000127	0.0000420	0.0000321
Thallium (Tl)-Dissolved	07-(20_21)	<0.0000050	<0.0000050	0.000631	0.0000718	0.0000362	0.0000310
Thallium (Tl)-Dissolved	10-(19_20)	<0.0000050	<0.0000050	0.000335	0.0000440	0.0000188	0.0000120

Table 94: Water quality Thallium (Tl)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Thallium (Tl)-Total	03-11	<0.0000050	<0.0000050	0.000366	0.0000587	0.0000184	0.0000156
Thallium (Tl)-Total	03-12	0.0000051	<0.0000050	0.000343	0.0000515	0.0000183	0.0000167
Thallium (Tl)-Total	03-17	<0.0000050	<0.0000050	0.000312	0.0000605	0.0000211	0.0000173
Thallium (Tl)-Total	03-18	<0.0000050	<0.0000050	0.000347	0.0000634	0.0000219	0.0000210
Thallium (Tl)-Total	03-29	0.0000053	<0.0000050	0.000697	0.000135	0.0000465	0.0000349
Thallium (Tl)-Total	07-(20_21)	<0.0000050	<0.0000050	0.000561	0.0000644	0.0000331	0.0000293
Thallium (Tl)-Total	10-(19_20)	<0.0000050	<0.0000050	0.000337	0.0000460	0.0000188	0.0000120

Table 95: Water quality Thorium (Th)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Thorium (Th)-Dissolved	03-11	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Thorium (Th)-Dissolved	03-12	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Thorium (Th)-Dissolved	03-29	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Thorium (Th)-Dissolved	07-(20_21)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Thorium (Th)-Dissolved	10-(19_20)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050

Table 96: Water quality Thorium (Th)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Thorium (Th)-Total	03-11	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Thorium (Th)-Total	03-12	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Thorium (Th)-Total	03-17	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Thorium (Th)-Total	03-18	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Thorium (Th)-Total	03-29	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Thorium (Th)-Total	07-(20_21)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Thorium (Th)-Total	10-(19_20)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050

Table 97: Water quality Tin (Sn)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Tin (Sn)-Dissolved	03-11	0.000027	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tin (Sn)-Dissolved	03-12	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tin (Sn)-Dissolved	03-17	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tin (Sn)-Dissolved	03-18	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tin (Sn)-Dissolved	03-29	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tin (Sn)-Dissolved	07-(20_21)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tin (Sn)-Dissolved	10-(19_20)	0.000046	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020

Table 98: Water quality Tin (Sn)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Tin (Sn)-Total	03-11	0.000029	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tin (Sn)-Total	03-12	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tin (Sn)-Total	03-17	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tin (Sn)-Total	03-18	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tin (Sn)-Total	07-(20_21)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Tin (Sn)-Total	10-(19_20)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020

Table 99: Water quality Titanium (Ti)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Titanium (Ti)-Dissolved	03-11	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Titanium (Ti)-Dissolved	03-12	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Titanium (Ti)-Dissolved	03-17	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Titanium (Ti)-Dissolved	03-18	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Titanium (Ti)-Dissolved	03-29	0.000054	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Titanium (Ti)-Dissolved	07-(20_21)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000065
Titanium (Ti)-Dissolved	10-(19_20)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050

Table 100: Water quality Titanium (Ti)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Titanium (Ti)-Total	03-11	0.000146	0.000274	0.000139	0.000126	0.000157	0.000124
Titanium (Ti)-Total	03-12	0.000152	0.000176	0.000335	0.000182	0.000184	0.000168
Titanium (Ti)-Total	03-17	0.000149	0.000140	0.000128	0.000157	0.000195	0.000156
Titanium (Ti)-Total	03-18	0.000142	0.000151	0.000157	0.000146	0.000123	0.000146
Titanium (Ti)-Total	03-29	0.000119	0.000200	0.000118	0.000301	0.000148	0.000126
Titanium (Ti)-Total	07-(20_21)	0.000283	0.000349	0.000322	0.000257	0.000267	0.000245
Titanium (Ti)-Total	10-(19_20)	0.000188	0.000229	0.000243	0.000270	0.000166	0.000182

Table 101: Water quality Total Dissolved Solids results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Total Dissolved Solids	03-11	86	79	91	72	78	80
Total Dissolved Solids	03-12	78	76	96	90	80	72
Total Dissolved Solids	03-17	90	92	105	92	88	91
Total Dissolved Solids	03-18	81	81	100	96	86	92
Total Dissolved Solids	03-29	91	90	87	86	86	84
Total Dissolved Solids	07-(20_21)	78	82	94	82	78	80
Total Dissolved Solids	10-(19_20)	79	68	95	76	73	75

Table 102: Water quality Total Kjeldahl Nitrogen results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Total Kjeldahl Nitrogen	03-11	0.052	0.097	0.076	0.066	0.067	0.056
Total Kjeldahl Nitrogen	03-12	0.064	0.073	0.079	0.063	0.069	0.077
Total Kjeldahl Nitrogen	03-17	0.065	0.083	0.108	0.076	0.060	0.056
Total Kjeldahl Nitrogen	03-18	0.061	0.078	0.119	0.072	0.062	0.066
Total Kjeldahl Nitrogen	03-29	0.053	0.060	0.083	0.061	0.060	0.063
Total Kjeldahl Nitrogen	07-(20_21)	0.073	0.060	0.071	0.080	0.063	0.068
Total Kjeldahl Nitrogen	10-(19_20)	0.080	0.075	0.130	0.112	0.079	0.067

Table 103: Water quality Total Organic Carbon results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Total Organic Carbon	03-11	0.82	0.88	0.97	0.94	0.95	0.98
Total Organic Carbon	03-12	0.93	1.25	1.20	1.10	1.24	1.04
Total Organic Carbon	03-17	1.22	1.19	1.08	1.09	1.11	1.07
Total Organic Carbon	03-18	1.07	1.14	1.08	1.07	1.13	1.07
Total Organic Carbon	03-29	1.14	1.18	1.20	1.31	1.27	1.21
Total Organic Carbon	07-(20_21)	1.12	1.25	1.10	1.06	1.12	1.02
Total Organic Carbon	10-(19_20)	1.26	1.23	1.26	1.23	1.22	3.10

Table 104: Water quality Total Suspended Solids results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Total Suspended Solids	03-11	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Total Suspended Solids	03-12	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Total Suspended Solids	03-17	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Total Suspended Solids	03-18	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Total Suspended Solids	03-29	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Total Suspended Solids	07-(20_21)	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Total Suspended Solids	10-(19_20)	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0

Table 105: Water quality Tungsten (W)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Tungsten (W)-Dissolved	03-11	0.000014	0.000015	0.000015	0.000015	0.000017	0.000016
Tungsten (W)-Dissolved	03-12	0.000017	0.000017	0.000017	0.000015	0.000015	0.000013
Tungsten (W)-Dissolved	03-17	0.000017	0.000016	0.000015	0.000016	0.000012	0.000015
Tungsten (W)-Dissolved	03-18	0.000016	0.000014	0.000016	0.000016	0.000015	0.000015
Tungsten (W)-Dissolved	03-29	0.000017	0.000018	0.000020	0.000018	0.000018	0.000017
Tungsten (W)-Dissolved	07-(20_21)	0.000015	0.000014	0.000014	0.000014	0.000014	0.000015
Tungsten (W)-Dissolved	10-(19_20)	0.000016	0.000018	0.000019	0.000018	0.000018	0.000015

Table 106: Water quality Tungsten (W)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Tungsten (W)-Total	03-11	0.000014	0.000016	0.000017	0.000018	0.000016	0.000014
Tungsten (W)-Total	03-12	0.000017	0.000014	0.000016	0.000014	0.000015	0.000015
Tungsten (W)-Total	03-17	0.000016	0.000016	0.000017	0.000013	0.000016	0.000015
Tungsten (W)-Total	03-18	0.000014	0.000016	0.000015	0.000017	0.000014	0.000016
Tungsten (W)-Total	03-29	0.000016	0.000018	0.000019	0.000018	0.000017	0.000016
Tungsten (W)-Total	07-(20_21)	0.000013	0.000012	0.000015	0.000013	0.000014	0.000014
Tungsten (W)-Total	10-(19_20)	0.000014	0.000015	0.000019	0.000016	0.000015	0.000018

Table 107: Water quality Turbidity results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Turbidity	03-11	0.17	0.28	0.19	0.28	0.18	0.14
Turbidity	03-12	0.20	0.18	0.22	0.13	0.21	0.31
Turbidity	03-17	0.19	0.25	0.17	0.29	0.21	0.23
Turbidity	03-18	0.18	0.19	0.19	0.18	0.21	0.19
Turbidity	03-29	0.24	0.33	0.30	0.27	0.30	0.28
Turbidity	07-(20_21)	0.45	0.45	0.44	0.37	0.29	0.30
Turbidity	10-(19_20)	0.28	0.33	0.25	0.32	0.27	0.23

Table 108: Water quality Uranium (U)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Uranium (U)-Dissolved	03-11	0.000528	0.000535	0.000542	0.000549	0.000540	0.000544
Uranium (U)-Dissolved	03-12	0.000518	0.000526	0.000548	0.000522	0.000527	0.000534
Uranium (U)-Dissolved	03-17	0.000531	0.000517	0.000542	0.000532	0.000536	0.000518
Uranium (U)-Dissolved	03-18	0.000551	0.000519	0.000544	0.000539	0.000540	0.000542
Uranium (U)-Dissolved	03-29	0.000558	0.000533	0.000575	0.000549	0.000552	0.000564
Uranium (U)-Dissolved	07-(20_21)	0.000472	0.000455	0.000456	0.000463	0.000457	0.000450
Uranium (U)-Dissolved	10-(19_20)	0.000410	0.000416	0.000432	0.000416	0.000412	0.000412

Table 109: Water quality Uranium (U)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Uranium (U)-Total	03-11	0.000540	0.000561	0.000561	0.000554	0.000545	0.000556
Uranium (U)-Total	03-12	0.000529	0.000544	0.000565	0.000546	0.000551	0.000544
Uranium (U)-Total	03-17	0.000545	0.000530	0.000544	0.000544	0.000536	0.000533
Uranium (U)-Total	03-18	0.000541	0.000546	0.000548	0.000553	0.000563	0.000558
Uranium (U)-Total	03-29	0.000519	0.000522	0.000563	0.000521	0.000525	0.000555
Uranium (U)-Total	07-(20_21)	0.000409	0.000421	0.000395	0.000400	0.000404	0.000413
Uranium (U)-Total	10-(19_20)	0.000422	0.000408	0.000424	0.000418	0.000409	0.000410

Table 110: Water quality Vanadium (V)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Vanadium (V)-Dissolved	03-11	0.000103	0.000110	0.000106	0.000105	0.000105	0.000104
Vanadium (V)-Dissolved	03-12	0.000097	0.000103	0.000106	0.000102	0.000096	0.000105
Vanadium (V)-Dissolved	03-17	0.000094	0.000102	0.000098	0.000099	0.000096	0.000099
Vanadium (V)-Dissolved	03-18	0.000097	0.000097	0.000100	0.000099	0.000099	0.000095
Vanadium (V)-Dissolved	03-29	0.000100	0.000110	0.000108	0.000110	0.000101	0.000103
Vanadium (V)-Dissolved	07-(20_21)	0.000128	0.000127	0.000128	0.000130	0.000119	0.000128
Vanadium (V)-Dissolved	10-(19_20)	0.000110	0.000108	0.000111	0.000106	0.000105	0.000104

Table 111: Water quality Vanadium (V)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Vanadium (V)-Total	03-11	0.000109	0.000116	0.000108	0.000110	0.000108	0.000107
Vanadium (V)-Total	03-12	0.000110	0.000113	0.000117	0.000113	0.000106	0.000110
Vanadium (V)-Total	03-17	0.000108	0.000108	0.000112	0.000108	0.000106	0.000112
Vanadium (V)-Total	03-18	0.000111	0.000111	0.000114	0.000110	0.000108	0.000110
Vanadium (V)-Total	03-29	0.000117	0.000120	0.000125	0.000118	0.000124	0.000115
Vanadium (V)-Total	07-(20_21)	0.000152	0.000153	0.000157	0.000151	0.000154	0.000156
Vanadium (V)-Total	10-(19_20)	0.000113	0.000115	0.000116	0.000118	0.000114	0.000113

Table 112: Water quality Yttrium (Y)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Yttrium (Y)-Dissolved	03-11	0.0000177	0.0000168	0.0000170	0.0000148	0.0000144	0.0000140
Yttrium (Y)-Dissolved	03-12	0.0000182	0.0000186	0.0000120	0.0000135	0.0000161	0.0000158
Yttrium (Y)-Dissolved	03-17	0.0000172	0.0000136	0.0000217	0.0000173	0.0000149	0.0000131
Yttrium (Y)-Dissolved	03-18	0.0000167	0.0000166	0.0000133	0.0000163	0.0000170	0.0000118
Yttrium (Y)-Dissolved	03-29	0.0000165	0.0000306	0.0000237	0.0000167	0.0000180	0.0000067
Yttrium (Y)-Dissolved	07-(20_21)	0.0000242	0.0000203	0.0000219	0.0000188	0.0000222	0.0000242
Yttrium (Y)-Dissolved	10-(19_20)	0.0000135	0.0000098	0.0000108	0.0000091	0.0000086	0.0000084

Table 113: Water quality Yttrium (Y)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Yttrium (Y)-Total	03-11	0.0000209	0.0000244	0.0000177	0.0000204	0.0000192	0.0000199
Yttrium (Y)-Total	03-12	0.0000192	0.0000216	0.0000256	0.0000178	0.0000227	0.0000189
Yttrium (Y)-Total	03-17	0.0000213	0.0000232	0.0000218	0.0000154	0.0000250	0.0000220
Yttrium (Y)-Total	03-18	0.0000200	0.0000176	0.0000186	0.0000219	0.0000218	0.0000240
Yttrium (Y)-Total	03-29	0.0000216	0.0000306	0.0000230	0.0000217	0.0000296	0.0000258
Yttrium (Y)-Total	07-(20_21)	0.0000230	0.0000247	0.0000254	0.0000289	0.0000272	0.0000245
Yttrium (Y)-Total	10-(19_20)	0.0000162	0.0000148	0.0000144	0.0000182	0.0000117	0.0000146

Table 114: Water quality Zinc (Zn)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Zinc (Zn)-Dissolved	03-11	0.00169	0.00164	0.00568	0.00221	0.00125	0.00120
Zinc (Zn)-Dissolved	03-12	0.00118	0.00144	0.00616	0.00170	0.00141	0.00142
Zinc (Zn)-Dissolved	03-17	0.00145	0.00278	0.00325	0.00153	0.00119	0.00218
Zinc (Zn)-Dissolved	03-18	0.00112	0.00164	0.00421	0.00162	0.00114	0.00131
Zinc (Zn)-Dissolved	03-29	0.00150	0.00213	0.00453	0.00224	0.00125	0.00131
Zinc (Zn)-Dissolved	07-(20_21)	0.00080	0.00245	0.00145	0.00256	0.00092	<0.00050
Zinc (Zn)-Dissolved	10-(19_20)	0.00343	0.00231	0.00476	0.00178	0.00101	0.00081

Table 115: Water quality Zinc (Zn)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Zinc (Zn)-Total	03-11	0.00169	0.00185	0.00728	0.00265	0.00128	0.00135
Zinc (Zn)-Total	03-12	0.00139	0.00155	0.00777	0.00260	0.00161	0.00156
Zinc (Zn)-Total	03-17	0.00151	0.00204	0.00453	0.00202	0.00195	0.00141
Zinc (Zn)-Total	03-18	0.00110	0.00248	0.00563	0.00205	0.00148	0.00165
Zinc (Zn)-Total	03-29	0.00117	0.00275	0.00720	0.00344	0.00159	0.00187
Zinc (Zn)-Total	07-(20_21)	0.00105	0.00196	0.00219	0.00167	0.00122	0.00082
Zinc (Zn)-Total	10-(19_20)	0.00129	0.00155	0.00565	0.00179	0.00102	0.00249

Table 116: Water quality Zirconium (Zr)-Dissolved results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Zirconium (Zr)-Dissolved	03-11	0.000011	0.000011	0.000014	0.000011	0.000012	0.000011
Zirconium (Zr)-Dissolved	03-12	<0.000010	0.000011	0.000011	0.000011	<0.000010	<0.000010
Zirconium (Zr)-Dissolved	03-17	0.000020	0.000012	0.000020	0.000014	0.000014	0.000014
Zirconium (Zr)-Dissolved	03-18	0.000013	0.000015	0.000017	0.000017	0.000011	0.000014
Zirconium (Zr)-Dissolved	03-29	0.000015	0.000014	0.000014	0.000013	0.000023	0.000015
Zirconium (Zr)-Dissolved	07-(20_21)	0.000012	0.000012	0.000014	0.000014	0.000013	0.000014
Zirconium (Zr)-Dissolved	10-(19_20)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010

Table 117: Water quality Zirconium (Zr)-Total results for right shallow (R-sh) samples in 2021.

Analyte	Date Sampled	Birchbank	Stoney Creek	New Bridge	Old Bridge	Maglios	Waneta
Zirconium (Zr)-Total	03-11	<0.000010	0.000010	0.000015	0.000010	<0.000010	<0.000010
Zirconium (Zr)-Total	03-12	0.000011	<0.000010	0.000022	0.000011	0.000012	0.000011
Zirconium (Zr)-Total	03-17	0.000015	0.000016	0.000014	0.000017	0.000018	0.000013
Zirconium (Zr)-Total	03-18	0.000017	0.000017	0.000016	0.000017	0.000014	0.000013
Zirconium (Zr)-Total	03-29	0.000018	0.000019	0.000019	0.000019	0.000016	0.000019
Zirconium (Zr)-Total	07-(20_21)	0.000015	0.000016	0.000018	0.000016	0.000016	0.000015
Zirconium (Zr)-Total	10-(19_20)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010

Table 118. Significant Mann Kendall results for analytes of interest in water quality samples taken in the right-hand shallows.

Site	Analyte	Season	n	Tau	p-Value
Birchbank	Aluminum (Al)-Total	Spring	10	-0.511	0.049
Birchbank	Copper (Cu)-Dissolved	Fall	8	0.691	0.025
Birchbank	Copper (Cu)-Total	Spring	10	-0.584	0.025
Birchbank	Lead (Pb)-Total	Spring	10	-0.556	0.032
Birchbank	Nickel (Ni)-Total	Summer	7	0.810	0.016
Birchbank	Selenium (Se)-Total	Fall	8	0.714	0.019
Birchbank	Sulfate (SO4)	Spring	10	0.600	0.020
Birchbank	Thallium (Tl)-Dissolved	Spring	10	0.689	0.007
Birchbank	Thallium (Tl)-Total	Spring	10	0.511	0.049
Birchbank	Total Organic Carbon	Fall	7	0.905	0.007
Maglios	Cadmium (Cd)-Dissolved	Fall	7	-0.905	0.007
Maglios	Cadmium (Cd)-Dissolved	Spring	8	-0.643	0.035
Maglios	Cadmium (Cd)-Total	Summer	7	-0.905	0.007
Maglios	Copper (Cu)-Dissolved	Spring	8	-0.714	0.019
Maglios	Nickel (Ni)-Dissolved	Spring	8	0.714	0.019
Maglios	Nickel (Ni)-Total	Spring	8	0.643	0.035
Maglios	Phosphorus (P)-Total Dissolved	Spring	8	0.945	0.002
Maglios	Selenium (Se)-Total	Summer	7	0.714	0.035
Maglios	Silver (Ag)-Total	Spring	8	-0.713	0.032
Maglios	Sulfate (SO4)	Spring	8	0.643	0.042
Maglios	Thallium (Tl)-Dissolved	Summer	7	0.810	0.016
Maglios	Thallium (Tl)-Total	Summer	7	0.905	0.007
Maglios	Total Kjeldahl Nitrogen	Spring	8	-0.714	0.019
Maglios	Total Kjeldahl Nitrogen	Summer	7	-0.781	0.023
New Bridge	Aluminum (Al)-Total	Spring	10	-0.511	0.049
New Bridge	Ammonia, Total (as N)	Summer	7	-0.878	0.010
New Bridge	Cadmium (Cd)-Dissolved	Fall	8	-0.643	0.035
New Bridge	Cadmium (Cd)-Dissolved	Spring	10	-0.556	0.032
New Bridge	Cadmium (Cd)-Dissolved	Summer	7	-0.714	0.035
New Bridge	Cadmium (Cd)-Total	Spring	10	-0.556	0.032
New Bridge	Cadmium (Cd)-Total	Summer	7	-0.810	0.016
New Bridge	Nitrate (as N)	Spring	10	0.556	0.032
New Bridge	Nitrite (as N)	Spring	10	0.609	0.034
New Bridge	Phosphorus (P)-Total	Summer	7	0.714	0.035
New Bridge	Phosphorus (P)-Total Dissolved	Spring	10	0.600	0.020
New Bridge	Selenium (Se)-Dissolved	Fall	8	0.643	0.035
New Bridge	Thallium (Tl)-Dissolved	Summer	7	0.714	0.035
New Bridge	Thallium (Tl)-Total	Summer	7	0.714	0.035
New Bridge	Zinc (Zn)-Dissolved	Fall	8	-0.618	0.046
New Bridge	Zinc (Zn)-Total	Fall	8	-0.714	0.019
New Bridge	Zinc (Zn)-Total	Summer	7	-0.810	0.016
Old Bridge	Aluminum (Al)-Dissolved	Fall	8	-0.714	0.019
Old Bridge	Cadmium (Cd)-Dissolved	Fall	8	-0.643	0.035
Old Bridge	Cadmium (Cd)-Dissolved	Spring	10	-0.600	0.020
Old Bridge	Cadmium (Cd)-Dissolved	Summer	7	-0.751	0.031
Old Bridge	Cadmium (Cd)-Total	Fall	8	-0.714	0.019
Old Bridge	Cadmium (Cd)-Total	Spring	10	-0.511	0.049
Old Bridge	Cadmium (Cd)-Total	Summer	7	-0.810	0.016
Old Bridge	Nickel (Ni)-Dissolved	Spring	10	0.511	0.049
Old Bridge	Thallium (Tl)-Dissolved	Summer	7	0.714	0.035
Stoney Creek	Ammonia, Total (as N)	Spring	10	0.511	0.049
Stoney Creek	Copper (Cu)-Dissolved	Fall	8	0.694	0.029
Stoney Creek	Nickel (Ni)-Total	Summer	7	0.714	0.035
Stoney Creek	Phosphorus (P)-Total Dissolved	Fall	8	0.645	0.046
Stoney Creek	Phosphorus (P)-Total Dissolved	Spring	10	0.584	0.025
Stoney Creek	Sulfate (SO4)	Spring	10	0.556	0.032
Stoney Creek	Thallium (Tl)-Total	Fall	8	-0.643	0.042
Waneta	Ammonia, Total (as N)	Summer	7	-0.714	0.035

Site	Analyte	Season	n	Tau	p-Value
Waneta	Cadmium (Cd)-Dissolved	Fall	8	-0.786	0.009
Waneta	Cadmium (Cd)-Total	Fall	8	-0.714	0.019
Waneta	Lead (Pb)-Dissolved	Summer	7	0.905	0.007
Waneta	Lead (Pb)-Total	Spring	12	-0.515	0.024
Waneta	Selenium (Se)-Total	Fall	8	0.643	0.035
Waneta	Sulfate (SO4)	Spring	12	0.473	0.039
Waneta	Thallium (Tl)-Dissolved	Summer	7	0.781	0.023
Waneta	Total Kjeldahl Nitrogen	Summer	7	-0.810	0.016

APPENDIX E CHLOROPHYLL A RESULTS

Table 119. Chlorophyll a test results by area and sites for 2021.

Client Sample ID	Date Sampled	Time Sampled	ALS Sample ID	chlorophyll a (µg/sample)
ERO-REF-1-1A	05-Oct-2021	21:40	VA21C3857-001	35.2
ERO-REF-1-1B	05-Oct-2021	21:45	VA21C3857-002	13.4
ERO-REF-1-1C	05-Oct-2021	21:50	VA21C3857-003	18.9
ERO-REF-1-2A	05-Oct-2021	21:30	VA21C3857-004	11.4
ERO-REF-1-2B	05-Oct-2021	21:35	VA21C3857-005	21.3
ERO-REF-1-2C	05-Oct-2021	21:40	VA21C3857-006	18.1
ERO-REF-1-3A	05-Oct-2021	21:40	VA21C3857-007	5.55
ERO-REF-1-3B	05-Oct-2021	21:45	VA21C3857-008	10.4
ERO-REF-1-3C	05-Oct-2021	21:50	VA21C3857-009	7.62
ERO-REF-1-4A	05-Oct-2021	22:00	VA21C3857-010	11.9
ERO-REF-1-4B	05-Oct-2021	22:05	VA21C3857-011	8.03
ERO-REF-1-4C	05-Oct-2021	22:10	VA21C3857-012	12.1
ERO-REF-1-5A	05-Oct-2021	22:00	VA21C3857-013	7.96
ERO-REF-1-5B	05-Oct-2021	22:05	VA21C3857-014	5.78
ERO-REF-1-5C	05-Oct-2021	22:10	VA21C3857-015	11.0
ERO-REF-2-1A	05-Oct-2021	21:30	VA21C3857-016	12.0
ERO-REF-2-1B	05-Oct-2021	21:35	VA21C3857-017	9.27
ERO-REF-2-1C	05-Oct-2021	21:40	VA21C3857-018	12.2
ERO-REF-2-2A	05-Oct-2021	22:15	VA21C3857-019	9.92
ERO-REF-2-2B	05-Oct-2021	22:20	VA21C3857-020	6.76
ERO-REF-2-2C	05-Oct-2021	22:25	VA21C3857-021	9.92
ERO-REF-2-3A	05-Oct-2021	21:30	VA21C3857-022	16.4
ERO-REF-2-3B	05-Oct-2021	21:35	VA21C3857-023	6.66
ERO-REF-2-3C	05-Oct-2021	21:40	VA21C3857-024	13.2
ERO-REF-2-4A	05-Oct-2021	22:15	VA21C3857-025	17.6
ERO-REF-2-4B	05-Oct-2021	22:20	VA21C3857-026	15.0
ERO-REF-2-4C	05-Oct-2021	22:25	VA21C3857-027	22.5
ERO-REF-2-5A	05-Oct-2021	22:30	VA21C3857-028	5.11
ERO-REF-2-5B	05-Oct-2021	22:35	VA21C3857-029	0.313
ERO-REF-2-5C	05-Oct-2021	22:40	VA21C3857-030	0.136
ERO-EXP-1-1A	05-Oct-2021	21:30	VA21C3857-031	8.05
ERO-EXP-1-1B	05-Oct-2021	21:35	VA21C3857-032	12.4
ERO-EXP-1-1C	05-Oct-2021	21:40	VA21C3857-033	13.6
ERO-EXP-1-2A	05-Oct-2021	22:30	VA21C3857-034	1.66
ERO-EXP-1-2B	05-Oct-2021	22:35	VA21C3857-035	16.8
ERO-EXP-1-2C	05-Oct-2021	19:30	VA21C3857-036	20.6
ERO-EXP-1-3A	06-Oct-2021	00:00	VA21C3857-037	13.5
ERO-EXP-1-3B	06-Oct-2021	19:35	VA21C3857-038	9.39
ERO-EXP-1-3C	06-Oct-2021	19:40	VA21C3857-039	8.40
ERO-EXP-1-4A	06-Oct-2021	20:30	VA21C3857-040	11.9
ERO-EXP-1-4B	06-Oct-2021	20:35	VA21C3857-041	8.33
ERO-EXP-1-4C	06-Oct-2021	20:40	VA21C3857-042	5.75

ERO-EXP-1-5A	06-Oct-2021	20:25	VA21C3857-043	12.2
ERO-EXP-1-5B	06-Oct-2021	20:30	VA21C3857-044	12.6
ERO-EXP-1-5C	06-Oct-2021	20:35	VA21C3857-045	13.0
ERO-EXP-2-1A	06-Oct-2021	19:30	VA21C3857-046	10.9
ERO-EXP-2-1B	06-Oct-2021	19:35	VA21C3857-047	23.6
ERO-EXP-2-1C	06-Oct-2021	19:40	VA21C3857-048	20.8
ERO-EXP-2-2A	06-Oct-2021	20:35	VA21C3857-049	15.3
ERO-EXP-2-2B	06-Oct-2021	20:40	VA21C3857-050	12.2
ERO-EXP-2-2C	06-Oct-2021	20:45	VA21C3857-051	14.8
ERO-EXP-2-4A	06-Oct-2021	19:30	VA21C3857-052	16.8
ERO-EXP-2-4B	06-Oct-2021	19:35	VA21C3857-053	9.24
ERO-EXP-2-4C	06-Oct-2021	19:40	VA21C3857-054	14.9
ERO-EXP-2-5A	06-Oct-2021	19:50	VA21C3857-055	23.0
ERO-EXP-2-5B	06-Oct-2021	19:55	VA21C3857-056	25.6
ERO-EXP-2-5C	06-Oct-2021	20:00	VA21C3857-057	22.3
ERO-EXP-3-1A	06-Oct-2021	19:40	VA21C3857-058	6.39
ERO-EXP-3-1B	06-Oct-2021	19:45	VA21C3857-059	11.9
ERO-EXP-3-1C	06-Oct-2021	19:50	VA21C3857-060	1.86
ERO-EXP-2-3A	06-Oct-2021	19:35	VA21C3857-061	11.7
ERO-EXP-2-3B	06-Oct-2021	19:40	VA21C3857-062	16.7
ERO-EXP-2-3C	06-Oct-2021	19:45	VA21C3857-063	18.6
ERO-EXP-3-2A	06-Oct-2021	19:30	VA21C3857-064	13.4
ERO-EXP-3-2B	06-Oct-2021	19:35	VA21C3857-065	9.17
ERO-EXP-3-2C	06-Oct-2021	19:40	VA21C3857-066	13.8
ERO-EXP-3-3A	06-Oct-2021	19:55	VA21C3857-067	6.77
ERO-EXP-3-3B	06-Oct-2021	20:00	VA21C3857-068	4.52
ERO-EXP-3-3C	06-Oct-2021	20:05	VA21C3857-069	4.69
ERO-EXP-3-4A	06-Oct-2021	20:10	VA21C3857-070	13.7
ERO-EXP-3-4B	06-Oct-2021	20:15	VA21C3857-071	13.8
ERO-EXP-3-4C	06-Oct-2021	20:15	VA21C3857-072	10.6
ERO-EXP-3-5A	06-Oct-2021	00:00	VA21C3857-073	7.27
ERO-EXP-3-5B	06-Oct-2021	20:20	VA21C3857-074	4.44
ERO-EXP-3-5C	06-Oct-2021	20:25	VA21C3857-075	5.74
ERO-EXP-4-1A	08-Oct-2021	12:10	VA21C3857-091	24.5
ERO-EXP-4-1B	08-Oct-2021	12:15	VA21C3857-092	12.4
ERO-EXP-4-1C	08-Oct-2021	12:20	VA21C3857-093	16.0
ERO-EXP-4-2A	08-Oct-2021	12:35	VA21C3857-094	3.95
ERO-EXP-4-2B	08-Oct-2021	12:30	VA21C3857-095	4.71
ERO-EXP-4-2C	08-Oct-2021	12:25	VA21C3857-096	5.90
ERO-EXP-4-3A	08-Oct-2021	12:00	VA21C3857-097	2.82
ERO-EXP-4-3B	08-Oct-2021	12:05	VA21C3857-098	4.67
ERO-EXP-4-3C	08-Oct-2021	12:10	VA21C3857-099	4.21
ERO-EXP-4-4A	08-Oct-2021	12:25	VA21C3857-100	3.43
ERO-EXP-4-4B	08-Oct-2021	12:30	VA21C3857-101	4.58
ERO-EXP-4-4C	08-Oct-2021	12:35	VA21C3857-102	3.53
ERO-EXP-4-5A	08-Oct-2021	11:45	VA21C3857-103	5.32
ERO-EXP-4-5B	08-Oct-2021	11:50	VA21C3857-104	10.6
ERO-EXP-4-5C	08-Oct-2021	11:55	VA21C3857-105	7.57
ERO-EXP-5-1A	07-Oct-2021	20:30	VA21C3857-106	11.7
ERO-EXP-5-1B	07-Oct-2021	20:35	VA21C3857-107	14.5

ERO-EXP-5-1C	07-Oct-2021	20:40	VA21C3857-108	14.9
ERO-EXP-5-2A	07-Oct-2021	20:50	VA21C3857-109	7.34
ERO-EXP-5-2B	07-Oct-2021	20:55	VA21C3857-110	15.4
ERO-EXP-5-2C	07-Oct-2021	21:00	VA21C3857-111	15.7
ERO-EXP-5-3A	07-Oct-2021	20:50	VA21C3857-112	7.36
ERO-EXP-5-3B	07-Oct-2021	20:55	VA21C3857-113	8.15
ERO-EXP-5-3C	07-Oct-2021	21:00	VA21C3857-114	5.71
ERO-EXP-5-4A	07-Oct-2021	20:30	VA21C3857-115	2.09
ERO-EXP-5-4B	07-Oct-2021	20:35	VA21C3857-116	1.53
ERO-EXP-5-4C	07-Oct-2021	20:40	VA21C3857-117	3.09
ERO-EXP-5-5A	07-Oct-2021	20:40	VA21C3857-118	1.58
ERO-EXP-5-5B	07-Oct-2021	20:45	VA21C3857-119	1.84
ERO-EXP-5-5C	07-Oct-2021	20:50	VA21C3857-120	4.64

APPENDIX F SEDIMENT QUALITY DATA

Table 120. Sediment quality sample metal concentrations for depositional sites in 2021.

Analyte (mg/kg dry)	Reporting Limit	DEP-EXP-1 (2mm)	DEP-EXP-1 (63um)	DEP-EXP-2 (2mm)	DEP-EXP-2 (63um)	DEP-EXP-3 (2mm)	DEP-EXP-3 (63um)	DEP-EXP-4 (2mm)	DEP-EXP-4 (63um)	DEP-EXP-5 (2mm)	DEP-EXP-5 (63um)	DEP-EXP-6 (2mm)	DEP-EXP-6 (63um)	DEP-EXP-7 (2mm)	DEP-EXP-7 (63um)	DEP-REF-1 (2mm)	DEP-REF-1 (63um)	DEP-REF-2 (2mm)	DEP-REF-2 (63um)	DEP-REF-3 (2mm)	DEP-REF-3 (63um)
Aluminum	40	5070	5730	4760	6250	8220	11100	5900	6540	5160	12300	5430	9520	7250	9970	5140	8860	6410	8260	4450	8400
Antimony	0.1	2.27	1.94	16.7	6.74	38.6	125	22.7	8.62	17.5	75.7	7.28	19.5	9.72	17.5	0.15	0.26	0.21	0.42	0.14	0.47
Arsenic	0.3	2.77	3.89	5.11	4.5	9.19	36.7	5.15	3.99	6.44	34.1	3.65	8.72	4.49	10.5	1.47	2.94	2.1	3.53	1.23	3.44
Barium	1	52.1	63.9	116	106	377	616	183	111	172	274	113	164	171	479	49	86.7	75.7	94.3	45	88.7
Beryllium	0.1	0.23	0.35	0.23	0.36	0.41	0.61	0.29	0.36	0.26	0.68	0.27	0.52	0.29	0.5	0.26	0.52	0.35	0.5	0.19	0.49
Bismuth	0.1	0.13	0.26	0.12	0.2	0.36	0.73	<0.10	0.24	0.14	1.53	0.9	0.34	<0.10	0.74	<0.10	0.16	<0.10	0.27	<0.10	0.19
Boron	2	<2.0	<2.0	3.6	<2.0	22.5	12.6	4.3	2.1	4	3.5	2.7	2	3	2.1	<2.0	<2.0	2	2.4	<2.0	<2.0
Cadmium	0.04	0.462	1.16	0.474	0.978	0.947	5.61	0.558	0.897	1.35	9.29	0.382	1.37	0.617	3.2	0.244	0.816	0.519	0.994	0.179	0.785
Calcium	100	2000	4910	4970	5440	20100	17900	6040	6100	5510	9230	4700	7620	7290	15100	2560	5890	3400	5840	2400	5760
Chromium	1	14.3	21.2	22.6	28	49.1	62.1	26.6	28.9	27.6	79.6	23.8	44.2	27.6	51.9	18	30.1	20.3	28.2	14.9	30.5
Cobalt	0.1	3.86	4.37	4.99	5.33	14.4	16.8	8.86	6.38	6.56	17.4	5.88	9.62	7.37	11.3	3.62	6.08	4.65	5.43	3.26	5.99
Copper	0.4	17.8	19.3	130	54.1	738	1130	265	78.5	221	1070	94.9	189	127	195	6.47	17.9	9.12	18.9	5.75	18.2
Iron	20	11200	13800	23400	20200	86600	72900	25700	21300	29000	75200	17600	26900	26000	36000	11600	19200	14300	18700	11400	19000
Lead	0.2	40.9	45	60.4	55	140	533	57.6	49.8	110	788	41	109	53.5	164	7.68	17.9	12	24.6	6.39	18.1
Lithium	0.1	11.2	9.75	9.16	10.5	9.18	13.7	9.54	10.7	8.16	13	10.5	14.4	9.57	13.5	12.1	17.2	15	15.1	9.57	15.8
Magnesium	10	3810	3830	3010	3960	3420	5250	3480	4180	2840	4820	4010	6650	5540	11100	3610	5640	4430	5190	3190	5380
Manganese	0.4	143	154	259	209	1480	1240	372	230	330	702	246	352	333	442	141	225	173	210	132	219
Mercury	0.04	<0.040	0.06	0.06	0.129	<0.040	0.418	0.045	0.141	0.158	3.47	0.072	0.112	<0.040	0.157	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Molybdenum	0.1	0.24	0.47	1.2	0.66	6.46	4.4	2.09	0.58	1.88	3.69	1.07	1.01	1.53	1.78	0.39	0.63	0.33	0.61	0.21	0.63
Nickel	0.6	10.5	14.7	11.2	16.6	10	19.9	11.3	16.1	12.3	32.3	14.2	24.7	14.1	26.7	10.9	20.8	15.1	19.8	10.2	20.4
Phosphorus	10	542	1350	795	1460	811	1740	920	1590	838	1470	737	1740	976	1840	721	1440	860	1440	651	1410
Potassium	40	994	954	830	1010	1360	1660	1020	1090	853	1320	1140	1510	1020	1490	1050	1430	1440	1460	884	1460

Selenium	0.2	<0.20	0.28	0.33	0.54	0.95	0.93	0.25	0.4	0.69	4.66	0.21	0.66	0.23	0.55	<0.20	0.66	<0.20	0.45	<0.20	0.51
Silver	0.1	<0.10	0.31	0.55	0.46	2.19	16.3	4.81	1.16	1.23	7.03	0.44	3.18	0.38	2.23	0.29	0.19	<0.10	0.17	<0.10	0.13
Sodium	50	104	193	138	210	474	485	220	221	184	290	158	316	293	357	111	268	138	234	99	251
Strontium	0.2	20.4	45	36.9	50.2	69.2	96.7	39.4	48.9	38	63.2	37.8	66	46.9	73.9	28.6	55.6	34.4	53.6	24.1	55.4
Sulfur	1000	<1000	<1000	<1000	<1000	1810	1200	<1000	<1000	1860	8540	<1000	1110	<1000	2230	<1000	<1000	<1000	<1000	<1000	<1000
Tellurium	0.1	<0.10	<0.10	<0.10	<0.10	<0.10	0.15	<0.10	<0.10	<0.10	0.62	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Thallium	0.1	0.16	0.16	0.12	0.14	<0.10	0.31	0.16	0.13	0.28	1.25	0.14	0.21	0.12	0.23	<0.10	0.13	0.15	0.12	<0.10	0.13
Thorium	0.5	4.5	7.31	5.07	10.3	5.81	10.7	5.14	10.1	5.87	9.08	4.37	10.3	4.69	10.5	4.35	9.26	5.22	9.15	4.88	10.7
Tin	0.2	1.2	1.86	17.6	6.89	64.1	114	24.6	6.9	27.7	161	10.5	20.7	15.8	33	0.49	1.19	0.59	1.02	0.34	1.17
Titanium	1	487	560	529	709	685	1050	655	723	557	1100	666	984	657	1080	606	899	791	751	476	839
Tungsten	0.2	0.21	0.82	0.5	1.26	3.19	3.54	1.36	1.15	1.21	2.83	0.59	1.23	0.97	4.1	0.3	0.57	0.21	0.64	0.26	0.43
Uranium	0.05	0.739	1.28	0.984	3.17	1.97	4.18	1.17	2.23	0.953	3.21	0.951	2.57	0.989	2.47	0.83	2.95	1.39	3.14	0.72	3.52
Vanadium	1	20	27.3	29.5	35.3	43.7	49.4	28.2	39.9	31.5	48.1	25.2	43.9	37.8	53.9	23.4	40.3	26.5	36.3	22.9	41.2
Zinc	2	176	188	934	380	8070	6140	1440	593	1520	5500	639	885	1030	1370	86.3	146	117	141	63.9	123
Zirconium	2	<2.0	<2.0	3	<2.0	17.2	12.1	4.3	<2.0	4.9	12.3	2.8	3.6	3.7	5.2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0

APPENDIX G PERIPHYTON TAXONOMIC DATA

Table 121. Taxonomic codes of periphyton species.

Final Code	Class	Order	Family	Genus	Species
P001	Bacillariophyceae	Achnanthales	Achnanthaceae	Achnanthidium	Achnanthidium linearis = Rossithidium
P002	Bacillariophyceae	Achnanthales	Achnanthaceae	Achnanthidium	Achnanthidium minutissima
P003	Bacillariophyceae	Achnanthales	Achnanthaceae	Achnanthidium	Achnanthidium spp.
P004	Bacillariophyceae	Pennales	Cymbellaceae	Amphora	Amphora ovalis
P005	Bacillariophyceae	Pennales	Cymbellaceae	Amphora	Amphora perpusilla
P006	Bacillariophyceae	Pennales	Cymbellaceae	Amphora	Amphora pediculus
P007	Bacillariophyceae	Pennales	Naviculaceae	Amphipleura	Amphipleura pellucida
P008	Bacillariophyceae	Pennales	Naviculaceae	Anomoeoneis	Anomoeoneis vitrea
P009	Bacillariophyceae	Fragilariales	Fragilariaceae	Asterionella	Asterionella formosa
P010	Bacillariophyceae	Centrales	Coscinodiscaceae	Aulicoseira	Aulicoseira distans
P011	Bacillariophyceae	Centrales	Coscinodiscaceae	Aulacoseira	Aulacoseira granulata
P012	Bacillariophyceae	Pennales	Naviculaceae	Caloneis	Caloneis silicula
P013	Bacillariophyceae	Achnanthales	Achnanthaceae	Cocconeis	Cocconeis fluviatilis
P014	Bacillariophyceae	Achnanthales	Achnanthaceae	Cocconeis	Cocconeis placentula
P015	Bacillariophyceae	Centrales	Coscinodiscaceae	Cyclotella	Cyclotella bodanica
P016	Bacillariophyceae	Centrales	Coscinodiscaceae	Cyclotella	Cyclotella comta
P017	Bacillariophyceae	Centrales	Coscinodiscaceae	Cyclotella	Cyclotella glomerata
P018	Bacillariophyceae	Centrales	Coscinodiscaceae	Cyclotella	Cyclotella ocellata
P019	Bacillariophyceae	Centrales	Coscinodiscaceae	Cyclotella	Cyclotella stelligera
P020	Bacillariophyceae	Pennales	Cymbellaceae	Cymbella	Cymbella cistula
P021	Bacillariophyceae	Pennales	Cymbellaceae	Cymbella	Cymbella parva
P022	Bacillariophyceae	Pennales	Cymbellaceae	Cymbella	Cymbella turgida
P023	Bacillariophyceae	Bacillariales	Epithemiaceae	Denticula	Denticula tenuis
P024	Bacillariophyceae	Fragilariales	Fragilariaceae	Diatoma	Diatoma hiemale
P025	Bacillariophyceae	Fragilariales	Fragilariaceae	Diatoma	Diatoma tenue var elongatum
P026	Bacillariophyceae	Fragilariales	Fragilariaceae	Diatoma	Diatoma vulgare
P027	Bacillariophyceae	Pennales	Cymbellaceae	Didymosphenia	Didymosphenia geminata
P028	Bacillariophyceae	Pennales	Naviculaceae	Diploneis	Diploneis elliptica
P029	Bacillariophyceae	Rhopalodiales	Rhopalodiaceae	Epithemia	Epithemia sp.
P030	Bacillariophyceae	Achnanthales	Achnanthaceae	Eucocconeis	Eucocconeis flexella
P031	Bacillariophyceae	Achnanthales	Achnanthaceae	Eucocconeis	Eucocconeis sp.
P032	Bacillariophyceae	Pennales	Eunotiaceae	Eunotia	Eunotia lunaris
P033	Bacillariophyceae	Pennales	Eunotiaceae	Eunotia	Eunotia pectinalis

Final Code	Class	Order	Family	Genus	Species
P034	Bacillariophyceae	Fragilariales	Fragilariaceae	Fragilaria	Fragilaria crotonensis
P035	Bacillariophyceae	Fragilariales	Fragilariaceae	Fragilaria	Fragilaria capucina (intermedia)
P036	Bacillariophyceae	Fragilariales	Fragilariaceae	Fragilariforma	Fragilariforma virescens
P037	Bacillariophyceae	Pennales	Naviculaceae	Frustulia	Frustulia rhomboides
P038	Bacillariophyceae	Pennales	Gomponemaceae	Gomphonema	Gomphonema ovilaceaides
P039	Bacillariophyceae	Pennales	Gomponemaceae	Gomphonema	Gomphonema sp.
P040	Bacillariophyceae	Pennales	Naviculaceae	Gyrosigma	Gyrosigma sp.
P041	Bacillariophyceae	Fragilariales	Fragilariaceae	Hannaea	Hannaea arcus
P042	Bacillariophyceae	Fragilariales	Fragilariaceae	Meridion	Meridion anceps
P043	Bacillariophyceae	Fragilariales	Fragilariaceae	Meridion	Meridion circulare
P044	Bacillariophyceae	Pennales	Naviculaceae	Navicula	Navicula gastrum
P045	Bacillariophyceae	Pennales	Naviculaceae	Navicula	Navicula radiosa
P046	Bacillariophyceae	Pennales	Naviculaceae	Navicula	Navicula tripunctata
P047	Bacillariophyceae	Pennales	Naviculaceae	Navicula	Navicula spp.
P048	Bacillariophyceae	Pennales	Naviculaceae	Neidium	Neidium bisulcatum
P049	Bacillariophyceae	Pennales	Naviculaceae	Neidium	Neidium spp.
P050	Bacillariophyceae	Bacillariales	Nitzschiaceae	Nitzschia	Nitzschia acicularis
P051	Bacillariophyceae	Bacillariales	Nitzschiaceae	Nitzschia	Nitzschia hantzschiana
P052	Bacillariophyceae	Bacillariales	Nitzschiaceae	Nitzschia	Nitzschia obtusa
P053	Bacillariophyceae	Bacillariales	Nitzschiaceae	Nitzschia	Nitzschia palea
P054	Bacillariophyceae	Bacillariales	Nitzschiaceae	Nitzschia	Nitzschia linearis
P055	Bacillariophyceae	Bacillariales	Nitzschiaceae	Nitzschia	Nitzschia - sigma
P056	Bacillariophyceae	Bacillariales	Nitzschiaceae	Nitzschia	Nitzschia sp.
P057	Bacillariophyceae	Pennales	Naviculaceae	Pinnularia	Pinnularia sp.
P058	Bacillariophyceae	Pennales	Naviculaceae	Pleurosigma	Pleurosigma sp.
P059	Bacillariophyceae	Pennales	Rhoicospheniaceae	Rhoicosphenia	Rhoicosphenia curvata
P060	Bacillariophyceae	Rhopalodiales	Rhopalodiaceae	Rhopalodia	Rhopalodia gibba
P061	Bacillariophyceae	Pennales	Naviculaceae	Stauroneis	Stauroneis phoenicenteron.
P062	Bacillariophyceae	Fragilariales	Fragilariaceae	Stauroforma	Stauroforma exiguiformis
P063	Bacillariophyceae	Fragilariales	Fragilariaceae	Staurosira	Staurosira ansata
P064	Bacillariophyceae	Fragilariales	Fragilariaceae	Staurosira	Staurosira construens v ventor
P065	Bacillariophyceae	Fragilariales	Fragilariaceae	Staurosira	Staurosira construens v. plumila
P066	Bacillariophyceae	Fragilariales	Fragilariaceae	Staurosirella	Staurosirella leptostauron
P067	Bacillariophyceae	Fragilariales	Fragilariaceae	Staurosirella	Staurosirella pinnata (cf. Fragilaria pinnata)
P068	Bacillariophyceae	Centrales	Coscinodiscaceae	Stephanodiscus	Stephanodiscus hantzschii

Final Code	Class	Order	Family	Genus	Species
P069	Bacillariophyceae	Centrales	Coscinodiscaceae	Stephanodiscus	Stephanodiscus sp
P070	Bacillariophyceae	Pennales	Fragilariaceae	Synedra	Synedra acus
P071	Bacillariophyceae	Pennales	Fragilariaceae	Synedra	Synedra acus var angustissima
P072	Bacillariophyceae	Pennales	Fragilariaceae	Synedra	Synedra nana
P073	Bacillariophyceae	Pennales	Fragilariaceae	Synedra	Synedra ulna
P074	Bacillariophyceae	Pennales	Fragilariaceae	Synedra	Synedra ulna (radiate on Didymo)
P075	Bacillariophyceae	Pennales	Suririellaceae	Surirella	Surirella ovata
P076	Bacillariophyceae	Pennales	Suririellaceae	Surirella	Surirella angusta
P077	Bacillariophyceae	Pennales	Suririellaceae	Surirella	Surirella sp.
P078	Bacillariophyceae	Pennales	Fragilariaceae	Tabellaria	Tabellaria fenestrata
P079	Bacillariophyceae	Pennales	Fragilariaceae	Tabellaria	Tabellaria flocculosa
P080	Not Identified Flagellates	Not Identified Flagellates	Not Identified Flagellates	Not Identified Flagellates	Not Identified Flagellates
P081	Chrysophyceae	Chromulinales	Chromulinaceae	Chromulina	Chromulina sp
P082	Cryptophyceae	Pyrenomonadales	Chroomonadaceae	Chroomonas	Chroomonas acuta.
P083	Prymnesiophyceae	Prymnesiales	Prymnesiaceae	Chrysochromulina	Chrysochromulina sp.
P084	Chrysophyceae	Chromulinales	Dinobryaceae	Chrysococcus	Chrysococcus sp.
P085	Cryptophyceae	Cryptomonadales	Cryptomonadaceae	Cryptomonas	Cryptomonas sp.
P086	Chrysophyceae	Chromulinales	Dinobryaceae	Dinobryon	Dinobryon divergens
P087	Chrysophyceae	Chromulinales	Dinobryaceae	Dinobryon	Dinobryon sertularia
P088	Chrysophyceae	Ochromonadales	Ochromonadaceae	Kephyrion	Kephyrion sp.
P089	Cryptophyceae	Pyrenomonadales	Scarabaeoiddea	Komma	Komma sp.
P090	Synurophyceae	Ochromonadales	Synuraceae	Mallomonas	Mallomonas sp.
P091	Dinophyceae	Peridiniales	Certatiaceae	Ceratium	Ceratium hirudinella
P092	Dinophyceae	Gymnodiniales	Gymnodiniaceae	Gymnodinium	Gymnodinium sp.
P093	Dinophyceae	Peridiniales	Peridiniaceae	Peridinium	Peridinium sp
P094	Cyanophyceae	Nostocales	Nostocaceae	Anabaena	Anabaena sp. (filaments)
P095	Cyanophyceae	Chroococcales	Chroococcaceae	Anacystis	Anacystis cyanea
P096	Cyanophyceae	Chroococcales	Merismopediaceae	Coelosphaerium	Coelosphaerium sp. (spheric colony)
P097	Cyanophyceae	Nostocales	Rivulariaceae	Gloeotrichia	Gloeotrichia sp.
P098	Cyanophyceae	Oscillatoriales	Oscillatoriaceae	Limnothrix	Limnothrix redekei (filament)
P099	Cyanophyceae	Oscillatoriales	Oscillatoriaceae	Lyngbya	Lyngbya sp. 100 micron length
P100	Cyanophyceae	Chroococcales	Merismopediaceae	Merismopedia	Merismopedia elegans
P101	Cyanophyceae	Oscillatoriales	Oscillatoriaceae	Oscillatoria	Oscillatoria 4mi sp. (100 L)
P102	Cyanophyceae	Oscillatoriales	Oscillatoriaceae	Planktolyngbya	Planktolyngbya limnetica (colony)
P103	Cyanophyceae	Oscillatoriales	Oscillatoriaceae	Planktothrix	Planktothrix agardhii (100 L filament)

Final Code	Class	Order	Family	Genus	Species
P104	Cyanophyceae	Oscillatoriales	Oscillatoriaceae	Planktothrix	Planktothrix limnetica (100 L filament)
P105	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Pseudanabaena	Pseudanabaena sp. 1.5mi (100 L)
P106	Cyanophyceae	Chroococcales	Synechococcacea	Synechococcus sp.	Synechococcus sp.
P107	Cyanophyceae	Chroococcales	Merismopediaceae	Synechocystis	Synechocystis sp
P108	Euglenophyceae	Eutreptiales	Astasiaceae	Distigma	Distigma sp. - flagellate
P109	Euglenophyceae	Euglenales	Euglenaceae	Euglena	Euglena spp. - flagellate
P110	Euglenophyceae	Euglenales	Euglenaceae	Trachelomonas	Trachelomonas sp. -flagellate
P111	Chlorophyceae	Chlorococcales	Oocystaceae	Ankistrodesmus	Ankistrodesmus spp.
P112	Chlorophyceae	Chlorococcales	Dictyosphaeriaceae	Botryococcus	Botryococcus sp. (colony)
P113	Chlorophyceae	Tetrasporales	Palmellopsidaceae	Chlamydocapsa	Chlamydocapsa sp.
P114	Chlorophyceae	Chlorococcales	Oocystaceae	Chlorella	Chlorella spp.
P115	Zygnematophyceae	Desmidiales	Closteriaceae	Closterium	Closterium sp.
P116	Zygnematophyceae	Desmidiales	Desmidiaceae	Cosmarium	Cosmarium spp
P117	Chlorophyceae	Chlorococcales	Oocystaceae	Dichtyosphaerium	Dictyosphaerium
P118	Trebouxiophyceae.	Chlorellales	Eremosphaeraceae	Eremosphaera	Eremosphaera sp. (colony) not used
P119	Zygnematophyceae	Desmidiales	Desmidiaceae	Euastrum	Euastrum sp.
P120	Chlorophyceae	Tetrasporales	Gloeocystaceae	Gloeocystis	Gloeocystis sp. colony
P121	Zygnematophyceae	Desmidiales	Desmidiaceae	Hyalotheca	Hyalotheca sp.
P122	Chlorophyceae	Chlorococcales	Oocystaceae	Oocystis	Oocystis sp. (cells)
P123	Chlorophyceae	Chlorococcales	Hydrodictyaceae	Pediastrum	Pediastrum sp.
P124	Chlorophyceae	Chlorococcales	Chlorococcaceae	Planctosphaeria	Planctosphaeria sp. colony
P125	Chlorophyceae	Chlorococcales	Scenedesmaceae	Scenedesmus	Scenedesmus sp.
P126	Zygnematophyceae	Desmidiales	Desmidiaceae	Spondylosium	Spondylosium sp. (cells - filaments)
P127	Zygnematophyceae	Desmidiales	Desmidiaceae	Staurastrum	Staurastrum sp.
P128	Chlorophyceae	Oedogoniales	Oedogoniaceae	Bulbochaete	Bulbochaete (cells)
P129	Chadophorophyceae	Cladophorales	Chladophoraceae	Cladophora	Cladophora sp. glomerata?
P130	Chlorophyceae	Chaetophorales	Chaetophoraceae	Draparnaldia	Draparnaldia sp. glomerata?
P131	Ulvophyceae	Ulotricales	Geminellaceae	Geminella	Geminella sp I cell
P132	Chlorophyceae	Microsporales	Microsporaceae	Microspora	Microspora sp.
P133	Zygnematophyceae	Zygnematales	Zygnemataceae	Mougeotia	Mougeotia sp,
P134	Chlorophyceae	Oedogoniales	Oedogoniaceae	Oedogonium	Oedogonium sp.
P135	Chlorophyceae	Chaetophorales	Chaetophoraceae	Stigeoclonium	Stigeoclonium sp.
P136	Zygnematophyceae	Zygnematales	Zygnemataceae	Spirogyra	Spirogyra spp.
P137	Chlorophyceae	Ulotrichales	Ulotrichaceae	Ulothirx	Ulothirx sp. (zonata)
P138	Zygnematophyceae	Zygnematales	Zygnemataceae	Zygnema	Zygnema sp.
P139	Cyanophyceae	Chroococcales	Cyanobacteriaceae	Aphanothece	Coccoid Chlorophyta

Final Code	Class	Order	Family	Genus	Species
					Complex (colony) unidentifiable
P140	pico-flagellates	pico-flagellates	pico-flagellates	pico-flagellates	pico-flagellates
P141	Bacillariophyceae	Pennales	Naviculaceae	Brachysira	Brachysira vitrea
P142	Bacillariophyceae	Bacillariales	Nitzschiaceae	Hantzschia	Hantzschia spp.
P143	Bacillariophyceae	Rhizosoleniaceales	Rhizosoleniacae	Rhizosolenia	Rhizosolenia sp.
P144	Bacillariophyceae	Achnanthales	Achnanthaceae	Achnanthidium	Rossithidium linearis
P145	Chrysophyceae	Chromulinales	Chromulinaceae	Ochromonas	Ochromonas sp.
P146	Cyanophyceae	Nostocales	Nostocaceae	Anabaenopsis	Anabaenopsis elenkinii
P147	Chlorophyceae	Sphaeropleales	Scenedesmaceae	Coelastrum	Coelastrum sp. (colony)
P148	Pedinophyceae	Scourfieldiales	Scourfieldiace	Scourfieldia	Scourfieldia sp. - flagellate
P149	Trebouxiophyceae	Prasiolales	Prasiolaceae	Stichococcus	Stichococcus minutissima
P150	Bacillariophyceae	Pennales	Naviculaceae	Navicula	Navicula minima (oval)
P151	Bacillariophyceae	Pennales	Naviculaceae	Stauroneis	Stauroneis sp.
P152	Cyanophyceae	Croococcales	Cyanobacteriaceae	Gomphosphaeria	Gomphosphaeria sp.
P153	Euglenophyceae	Euglenales	Phacaceae	Lepocinclis	Lepocinclis ovum
P154	Chlorophyceae	Chlamydomonales	Chlamydomonaceae	Chlamydomonas	Small euglenoid (Chlamydomonas?)
P155	Cyanophyceae	Pseudanabaenales	Pseudanabaenaceae	Leptolyngbya	Leptolyngbya sp.
P156	protozoa		Protozoa	Amoeba	amoeba
P157	Cyanophyceae	Pseudanabaenales	Pseudanabaenaceae	Spirulina	Spirulina sp. (Arthrospira)
P158	Cyanophyceae	Oscillatoriales	Oscillatoriaceae	Dactylococcopsis	Dactylococcopsis sp.
P159	Bacillariophyceae	Surirellales	Suririellaceae	Campylodiscus	Campylodiscus sp.
P160	Euglenophyceae	Euglenales	Phacaceae	Phacus	Euglenoid (Phacus?)
P161	Euglenophyceae	Euglenales	Peranemataceae	Peranema	Peranema sp.
P162	Bacillariophyceae	Pennales	Gomponemaceae	Gomphonema	Gomphonema parvulum
P163	Bacillariophyceae	Fragilariales	Fragilariaceae	Staurosirella	Staurosirella sp.
P164	Bacillariophyceae	Pennales	Cymbellaceae	Cymbella	Cymbella minuta
P165	Bacillariophyceae	Pennales	Gomponemaceae	Gomphonema	Gomphonema minutum
P166	Cyanophyceae	Croococcales	Cyanobacteriaceae	Aphanocapsa	Aphanocapsa sp.
P167	Bacillariophyceae	Naviculales	Naviculaceae	Caloneis	Caloneis sp.
P168	Bacillariophyceae	Achnanthales	Achnanthaceae	Achnanthidium	Achnanthidium exiguum
P169	Bacillariophyceae	Pennales	Cymbellaceae	Amphora	Amphora sp.
P170	Bacillariophyceae	Naviculales	Ampipleuraceae	Frustulia	Frustulia sp.
P171	Bacillariophyceae	Naviculales	Diploneidaceae	Diploneis	Diploneis sp.
P172	Bacillariophyceae	Pennales	Cymbellaceae	Cymbella	Cymbella sp.
P173	Dinophyceae	Peridinales	Peridiniaceae	Glenodinium	Glenodinium sp.
P174	Cyanophyceae	Nostocales	Stigonemataceae	Stigonema	Stigonema ocellata
P175	Cyanophyceae	Chroococcales	Chroococaceae	Chroococcus	Chroococcus sp.

Final Code	Class	Order	Family	Genus	Species
P176	Bacillariophyceae	Cymbellales	Cymbellaceae	Cymbopleura	Cymbopleura sp.
P177	Bacillariophyceae	Cymbellales	Cymbellaceae	Encyonema	Encyonema minuta
P178	Bacillariophyceae	Cymbellales	Gomphonemaceae	Gomphoneis	Gomphoneis minuta
P179	Bacillariophyceae	Surirellales	Suririellaceae	Cymatopleura	Cymatopleura sp.
P180	Chrysophyceae	Chromulinales	Dinobryaceae	Dinobryon	Dinobryon bavaricum
P181	Coscinodiscophyceae	Thalassiosirales	Stephanodiscaceae	Cyclotella	Cyclotella sp. (Wehr)
P182	Cyanophyceae	Nostocales	Rivulariaceae	Calothrix	Calothrix (fusca?)
P183	Euglenophyceae	Euglenales	Phacaceae	Phacus	Phacus (trimarginatus?)
P184	Bacillariophyceae	Pennales	Naviculaceae	Navicula	Navicula lancelota
P185	Coscinodiscophyceae	Thalassiosirales	Stephanodiscaceae	Cyclotella	Cyclotella rossi
P186	Bodonophyceae	Bodonales	Bodonaceae	Bodo	Bodo sp.
P187	Bacillariophyceae	Pennales	Eunotiaceae	Eunotia	Eunotia spp.
P188	Cyanophyceae	Oscillatoriales	Borziaceae	Komvophoron	Komvophoron minutissima
P189	Bacillariophyceae	Pennales	Gomponemaceae	Gomphonema	Gomphonema acuminatum
P190	Xanthophyceae	Tribonematales	Heteropediaceae	Heterococcus	Heterococcus (subaerial)
P191	Cyanophyceae	Nostocales	Nostocales	Fischerella	Fischerella sp.
P192	Bacillariophyceae	Pennales	Fragilariaceae	Synedra	Synedra cyclopum
P193	Bacillariophyceae	Pennales	Cymbellaceae	Cymbella	Cymbella caespitosum (Encyonema caespitosum)
P194	Bacillariophyceae	Pennales	Mastogloiaceae	Mastogloia	Mastogloia sp.
P195	Trebouxiophyceae	Trebouxiophyceae	Trebouxiophyceae	Crucigenia	Crucigenia tetrapedia
P196	Rhodophyceae	Rhodophyceae	Rhodophyceae	Rhodophyceae	Rhodophyceae
P197	Bacillariophyceae	Rhopalodiales	Rhopalodiaceae	Epithemia	Epithemia turgida
P198	Cyanophyceae	Nostocales	Nostocaceae	Aphanizomenon	Aphanizomenon sp. (cells)
P199	Chlorophyceae	Sphaeropleales	Hydrodictyaceae	Tetraedron	Tetraedron sp.
P200	Trebouxiophyceae	Chlorellales	Chlorellaceae	Gloeotila	Gloeotila sp.
P201	Unidentified coccoid green	Unidentified coccoid green	Unidentified coccoid green	Unidentified coccoid green	Unidentified coccoid green
P202	Bacillariophyceae	Cymbellales	Cymbellaceae	Cymbella	Cymbella microcephala (E. microcephala)
P203	Bacillariophyceae	Cymbellales	Cymbellaceae	Cymbella	Cymbella ventricosa
P204	Bacillariophyceae	Cymbellales	Cymbellaceae	Cymbella	Cymbella sp. lrg
P205	Bacillariophyceae	Pennales	Gomponemaceae	Gomphoneis	Gomphoneis spp.
P206	Cyanophyceae	Oscillatoriales	Homoeotrichaceae	Homeothrix	Homeothrix sp. (colony)
P207	Bacillariophyceae	Fragilariales	Fragilariaceae	Diatoma	Diatoma mesodon
P208	Cyanophyceae	Oscillatoriales	Oscillatoriaceae	Oscillatoria	Oscillatoria limnosa
P209	Bacillariophyceae	Pennales	Naviculaceae	Navicula	Navicula cryptocephala

Final Code	Class	Order	Family	Genus	Species
P210	Bacillariophyceae	Cymbellales	Cymbellaceae	Cymbella	Cymbella excisiformis (Encyonema excisiformis)
P211	Florideophyceae	Acrochaetiales	Acrochaeriaceae	Audouinella	Audouinella sp.
P212	Cyanophyceae	Oscillatoriales	Oscillatoriaceae	Phormidium	Phormidium autumnale (colony)
P213	Chrysophyceae	Hydrurales	Hydruraceae	Hydrurus	Hydrurus foetidus or sp.
P214	Cyanophyceae	Synechococcales	Chamaesiphonaceae	Chamaesiphon	Chamaesiphon incrustans
P215	Cyanophyceae	Chroococcales	Chroococaceae	Gloeocapsa	Gloeocapsa sp.
P216	Bacillariophyceae	Centrales	Coscinodiscaceae	Aulicoseira	Aulacoseira sp.
P217	Zygnematophyceae	Zygnematales	Zygnemataceae	un-ID filament	un-ID filament
P218	Bacillariophyceae	Cymbellales	Cymbellaceae	Encyonema	Encyonema silesiacum
P219	Bacillariophyceae	Pennales	Fragilariaceae	Synedra	Synedra ulna curved
P220	Bacillariophyceae	Rhopalodiales	Rhopalodiaceae	Epithemia	Epithemia adnata
P221	Bacillariophyceae	Rhopalodiales	Rhopalodiaceae	Epithemia	Epithemia sorex
P222	Bacillariophyceae	Bacillariales	Nitzschiaceae	Nitzschia	Nitzschia dissipata
P223	Chlorophyceae	Desmidiales	Desmidiaceae	Desmidium	Desmidium sp.
P224	Myxophyceae	Oscillatoriales	Pseudanabaenaceae	Heteroleibleinia	Heteroleibleinia sp.
P225	Bacillariophyceae	Pennales	Cymbellaceae	Encyonema	Encyonema prostratum
P226	Bacillariophyceae	Pennales	Eunotiaceae	Eunotia	Eunotia spp.
P227	Bacillariophyceae	Pennales	Cymbellaceae	Cymbella	Cymbella cymbiformis
P228	Bacillariophyceae	Pennales	Suriellaceae	Surirella	Surirella linearis var constricta
P229	Bacillariophyceae	Pennales	Gomponemaceae	Gomphonema	Gomphosphenia sp.
P230	Bacillariophyceae	Pennales	Fragilariaceae	Ulnaria	Ulnaria delicatissima
P231	Bacillariophyceae	Pennales	Naviculaceae	Anomoeoneis	Anomoeoneis sphaerophora
P232	Bacillariophyceae	Pennales	Naviculaceae	Pinnularia	Pinnularia brebissonii
P233	Cyanophyceae	Synechococcales	Coelosphaeriaceae	Snowella	Snowella sp. (lacustris?)
P234	Bacillariophyceae	Naviculales	Sellaphoraceae	Eolimna	Eolimna minima
P235	Florideophyceae	Batrachospermales	Batrachospermaceae	Batrachospermum	Batrachospermum gelatinosum
P236	Chlorophyceae	Sphaeropleales	Scenedesmaceae	Westella	Westella botryoides
P237	Bacillariophyceae	Naviculales	Stauroneidaceae	Stauroneis	Stauroneis anceps
P238	Bacillariophyceae	Naviculales	Sellaphoraceae	Sellaphora	Sellaphora pupula
P239	Coscinodiscophyceae	Melosirales	Melosiraceae	Melosira	Melosira varians
P240	Chlorophyceae	Chlamydomonales	Volvocaceae	Pandorina	Pandorina
P241	Cyanophyceae	Synechrococcales	Synechococcales	Schizothrix	Schizothrix sp.
P242	Bacillariophyceae	Cymbellales	Cymbellaceae	Cymbella	Cymbella prostrata
P243	Bacillariophyceae	Surirellales	Suriellaceae	Suririella	Suririella robusta

Final Code	Class	Order	Family	Genus	Species
P244	Bacillariophyceae	Achnanthales	Achnanthaceae	Achnanthidium	Achnanthidium deflexum
P245	Cyanophyceae	Nostocales	Nostocaceae	Anabaena	Anabaena cf. variabilis
P246	Chlorophyceae	Chlorococcales	Oocystaceae	Ankistrodesmus	Ankistrodesmus spiralis
P247	Bacillariophyceae	Centrales	Aulacoseiraceae	Aulacoseira	Aulacoseira alpigena
P248	Bacillariophyceae	Surirellales	Surirellaceae	Campylodiscus	Campylodiscus cf. hibernicus
P249	Chlorophyceae	Volvocales	Chlamydomonadaceae	Carteria	Carteria sp.
P250	Euglenophyceae			Petalomonas	Petalomonas sp.
P251	Chlorophyceae	Cladophorales	Cladophoraceae	Cladophora	Cladophora fracta
P252	Cryptophyceae	Cryptomonadales	Cryptomonadaceae		microflagellates
P253	Bacillariophyceae	Centrales	Stephanodiscaceae	Cyclotella	Cyclotella meneghiniana
P254	Chlorophyceae	Cylindrocapsales	Cylindrocapsaceae	Cylindrocapsa	Cylindrocapsa sp.
P255	Bacillariophyceae	Pennales	Cymbellaceae	Cymbella	Cymbella lanceolata
P256	Bacillariophyceae	Pennales	Cymbellaceae	Delicata	Delicata delicatula
P257	Bacillariophyceae	Pennales	Bacillariaceae	Denticula	Denticula subtilis
P258	Bacillariophyceae	Pennales		Encyonopsis	Encyonopsis minuta
P259	Bacillariophyceae	Pennales	Eunotiaceae	Eunotia	Eunotia cf. bidens
P260	Bacillariophyceae	Pennales	Eunotiaceae	Eunotia	Eunotia cf. rhomboidea
P261	Bacillariophyceae	Centrales	Rhizosoleniaceae	Urosolenia	Urosolenia eriensis
P262	Bacillariophyceae	Pennales	Fragilariaceae	Fragilaria	Fragilaria vaucheria
P263	Bacillariophyceae	Pennales	Amphipleuraceae	Frustulia	Frustulia capitata
P264	Bacillariophyceae	Pennales	Gomphonemataceae	Gomphonema	Gomphonema gracile
P265	Myxophyceae	Stigonematales	Mastigocladaceae	Hapalosiphon	Hapalosiphon sp.
P266	Cyanophyceae	Oscillatoriales	Oscillatoriaceae	Lyngbya	Lyngbya birgei
P267	Bacillariophyceae	Pennales	Mastogloiaceae	Mastogloia	Mastogloia cf. smithii
P268	Bacillariophyceae	Centrales	Melosiraceae	Melosira	Melosira undulata
P269					microflagellates
P270	Choanoflagellatea	Craspedida	Codonosigaceae	Monosiga	Monosiga ovata
P271	Bacillariophyceae	Pennales	Naviculaceae	Navicula	Navicula aurora
P272	Bacillariophyceae	Pennales	Naviculaceae	Navicula	Navicula capitoradiata
P273	Bacillariophyceae	Pennales	Naviculaceae	Navicula	Navicula cinta
P274	Bacillariophyceae	Pennales	Naviculaceae	Navicula	Navicula gregaria
P275	Cyanophyceae	Oscillatoriales	Oscillatoriaceae	Oscillatoria	Oscillatoria cf. tenuis
P276	Chlorophyceae	Chlamydomonales	Volvocaceae	Pandorina	Pandorina cf. morum
P277	Bacillariophyceae	Pennales	Pinnularaceae	Pinnularia	Pinnularia caudata
P278	Bacillariophyceae	Achnanthales	Achnanthaceae	Planothidium	Planothidium cf. amphibium
P279	Bacillariophyceae	Pennales	Rhoicospheniaceae	Rhoicosphenia	Rhoicosphenia abbreviata

Final Code	Class	Order	Family	Genus	Species
P280	Bacillariophyceae	Achnanthales	Achnanthaceae	Rossithidium	Rossithidium petersenii
P281	Bacillariophyceae	Naviculales	Sellaphoraceae	Sellaphora	Sellaphora atomoides
P282	Bacillariophyceae	Naviculales	Sellaphoraceae	Sellaphora	Sellaphora bacillum
P283	Bacillariophyceae	Naviculales	Sellaphoraceae	Sellaphora	Sellaphora spp.
P284	Chrysophyceae	Chromulineales	Chromulineaceae	Spumella	Spumella sp.
P285	Zygnematophyceae	Desmidiales	Desmidiaceae	Staurastrum	Staurastrum striatum
P286	Bacillariophyceae	Pennales	Naviculaceae	Stauroneis	Stauroneis gracilis
P287	Bacillariophyceae	Pennales	Fragilariaceae	Staurosira	Staurosira binodis
P288	Chlorophyceae	Chaetophorales	Chaetophoraceae	Stigeoclonium	Stigeoclonium cf. lubricum
P289	Myxophyceae	Nostocales	Microchaetaceae	Tolypothrix	Tolypothrix sp.
P290	Bacillariophyceae	Bacillariales	Nitzschiaceae	Tryblionella	Tryblionella sp.
P291	Chlorophyceae	Chlorellales	Chlorellaceae	Closteriopsis	Closteriopsis sp.
P292	Myxophyceae	Nostocales	Rivulariaceae	Dichothrix	Dichothrix cf. gypsophilia
P293	Bacillariophyceae	Pennales	Gomponemaceae	Gomphonema	Gomphonema coronatum
P294	Chlorophyceae	Chlorococcales	Hydrodictyaceae	Pediastrum	Pediastrum tetras
P295	Bacillariophyceae	Pennales	Naviculaceae	Pinnularia	Pinnularia dactylus
P296	Myxophyceae	Nostocales	Scytomenataceae	Scytonema	Scytonema sp.
P297	Chlorophyceae	Sphaeropleales	Hydrodictyaceae	Tetraedron	Tetraedron minimum
P298	Euglenophyceae	Euglenales	Euglenaceae	Trachelomonas	Trachelomonas hispida
P299	Bacillariophyceae	Centrales	Coscinodiscaceae	Cyclotella	Cyclotella bodanica
P300	Cyanophyceae	Croococcales	Cyanobacteriaceae	Aphanothece	Aphanothece sp.
P301	Chlorophyceae	Chlorococcales	Oocystaceae	Chlorella	Chlorella cf. vulgaris
P302	Chlorophyceae	Chlorococcales	Oocystaceae	Chlorella	Chlorella vulgaris
P303	Bacillariophyceae	Cymbellales	Cymbellaceae	Cymbopleura	Cymbopleura spp.
P304	Bacillariophyceae	Pennales	Gomponemaceae	Gomphonema	Gomphonema truncatum
P305	Bacillariophyceae	Pennales	Gomponemaceae	Gomphonema	Gomphonema truncatum
P306	Bacillariophyceae	Pennales	Naviculaceae	Navicula	Navicula cryptotenella
P307	Bacillariophyceae	Pennales	Naviculaceae	Neidium	Neidium sp.
P308	Chlorophyceae	Chlorococcales	Hydrodictyaceae	Pediastrum	Pediastrum boryanum
P309	Chlorophyceae	Chlorococcales	Scenedesmaceae	Scenedesmus	Scenedesmus dimorphus
P310	Chlorophyceae	Chlorococcales	Scenedesmaceae	Scenedesmus	Scenedesmus quadricauda
P311	Euglenophyceae	Euglenales	Euglenaceae	Trachelomonas	Trachelomonas volvocina
P312	Bacillariophyceae	Pennales	Naviculaceae	Frustulia	Frustulia vulgaris

APPENDIX H PERIPHYTON STATISTICAL OUTPUTS

Table 122: Dominant periphyton species as defined by percent biovolume for erosional and depositional sites with upstream reference sites shown separately from downstream exposure sites, 2012 - 2021.

Depositional

Dominant Reference Taxa	Biovolume Ref (%)	Biovolume Exp (%)	Dominant Exposure Taxa
Didymosphenia geminata	15.96	17.70	Synedra ulna (radiate on Didymo)
Synedra ulna (radiate on Didymo)	7.97	9.50	Didymosphenia geminata
Navicula spp.	6.22	7.13	Navicula spp.
Cyclotella ocellata	6.11	4.97	Cyclotella ocellata
Navicula tripunctata	6.11	4.83	Synedra ulna
Eucocconeis flexella	5.99	4.33	Eucocconeis flexella
Tabellaria fenestrata	5.92	4.05	Cyclotella bodanica
Fragilaria crotonensis	4.40	3.57	Tabellaria fenestrata
Staurosira construens v ventor	4.32	3.33	Staurosira construens v ventor
Synedra ulna	3.99	3.20	Nitzschia sp.

Erosional

Rank	Taxa	Site Category	Percentage Biovolume
1	Didymosphenia geminata	Ref	31.86
2	Gomphonema gracile	Ref	24.81
3	Gomphoneis minuta	Ref	5.84
4	Achnanthidium minutissima	Ref	3.50
5	Gomphonema ovilaceaides	Ref	3.49
6	Synedra ulna	Ref	2.85
7	Cocconeis placentula	Ref	2.27
8	Lyngbya sp. 100 micron length	Ref	2.18
9	Fragilaria crotonensis	Ref	1.66
10	Staurosira construens v ventor	Ref	1.59
1	Didymosphenia geminata	IDZ RB	39.21

Rank	Taxa	Site Category	Percentage Biovolume
2	Gomphonema gracile	IDZ RB	19.12
3	Phormidium autumnale (colony)	IDZ RB	10.39
4	Cladophora fracta	IDZ RB	7.89
5	Synedra ulna	IDZ RB	2.47
6	Achnanthidium minutissima	IDZ RB	2.44
7	Gomphonema ovilaceaides	IDZ RB	1.82
8	Cyclotella bodanica	IDZ RB	0.88
9	Navicula gregaria	IDZ RB	0.85
10	Achnanthidium linearis = Rossithidium	IDZ RB	0.80
1	Didymosphenia geminata	FF	32.43
2	Gomphonema gracile	FF	29.97
3	Gomphoneis minuta	FF	6.64
4	Stigeoclonium sp.	FF	2.92
5	Synedra ulna	FF	2.82
6	Achnanthidium minutissima	FF	2.29
7	Gomphonema ovilaceaides	FF	2.25
8	Navicula cinta	FF	1.66
9	Cocconeis placentula	FF	1.58
10	Diatoma tenue var elongatum	FF	1.39

Depositional ANOVAs

Table 123: ANOVA summary table for total abundance in depositional sites.

term	df	sumsq	meansq	statistic	p.value	form
x$year	3	3.400	1.100	30.00	<0.001	aov(tot.abun ~ year + ref_exp)
x$ref_exp	1	0.011	0.011	0.29	0.59	aov(tot.abun ~ year + ref_exp)
Residuals	35	1.300	0.037			aov(tot.abun ~ year + ref_exp)

Table 124: Tukey HSD summary table for comparisons between years for total abundance in depositional sites.

year	diff	lwr	upr	p adj
2015-2012	0.4790	0.246	0.711	<0.001
2018-2012	0.4260	0.193	0.658	<0.001
2021-2012	0.8160	0.584	1.050	<0.001
2018-2015	-0.0529	-0.285	0.179	0.927
2021-2015	0.3380	0.105	0.570	0.00213
2021-2018	0.3910	0.158	0.623	<0.001

Table 125: Effect size for total abundance in depositional sites.

Parameter	Eta2_partial	CI	CI_low	CI_high
x$year	0.7300	0.95	0.58	1
x$ref_exp	0.0087	0.95	0.00	1
x$year:x$ref_exp	0.0460	0.95	0.00	1

Table 126: ANOVA summary table for total biovolume in depositional sites.

term	df	sumsq	meansq	statistic	p.value	form
x$year	3	4.300	1.400	26.00	<0.001	aov(tot.biov ~ year + ref_exp)
x$ref_exp	1	0.021	0.021	0.37	0.55	aov(tot.biov ~ year + ref_exp)

term	df	sumsq	meansq	statistic	p.value	form
Residuals	35	1.900	0.055			aov(tot.biov ~ year + ref_exp)

Table 127: Tukey HSD summary table for comparisons between years for total biovolume in depositional sites.

year	diff	lwr	upr	p adj
2015-2012	0.5030	0.219	0.787	<0.001
2018-2012	0.4910	0.207	0.775	<0.001
2021-2012	0.9250	0.641	1.210	<0.001
2018-2015	-0.0123	-0.296	0.272	0.999
2021-2015	0.4220	0.138	0.706	0.00166
2021-2018	0.4340	0.150	0.718	0.00119

Table 128: Effect size for total biovolume in depositional sites.

Parameter	Eta2_partial	CI	CI_low	CI_high
x$year	0.700	0.95	0.53	1
x$ref_exp	0.011	0.95	0.00	1
x$year:x$ref_exp	0.061	0.95	0.00	1

Table 129: ANOVA summary table for species richness in depositional sites.

term	df	sumsq	meansq	statistic	p.value	form
x$year	3	840	280	11.0	<0.001	aov(sp.rich ~ year + ref_exp)
x$ref_exp	1	120	120	4.8	0.035	aov(sp.rich ~ year + ref_exp)
Residuals	35	900	26			aov(sp.rich ~ year + ref_exp)

Table 130: Tukey HSD summary table for comparisons between years for species richness in depositional sites.

year	diff	lwr	upr	p adj
2015-2012	-3.5	-9.6	2.6	0.43
2018-2012	-2.2	-8.3	3.9	0.77
2021-2012	8.3	2.2	14.0	0.0045
2018-2015	1.3	-4.8	7.4	0.94
2021-2015	12.0	5.7	18.0	<0.001
2021-2018	10.0	4.4	17.0	<0.001

Table 131: Effect size for species richness in depositional sites.

Parameter	Eta2_partial	CI	CI_low	CI_high
x$year	0.500	0.95	0.2600	1
x$ref_exp	0.130	0.95	0.0048	1
x$year:x$ref_exp	0.073	0.95	0.0000	1

Table 132: ANOVA summary table for Shannon evenness in depositional sites.

term	df	sumsq	meansq	statistic	p.value	form
x$year	3	1.570	0.5240	9.73	<0.001	aov(value~year+ref_exp)
x$ref_exp	1	0.254	0.2540	4.72	0.0366	aov(value~year+ref_exp)
Residuals	35	1.880	0.0538			aov(value~year+ref_exp)

Table 133: Tukey HSD summary table for comparisons between years for Shannon evenness in depositional sites.

year	diff	lwr	upr	p adj
2015-2012	-0.5250	-0.8040	-0.245	<0.001
2018-2012	-0.1520	-0.4320	0.128	0.471
2021-2012	-0.1020	-0.3820	0.177	0.757

year	diff	lwr	upr	p adj
2018-2015	0.3730	0.0931	0.653	0.00523
2021-2015	0.4220	0.1420	0.702	0.0014
2021-2018	0.0491	-0.2310	0.329	0.964

Table 134: Effect size for Shannon evenness in depositional sites.

Parameter	Eta2_partial	CI	CI_low	CI_high
x$year	0.49	0.95	0.2500	1
x$ref_exp	0.13	0.95	0.0062	1
x$year:x$ref_exp	0.13	0.95	0.0000	1

Table 135: ANOVA summary table for effective species in depositional sites.

term	df	sumsq	meansq	statistic	p.value	form
x$year	3	300	100	9.5	<0.001	aov(eff.species ~ year + ref_exp)
x$ref_exp	1	46	46	4.3	0.045	aov(eff.species ~ year + ref_exp)
Residuals	35	370	11			aov(eff.species ~ year + ref_exp)

Table 136: Tukey HSD summary table for comparisons between years for effective species in depositional sites.

year	diff	lwr	upr	p adj
2015-2012	-7.4	-11.00	-3.4	<0.001
2018-2012	-2.6	-6.60	1.3	0.29
2021-2012	-1.5	-5.50	2.4	0.73
2018-2015	4.7	0.78	8.7	0.014
2021-2015	5.9	1.90	9.8	0.0017
2021-2018	1.1	-2.80	5.1	0.86

Table 137: Effect size for effective species in depositional sites.

Parameter	Eta2_partial	CI	CI_low	CI_high
x$year	0.470	0.95	0.2300	1
x$ref_exp	0.120	0.95	0.0015	1
x$year:x$ref_exp	0.096	0.95	0.0000	1

Erosional Linear Mixed Effects Models

Table 138: Formulae used for periphyton linear mixed effects models.

Model Formula
Total Abundance (log) ~ Water Temperature + pH.std + Dissolved Oxygen + Velocity + Substrate Median Size + Proportion of Cobble in Substrate + Site Category + year + Site Category:year + (1 | Area) + (1 | area:year)
Total Biovolume (log) ~ Water Temperature + pH.std + Dissolved Oxygen + Velocity + Substrate Median Size + Proportion of Cobble in Substrate + Site Category + year + Site Category:year + (1 | Area) + (1 | area:year)
Chorophyll-a ~ Water Temperature + pH.std + Dissolved Oxygen + Velocity + Substrate Median Size + Proportion of Cobble in Substrate + Site Category + year + Site Category:year + (1 | Area) + (1 | area:year)
Species Richness ~ Water Temperature + pH.std + Dissolved Oxygen + Velocity + Substrate Median Size + Proportion of Cobble in Substrate + Site Category + year + Site Category:year + (1 | Area) + (1 | area:year)
Shannon's Equitability ~ Water Temperature + pH.std + Dissolved Oxygen + Velocity + Substrate Median Size + Proportion of Cobble in Substrate + Site Category + year + Site Category:year + (1 | Area) + (1 | area:year)
Percent Diatoms ~ Water Temperature + pH.std + Dissolved Oxygen + Velocity + Substrate Median Size + Proportion of Cobble in Substrate + Site Category + year + Site Category:year + (1 | Area) + (1 | area:year)
Percent Cyanobacteria ~ Water Temperature + pH.std + Dissolved Oxygen + Velocity + Substrate Median Size + Proportion of Cobble in Substrate + Site Category + year + Site Category:year + (1 | Area) + (1 | area:year)
Percent Green Algae ~ Water Temperature + pH.std + Dissolved Oxygen + Velocity + Substrate Median Size + Proportion of Cobble in Substrate + Site Category + year + Site Category:year + (1 | Area) + (1 | area:year)

Table 139: Summary of plausible models identified using model averaging (those with a delta AIC < 3) with pseudo-R2 values and coefficients for all periphyton erosional samples.

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	site_group.year	R.2	R21	R22	df	AICc	delta	weight
Chl-a (ug cm-2)	1.010	0.21800			+	0.46300			+		0.468	0.4030	0.546	11	320.0	0.000	0.1200
Chl-a (ug cm-2)	1.030				+	0.47500			+		0.458	0.3940	0.532	10	320.0	0.389	0.0987
Chl-a (ug cm-2)	0.929	0.24000		0.22100	+	0.46900			+		0.475	0.4170	0.537	12	320.0	0.630	0.0875
Chl-a (ug cm-2)	0.869	0.25600		0.27200	+	0.49700	-0.15500		+		0.481	0.4220	0.535	13	321.0	1.390	0.0599
Chl-a (ug cm-2)	0.981	0.23100			+	0.48100	-0.12400		+		0.471	0.4030	0.548	12	322.0	1.720	0.0506
Chl-a (ug cm-2)	0.973			0.15700	+	0.47800			+		0.462	0.4020	0.526	11	322.0	1.790	0.0490
Chl-a (ug cm-2)	1.010				+	0.49200	-0.10300		+		0.461	0.3950	0.530	11	322.0	2.030	0.0434
Chl-a (ug cm-2)	0.988	0.21500	-0.04710		+	0.46100			+		0.469	0.4020	0.545	12	322.0	2.360	0.0368
Chl-a (ug cm-2)	1.050				+	0.43400		-0.4390	+		0.459	0.3750	0.600	11	322.0	2.370	0.0367
Chl-a (ug cm-2)	0.985		-0.08660		+	0.47200			+		0.458	0.3930	0.530	11	322.0	2.610	0.0325

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	site_group.year	R.2	R21	R22	df	AICc	delta	weight
Chl-a (ug cm-2)	1.030	0.19500			+	0.42800		-0.3900	+		0.468	0.3850	0.605	12	322.0	2.630	0.0322
Chl-a (ug cm-2)	0.925			0.19800	+	0.50300	-0.12900		+		0.466	0.4060	0.522	12	323.0	2.960	0.0272
Chl-a (ug cm-2)	0.893	0.23800	-0.06550	0.22300	+	0.46600			+		0.475	0.4150	0.535	13	323.0	2.970	0.0271
Log Total Abundance	5.260	0.10200				0.09720	0.06940		+		0.786	0.6720	0.838	10	-24.5	0.000	0.1450
Log Total Abundance	5.210	0.09890			+	0.10400	0.06970		+		0.792	0.7020	0.841	12	-23.4	1.070	0.0849
Log Total Abundance	5.250	0.11000				0.09990			+		0.781	0.6560	0.839	9	-23.2	1.290	0.0760
Log Total Abundance	5.260	0.10400				0.09990	0.06920	0.0340	+		0.787	0.6780	0.835	11	-22.5	2.010	0.0531
Log Total Abundance	5.260	0.10200		0.00312		0.09740	0.06920		+		0.786	0.6700	0.837	11	-22.1	2.370	0.0443
Log Total Abundance	5.260	0.10200	-0.00163			0.09710	0.06930		+		0.786	0.6700	0.837	11	-22.1	2.370	0.0443
Log Total Abundance	5.190	0.10800			+	0.10600			+		0.786	0.6840	0.842	11	-21.7	2.760	0.0364
Log Total Biovolume	7.480	0.14700			+	0.16700			+		0.608	0.5560	0.679	11	77.2	0.000	0.1150
Log Total Biovolume	7.480	0.12500			+	0.16200		-0.1450	+		0.614	0.5530	0.693	12	77.6	0.390	0.0945

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	site_group.year	R.2	R21	R22	df	AICc	delta	weight
Log Total Biovolume	7.440	0.13400		0.09990	+	0.16600		-0.1520	+		0.620	0.5650	0.682	13	77.9	0.736	0.0795
Log Total Biovolume	7.450	0.15400		0.07860	+	0.16800			+		0.612	0.5630	0.672	12	78.3	1.170	0.0640
Log Total Biovolume	7.470	0.14800			+	0.16800	-0.01390		+		0.609	0.5540	0.679	12	79.5	2.350	0.0354
Log Total Biovolume	7.480	0.14800	0.01350		+	0.16700			+		0.608	0.5540	0.679	12	79.6	2.410	0.0344
Log Total Biovolume	7.630	0.14000				0.15000			+		0.587	0.4990	0.679	9	79.8	2.670	0.0302
Log Total Biovolume	7.710	0.18100			+	0.14400			+	+	0.641	0.5960	0.683	17	80.0	2.820	0.0280
Log Total Biovolume	7.490	0.12600	0.02100		+	0.16200		-0.1460	+		0.614	0.5510	0.693	13	80.0	2.820	0.0280
Log Total Biovolume	7.480	0.12600			+	0.16200	-0.00559	-0.1450	+		0.614	0.5510	0.691	13	80.0	2.830	0.0279
Percent Cyanobacteria	5.740			4.93000				16.7000			0.578	0.3260	0.652	6	1,090.0	0.000	0.0968
Percent Cyanobacteria	5.690			4.83000			2.77000	16.4000			0.584	0.3410	0.653	7	1,090.0	0.254	0.0853
Percent Cyanobacteria	5.740	-2.29000		4.72000			3.04000	16.1000			0.588	0.3450	0.652	8	1,090.0	1.260	0.0516
Percent Cyanobacteria	5.680						2.84000	17.3000			0.574	0.3000	0.650	6	1,090.0	1.280	0.0511

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	site_group.year	R.2	R21	R22	df	AICc	delta	weight
Percent Cyanobacteria	5.790	-1.88000		4.85000				16.4000			0.581	0.3280	0.649	7	1,090.0	1.360	0.0490
Percent Cyanobacteria	5.750		-1.47000	4.78000				17.1000			0.579	0.3250	0.651	7	1,090.0	1.950	0.0366
Percent Cyanobacteria	5.760			4.86000		-1.00000		16.5000			0.579	0.3210	0.650	7	1,090.0	2.010	0.0354
Percent Cyanobacteria	5.740	-2.42000					3.14000	16.9000			0.578	0.3040	0.648	7	1,090.0	2.120	0.0336
Percent Cyanobacteria	5.700		-1.66000	4.65000			2.82000	16.9000			0.585	0.3390	0.651	8	1,090.0	2.150	0.0331
Percent Cyanobacteria	5.710			4.76000		-1.14000	2.81000	16.2000			0.585	0.3360	0.651	8	1,090.0	2.230	0.0318
Percent Cyanobacteria	5.790	-2.00000						17.2000			0.571	0.2860	0.646	6	1,090.0	2.370	0.0296
Percent Cyanobacteria	5.750		-1.97000					18.1000			0.570	0.2830	0.647	6	1,090.0	2.830	0.0235
Percent Cyanobacteria	5.690		-2.15000				2.91000	17.8000			0.576	0.2990	0.646	7	1,090.0	2.910	0.0227

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	site_group.year	R.2	R21	R22	df	AICc	delta	weight
Percent Diatoms	72.500			-10.00000					+		0.497	0.4330	0.604	8	1,260.0	0.000	0.0924
Percent Diatoms	71.800			-9.22000			-3.01000		+		0.500	0.4330	0.603	9	1,260.0	1.560	0.0423
Percent Diatoms	74.400		4.95000	-10.00000					+		0.499	0.4330	0.601	9	1,260.0	1.660	0.0402
Percent Diatoms	67.500						-3.99000		+		0.490	0.4170	0.595	8	1,260.0	1.930	0.0352
Percent Diatoms	72.100			-9.96000		2.21000			+		0.498	0.4340	0.602	9	1,260.0	1.960	0.0346
Percent Diatoms	73.000	-1.83000		-10.40000					+		0.498	0.4320	0.604	9	1,260.0	2.070	0.0328
Percent Diatoms	72.600			-10.20000				1.5000	+		0.497	0.4290	0.604	9	1,260.0	2.230	0.0302
Percent Diatoms	79.200			-9.12000	+				+		0.505	0.4510	0.614	10	1,260.0	2.450	0.0271
Percent Diatoms	69.800		4.72000						+		0.487	0.4140	0.596	8	1,260.0	2.650	0.0246
Percent Diatoms	67.700					2.31000			+		0.487	0.4150	0.597	8	1,260.0	2.860	0.0221

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	site_group.year	R.2	R21	R22	df	AICc	delta	weight
Percent Green algae	20.200							-20.6000	+		0.533	0.4860	0.589	8	1,230.0	0.000	0.1900
Percent Green algae	19.700	3.45000						-20.2000	+		0.536	0.4910	0.588	9	1,230.0	1.310	0.0990
Percent Green algae	20.300						0.90900	-20.6000	+		0.533	0.4830	0.587	9	1,230.0	2.200	0.0633
Percent Green algae	19.200			2.14000				-20.8000	+		0.533	0.4820	0.591	9	1,230.0	2.240	0.0621
Percent Green algae	19.800		-0.96400					-20.5000	+		0.533	0.4840	0.588	9	1,230.0	2.290	0.0607
Percent Green algae	20.200					-0.25200		-20.6000	+		0.533	0.4840	0.587	9	1,230.0	2.290	0.0607
Shannon Evenness	0.673		0.03720				-0.04270	-0.0496			0.355	0.1040	0.479	7	-267.0	0.000	0.0965
Shannon Evenness	0.674						-0.04190	-0.0403			0.343	0.0905	0.463	6	-266.0	0.513	0.0746
Shannon Evenness	0.674		0.02760				-0.04210				0.336	0.0455	0.498	6	-265.0	1.910	0.0372

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	site_group.year	R.2	R21	R22	df	AICc	delta	weight
Shannon Evenness	0.674	-0.00838	0.03630				-0.04120	-0.0504			0.356	0.1010	0.485	8	-265.0	2.050	0.0347
Shannon Evenness	0.709		0.06190				-0.04010	-0.0440	+		0.377	0.1390	0.503	10	-265.0	2.170	0.0326
Shannon Evenness	0.673		0.03810	0.00683			-0.04250	-0.0507			0.356	0.0988	0.485	8	-265.0	2.210	0.0319
Shannon Evenness	0.673		0.03740			0.00203	-0.04270	-0.0489			0.355	0.1010	0.477	8	-264.0	2.260	0.0312
Shannon Evenness	0.674	-0.01050					-0.04020	-0.0416			0.344	0.0891	0.471	7	-264.0	2.390	0.0292
Shannon Evenness	0.674					-0.00198	-0.04180	-0.0409			0.343	0.0913	0.463	7	-264.0	2.710	0.0249
Shannon Evenness	0.674			0.00279			-0.04180	-0.0409			0.343	0.0884	0.467	7	-264.0	2.730	0.0246
Shannon Evenness	0.708		0.06250				-0.03890		+		0.364	0.0958	0.525	9	-264.0	2.780	0.0240
Species Richness	36.700					3.45000			+		0.486	0.3850	0.610	8	906.0	0.000	0.1220
Species Richness	34.600				+	3.64000			+		0.499	0.4240	0.614	10	907.0	1.170	0.0680

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	site_group.year	R.2	R21	R22	df	AICc	delta	weight
Species Richness	36.500	0.99200				3.38000			+		0.490	0.3930	0.601	9	907.0	1.370	0.0616
Species Richness	37.200		1.41000			3.55000			+		0.488	0.3860	0.611	9	908.0	1.770	0.0505
Species Richness	34.500	1.01000			+	3.59000			+		0.504	0.4350	0.603	11	908.0	2.150	0.0417
Species Richness	36.600					3.46000	-0.25100		+		0.487	0.3840	0.608	9	908.0	2.200	0.0406
Species Richness	36.400			0.56700		3.46000			+		0.486	0.3830	0.613	9	908.0	2.260	0.0394
Species Richness	36.700					3.42000		-0.3470	+		0.486	0.3820	0.612	9	908.0	2.310	0.0386
Species Richness	34.600				+	3.58000		-1.0900	+		0.501	0.4270	0.611	11	909.0	2.910	0.0285

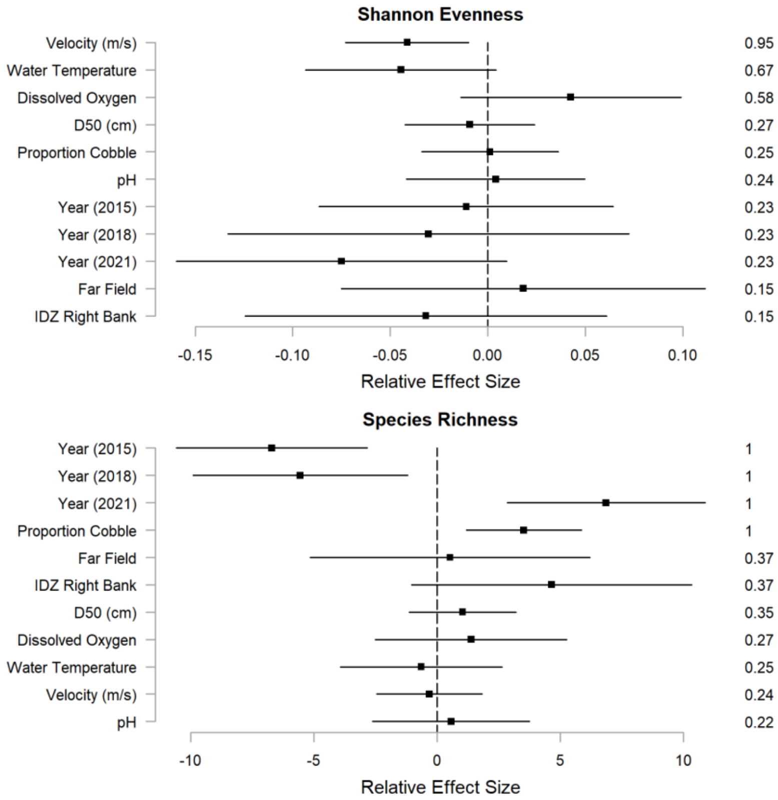


Figure 8: The coefficients and their 95% CLs of standardized explanatory variables of periphtyon erosional samples. Periphtyon responses included species richness and Shannon Evenness. Explanatory variables included D50 (substrate), Proportion of Cobble, Velocity, Water Temperature, pH, Dissolved Oxygen, Year sampled, and Site category (Reference, IDZ RB, or FF). Coefficients were standardized to allow comparisons of the direction and size of effects, noting that variables with CLs that do not cross zero have an effect on the response variable. Key explanatory variables are those that have a relative variable sw (RVI) of greater than 0.6-0.7 and the RVI is shown on the right-hand side of each figure.

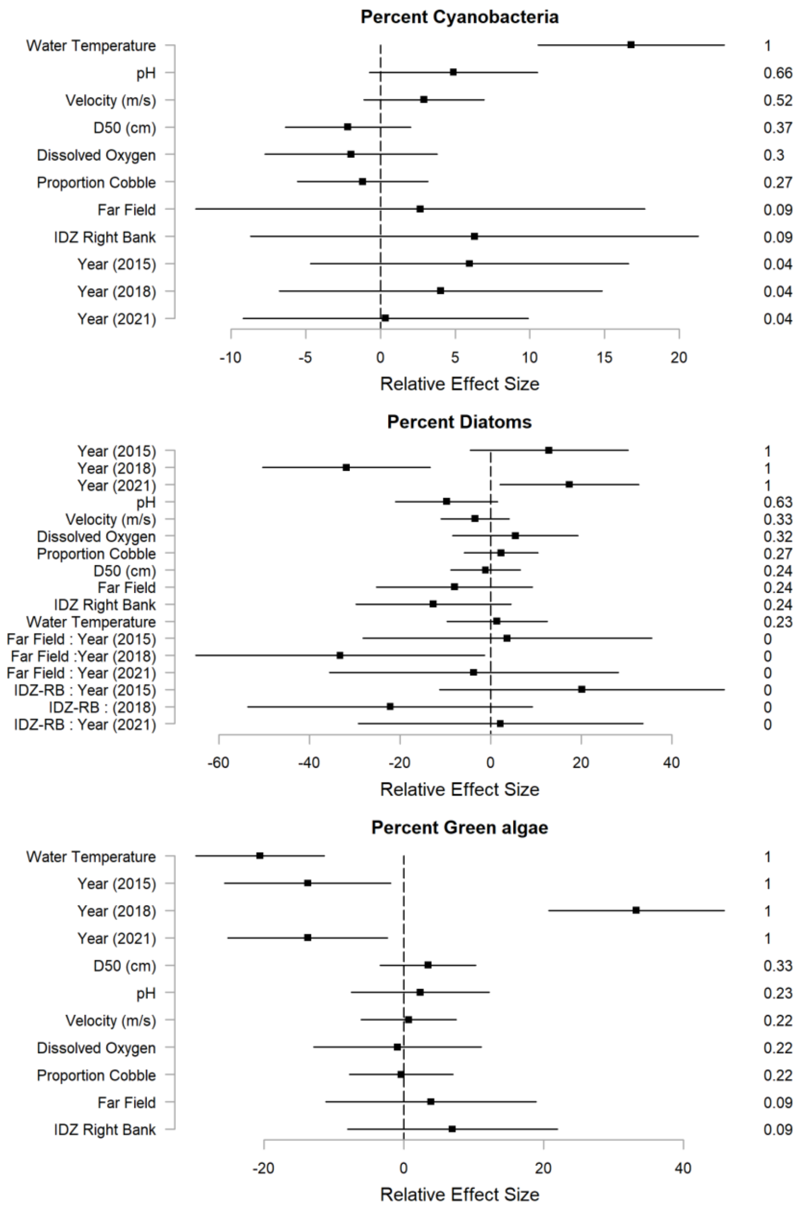


Figure 9: The coefficients and their 95% CLs of standardized explanatory variables of periphtyon erosional samples. Periphtyon responses included species richness and Shannon Evenness. Explanatory variables included D50 (substrate), Proportion of Cobble, Velocity, Water Temperature, pH, Dissolved Oxygen, Year sampled, and Site category (Reference, IDZ RB, or FF). Coefficients were standardized to allow comparisons of the direction and size of effects, noting that variables with CLs that do not cross zero have an effect on the response variable. Key explanatory variables are those that have a relative variable sw (RVI) of greater than 0.6-0.7 and the RVI is shown on the right-hand side of each figure

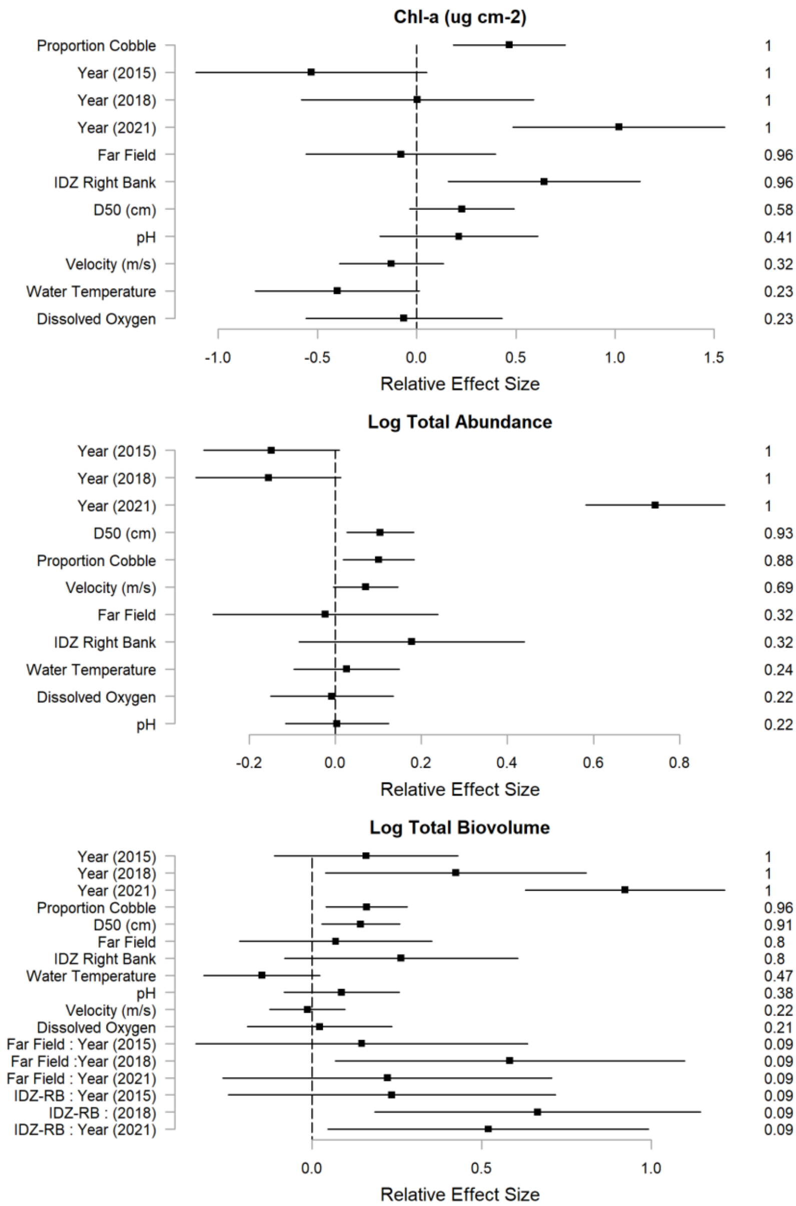


Figure 10: The coefficients and their 95% CLs of standardized explanatory variables of periphyton erosional samples. Periphyton responses included chl-a (log), total abundance (log) and total biovolume (log). Explanatory variables included D50 (substrate), Proportion of Cobble, Velocity, Water Temperature, pH, Dissolved Oxygen, Year sampled, and Site category (Reference, IDZ RB, or FF). Coefficients were standardized to allow comparisons of the direction and size of effects, noting that variables with CLs that do not cross zero have an effect on the response variable. Key explanatory variables are those that have a relative variable sw (RVI) of greater than 0.6-0.7 and the RVI is shown on the right-hand side of each figure

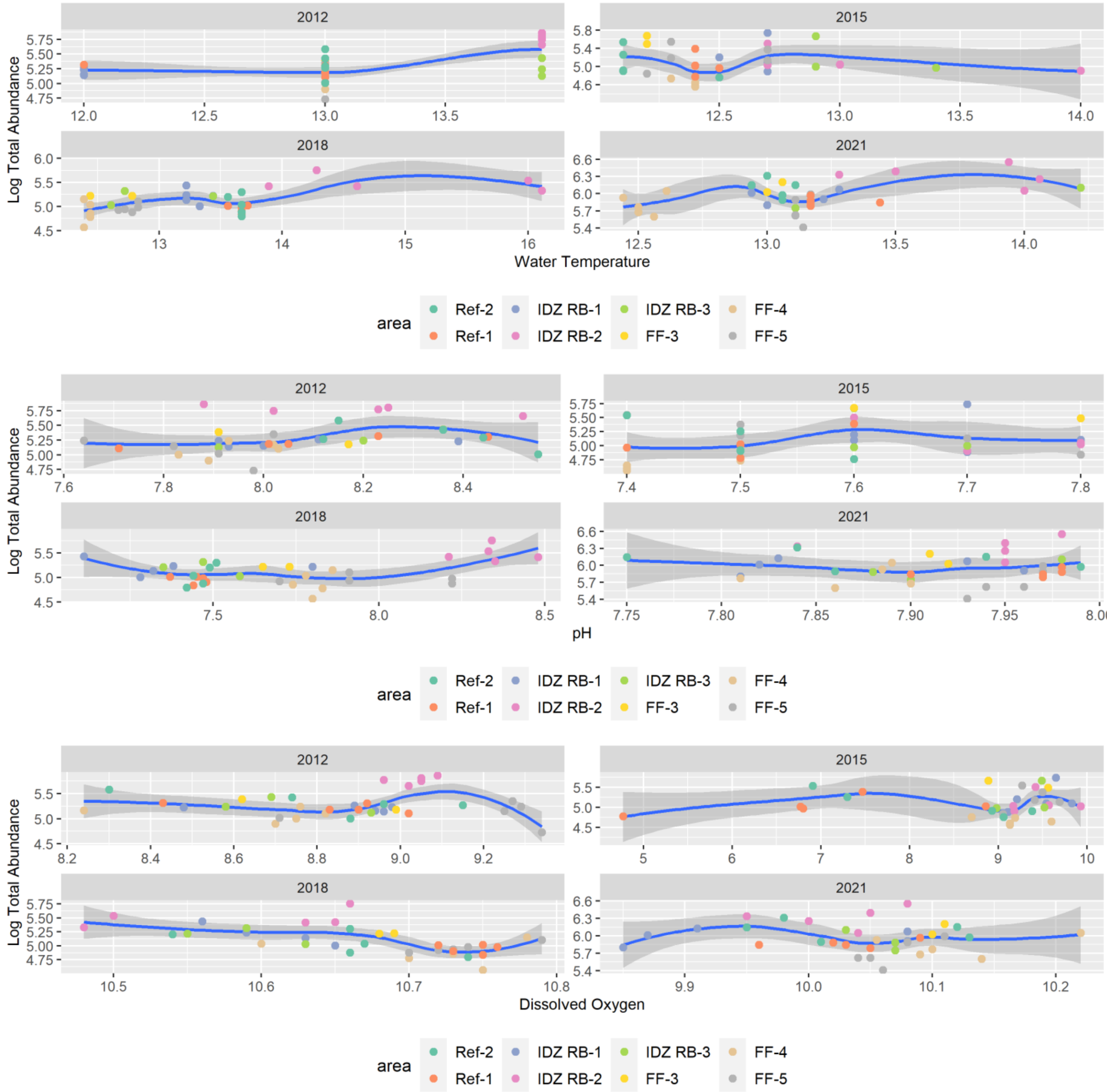


Figure 11: Explanatory variables and Log Total Abundance grouped by erosional areas for 2012, 2015, 2018 and 2021 periphyton samples.

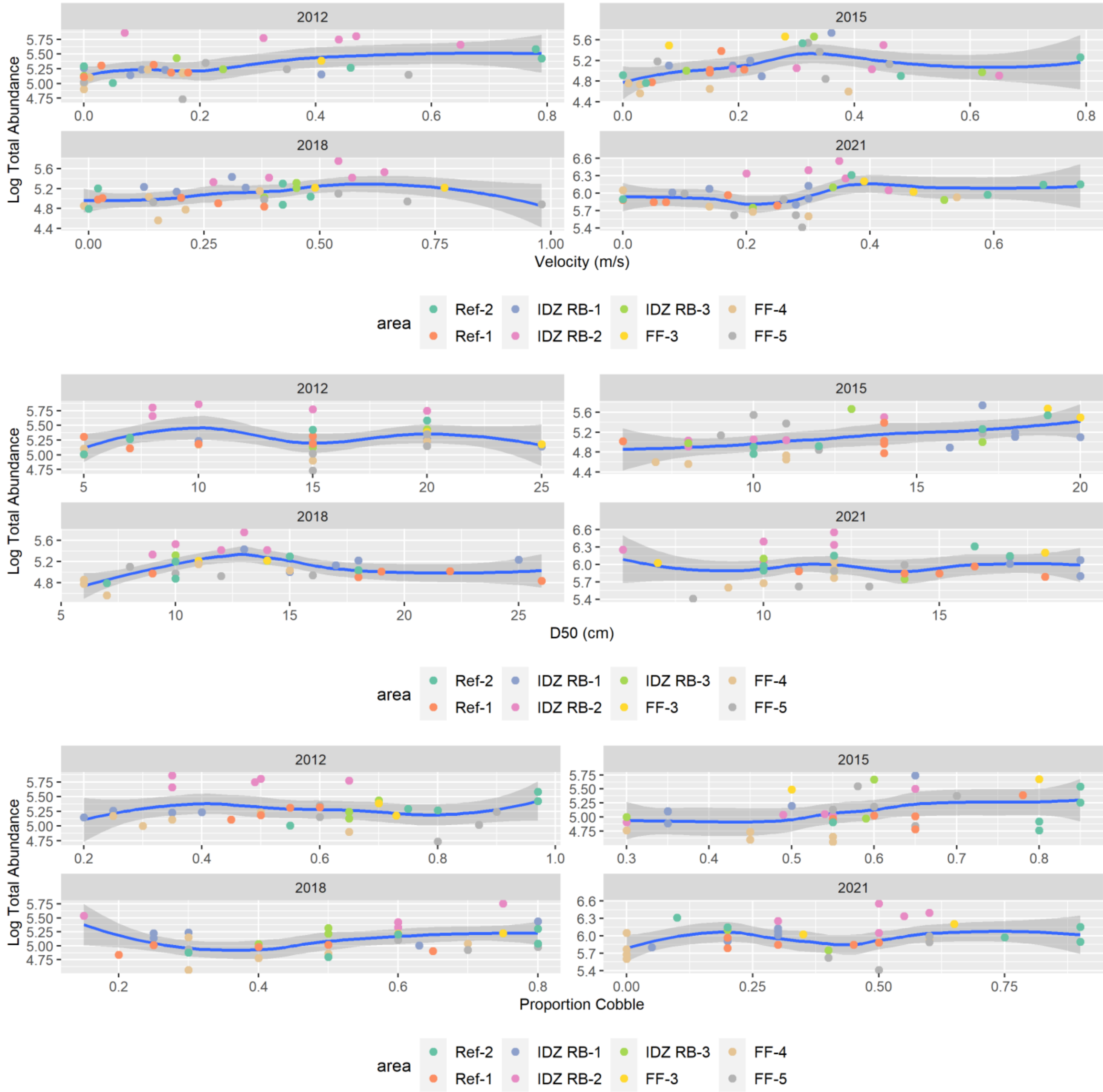


Figure 12: Explanatory variables and Log Total Abundance grouped by erosional areas for 2012, 2015, 2018 and 2021 periphyton samples.

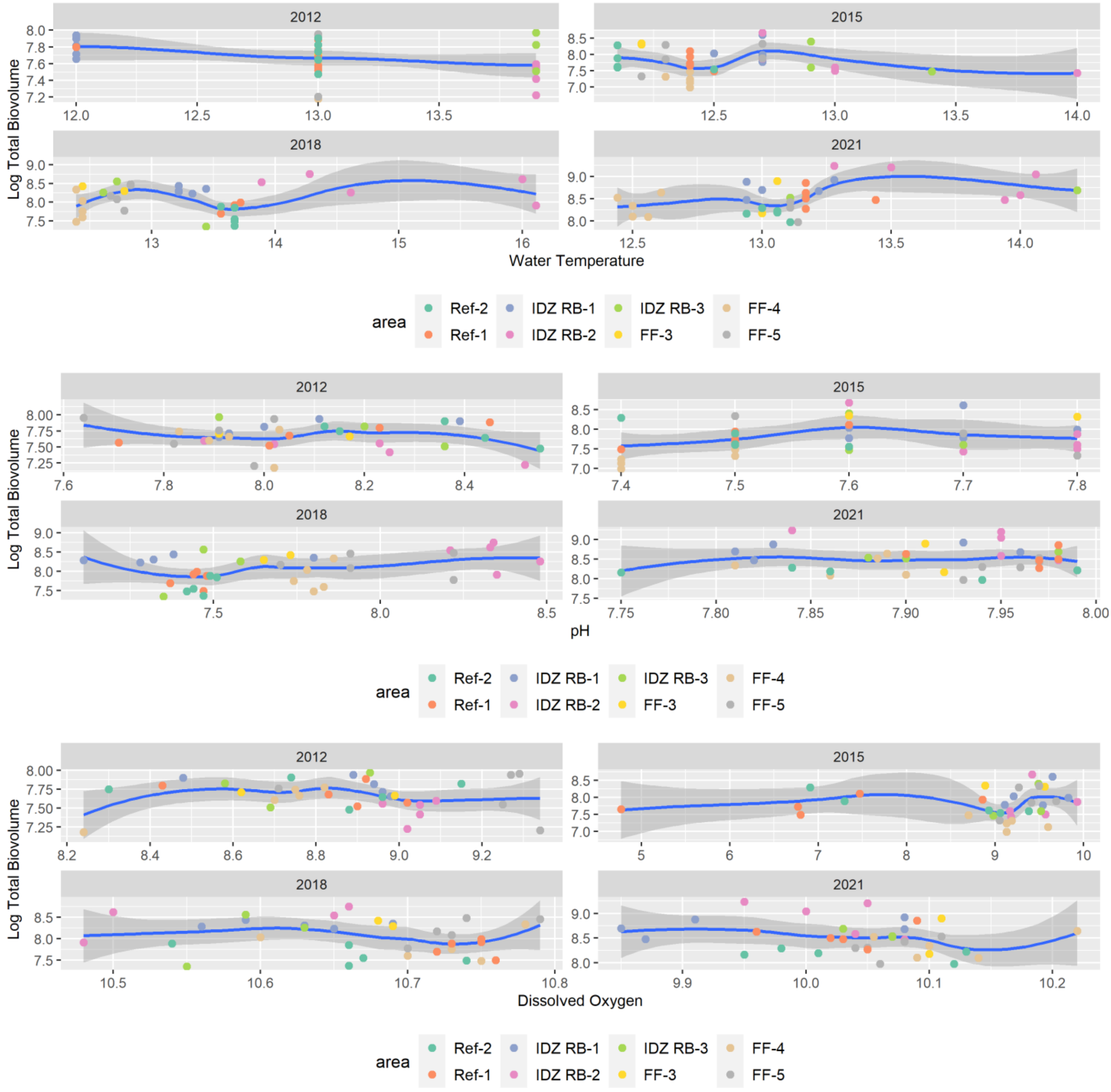


Figure 13: Explanatory variables and Log Total Biovolume grouped by erosional areas for 2012, 2015, 2018 and 2021 periphyton samples.

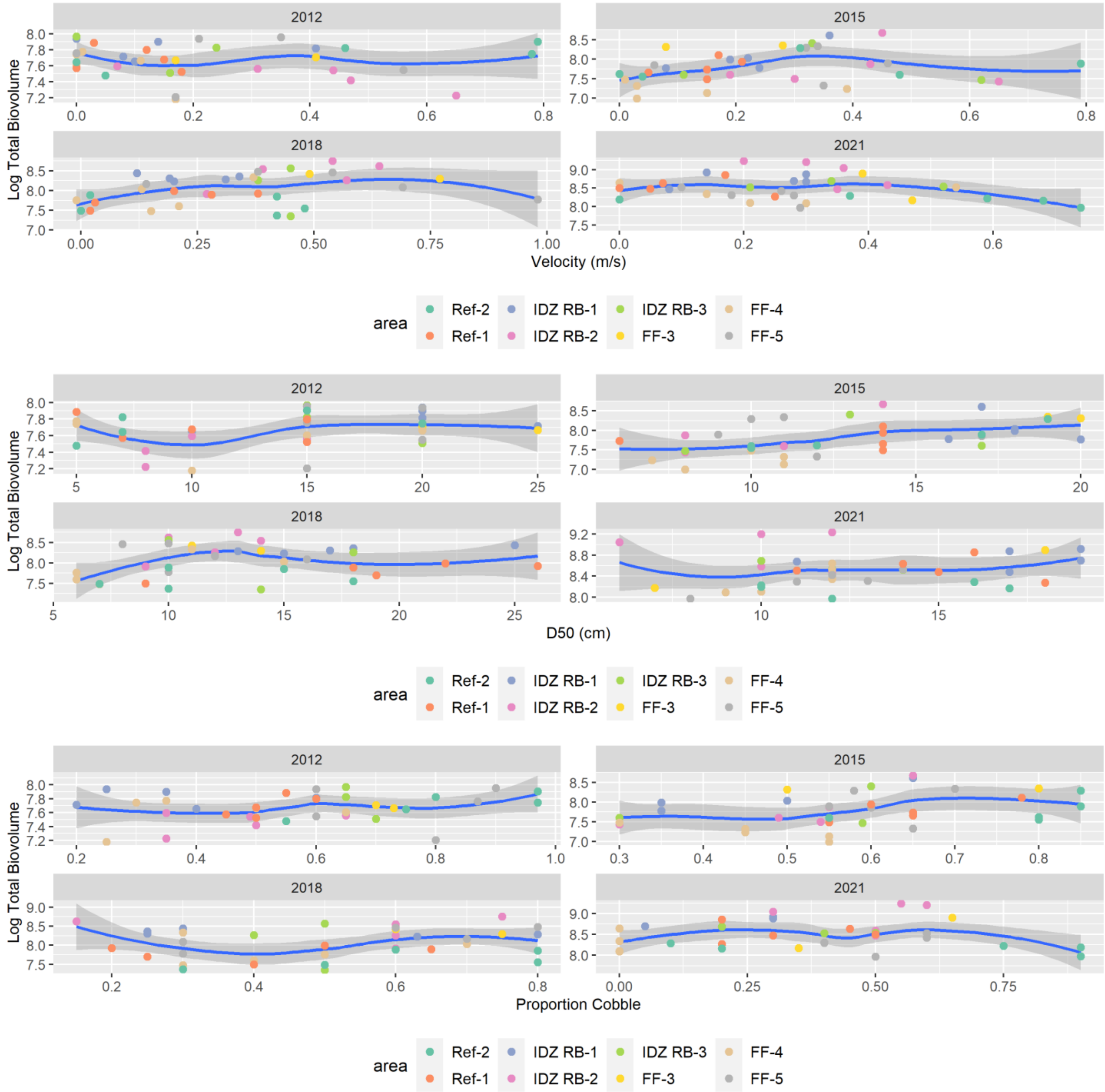


Figure 14: Explanatory variables and Log Total Biovolume grouped by erosional areas for 2012, 2015, 2018 and 2021 periphyton samples.

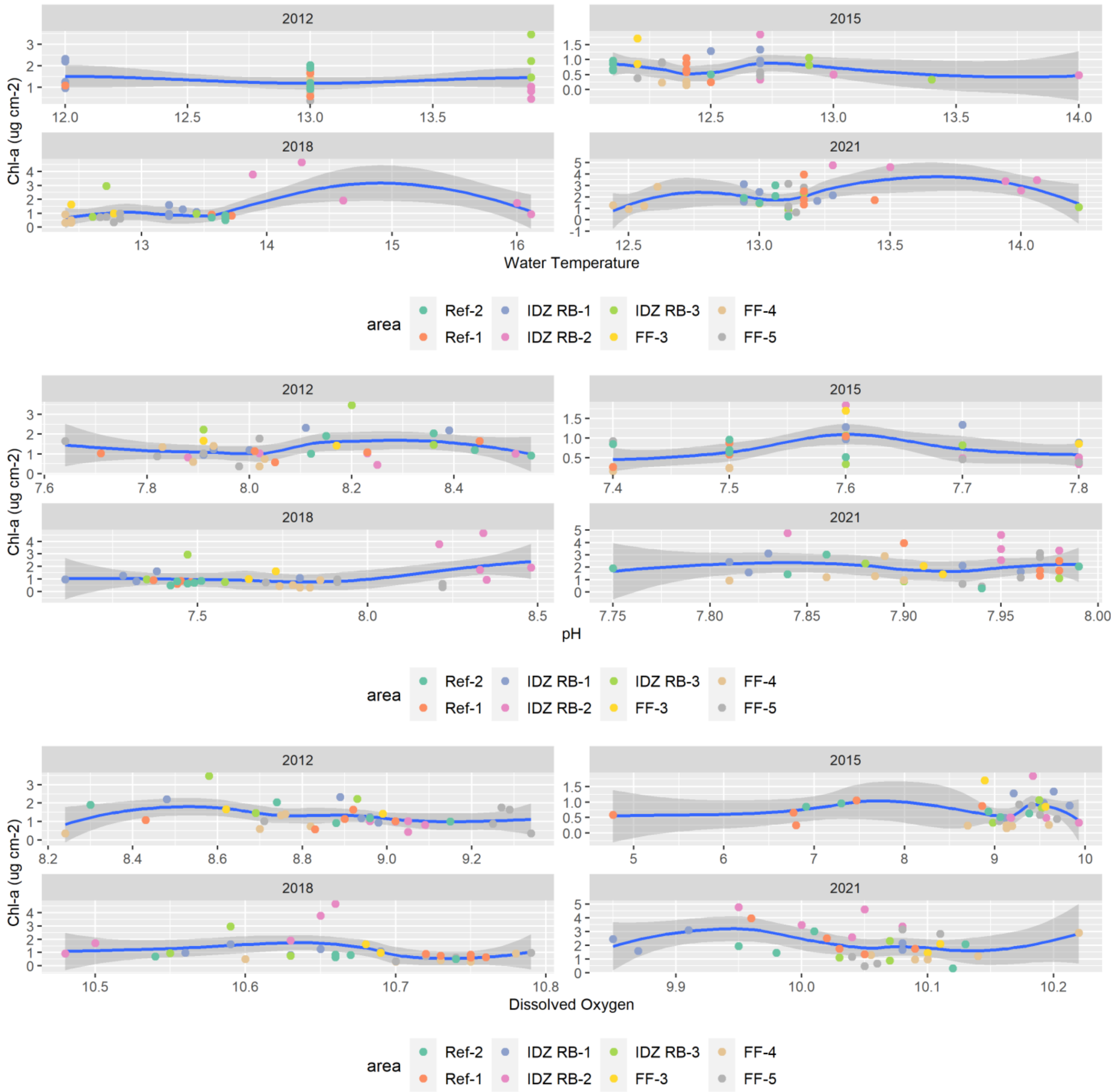


Figure 15: Explanatory variables and Chl-a (ug cm-2) grouped by erosional areas for 2012, 2015, 2018 and 2021 periphyton samples.

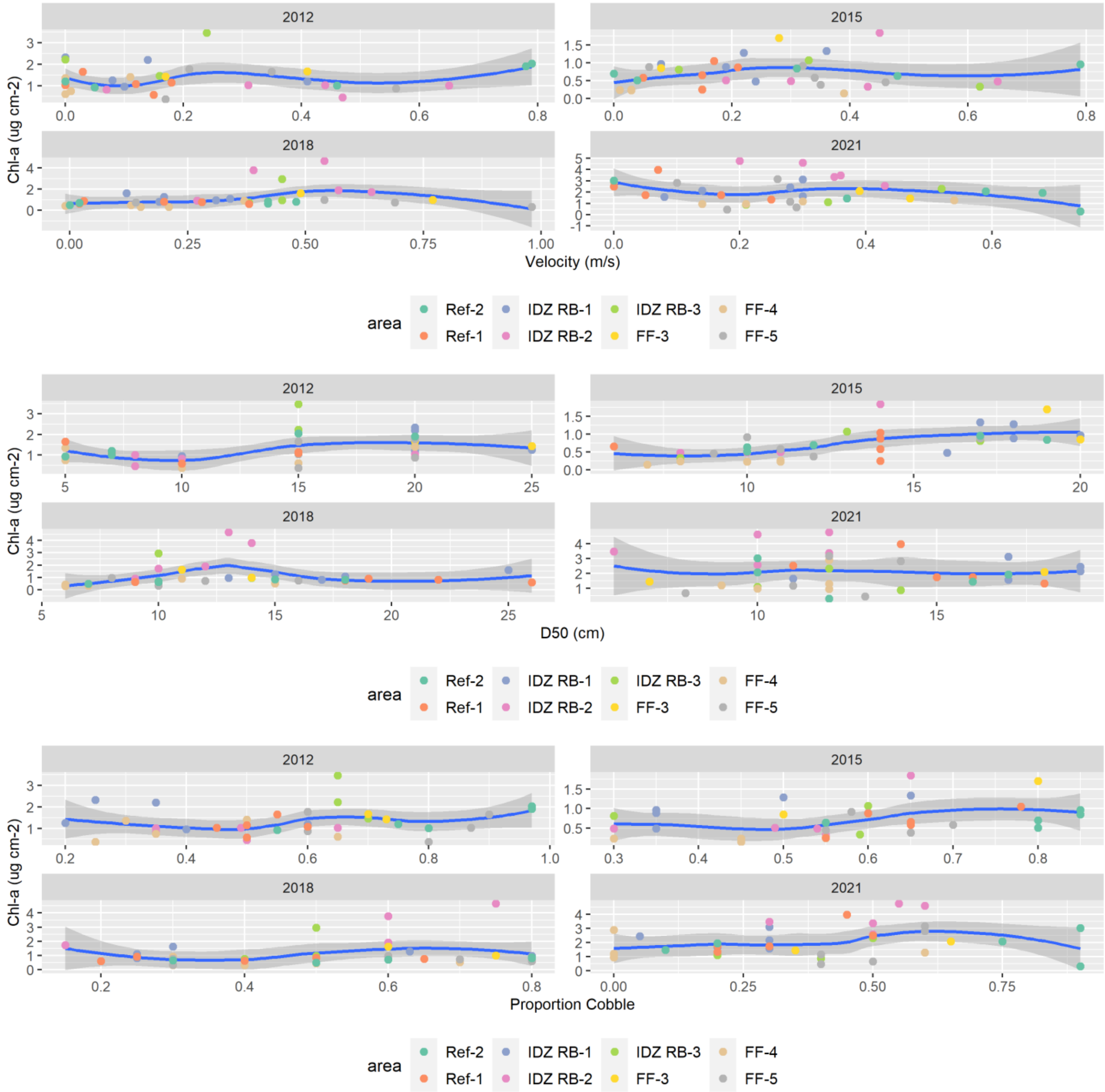


Figure 16: Explanatory variables and Chl-a (ug cm-2) grouped by erosional areas for 2012, 2015, 2018 and 2021 periphyton samples.

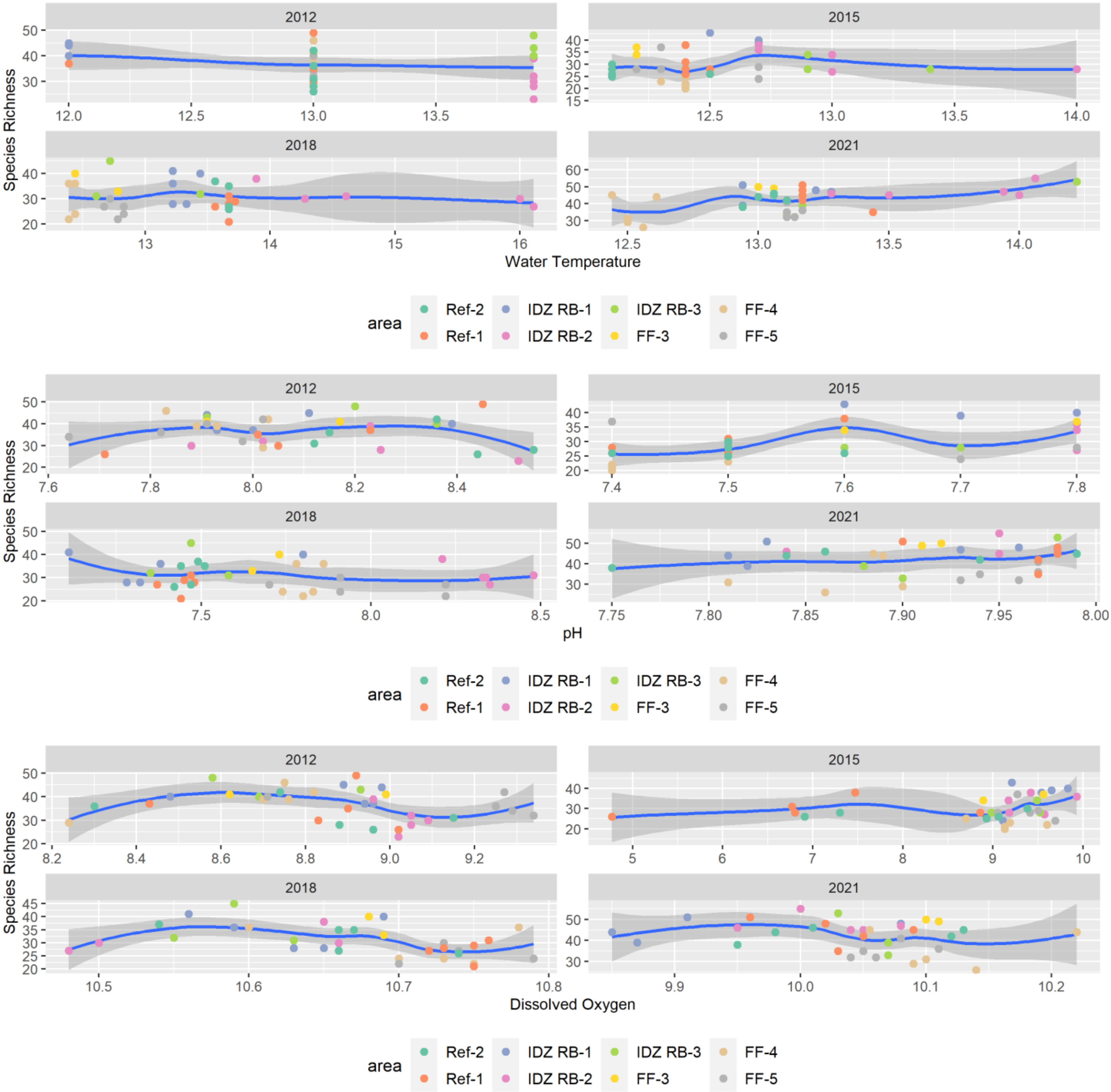


Figure 17: Explanatory variables and Species Richness grouped by erosional areas for 2012, 2015, 2018 and 2021 periphyton samples.

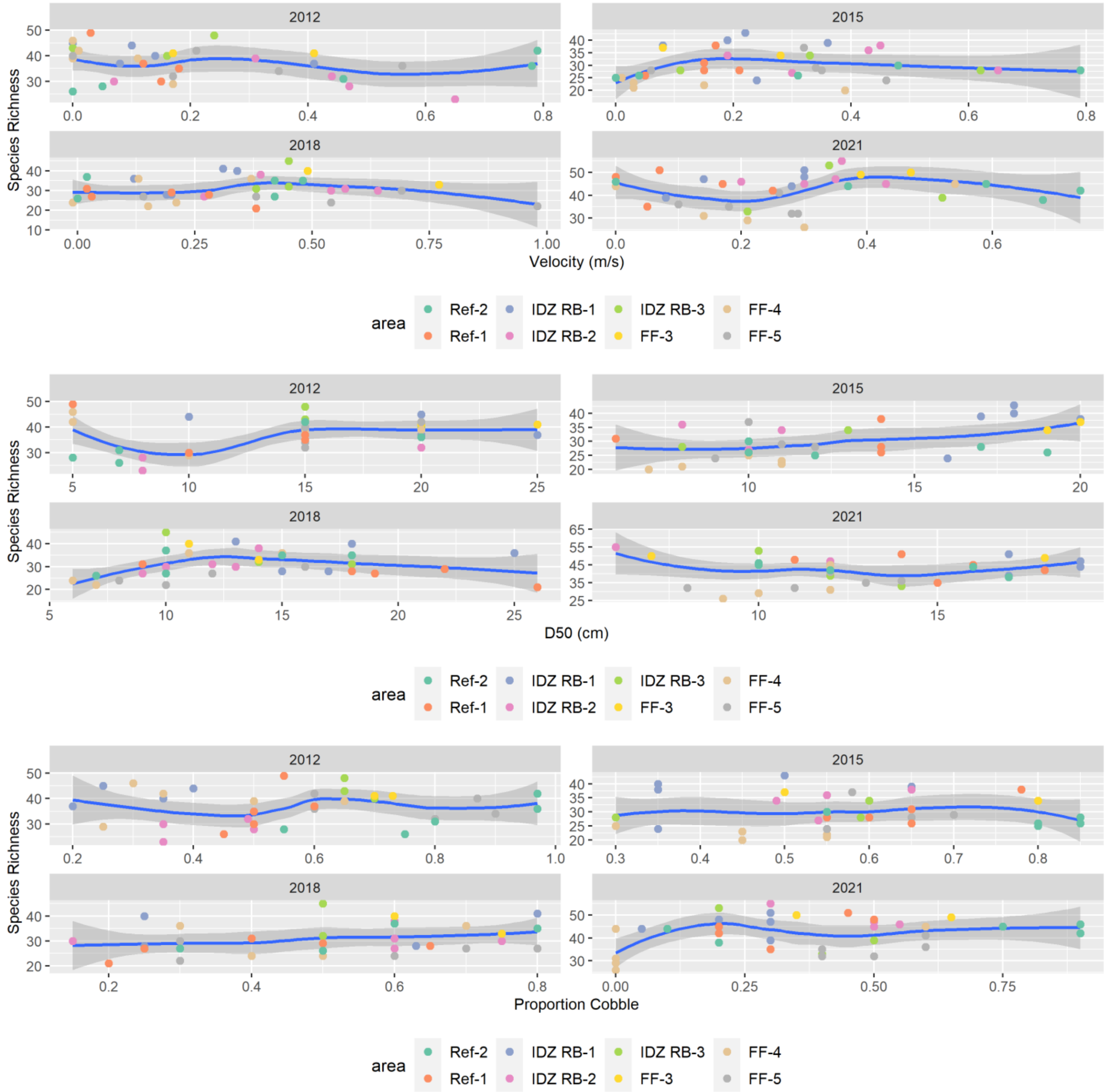


Figure 18: Explanatory variables and Species Richness grouped by erosional areas for 2012, 2015, 2018 and 2021 periphyton samples.

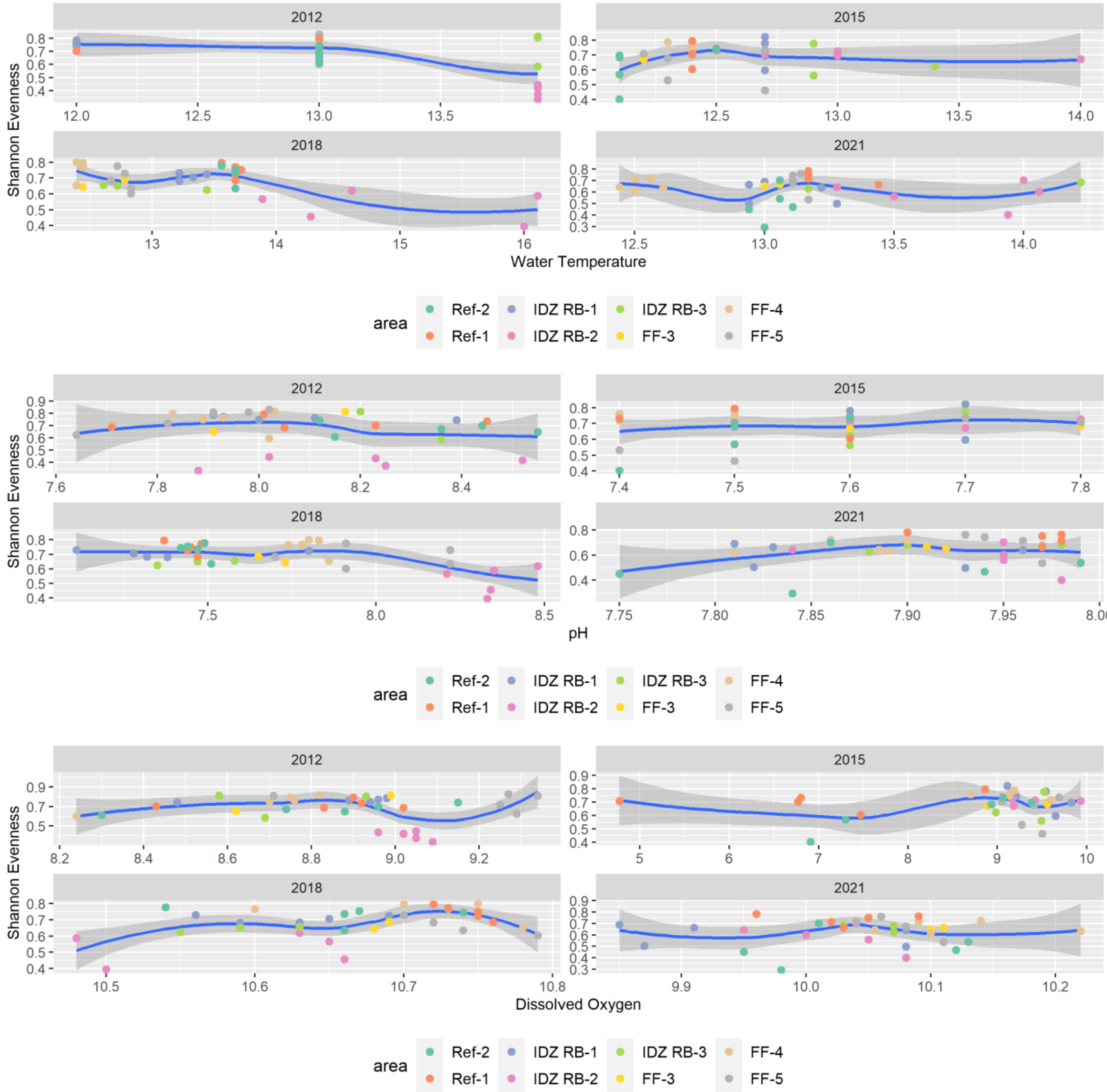


Figure 19: Explanatory variables and Shannon Evenness grouped by erosional areas for 2012, 2015, 2018 and 2021 periphyton samples.

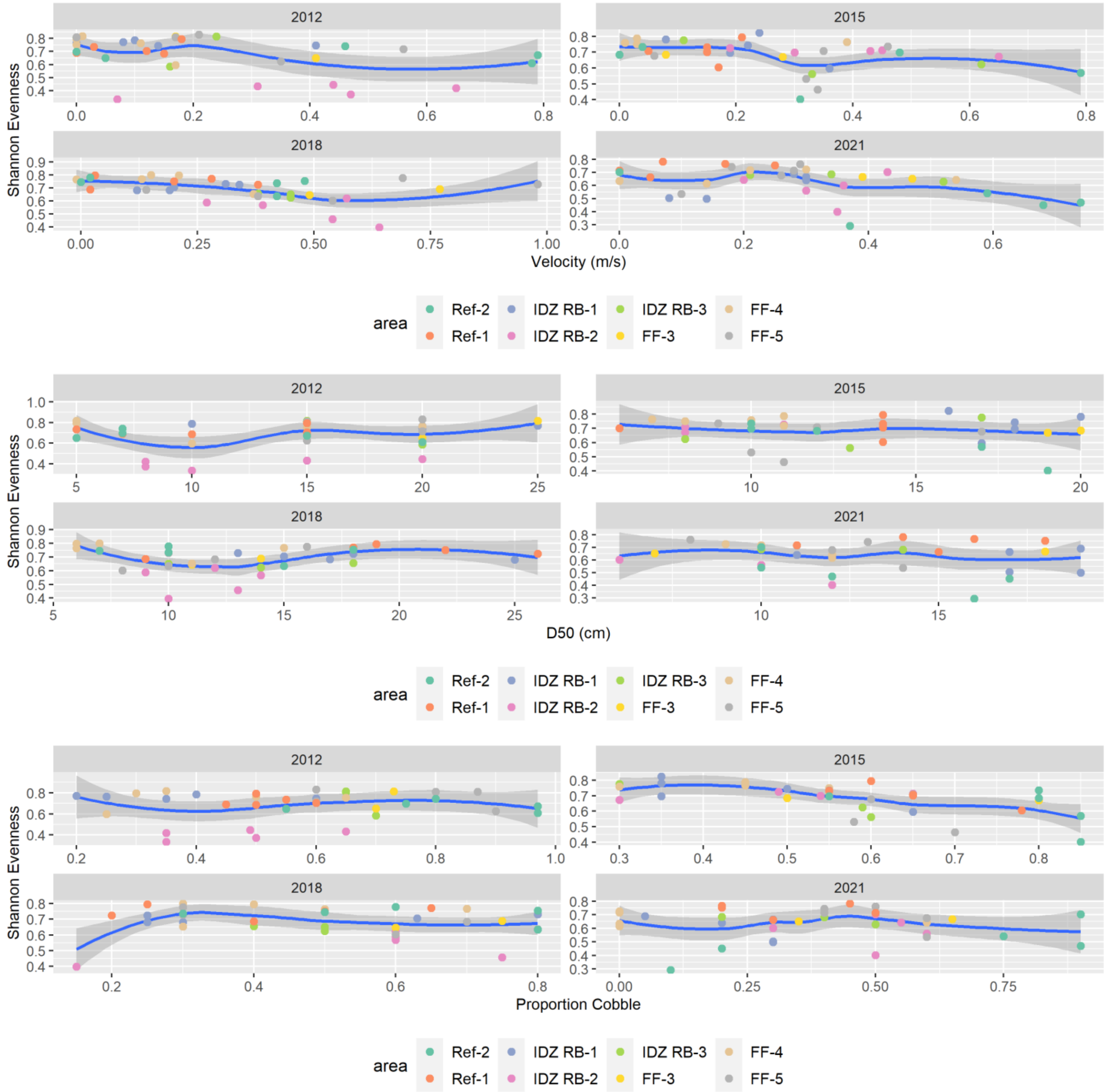


Figure 20: Explanatory variables and Shannon Evenness grouped by erosional areas for 2012, 2015, 2018 and 2021 periphyton samples.

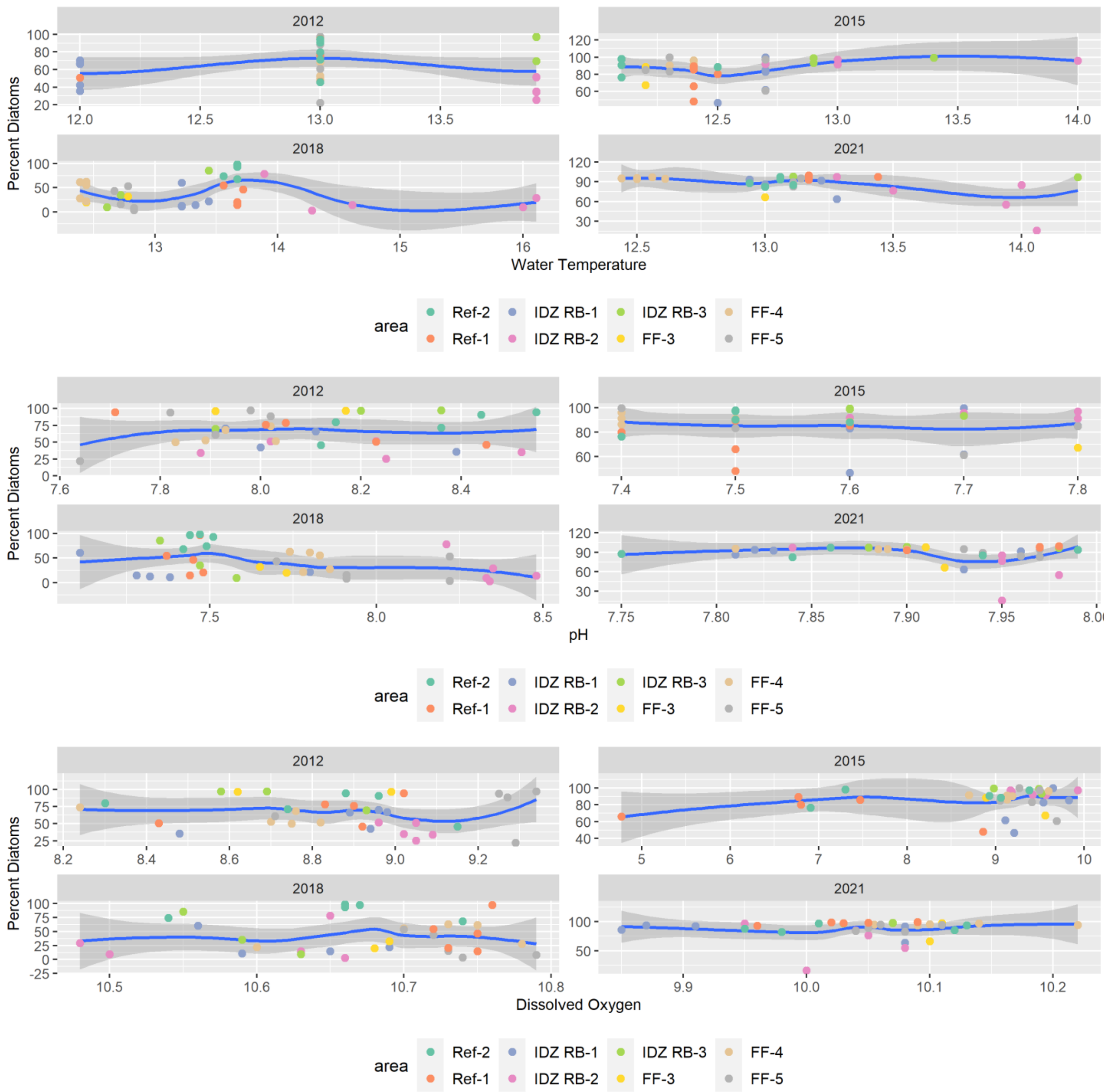
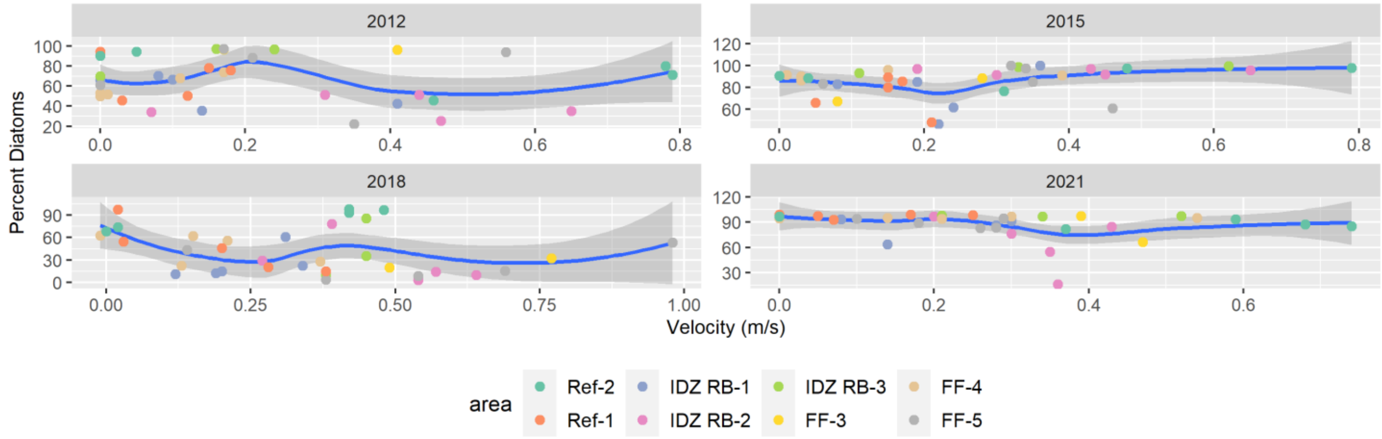
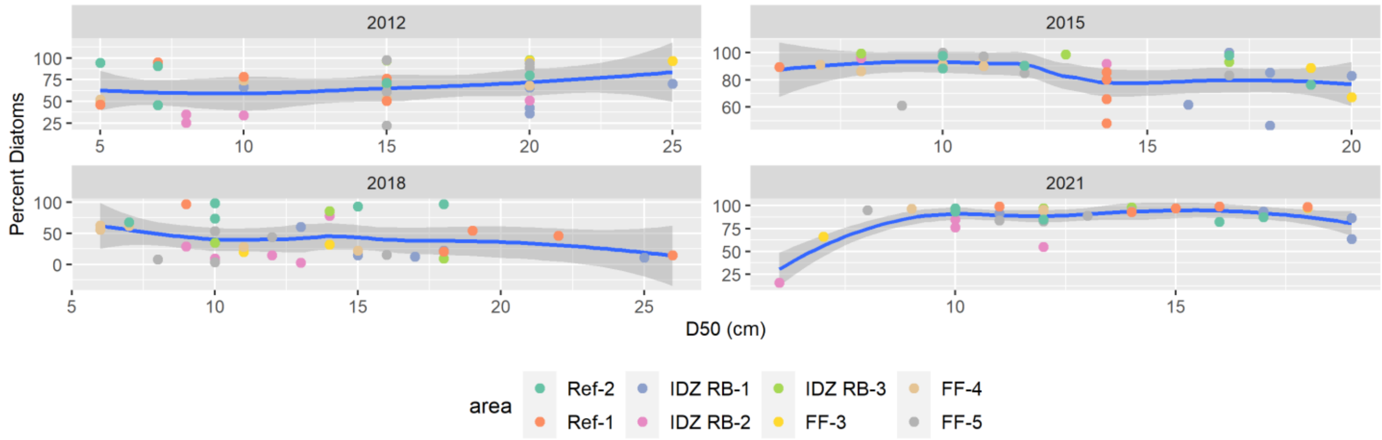


Figure 21: Explanatory variables and Percent Diatoms grouped by erosional areas for 2012, 2015, 2018 and 2021 periphyton samples.





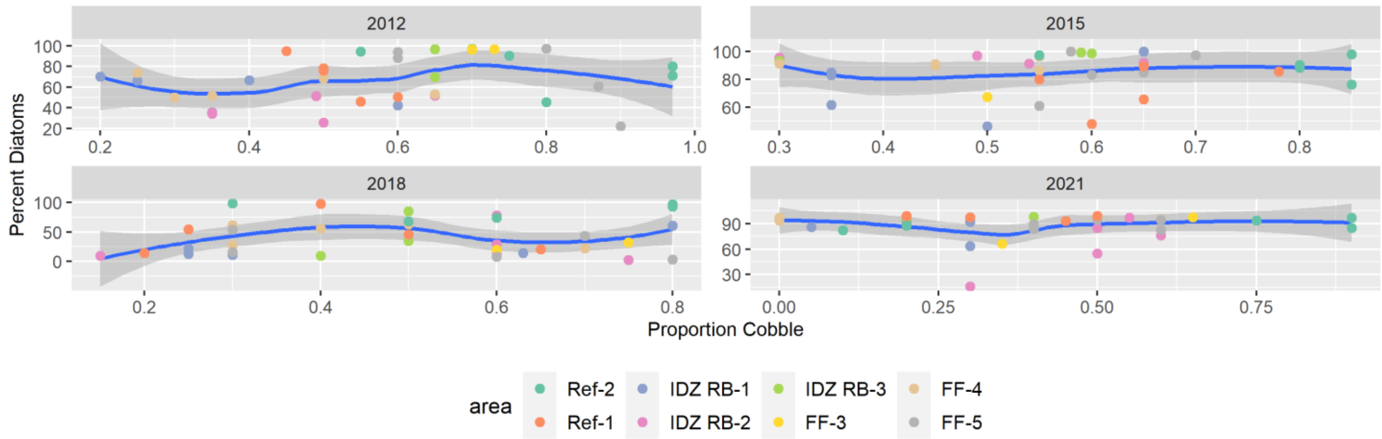


Figure 22: Explanatory variables and Percent Diatoms grouped by erosional areas for 2012, 2015, 2018, and 2021 periphyton samples.

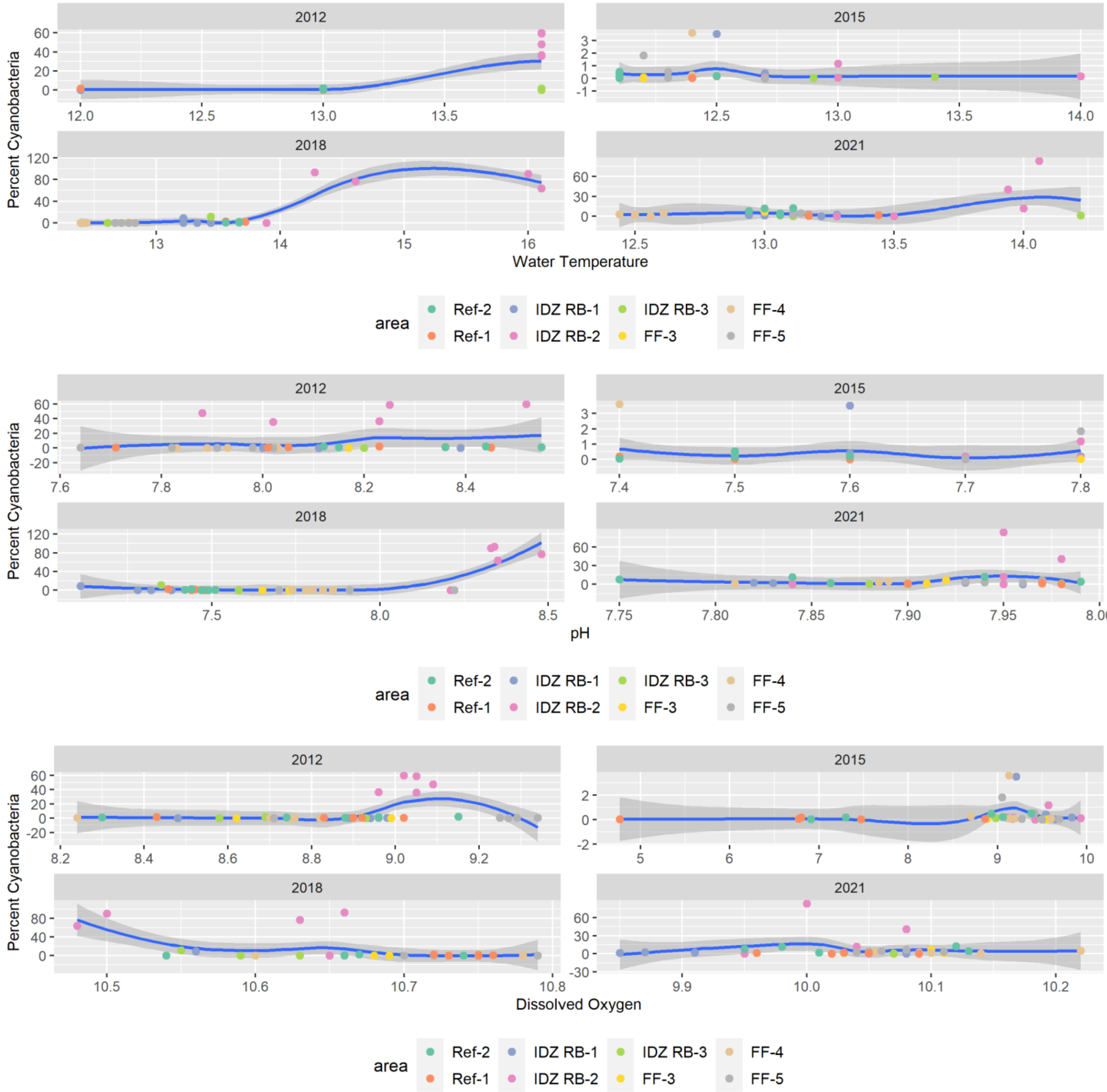


Figure 23: Explanatory variables and Percent Cyanobacteria grouped by erosional areas for 2012, 2015, 2018, and 2021 periphyton samples.

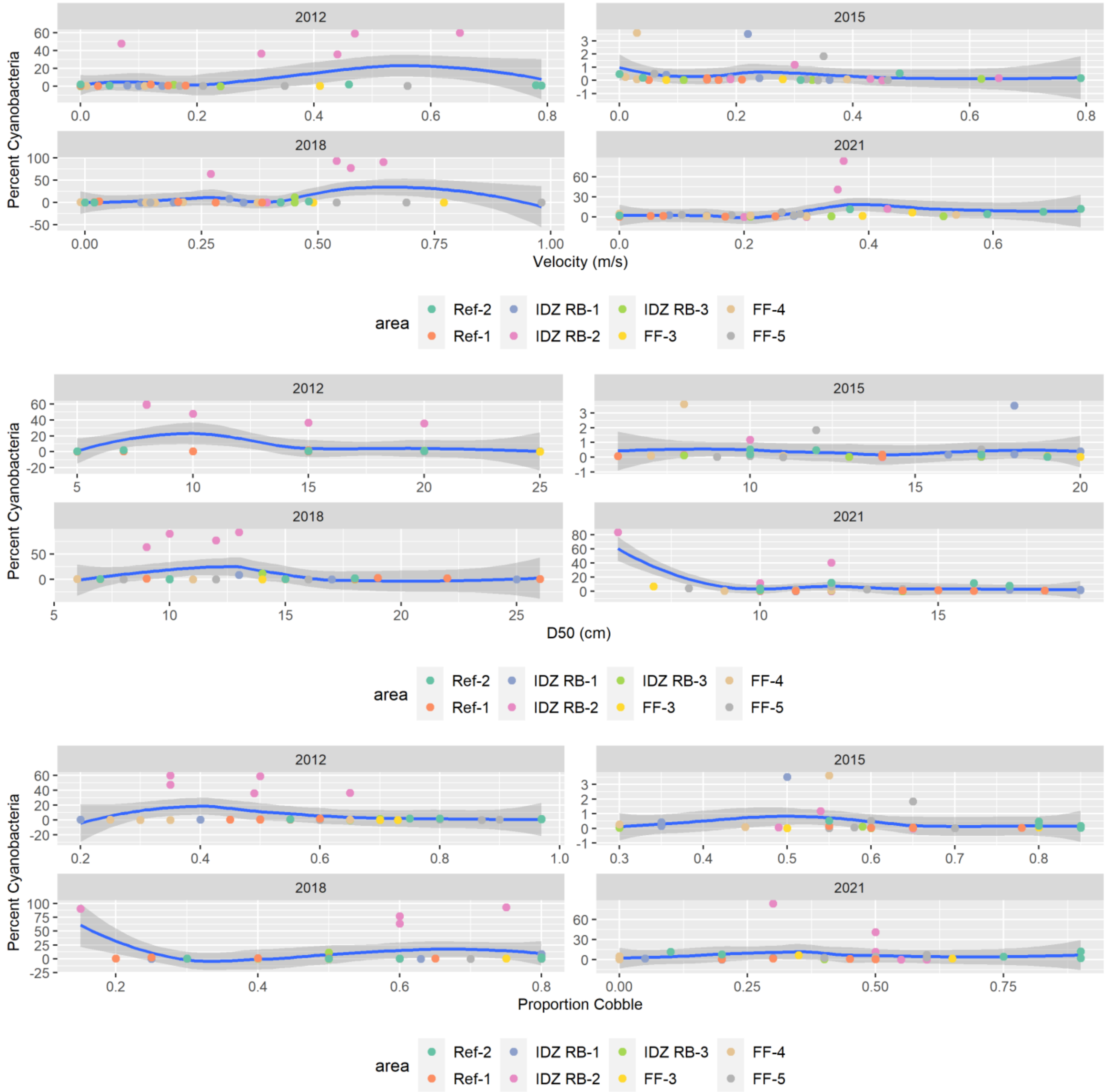


Figure 24: Explanatory variables and Percent Cyanobacteria grouped by erosional areas for 2012, 2015, 2018, and 2021 periphyton samples.

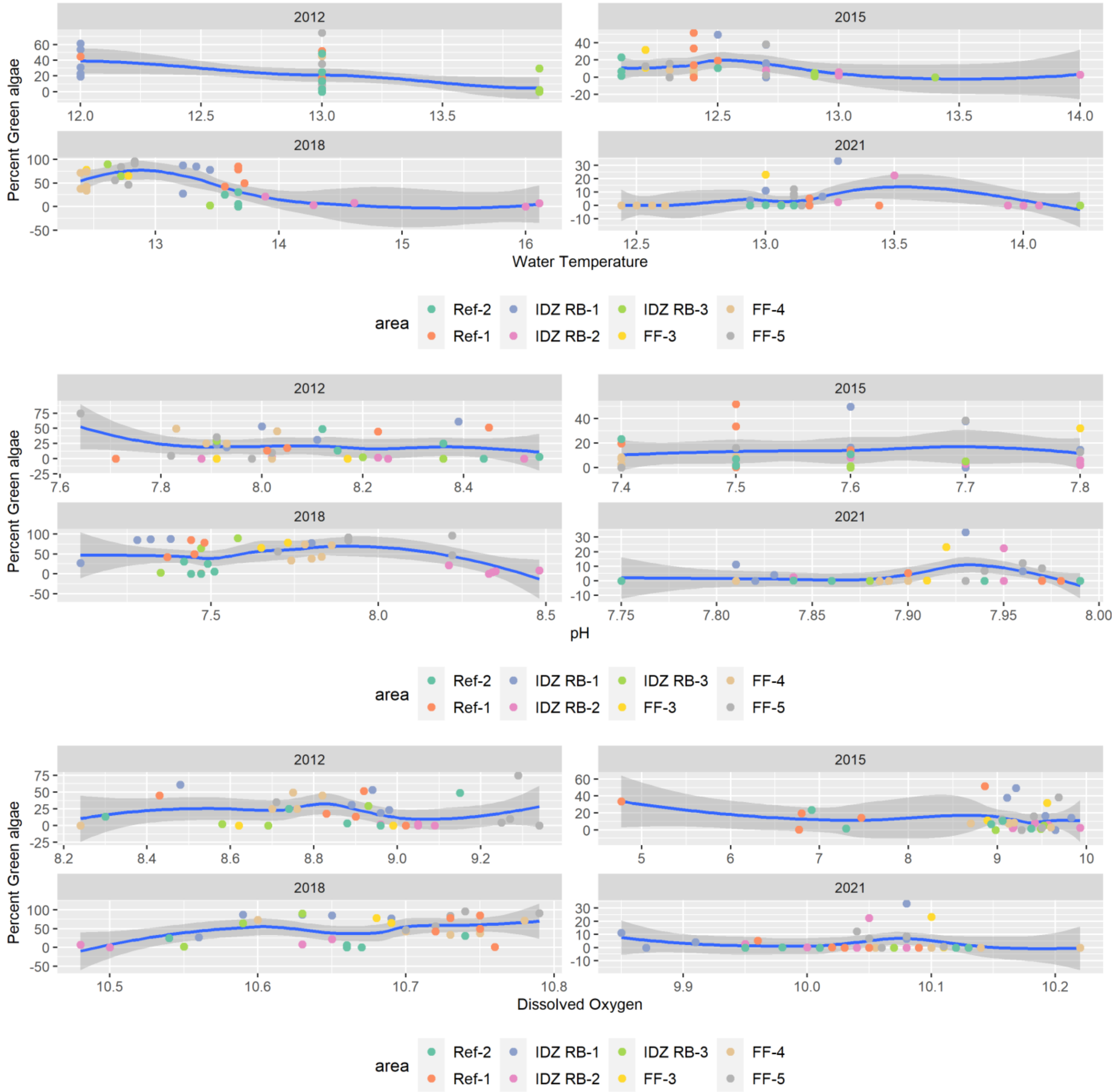


Figure 25: Explanatory variables and Percent Green algae grouped by erosional areas for 2012, 2015, 2018 and 2021 periphyton samples.

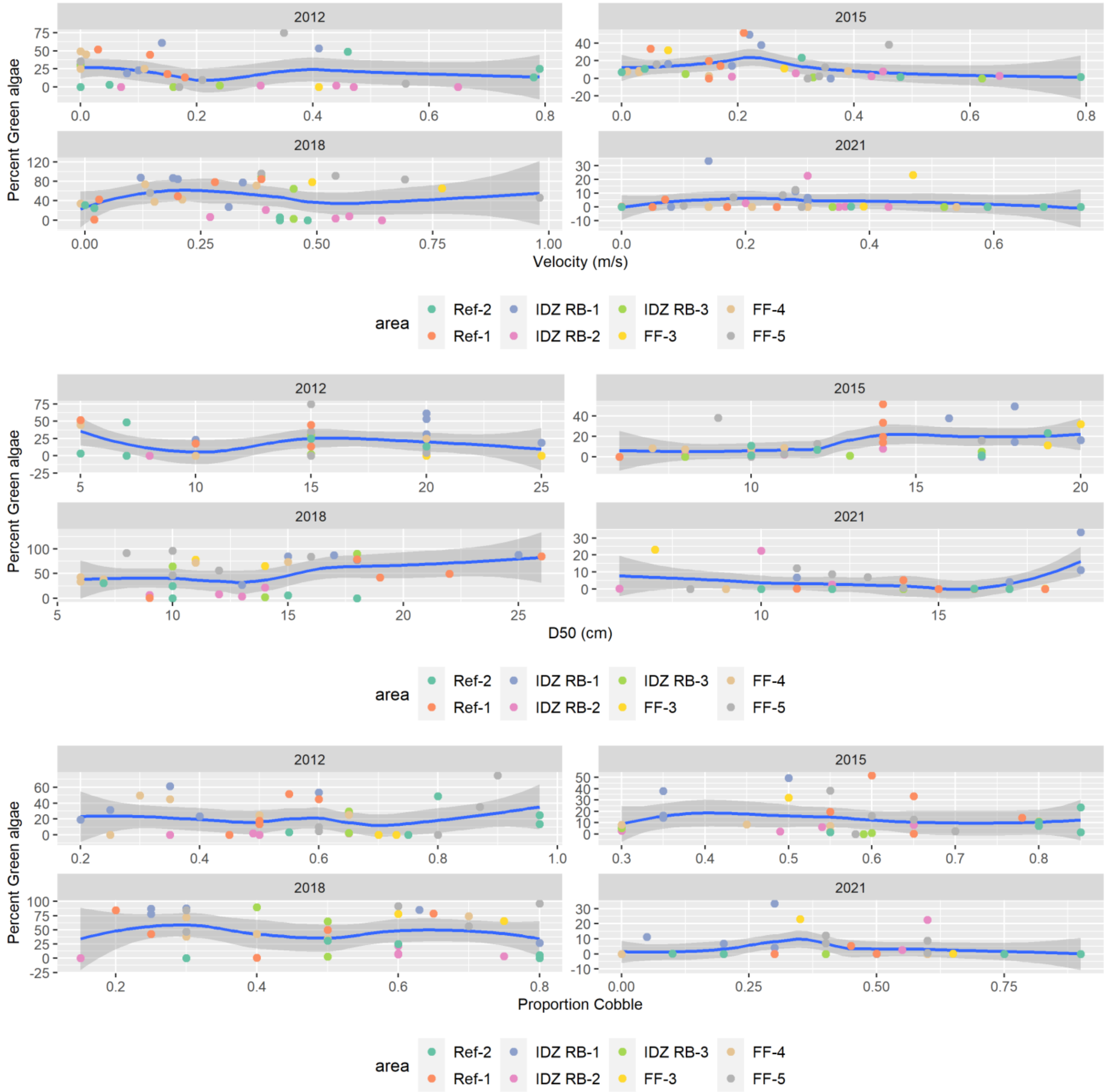


Figure 26: Explanatory variables and Percent Green algae grouped by erosional areas for 2012, 2015, 2018 and 2021 periphyton samples.

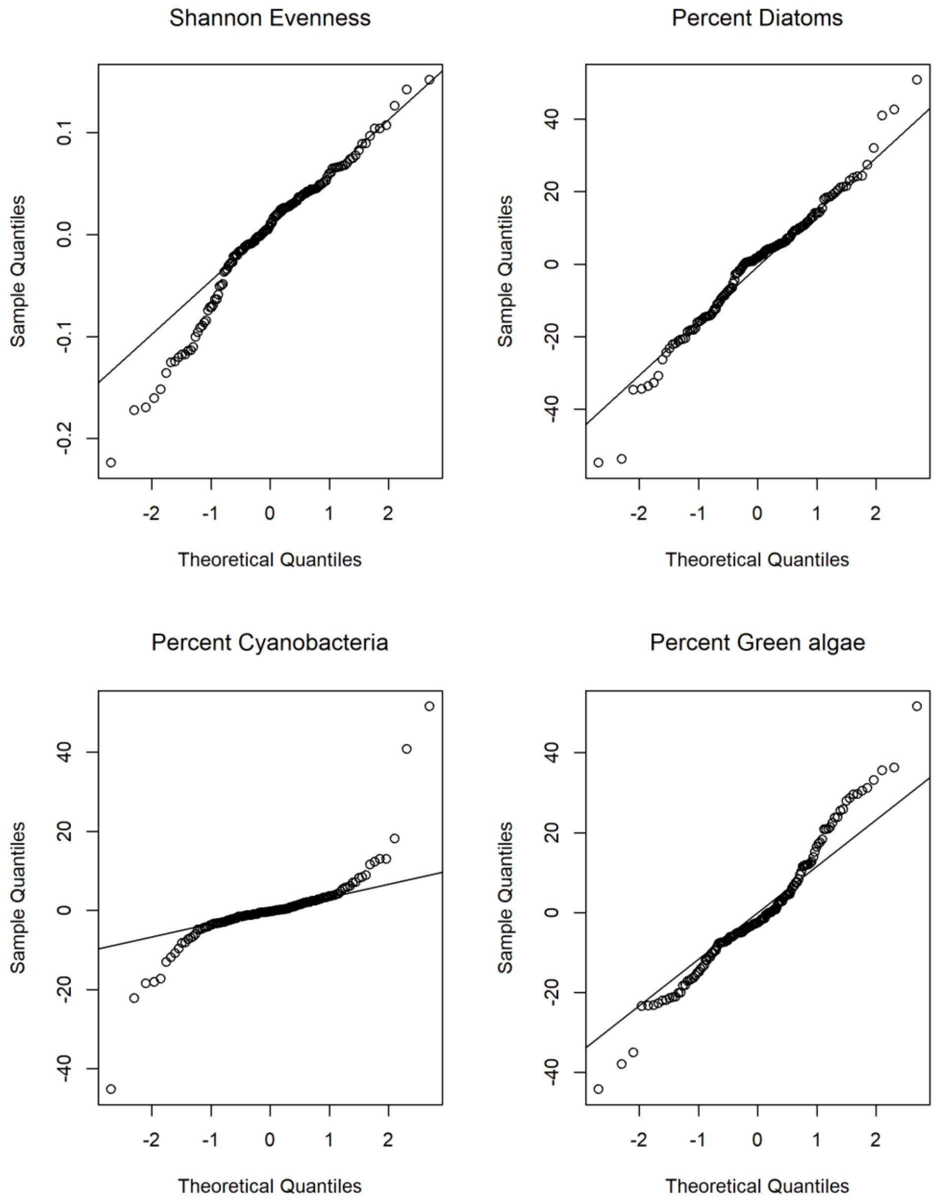


Figure 27: Quantile-Quantile plots for periphyton models of diversity metrics.

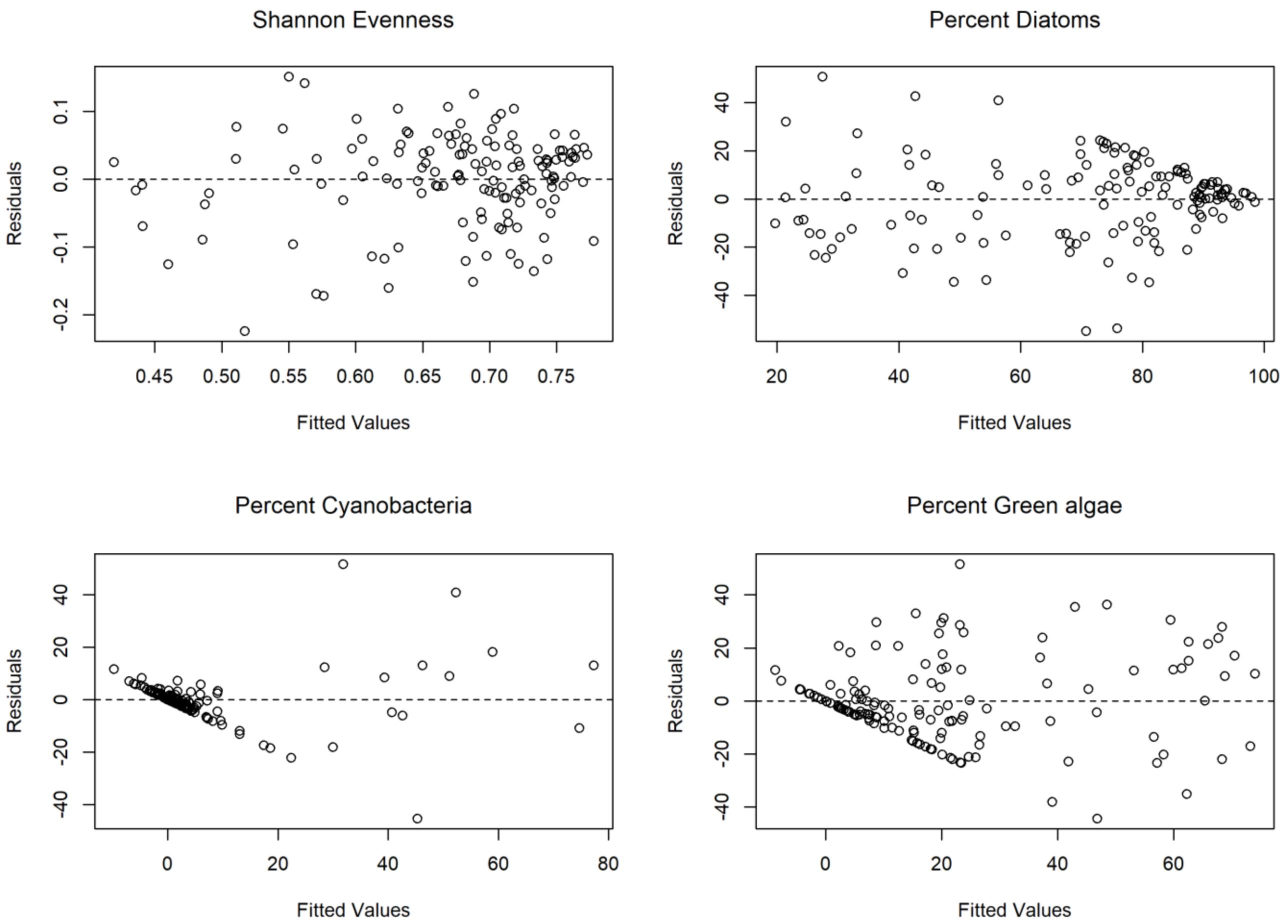


Figure 28: Residual plots for periphyton models of diversity metrics.

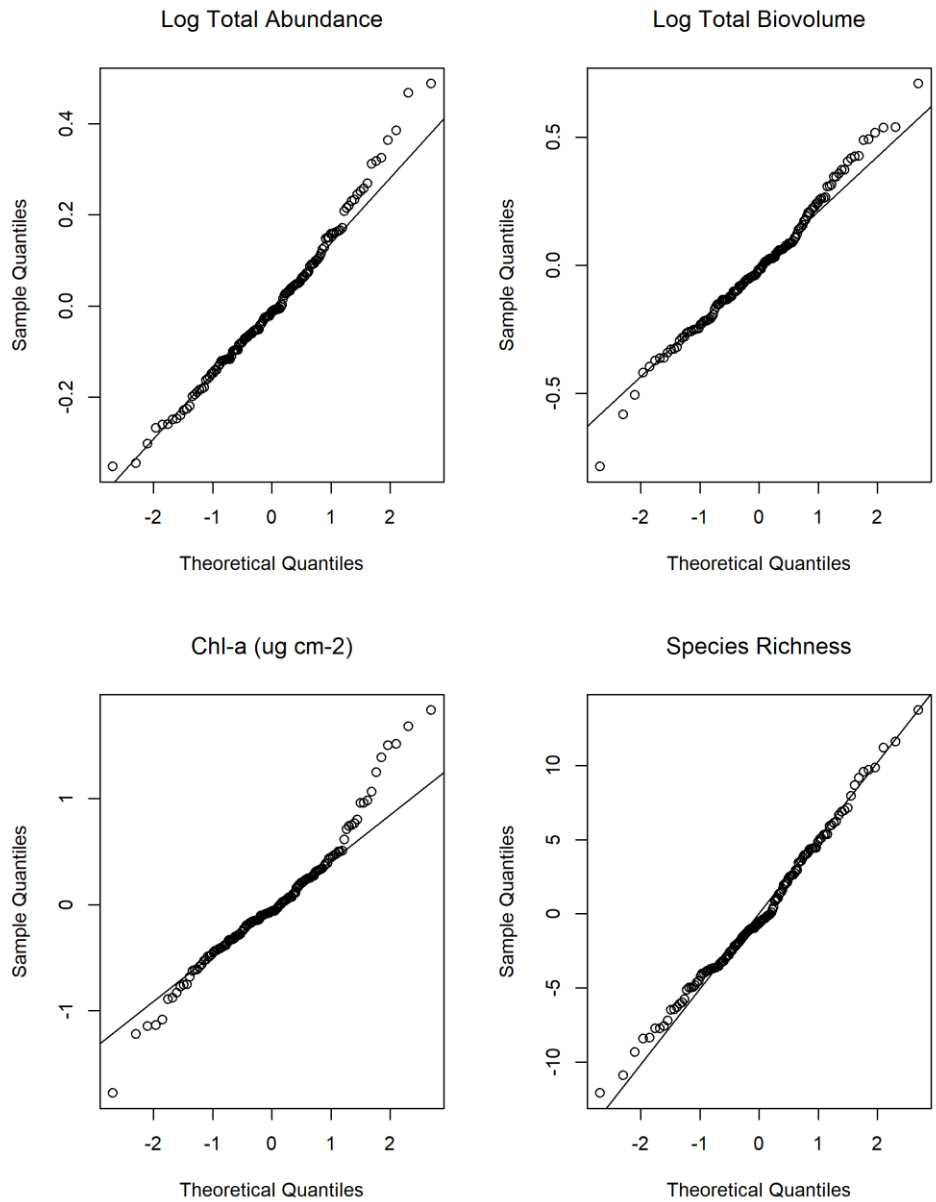


Figure 29: Quantile-Quantile plots for periphyton models of productivity metrics.

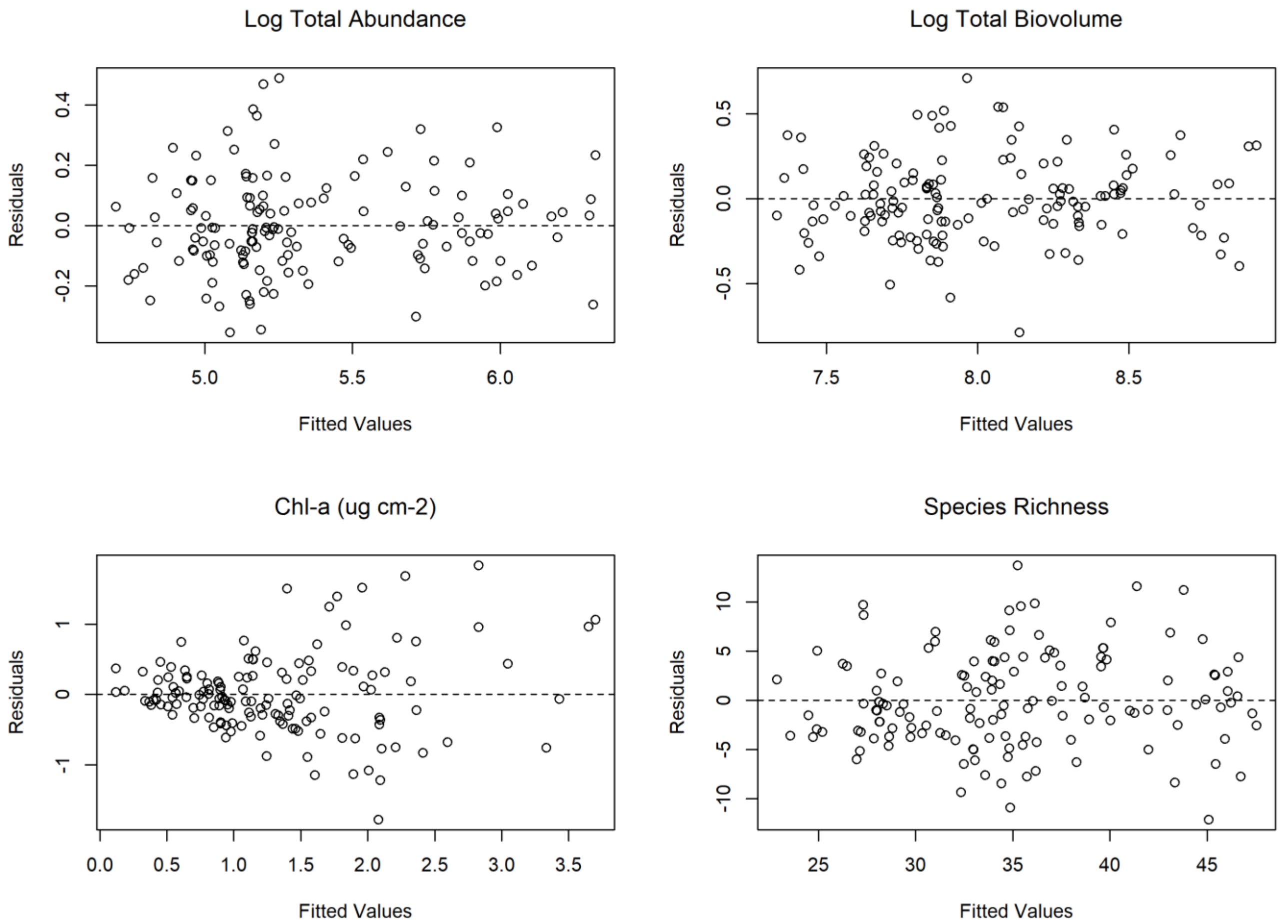


Figure 30: Residual plots for periphyton models of productivity metrics.

APPENDIX I BENTHIC INVERTEBRATE TAXONOMY AND METRICS

Table 140. Benthic invertebrate taxonomic identification for depositional and erosional sites.

Site - DEP-EXP-1, Sample - DEP-EXP-1-1, CC# - CC222055, Percent sampled = 46%, Sieve size = 400		
Chironomidae	Pupa	1
Cryptochironomus	Larvae	11
Paralauterborniella nigrohalterale	Larvae	4
Polypedilum	Larvae	7
Cladotanytarsus	Larvae	1
Tanytarsus	Larvae	8
Eukiefferiella	Larvae	1
Heterotrissocladius	Larvae	1
Hydrobaenus	Larvae	3
Monodiamesa	Larvae	6
Tanypodinae	Juvenile/Damaged	1
Procladius	Larvae	7
Ephemerellidae	Juvenile/Damaged	1
Brachycentrus occidentalis	Larvae	30
Mystacides	Larvae	2
Nais	None	5
Slavina appendiculata	None	7
Stylaria lacustris	None	1
Pisidiidae	Juvenile/Damaged	11
Pisidium	None	15
Lymnaeidae	Juvenile/Damaged	4
Fossaria	None	1
Planorbidae	Juvenile/Damaged	2
Gyraulus	None	17
Valvata	None	12
Baetis rhodani group	Juvenile/Damaged	1
Tubificinae with hair chaetae	None	67
Tubificinae without hair chaetae	None	89
Physella	None	1
Total:		317

Site - DEP-EXP-1, Sample - DEP-EXP-1-2, CC# - CC222056, Percent sampled = 37%, Sieve size = 400		
Physella	None	1
Tubificinae without hair chaetae	None	65
Tubificinae with hair chaetae	None	54
Baetis rhodani group	Juvenile/Damaged	2
Kogotus	Larvae	1
Valvata	None	12
Gyraulus	None	28
Planorbidae	Juvenile/Damaged	3
Fossaria	None	2
Lymnaeidae	Juvenile/Damaged	8
Gastropoda	Juvenile/Damaged	2
Pisidium	None	1

Pisidiidae	Juvenile/Damaged	9
Slavina appendiculata	None	5
Stylaria lacustris	None	2
Nais	None	9
Ophidonais serpentina	None	1
Erpobdella	None	1
Mystacides	Larvae	1
Amphipoda	Juvenile/Damaged	1
Hyalella	None	5
Caecidotea	None	1
Brachycentrus occidentalis	Larvae	58
Ephemerellidae	Juvenile/Damaged	1
Ephemerella	Larvae	2
Procladius	Larvae	2
Baetis	Juvenile/Damaged	1
Synorthocladius	Larvae	1
Orthocladius complex	Larvae	3
Hydrobaenus	Larvae	1
Potthastia longimana group	Larvae	3
Tanytarsus	Larvae	5
Rheotanytarsus	Larvae	4
Polypedilum	Larvae	1
Phaenopsectra	Larvae	5
Cryptochironomus	Larvae	2
Dicrotendipes	Larvae	3
Chironomidae	Pupa	5
Bezzia/ Palpomyia	Larvae	1
Probezzia	Larvae	1
Total:		**313**

Site - DEP-EXP-1, Sample - DEP-EXP-1-3, CC# - CC222057, Percent sampled = 100%, Sieve size = 400		
Probezzia	Larvae	1
Chironomus	Larvae	2
Cryptochironomus	Larvae	3
Paralauterborniella nigrohalterale	Larvae	3
Microtendipes	Larvae	3
Polypedilum	Larvae	7
Paratanytarsus	Larvae	1
Tanytarsus	Larvae	10
Potthastia longimana group	Larvae	1
Rheocricotopus	Larvae	1
Heterotrissocladius	Larvae	1
Orthocladius complex	Larvae	7
Monodiamesa	Larvae	20
Procladius	Larvae	5
Ephemerellidae	Juvenile/Damaged	2
Cheumatopsyche	Larvae	1
Ephemerella	Larvae	2
Rhithrogena	Larvae	1
Sigara	Adult	1
Nemouridae	Juvenile/Damaged	1
Hyalella	None	5
Crangonyx	None	2
Mystacides	Larvae	1
Nais	None	14
Slavina appendiculata	None	20
Pisidiidae	Juvenile/Damaged	26
Pisidium	None	24

Lymnaeidae	Juvenile/Damaged	3
Planorbidae	Juvenile/Damaged	3
Gyraulus	None	43
Valvata	None	13
Thysanoptera	Adult	1
Tubificinae with hair chaetae	None	109
Tubificinae without hair chaetae	None	68
Physella	None	2
Total:		**407**

Site - DEP-EXP-1, Sample - DEP-EXP-1-4, CC# - CC222058, Percent sampled = 50%, Sieve size = 400		
Tubificinae without hair chaetae	None	45
Tubificinae with hair chaetae	None	72
Valvata	None	21
Planorbidae	Juvenile/Damaged	4
Gyraulus	None	39
Fossaria	None	1
Lymnaeidae	Juvenile/Damaged	4
Pisidium	None	37
Pisidiidae	Juvenile/Damaged	12
Unionidae	Juvenile/Damaged	1
Slavina appendiculata	None	21
Nais	None	7
Hygrobates	Adult	1
Amphipoda	Juvenile/Damaged	1
Asellidae	Juvenile/Damaged	1
Brachycentrus	Juvenile/Damaged	1
Brachycentrus occidentalis	Larvae	24
Ephemerella	Larvae	2
Ephemerellidae	Juvenile/Damaged	2
Procladius	Larvae	2
Monodiamesa	Larvae	14
Synorthocladius	Larvae	1
Tanytarsus	Larvae	5
Polypedilum	Larvae	5
Microtendipes	Larvae	1
Paralauterborniella nigrohalterale	Larvae	1
Cryptochironomus	Larvae	10
Probezzia	Larvae	3
Total:		**338**

Site - DEP-EXP-1, Sample - DEP-EXP-1-5, CC# - CC222059, Percent sampled = 100%, Sieve size = 400		
Chironomidae	Pupa	1
Cryptochironomus	Larvae	28
Paralauterborniella nigrohalterale	Larvae	1
Microtendipes	Larvae	1
Polypedilum	Larvae	25
Tanytarsus	Larvae	6
Orthocladius complex	Larvae	2
Monodiamesa	Larvae	19
Tvetenia	Larvae	1
Tanypodinae	Juvenile/Damaged	2
Procladius	Larvae	10
Ephemerellidae	Juvenile/Damaged	4
Ephemerella	Larvae	2
Brachycentrus occidentalis	Larvae	29
Hydropsyche	Larvae	1

Crangonyx	None	1
Hyalella	None	5
Mystacides	Larvae	1
Nais	None	3
Ophidonais serpentina	None	1
Pisidiidae	Juvenile/Damaged	32
Pisidium	None	8
Lymnaeidae	Juvenile/Damaged	7
Fossaria	None	2
Planorbidae	Juvenile/Damaged	3
Gyraulus	None	18
Valvata	None	16
Tubificinae with hair chaetae	None	18
Tubificinae without hair chaetae	None	28
Physella	None	3
Total:		**278**

Site - DEP-EXP-2, Sample - DEP-EXP-2-1, CC# - CC222060, Percent sampled = 50%, Sieve size = 400		
Tubificinae with hair chaetae	None	80
Tubificinae without hair chaetae	None	106
Helisoma	None	2
Valvata	None	30
Hydrobiidae	Juvenile/Damaged	3
Gyraulus	None	16
Fossaria	None	4
Pisidium	None	61
Gastropoda	Juvenile/Damaged	1
Lymnaeidae	Juvenile/Damaged	1
Pisidiidae	Juvenile/Damaged	12
Unionidae	Juvenile/Damaged	1
Ophidonais serpentina	None	2
Arcteonais lomondi	None	4
Hyalella	None	3
Brachycentrus occidentalis	Larvae	3
Ephemerellidae	Juvenile/Damaged	1
Procladius	Larvae	1
Tanytarsus	Larvae	4
Polypedilum	Larvae	5
Physella	None	3
Total:		**343**

Site - DEP-EXP-2, Sample - DEP-EXP-2-2, CC# - CC222061, Percent sampled = 50%, Sieve size = 400		
Polypedilum	Larvae	6
Cryptochironomus	Larvae	6
Demicryptochironomus	Larvae	1
Constempellina	Larvae	1
Potthastia longimana group	Larvae	4
Tanytarsus	Larvae	6
Procladius	Larvae	1
Hyalella	None	1
Pisidiidae	Juvenile/Damaged	76
Sphaerium	None	1
Pisidium	None	62
Fossaria	None	3
Gyraulus	None	9
Valvata	None	19
Hexagenia	Larvae	1

Tubificinae with hair chaetae	None	19
Tubificinae without hair chaetae	None	229
Total:		**445**

Site - DEP-EXP-2, Sample - DEP-EXP-2-3, CC# - CC222062, Percent sampled = 40%, Sieve size = 400		
Tubificinae without hair chaetae	None	196
Tubificinae with hair chaetae	None	14
Hydrobiidae	Juvenile/Damaged	2
Valvata	None	8
Gyraulus	None	10
Fossaria	None	3
Pisidium	None	38
Gastropoda	Juvenile/Damaged	1
Pisidiidae	Juvenile/Damaged	28
Tanytarsus	Larvae	8
Monodiamesa	Larvae	1
Cryptochironomus	Larvae	4
Polypedilum	Larvae	6
Total:		**319**

Site - DEP-EXP-2, Sample - DEP-EXP-2-4, CC# - CC222063, Percent sampled = 45%, Sieve size = 400		
Polypedilum	Larvae	1
Paralauterborniella nigrohalterale	Larvae	1
Cryptochironomus	Larvae	3
Tanytarsus	Larvae	3
Procladius	Larvae	2
Ephemerellidae	Juvenile/Damaged	1
Brachycentrus occidentalis	Larvae	2
Pisidiidae	Juvenile/Damaged	22
Unionidae	Juvenile/Damaged	2
Hyalella	None	1
Gastropoda	Juvenile/Damaged	1
Pisidium	None	30
Fossaria	None	2
Gyraulus	None	11
Valvata	None	20
Helisoma	None	1
Hydrobiidae	Juvenile/Damaged	2
Menetus	None	1
Tubificinae with hair chaetae	None	40
Tubificinae without hair chaetae	None	185
Total:		**331**

Site - DEP-EXP-2, Sample - DEP-EXP-2-5, CC# - CC222064, Percent sampled = 100%, Sieve size = 400		
Tubificinae without hair chaetae	None	84
Physella	None	3
Tubificinae with hair chaetae	None	45
Hydrobiidae	Juvenile/Damaged	2
Valvata	None	9
Gyraulus	None	7
Planorbidae	Juvenile/Damaged	2
Fossaria	None	2
Pisidium	None	72
Sphaerium	None	1
Gastropoda	Juvenile/Damaged	1
Lymnaeidae	Juvenile/Damaged	2

Hyalella	None	4
Pisidiidae	Juvenile/Damaged	11
Ophidonais serpentina	None	9
Arcteonais lomondi	None	3
Nais	None	14
Sigara	Adult	1
Procladius	Larvae	2
Tanytarsus	Larvae	7
Monodiamesa	Larvae	1
Orthocladius complex	Larvae	1
Psectrocladius	Larvae	1
Cryptochironomus	Larvae	4
Zaitzevia	Larvae	1
Polypedilum	Larvae	5
Total:		**294**

Site - DEP-EXP-3, Sample - DEP-EXP-3-1, CC# - CC222065, Percent sampled = 100%, Sieve size = 400		
Polypedilum	Larvae	9
Paralauterborniella nigrohalterale	Larvae	1
Chironomus	Larvae	1
Cryptochironomus	Larvae	16
Dicrotendipes	Larvae	39
Monodiamesa	Larvae	1
Tanytarsus	Larvae	5
Procladius	Larvae	8
Callibaetis	Larvae	1
Brachycentrus occidentalis	Larvae	1
Lebertia	Adult	2
Mideopsis	Adult	1
Nais	None	4
Ophidonais serpentina	None	3
Unionidae	Juvenile/Damaged	1
Anodonta	None	1
Pisidiidae	Juvenile/Damaged	29
Asellidae	Juvenile/Damaged	1
Hyalella	None	1
Mystacides	Larvae	15
Oecetis	Larvae	1
Psychomyia	Larvae	1
Lymnaeidae	Juvenile/Damaged	2
Pisidium	None	61
Gyraulus	None	1
Valvata	None	5
Rhynchelmis	None	2
Radix auricularia	None	1
Tubificinae without hair chaetae	None	59
Tubificinae with hair chaetae	None	19
Total:		**292**

Site - DEP-EXP-3, Sample - DEP-EXP-3-2, CC# - CC222066, Percent sampled = 100%, Sieve size = 400		
Tubificinae without hair chaetae	None	31
Tubificinae with hair chaetae	None	12
Radix auricularia	None	4
Rhynchelmis	None	2
Valvata	None	5
Gyraulus	None	1
Pisidium	None	34

Lymnaeidae	Juvenile/Damaged	1
Mystacides	Larvae	20
Asellidae	Juvenile/Damaged	1
Pisidiidae	Juvenile/Damaged	6
Lumbriculidae	None	22
Procladius	Larvae	18
Tanytarsus	Larvae	9
Potthastia longimana group	Larvae	1
Cryptochironomus	Larvae	10
Chironomus	Larvae	2
Chironomidae	Pupa	1
Paralauterborniella nigrohalterale	Larvae	1
Dicrotendipes	Larvae	18
Polypedilum	Larvae	5
Total:		**204**

Site - DEP-EXP-3, Sample - DEP-EXP-3-3, CC# - CC222067, Percent sampled = 100%, Sieve size = 400		
Polypedilum	Larvae	10
Stictochironomus	Larvae	3
Tanytarsini	Juvenile/Damaged	10
Endochironomus	Larvae	1
Paralauterborniella nigrohalterale	Larvae	2
Pagastiella	Larvae	1
Chironomus	Larvae	44
Cryptochironomus	Larvae	3
Dicrotendipes	Larvae	72
Tanytarsus	Larvae	14
Procladius	Larvae	20
Brachycentrus occidentalis	Larvae	2
Sigara	Adult	1
Lumbriculidae	None	29
Pisidiidae	Juvenile/Damaged	23
Hyalella	None	3
Mystacides	Larvae	18
Lymnaeidae	Juvenile/Damaged	5
Pisidium	None	20
Valvata	None	5
Rhynchelmis	None	5
Radix auricularia	None	3
Tubificinae with hair chaetae	None	46
Tubificinae without hair chaetae	None	118
Physella	None	4
Anafroptilum	Larvae	1
Total:		**463**

Site - DEP-EXP-3, Sample - DEP-EXP-3-4, CC# - CC222068, Percent sampled = 100%, Sieve size = 400		
Tubificinae with hair chaetae	None	2
Physella	None	1
Tubificinae without hair chaetae	None	30
Radix auricularia	None	6
Valvata	None	4
Pisidium	None	63
Lymnaeidae	Juvenile/Damaged	6
Gyraulus	None	3
Fossaria	None	1
Oecetis	Larvae	2
Mystacides	Larvae	30

Asellidae	Juvenile/Damaged	6
Hyalella	None	6
Pisidiidae	Juvenile/Damaged	5
Lebertia	Adult	2
Brachycentrus occidentalis	Larvae	3
Procladius	Larvae	15
Tanytarsus	Larvae	2
Rheotanytarsus	Larvae	1
Potthastia longimana group	Larvae	2
Dicrotendipes	Larvae	12
Cryptochironomus	Larvae	6
Probezzia	Larvae	1
Microtendipes	Larvae	1
Polypedilum	Larvae	3
Total:		**213**

Site - DEP-EXP-3, Sample - DEP-EXP-3-5, CC# - CC222069, Percent sampled = 100%, Sieve size = 400		
Stictochironomus	Larvae	4
Polypedilum	Larvae	2
Endochironomus	Larvae	1
Paralauterborniella nigrohalterale	Larvae	1
Chironomidae	Pupa	1
Chironomus	Larvae	2
Dicrotendipes	Larvae	7
Cryptochironomus	Larvae	12
Potthastia longimana group	Larvae	1
Tanytarsus	Larvae	13
Procladius	Larvae	8
Corixidae	Adult	1
Brachycentrus occidentalis	Larvae	3
Pisidiidae	Juvenile/Damaged	23
Unionidae	Juvenile/Damaged	1
Asellidae	Juvenile/Damaged	1
Mystacides	Larvae	36
Fossaria	None	1
Gyraulus	None	7
Lymnaeidae	Juvenile/Damaged	8
Gastropoda	Juvenile/Damaged	1
Pisidium	None	66
Valvata	None	12
Radix auricularia	None	5
Tubificinae without hair chaetae	None	92
Tubificinae with hair chaetae	None	49
Physella	None	4
Total:		**362**

Site - DEP-EXP-4, Sample - DEP-EXP-4-1, CC# - CC222070, Percent sampled = 50%, Sieve size = 400		
Physella	None	4
Tubificinae with hair chaetae	None	94
Tubificinae without hair chaetae	None	121
Radix auricularia	None	7
Valvata	None	5
Pisidium	None	29
Lymnaeidae	Juvenile/Damaged	5
Gyraulus	None	11
Mystacides	Larvae	6
Asellidae	Juvenile/Damaged	14

Caecidotea	None	11
Crangonyx	None	2
Pisidiidae	Juvenile/Damaged	8
Nephelopsis obscura	None	1
Corixidae	Adult	1
Procladius	Larvae	1
Potthastia longimana group	Larvae	1
Dicrotendipes	Larvae	2
Endochironomus	Larvae	1
Chironomus	Larvae	42
Polypedilum	Larvae	4
Total:		**370**

Site - DEP-EXP-4, Sample - DEP-EXP-4-2, CC# - CC222071, Percent sampled = 40%, Sieve size = 400		
Polypedilum	Larvae	2
Stictochironomus	Larvae	1
Chironomus	Larvae	35
Endochironomus	Larvae	1
Chironomidae	Pupa	1
Procladius	Larvae	2
Corixidae	Adult	1
Erpobdellidae	Juvenile/Damaged	1
Helobdella stagnalis	None	3
Pisidiidae	Juvenile/Damaged	29
Caecidotea	None	3
Asellidae	Juvenile/Damaged	7
Mystacides	Larvae	2
Gyraulus	None	8
Fossaria	None	2
Lymnaeidae	Juvenile/Damaged	1
Pisidium	None	49
Valvata	None	7
Radix auricularia	None	6
Tubificinae without hair chaetae	None	160
Tubificinae with hair chaetae	None	101
Total:		**422**

Site - DEP-EXP-4, Sample - DEP-EXP-4-3, CC# - CC222072, Percent sampled = 50%, Sieve size = 400		
Tubificinae with hair chaetae	None	63
Tubificinae without hair chaetae	None	115
Valvata	None	6
Helisoma	None	2
Pisidium	None	20
Lymnaeidae	Juvenile/Damaged	13
Gyraulus	None	10
Mystacides	Larvae	13
Asellidae	Juvenile/Damaged	6
Caecidotea	None	4
Pisidiidae	Juvenile/Damaged	6
Helobdella stagnalis	None	3
Erpobdellidae	Juvenile/Damaged	1
Nephelopsis obscura	None	1
Procladius	Larvae	9
Endochironomus	Larvae	2
Cryptochironomus	Larvae	3
Chironomus	Larvae	33
Stictochironomus	Larvae	1

Polypedilum	Larvae	2
Paralauterborniella nigrohalterale	Larvae	1
Tanytarsus	Larvae	1
Physella	None	2
Total:		**317**

Site - DEP-EXP-4, Sample - DEP-EXP-4-4, CC# - CC222073, Percent sampled = 100%, Sieve size = 400		
Tanytarsus	Larvae	5
Polypedilum	Larvae	2
Chironomus	Larvae	2
Cryptochironomus	Larvae	2
Probezzia	None	1
Procladius	Larvae	8
Corixidae	Adult	1
Sigara	Adult	1
Helobdella stagnalis	None	1
Pisidiidae	Juvenile/Damaged	13
Asellidae	Juvenile/Damaged	4
Gyraulus	None	1
Planorbidae	Juvenile/Damaged	3
Lymnaeidae	Juvenile/Damaged	3
Pisidium	None	77
Valvata	None	5
Radix auricularia	None	1
Tubificinae with hair chaetae	None	59
Tubificinae without hair chaetae	None	115
Total:		**304**

Site - DEP-EXP-4, Sample - DEP-EXP-4-5, CC# - CC222074, Percent sampled = 25%, Sieve size = 400		
Physella	None	2
Tubificinae without hair chaetae	None	86
Tubificinae with hair chaetae	None	71
Valvata	None	10
Pisidium	None	37
Lymnaeidae	Juvenile/Damaged	7
Planorbidae	Juvenile/Damaged	2
Gyraulus	None	13
Asellidae	Juvenile/Damaged	14
Caecidotea	None	8
Amphipoda	Juvenile/Damaged	2
Mystacides	Larvae	1
Pisidiidae	Juvenile/Damaged	35
Nephelopsis obscura	None	2
Helobdella stagnalis	None	3
Procladius	Larvae	2
Ephemerella	Larvae	1
Probezzia	Larvae	1
Chironomus	Larvae	10
Synorthocladius	Larvae	1
Placobdella montifera	None	1
Total:		**309**

Site - DEP-EXP-5, Sample - DEP-EXP-5-1, CC# - CC222075, Percent sampled = 100%, Sieve size = 400		
Tanytarsus	Larvae	1
Stempellinella	Larvae	1
Potthastia longimana group	Larvae	1

Chironomus	Larvae	2
Cryptochironomus	Larvae	2
Polypedilum	Larvae	2
Paralauterborniella nigrohalterale	Larvae	1
Nais	Larvae	5
Pisidiidae	Juvenile/Damaged	6
Unionidae	Juvenile/Damaged	2
Ophidonais serpentina	Larvae	14
Mystacides	Larvae	1
Gyraulus	None	10
Fossaria	None	1
Planorbidae	Juvenile/Damaged	1
Pisidium	None	47
Valvata	None	23
Hydrobiidae	Juvenile/Damaged	1
Physella	None	1
Tubificinae without hair chaetae	Larvae	352
Total:		**474**

Site - DEP-EXP-5, Sample - DEP-EXP-5-2, CC# - CC222076, Percent sampled = 50%, Sieve size = 400		
Physella	None	3
Tubificinae without hair chaetae	None	229
Valvata	None	15
Pisidium	None	39
Lymnaeidae	Juvenile/Damaged	2
Fossaria	None	2
Gyraulus	None	6
Mystacides	Larvae	4
Hyalella	None	1
Ophidonais serpentina	None	3
Unionidae	Juvenile/Damaged	1
Pisidiidae	Juvenile/Damaged	4
Nais	None	5
Hygrobates	Adult	1
Lebertia	Adult	1
Polypedilum	Larvae	2
Cryptochironomus	Larvae	6
Chironomus	Larvae	1
Tanytarsus	Larvae	6
Orthocladius complex	Larvae	5
Ephemerellidae	Juvenile/Damaged	1
Procladius	Larvae	1
Chrysops	Larvae	1
Total:		**339**

Site - DEP-EXP-5, Sample - DEP-EXP-5-3, CC# - CC222077, Percent sampled = 42%, Sieve size = 400		
Procladius	Larvae	1
Ephemerellidae	Juvenile/Damaged	1
Ephemerella	Larvae	1
Orthocladius complex	Larvae	2
Chironomus	Larvae	1
Hygrobates	Adult	1
Nais	None	16
Pisidiidae	Juvenile/Damaged	3
Ophidonais serpentina	None	9
Hyalella	None	1
Amphipoda	Juvenile/Damaged	1

Gyraulus	None	1
Fossaria	None	1
Lymnaeidae	Juvenile/Damaged	2
Pisidium	None	4
Valvata	None	1
Tubificinae without hair chaetae	None	296
Physella	None	2
Total:		**344**

Site - DEP-EXP-5, Sample - DEP-EXP-5-4, CC# - CC222078, Percent sampled = 50%, Sieve size = 400		
Physella	None	1
Tubificinae with hair chaetae	None	215
Valvata	None	22
Hydrobiidae	Juvenile/Damaged	1
Pisidium	None	20
Lymnaeidae	Juvenile/Damaged	9
Fossaria	None	10
Planorbidae	Juvenile/Damaged	1
Gyraulus	None	3
Mystacides	Larvae	4
Ceraclea	Larvae	1
Ophidonais serpentina	None	5
Pisidiidae	Juvenile/Damaged	15
Unionidae	Juvenile/Damaged	1
Nais	None	12
Chironomus	Larvae	1
Cryptochironomus	Larvae	3
Probezzia	Larvae	1
Polypedilum	Larvae	3
Phaenopsectra	Larvae	2
Ephemerella	Larvae	1
Ephemerellidae	Juvenile/Damaged	3
Procladius	Larvae	6
Baetis	Juvenile/Damaged	1
Total:		**341**

Site - DEP-EXP-5, Sample - DEP-EXP-5-5, CC# - CC222079, Percent sampled = 47%, Sieve size = 400		
Ephemerellidae	Juvenile/Damaged	3
Ephemerella	Larvae	3
Polypedilum	Larvae	3
Stictochironomus	Larvae	1
Orthocladius complex	Larvae	1
Tanytarsus	Larvae	1
Hygrobates	Adult	1
Pisidiidae	Juvenile/Damaged	13
Ophidonais serpentina	None	10
Nais	None	10
Mystacides	Larvae	7
Hyalella	None	1
Gyraulus	None	5
Fossaria	None	1
Lymnaeidae	Juvenile/Damaged	3
Pisidium	None	17
Valvata	None	16
Tubificinae without hair chaetae	None	242
Total:		**338**

Site - DEP-EXP-6, Sample - DEP-EXP-6-1, CC# - CC222080, Percent sampled = 100%, Sieve size = 400		
Tubificinae without hair chaetae	None	53
Physella	None	4
Tubificinae with hair chaetae	None	6
Valvata	None	8
Hydrobiidae	Juvenile/Damaged	6
Pisidium	None	4
Lymnaeidae	Juvenile/Damaged	3
Fossaria	None	4
Gyraulus	None	1
Caecidotea	None	1
Crangonyx	None	1
Hyalella	None	1
Pisidiidae	Juvenile/Damaged	11
Tanytarsus	Larvae	2
Monodiamesa	Larvae	1
Microtendipes	Larvae	1
Cryptochironomus	Larvae	1
Procladius	Larvae	1
Total:		**109**

Site - DEP-EXP-6, Sample - DEP-EXP-6-2, CC# - CC222081, Percent sampled = 100%, Sieve size = 400		
Ephemerellidae	Juvenile/Damaged	1
Ephemerella	Larvae	1
Sigara	Adult	3
Corixidae	Adult	7
Probezzia	Larvae	2
Polypedilum	Larvae	2
Monodiamesa	Larvae	1
Tanytarsus	Larvae	3
Cladotanytarsus	Larvae	1
Pisidiidae	Juvenile/Damaged	8
Crangonyx	None	3
Mystacides	Larvae	1
Ceraclea	Larvae	3
Gyraulus	None	2
Fossaria	None	9
Lymnaeidae	Juvenile/Damaged	2
Pisidium	None	15
Gastropoda	Juvenile/Damaged	1
Valvata	None	2
Tubificinae with hair chaetae	None	19
Physella	None	9
Tubificinae without hair chaetae	None	60
Total:		**155**

Site - DEP-EXP-6, Sample - DEP-EXP-6-3, CC# - CC222082, Percent sampled = 100%, Sieve size = 400		
Tubificinae without hair chaetae	None	91
Physella	None	10
Tubificinae with hair chaetae	None	35
Valvata	None	1
Hydrobiidae	Juvenile/Damaged	1
Pisidium	None	18
Lymnaeidae	Juvenile/Damaged	8
Fossaria	None	14
Gyraulus	None	2

Ceraclea	Larvae	2
Mystacides	Larvae	2
Crangonyx	None	42
Amphipoda	Juvenile/Damaged	3
Pisidiidae	Juvenile/Damaged	14
Unionidae	Juvenile/Damaged	1
Tanytarsus	Larvae	3
Polypedilum	Larvae	2
Microtendipes	Larvae	1
Paralauterborniella nigrohalterale	Larvae	5
Corixidae	Juvenile/Damaged	3
Sigara	Adult	4
Ephemerella	Larvae	1
Callibaetis	Larvae	1
Ephemerellidae	Juvenile/Damaged	1
Procladius	Larvae	1
Total:		**266**

Site - DEP-EXP-6, Sample - DEP-EXP-6-4, CC# - CC222083, Percent sampled = 100%, Sieve size = 400		
Procladius	Larvae	1
Sigara	Adult	17
Corixidae	Adult	21
Unionidae	Juvenile/Damaged	1
Pisidiidae	Juvenile/Damaged	4
Hygrobates	Adult	1
Lebertia	Adult	1
Lumbriculidae	None	2
Crangonyx	None	9
Amphipoda	Juvenile/Damaged	3
Gyraulus	None	2
Fossaria	None	12
Lymnaeidae	Juvenile/Damaged	23
Pisidium	None	21
Gastropoda	Juvenile/Damaged	2
Sphaerium	None	1
Hydrobiidae	Juvenile/Damaged	2
Valvata	None	6
Tubificinae with hair chaetae	None	13
Physella	None	6
Tubificinae without hair chaetae	None	15
Total:		**163**

Site - DEP-EXP-6, Sample - DEP-EXP-6-5, CC# - CC222084, Percent sampled = 50%, Sieve size = 400		
Tubificinae without hair chaetae	None	49
Physella	None	1
Rhynchelmis	None	3
Sphaerium	None	1
Pisidium	None	24
Lymnaeidae	Juvenile/Damaged	5
Fossaria	None	3
Gyraulus	None	1
Planorbidae	Juvenile/Damaged	2
Crangonyx	None	128
Amphipoda	Juvenile/Damaged	61
Caecidotea	None	1
Asellidae	Juvenile/Damaged	2
Lumbriculidae	None	14

Pisidiidae	Juvenile/Damaged	80
Hydra	None	1
Trichoptera	Pupa	1
Drunella grandis group	Juvenile/Damaged	1
Paralauterborniella nigrohalterale	Larvae	2
Pagastiella	Larvae	1
Polypedilum	Larvae	1
Thienemannimyia group	Larvae	1
Total:		**383**

Site - DEP-EXP-7, Sample - DEP-EXP-7-1, CC# - CC222085, Percent sampled = 50%, Sieve size = 400		
Orthocladius complex	Larvae	10
Tanytarsus	Larvae	1
Potthastia longimana group	Larvae	1
Cladotanytarsus	Larvae	1
Polypedilum	Larvae	3
Microtendipes	Larvae	1
Paralauterborniella nigrohalterale	Larvae	1
Chironomidae	Pupa	2
Ephemerella	Larvae	1
Ephemerellidae	Juvenile/Damaged	2
Brachycentrus occidentalis	Larvae	3
Glossosoma	Larvae	1
Slavina appendiculata	None	4
Pisidiidae	Juvenile/Damaged	86
Nais	None	11
Lebertia	Adult	1
Asellidae	Juvenile/Damaged	5
Caecidotea	None	3
Hyalella	None	1
Crangonyx	None	3
Amphipoda	Juvenile/Damaged	2
Mystacides	Larvae	2
Ceraclea	Larvae	3
Gyraulus	None	4
Fossaria	None	8
Lymnaeidae	Juvenile/Damaged	23
Pisidium	None	32
Sphaerium	None	2
Valvata	None	4
Hydrobiidae	Juvenile/Damaged	1
Physella	None	3
Tubificinae without hair chaetae	None	108
Tubificinae with hair chaetae	None	19
Total:		**352**

Site - DEP-EXP-7, Sample - DEP-EXP-7-2, CC# - CC222086, Percent sampled = 100%, Sieve size = 400		
Tubificinae with hair chaetae	None	47
Physella	None	1
Valvata	None	1
Sphaerium	None	1
Pisidium	None	65
Fossaria	None	2
Lymnaeidae	Juvenile/Damaged	3
Ceraclea	Larvae	1
Hydropsyche	Larvae	1
Lepidostomatidae	Pupa	1

Mystacides	Larvae	3
Hyalella	None	7
Nais	None	19
Helobdella stagnalis	None	1
Sperchon	Adult	1
Pisidiidae	Juvenile/Damaged	126
Hydra	None	2
Brachycentrus occidentalis	Larvae	5
Ephemerellidae	Juvenile/Damaged	4
Ephemerella	Larvae	7
Cryptochironomus	Larvae	1
Polypedilum	Larvae	1
Potthastia longimana group	Larvae	1
Eukiefferiella	Larvae	1
Orthocladius complex	Larvae	1
Total:		**303**

Site - DEP-EXP-7, Sample - DEP-EXP-7-3, CC# - CC222087, Percent sampled = 100%, Sieve size = 400		
Psectrocladius	Larvae	2
Synorthocladius	Larvae	1
Ephemerellidae	Juvenile/Damaged	1
Brachycentrus occidentalis	Larvae	1
Nais	None	12
Pisidiidae	Juvenile/Damaged	3
Lebertia	Adult	3
Ceraclea	Larvae	1
Pisidium	None	4
Lymnaeidae	Juvenile/Damaged	1
Baetis rhodani group	Juvenile/Damaged	2
Tubificinae without hair chaetae	None	66
Physella	None	1
Total:		**98**

Site - DEP-EXP-7, Sample - DEP-EXP-7-4, CC# - CC222088, Percent sampled = 100%, Sieve size = 400		
Physella	None	7
Tubificinae without hair chaetae	None	221
Valvata	None	4
Helisoma	None	1
Hydrobiidae	Juvenile/Damaged	1
Lymnaeidae	Juvenile/Damaged	18
Sphaerium	None	1
Gastropoda	Juvenile/Damaged	1
Pisidium	None	46
Fossaria	None	14
Gyraulus	None	5
Planorbidae	Juvenile/Damaged	2
Ceraclea	Larvae	1
Leptoceridae	Juvenile/Damaged	1
Mystacides	Larvae	3
Oecetis	Larvae	1
Hyalella	None	1
Caecidotea	None	3
Asellidae	Juvenile/Damaged	4
Nais	None	21
Pisidiidae	Juvenile/Damaged	97
Hydropsychidae	Juvenile/Damaged	1
Brachycentrus occidentalis	Larvae	2

Ephemerella	Larvae	2
Drunella grandis group	Juvenile/Damaged	1
Ephemerellidae	Juvenile/Damaged	8
Synorthocladius	Larvae	2
Thienemannimyia group	Larvae	1
Orthocladius complex	Larvae	4
Eukiefferiella	Larvae	3
Potthastia longimana group	Larvae	2
Rheotanytarsus	Larvae	1
Tanytarsus	Larvae	2
Polypedilum	Larvae	4
Microtendipes	Larvae	1
Chironomidae	Pupa	1
Total:		**488**

Site - DEP-EXP-7, Sample - DEP-EXP-7-5, CC# - CC222089, Percent sampled = 50%, Sieve size = 400		
Microtendipes	Larvae	2
Polypedilum	Larvae	2
Tanytarsus	Larvae	1
Orthocladius complex	Larvae	5
Synorthocladius	Larvae	1
Ephemerella	Larvae	6
Pisidiidae	Juvenile/Damaged	79
Unionidae	Juvenile/Damaged	1
Nais	None	19
Caecidotea	None	3
Asellidae	Juvenile/Damaged	6
Hyalella	None	2
Ceraclea	Larvae	3
Planorbidae	Juvenile/Damaged	1
Gyraulus	None	12
Fossaria	None	3
Pisidium	None	29
Sphaerium	None	3
Lymnaeidae	Juvenile/Damaged	10
Valvata	None	3
Hydrobiidae	Juvenile/Damaged	2
Tubificinae without hair chaetae	None	115
Physella	None	5
Total:		**313**

Site - DEP-REF-1, Sample - DEP-REF-1-1, CC# - CC222090, Percent sampled = 50%, Sieve size = 400		
Physella	None	2
Tubificinae without hair chaetae	None	33
Tubificinae with hair chaetae	None	6
Valvata	None	1
Lymnaeidae	Juvenile/Damaged	17
Pisidium	None	15
Gyraulus	None	40
Planorbidae	Juvenile/Damaged	9
Oecetis	Larvae	3
Mystacides	Larvae	11
Asellidae	Juvenile/Damaged	78
Caecidotea	None	37
Hyalella	None	23
Amphipoda	Juvenile/Damaged	6
Crangonyx	None	13

Glossiphoniidae	Juvenile/Damaged	1
Pisidiidae	Juvenile/Damaged	46
Procladius	Larvae	3
Coenagrionidae	Juvenile/Damaged	11
Tanytarsus	Larvae	7
Paratanytarsus	Larvae	1
Polypedilum	Larvae	3
Probezzia	Larvae	2
Dubiraphia	Larvae	3
Cryptochironomus	Larvae	5
Chironomus	Larvae	1
Dicrotendipes	Larvae	2
Total:		**379**

Site - DEP-REF-1, Sample - DEP-REF-1-2, CC# - CC222091, Percent sampled = 34%, Sieve size = 400		
Dicrotendipes	Larvae	1
Cryptochironomus	Larvae	2
Probezzia	Larvae	1
Polypedilum	Larvae	3
Stictochironomus	Larvae	3
Tanytarsus	Larvae	3
Procladius	Larvae	2
Pisidiidae	Juvenile/Damaged	47
Crangonyx	None	2
Asellidae	Juvenile/Damaged	77
Caecidotea	None	22
Hyalella	None	29
Oecetis	Larvae	1
Mystacides	Larvae	8
Ceraclea	Larvae	1
Leptoceridae	Juvenile/Damaged	1
Planorbidae	Juvenile/Damaged	20
Gyraulus	None	58
Pisidium	None	15
Lymnaeidae	Juvenile/Damaged	8
Tubificinae without hair chaetae	None	36
Physella	None	1
Total:		**341**

Site - DEP-REF-1, Sample - DEP-REF-1-3, CC# - CC222092, Percent sampled = 32%, Sieve size = 400		
Physella	None	5
Tubificinae without hair chaetae	None	39
Tubificinae with hair chaetae	None	4
Lymnaeidae	Juvenile/Damaged	3
Pisidium	None	15
Sphaerium	None	1
Gyraulus	None	101
Planorbidae	Juvenile/Damaged	9
Leptoceridae	Juvenile/Damaged	2
Mystacides	Larvae	8
Oecetis	Larvae	2
Polycentropus	Larvae	2
Hyalella	None	8
Caecidotea	None	25
Asellidae	Juvenile/Damaged	85
Amphipoda	Juvenile/Damaged	1
Pisidiidae	Juvenile/Damaged	72

Procladius	Larvae	2
Coenagrionidae	Juvenile/Damaged	4
Rheotanytarsus	Larvae	1
Tanytarsus	Larvae	7
Corynoneura	Larvae	1
Stictochironomus	Larvae	6
Polypedilum	Larvae	2
Paralauterborniella nigrohalterale	Larvae	1
Diptera	Juvenile/Damaged	1
Chironomidae	Pupa	4
Dicrotendipes	Larvae	9
Total:		**420**

Site - DEP-REF-1, Sample - DEP-REF-1-4, CC# - CC222093, Percent sampled = 39%, Sieve size = 400		
Cryptochironomus	Larvae	4
Chironomidae	Pupa	1
Paralauterborniella nigrohalterale	Larvae	2
Polypedilum	Larvae	3
Stictochironomus	Larvae	3
Cladotanytarsus	Larvae	5
Tanytarsus	Larvae	6
Coenagrionidae	Juvenile/Damaged	1
Corixidae	Juvenile/Damaged	3
Procladius	Larvae	5
Pisidiidae	Juvenile/Damaged	21
Arcteonais lomondi	None	87
Hyalella	None	14
Caecidotea	None	6
Asellidae	Juvenile/Damaged	20
Oecetis	Larvae	14
Mystacides	Larvae	1
Leptoceridae	Juvenile/Damaged	1
Planorbidae	Juvenile/Damaged	4
Gyraulus	None	13
Pisidium	None	24
Lymnaeidae	Juvenile/Damaged	1
Tubificinae with hair chaetae	None	65
Tubificinae without hair chaetae	None	15
Helisoma	None	1
Total:		**320**

Site - DEP-REF-1, Sample - DEP-REF-1-5, CC# - CC222094, Percent sampled = 50%, Sieve size = 400		
Tubificinae without hair chaetae	None	40
Tubificinae with hair chaetae	None	19
Pisidium	None	20
Planorbidae	Juvenile/Damaged	28
Gyraulus	None	60
Mystacides	Larvae	17
Oecetis	Larvae	4
Asellidae	Juvenile/Damaged	148
Caecidotea	None	50
Hyalella	None	31
Amphipoda	Juvenile/Damaged	6
Crangonyx	None	5
Pisidiidae	Juvenile/Damaged	61
Procladius	Larvae	2
Sigara	Adult	5

Corixidae	Adult	9
Coenagrionidae	Juvenile/Damaged	20
Stempellinella	Larvae	1
Tanytarsus	Larvae	7
Stictochironomus	Larvae	20
Cladotanytarsus	Larvae	4
Polypedilum	Larvae	3
Parachironomus	Larvae	1
Probezzia	Larvae	2
Dicrotendipes	Larvae	6
Total:		**569**

Site - DEP-REF-2, Sample - DEP-REF-2-1, CC# - CC222095, Percent sampled = 100%, Sieve size = 400		
Dicrotendipes	Larvae	13
Chironomus	Larvae	26
Endochironomus	Larvae	14
Phaenopsectra	Larvae	2
Orthocladius complex	Larvae	1
Coenagrionidae	Juvenile/Damaged	1
Procladius	Larvae	5
Pisidiidae	Juvenile/Damaged	44
Slavina appendiculata	None	2
Helobdella	Juvenile/Damaged	11
Helobdella stagnalis	None	17
Erpobdellidae	Juvenile/Damaged	3
Crangonyx	None	2
Amphipoda	Juvenile/Damaged	1
Asellidae	Juvenile/Damaged	31
Caecidotea	None	22
Mystacides	Larvae	1
Ceraclea	Larvae	1
Gyraulus	None	3
Planorbidae	Juvenile/Damaged	1
Pisidium	None	2
Gastropoda	Juvenile/Damaged	1
Tubificinae with hair chaetae	None	16
Tubificinae without hair chaetae	None	35
Valvata	None	5
Total:		**260**

Site - DEP-REF-2, Sample - DEP-REF-2-2, CC# - CC222096, Percent sampled = 50%, Sieve size = 400		
Valvata	None	5
Tubificinae without hair chaetae	None	115
Tubificinae with hair chaetae	None	101
Pisidium	None	4
Lymnaeidae	Juvenile/Damaged	1
Planorbidae	Juvenile/Damaged	5
Gyraulus	None	7
Mystacides	Larvae	1
Ceraclea	Larvae	1
Caecidotea	None	3
Asellidae	Juvenile/Damaged	4
Amphipoda	Juvenile/Damaged	2
Crangonyx	None	2
Erpobdellidae	Juvenile/Damaged	1
Helobdella stagnalis	None	12
Slavina appendiculata	None	8

Pisidiidae	Juvenile/Damaged	9
Procladius	Larvae	3
Paratanytarsus	Larvae	1
Polypedilum	Larvae	6
Endochironomus	Larvae	11
Phaenopsectra	Larvae	3
Chironomus	Larvae	18
Dicrotendipes	Larvae	3
Total:		**326**

Site - DEP-REF-2, Sample - DEP-REF-2-3, CC# - CC222097, Percent sampled = 50%, Sieve size = 400		
Dicrotendipes	Larvae	19
Cryptochironomus	Larvae	1
Chironomus	Larvae	15
Chironomidae	Pupa	2
Endochironomus	Larvae	2
Polypedilum	Larvae	4
Tanytarsus	Larvae	2
Procladius	Larvae	5
Sigara	Adult	1
Pisidiidae	Juvenile/Damaged	18
Slavina appendiculata	None	5
Stylaria lacustris	None	2
Helobdella stagnalis	None	30
Helobdella	Juvenile/Damaged	2
Nephelopsis obscura	None	5
Nais	None	19
Theromyzon	None	19
Amphipoda	Juvenile/Damaged	9
Crangonyx	None	2
Asellidae	Juvenile/Damaged	19
Caecidotea	None	9
Hyalella	None	1
Mystacides	None	5
Gyraulus	None	33
Planorbidae	Juvenile/Damaged	17
Gastropoda	Juvenile/Damaged	1
Tubificinae with hair chaetae	None	22
Tubificinae without hair chaetae	None	51
Valvata	None	21
Total:		**341**

Site - DEP-REF-2, Sample - DEP-REF-2-4, CC# - CC222098, Percent sampled = 37%, Sieve size = 400		
Valvata	None	8
Tubificinae without hair chaetae	None	124
Tubificinae with hair chaetae	None	41
Gastropoda	Juvenile/Damaged	1
Planorbidae	Juvenile/Damaged	11
Gyraulus	None	15
Mystacides	Larvae	1
Hyalella	None	1
Asellidae	Juvenile/Damaged	6
Caecidotea	None	2
Crangonyx	None	4
Amphipoda	Juvenile/Damaged	6
Theromyzon	None	2
Nais	None	25

Helobdella stagnalis	None	6
Stylaria lacustris	None	4
Ophidonais serpentina	None	2
Pisidiidae	Juvenile/Damaged	20
Sigara	Adult	1
Brachycentrus occidentalis	Larvae	1
Procladius	Larvae	3
Baetis	Juvenile/Damaged	1
Ephemerellidae	Juvenile/Damaged	1
Tanytarsus	Larvae	3
Rheotanytarsus	Larvae	1
Phaenopsectra	Larvae	1
Polypedilum	Larvae	9
Endochironomus	Larvae	9
Paralauterborniella nigrohalterale	Larvae	1
Chironomidae	Pupa	1
Chironomus	Larvae	22
Total:		**333**

Site - DEP-REF-2, Sample - DEP-REF-2-5, CC# - CC222099, Percent sampled = 100%, Sieve size = 400		
Chironomus	Larvae	52
Dicrotendipes	Larvae	22
Chironomidae	Pupa	1
Pagastiella	Larvae	1
Endochironomus	Larvae	33
Polypedilum	Larvae	4
Paratanytarsus	Larvae	1
Eukiefferiella	Larvae	1
Synorthocladius	Larvae	1
Psectrocladius	Larvae	1
Procladius	Larvae	2
Sigara	Adult	3
Corixidae	Adult	3
Pisidiidae	Juvenile/Damaged	19
Helobdella	Juvenile/Damaged	1
Helobdella stagnalis	None	10
Mooreobdella	None	1
Nephelopsis obscura	None	2
Erpobdellidae	Juvenile/Damaged	3
Amphipoda	Juvenile/Damaged	4
Crangonyx	None	2
Hyalella	None	1
Caecidotea	None	20
Asellidae	Juvenile/Damaged	47
Mystacides	Larvae	4
Planorbidae	Juvenile/Damaged	9
Gyraulus	None	40
Pisidium	None	1
Gastropoda	Juvenile/Damaged	2
Tubificinae with hair chaetae	None	11
Tubificinae without hair chaetae	None	33
Valvata	None	50
Total:		**385**

Site - DEP-REF-3, Sample - DEP-REF-3-1, CC# - CC222100, Percent sampled = 100%, Sieve size = 400		
Valvata	None	3
Rhynchelmis	None	1

Tubificinae without hair chaetae	None	145
Tubificinae with hair chaetae	None	84
Pisidium	None	16
Gastropoda	Juvenile/Damaged	2
Lymnaeidae	Juvenile/Damaged	3
Gyraulus	None	9
Fossaria	None	9
Planorbidae	Juvenile/Damaged	2
Rhyacophila brunnea/vemna group	Larvae	1
Ceraclea	Larvae	1
Crangonyx	None	1
Hyalella	None	8
Arcteonais lomondi	None	7
Helobdella stagnalis	None	1
Pisidiidae	Juvenile/Damaged	36
Slavina appendiculata	None	6
Ophidonais serpentina	None	6
Nais	None	5
Cinygmula	Larvae	1
Capniidae	Juvenile/Damaged	2
Nemouridae	Juvenile/Damaged	6
Procladius	Larvae	3
Baetis	Juvenile/Damaged	1
Orthocladius complex	Larvae	1
Monodiamesa	Larvae	3
Potthastia longimana group	Larvae	3
Pagastia	Larvae	1
Tanytarsus	Larvae	5
Polypedilum	Larvae	20
Cryptochironomus	Larvae	23
Dicrotendipes	Larvae	2
Physella	None	4
Total:		**421**

Site - DEP-REF-3, Sample - DEP-REF-3-2, CC# - CC222101, Percent sampled = 50%, Sieve size = 400		
Physella	None	9
Dicrotendipes	Larvae	3
Cryptochironomus	Larvae	11
Probezzia	Larvae	1
Chironomidae	Pupa	1
Polypedilum	Larvae	15
Endochironomus	Larvae	1
Paralauterborniella nigrohalterale	Larvae	4
Tanytarsus	Larvae	10
Paratanytarsus	Larvae	1
Potthastia longimana group	Larvae	1
Eukiefferiella	Larvae	1
Synorthocladius	Larvae	1
Orthocladius complex	Larvae	5
Baetidae	Juvenile/Damaged	1
Procladius	Larvae	3
Nemouridae	Juvenile/Damaged	3
Corixidae	Juvenile/Damaged	4
Ophidonais serpentina	None	8
Nais	None	2
Slavina appendiculata	None	7
Stylaria lacustris	None	1
Hydra	None	1

Pisidiidae	Juvenile/Damaged	42
Unionidae	Juvenile/Damaged	2
Lumbriculidae	None	19
Arcteonais lomondi	None	4
Hygrobates	Adult	2
Hyalella	None	17
Asellidae	Juvenile/Damaged	2
Leptoceridae	Juvenile/Damaged	1
Ceraclea	Larvae	2
Rhyacophila brunnea/vemna group	Larvae	1
Fossaria	None	12
Planorbidae	Juvenile/Damaged	4
Gyraulus	None	8
Lymnaeidae	Juvenile/Damaged	12
Pisidium	None	25
Tubificinae with hair chaetae	None	18
Tubificinae without hair chaetae	None	50
Rhynchelmis	None	1
Valvata	None	20
Hydrobiidae	Juvenile/Damaged	1
Total:		**337**

Site - DEP-REF-3, Sample - DEP-REF-3-3, CC# - CC222102, Percent sampled = 100%, Sieve size = 400		
Hydrobiidae	Juvenile/Damaged	2
Valvata	None	8
Helisoma	None	1
Ephemera	Larvae	1
Tubificinae without hair chaetae	None	151
Tubificinae with hair chaetae	None	19
Pisidium	None	40
Lymnaeidae	Juvenile/Damaged	5
Gyraulus	None	9
Fossaria	None	4
Planorbidae	Juvenile/Damaged	2
Rhyacophila brunnea/vemna group	Larvae	1
Lebertia	Adult	1
Lumbriculidae	None	12
Pisidiidae	Juvenile/Damaged	33
Unionidae	Juvenile/Damaged	1
Ophidonais serpentina	None	1
Nais	None	12
Corixidae	Juvenile/Damaged	3
Isoperla	Larvae	1
Taeniopterygidae	Juvenile/Damaged	1
Sweltsa	Larvae	1
Nemouridae	Juvenile/Damaged	6
Capniidae	Juvenile/Damaged	9
Sigara	Adult	3
Procladius	Larvae	4
Dicranota	Larvae	1
Orthocladius complex	Larvae	1
Synorthocladius	Larvae	1
Constempellina	Larvae	1
Tanytarsus	Larvae	3
Paralauterborniella nigrohalterale	Larvae	3
Endochironomus	Larvae	5
Polypedilum	Larvae	13
Chironomidae	Pupa	3

Probezzia	Larvae	1
Heterlimnius	Adult	1
Cryptochironomus	Larvae	16
Physella	None	2
Total:		**382**

Site - DEP-REF-3, Sample - DEP-REF-3-4, CC# - CC222103, Percent sampled = 100%, Sieve size = 400		
Physella	None	7
Cryptochironomus	Larvae	36
Dicrotendipes	Larvae	2
Probezzia	Larvae	3
Polypedilum	Larvae	11
Endochironomus	Larvae	4
Paralauterborniella nigrohalterale	Larvae	3
Tanytarsus	Larvae	10
Monodiamesa	Larvae	2
Orthocladius complex	Larvae	2
Chrysops	Larvae	1
Procladius	Larvae	6
Ephemerellidae	Juvenile/Damaged	2
Sigara	Adult	5
Nemouridae	Juvenile/Damaged	1
Corixidae	Juvenile/Damaged	7
Ophidonais serpentina	None	2
Nais	None	8
Slavina appendiculata	None	3
Pisidiidae	Juvenile/Damaged	58
Unionidae	Juvenile/Damaged	2
Lebertia	Adult	1
Mystacides	Larvae	1
Ceraclea	Larvae	2
Hyalella	None	5
Planorbidae	Juvenile/Damaged	1
Fossaria	None	7
Gyraulus	None	11
Lymnaeidae	Juvenile/Damaged	6
Pisidium	None	61
Tubificinae with hair chaetae	None	12
Tubificinae without hair chaetae	None	141
Rhynchelmis	None	1
Helisoma	None	1
Valvata	None	7
Hydrobiidae	Juvenile/Damaged	1
Total:		**433**

Site - DEP-REF-3, Sample - DEP-REF-3-5, CC# - CC222104, Percent sampled = 100%, Sieve size = 400		
Valvata	None	4
Tubificinae without hair chaetae	None	38
Pisidium	None	9
Lymnaeidae	Juvenile/Damaged	1
Gyraulus	None	8
Fossaria	None	3
Planorbidae	Juvenile/Damaged	1
Hyalella	None	1
Asellidae	Juvenile/Damaged	1
Mystacides	Larvae	3
Lebertia	Adult	2

Unionidae	Juvenile/Damaged	1
Pisidiidae	Juvenile/Damaged	42
Sigara	Adult	1
Procladius	Larvae	1
Orthocladius complex	Larvae	1
Monodiamesa	Larvae	2
Tanytarsus	Larvae	15
Cladotanytarsus	Larvae	2
Paralauterborniella nigrohalterale	Larvae	1
Microtendipes	Larvae	1
Polypedilum	Larvae	6
Dicrotendipes	Larvae	1
Cryptochironomus	Larvae	15
Physella	None	4
Total:		**164**

Site - ERO-EXP-1, Sample - ERO-EXP-1-1, CC# - CC222105, Percent sampled = 7%, Sieve size = 400		
Eukiefferiella	Larvae	2
Tvetenia	Larvae	2
Orthocladius complex	Larvae	10
Baetidae	Juvenile/Damaged	9
Baetis	Juvenile/Damaged	2
Ephemerellidae	Juvenile/Damaged	36
Ephemerella	Larvae	5
Drunella grandis group	Juvenile/Damaged	5
Heptageniidae	Juvenile/Damaged	1
Glossosoma	Larvae	5
Hydropsychidae	Juvenile/Damaged	34
Cheumatopsyche	Larvae	15
Lebertia	Adult	1
Sperchon	Adult	1
Hydropsyche	Larvae	194
Hydrobiidae	Juvenile/Damaged	1
Baetis rhodani group	Juvenile/Damaged	1
Total:		**324**

Site - ERO-EXP-1, Sample - ERO-EXP-1-2, CC# - CC222106, Percent sampled = 10%, Sieve size = 400		
Baetis rhodani group	Juvenile/Damaged	1
Rhynchelmis	None	1
Tubificinae without hair chaetae	None	1
Tubificinae with hair chaetae	None	1
Lymnaeidae	Juvenile/Damaged	3
Hydroptila	Larvae	1
Ceraclea	Larvae	7
Hydropsyche	Larvae	113
Psychomyia	Larvae	3
Crangonyx	None	4
Hyalella	None	4
Amphipoda	Juvenile/Damaged	2
Hygrobates	Adult	12
Atractides	Adult	1
Cheumatopsyche	Larvae	24
Hydropsychidae	Juvenile/Damaged	30
Glossosoma	Larvae	2
Heptageniidae	Juvenile/Damaged	1
Drunella grandis group	Juvenile/Damaged	1
Ephemerella	Larvae	16

Ephemerellidae	Juvenile/Damaged	68
Baetis	Juvenile/Damaged	4
Baetidae	Juvenile/Damaged	2
Orthocladius complex	Larvae	7
Synorthocladius	Larvae	1
Tanypodinae	Juvenile/Damaged	1
Sublettea	Larvae	1
Chironomidae	Pupa	1
Microtendipes	Larvae	3
Physella	None	1
Total:		**317**

Site - ERO-EXP-1, Sample - ERO-EXP-1-3, CC# - CC222107, Percent sampled = 6%, Sieve size = 400		
Physella	None	3
Microtendipes	Larvae	7
Chironomidae	Pupa	1
Oreodytes	Adult	1
Sublettea	Larvae	4
Eukiefferiella	Larvae	3
Synorthocladius	Larvae	5
Tvetenia	Larvae	2
Orthocladius complex	Larvae	34
Baetidae	Juvenile/Damaged	4
Baetis	Juvenile/Damaged	5
Thienemannimyia group	Larvae	2
Ephemerellidae	Juvenile/Damaged	91
Ephemerella	Larvae	22
Drunella grandis group	Juvenile/Damaged	2
Heptageniidae	Juvenile/Damaged	2
Hydropsychidae	Juvenile/Damaged	15
Cheumatopsyche	Larvae	33
Atractides	Adult	3
Hygrobates	Adult	1
Nais	None	9
Psychomyia	Larvae	1
Ceraclea	Larvae	3
Hydroptila	Larvae	1
Hydropsyche	Larvae	81
Lymnaeidae	Juvenile/Damaged	1
Gastropoda	Juvenile/Damaged	5
Baetis rhodani group	Juvenile/Damaged	2
Total:		**343**

Site - ERO-EXP-1, Sample - ERO-EXP-1-4, CC# - CC222108, Percent sampled = 25%, Sieve size = 400		
Baetis rhodani group	Juvenile/Damaged	11
Hydrobiidae	Juvenile/Damaged	4
Gyraulus	None	5
Gastropoda	Juvenile/Damaged	4
Lymnaeidae	Juvenile/Damaged	7
Hydropsyche	Larvae	95
Ceraclea	Larvae	2
Psychomyia	Larvae	1
Amphipoda	Juvenile/Damaged	2
Crangonyx	None	13
Cambaridae	Juvenile/Damaged	2
Atractides	Adult	2
Hygrobates	Adult	3

Lebertia	Adult	1
Cheumatopsyche	Larvae	24
Hydropsychidae	Juvenile/Damaged	49
Protoptila	Larvae	3
Glossosoma	Larvae	1
Heptageniidae	Juvenile/Damaged	1
Drunella grandis group	Juvenile/Damaged	2
Ephemerella	Larvae	12
Ephemerellidae	Juvenile/Damaged	40
Thienemannimyia group	Larvae	1
Baetis	Juvenile/Damaged	12
Baetidae	Juvenile/Damaged	5
Orthocladius complex	Larvae	15
Synorthocladius	Larvae	6
Monodiamesa	Larvae	1
Pagastia	Larvae	1
Oreodytes	Adult	1
Microtendipes	Larvae	4
Physella	None	14
Total:		**344**

Site - ERO-EXP-1, Sample - ERO-EXP-1-5, CC# - CC222109, Percent sampled = 5%, Sieve size = 400		
Cladotanytarsus	Larvae	1
Eukiefferiella	Larvae	1
Tvetenia	Larvae	1
Orthocladius complex	Larvae	3
Baetidae	Juvenile/Damaged	1
Ephemerellidae	Juvenile/Damaged	20
Ephemerella	Larvae	2
Drunella grandis group	Juvenile/Damaged	12
Heptageniidae	Juvenile/Damaged	1
Nemouridae	Juvenile/Damaged	2
Brachycentrus occidentalis	Larvae	11
Brachycentrus	Juvenile/Damaged	3
Hydropsychidae	Juvenile/Damaged	112
Cheumatopsyche	Larvae	4
Sperchon	Adult	1
Torrenticola	Adult	1
Ceraclea	Larvae	1
Hydropsyche	Larvae	230
Aturus	Adult	1
Baetis rhodani group	Juvenile/Damaged	2
Physella	None	4
Total:		**414**

Site - ERO-EXP-2, Sample - ERO-EXP-2-1, CC# - CC222110, Percent sampled = 5%, Sieve size = 400		
Physella	None	7
Gastropoda	Juvenile/Damaged	4
Lymnaeidae	Juvenile/Damaged	1
Fossaria	None	3
Ceraclea	Larvae	2
Sperchon	Adult	1
Hygrobates	Adult	1
Nais	None	19
Cheumatopsyche	Larvae	3
Hydropsyche	Larvae	167
Hydropsychidae	Juvenile/Damaged	46

Brachycentrus	Juvenile/Damaged	2
Brachycentrus occidentalis	Larvae	34
Ephemerella	Larvae	14
Corixidae	Adult	1
Drunella grandis group	Larvae	8
Ephemerellidae	Juvenile/Damaged	59
Drunella	Juvenile/Damaged	1
Baetis	Juvenile/Damaged	2
Tipula	Larvae	3
Orthocladius complex	Larvae	11
Synorthocladius	Larvae	1
Eukiefferiella	Larvae	2
Sublettea	Larvae	11
Endochironomus	Larvae	1
Microtendipes	Larvae	8
Chironomidae	Pupa	2
Zaitzevia	Adult	1
Total:		**415**

Site - ERO-EXP-2, Sample - ERO-EXP-2-2, CC# - CC222111, Percent sampled = 5%, Sieve size = 400		
Eukiefferiella	Larvae	1
Pagastia	Larvae	2
Orthocladius complex	Larvae	15
Tvetenia	Larvae	1
Simulium	Larvae	1
Baetis	Juvenile/Damaged	7
Baetidae	Juvenile/Damaged	2
Ephemerellidae	Juvenile/Damaged	118
Drunella grandis group	Juvenile/Damaged	25
Drunella	Juvenile/Damaged	1
Rhithrogena	Larvae	1
Ephemerella	Larvae	25
Heptageniidae	Juvenile/Damaged	2
Brachycentrus occidentalis	Larvae	26
Hydropsychidae	Juvenile/Damaged	67
Glossosoma	Larvae	42
Hydropsyche	Larvae	393
Cheumatopsyche	Larvae	12
Sperchon	Adult	1
Lebertia	Adult	1
Ceraclea	Larvae	4
Lymnaeidae	Juvenile/Damaged	1
Gastropoda	Juvenile/Damaged	7
Physella	None	16
Baetis rhodani group	Juvenile/Damaged	1
Hydrobiidae	Juvenile/Damaged	4
Kogotus	Larvae	1
Total:		**777**

Site - ERO-EXP-2, Sample - ERO-EXP-2-3, CC# - CC222112, Percent sampled = 5%, Sieve size = 400		
Baetis rhodani group	Juvenile/Damaged	2
Physella	None	1
Gastropoda	Juvenile/Damaged	1
Lymnaeidae	Juvenile/Damaged	1
Psychomyia	Larvae	1
Lebertia	Adult	1
Sperchon	Adult	9

Atractides	Adult	2
Cheumatopsyche	Larvae	7
Hydropsyche	Larvae	233
Glossosoma	Larvae	7
Hydropsychidae	Juvenile/Damaged	43
Protoptila	Larvae	1
Brachycentrus occidentalis	Larvae	29
Ephemerella	Larvae	6
Drunella grandis group	Juvenile/Damaged	6
Ephemerellidae	Juvenile/Damaged	43
Drunella	Juvenile/Damaged	1
Baetidae	Juvenile/Damaged	3
Baetis	Juvenile/Damaged	2
Orthocladius complex	Larvae	3
Eukiefferiella	Larvae	1
Chironomidae	Pupa	2
Total:		**405**

Site - ERO-EXP-2, Sample - ERO-EXP-2-4, CC# - CC222113, Percent sampled = 5%, Sieve size = 400		
Sublettea	Larvae	1
Orthocladius complex	Larvae	4
Baetis	Juvenile/Damaged	1
Baetidae	Juvenile/Damaged	1
Ephemerellidae	Juvenile/Damaged	51
Ephemerella	Larvae	4
Drunella grandis group	Juvenile/Damaged	9
Brachycentrus occidentalis	Larvae	36
Skwala	Larvae	1
Hydropsychidae	Juvenile/Damaged	73
Glossosoma	Larvae	10
Glossosomatidae	Juvenile/Damaged	4
Cheumatopsyche	Larvae	3
Atractides	Adult	1
Sperchon	Adult	3
Hydropsyche	Larvae	215
Ceraclea	Larvae	1
Gastropoda	Juvenile/Damaged	1
Kogotus	Larvae	1
Hydrobiidae	Juvenile/Damaged	1
Physella	None	3
Total:		**424**

Site - ERO-EXP-2, Sample - ERO-EXP-2-5, CC# - CC222114, Percent sampled = 5%, Sieve size = 400		
Physella	None	2
Baetis rhodani group	Juvenile/Damaged	7
Ceraclea	Larvae	1
Hydropsyche	Larvae	489
Amphipoda	Juvenile/Damaged	1
Sperchon	Adult	6
Atractides	Adult	1
Cheumatopsyche	Larvae	16
Glossosomatidae	Juvenile/Damaged	1
Hydropsychidae	Juvenile/Damaged	211
Trichoptera	Pupa	1
Brachycentrus occidentalis	Larvae	24
Rhithrogena	Larvae	1
Ephemerella	Larvae	14

Drunella grandis group	Larvae	16
Ephemerellidae	Juvenile/Damaged	103
Drunella	Juvenile/Damaged	1
Baetidae	Juvenile/Damaged	6
Baetis	Juvenile/Damaged	3
Thienemannimyia group	Larvae	1
Nanocladius	Larvae	1
Orthocladius complex	Larvae	21
Tvetenia	Larvae	5
Sublettea	Larvae	2
Rheotanytarsus	Larvae	1
Eukiefferiella	Larvae	8
Chironomidae	Pupa	3
Microtendipes	Larvae	2
Total:		**948**

Site - ERO-EXP-3, Sample - ERO-EXP-3-1, CC# - CC222115, Percent sampled = 5%, Sieve size = 400		
Microtendipes	Larvae	1
Chironomidae	Pupa	1
Eukiefferiella	Larvae	5
Pagastia	Larvae	2
Sublettea	Larvae	5
Tvetenia	Larvae	6
Orthocladius complex	Larvae	6
Baetis	Juvenile/Damaged	1
Ephemerellidae	Juvenile/Damaged	59
Drunella grandis group	Juvenile/Damaged	7
Ephemerella	Larvae	7
Brachycentrus occidentalis	Larvae	28
Nemouridae	Juvenile/Damaged	1
Hydropsychidae	Juvenile/Damaged	84
Glossosoma	Larvae	6
Cheumatopsyche	Larvae	5
Atractides	Adult	1
Sperchon	Adult	5
Hydropsyche	Larvae	497
Ceraclea	Larvae	1
Baetis rhodani group	Juvenile/Damaged	7
Physella	None	1
Total:		**736**

Site - ERO-EXP-3, Sample - ERO-EXP-3-2, CC# - CC222116, Percent sampled = 5%, Sieve size = 400		
Physella	None	3
Baetis rhodani group	Juvenile/Damaged	3
Fossaria	None	3
Hydropsyche	Larvae	274
Ceraclea	Larvae	1
Atractides	Adult	1
Sperchon	Adult	4
Cheumatopsyche	Larvae	10
Hydropsychidae	Juvenile/Damaged	87
Brachycentrus occidentalis	Larvae	7
Ephemerella	Larvae	6
Drunella grandis group	Juvenile/Damaged	6
Drunella	Juvenile/Damaged	1
Ephemerellidae	Juvenile/Damaged	41
Baetidae	Juvenile/Damaged	1

Simuliidae	Pupa	1
Orthocladius complex	Larvae	11
Synorthocladius	Larvae	1
Tvetenia	Larvae	2
Pagastia	Larvae	1
Eukiefferiella	Larvae	2
Chironomidae	Pupa	1
Microtendipes	Larvae	1
Total:		**468**

Site - ERO-EXP-3, Sample - ERO-EXP-3-3, CC# - CC222117, Percent sampled = 5%, Sieve size = 400		
Optioservus	Larvae	1
Chironomidae	Pupa	1
Eukiefferiella	Larvae	1
Sublettea	Larvae	5
Tvetenia	Larvae	3
Orthocladius complex	Larvae	2
Baetidae	Juvenile/Damaged	2
Baetis	Juvenile/Damaged	10
Ephemerellidae	Juvenile/Damaged	64
Drunella	Juvenile/Damaged	1
Drunella grandis group	Juvenile/Damaged	10
Ephemerella	Larvae	9
Brachycentrus occidentalis	Larvae	12
Heptageniidae	Juvenile/Damaged	2
Cheumatopsyche	Larvae	16
Glossosoma	Larvae	1
Hydropsychidae	Juvenile/Damaged	96
Sperchon	Adult	1
Nais	None	8
Hydropsyche	Larvae	354
Ceraclea	Larvae	1
Fossaria	None	3
Gastropoda	Juvenile/Damaged	3
Lymnaeidae	Juvenile/Damaged	1
Baetis rhodani group	Juvenile/Damaged	20
Physella	None	6
Total:		**633**

Site - ERO-EXP-3, Sample - ERO-EXP-3-4, CC# - CC222118, Percent sampled = 5%, Sieve size = 400		
Baetis rhodani group	Juvenile/Damaged	8
Hydropsyche	Larvae	262
Sperchon	Adult	4
Atractides	Adult	1
Hydropsychidae	Juvenile/Damaged	51
Glossosoma	Larvae	5
Cheumatopsyche	Larvae	25
Heptageniidae	Juvenile/Damaged	2
Brachycentrus occidentalis	Larvae	52
Drunella grandis group	Juvenile/Damaged	15
Drunella	Juvenile/Damaged	2
Ephemerellidae	Juvenile/Damaged	29
Baetis	Juvenile/Damaged	4
Baetidae	Juvenile/Damaged	10
Simulium	Larvae	1
Orthocladius complex	Larvae	5
Eukiefferiella	Larvae	5

Potthastia longimana group	Larvae	1
Chironomidae	Pupa	2
Total:		**484**

Site - ERO-EXP-3, Sample - ERO-EXP-3-5, CC# - CC222119, Percent sampled = 5%, Sieve size = 400		
Chironomidae	Pupa	1
Orthocladius complex	Larvae	1
Synorthocladius	Larvae	1
Baetidae	Juvenile/Damaged	1
Baetis	Juvenile/Damaged	2
Drunella	Juvenile/Damaged	1
Ephemerellidae	Juvenile/Damaged	16
Drunella grandis group	Juvenile/Damaged	12
Ephemerella	Larvae	1
Brachycentrus occidentalis	Larvae	18
Cheumatopsyche	Larvae	8
Glossosoma	Larvae	8
Hydropsychidae	Juvenile/Damaged	77
Sperchon	Adult	14
Hydropsyche	Larvae	350
Baetis rhodani group	Juvenile/Damaged	3
Total:		**514**

Site - ERO-CRADT-3, Sample - ERO-CRADT-3-1, CC# - CC222120, Percent sampled = 5%, Sieve size = 400		
Baetis rhodani group	Juvenile/Damaged	18
Ceraclea	Larvae	1
Sperchon	Adult	4
Hydropsychidae	Juvenile/Damaged	136
Glossosoma	Larvae	4
Cheumatopsyche	Larvae	14
Hydropsyche	Larvae	581
Brachycentrus occidentalis	Larvae	51
Ephemerella	Larvae	8
Drunella grandis group	Larvae	21
Ephemerellidae	Juvenile/Damaged	35
Baetidae	Juvenile/Damaged	6
Baetis	Juvenile/Damaged	5
Simuliidae	Pupa	1
Simulium	Larvae	4
Orthocladius complex	Larvae	16
Tvetenia	Larvae	1
Eukiefferiella	Larvae	4
Sublettea	Larvae	1
Chironomidae	Pupa	3
Total:		**914**

Site - ERO-CRADT-3, Sample - ERO-CRADT-3-2, CC# - CC222121, Percent sampled = 9%, Sieve size = 400		
Chironomidae	Pupa	3
Microtendipes	Larvae	13
Polypedilum	Larvae	1
Sublettea	Larvae	39
Eukiefferiella	Larvae	3
Pagastia	Larvae	1
Potthastia longimana group	Larvae	1
Thienemannimyia group	Larvae	2
Tvetenia	Larvae	1

Orthocladius complex	Larvae	14
Synorthocladius	Larvae	6
Antocha	Larvae	2
Baetis	Juvenile/Damaged	2
Baetidae	Juvenile/Damaged	3
Ephemerellidae	Juvenile/Damaged	96
Drunella grandis group	Larvae	2
Brachycentrus occidentalis	Larvae	1
Ephemerella	Larvae	45
Heptageniidae	Juvenile/Damaged	1
Rhithrogena	Larvae	1
Hydropsyche	Larvae	30
Cheumatopsyche	Larvae	17
Glossosoma	Larvae	1
Hydropsychidae	Juvenile/Damaged	6
Atractides	Adult	1
Hygrobates	Adult	2
Nais	None	71
Hydroptila	Larvae	1
Ceraclea	Larvae	6
Baetis rhodani group	Juvenile/Damaged	5
Physella	None	9
Hydrozetidae	Juvenile/Damaged	1
Aturus	Adult	1
Lymnaeidae	Juvenile/Damaged	1
Gastropoda	Juvenile/Damaged	1
Fossaria	None	4
Total:		**394**

Site - ERO-CRADT-3, Sample - ERO-CRADT-3-3, CC# - CC222122, Percent sampled = 5%, Sieve size = 400

Fossaria	None	2
Lymnaeidae	Juvenile/Damaged	1
Gastropoda	Juvenile/Damaged	1
Physella	None	5
Baetis rhodani group	Juvenile/Damaged	5
Ceraclea	Larvae	2
Nais	None	23
Hydropsychidae	Juvenile/Damaged	69
Hydropsyche	Larvae	260
Cheumatopsyche	Larvae	8
Heptageniidae	Juvenile/Damaged	1
Brachycentrus occidentalis	Larvae	7
Drunella grandis group	Larvae	10
Ephemerella	Larvae	14
Ephemerellidae	Juvenile/Damaged	37
Baetidae	Juvenile/Damaged	1
Baetis	Juvenile/Damaged	1
Synorthocladius	Larvae	1
Orthocladius complex	Larvae	6
Thienemannimyia group	Larvae	2
Tvetenia	Larvae	3
Pagastia	Larvae	1
Sublettea	Larvae	15
Total:		**475**

Site - ERO-CRADT-3, Sample - ERO-CRADT-3-4, CC# - CC222123, Percent sampled = 100%, Sieve size = 400

Sublettea	Larvae	8

Tanytarsus	Larvae	3
Pagastia	Larvae	1
Potthastia longimana group	Larvae	2
Orthocladius complex	Larvae	1
Synorthocladius	Larvae	2
Polypedilum	Larvae	2
Microtendipes	Larvae	5
Chironomidae	Pupa	1
Optioservus	Larvae	1
Baetis	Juvenile/Damaged	7
Ephemeroptera	Adult	2
Ephemerellidae	Juvenile/Damaged	29
Drunella grandis group	Juvenile/Damaged	2
Ephemerella	Larvae	4
Heptagenia	Larvae	1
Hydropsyche	Larvae	15
Cheumatopsyche	Larvae	42
Hydropsychidae	Juvenile/Damaged	3
Hygrobates	Adult	24
Lebertia	Adult	2
Torrenticola	Adult	3
Lumbriculidae	None	15
Enchytraeidae	None	7
Ceraclea	Larvae	9
Crangonyx	Larvae	8
Hyalella	None	4
Baetis rhodani group	Juvenile/Damaged	3
Lymnaeidae	Juvenile/Damaged	10
Fossaria	None	5
Gyraulus	None	5
Physella	None	38
Total:		**264**

Site - ERO-CRADT-3, Sample - ERO-CRADT-3-5, CC# - CC222124, Percent sampled = 17%, Sieve size = 400		
Fossaria	None	4
Lymnaeidae	Juvenile/Damaged	3
Gastropoda	Juvenile/Damaged	5
Baetis rhodani group	Juvenile/Damaged	4
Physella	None	14
Hydrobiidae	Juvenile/Damaged	1
Enchytraeus	None	1
Hyalella	None	1
Crangonyx	None	2
Ceraclea	Larvae	8
Torrenticola	Adult	1
Hygrobates	Adult	26
Nais	None	48
Hydra	None	4
Protoptila	Larvae	1
Hydropsychidae	Juvenile/Damaged	4
Cheumatopsyche	Larvae	33
Hydropsyche	Larvae	66
Ephemerella	Larvae	20
Heptageniidae	Juvenile/Damaged	4
Drunella	Juvenile/Damaged	1
Drunella grandis group	Larvae	3
Ephemerellidae	Juvenile/Damaged	61
Baetis	Juvenile/Damaged	1

Chironomidae	Pupa	1
Microtendipes	Larvae	14
Polypedilum	Larvae	1
Synorthocladius	Larvae	3
Orthocladius complex	Larvae	10
Thienemannimyia group	Larvae	1
Tvetenia	Larvae	2
Pagastia	Larvae	1
Sublettea	Larvae	14
Micropsectra	Larvae	4
Total:		**367**

Site - ERO-EXP-4, Sample - ERO-EXP-4-1, CC# - CC222125, Percent sampled = 20%, Sieve size = 400		
Tanytarsus	Larvae	1
Sublettea	Larvae	57
Potthastia longimana group	Larvae	3
Tvetenia	Larvae	2
Thienemannimyia group	Larvae	2
Orthocladius complex	Larvae	20
Synorthocladius	Larvae	8
Polypedilum	Larvae	4
Microtendipes	Larvae	6
Chironomidae	Pupa	16
Ephemerellidae	Juvenile/Damaged	55
Ephemerella	Larvae	10
Rhithrogena	Larvae	2
Corixidae	Adult	4
Brachycentrus occidentalis	Larvae	1
Skwala	Larvae	1
Sigara	Adult	2
Hydropsyche	Larvae	50
Cheumatopsyche	Larvae	29
Protoptila	Larvae	6
Hydropsychidae	Juvenile/Damaged	1
Glossosoma	Larvae	4
Hydra	None	6
Nais	None	49
Atractides	Adult	3
Ceraclea	Larvae	8
Crangonyx	None	1
Enchytraeus	None	7
Thysanoptera	Adult	2
Physella	None	5
Baetis rhodani group	Juvenile/Damaged	2
Gastropoda	Juvenile/Damaged	4
Total:		**371**

Site - ERO-EXP-4, Sample - ERO-EXP-4-2, CC# - CC222126, Percent sampled = 7%, Sieve size = 400		
Gastropoda	Juvenile/Damaged	9
Lymnaeidae	Juvenile/Damaged	5
Fossaria	None	2
Baetis rhodani group	Juvenile/Damaged	9
Physella	None	11
Hydrobiidae	Juvenile/Damaged	1
Cambaridae	Juvenile/Damaged	1
Ceraclea	Larvae	6
Atractides	Adult	2

Hygrobates	Adult	3
Lebertia	Adult	1
Glossosoma	Larvae	3
Protoptila	Larvae	1
Hydropsychidae	Juvenile/Damaged	74
Cheumatopsyche	Larvae	41
Hydropsyche	Larvae	135
Skwala	Larvae	1
Ephemerella	Larvae	5
Ephemerellidae	Juvenile/Damaged	24
Drunella grandis group	Juvenile/Damaged	5
Baetis	Juvenile/Damaged	2
Baetidae	Juvenile/Damaged	5
Ephemeroptera	Adult	12
Chironomidae	Adult	1
Orthocladius complex	Larvae	1
Thienemannimyia group	Larvae	1
Synorthocladius	Larvae	1
Eukiefferiella	Larvae	1
Total:		**363**

Site - ERO-EXP-4, Sample - ERO-EXP-4-3, CC# - CC222127, Percent sampled = 6%, Sieve size = 400		
Sublettea	Larvae	1
Thienemannimyia group	Larvae	1
Orthocladius complex	Larvae	1
Chironomidae	Pupa	4
Ephemeroptera	Adult	1
Simuliidae	Pupa	2
Baetidae	Juvenile/Damaged	2
Drunella grandis group	Juvenile/Damaged	2
Drunella	Juvenile/Damaged	1
Ephemerellidae	Juvenile/Damaged	37
Ephemerella	Larvae	10
Heptageniidae	Juvenile/Damaged	1
Rhithrogena	Larvae	2
Hydropsyche	Larvae	161
Cheumatopsyche	Larvae	36
Hydropsychidae	Juvenile/Damaged	55
Glossosoma	Larvae	2
Atractides	Adult	4
Nais	None	3
Hydra	None	1
Pisidiidae	Juvenile/Damaged	2
Ceraclea	Larvae	3
Cambaridae	Juvenile/Damaged	1
Hydrobiidae	Juvenile/Damaged	2
Kogotus	Larvae	1
Physella	None	4
Baetis rhodani group	Juvenile/Damaged	7
Lymnaeidae	Juvenile/Damaged	3
Gastropoda	Juvenile/Damaged	1
Pisidium	None	1
Total:		**352**

Site - ERO-EXP-4, Sample - ERO-EXP-4-4, CC# - CC222128, Percent sampled = 6%, Sieve size = 400		
Gastropoda	Juvenile/Damaged	2
Fossaria	None	4

Hydrobiidae	Juvenile/Damaged	1
Ceraclea	Larvae	5
Hydropsyche	Larvae	146
Nais	None	3
Sperchon	Adult	1
Glossosoma	Larvae	11
Cheumatopsyche	Larvae	26
Hydropsychidae	Juvenile/Damaged	25
Heptageniidae	Juvenile/Damaged	1
Brachycentrus occidentalis	Larvae	2
Perlidae	Juvenile/Damaged	1
Ephemerellidae	Juvenile/Damaged	60
Drunella grandis group	Juvenile/Damaged	3
Ephemerella	Larvae	14
Baetidae	Juvenile/Damaged	2
Chironomidae	Pupa	3
Microtendipes	Larvae	6
Orthocladius complex	Larvae	1
Synorthocladius	Larvae	1
Tvetenia	Larvae	1
Sublettea	Larvae	1
Physella	None	3
Total:		**323**

Site - ERO-EXP-4, Sample - ERO-EXP-4-5, CC# - CC222129, Percent sampled = 5%, Sieve size = 400		
Physella	None	7
Orthocladius complex	Larvae	1
Chironomidae	Pupa	1
Baetidae	Juvenile/Damaged	9
Drunella grandis group	Larvae	16
Ephemerellidae	Juvenile/Damaged	101
Brachycentrus occidentalis	Larvae	26
Ephemerella	Larvae	12
Heptageniidae	Juvenile/Damaged	1
Rhithrogena	Larvae	3
Cheumatopsyche	Larvae	26
Hydropsyche	Larvae	633
Glossosoma	Larvae	16
Hydropsychidae	Juvenile/Damaged	118
Sperchon	Adult	3
Nais	None	3
Hydra	None	1
Ceraclea	Larvae	2
Atractides	Adult	1
Kogotus	Larvae	1
Hydrobiidae	Juvenile/Damaged	2
Baetis rhodani group	Juvenile/Damaged	5
Fossaria	None	1
Total:		**989**

Site - ERO-EXP-5, Sample - ERO-EXP-5-1, CC# - CC222130, Percent sampled = 5%, Sieve size = 400		
Fossaria	None	3
Lymnaeidae	Juvenile/Damaged	1
Gastropoda	Juvenile/Damaged	2
Baetis rhodani group	Juvenile/Damaged	1
Aturidae	Juvenile/Damaged	1
Atractides	Adult	2

Crangonyx	None	1
Ceraclea	Larvae	10
Psychomyia	Larvae	8
Nais	None	5
Hydropsychidae	Juvenile/Damaged	82
Protoptila	Larvae	3
Glossosoma	Larvae	1
Hydropsyche	Larvae	241
Cheumatopsyche	Larvae	30
Ephemerella	Larvae	30
Brachycentrus occidentalis	Larvae	1
Ephemerellidae	Juvenile/Damaged	101
Drunella grandis group	Juvenile/Damaged	9
Baetidae	Juvenile/Damaged	2
Baetis	Juvenile/Damaged	2
Chironomidae	Pupa	3
Microtendipes	Larvae	1
Orthocladius complex	Larvae	25
Synorthocladius	Larvae	9
Tvetenia	Larvae	5
Thienemannimyia group	Larvae	2
Sublettea	Larvae	2
Eukiefferiella	Larvae	6
Physella	None	8
Total:		**597**

Site - ERO-EXP-5, Sample - ERO-EXP-5-2, CC# - CC222131, Percent sampled = 5%, Sieve size = 400		
Eukiefferiella	Larvae	1
Tvetenia	Larvae	1
Orthocladius complex	Larvae	1
Baetis	Juvenile/Damaged	3
Baetidae	Juvenile/Damaged	4
Thienemannimyia group	Larvae	3
Drunella grandis group	Juvenile/Damaged	3
Ephemerella	Larvae	10
Ephemerellidae	Juvenile/Damaged	67
Drunella	Juvenile/Damaged	1
Brachycentrus occidentalis	Larvae	11
Heptageniidae	Juvenile/Damaged	1
Hydropsychidae	Juvenile/Damaged	60
Cheumatopsyche	Larvae	22
Glossosoma	Larvae	1
Sperchon	Adult	1
Psychomyia	Larvae	1
Hydropsyche	Larvae	278
Ceraclea	Larvae	3
Tardigrada	None	1
Baetis rhodani group	Juvenile/Damaged	3
Gyraulus	None	1
Total:		**477**

Site - ERO-EXP-5, Sample - ERO-EXP-5-3, CC# - CC222132, Percent sampled = 5%, Sieve size = 400		
Gastropoda	Juvenile/Damaged	2
Lymnaeidae	Juvenile/Damaged	1
Baetis rhodani group	Juvenile/Damaged	7
Physella	None	1
Ceraclea	Larvae	2

Sperchon	Adult	1
Torrenticola	Adult	1
Nais	None	1
Glossosoma	Larvae	3
Hydropsychidae	Juvenile/Damaged	79
Cheumatopsyche	Larvae	9
Hydropsyche	Larvae	326
Ephemerella	Larvae	18
Brachycentrus occidentalis	Larvae	7
Ephemerellidae	Juvenile/Damaged	95
Drunella grandis group	Juvenile/Damaged	9
Baetidae	Juvenile/Damaged	5
Tvetenia	Larvae	6
Thienemannimyia group	Larvae	1
Eukiefferiella	Larvae	8
Robackia demeijerei	Larvae	1
Zaitzevia	Adult	1
Total:		**584**

Site - ERO-EXP-5, Sample - ERO-EXP-5-4, CC# - CC222133, Percent sampled = 100%, Sieve size = 400		
Optioservus	Adult	1
Zaitzevia	Larvae	1
Chironomidae	Pupa	15
Robackia demeijerei	Larvae	1
Polypedilum	Larvae	1
Microtendipes	Larvae	2
Potthastia longimana group	Larvae	1
Sublettea	Larvae	1
Thienemannimyia group	Larvae	3
Tvetenia	Larvae	3
Synorthocladius	Larvae	9
Nanocladius	Larvae	2
Orthocladius complex	Larvae	51
Baetidae	Juvenile/Damaged	2
Baetis	Juvenile/Damaged	2
Tipula	Larvae	1
Drunella grandis group	Juvenile/Damaged	8
Ephemerellidae	Juvenile/Damaged	32
Drunella	Juvenile/Damaged	1
Brachycentrus occidentalis	Larvae	2
Skwala	Larvae	12
Trichoptera	Pupa	1
Ephemerella	Larvae	9
Cheumatopsyche	Larvae	37
Hydropsyche	Larvae	35
Protoptila	Larvae	1
Hydropsychidae	Juvenile/Damaged	12
Glossosomatidae	Juvenile/Damaged	1
Glossosoma	Larvae	69
Nais	None	29
Hydra	None	2
Pisidiidae	Juvenile/Damaged	2
Sperchon	Adult	7
Testudacarus	Adult	1
Torrenticola	Adult	1
Lebertia	Adult	2
Atractides	Adult	3
Ceraclea	Larvae	16

Amphipoda	Juvenile/Damaged	1
Hyalella	None	1
Physella	None	44
Baetis rhodani group	Juvenile/Damaged	7
Hydrobiidae	Juvenile/Damaged	1
Enchytraeus	None	2
Rhynchelmis	None	2
Helisoma	None	1
Lymnaeidae	Juvenile/Damaged	8
Gastropoda	Juvenile/Damaged	6
Gyraulus	None	12
Fossaria	None	24
Total:		**488**

Site - ERO-EXP-5, Sample - ERO-EXP-5-5, CC# - CC222134, Percent sampled = 100%, Sieve size = 400		
Fossaria	None	6
Gyraulus	None	1
Pisidium	None	1
Lymnaeidae	Juvenile/Damaged	7
Rhynchelmis	None	1
Enchytraeus	None	12
Ceraclea	Larvae	4
Hydropsyche	Larvae	16
Atractides	Adult	1
Lebertia	Adult	1
Sperchon	Adult	2
Torrenticola	Adult	1
Lumbriculidae	None	4
Pisidiidae	Juvenile/Damaged	1
Hydra	None	6
Nais	None	2
Glossosoma	Larvae	12
Protoptila	Larvae	1
Hydropsychidae	Juvenile/Damaged	4
Cheumatopsyche	Larvae	3
Heptageniidae	Juvenile/Damaged	1
Trichoptera	Pupa	2
Trichoptera	Juvenile/Damaged	1
Ephemerellidae	None	4
Ephemerellidae	Juvenile/Damaged	4
Ephemerella	Larvae	1
Baetidae	Juvenile/Damaged	1
Orthocladius complex	Larvae	3
Synorthocladius	Larvae	1
Pagastia	Larvae	1
Chironomidae	Adult	4
Chironomidae	Pupa	1
Physella	None	6
Total:		**116**

Site - ERO-REF-1, Sample - ERO-REF-1-1, CC# - CC222135, Percent sampled = 7%, Sieve size = 400		
Physella	None	12
Chironomidae	Pupa	4
Microtendipes	Larvae	2
Pagastia	Larvae	1
Eukiefferiella	Larvae	1
Synorthocladius	Larvae	13

Tvetenia	Larvae	1
Thienemannimyia group	Larvae	1
Orthocladius complex	Larvae	31
Baetidae	Juvenile/Damaged	7
Ephemerella	Larvae	1
Drunella grandis group	Juvenile/Damaged	6
Ephemerellidae	Juvenile/Damaged	42
Heptageniidae	Juvenile/Damaged	2
Cheumatopsyche	Larvae	24
Hydropsychidae	Juvenile/Damaged	44
Protoptila	Larvae	1
Brachycentrus occidentalis	Larvae	2
Nais	None	1
Atractides	Adult	1
Hygrobates	Adult	3
Hydropsyche	Larvae	101
Ceraclea	Larvae	5
Crangonyx	None	2
Cambaridae	Juvenile/Damaged	1
Baetis rhodani group	Juvenile/Damaged	10
Thysanoptera	Adult	1
Gastropoda	Juvenile/Damaged	1
Gyraulus	None	6
Total:		**327**

Site - ERO-REF-1, Sample - ERO-REF-1-2, CC# - CC222136, Percent sampled = 36%, Sieve size = 400		
Gyraulus	None	13
Fossaria	None	1
Planorbidae	Juvenile/Damaged	2
Lymnaeidae	Juvenile/Damaged	35
Pisidium	Larvae	5
Rhynchelmis	None	1
Hydrobiidae	Juvenile/Damaged	1
Asellidae	Juvenile/Damaged	4
Cambaridae	Juvenile/Damaged	4
Caecidotea	None	1
Crangonyx	None	54
Hyalella	None	1
Amphipoda	Juvenile/Damaged	31
Hydropsyche	Larvae	2
Ceraclea	Larvae	3
Hygrobates	Adult	4
Lumbriculidae	None	50
Pisidiidae	Juvenile/Damaged	9
Protoptila	Larvae	1
Hydropsychidae	Juvenile/Damaged	1
Cheumatopsyche	Larvae	2
Heptageniidae	Juvenile/Damaged	3
Paraleptophlebia	Larvae	3
Corixidae	Juvenile/Damaged	4
Sigara	Adult	3
Ephemerellidae	Larvae	1
Ephemerella	Larvae	1
Ameletus	Larvae	1
Orthocladius complex	Larvae	4
Parakiefferiella	Larvae	4
Monodiamesa	Larvae	7
Potthastia longimana group	Larvae	1

Stempellina	Larvae	2
Paralauterborniella nigrohalterale	Larvae	1
Microtendipes	Larvae	6
Stictochironomus	Larvae	1
Cladotanytarsus	Larvae	1
Tanytarsini	Larvae	3
Polypedilum	Larvae	1
Chironomidae	Pupa	2
Oreodytes	Adult	1
Cryptochironomus	Larvae	24
Physella	None	5
Total:		**304**

Site - ERO-REF-1, Sample - ERO-REF-1-3, CC# - CC222137, Percent sampled = 5%, Sieve size = 400		
Physella	None	5
Tvetenia	Larvae	2
Synorthocladius	Larvae	1
Baetidae	Juvenile/Damaged	1
Baetis	Juvenile/Damaged	2
Drunella grandis group	Juvenile/Damaged	6
Drunella	Juvenile/Damaged	1
Ephemerellidae	Juvenile/Damaged	31
Heptageniidae	Juvenile/Damaged	1
Ephemerella	Larvae	4
Cheumatopsyche	Larvae	12
Hydropsychidae	Juvenile/Damaged	143
Hydropsyche	Larvae	217
Ceraclea	Larvae	2
Baetis rhodani group	Juvenile/Damaged	7
Total:		**435**

Site - ERO-REF-1, Sample - ERO-REF-1-4, CC# - CC222138, Percent sampled = 5%, Sieve size = 400		
Baetis rhodani group	Juvenile/Damaged	4
Hydropsyche	Larvae	158
Ceraclea	Larvae	2
Hydropsychidae	Juvenile/Damaged	58
Cheumatopsyche	Larvae	11
Protoptila	Larvae	1
Heptageniidae	Juvenile/Damaged	1
Perlidae	Juvenile/Damaged	1
Ephemerellidae	Juvenile/Damaged	39
Drunella grandis group	Juvenile/Damaged	2
Ephemerella	Larvae	11
Baetis	Juvenile/Damaged	3
Baetidae	Juvenile/Damaged	3
Synorthocladius	Larvae	1
Thienemannimyia group	Larvae	1
Orthocladius complex	Larvae	8
Sublettea	Larvae	1
Nanocladius	Larvae	1
Chironomidae	Pupa	1
Physella	None	9
Total:		**316**

Site - ERO-REF-1, Sample - ERO-REF-1-5, CC# - CC222139, Percent sampled = 50%, Sieve size = 400		
Physella	None	19

Chironomidae	Pupa	4
Stictotarsus	Adult	1
Cryptochironomus	Larvae	2
Microtendipes	Larvae	12
Potthastia longimana group	Larvae	1
Eukiefferiella	Larvae	1
Diamesa	Larvae	1
Pagastia	Larvae	1
Sublettea	Larvae	1
Orthocladius complex	Larvae	33
Synorthocladius	Larvae	12
Baetis	Juvenile/Damaged	9
Baetidae	Juvenile/Damaged	1
Hemerodromia	Larvae	1
Ephemerella	Larvae	11
Ephemerellidae	Juvenile/Damaged	49
Heptageniidae	Juvenile/Damaged	9
Protoptila	Larvae	1
Hydropsychidae	Juvenile/Damaged	7
Cheumatopsyche	Larvae	14
Ceraclea	Larvae	6
Hydropsyche	Larvae	6
Limnephilidae	Juvenile/Damaged	2
Oecetis	Larvae	1
Amphipoda	Juvenile/Damaged	4
Crangonyx	None	17
Cambaridae	Juvenile/Damaged	1
Pisidiidae	Juvenile/Damaged	2
Nais	None	6
Hydra	None	3
Lumbriculidae	None	4
Enchytraeidae	None	14
Hygrobates	Adult	15
Atractides	Adult	2
Lebertia	Adult	1
Baetis rhodani group	Juvenile/Damaged	12
Rhynchelmis	None	1
Thysanoptera	Adult	1
Hydrobiidae	Juvenile/Damaged	5
Pisidium	None	4
Lymnaeidae	Juvenile/Damaged	36
Gastropoda	Juvenile/Damaged	13
Planorbidae	Juvenile/Damaged	2
Fossaria	None	2
Gyraulus	None	21
Total:		**371**

Site - ERO-REF-2, Sample - ERO-REF-2-1, CC# - CC222140, Percent sampled = 5%, Sieve size = 400		
Lymnaeidae	Juvenile/Damaged	1
Baetis rhodani group	Juvenile/Damaged	5
Sperchon	Adult	1
Hydropsyche	Larvae	405
Cheumatopsyche	Larvae	11
Hydropsychidae	Juvenile/Damaged	41
Heptageniidae	Juvenile/Damaged	1
Rhithrogena	Larvae	2
Zapada cinctipes	Larvae	1
Brachycentrus occidentalis	Larvae	18

Ephemerellidae	Juvenile/Damaged	11
Drunella	Juvenile/Damaged	1
Ephemerella	Larvae	2
Drunella grandis group	Juvenile/Damaged	18
Simuliidae	Pupa	2
Simulium	Larvae	2
Baetis	Juvenile/Damaged	3
Baetidae	Juvenile/Damaged	1
Physella	None	1
Total:		**527**

Site - ERO-REF-2, Sample - ERO-REF-2-2, CC# - CC222141, Percent sampled = 5%, Sieve size = 400		
Physella	None	10
Baetis	Juvenile/Damaged	5
Simulium	Larvae	1
Baetidae	Juvenile/Damaged	5
Simuliidae	Pupa	1
Drunella grandis group	Juvenile/Damaged	13
Ephemerella	Larvae	3
Drunella	Juvenile/Damaged	3
Ephemerellidae	Juvenile/Damaged	23
Brachycentrus occidentalis	Larvae	22
Skwala	Larvae	1
Heptageniidae	Juvenile/Damaged	1
Hydropsychidae	Juvenile/Damaged	133
Cheumatopsyche	Larvae	23
Glossosoma	Larvae	3
Tvetenia	Larvae	4
Orthocladius complex	Larvae	8
Hydropsyche	Larvae	431
Ceraclea	Larvae	2
Psychomyia	Larvae	1
Sperchon	Adult	7
Baetis rhodani group	Juvenile/Damaged	8
Hydrobiidae	Juvenile/Damaged	1
Lymnaeidae	Juvenile/Damaged	1
Total:		**710**

Site - ERO-REF-2, Sample - ERO-REF-2-3, CC# - CC222142, Percent sampled = 5%, Sieve size = 400		
Baetis rhodani group	Juvenile/Damaged	9
Sperchon	Adult	2
Hydropsyche	Larvae	323
Orthocladius complex	Larvae	1
Glossosomatidae	Pupa	1
Cheumatopsyche	Larvae	26
Hydropsychidae	Juvenile/Damaged	86
Skwala	Larvae	1
Brachycentrus occidentalis	Larvae	4
Ephemerellidae	Juvenile/Damaged	26
Drunella	Juvenile/Damaged	1
Ephemerella	Larvae	3
Drunella grandis group	Larvae	7
Baetis	Juvenile/Damaged	4
Baetidae	Juvenile/Damaged	2
Physella	None	2
Total:		**498**

Site - ERO-REF-2, Sample - ERO-REF-2-4, CC# - CC222143, Percent sampled = 15%, Sieve size = 400		
Physella	None	2
Baetidae	Juvenile/Damaged	1
Thienemannimyia group	Larvae	1
Ephemerellidae	Juvenile/Damaged	2
Orthocladius complex	Larvae	34
Synorthocladius	Larvae	2
Monodiamesa	Larvae	1
Paratanytarsus	Larvae	4
Constempellina	Larvae	2
Potthastia longimana group	Larvae	1
Microtendipes	Larvae	6
Polypedilum	Larvae	7
Tanytarsini	Juvenile/Damaged	1
Cryptochironomus	Larvae	1
Stictotarsus	Adult	1
Dytiscidae	Adult	1
Oreodytes	Adult	7
Chironomidae	Pupa	2
Ceraclea	Larvae	6
Leptoceridae	Juvenile/Damaged	1
Mystacides	Larvae	3
Asellidae	Juvenile/Damaged	2
Caecidotea	None	2
Crangonyx	None	15
Amphipoda	Juvenile/Damaged	18
Lebertia	Adult	10
Hygrobates	Adult	13
Lumbriculidae	None	22
Nais	None	32
Pisidiidae	Juvenile/Damaged	1
Thysanoptera	Adult	1
Aturus	Adult	1
Valvata	None	10
Helisoma	None	1
Lymnaeidae	Juvenile/Damaged	12
Gastropoda	Juvenile/Damaged	11
Gyraulus	None	91
Fossaria	None	2
Total:		330

Site - ERO-REF-2, Sample - ERO-REF-2-5, CC# - CC222144, Percent sampled = 5%, Sieve size = 400		
Baetis rhodani group	Larvae	4
Hydropsyche	Larvae	303
Chironomidae	Pupa	1
Eukiefferiella	Larvae	1
Ephemerellidae	Juvenile/Damaged	19
Drunella grandis group	Juvenile/Damaged	12
Ephemerella	Larvae	6
Simuliidae	Pupa	1
Simulium	Larvae	1
Baetidae	Juvenile/Damaged	2
Baetis	Juvenile/Damaged	2
Brachycentrus occidentalis	Larvae	16
Perlodidae	Juvenile/Damaged	1
Rhithrogena	Larvae	1
Hydropsychidae	Juvenile/Damaged	74

Cheumatopsyche	Larvae	22
Glossosoma	Larvae	1
Total:		467

Table 141 Benthic invertebrate community metrics for depositional reference and exposure sites in 2021.

	Reference			Exposure						
	DEP-REF-1	DEP-REF-2	DEP-REF-3	DEP-EXP-1	DEP-EXP-2	DEP-EXP-3	DEP-EXP-4	DEP-EXP-5	DEP-EXP-6	DEP-EXP-7
Abundance (organisms/m2)	44,880	25,680	18,515.56	25,911.11	30,213.33	13,653.33	35,288.89	29,928.89	13,004.44	19,786.67
Biomass (mg/m2)	10,739.41	6,318.31	5,105.001	14,165.62	5,322.485	17,098.61	11,733.16	5,581.871	5,205.911	7,200.467
Taxa Richness	44	49	67	61	35	46	37	35	45	53
EPT Richness	5	5	15	11	3	6	2	5	8	14
Percent EPT	3.72	1.11	2.93	12.18	0.47	8.72	1.28	1.84	1.3	4.04
Percent Chironomidae	7.25	17.76	16.85	15.81	4.71	27.41	9.65	3.06	2.6	4.36
Shannon Diversity Index	2.64961	2.530318	2.697202	2.538928	1.54239	2.51942	1.765625	1.294954	2.362785	2.163214
Shannon's Evenness	0.700179	0.650163	0.641474	0.617613	0.433823	0.658045	0.488969	0.364227	0.620697	0.54485
Effective Species Number (Shannon)	14.14852	12.5575	14.83815	12.66608	4.675753	12.42138	5.845226	3.650829	10.62049	8.699053

Table 142 Benthic invertebrate community metrics for erosional reference and exposure sites in 2021.

	Reference		Exposure				
	ERO-REF-1	ERO-REF-2	ERO-EXP-1	ERO-EXP-2	ERO-EXP-3	ERO-EXP-4	ERO-EXP-5
Abundance (organisms/m2)	1,548	3,384.571	1,685.5	4,350	4,137.143	2,774	2,458.286
Biomass (mg/m2)	43,696.4	4,429.376	6,325.942	4,390.959	4,476.832	5,500.912	2,020.894
Taxa Richness	30.8	22.4	26	25.4	21.6	28.2	31.2
EPT Richness	11.8	11.6	13.2	13.6	11.6	13.8	13.4
Percent EPT	61.018	79.21	85.69	92.09	95.11	82.168	74.878
Percent Chironomidae	12.29	4.406	7.256	3.864	2.718	9.126	9.478
Shannon Diversity Index	2.340085	1.620831	2.043034	1.843222	1.536342	2.086571	2.293964
Shannon's Evenness	0.687074	0.519082	0.626601	0.56988	0.502842	0.62311	0.665163
Effective Species Number (Shannon)	12.90711	6.26894	8.461919	6.464629	4.733845	8.814013	12.45291
Hilsenhoff Biotic Index	4.576602	4.424532	3.768138	3.41372	3.696457	3.933232	4.093025

Table 143 Benthic invertebrate community metrics for depositional reference and exposure sites across all sample years.

		2012		2015		2018		2021	
	Statistic	**Exposure**	**Reference**	**Exposure**	**Reference**	**Exposure**	**Reference**	**Exposure**	**Reference**
Abundance (organisms/m^2)	mean	8 302.22	14 780.00	8 887.62	20 115.56	9 652.06	19 742.22	23 969.52	29 691.85
	st.dev	5 766.19	11 922.67	9 252.48	16 760.98	4 750.18	12 000.52	8 665.55	13 632.40
	max	17 644.44	27 697.78	28 622.22	37 404.44	18 248.89	33 137.78	35 288.89	44 880.00
Biomass (mg/m^2)	mean	NA	NA	862.09	1 505.93	4 349.86	2 654.36	9 472.59	7 387.57
	st.dev	NA	NA	1 032.05	1 540.77	3 955.77	1 942.20	4 848.01	2 965.49
	max	NA	NA	3 039.81	3 187.14	12 263.73	4 895.37	17 098.61	10 739.41
EPT Richness	mean	3.43	3.25	4.00	3.33	6.00	6.33	7.00	8.33
	st.dev	2.07	2.63	2.52	0.58	2.65	3.06	4.32	5.77
	max	7.00	6.00	9.00	4.00	9.00	9.00	14.00	15.00
Percent EPT	mean	1.34	1.31	8.49	2.08	4.87	4.00	4.26	2.59
	st.dev	1.36	0.66	8.80	1.50	7.73	5.38	4.48	1.34
	max	3.93	2.00	23.73	3.70	21.85	10.20	12.18	3.72
Percent Chironomidae	mean	41.28	11.42	13.94	17.82	15.22	12.40	9.66	13.95
	st.dev	35.50	9.92	9.08	25.88	10.49	6.36	9.12	5.82
	max	81.03	23.84	25.70	47.63	37.33	19.53	27.41	17.76
Shannon Diversity Index	mean	1.84	1.62	2.16	2.00	2.49	2.33	2.03	2.63
	st.dev	0.47	0.42	0.54	0.47	0.26	0.19	0.50	0.09
	max	2.46	2.01	2.75	2.54	2.96	2.52	2.54	2.70
Shannon's Evenness	mean	0.57	0.52	0.66	0.58	0.66	0.61	0.53	0.66
	st.dev	0.15	0.09	0.14	0.13	0.06	0.05	0.11	0.03
	max	0.79	0.63	0.84	0.73	0.77	0.65	0.66	0.70
Effective Species Number (Shannon)	mean	6.91	5.35	9.69	8.00	12.44	10.37	8.37	13.85
	st.dev	3.32	2.00	4.18	4.06	3.59	2.00	3.70	1.17
	max	11.73	7.50	15.56	12.69	19.34	12.48	12.67	14.84

Table-144. Benthic invertebrate community metrics for erosional reference and exposure sites across all sample years.

variable	Statistic	Ref_2012	Ref_2015	Ref_2018	Ref_2021	IDZ RB_2012	IDZ RB_2015	IDZ RB_2018	IDZ RB_2021	FF_2012	FF_2015	FF_2018	FF_2021
Abundance Density	mean	1,673.68	504.25	2,785.93	2,466.29	2,958.82	679.53	4,129.53	3,346.07	1,265.00	285.33	1,623.15	2,793.81
	st.dev	2,083.05	412.10	2,611.29	1,668.50	2,792.56	442.53	2,142.47	1,865.50	1,350.10	270.05	1,528.93	2,058.58
	median	839.29	365.18	1,979.46	2,721.43	1,688.57	495.71	4,414.29	3,042.86	812.14	178.75	965.71	2,800.71
	min	132.14	74.29	473.21	267.86	223.57	154.64	585.71	495.71	24.64	38.21	220.00	43.21
	max	6,264.29	1,484.64	7,864.29	5,185.71	9,264.29	1,499.64	8,828.57	6,921.43	3,621.43	784.29	5,078.57	7,185.71
	n	10.00	10.00	10.00	10.00	13.00	13.00	13.00	13.00	12.00	12.00	12.00	12.00
Biomass Density	mean		112.49	1,928.57	10,017.62		139.94	3,991.39	5,188.35		56.34	1,028.71	3,844.10
	st.dev		115.05	1,616.04	17,448.06		76.95	3,262.40	5,925.03		54.67	1,155.55	3,292.99
	median		67.41	1,943.72	5,023.06		140.68	3,157.31	4,403.50		39.70	458.52	3,430.01
	min	Inf	16.98	94.77	266.54	Inf	33.94	205.10	546.63	Inf	8.46	334.16	54.94
	max	-Inf	373.01	4,978.10	59,295.98	-Inf	262.78	13,453.53	24,083.96	-Inf	160.98	4,150.44	11,295.97
	n	0.00	10.00	10.00	10.00	0.00	13.00	13.00	13.00	0.00	12.00	12.00	12.00
EPT Richness	mean	9.30	9.40	9.20	11.70	11.62	11.23	12.85	13.08	12.33	10.50	11.58	13.17
	st.dev	2.79	3.24	2.15	2.71	1.94	1.79	1.91	1.44	3.42	3.09	1.44	1.75
	median	9.00	8.50	9.00	12.50	12.00	11.00	13.00	13.00	13.00	11.00	12.00	13.50
	min	4.00	6.00	6.00	5.00	9.00	7.00	11.00	11.00	7.00	6.00	9.00	11.00
	max	15.00	15.00	13.00	15.00	14.00	14.00	16.00	15.00	20.00	17.00	14.00	16.00

Table-144. Benthic invertebrate community metrics for erosional reference and exposure sites across all sample years.

variable	Statistic	Ref_2012	Ref_2015	Ref_2018	Ref_2021	IDZ RB_2012	IDZ RB_2015	IDZ RB_2018	IDZ RB_2021	FF_2012	FF_2015	FF_2018	FF_2021
	n	10.00	10.00	10.00	10.00	13.00	13.00	13.00	13.00	12.00	12.00	12.00	12.00
Percent EPT	mean	52.81	48.43	61.87	70.11	85.31	77.27	92.30	90.16	66.88	56.37	73.47	81.47
	st.dev	39.39	40.79	44.45	39.76	18.34	26.79	7.50	7.87	32.79	30.78	27.38	21.78
	median	54.74	51.19	91.67	93.97	97.59	91.65	94.57	94.01	78.74	50.30	81.97	90.41
	min	4.86	1.54	4.35	3.91	46.96	16.86	71.04	74.93	17.57	6.15	17.87	43.44
	max	98.13	96.41	99.09	99.01	99.46	97.56	97.55	96.95	98.32	97.15	99.16	97.91
	n	10.00	10.00	10.00	10.00	13.00	13.00	13.00	13.00	12.00	12.00	12.00	12.00
Percent Chironomidae	mean	3.72	3.87	2.51	8.35	2.46	2.40	3.01	5.03	4.16	2.24	5.91	8.06
	st.dev	4.36	3.40	3.42	9.20	2.08	2.30	1.82	4.47	3.82	1.61	5.13	10.43
	median	1.49	3.25	0.99	3.17	2.12	2.28	2.69	4.20	3.47	2.35	4.91	3.17
	min	0.00	0.63	0.00	0.00	0.23	0.28	0.68	1.15	0.00	0.33	0.25	0.30
	max	13.18	12.64	11.21	19.56	6.86	8.20	6.10	17.53	13.41	5.22	16.49	35.22
	n	10.00	10.00	10.00	10.00	13.00	13.00	13.00	13.00	12.00	12.00	12.00	12.00
Shannon Diversity Index	mean	2.06	2.20	1.80	1.98	1.83	2.06	1.52	1.85	2.16	2.08	2.04	2.08
	st.dev	0.69	0.44	0.58	0.77	0.67	0.36	0.38	0.38	0.46	0.27	0.76	0.62
	median	2.10	2.31	1.62	1.63	1.55	1.96	1.41	1.70	2.13	2.14	1.99	2.01
	min	1.00	1.34	1.08	1.13	1.00	1.65	1.15	1.35	1.46	1.51	1.07	1.30
	max	2.92	2.81	2.78	3.22	2.80	2.75	2.34	2.59	2.96	2.52	3.20	3.14
	n	10.00	10.00	10.00	10.00	13.00	13.00	13.00	13.00	12.00	12.00	12.00	12.00
	mean	0.65	0.67	0.56	0.60	0.59	0.65	0.48	0.57	0.68	0.66	0.61	0.63

Table-144. Benthic invertebrate community metrics for erosional reference and exposure sites across all sample years.

variable	Statistic	Ref_2012	Ref_2015	Ref_2018	Ref_2021	IDZ RB_2012	IDZ RB_2015	IDZ RB_2018	IDZ RB_2021	FF_2012	FF_2015	FF_2018	FF_2021
Shannon's Evenness	st.dev	0.16	0.10	0.12	0.16	0.15	0.08	0.10	0.09	0.10	0.07	0.17	0.14
	median	0.67	0.69	0.56	0.55	0.53	0.63	0.45	0.55	0.67	0.65	0.60	0.61
	min	0.37	0.47	0.41	0.39	0.40	0.53	0.38	0.43	0.54	0.56	0.37	0.45
	max	0.83	0.80	0.75	0.84	0.82	0.83	0.69	0.74	0.89	0.76	0.84	0.89
	n	10.00	10.00	10.00	10.00	13.00	13.00	13.00	13.00	12.00	12.00	12.00	12.00
Effective Species Number (Shannon)	mean	9.52	9.80	7.07	9.59	7.68	8.38	4.93	6.82	9.63	8.29	9.90	9.67
	st.dev	5.85	3.77	4.39	7.74	5.27	3.36	2.40	2.88	4.69	2.13	7.08	6.64
	median	8.19	10.10	5.09	5.13	4.72	7.09	4.10	5.45	8.40	8.48	7.94	7.48
	min	2.72	3.84	2.93	3.10	2.71	5.19	3.15	3.86	4.30	4.53	2.93	3.65
	max	18.61	16.59	16.06	25.10	16.51	15.64	10.33	13.29	19.22	12.47	24.47	23.09
	n	10.00	10.00	10.00	10.00	13.00	13.00	13.00	13.00	12.00	12.00	12.00	12.00

Table 145: Dominant benthic taxa in erosional area samples collected in 2012, 2015, 2018, and 2021.

Class	Order	Family	Predominant Taxa*	Common Name	Functional Feeding Group
Arachnida	Trombidiformes	Hygrobatidae	*Hygrobates*	Water mite	Predator
	Trombidiformes	Sperchontidae		Prostig mite	Predator
Bivalvia	Veneroida	Pisidiidae	*Pisidium*	Pill clam	Collector – Filterer
	Unionida	Margaritiferidae		Pearl mussel	Collector – Filterer
Gastropoda	Basommatophora	Lymnaeidae Physidae Planorbidae	*Lymnaeidae* *Physa* *Planorbidae*	Pond snail Bladder snail Ramshorn snail	Scraper Scraper Scraper
	Hypsogastropoda	Hydrobiidae	*Hydrobiidae*	Mud snail	Scraper
Insecta	Diptera	Empididae	*Hemerodromia sp.*	Dance fly	Predator
	Diptera	Chironomidae			Collector-Gatherer
	Ephemeroptera	Ephemerellidae Baetidae	*Drunella grandis group* *Ephemerella*	Western green Drake Pale morning Dun Small minnow Mayflies	Collector-Gatherer Collector-Gatherer Collector-Gatherer
	Hemiptera	Corixidae	*Sigara*	Water boatman	Predator
	Trichoptera	Brachycentridae Hydropsychidae Leptoceridae Glossosomatidae	*Brachycentrus occidentalis* *Cheumatopsyche* *Hydropsyche* *Protoptila*	Humpless Casemaker Net-spinning Caddisfly Long-horned Caddisfly Saddle-case Maker	Collector-Filterer Collector-Filterer Collector-Filterer Collector-Gatherer/Predator Scraper
Malacostraca	Amphipoda	Crangonyctidae	*Crangonyx*		Collector-Gatherer
Oligochaeta	Lumbriculida	Lumbriculidae	*Lumbriculidae*	Aquatic worm	Collector-Gatherer
	Tubificida	Enchytraeidae Naididae	*Enchytraeus* *Naididae*	White worm Detritus worm	Collector-Gatherer Collector-Gatherer

Table 146. Dominant taxa and percent of total abundance each taxa constitutes by site for depositional and erosional areas in 2021.

Site	Dominant Taxa Rank	Family	Percent of Abundance
2021-dep-exp-1-0	1st	Naididae	44.11664
	2nd	Chironomidae	15.81475
	3rd	Brachycentridae	10.3259
2021-dep-exp-2-0	1st	Naididae	60.60606
	2nd	Margaritiferidae	14.21006
	3rd	Pisidiidae	9.002648
2021-dep-exp-3-0	1st	Naididae	30.27344
	2nd	Chironomidae	27.40885
	3rd	Margaritiferidae	15.88542
2021-dep-exp-4-0	1st	Naididae	56.42317
	2nd	Margaritiferidae	11.23426

	3rd	Chironomidae	9.647355
2021-dep-exp-5-0	1st	Naididae	78.11108
	2nd	Margaritiferidae	6.266706
	3rd	Valvatidae	3.950104
2021-dep-exp-6-0	1st	Naididae	26.65755
	2nd	Crangonyctidae	21.25769
	3rd	Pisidiidae	13.46548
2021-dep-exp-7-0	1st	Naididae	42.13836
	2nd	Pisidiidae	24.97754
	3rd	Margaritiferidae	11.18598
2021-dep-ref-1-0	1st	Isopoda	26.28243
	2nd	Planorbidae	17.70648
	3rd	Naididae	17.1123
2021-dep-ref-2-0	1st	Naididae	44.06369
	2nd	Chironomidae	17.75701
	3rd	Planorbidae	8.584285
2021-dep-ref-3-0	1st	Naididae	39.3663
	2nd	Chironomidae	16.8507
	3rd	Pisidiidae	12.14594
2021-ero-exp-1-1	1st	Hydropsychidae	73.8825
	2nd	Ephemerellidae	15.47467
	3rd	Chironomidae	4.278416
2021-ero-exp-1-2	1st	Hydropsychidae	52.3511
	2nd	Ephemerellidae	26.95925
	3rd	Chironomidae	4.702194
2021-ero-exp-1-3	1st	Hydropsychidae	37.06258
	2nd	Ephemerellidae	33.61489
	3rd	Chironomidae	17.53146
2021-ero-exp-1-4	1st	Hydropsychidae	48.41499
	2nd	Ephemerellidae	16.13833
	3rd	Chironomidae	8.357349
2021-ero-exp-1-5	1st	Hydropsychidae	81.22066
	2nd	Ephemerellidae	10.79812
	3rd	Brachycentridae	3.286385
2021-ero-exp-2-1	1st	Hydropsychidae	50.70423
	2nd	Ephemerellidae	21.3615
	3rd	Chironomidae	8.920188
2021-ero-exp-2-2	1st	Hydropsychidae	58.77958
	2nd	Ephemerellidae	24.28394
	3rd	Glossosomatidae	5.230386
2021-ero-exp-2-3	1st	Hydropsychidae	68.35749
	2nd	Ephemerellidae	15.21739
	3rd	Brachycentridae	7.004831
2021-ero-exp-2-4	1st	Hydropsychidae	67.20554
	2nd	Ephemerellidae	16.85912
	3rd	Brachycentridae	8.314088
2021-ero-exp-2-5	1st	Hydropsychidae	73.89061
	2nd	Ephemerellidae	15.58308
	3rd	Chironomidae	4.95356

2021-ero-exp-3-1	1st	Hydropsychidae	78.76344
	2nd	Ephemerellidae	10.75269
	3rd	Brachycentridae	3.763441
2021-ero-exp-3-2	1st	Hydropsychidae	77.94118
	2nd	Ephemerellidae	12.81513
	3rd	Chironomidae	4.201681
2021-ero-exp-3-3	1st	Hydropsychidae	72.24806
	2nd	Ephemerellidae	14.72868
	3rd	Baetidae	4.96124
2021-ero-exp-3-4	1st	Hydropsychidae	67.19682
	2nd	Ephemerellidae	12.52485
	3rd	Brachycentridae	10.33797
2021-ero-exp-3-5	1st	Hydropsychidae	82.38636
	2nd	Ephemerellidae	8.143939
	3rd	Brachycentridae	3.409091
2021-ero-exp-4-1	1st	Chironomidae	35.21851
	2nd	Hydropsychidae	20.56555
	3rd	Ephemerellidae	16.70951
2021-ero-exp-4-2	1st	Hydropsychidae	67.6131
	2nd	Ephemerellidae	10.52432
	3rd	Baetidae	4.334658
2021-ero-exp-4-3	1st	Hydropsychidae	69.95336
	2nd	Ephemerellidae	14.72352
	3rd	Chironomidae	3.364424
2021-ero-exp-4-4	1st	Hydropsychidae	59.86506
	2nd	Ephemerellidae	24.30708
	3rd	Chironomidae	4.886944
2021-ero-exp-4-5	1st	Hydropsychidae	77.23658
	2nd	Ephemerellidae	14.41352
	3rd	Brachycentridae	2.584493
2021-ero-exp-5-1	1st	Hydropsychidae	57.77414
	2nd	Ephemerellidae	24.38625
	3rd	Chironomidae	9.492635
2021-ero-exp-5-2	1st	Hydropsychidae	74.38017
	2nd	Ephemerellidae	17.56198
	3rd	Brachycentridae	2.272727
2021-ero-exp-5-3	1st	Hydropsychidae	69.69697
	2nd	Ephemerellidae	22.05387
	3rd	Chironomidae	2.861953
2021-ero-exp-5-4	1st	Chironomidae	20.7767
	2nd	Hydropsychidae	16.31068
	3rd	Glossosomatidae	13.78641
2021-ero-exp-5-5	1st	Hydropsychidae	19.00826
	2nd	Chironomidae	12.39669
	3rd	Glossosomatidae	10.7438
2021-ero-ref-1-1	1st	Hydropsychidae	50.02071
	2nd	Chironomidae	17.43993
	3rd	Ephemerellidae	16.28003
2021-ero-ref-1-2	1st	Chironomidae	19.43794

	2nd	Crangonyctidae	17.5644
	3rd	Lumbriculidae	16.62763
2021-ero-ref-1-3	1st	Hydropsychidae	84.1629
	2nd	Ephemerellidae	11.08597
	3rd	Baetidae	2.262443
2021-ero-ref-1-4	1st	Hydropsychidae	70.9375
	2nd	Ephemerellidae	16.875
	3rd	Chironomidae	4.6875
2021-ero-ref-1-5	1st	Chironomidae	19.2
	2nd	Ephemerellidae	16
	3rd	Lymnaeidae	10.13333
2021-ero-ref-2-1	1st	Hydropsychidae	83.69963
	2nd	Ephemerellidae	9.340659
	3rd	Brachycentridae	3.296703
2021-ero-ref-2-2	1st	Hydropsychidae	80.85399
	2nd	Ephemerellidae	7.988981
	3rd	Brachycentridae	3.030303
2021-ero-ref-2-3	1st	Hydropsychidae	85.96838
	2nd	Ephemerellidae	8.893281
	3rd	Baetidae	2.964427
2021-ero-ref-2-4	1st	Planorbidae	27.60791
	2nd	Chironomidae	19.55935
	3rd	Naididae	9.577338
2021-ero-ref-2-5	1st	Hydropsychidae	83.125
	2nd	Ephemerellidae	10.20833
	3rd	Brachycentridae	3.333333

APPENDIX J DEPOSITIONAL BENTHIC INVERTEBRATES STATISTICAL OUTPUTS

Table -147. Shapiro-Wilks normality test summary for benthic invertebrate metrics in depositional sites by combinations of treatment and year.

	Treatment and Year	p Value
Log Total Abundance	exp-2012	0.462385
Log Total Abundance	exp-2015	0.009573
Log Total Abundance	exp-2018	0.802627
Log Total Abundance	exp-2021	0.45242
Log Total Abundance	ref-2012	0.902446
Log Total Abundance	ref-2015	0.890294
Log Total Abundance	ref-2018	0.49426
Log Total Abundance	ref-2021	0.507822
Log Perc. Chironomidae	exp-2012	0.100619
Log Perc. Chironomidae	exp-2015	0.538198
Log Perc. Chironomidae	exp-2018	0.043827
Log Perc. Chironomidae	exp-2021	0.048407
Log Perc. Chironomidae	ref-2012	0.953725
Log Perc. Chironomidae	ref-2015	0.132962
Log Perc. Chironomidae	ref-2018	0.460765
Log Perc. Chironomidae	ref-2021	0.149384

Perc. EPT	exp-2012	0.115944
Perc. EPT	exp-2015	0.222584
Perc. EPT	exp-2018	0.000554
Perc. EPT	exp-2021	0.063337
Perc. EPT	ref-2012	0.502832
Perc. EPT	ref-2015	0.697099
Perc. EPT	ref-2018	0.12956
Perc. EPT	ref-2021	0.572155
Effective Species	exp-2012	0.105103
Effective Species	exp-2015	0.920393
Effective Species	exp-2018	0.055674
Effective Species	exp-2021	0.37105
Effective Species	ref-2012	0.934756
Effective Species	ref-2015	0.087872
Effective Species	ref-2018	0.815685
Effective Species	ref-2021	0.57153

Table 148*: ANOVA summary table for total abundance for depositional sites.*

term	df	sumsq	meansq	statistic	p.value	form
x$year	3	1.9	0.63	4.3	0.011	aov(tot.abun ~ year + ref_exp)
x$ref_exp	1	0.3	0.30	2.1	0.16	aov(tot.abun ~ year + ref_exp)
Residuals	35	5.1	0.15			aov(tot.abun ~ year + ref_exp)

Table 149*: Tukey HSD ANOVA summary table for total abundance for depositional sites.*

year	diff	lwr	upr	p adj
2015-2012	0.086	-0.370	0.55	0.96
2018-2012	0.220	-0.240	0.68	0.58
2021-2012	0.570	0.110	1.00	0.01
2018-2015	0.130	-0.330	0.59	0.87
2021-2015	0.480	0.024	0.94	0.036
2021-2018	0.350	-0.110	0.81	0.18

Table 150*: Effect size for total abundance for depositional sites.*

Parameter	Eta2_partial	CI	CI_low	CI_high
x$year	0.280	0.95	0.041	1
x$ref_exp	0.058	0.95	0.000	1
x$year:x$ref_exp	0.038	0.95	0.000	1

Table 151*: ANOVA summary table for total biomass for depositional sites.*

term	df	sumsq	meansq	statistic	p.value	form
x$year	2	3,900,000	2,000,000	14.00	<0.001	aov(tot.biom ~ year + ref_exp)
x$ref_exp	1	87,000	87,000	0.64	0.43	aov(tot.biom ~ year + ref_exp)
Residuals	26	3,500,000	140,000			aov(tot.biom ~ year + ref_exp)

Table 152*: Tukey HSD ANOVA summary table for total biomass for depositional sites.*

year	diff	lwr	upr	p adj
2018-2015	310	-97	720	0.16
2021-2015	880	470	1,300	<0.001
2021-2018	560	150	970	0.0059

Table 153*: Effect size for total biomass for depositional sites.*

Parameter	Eta2_partial	CI	CI_low	CI_high
x$year	0.530	0.95	0.27	1
x$ref_exp	0.025	0.95	0.00	1
x$year:x$ref_exp	0.033	0.95	0.00	1

Table 154*: ANOVA summary table for taxa richness* for *depositional sites.*

term	df	sumsq	meansq	statistic	p.value	form
x$year	3	3,600	1,200	18.0	<0.001	aov(taxa_rich ~ year + ref_exp)
x$ref_exp	1	110	110	1.6	0.21	aov(taxa_rich ~ year + ref_exp)
Residuals	35	2,300	66			aov(taxa_rich ~ year + ref_exp)

Table 155*: Tukey HSD ANOVA summary table for taxa richness* for *depositional sites.*

year	diff	lwr	upr	p adj
2015-2012	2.7	-7.1	12	0.88
2018-2012	19.0	9.5	29	<0.001
2021-2012	21.0	11.0	31	<0.001
2018-2015	17.0	6.8	26	<0.001
2021-2015	18.0	8.4	28	<0.001
2021-2018	1.6	-8.2	11	0.97

Table 156*: Effect size for taxa richness* for *depositional sites.*

Parameter	Eta2_partial	CI	CI_low	CI_high
x$year	0.620	0.95	0.41	1
x$ref_exp	0.045	0.95	0.00	1
x$year:x$ref_exp	0.038	0.95	0.00	1

Table 157*: ANOVA summary table for Shannon evenness depositional sites.*

term	df	sumsq	meansq	statistic	p.value	form
x$year	3	0.0680	0.0230	1.7	0.19	aov(shannonEq ~ year + ref_exp)
x$ref_exp	1	0.0028	0.0028	0.2	0.65	aov(shannonEq ~ year + ref_exp)
Residuals	35	0.4800	0.0140			aov(shannonEq ~ year + ref_exp)

Table 158*: Tukey HSD ANOVA summary table for Shannon evenness depositional sites.*

year	diff	lwr	upr	p adj
2015-2012	0.0910	-0.049	0.230	0.31
2018-2012	0.0970	-0.043	0.240	0.26
2021-2012	0.0290	-0.110	0.170	0.94
2018-2015	0.0063	-0.130	0.150	1
2021-2015	-0.0620	-0.200	0.078	0.64
2021-2018	-0.0680	-0.210	0.072	0.56

Table 159*: Effect size for Shannon evenness depositional sites.*

Parameter	Eta2_partial	CI	CI_low	CI_high
x$year	0.1400	0.95	0	1
x$ref_exp	0.0067	0.95	0	1
x$year:x$ref_exp	0.1300	0.95	0	1

Table 160*: ANOVA summary table for EPT richness depositional sites.*

term	df	sumsq	meansq	statistic	p.value	form
x$year	3	100.0	34.0	3.70	0.021	aov(ept.rich ~ year + ref_exp)
x$ref_exp	1	1.3	1.3	0.14	0.71	aov(ept.rich ~ year + ref_exp)
Residuals	35	320.0	9.2			aov(ept.rich ~ year + ref_exp)

Table 161*: Tukey HSD ANOVA summary table for EPT richness depositional sites.*

year	diff	lwr	upr	p adj
2015-2012	0.2	-3.500	3.9	1
2018-2012	2.5	-1.200	6.2	0.27
2021-2012	3.8	0.140	7.5	0.039
2018-2015	2.3	-1.400	6.0	0.34
2021-2015	3.6	-0.058	7.3	0.055
2021-2018	1.3	-2.400	5.0	0.77

Table 162*: Effect size for EPT richness depositional sites.*

Parameter	Eta2_partial	CI	CI_low	CI_high
x$year	0.2400	0.95	0.017	1
x$ref_exp	0.0041	0.95	0.000	1
x$year:x$ref_exp	0.0130	0.95	0.000	1

Table 163*: ANOVA summary table for percent EPT depositional sites.*

term	df	sumsq	meansq	statistic	p.value	form
x$year	3	140	46	1.5	0.23	aov(perc.EPT ~ year + ref_exp)
x$ref_exp	1	40	40	1.3	0.26	aov(perc.EPT ~ year + ref_exp)
Residuals	35	1,100	31			aov(perc.EPT ~ year + ref_exp)

Table 164*: Tukey HSD ANOVA summary table for percent EPT depositional sites.*

year	diff	lwr	upr	p adj
2015-2012	5.20	-1.5	12.0	0.18
2018-2012	3.20	-3.5	9.9	0.57
2021-2012	2.40	-4.3	9.0	0.78
2018-2015	-2.00	-8.7	4.7	0.86
2021-2015	-2.80	-9.5	3.9	0.67
2021-2018	-0.85	-7.5	5.8	0.99

Table 165*: Effect size for percent EPT depositional sites.*

Parameter	Eta2_partial	CI	CI_low	CI_high
x$year	0.120	0.95	0	1
x$ref_exp	0.038	0.95	0	1
x$year:x$ref_exp	0.050	0.95	0	1

Table 166*: ANOVA summary table for percent Chironomidae depositional sites.*

term	df	sumsq	meansq	statistic	p.value	form
x$year	3	0.66	0.22	1.300	0.28	aov(perc.Chironomidae ~ year + ref_exp)
x$ref_exp	1	0.01	0.01	0.062	0.8	aov(perc.Chironomidae ~ year + ref_exp)
Residuals	35	5.80	0.17			aov(perc.Chironomidae ~ year + ref_exp)

Table 167*: Tukey HSD ANOVA summary table for percent Chironomidae depositional sites.*

year	diff	lwr	upr	p adj
2015-2012	-0.290	-0.79	0.20	0.38
2018-2012	-0.180	-0.67	0.31	0.77
2021-2012	-0.330	-0.82	0.16	0.29
2018-2015	0.120	-0.37	0.61	0.91
2021-2015	-0.031	-0.52	0.46	1
2021-2018	-0.150	-0.64	0.34	0.84

Table 168*: Effect size for percent Chironomidae depositional sites.*

Parameter	Eta2_partial	CI	CI_low	CI_high
x$year	0.1100	0.95	0	1
x$ref_exp	0.0019	0.95	0	1
x$year:x$ref_exp	0.0410	0.95	0	1

Table 169*: ANOVA summary table for percent Collector Filterer depositional sites.*

term	df	sumsq	meansq	statistic	p.value	form
x$year	3	430	140	0.67	0.58	aov(perc.Collector.Filterer ~ year + ref_exp)
x$ref_exp	1	670	670	3.10	0.086	aov(perc.Collector.Filterer ~ year + ref_exp)
Residuals	35	7,500	220			aov(perc.Collector.Filterer ~ year + ref_exp)

Table 170*: Tukey HSD ANOVA summary table for percent Collector Filterer depositional sites.*

year	diff	lwr	upr	p adj
2015-2012	0.47	-17	18.0	1
2018-2012	6.50	-11	24.0	0.76
2021-2012	-2.40	-20	15.0	0.98
2018-2015	6.00	-12	24.0	0.8
2021-2015	-2.90	-21	15.0	0.97
2021-2018	-8.90	-27	8.8	0.53

Table 171*: Effect size for percent Collector Filterer depositional sites.*

Parameter	Eta2_partial	CI	CI_low	CI_high
x$year	0.055	0.95	0	1
x$ref_exp	0.083	0.95	0	1
x$year:x$ref_exp	0.018	0.95	0	1

Table 172*: ANOVA summary table for percent Collector Gatherer depositional sites.*

term	df	sumsq	meansq	statistic	p.value	form
x$year	3	1,200	400	0.94	0.43	aov(perc.Collector.Gatherer ~ year + ref_exp)
x$ref_exp	1	230	230	0.54	0.47	aov(perc.Collector.Gatherer ~ year + ref_exp)
Residuals	35	15,000	430			aov(perc.Collector.Gatherer ~ year + ref_exp)

Table 173*: Tukey HSD ANOVA summary table for percent Collector Gatherer depositional sites.*

year	diff	lwr	upr	p adj
2015-2012	-2.1	-27	23	1
2018-2012	-11.0	-36	14	0.61
2021-2012	3.4	-21	28	0.98
2018-2015	-9.2	-34	16	0.75
2021-2015	5.5	-19	30	0.93
2021-2018	15.0	-10	40	0.39

Table 174*: Effect size for percent Collector Gatherer depositional sites.*

Parameter	Eta2_partial	CI	CI_low	CI_high
x$year	0.078	0.95	0	1
x$ref_exp	0.016	0.95	0	1
x$year:x$ref_exp	0.055	0.95	0	1

Table 175*: ANOVA summary table for percent Omnivore depositional sites.*

term	df	sumsq	meansq	statistic	p.value	form
x$year	3	57	19	1.20	0.32	aov(perc.Omnivore ~ year + ref_exp)
x$ref_exp	1	13	13	0.86	0.36	aov(perc.Omnivore ~ year + ref_exp)
Residuals	35	550	16			aov(perc.Omnivore ~ year + ref_exp)

Table 176*: Tukey HSD ANOVA summary table for percent Omnivore depositional sites.*

year	diff	lwr	upr	p adj
2015-2012	3.10	-1.7	7.8	0.32
2018-2012	0.59	-4.2	5.4	0.99
2021-2012	2.00	-2.8	6.7	0.68
2018-2015	-2.50	-7.2	2.3	0.51
2021-2015	-1.10	-5.9	3.7	0.93
2021-2018	1.40	-3.4	6.1	0.86

Table 177*: Effect size for percent Omnivore depositional sites.*

Parameter	Eta2_partial	CI	CI_low	CI_high
x$year	0.099	0.95	0	1
x$ref_exp	0.025	0.95	0	1
x$year:x$ref_exp	0.048	0.95	0	1

Table 178*: ANOVA summary table for percent Predator depositional sites.*

term	df	sumsq	meansq	statistic	p.value	form
x$year	3	110.00	38.00	2.20000	0.11	aov(perc.Predator ~ year + ref_exp)
x$ref_exp	1	0.01	0.01	0.00059	0.98	aov(perc.Predator ~ year + ref_exp)
Residuals	35	610.00	18.00			aov(perc.Predator ~ year + ref_exp)

Table 179*: Tukey HSD ANOVA summary table for percent Predator depositional sites.*

year	diff	lwr	upr	p adj
2015-2012	3.700	-1.3	8.8	0.21
2018-2012	3.000	-2.1	8.0	0.4
2021-2012	0.065	-5.0	5.1	1
2018-2015	-0.750	-5.8	4.3	0.98
2021-2015	-3.700	-8.7	1.4	0.22
2021-2018	-2.900	-8.0	2.1	0.42

Table 180*: Effect size for percent Predator depositional sites.*

Parameter	Eta2_partial	CI	CI_low	CI_high
x$year	0.160000	0.95	0	1
x$ref_exp	0.000018	0.95	0	1
x$year:x$ref_exp	0.046000	0.95	0	1

Table 181*: ANOVA summary table for percent Scraper depositional sites.*

term	df	sumsq	meansq	statistic	p.value	form
x$year	3	250	85	0.45	0.72	aov(perc.Scraper ~ year + ref_exp)
x$ref_exp	1	170	170	0.89	0.35	aov(perc.Scraper ~ year + ref_exp)
Residuals	35	6,600	190			aov(perc.Scraper ~ year + ref_exp)

Table 182*: Tukey HSD ANOVA summary table for percent Scraper depositional sites.*

year	diff	lwr	upr	p adj
2015-2012	-5.60	-22	11	0.8
2018-2012	0.38	-16	17	1
2021-2012	-3.80	-20	13	0.93
2018-2015	6.00	-11	23	0.77
2021-2015	1.80	-15	18	0.99
2021-2018	-4.10	-21	12	0.91

Table 183*: Effect size for percent Scraper depositional sites.*

Parameter	Eta2_partial	CI	CI_low	CI_high
x$year	0.044	0.95	0	1
x$ref_exp	0.030	0.95	0	1
x$year:x$ref_exp	0.170	0.95	0	1

APPENDIX K EROSIONAL BENTHIC INVERTEBRATES STATISTICAL OUTPUTS

Benthic invertebrate erosional sites community metrics linear mixed effects model outputs.

Table 184: Formulae used for benthic linear mixed effects models in erosional sites.

Model Formula
Total Abundance (log) ~ Water Temperature + pH.std + Dissolved Oxygen + Velocity + Substrate Median Size + Proportion of Cobble in Substrate + Site Category + year + (1 | Area) + (1 | area:year)
Total Biomass (log) ~ Water Temperature + pH.std + Dissolved Oxygen + Velocity + Substrate Median Size + Proportion of Cobble in Substrate + Site Category + year + (1 | Area) + (1 | area:year)
Taxa (Family) Richness ~ Water Temperature + pH.std + Dissolved Oxygen + Velocity + Substrate Median Size + Proportion of Cobble in Substrate + Site Category + year + (1 | Area) + (1 | area:year)
Shannon's Equitability ~ Water Temperature + pH.std + Dissolved Oxygen + Velocity + Substrate Median Size + Proportion of Cobble in Substrate + Site Category + year + (1 | Area) + (1 | area:year)
EPT Richness ~ Water Temperature + pH.std + Dissolved Oxygen + Velocity + Substrate Median Size + Proportion of Cobble in Substrate + Site Category + year + (1 | Area) + (1 | area:year)
EPT (%) ~ Water Temperature + pH.std + Dissolved Oxygen + Velocity + Substrate Median Size + Proportion of Cobble in Substrate + Site Category + year + (1 | Area) + (1 | area:year)
Chironomidae (%) ~ Water Temperature + pH.std + Dissolved Oxygen + Velocity + Substrate Median Size + Proportion of Cobble in Substrate + Site Category + year + (1 | Area) + (1 | area:year)
Percent Collector Filterer ~ Water Temperature + pH.std + Dissolved Oxygen + Velocity + Substrate Median Size + Proportion of Cobble in Substrate + Site Category + year + (1 | Area) + (1 | area:year)
Percent Collector Gatherer ~ Water Temperature + pH.std + Dissolved Oxygen + Velocity + Substrate Median Size + Proportion of Cobble in Substrate + Site Category + year + (1 | Area) + (1 | area:year)
Percent Omnivore ~ Water Temperature + pH.std + Dissolved Oxygen + Velocity + Substrate Median Size + Proportion of Cobble in Substrate + Site Category + year + (1 | Area) + (1 | area:year)
Percent Predator ~ Water Temperature + pH.std + Dissolved Oxygen + Velocity + Substrate Median Size + Proportion of Cobble in Substrate + Site Category + year + (1 | Area) + (1 | area:year)
Percent Scraper ~ Water Temperature + pH.std + Dissolved Oxygen + Velocity + Substrate Median Size + Proportion of Cobble in Substrate + Site Category + year + (1 | Area) + (1 | area:year)

Table 185: Summary of plausible models identified using model averaging (those with a delta AIC \< 3) with pseudo-R2 values and coefficients for all erosional samples.

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	R.2	R21	R22	df	AICc	delta	weight
EPT Richness	10.100	0.7780			+	-0.82000	1.0900		+	0.288	0.280	0.323	12	647	0.000	0.0900
EPT Richness	10.200				+	-0.88100	1.0500		+	0.273	0.265	0.294	11	648	0.516	0.0696
EPT Richness	10.200	0.7560			+	-1.22000	1.1900			0.243	0.226	0.301	9	649	1.480	0.0430
EPT Richness	9.810	0.8270			+		1.1600		+	0.265	0.265	0.356	11	649	2.060	0.0321
EPT Richness	9.820	0.7280			+	-0.66400			+	0.265	0.255	0.255	11	649	2.150	0.0307
EPT Richness	10.200	0.7320		-0.28900	+	-0.82600	1.1500		+	0.289	0.279	0.329	13	650	2.320	0.0282
EPT Richness	10.400			-0.52400	+	-0.86600	1.1700		+	0.276	0.267	0.308	12	650	2.400	0.0271

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	R.2	R21	R22	df	AICc	delta	weight
EPT Richness	10.100	0.7770	-0.0246		+	-0.82400	1.1000		+	0.288	0.278	0.323	13	650	2.470	0.0262
EPT Richness	10.200				+	-0.85700	1.1000	-0.39200	+	0.275	0.266	0.302	12	650	2.520	0.0256
EPT Richness	10.200				+	-1.19000	1.2000			0.225	0.211	0.281	8	650	2.520	0.0255
EPT Richness	9.600	0.7410			+				+	0.250	0.243	0.253	10	650	2.580	0.0248
EPT Richness	10.100	0.7600			+	-0.79500	1.1300	-0.18700	+	0.287	0.278	0.329	13	650	2.610	0.0244
EPT Richness	10.100		-0.1670		+	-0.88800	1.0600		+	0.273	0.264	0.293	12	650	2.860	0.0216
Log Total Abundance	3.440	0.3010					0.4350		+	0.593	0.485	0.612	9	146	0.000	0.2030
Log Total Abundance	3.440	0.2930			+		0.4360		+	0.602	0.531	0.632	11	148	1.560	0.0931

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	R.2	R21	R22	df	AICc	delta	weight
Log Total Abundance	3.480	0.2920		-0.07080			0.4430		+	0.595	0.480	0.615	10	148	1.770	0.0835
Log Total Abundance	3.430	0.3000				0.05310	0.4330		+	0.594	0.487	0.613	10	148	1.850	0.0806
Log Total Abundance	3.440	0.3010	-0.0114				0.4350		+	0.593	0.483	0.610	10	149	2.310	0.0639
Log Total Abundance	3.440	0.3010					0.4350	0.00193	+	0.593	0.483	0.611	10	149	2.320	0.0634
Log Total Biomass	3.440				+		0.2260		+	0.714	0.687	0.746	10	178	0.000	0.1230
Log Total Biomass	3.430	0.0980			+		0.2180		+	0.717	0.690	0.746	11	178	0.640	0.0894
Log Total Biomass	3.490			-0.11300	+		0.2390		+	0.715	0.685	0.748	11	179	1.520	0.0575
Log Total Biomass	3.440						0.2320		+	0.700	0.637	0.745	8	180	1.970	0.0461
Log Total Biomass	3.470		0.0527		+		0.2280		+	0.714	0.685	0.746	11	180	2.280	0.0394
Log Total Biomass	3.440				+	0.00204	0.2260		+	0.714	0.685	0.745	11	180	2.380	0.0374

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	R.2	R21	R22	df	AICc	delta	weight
Log Total Biomass	3.440				+		0.2280	-0.05700	+	0.714	0.683	0.748	11	180	2.420	0.0367
Log Total Biomass	3.420	0.1030					0.2230		+	0.704	0.642	0.743	9	180	2.500	0.0353
Log Total Biomass	3.470	0.0856		-0.09120	+		0.2300		+	0.718	0.687	0.748	12	180	2.620	0.0333
Log Total Biomass	3.470	0.1000	0.0641		+		0.2200		+	0.717	0.688	0.746	12	181	2.890	0.0290
Percent C-F	53.000	15.4000					37.0000		+	0.638	0.608	0.656	9	1,220	0.000	0.2170
Percent C-F	53.000	15.5000					36.9000	3.38000	+	0.640	0.614	0.655	10	1,220	1.560	0.0995
Percent C-F	48.400	15.0000			+		36.7000		+	0.645	0.629	0.667	11	1,220	1.700	0.0925
Percent C-F	52.500	15.6000		1.10000			36.8000		+	0.638	0.608	0.654	10	1,220	2.240	0.0707
Percent C-F	53.500	15.5000	1.1000				37.0000		+	0.638	0.607	0.655	10	1,220	2.270	0.0696

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	R.2	R21	R22	df	AICc	delta	weight
Percent C-F	53.000	15.4000				0.54500	36.9000		+	0.638	0.606	0.656	10	1,220	2.320	0.0679
Percent C-G	17.100		11.7000				-8.4200		+	0.548	0.523	0.550	9	1,070	0.000	0.2720
Percent C-G	17.200	-1.5900	11.6000				-8.2000		+	0.549	0.520	0.554	10	1,070	1.790	0.1110
Percent C-G	17.200		11.4000			-1.35000	-8.3600		+	0.549	0.526	0.548	10	1,070	1.840	0.1090
Percent C-G	17.000		11.6000				-8.3500	0.89900	+	0.548	0.518	0.551	10	1,070	2.300	0.0863
Percent C-G	17.000		11.7000	0.27400			-8.4600		+	0.548	0.521	0.548	10	1,070	2.320	0.0855
Percent Chironomidae	2.010			1.85000			-4.1900		+	0.260	0.239	0.267	9	836	0.000	0.1230
Percent Chironomidae	2.870						-3.9000		+	0.244	0.230	0.250	8	837	0.597	0.0911
Percent Chironomidae	1.920			2.10000			-4.1900	-1.15000	+	0.268	0.251	0.270	10	837	0.757	0.0840

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	R.2	R21	R22	df	AICc	delta	weight
Percent Chironomidae	1.700		-0.7560	1.88000			-4.1900		+	0.261	0.240	0.267	10	838	1.980	0.0455
Percent Chironomidae	2.080	-0.3150		1.77000			-4.1500		+	0.260	0.238	0.267	10	838	2.200	0.0409
Percent Chironomidae	2.890						-3.8400	-0.74700	+	0.248	0.235	0.254	9	838	2.220	0.0405
Percent Chironomidae	2.000			1.86000		0.02220	-4.1800		+	0.259	0.237	0.266	10	839	2.340	0.0380
Percent Chironomidae	2.930	-0.5840					-3.8700		+	0.247	0.230	0.252	9	839	2.380	0.0373
Percent Chironomidae	2.290			2.01000	+		-4.1400		+	0.271	0.254	0.279	11	839	2.470	0.0357
Percent Chironomidae	2.640		-0.6110				-3.8900		+	0.245	0.230	0.251	9	839	2.670	0.0322
Percent Chironomidae	1.640		-0.6780	2.13000			-4.1900	-1.12000	+	0.269	0.252	0.270	11	839	2.840	0.0296
Percent Chironomidae	2.880					-0.03410	-3.8900		+	0.244	0.228	0.250	9	839	2.910	0.0287

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	R.2	R21	R22	df	AICc	delta	weight
Percent Chironomidae	2.000	-0.3550		2.00000			-4.1500	-1.16000	+	0.269	0.250	0.270	11	839	2.950	0.0280
Percent EPT	61.100	16.6000			+		38.8000		+	0.596	0.586	0.611	11	1,260	0.000	0.1470
Percent EPT	66.400	17.0000	9.6100		+		38.9000		+	0.602	0.591	0.621	12	1,260	0.308	0.1260
Percent EPT	61.100	16.9000			+		38.5000	4.39000	+	0.599	0.589	0.609	12	1,260	1.230	0.0793
Percent EPT	66.100	17.2000	9.1700		+		38.8000	3.69000	+	0.604	0.593	0.620	13	1,260	1.910	0.0564
Percent EPT	62.300	16.2000		-2.96000	+		39.2000		+	0.596	0.584	0.611	12	1,260	2.180	0.0494
Percent EPT	67.700	16.5000	9.7600	-3.26000	+		39.5000		+	0.603	0.589	0.622	13	1,260	2.430	0.0435
Percent EPT	60.800	16.6000			+	1.00000	38.6000		+	0.595	0.584	0.611	12	1,260	2.460	0.0430
Percent EPT	78.300	17.8000	12.0000				39.5000		+	0.581	0.527	0.604	10	1,260	2.570	0.0407

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	R.2	R21	R22	df	AICc	delta	weight
Percent EPT	65.900	17.0000	10.0000		+	1.97000	38.8000		+	0.602	0.590	0.624	13	1,260	2.730	0.0375
Percent Omnivore	6.280				+				+	0.361	0.306	0.533	9	727	0.000	0.0986
Percent Omnivore	6.140				+	0.39500			+	0.364	0.307	0.530	10	728	1.780	0.0404
Percent Omnivore	7.610							0.85000	+	0.342	0.262	0.531	8	728	1.840	0.0393
Percent Omnivore	6.280				+			0.58200	+	0.363	0.305	0.539	10	729	2.000	0.0363
Percent Omnivore	6.300	-0.2010			+				+	0.362	0.306	0.531	10	729	2.140	0.0338
Percent Omnivore	6.060		-0.4000		+				+	0.362	0.305	0.533	10	729	2.190	0.0329
Percent Omnivore	6.470			-0.51500	+				+	0.362	0.304	0.544	10	729	2.270	0.0317
Percent Omnivore	6.260				+		-0.0758		+	0.362	0.305	0.531	10	729	2.290	0.0314

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	R.2	R21	R22	df	AICc	delta	weight
Percent Omnivore	7.590					0.21400			+	0.339	0.256	0.524	8	729	2.590	0.0270
Percent Omnivore	7.830			-0.44300					+	0.338	0.255	0.536	8	729	2.660	0.0261
Percent Omnivore	7.650	-0.1210							+	0.338	0.256	0.524	8	729	2.660	0.0260
Percent Omnivore	7.620						-0.0377		+	0.338	0.256	0.523	8	729	2.710	0.0254
Percent Omnivore	7.640		0.0352						+	0.338	0.256	0.525	8	729	2.740	0.0251
Percent Predator	-0.525		-4.9900				-8.8000		+	0.351	0.351	0.396	9	967	0.000	0.0838
Percent Predator	4.750				+		-8.0400		+	0.360	0.359	0.368	10	968	0.342	0.0706
Percent Predator	2.540		-3.9400		+		-8.3500		+	0.370	0.378	0.401	11	968	0.495	0.0655
Percent Predator	-0.381	-1.6400	-5.1100				-8.6800		+	0.359	0.355	0.397	10	968	0.685	0.0595

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	R.2	R21	R22	df	AICc	delta	weight
Percent Predator	4.880	-1.4500			+		-7.9900		+	0.367	0.362	0.370	11	969	1.280	0.0441
Percent Predator	2.630	-1.5500	-4.0400		+		-8.2700		+	0.377	0.381	0.402	12	969	1.290	0.0439
Percent Predator	0.175		-4.8900	-1.44000			-8.5700		+	0.355	0.355	0.400	10	969	1.600	0.0376
Percent Predator	0.588	-1.9400	-5.0100	-1.93000			-8.3400		+	0.365	0.362	0.401	11	969	1.750	0.0350
Percent Predator	-0.561		-5.0500				-8.8500	0.77600	+	0.352	0.348	0.396	10	970	2.120	0.0291
Percent Predator	4.760				+		-8.1200	1.09000	+	0.363	0.358	0.366	11	970	2.170	0.0283
Percent Predator	2.490		-4.0500		+		-8.4000	1.26000	+	0.373	0.377	0.399	12	970	2.200	0.0278
Percent Predator	-0.462		-5.1000			-0.69700	-8.8200		+	0.351	0.353	0.409	10	970	2.270	0.0269

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	R.2	R21	R22	df	AICc	delta	weight
Percent Predator	5.160			-1.11000	+		-7.9300		+	0.361	0.361	0.374	11	970	2.520	0.0238
Percent Predator	2.950		-3.9300	-1.09000	+		-8.2300		+	0.371	0.380	0.407	12	970	2.660	0.0222
Percent Predator	4.760				+	-0.05580	-8.0800		+	0.360	0.358	0.369	11	970	2.850	0.0201
Percent Predator	5.530	-1.7400		-1.64000	+		-7.7400		+	0.370	0.366	0.375	12	970	2.920	0.0195
Percent Predator	-0.414	-1.6000	-5.1500				-8.7400	0.64800	+	0.359	0.352	0.397	11	970	2.920	0.0194
Percent Predator	3.280	-1.8200	-4.0100	-1.60000	+		-8.0300		+	0.381	0.385	0.408	13	970	2.970	0.0190
Percent Scraper	30.300	-10.2000			+		-19.0000		+	0.510	0.502	0.524	11	1,160	0.000	0.1160

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	R.2	R21	R22	df	AICc	delta	weight
Percent Scraper	30.300	-10.6000			+		-18.8000	-4.07000	+	0.516	0.507	0.526	12	1,160	0.594	0.0861
Percent Scraper	27.000	-10.4000	-5.9900		+		-19.1000		+	0.515	0.506	0.534	12	1,160	0.858	0.0755
Percent Scraper	22.000	-11.2000	-7.0900				-19.4000	-4.85000	+	0.506	0.480	0.523	11	1,160	1.160	0.0649
Percent Scraper	21.800	-10.9000	-7.4400				-19.6000		+	0.497	0.463	0.520	10	1,160	1.210	0.0633
Percent Scraper	24.700	-11.0000					-19.4000	-5.16000	+	0.495	0.468	0.515	10	1,160	1.700	0.0496
Percent Scraper	27.200	-10.7000	-5.5800		+		-19.0000	-3.72000	+	0.520	0.511	0.535	13	1,160	1.800	0.0471
Percent Scraper	24.600	-10.8000					-19.5000		+	0.486	0.448	0.511	9	1,160	2.010	0.0424

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	R.2	R21	R22	df	AICc	delta	weight
Percent Scraper	29.900	-10.2000			+	1.18000	-19.2000		+	0.511	0.499	0.521	12	1,160	2.150	0.0395
Percent Scraper	29.900	-10.0000		0.94900	+		-19.2000		+	0.510	0.499	0.523	12	1,160	2.390	0.0351
Percent Scraper	29.800	-10.6000			+	1.40000	-19.0000	-4.16000	+	0.518	0.505	0.521	13	1,160	2.590	0.0317
Percent Scraper	29.600	-10.3000		1.61000	+		-19.1000	-4.31000	+	0.517	0.505	0.525	13	1,160	2.840	0.0281
Shannon Evenness	0.609	-0.0443	-0.0282				-0.1560	-0.05310		0.539	0.512	0.551	8	-264	0.000	0.1380
Shannon Evenness	0.609	-0.0424					-0.1600	-0.06550		0.530	0.512	0.543	7	-263	0.446	0.1110
Shannon Evenness	0.620	-0.0429					-0.1530	-0.04050	+	0.550	0.508	0.554	10	-262	1.170	0.0770

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	R.2	R21	R22	df	AICc	delta	weight
Shannon Evenness	0.609	-0.0441	-0.0316			-0.01150	-0.1550	-0.05300		0.540	0.513	0.555	9	-262	1.870	0.0542
Shannon Evenness	0.609	-0.0413		0.01390			-0.1610	-0.06920		0.532	0.512	0.542	8	-262	1.920	0.0529
Shannon Evenness	0.609	-0.0434	-0.0264	0.00891			-0.1570	-0.05630		0.540	0.511	0.549	9	-262	1.950	0.0521
Shannon Evenness	0.609	-0.0424				-0.00264	-0.1600	-0.06580		0.530	0.510	0.542	8	-261	2.700	0.0359
Shannon Evenness	0.619	-0.0426					-0.1520		+	0.537	0.469	0.549	9	-261	2.810	0.0339
Shannon Evenness	0.611	-0.0404		0.01790			-0.1560	-0.04280	+	0.552	0.506	0.553	11	-261	2.840	0.0334
Taxa Richness	22.700	-2.7600					-8.7000	-2.70000	+	0.411	0.400	0.400	10	914	0.000	0.1760

Response	X.Intercept.	D50 (cm)	Dissolved Oxygen	pH	Reference	Proportion Cobble	Velocity (m/s)	Water Temperature	Year (2012)	R.2	R21	R22	df	AICc	delta	weight
Taxa Richness	22.900	-2.7800				-1.31000	-8.4400	-2.71000	+	0.417	0.405	0.405	11	915	0.914	0.1120
Taxa Richness	22.000	-2.5500		1.43000			-8.9600	-2.99000	+	0.415	0.403	0.403	11	915	1.370	0.0890
Taxa Richness	22.300	-2.7900	-1.0200				-8.6700	-2.64000	+	0.412	0.400	0.400	11	916	2.050	0.0633
Taxa Richness	22.200	-2.5800		1.36000		-1.26000	-8.6900	-2.98000	+	0.421	0.406	0.406	12	917	2.410	0.0529
Taxa Richness	22.400	-2.8100	-1.3600			-1.44000	-8.3800	-2.65000	+	0.420	0.405	0.405	12	917	2.680	0.0462

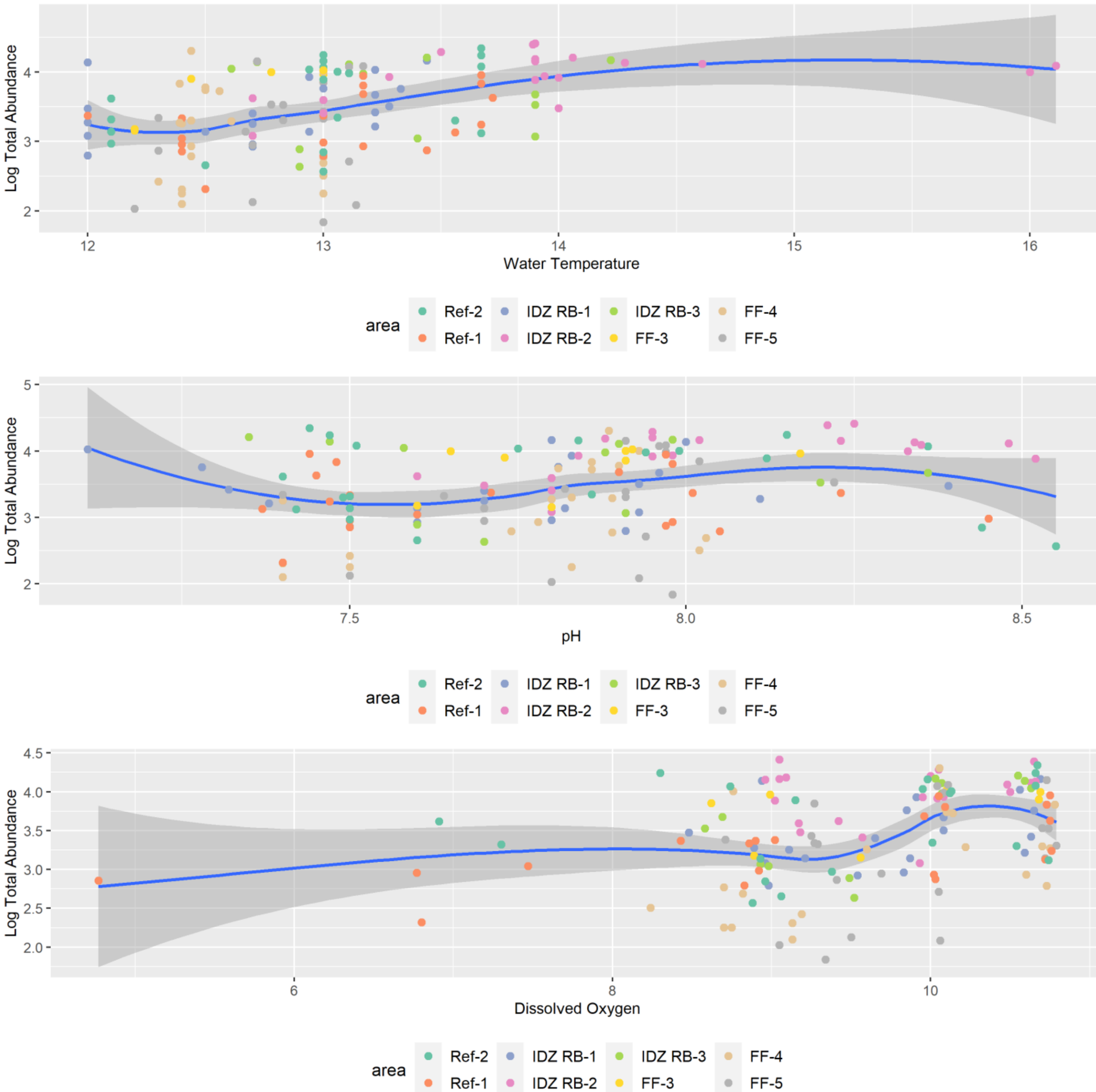


Figure 31: Explanatory variables and Log Total Abundance grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

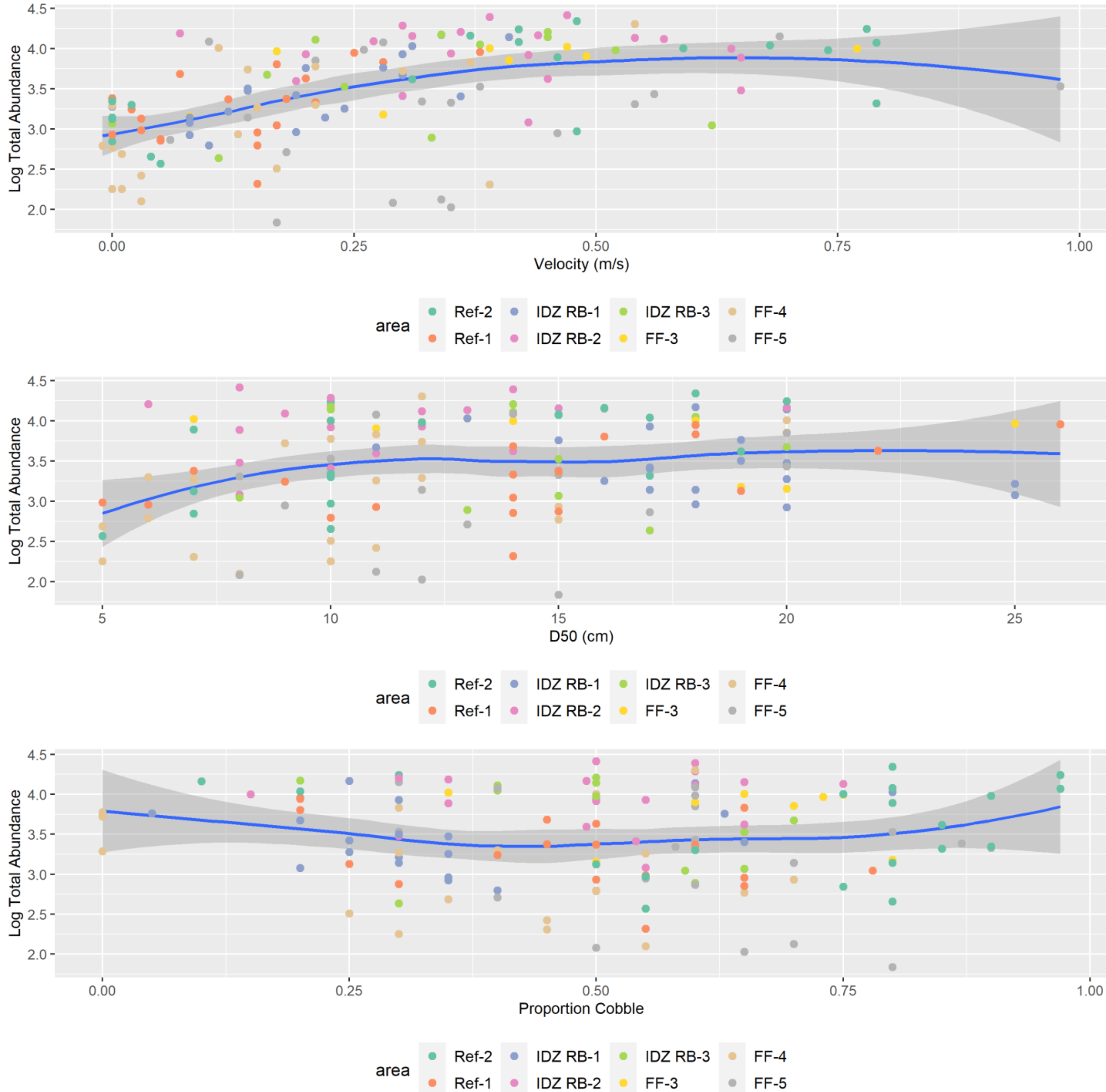


Figure 32: Explanatory variables and Log Total Abundance grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

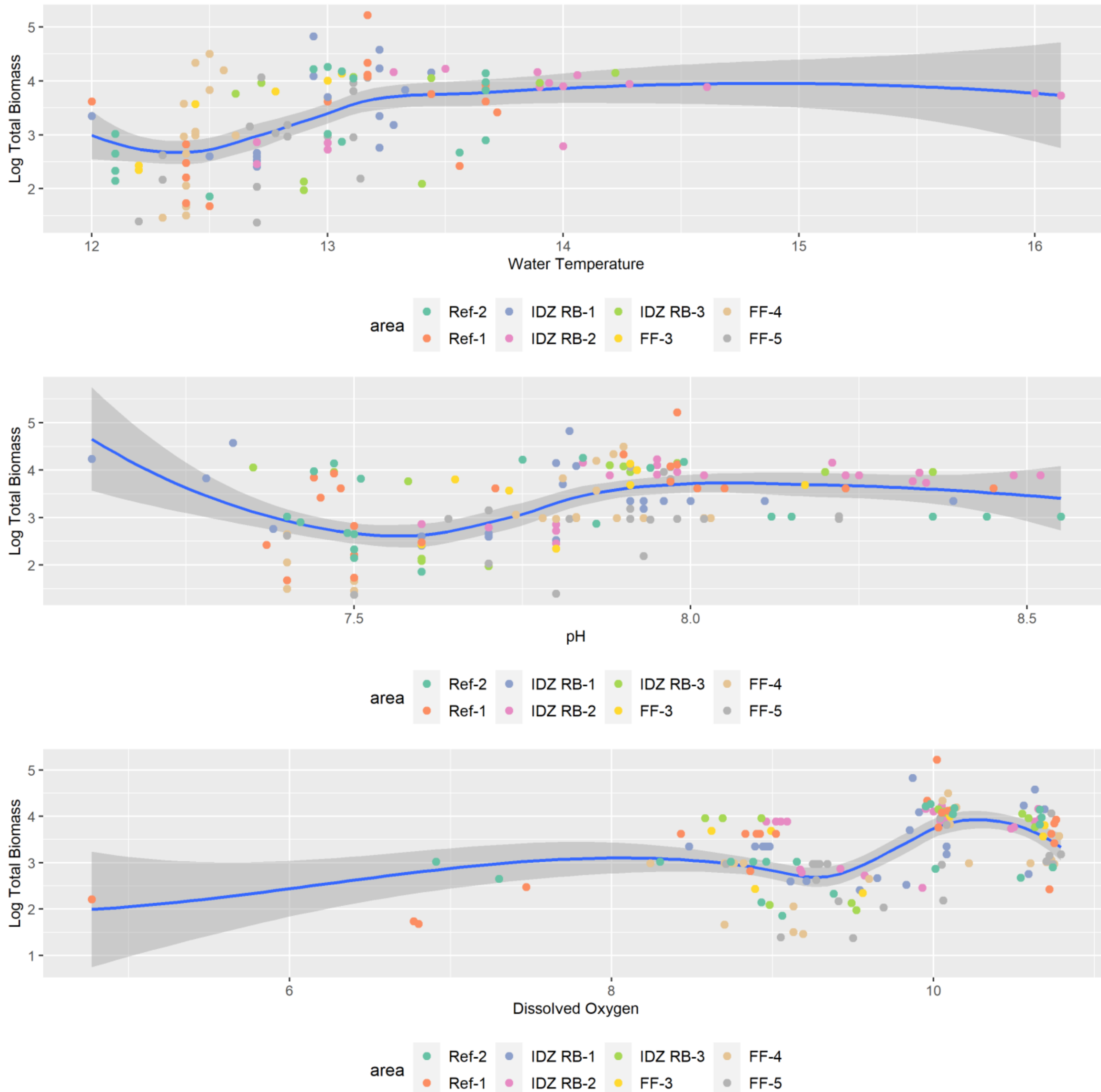


Figure 33: Explanatory variables and Log Total Biomass grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

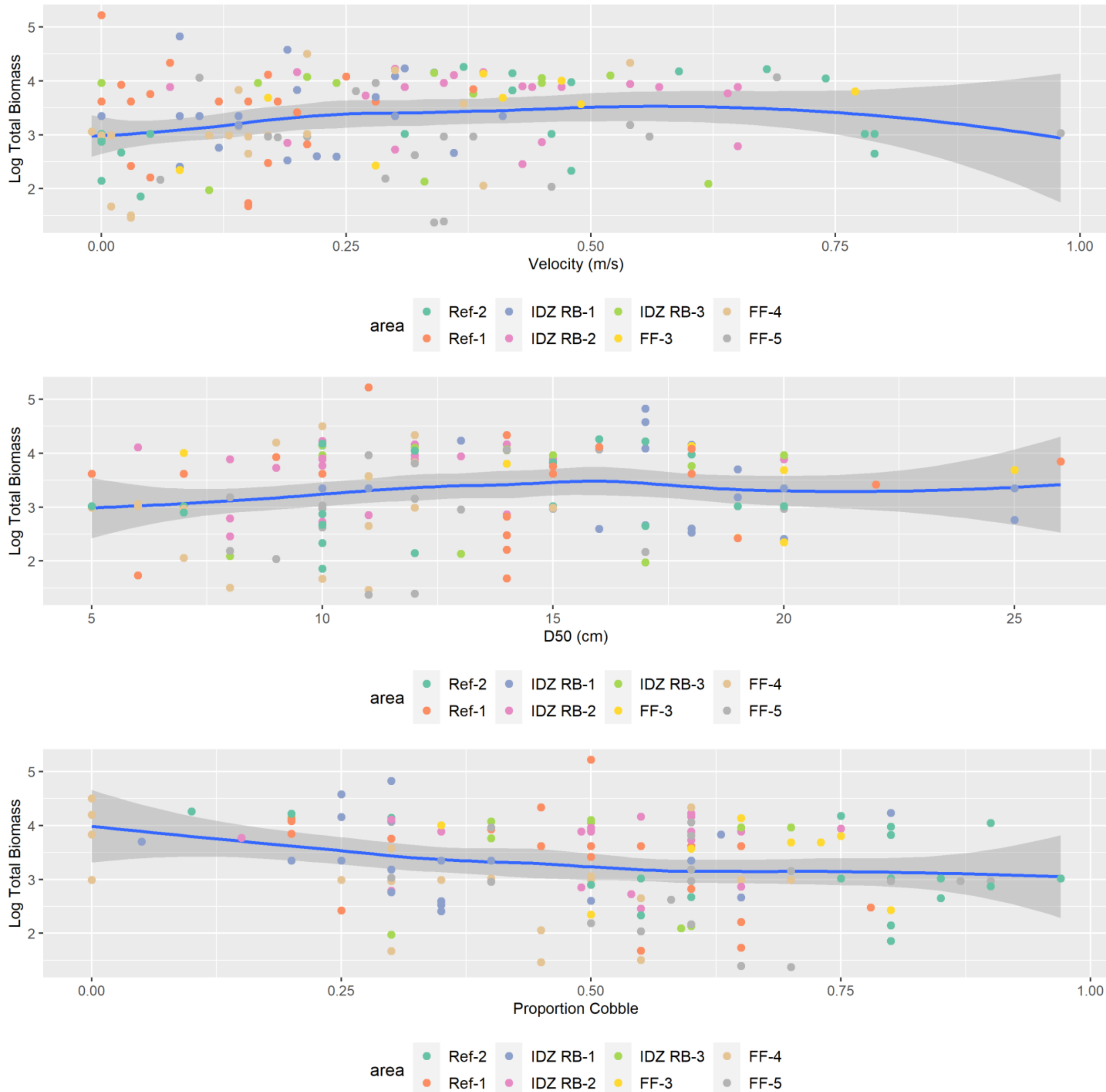


Figure 34: Explanatory variables and Log Total Biomass grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

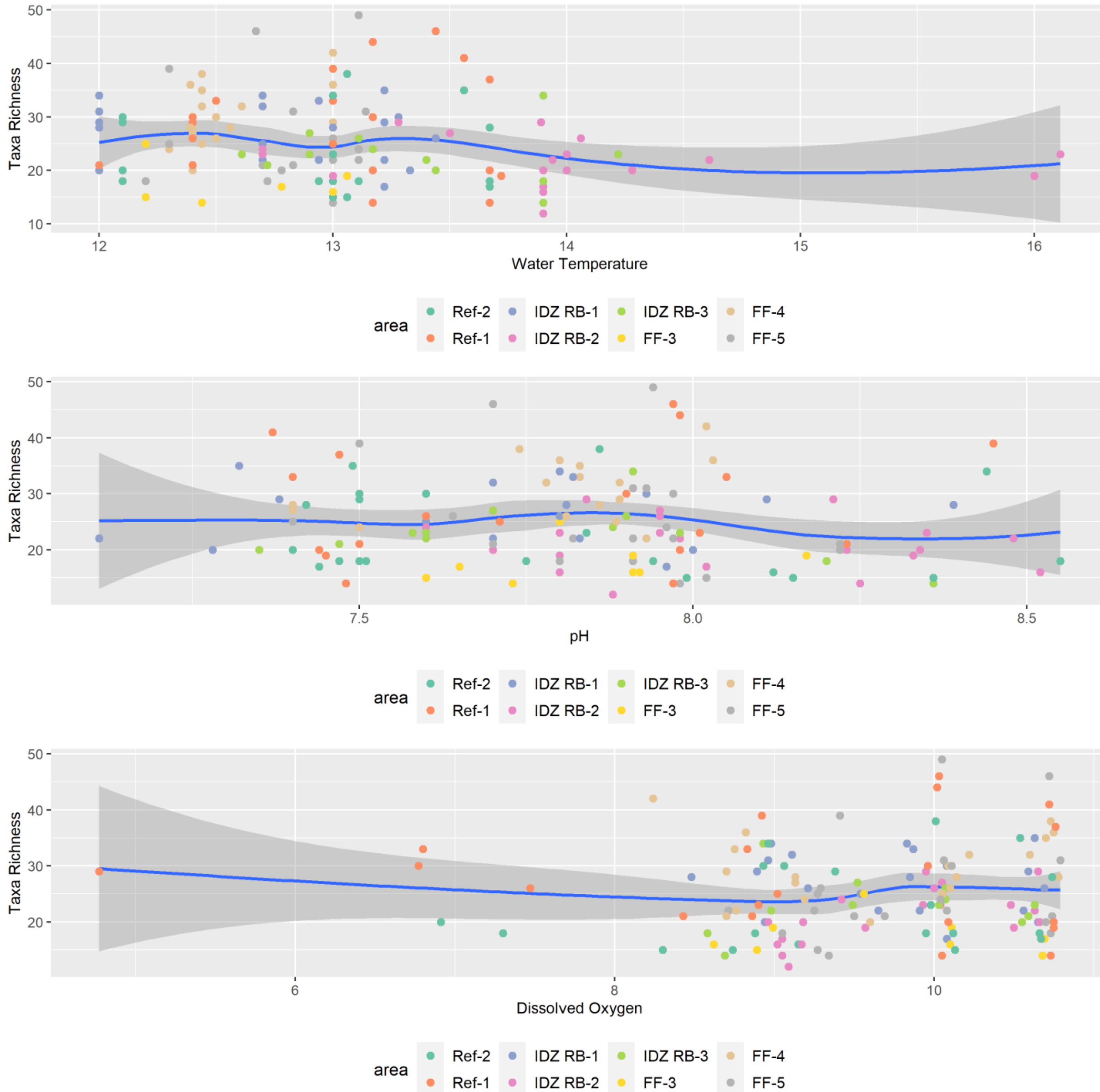


Figure 35: Explanatory variables and Taxa Richness grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

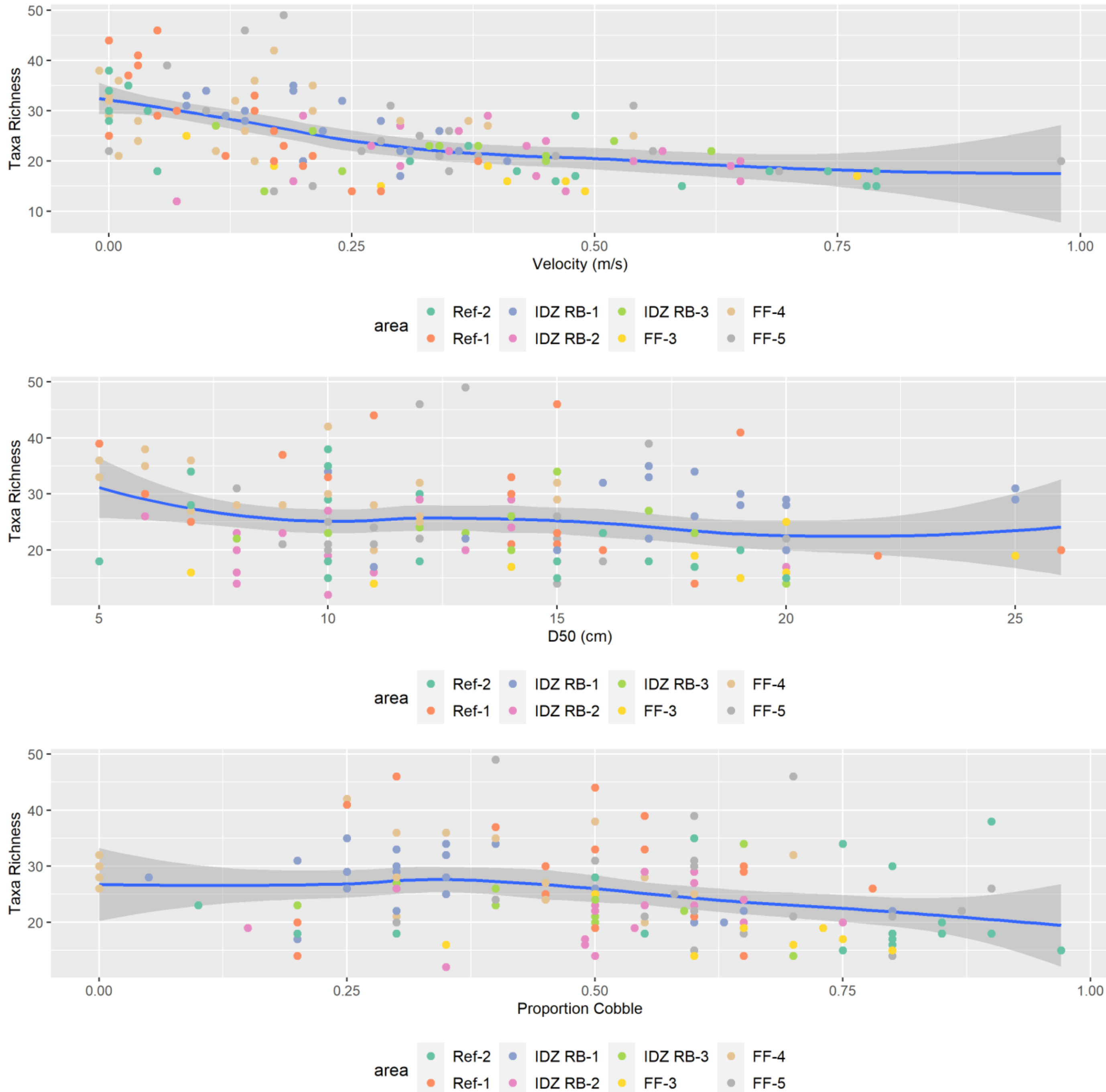


Figure 36: Explanatory variables and Taxa Richness grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

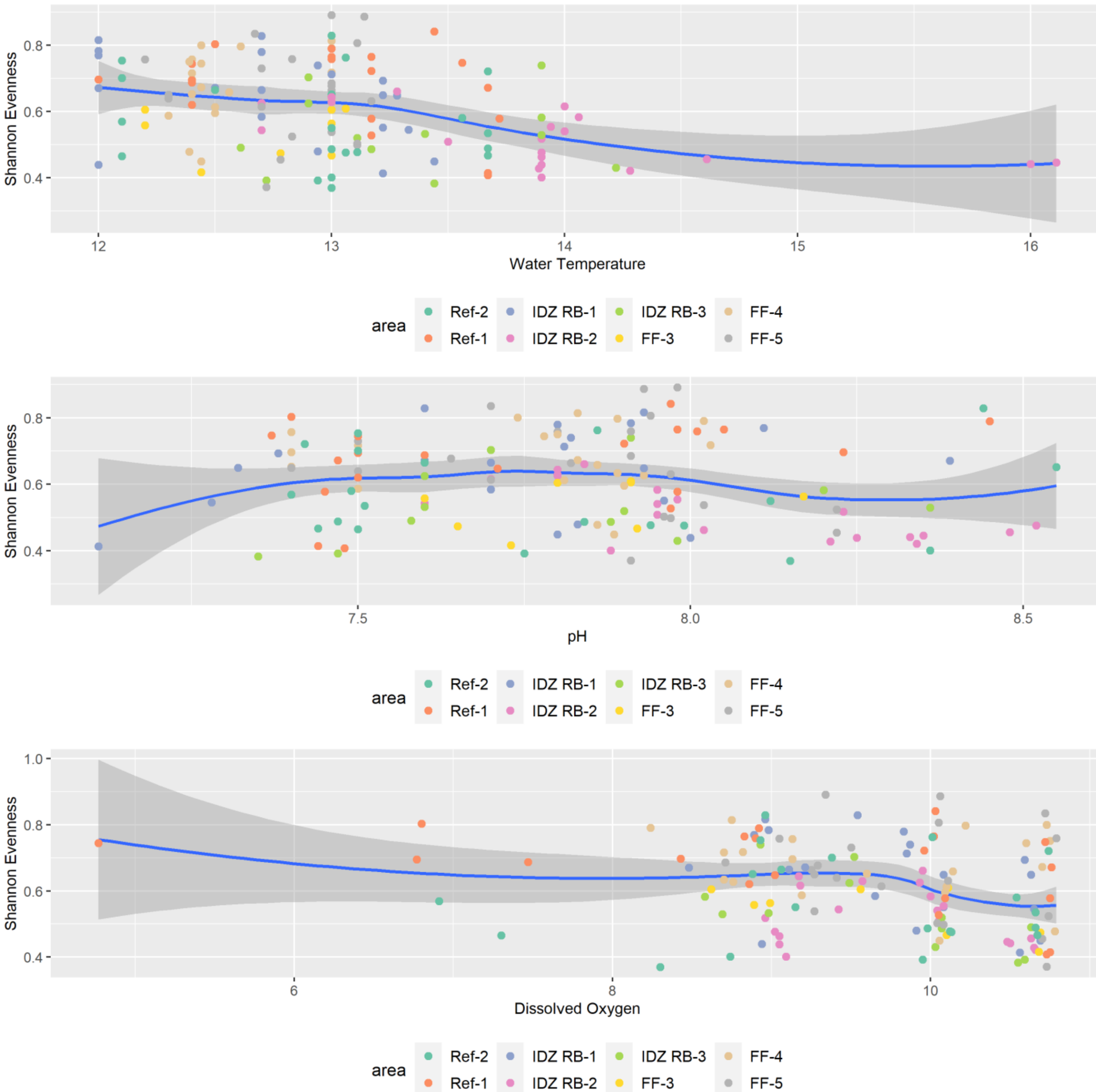


Figure 37: Explanatory variables and Shannon Evenness grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

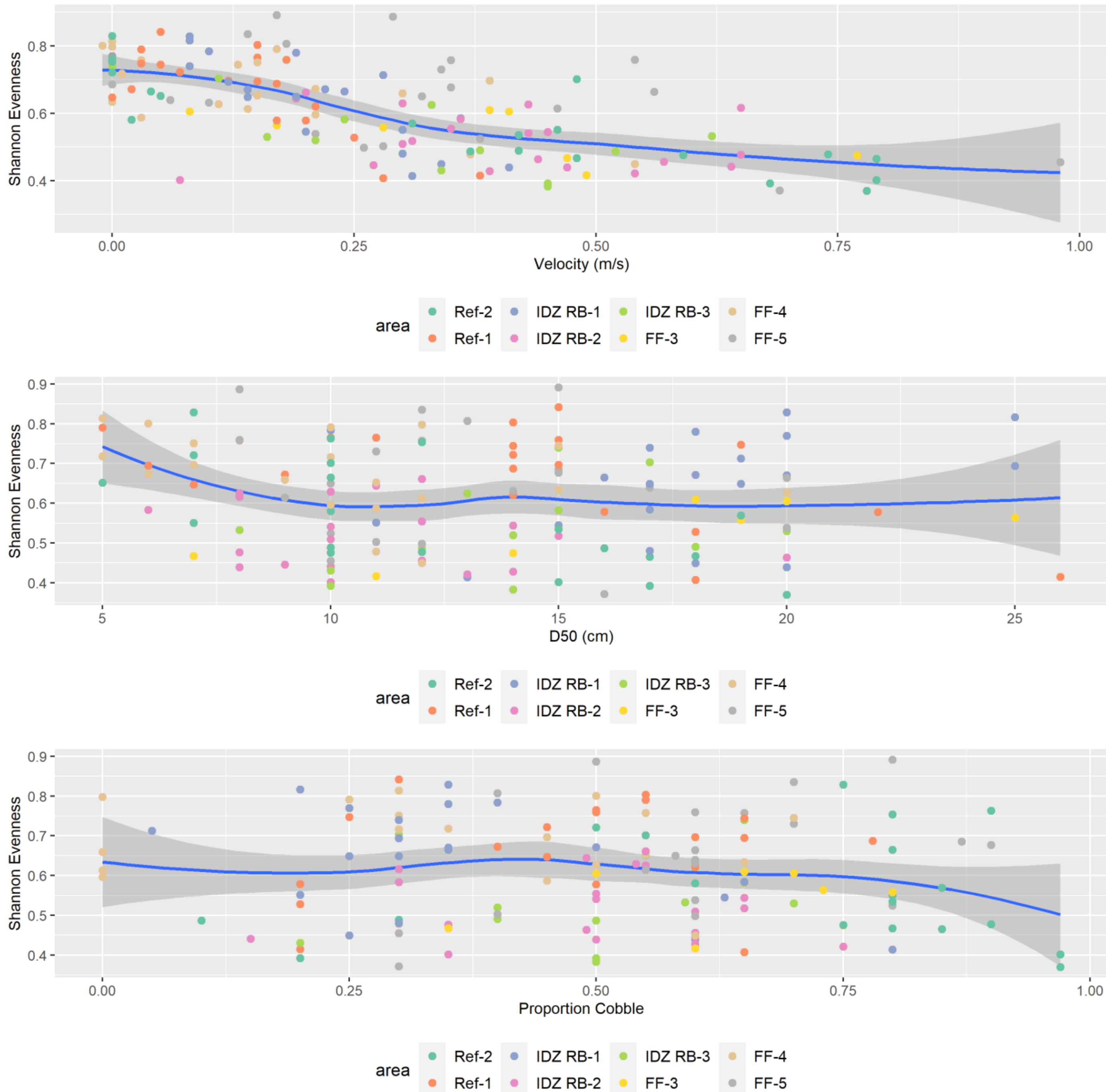


Figure 38: Explanatory variables and Shannon Evenness grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

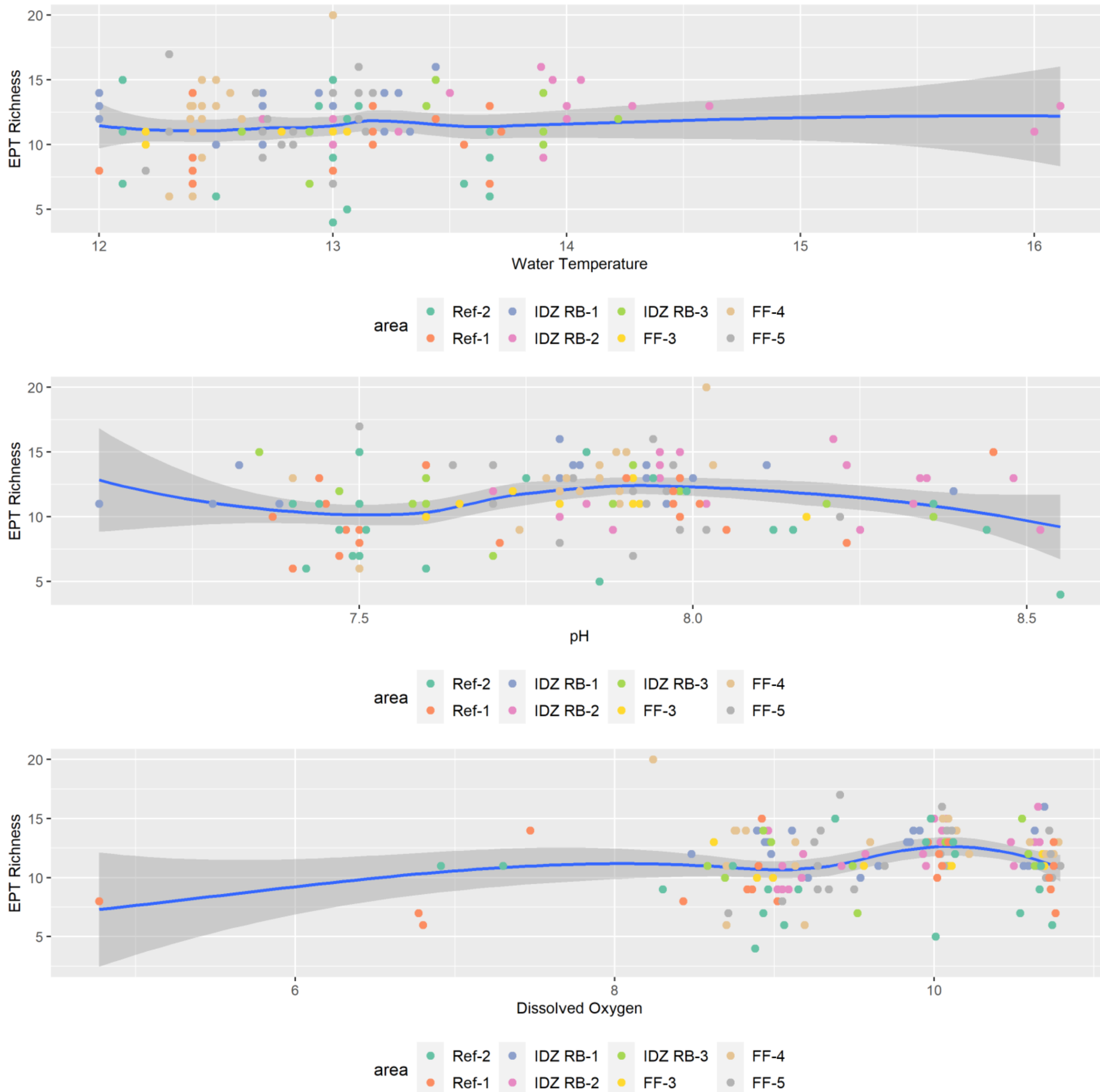


Figure 39: Explanatory variables and EPT Richness grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

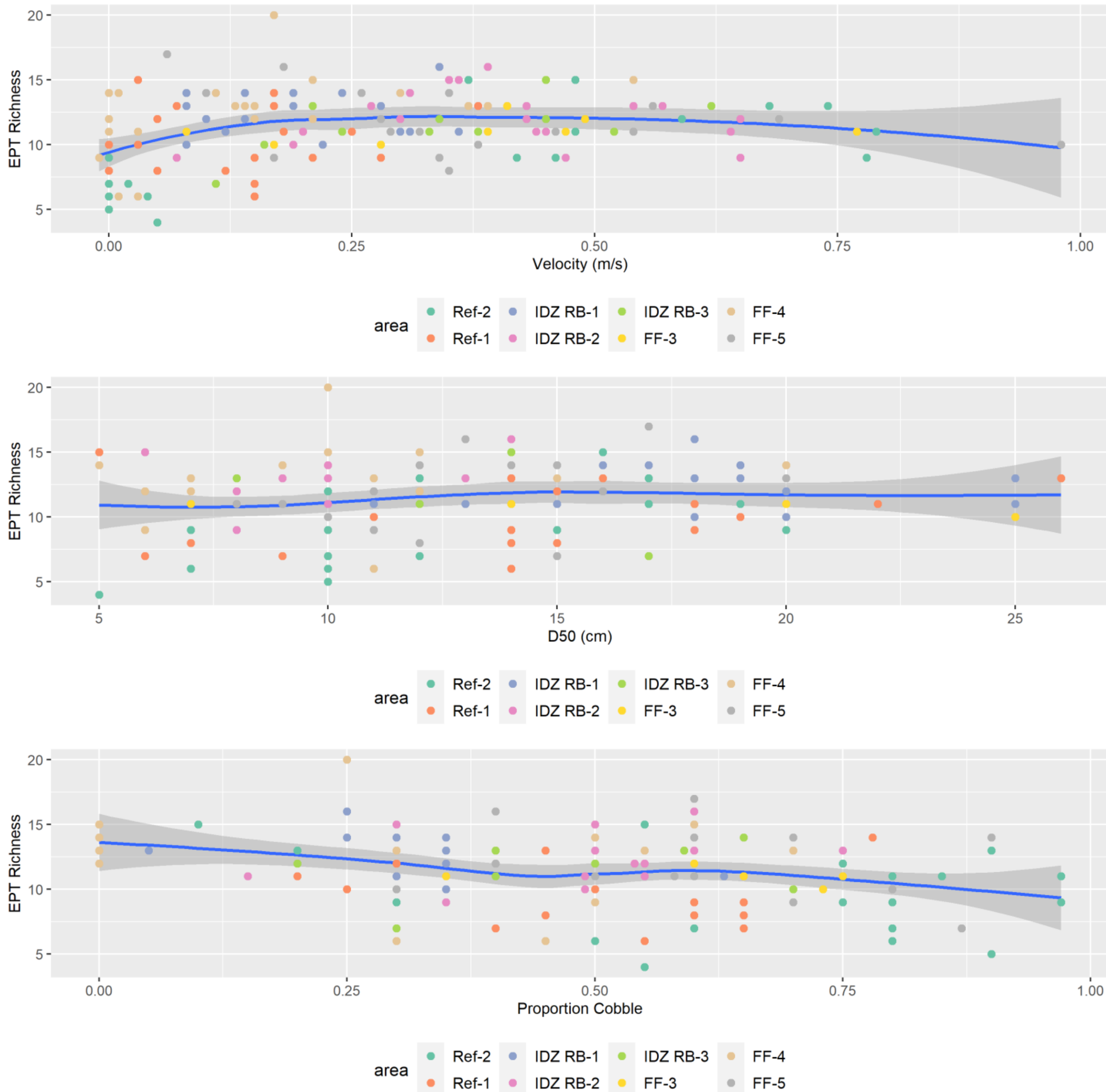


Figure 40: Explanatory variables and EPT Richness grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

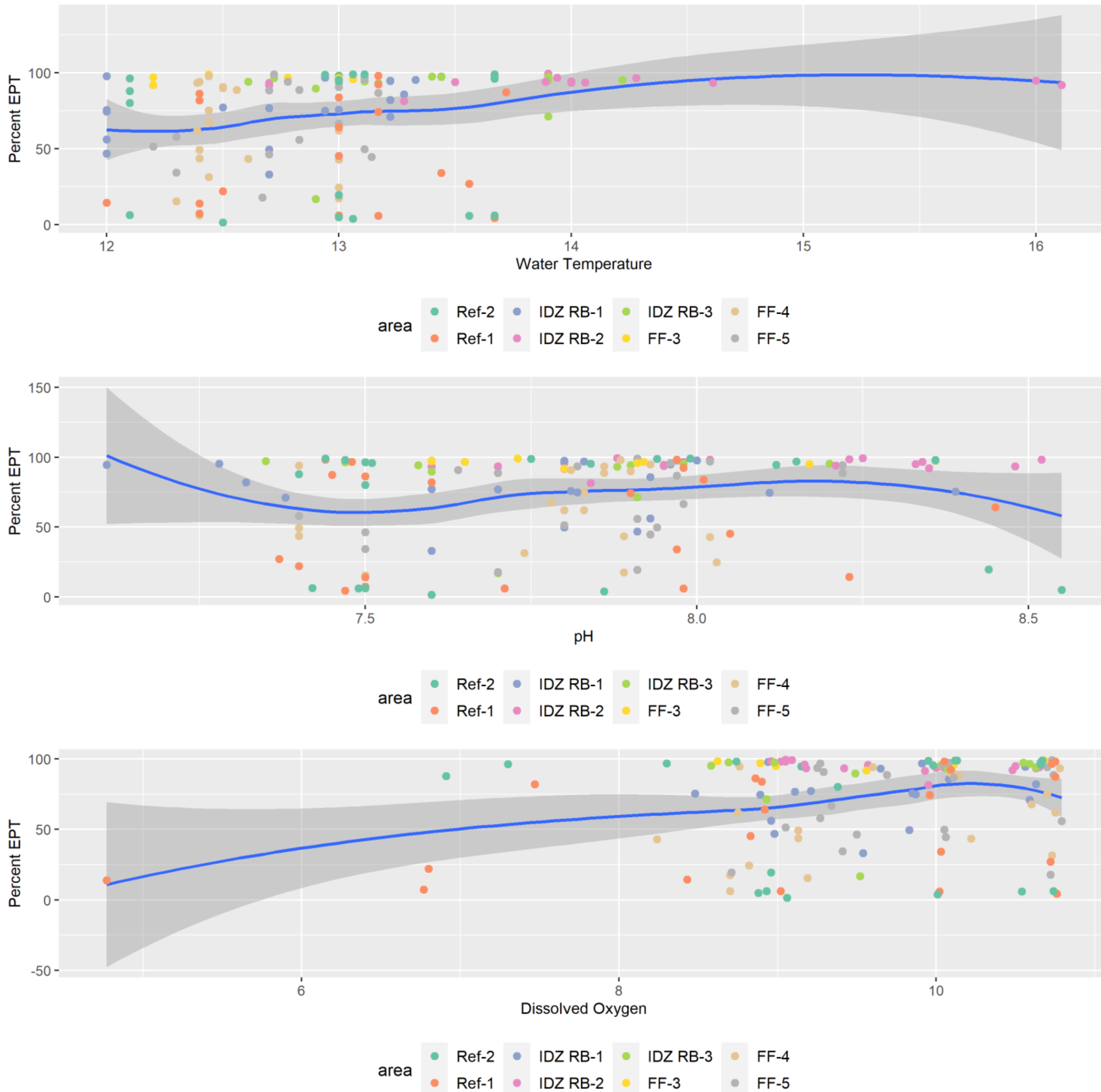


Figure 41: Explanatory variables and Percent EPT grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

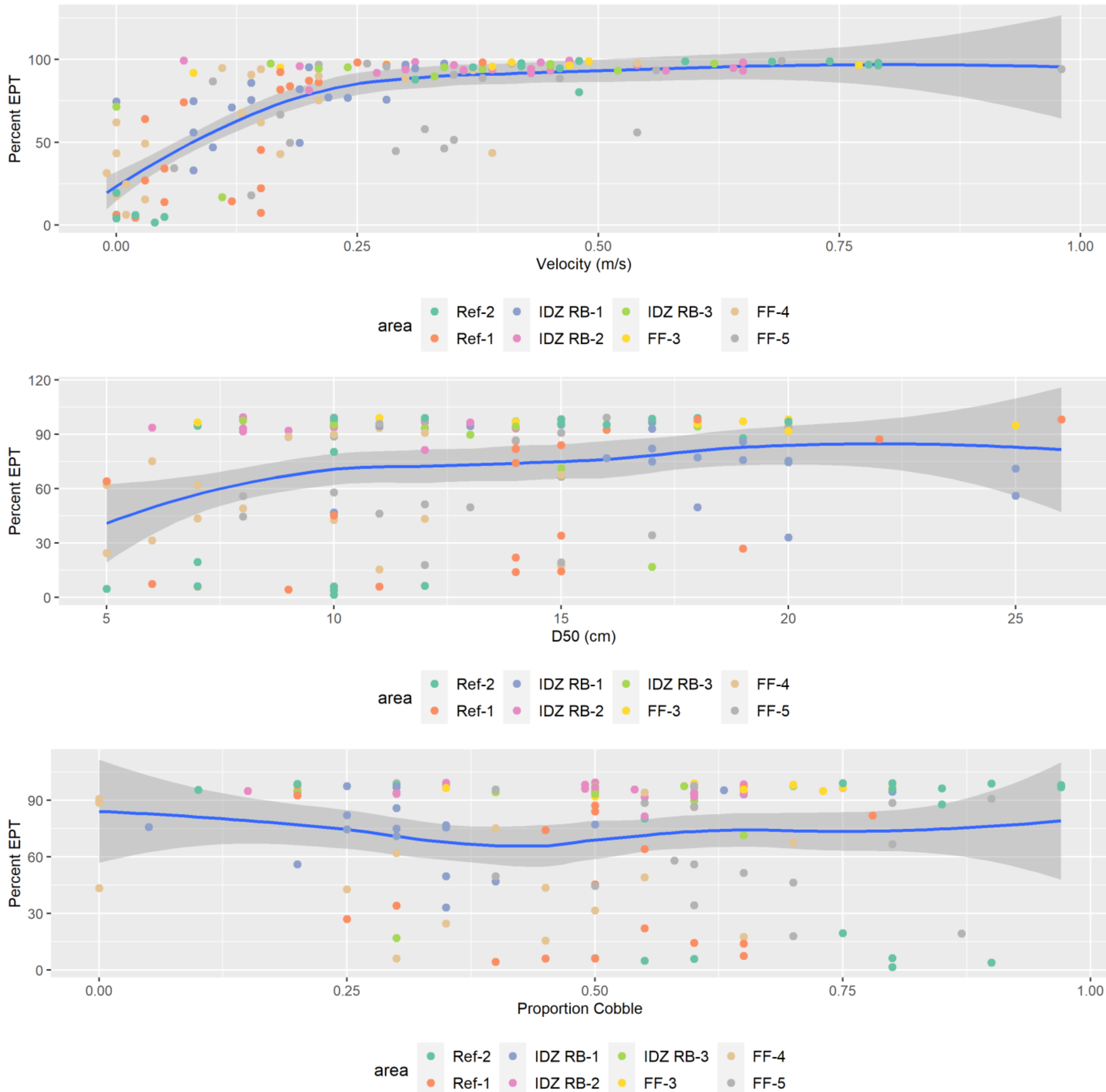


Figure 42: Explanatory variables and Percent EPT grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

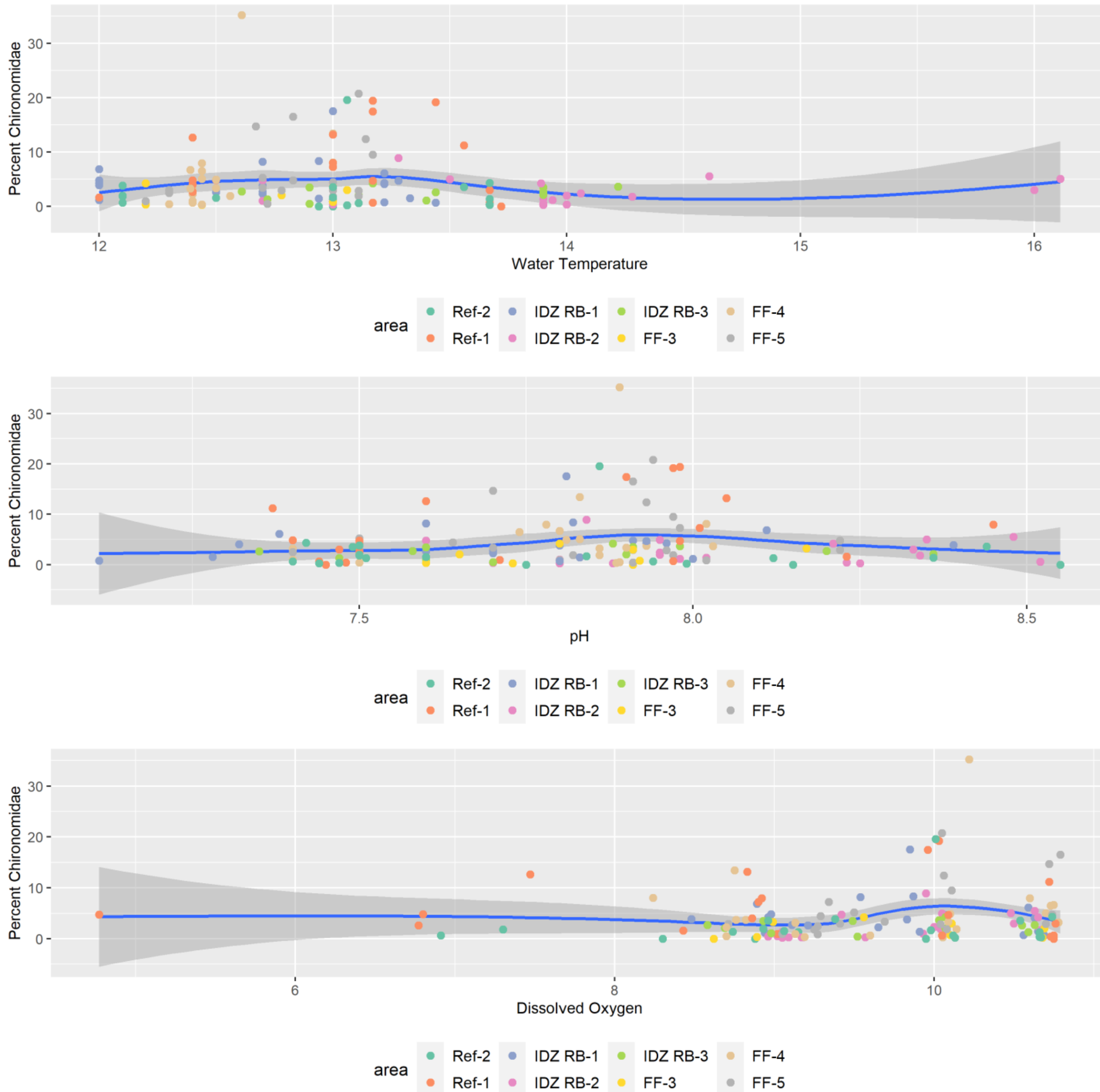


Figure 43: Explanatory variables and Percent Chironomidae grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

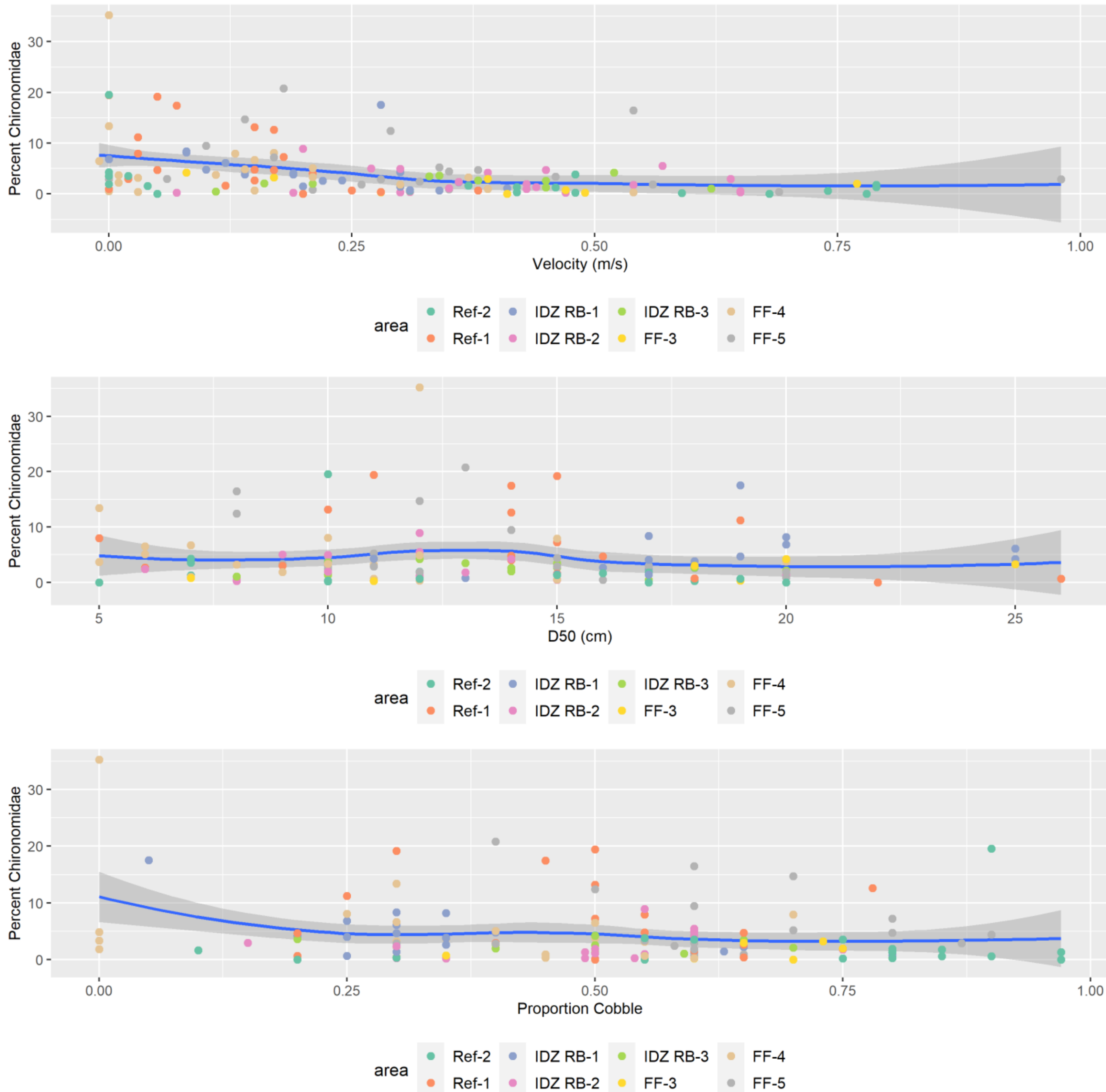


Figure 44: Explanatory variables and Percent Chironomidae grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

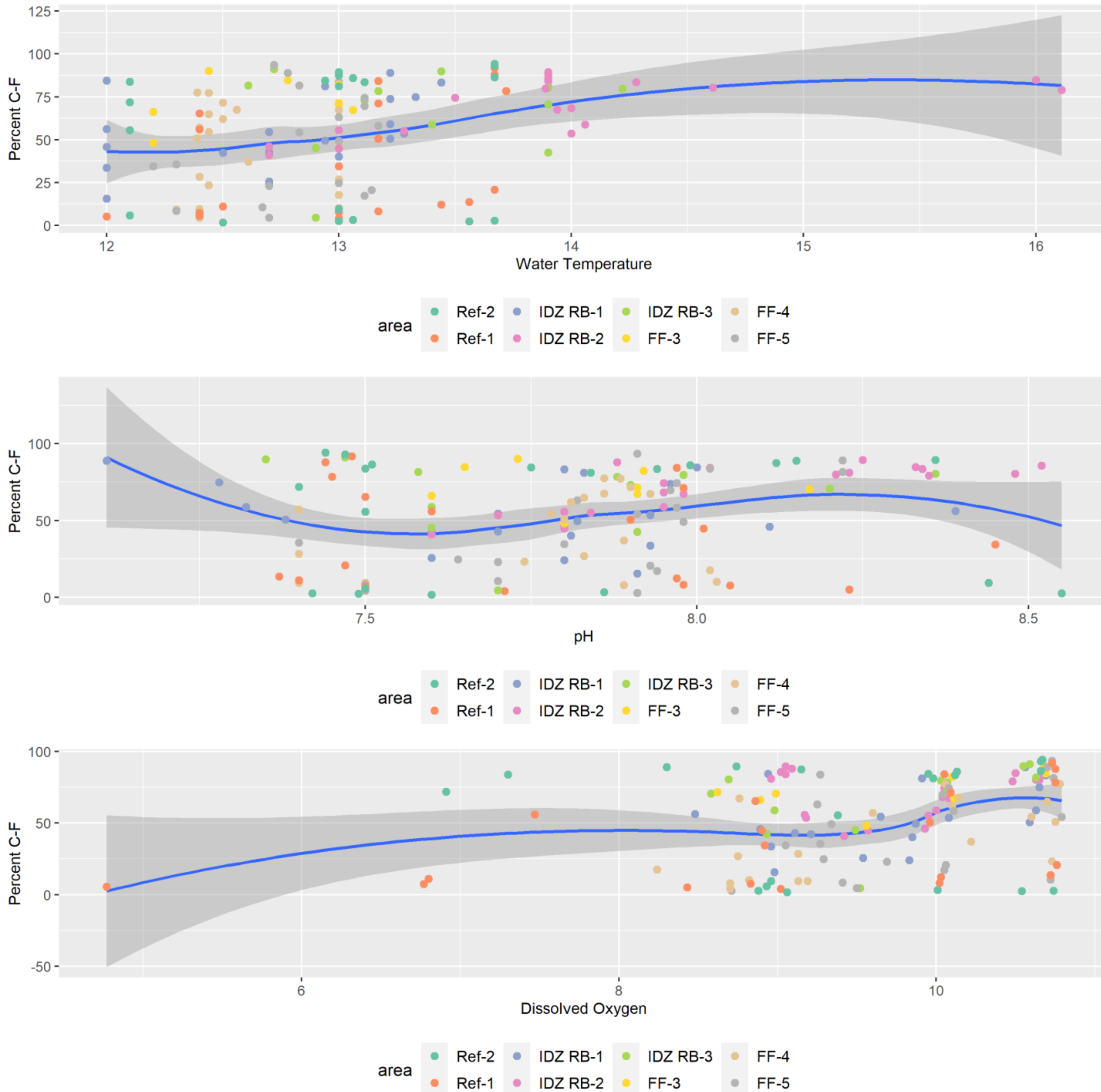


Figure 45: Explanatory variables and Percent C-F grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

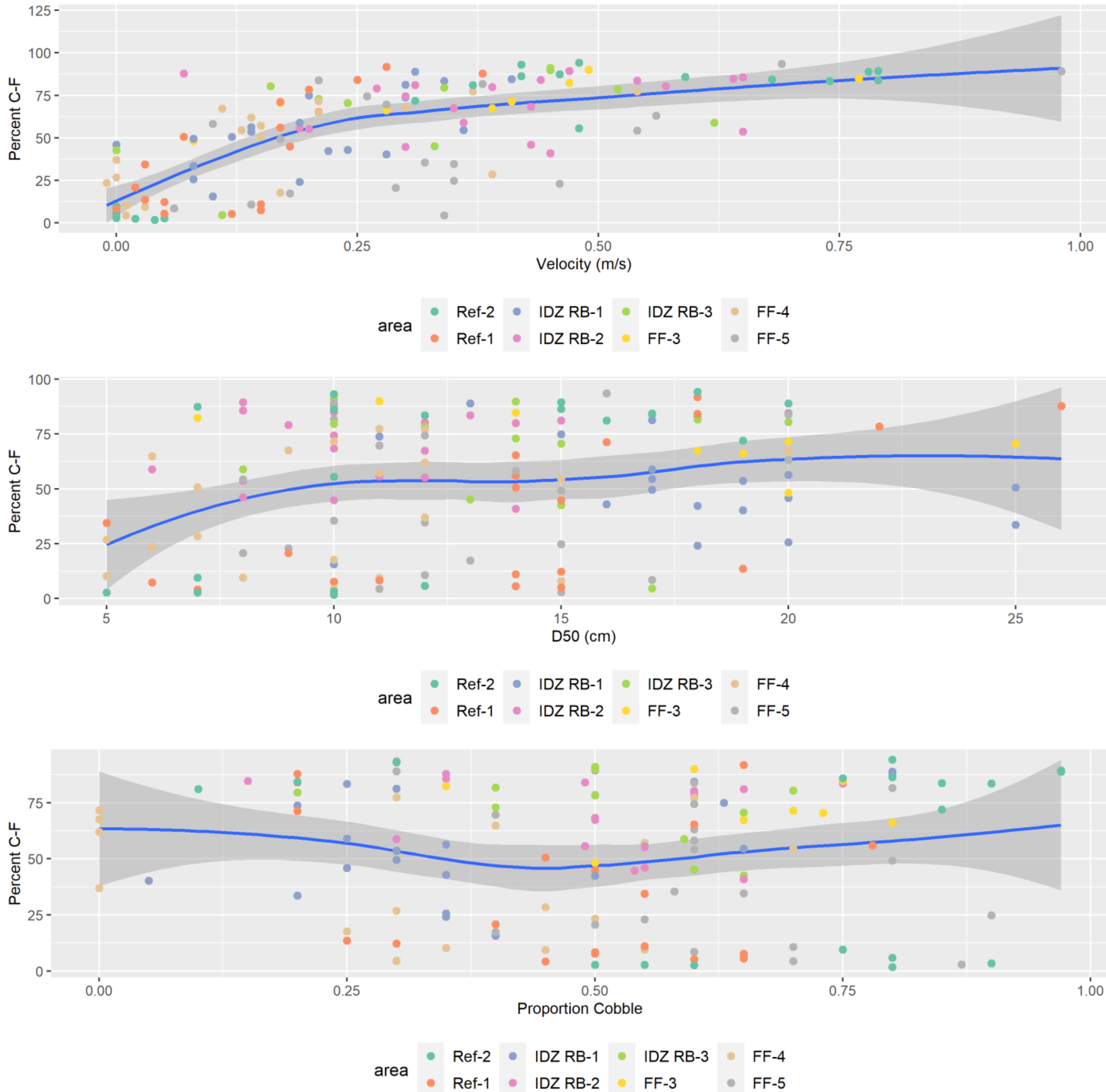


Figure 46: Explanatory variables and Percent C-F grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

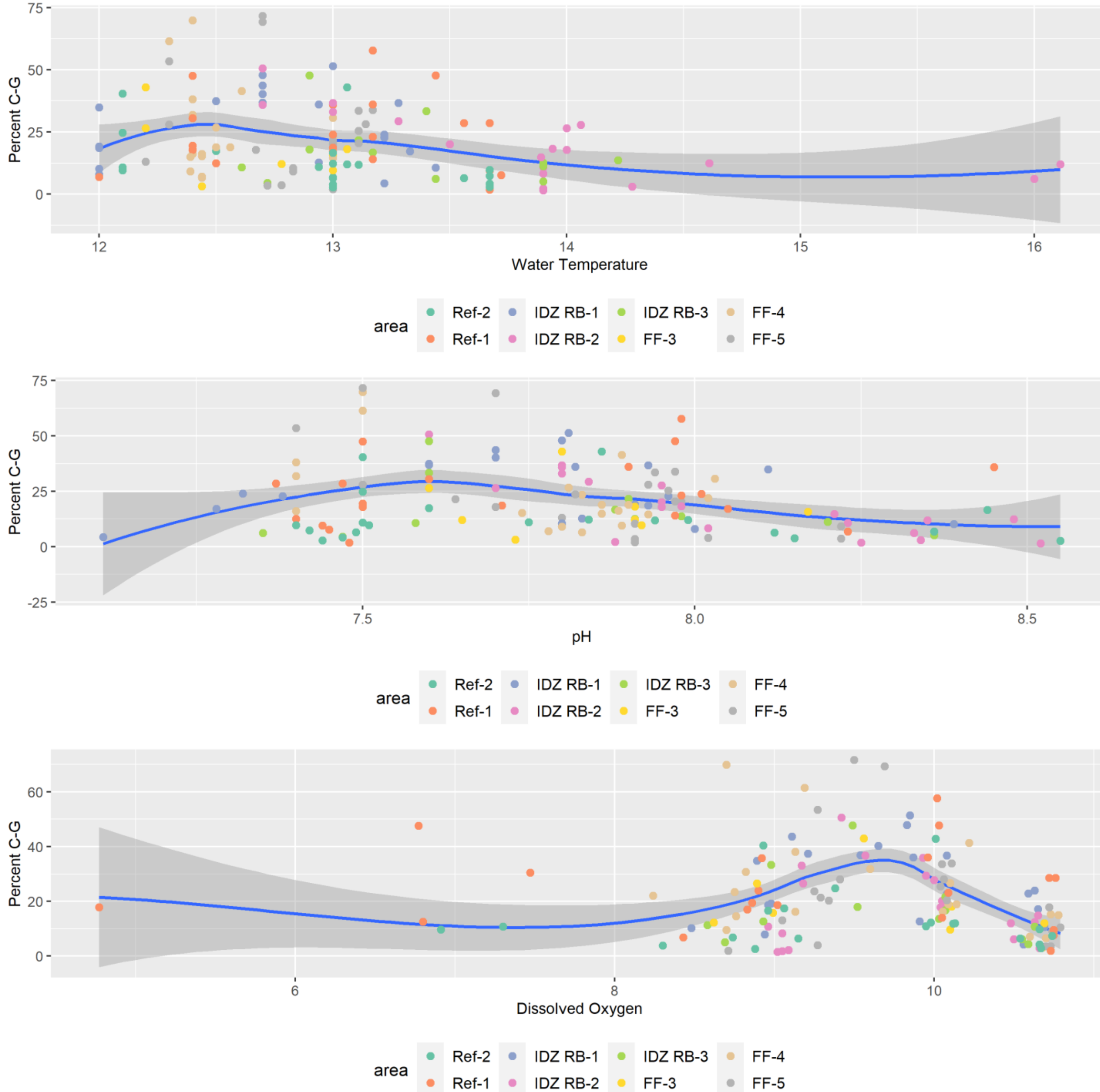


Figure 47: Explanatory variables and Percent C-G grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

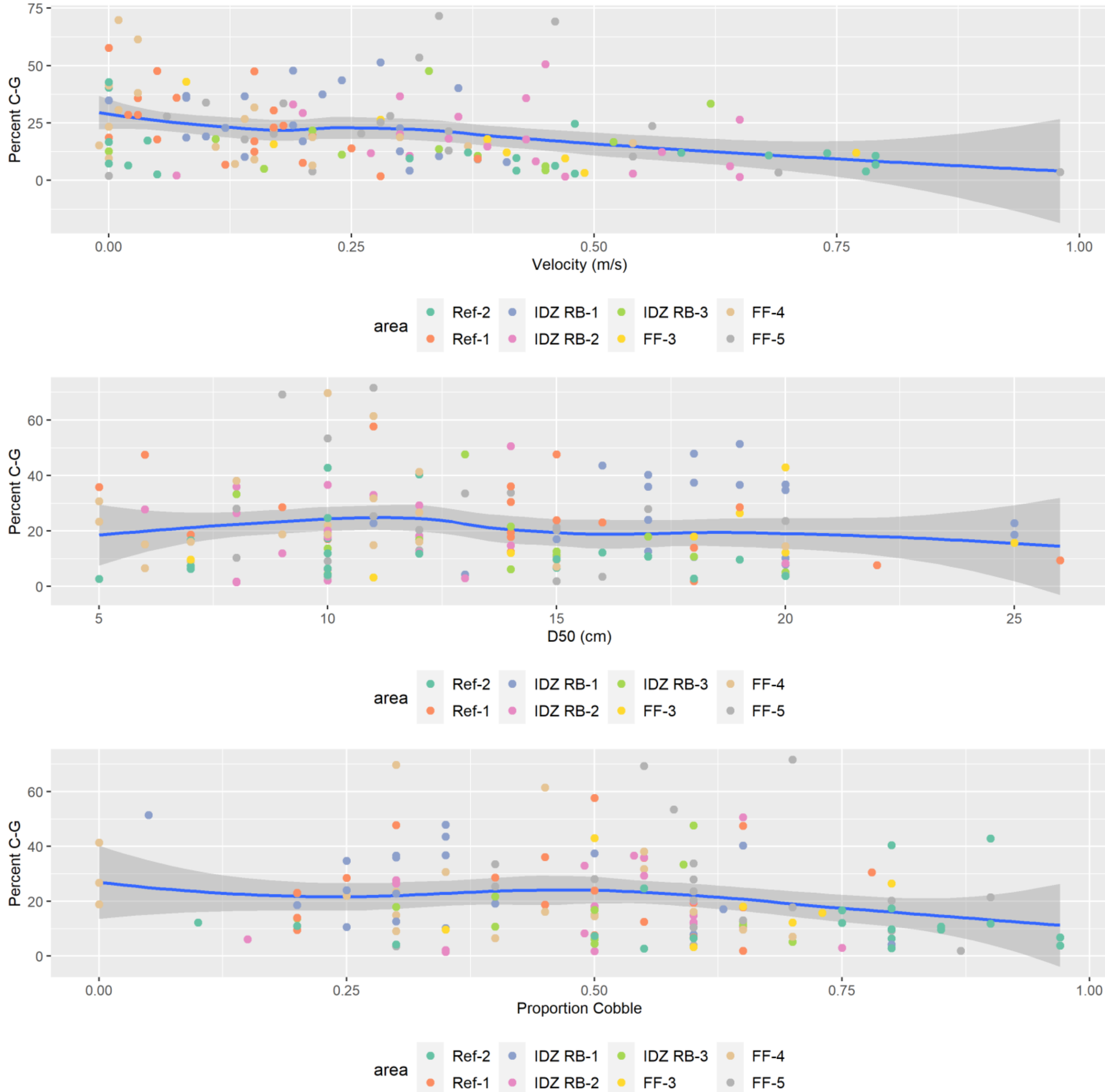


Figure 48: Explanatory variables and Percent C-G grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

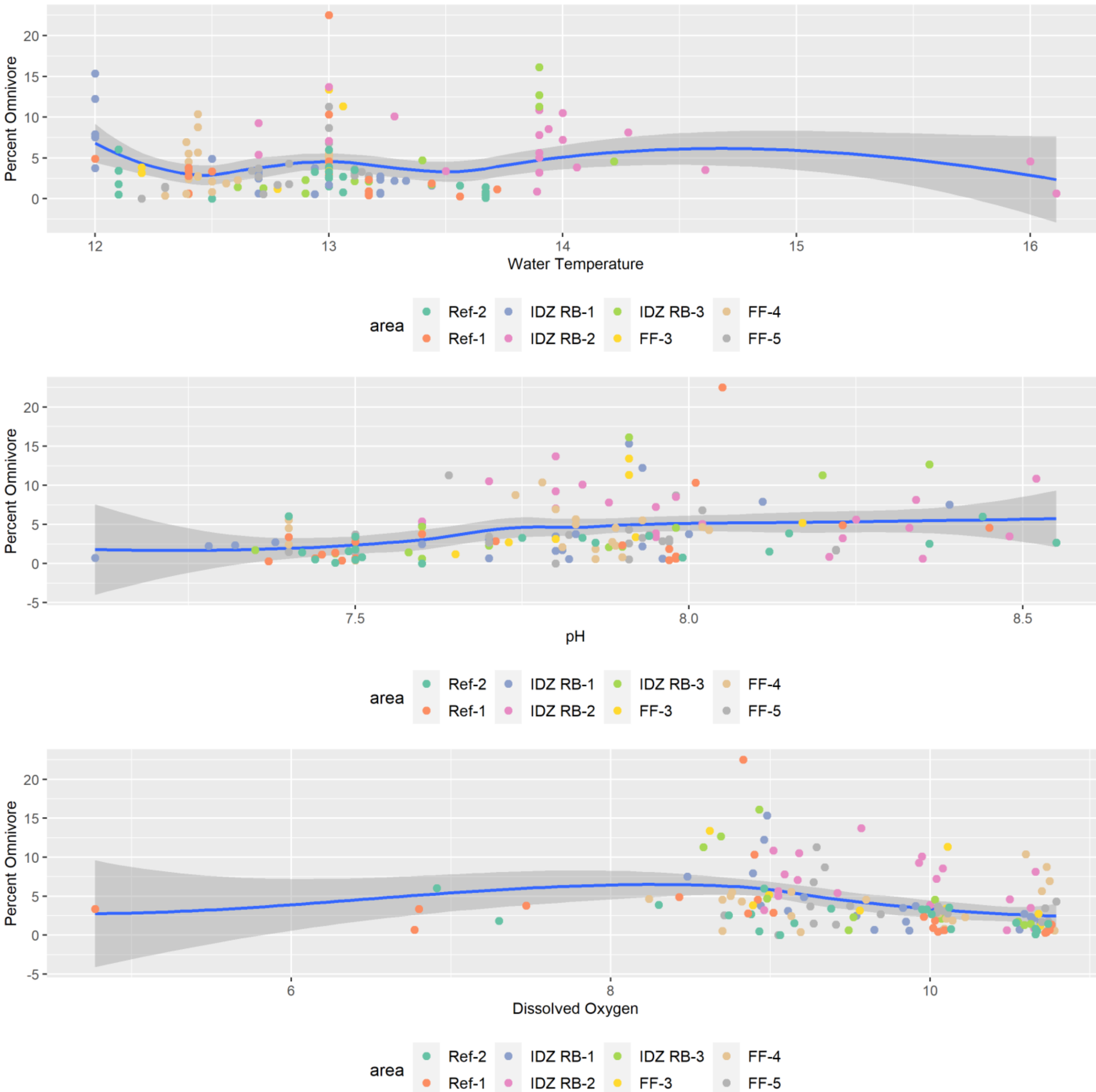


Figure 49: Explanatory variables and Percent Omnivore grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

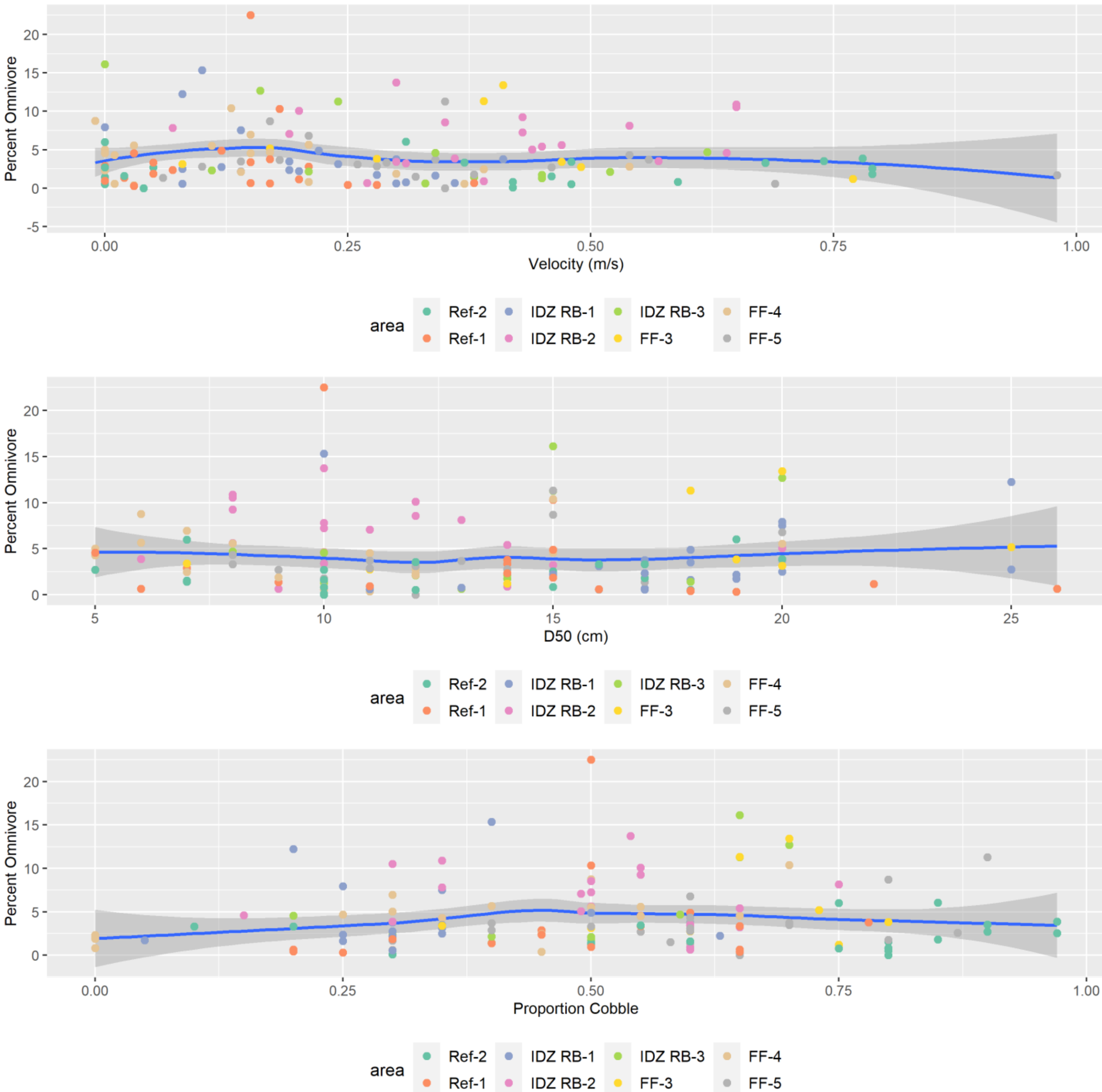


Figure 50: Explanatory variables and Percent Omnivore grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

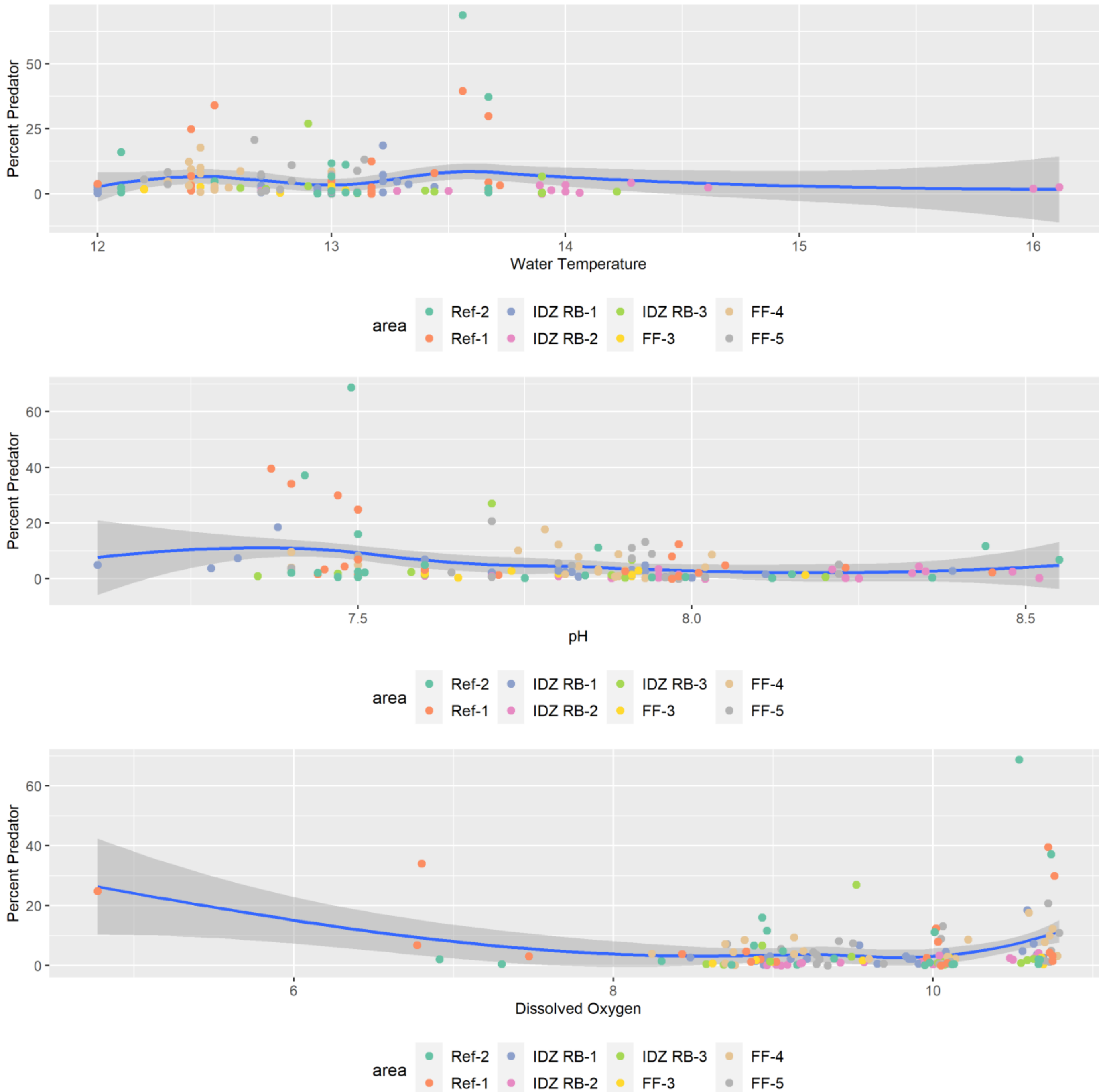


Figure 51: Explanatory variables and Percent Predator grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

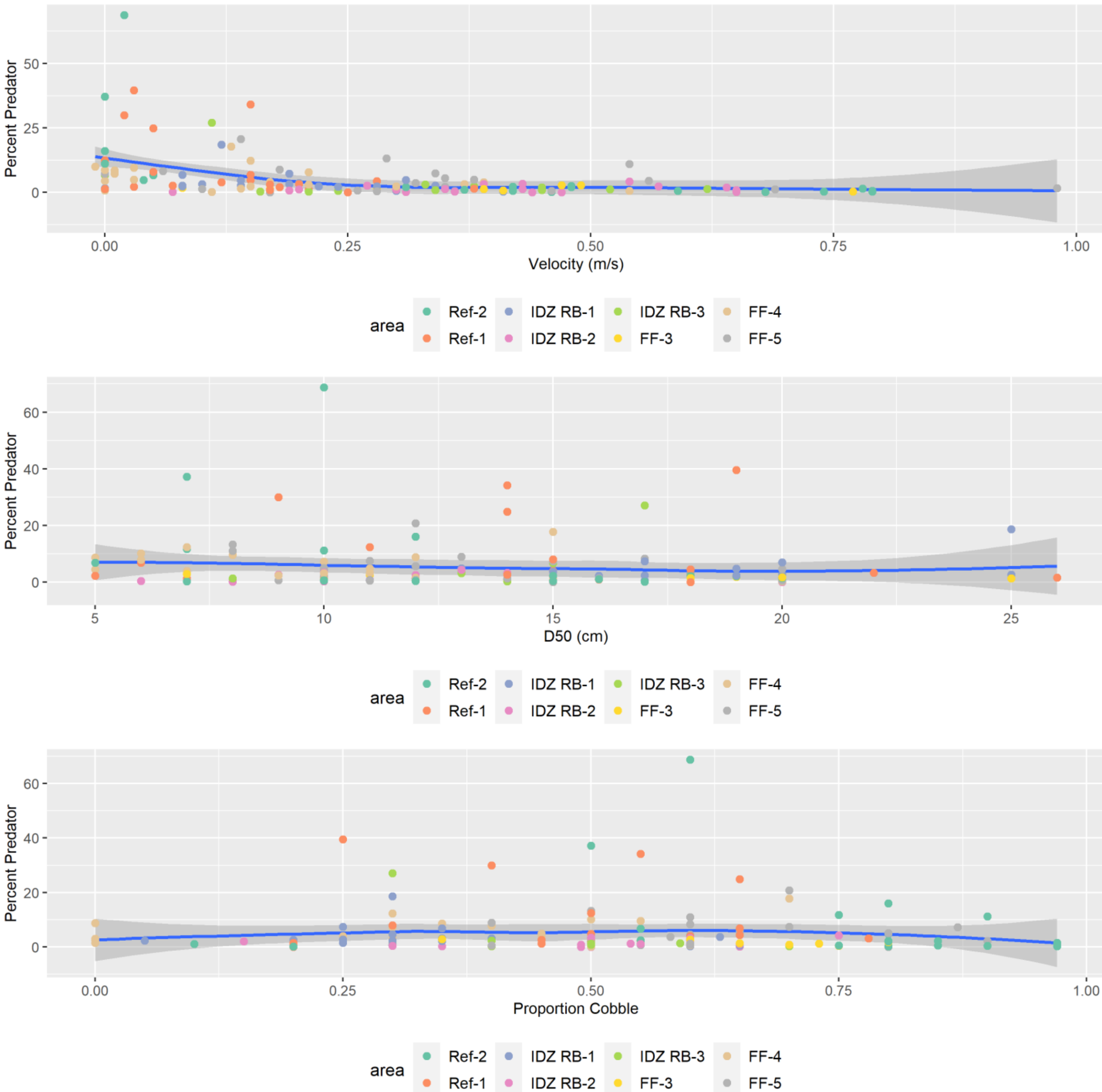


Figure 52: Explanatory variables and Percent Predator grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

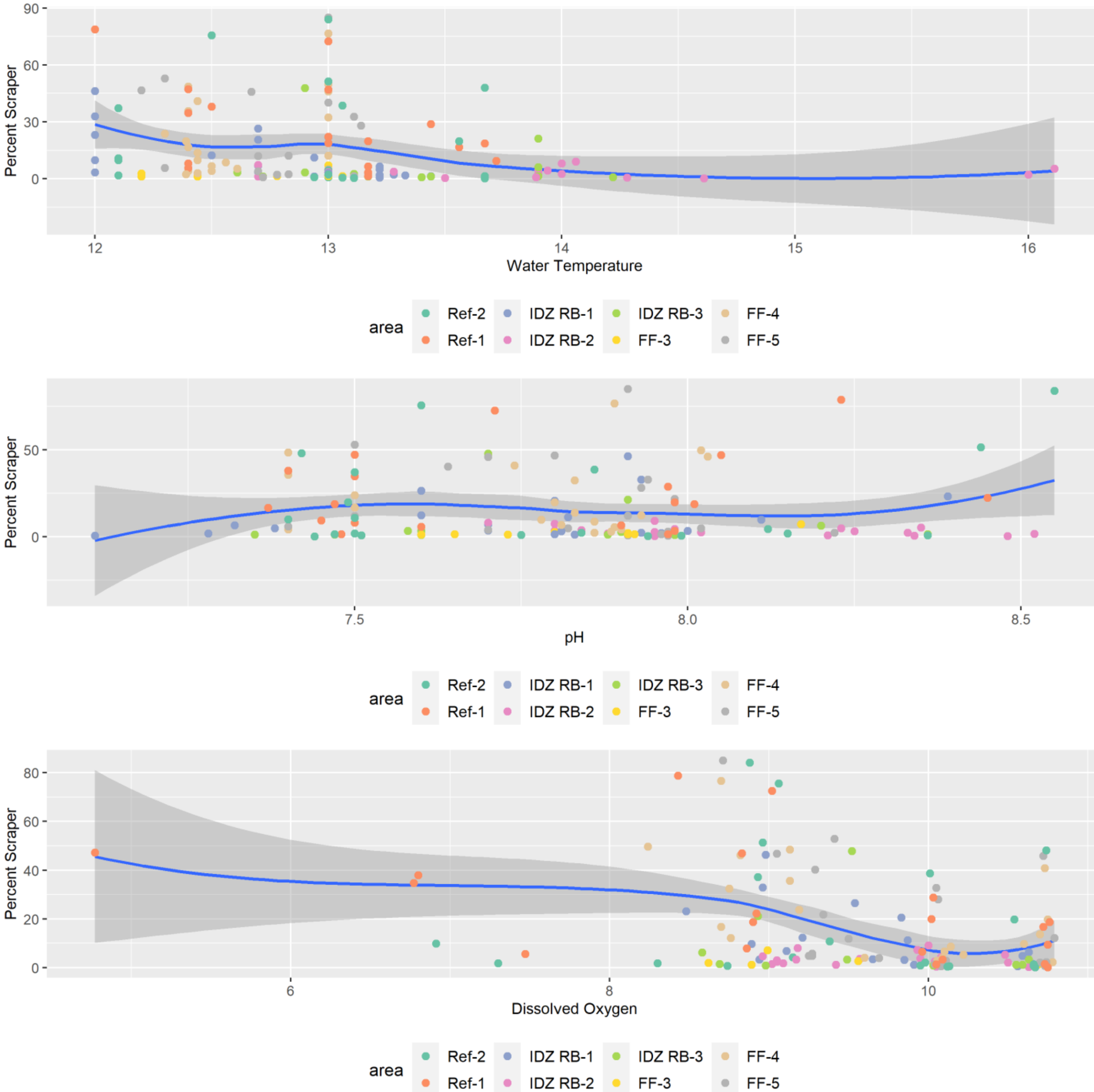


Figure 53: Explanatory variables and Percent Scraper grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

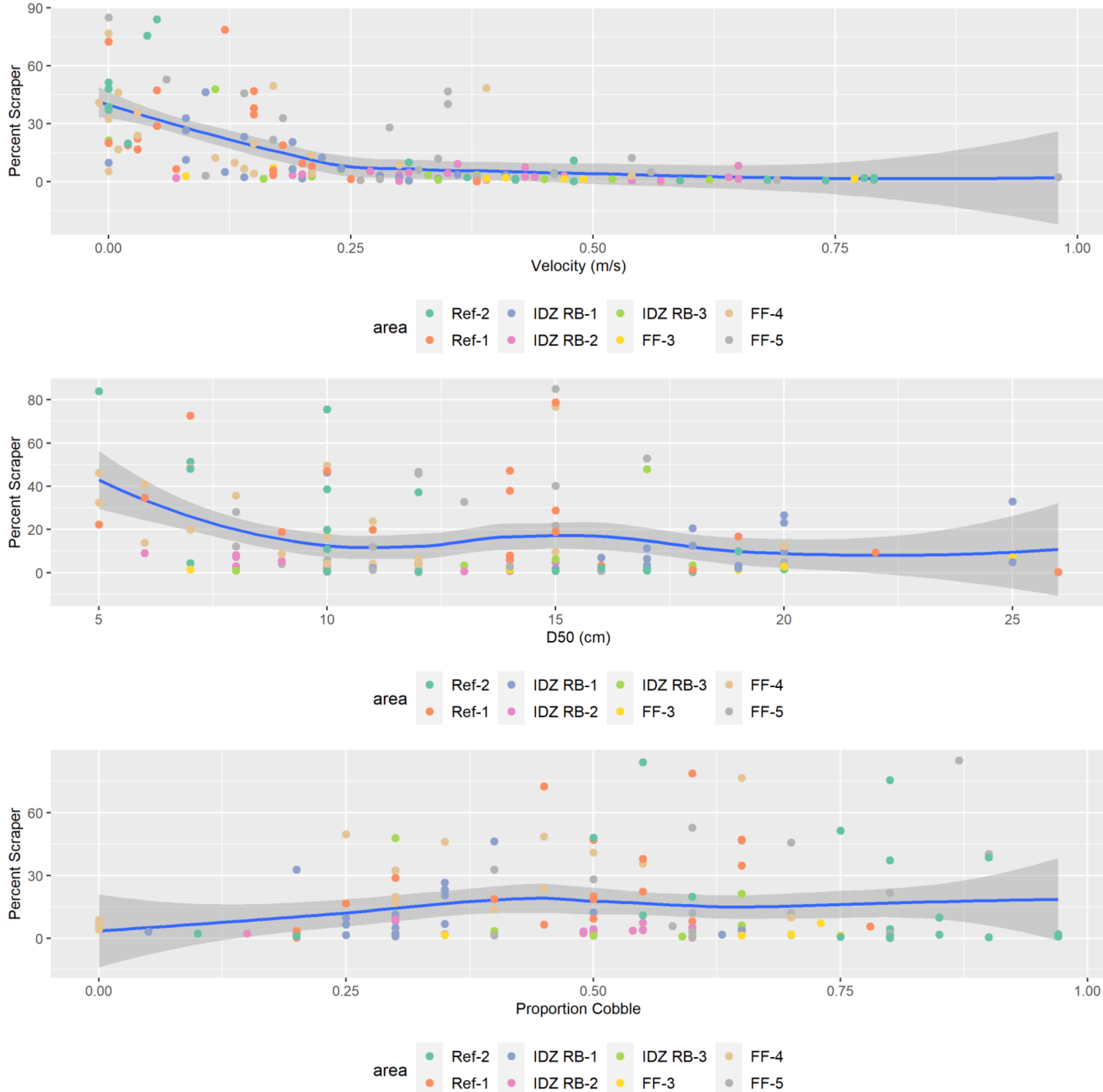


Figure 54: Explanatory variables and Percent Scraper grouped by erosional areas for 2012, 2015, 2018 and 2021 invertebrate samples.

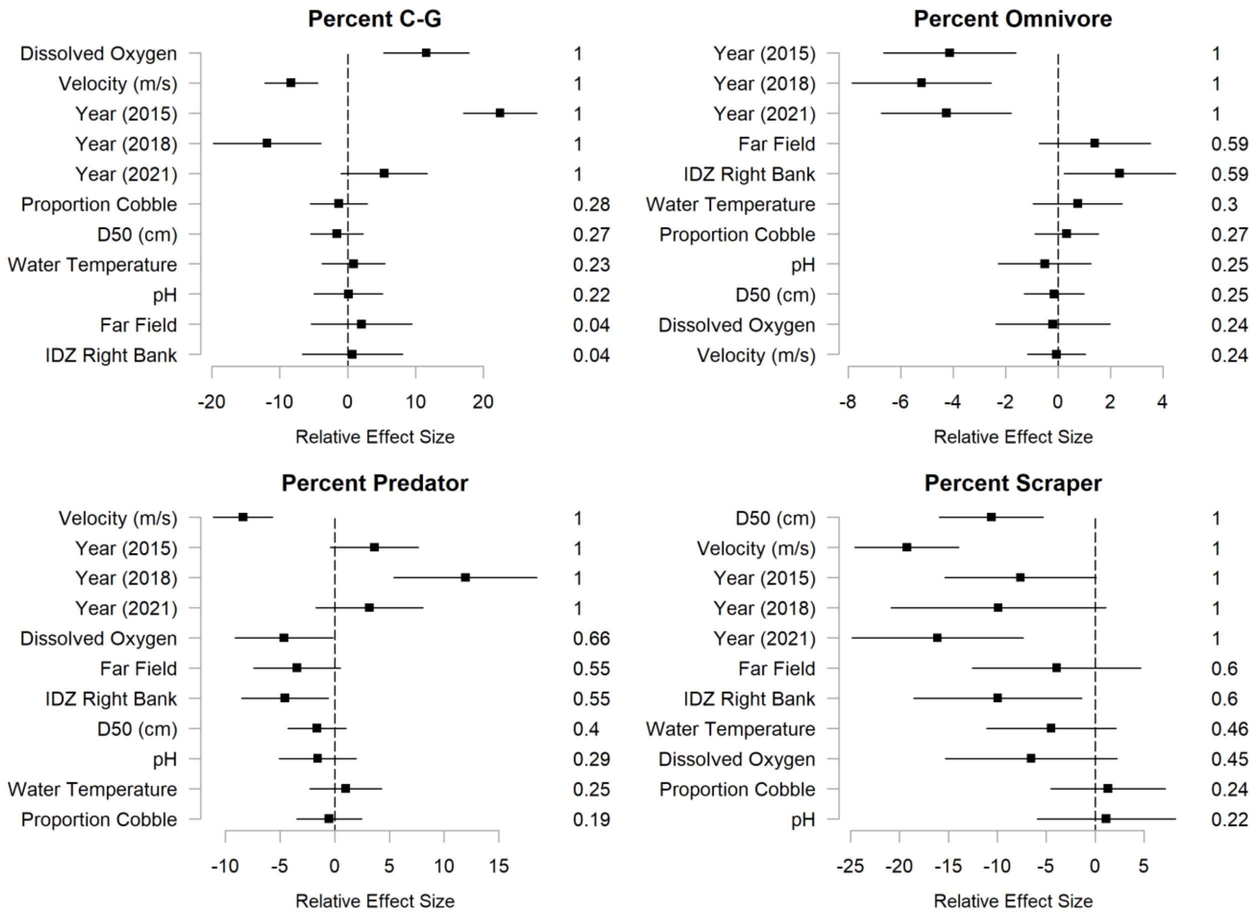


Figure 55: The coefficients and their 95% CLs of standardized explanatory variables of invertebrate erosional samples. FFG

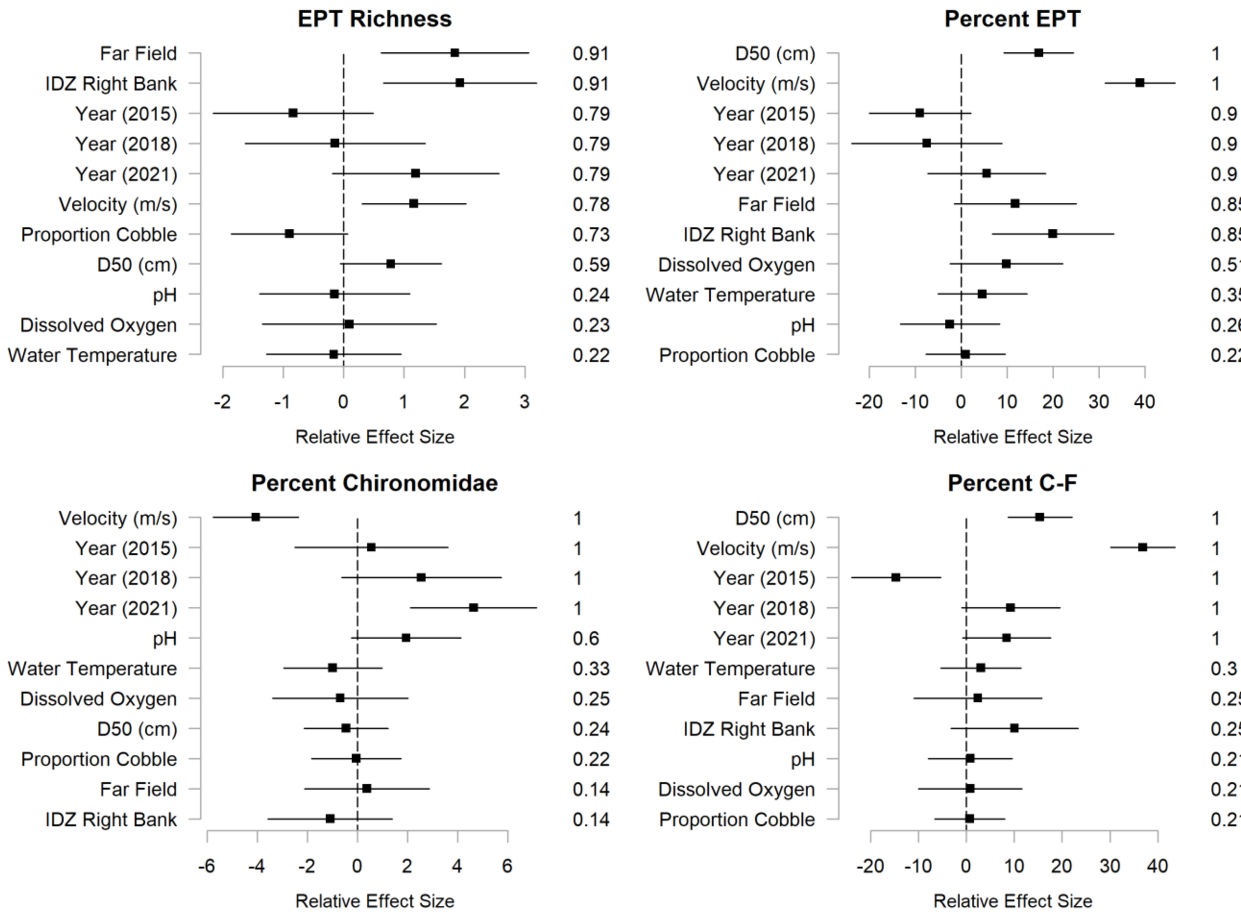


Figure 56: The coefficients and their 95% CLs of standardized explanatory variables of invertebrate erosional samples. Invertebrate responses included percent EPT, percent Chironomidae, and Shannon Evenness. Explanatory variables included D50 (substrate), Proportion of Cobble, Velocity, Water Temperature, pH, Dissolved Oxygen, Year sampled, and Site category (Reference, IDZ RB, or FF). Coefficients were standardized to allow comparisons of the direction and size of effects, noting that variables with CLs that do not cross zero influence the response variable. Key explanatory variables are those that have a relative variable importance (RVI) of or greater than 0.6-0.7. RVI is shown on the right-hand side of each figure.

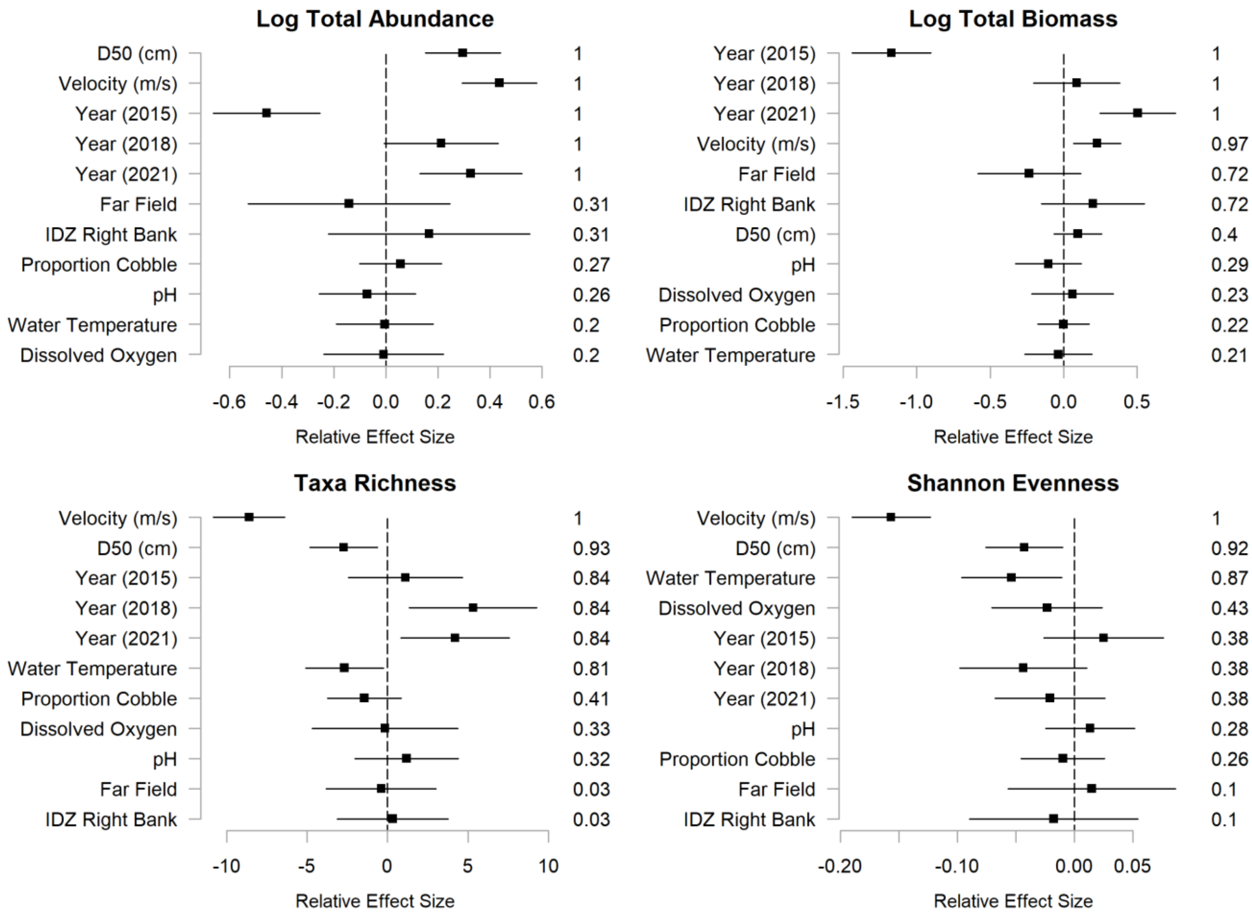


Figure 57: The coefficients and their 95% CLs of standardized explanatory variables of invertebrate erosional samples. Invertebrate responses included Log of Total abundance, biomass, taxa richness, and EPT Richness. Explanatory variables included D50 (substrate), Proportion of Cobble, Velocity, Water Temperature, pH, Dissolved Oxygen, Year sampled, and Site category (Reference, IDZ RB, or FF). Coefficients were standardized to allow comparisons of the direction and size of effects, noting that variables with CLs that do not cross zero influence the response variable. Key explanatory variables are those that have a relative variable importance (RVI) of or greater than 0.6-0.7. RVI is shown on the right-hand side of each figure.

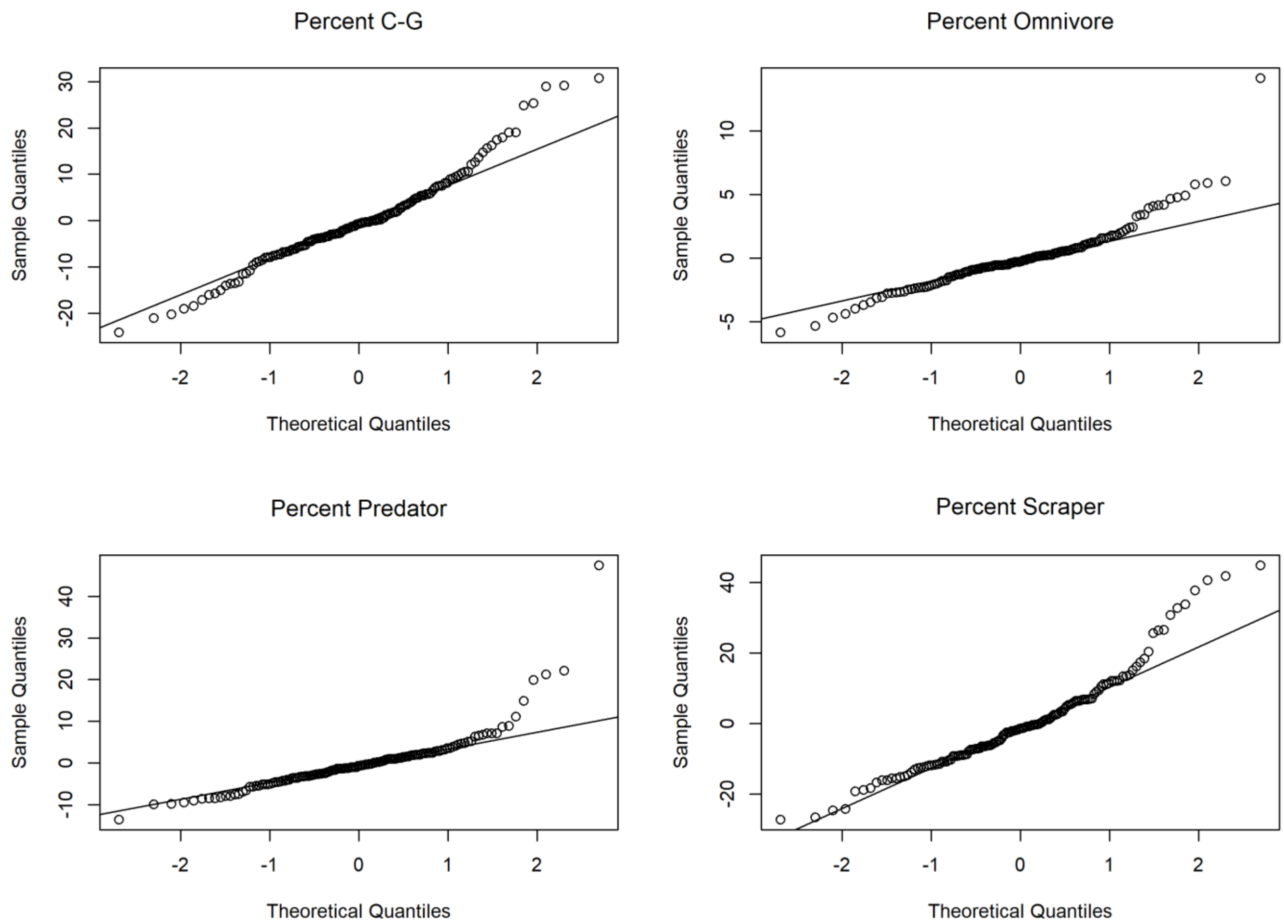


Figure 58: Quantile-Quantile plots for invertebrate models of FFG.

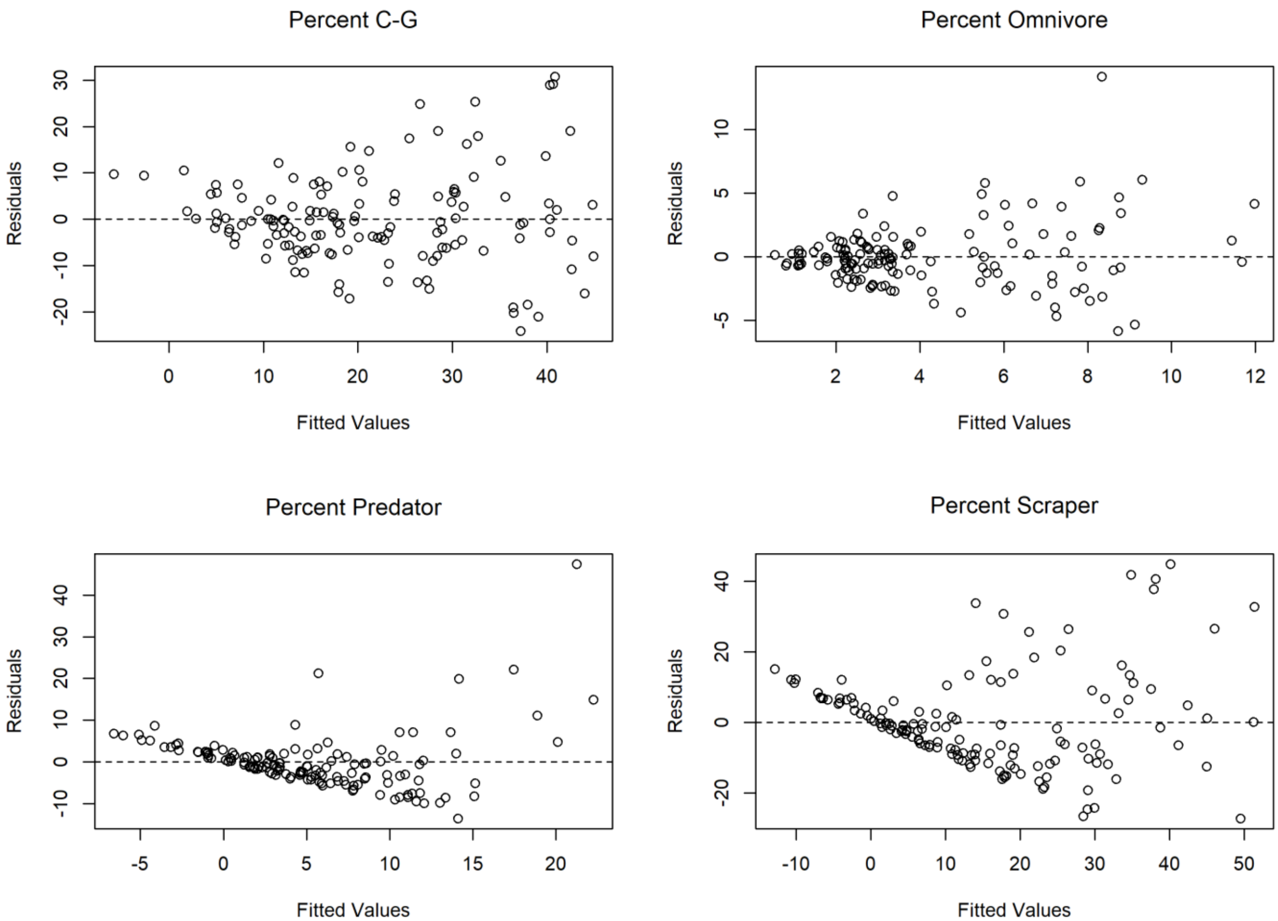


Figure 59: Residual plots for invertebrate models of FFG.

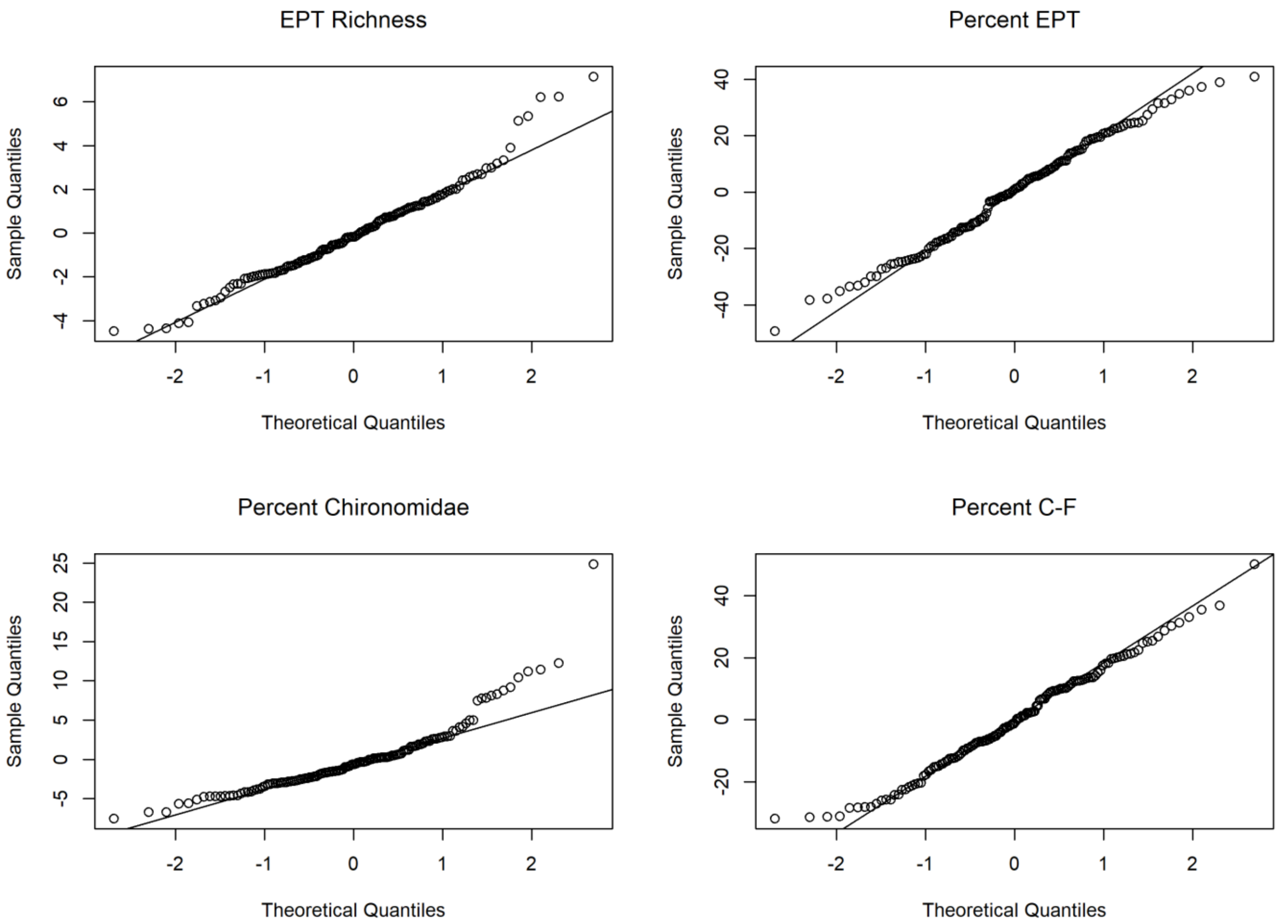


Figure 60: Quantile-Quantile plots for invertebrate models of percent EPT, percent Chironomidae, and Shannon Evenness.

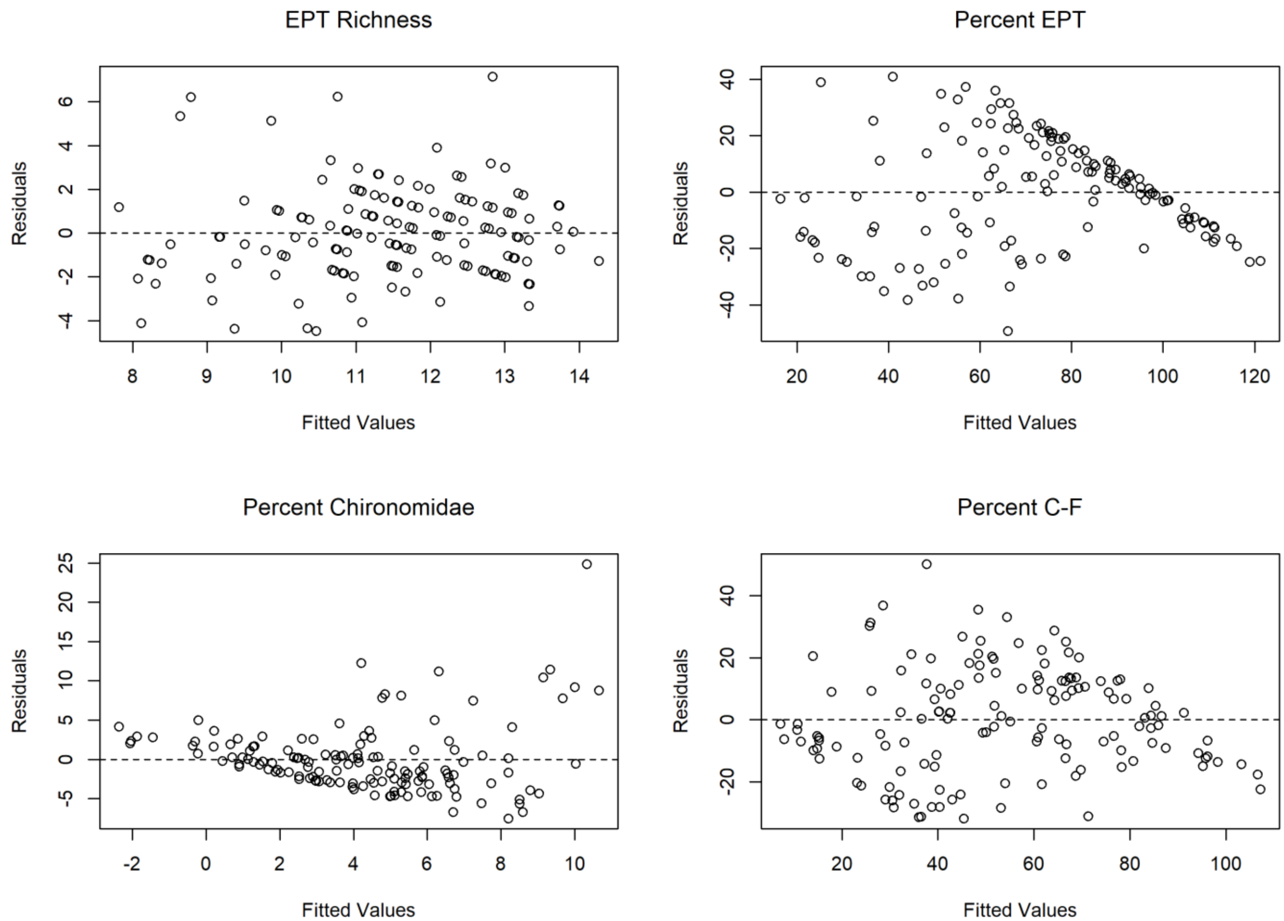


Figure 61: Residual plots for invertebrate models of percent EPT, percent Chironomidae, and Shannon Evenness.

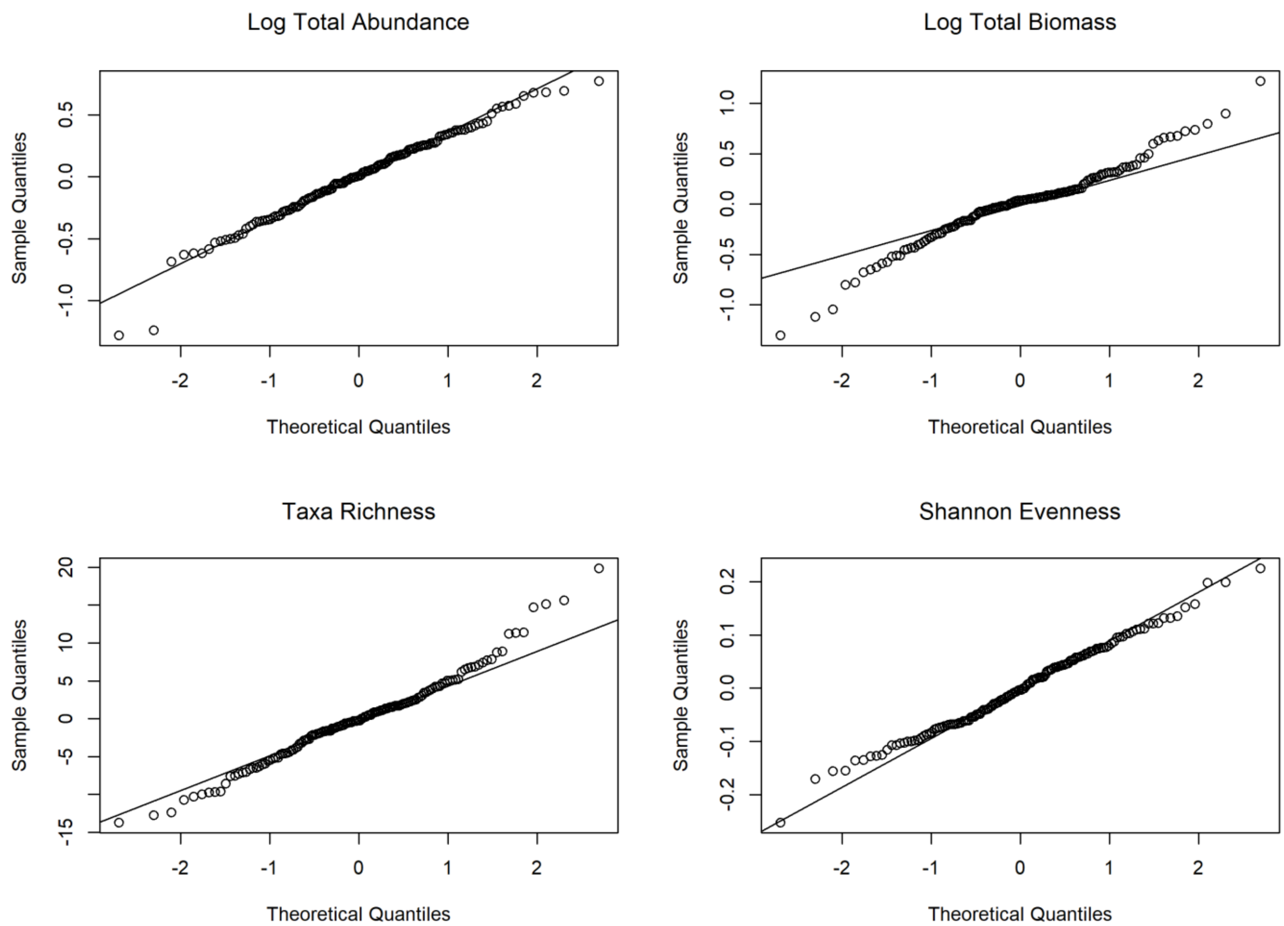


Figure 62: Quantile-Quantile plots for invertebrate models of abundance, biomass, taxa richness, and EPT Richness.

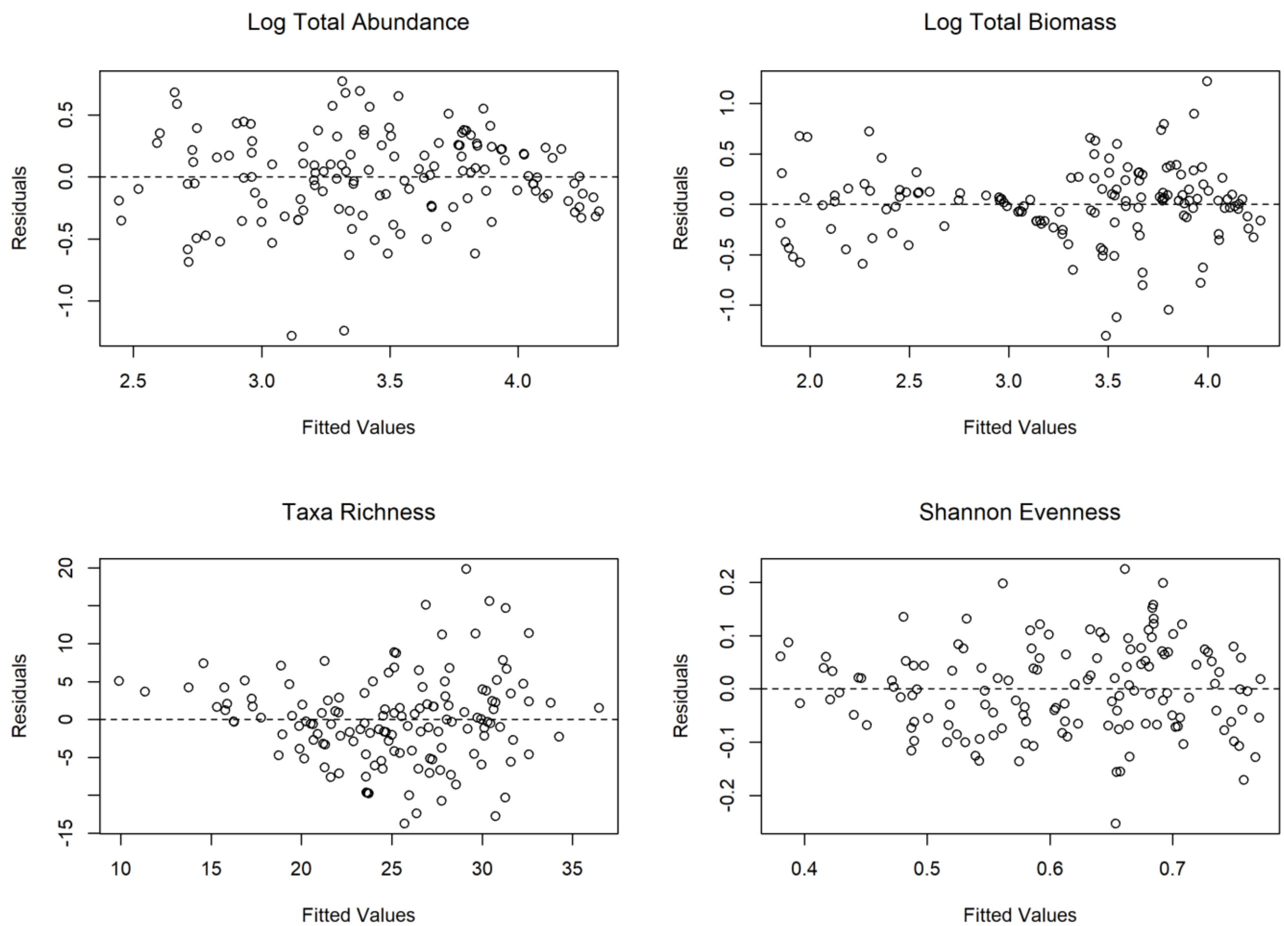


Figure 63: Residual plots for invertebrate models of abundance, biomass, taxa richness, and EPT Richness.

APPENDIX L WATER QUALITY SUPPLEMENTAL RESULTS

Table 186 Mann Kendall results for analytes in water quality samples taken in the right-hand shallows for each sampling season since 2011.

Site	Analyte	Season	n	Tau	p-Value
Birchbank	Alkalinity, Total (as CaCO3)	Spring	8	-0.071	0.902
Birchbank	Aluminum (Al)-Dissolved	Fall	8	-0.571	0.064
Birchbank	Aluminum (Al)-Dissolved	Spring	10	0.200	0.474
Birchbank	Aluminum (Al)-Dissolved	Summer	7	-0.238	0.548
Birchbank	Aluminum (Al)-Total	Fall	8	-0.357	0.266
Birchbank	Aluminum (Al)-Total	Spring	10	-0.511	0.049
Birchbank	Aluminum (Al)-Total	Summer	7	-0.143	0.764
Birchbank	Ammonia, Total (as N)	Fall	8	-0.178	0.667
Birchbank	Ammonia, Total (as N)	Spring	10	1.000	1.000
Birchbank	Ammonia, Total (as N)	Summer	7	-0.103	0.875
Birchbank	Antimony (Sb)-Dissolved	Fall	8	0.429	0.174
Birchbank	Antimony (Sb)-Dissolved	Spring	10	-0.244	0.371
Birchbank	Antimony (Sb)-Dissolved	Summer	7	0.195	0.649

Site	Analyte	Season	n	Tau	p-Value
Birchbank	Antimony (Sb)-Total	Fall	8	0.182	0.618
Birchbank	Antimony (Sb)-Total	Spring	10	-0.111	0.721
Birchbank	Antimony (Sb)-Total	Summer	7	0.050	1.000
Birchbank	Arsenic (As)-Dissolved	Fall	8	0.429	0.174
Birchbank	Arsenic (As)-Dissolved	Spring	10	-0.022	1.000
Birchbank	Arsenic (As)-Dissolved	Summer	7	0.195	0.649
Birchbank	Arsenic (As)-Total	Fall	8	0.286	0.386
Birchbank	Arsenic (As)-Total	Spring	10	-0.022	1.000
Birchbank	Arsenic (As)-Total	Summer	7	0.619	0.072
Birchbank	Barium (Ba)-Dissolved	Fall	8	0.429	0.174
Birchbank	Barium (Ba)-Dissolved	Spring	10	0.022	1.000
Birchbank	Barium (Ba)-Dissolved	Summer	7	0.781	0.023
Birchbank	Barium (Ba)-Total	Fall	8	0.546	0.081
Birchbank	Barium (Ba)-Total	Spring	10	0.022	1.000
Birchbank	Barium (Ba)-Total	Summer	7	0.429	0.230
Birchbank	Beryllium (Be)-Dissolved	Fall	8	-0.655	0.067
Birchbank	Beryllium (Be)-Dissolved	Spring	10	-0.596	0.050
Birchbank	Beryllium (Be)-Dissolved	Summer	7	-0.690	0.081
Birchbank	Beryllium (Be)-Total	Fall	8	-0.732	0.037
Birchbank	Beryllium (Be)-Total	Spring	10	-0.637	0.024
Birchbank	Beryllium (Be)-Total	Summer	7	-0.756	0.052
Birchbank	Bismuth (Bi)-Dissolved	Fall	8	-0.357	0.383
Birchbank	Bismuth (Bi)-Dissolved	Spring	10	-0.149	0.728
Birchbank	Bismuth (Bi)-Dissolved	Summer	7	-0.356	0.453
Birchbank	Bismuth (Bi)-Total	Fall	8	-0.357	0.383
Birchbank	Bismuth (Bi)-Total	Spring	10	0.108	0.796
Birchbank	Bismuth (Bi)-Total	Summer	7	-0.356	0.453
Birchbank	Boron (B)-Dissolved	Fall	8	<0.001	1.000
Birchbank	Boron (B)-Dissolved	Spring	10	0.083	0.841
Birchbank	Boron (B)-Dissolved	Summer	7	-0.252	0.596
Birchbank	Boron (B)-Total	Fall	8	1.000	1.000
Birchbank	Boron (B)-Total	Spring	10	-0.447	0.164
Birchbank	Boron (B)-Total	Summer	7	1.000	1.000
Birchbank	Bromide (Br)	Fall	7	1.000	1.000
Birchbank	Bromide (Br)	Spring	10	0.447	0.164
Birchbank	Bromide (Br)	Summer	7	1.000	1.000
Birchbank	Cadmium (Cd)-Dissolved	Fall	8	0.182	0.618
Birchbank	Cadmium (Cd)-Dissolved	Spring	10	0.156	0.592
Birchbank	Cadmium (Cd)-Dissolved	Summer	7	0.048	1.000
Birchbank	Cadmium (Cd)-Total	Fall	8	-0.143	0.711
Birchbank	Cadmium (Cd)-Total	Spring	10	-0.111	0.721
Birchbank	Cadmium (Cd)-Total	Summer	7	-0.048	1.000
Birchbank	Calcium (Ca)-Dissolved	Fall	8	-0.231	0.521
Birchbank	Calcium (Ca)-Dissolved	Spring	10	0.022	1.000
Birchbank	Calcium (Ca)-Dissolved	Summer	7	-0.238	0.548
Birchbank	Calcium (Ca)-Total	Fall	8	-0.214	0.536
Birchbank	Calcium (Ca)-Total	Spring	10	-0.111	0.721
Birchbank	Calcium (Ca)-Total	Summer	7	0.429	0.230

Site	Analyte	Season	n	Tau	p-Value
Birchbank	Chloride (Cl)	Fall	7	0.488	0.172
Birchbank	Chloride (Cl)	Spring	10	0.244	0.371
Birchbank	Chloride (Cl)	Summer	7	0.592	0.128
Birchbank	Chromium (Cr)-Dissolved	Fall	8	1.000	1.000
Birchbank	Chromium (Cr)-Dissolved	Spring	10	-0.447	0.164
Birchbank	Chromium (Cr)-Dissolved	Summer	7	1.000	1.000
Birchbank	Chromium (Cr)-Total	Fall	8	1.000	1.000
Birchbank	Chromium (Cr)-Total	Spring	10	-0.108	0.796
Birchbank	Chromium (Cr)-Total	Summer	7	1.000	1.000
Birchbank	Cobalt (Co)-Dissolved	Fall	8	0.109	0.803
Birchbank	Cobalt (Co)-Dissolved	Spring	10	0.289	0.283
Birchbank	Cobalt (Co)-Dissolved	Summer	7	0.048	1.000
Birchbank	Cobalt (Co)-Total	Fall	8	-0.071	0.902
Birchbank	Cobalt (Co)-Total	Spring	10	-0.225	0.419
Birchbank	Cobalt (Co)-Total	Summer	7	0.195	0.649
Birchbank	Conductivity	Spring	8	0.357	0.266
Birchbank	Copper (Cu)-Dissolved	Fall	8	0.691	0.025
Birchbank	Copper (Cu)-Dissolved	Spring	10	-0.111	0.721
Birchbank	Copper (Cu)-Dissolved	Summer	7	-0.050	1.000
Birchbank	Copper (Cu)-Total	Fall	8	-0.214	0.536
Birchbank	Copper (Cu)-Total	Spring	10	-0.584	0.025
Birchbank	Copper (Cu)-Total	Summer	7	0.098	0.879
Birchbank	Fluoride (F)	Fall	7	0.619	0.072
Birchbank	Fluoride (F)	Spring	10	0.068	0.857
Birchbank	Fluoride (F)	Summer	7	0.514	0.158
Birchbank	Hardness (as CaCO3)	Fall	8	-0.255	0.454
Birchbank	Hardness (as CaCO3)	Spring	10	0.156	0.592
Birchbank	Hardness (as CaCO3)	Summer	7	-0.048	1.000
Birchbank	Iron (Fe)-Dissolved	Fall	8	0.327	0.319
Birchbank	Iron (Fe)-Dissolved	Spring	10	0.022	1.000
Birchbank	Iron (Fe)-Dissolved	Summer	7	0.143	0.764
Birchbank	Iron (Fe)-Total	Fall	8	0.182	0.618
Birchbank	Iron (Fe)-Total	Spring	10	-0.333	0.210
Birchbank	Iron (Fe)-Total	Summer	7	0.238	0.548
Birchbank	Lead (Pb)-Dissolved	Fall	8	-0.400	0.212
Birchbank	Lead (Pb)-Dissolved	Spring	10	-0.022	1.000
Birchbank	Lead (Pb)-Dissolved	Summer	7	-0.048	1.000
Birchbank	Lead (Pb)-Total	Fall	8	0.036	1.000
Birchbank	Lead (Pb)-Total	Spring	10	-0.556	0.032
Birchbank	Lead (Pb)-Total	Summer	7	0.143	0.764
Birchbank	Lithium (Li)-Dissolved	Fall	8	0.286	0.386
Birchbank	Lithium (Li)-Dissolved	Spring	10	0.289	0.283
Birchbank	Lithium (Li)-Dissolved	Summer	7	0.390	0.288
Birchbank	Lithium (Li)-Total	Fall	8	0.255	0.454
Birchbank	Lithium (Li)-Total	Spring	10	0.244	0.371
Birchbank	Lithium (Li)-Total	Summer	7	0.619	0.072
Birchbank	Magnesium (Mg)-Dissolved	Fall	8	-0.036	1.000
Birchbank	Magnesium (Mg)-Dissolved	Spring	10	0.333	0.210

Site	Analyte	Season	n	Tau	p-Value
Birchbank	Magnesium (Mg)-Dissolved	Summer	7	0.333	0.368
Birchbank	Magnesium (Mg)-Total	Fall	8	<0.001	1.000
Birchbank	Magnesium (Mg)-Total	Spring	10	0.467	0.074
Birchbank	Magnesium (Mg)-Total	Summer	7	0.429	0.230
Birchbank	Manganese (Mn)-Dissolved	Fall	8	-0.143	0.711
Birchbank	Manganese (Mn)-Dissolved	Spring	10	0.467	0.074
Birchbank	Manganese (Mn)-Dissolved	Summer	7	-0.098	0.879
Birchbank	Manganese (Mn)-Total	Fall	8	0.071	0.902
Birchbank	Manganese (Mn)-Total	Spring	10	-0.333	0.210
Birchbank	Manganese (Mn)-Total	Summer	7	0.048	1.000
Birchbank	Mercury (Hg)-Dissolved	Fall	8	1.000	1.000
Birchbank	Mercury (Hg)-Dissolved	Spring	10	-0.183	0.578
Birchbank	Mercury (Hg)-Dissolved	Summer	7	1.000	1.000
Birchbank	Mercury (Hg)-Total	Fall	8	-0.500	0.190
Birchbank	Mercury (Hg)-Total	Spring	10	-0.122	0.738
Birchbank	Mercury (Hg)-Total	Summer	7	1.000	1.000
Birchbank	Molybdenum (Mo)-Dissolved	Fall	8	0.286	0.386
Birchbank	Molybdenum (Mo)-Dissolved	Spring	10	-0.067	0.858
Birchbank	Molybdenum (Mo)-Dissolved	Summer	7	-0.333	0.368
Birchbank	Molybdenum (Mo)-Total	Fall	8	0.286	0.386
Birchbank	Molybdenum (Mo)-Total	Spring	10	0.333	0.210
Birchbank	Molybdenum (Mo)-Total	Summer	7	0.238	0.548
Birchbank	Nickel (Ni)-Dissolved	Fall	8	0.327	0.319
Birchbank	Nickel (Ni)-Dissolved	Spring	10	0.422	0.107
Birchbank	Nickel (Ni)-Dissolved	Summer	7	0.524	0.133
Birchbank	Nickel (Ni)-Total	Fall	8	0.143	0.711
Birchbank	Nickel (Ni)-Total	Spring	10	0.289	0.283
Birchbank	Nickel (Ni)-Total	Summer	7	0.810	0.016
Birchbank	Nitrate (as N)	Fall	7	0.238	0.548
Birchbank	Nitrate (as N)	Spring	10	-0.244	0.371
Birchbank	pH	Spring	8	-0.357	0.266
Birchbank	Phosphorus (P)-Dissolved	Fall	7	1.000	1.000
Birchbank	Phosphorus (P)-Dissolved	Spring	9	1.000	1.000
Birchbank	Phosphorus (P)-Total	Fall	8	-0.400	0.212
Birchbank	Phosphorus (P)-Total	Spring	10	-0.689	0.007
Birchbank	Phosphorus (P)-Total	Summer	7	-0.619	0.072
Birchbank	Phosphorus (P)-Total Dissolved	Fall	8	0.157	0.742
Birchbank	Phosphorus (P)-Total Dissolved	Spring	10	0.501	0.064
Birchbank	Phosphorus (P)-Total Dissolved	Summer	7	0.197	0.704
Birchbank	Potassium (K)-Dissolved	Fall	8	-0.286	0.386
Birchbank	Potassium (K)-Dissolved	Spring	10	0.156	0.592
Birchbank	Potassium (K)-Dissolved	Summer	7	-0.619	0.072
Birchbank	Potassium (K)-Total	Fall	8	-0.327	0.319
Birchbank	Potassium (K)-Total	Spring	10	0.200	0.474
Birchbank	Potassium (K)-Total	Summer	7	-0.333	0.368
Birchbank	Selenium (Se)-Dissolved	Fall	8	0.546	0.081
Birchbank	Selenium (Se)-Dissolved	Spring	10	0.244	0.371
Birchbank	Selenium (Se)-Dissolved	Summer	7	0.524	0.133

Site	Analyte	Season	n	Tau	p-Value
Birchbank	Selenium (Se)-Total	Fall	8	0.714	0.019
Birchbank	Selenium (Se)-Total	Spring	10	0.244	0.371
Birchbank	Selenium (Se)-Total	Summer	7	0.524	0.133
Birchbank	Silicon (Si)-Dissolved	Fall	8	-0.182	0.618
Birchbank	Silicon (Si)-Dissolved	Spring	10	-0.022	1.000
Birchbank	Silicon (Si)-Dissolved	Summer	7	0.143	0.764
Birchbank	Silicon (Si)-Total	Fall	8	-0.143	0.711
Birchbank	Silicon (Si)-Total	Spring	10	0.067	0.858
Birchbank	Silicon (Si)-Total	Summer	7	0.238	0.548
Birchbank	Silver (Ag)-Dissolved	Fall	8	1.000	1.000
Birchbank	Silver (Ag)-Dissolved	Spring	10	1.000	1.000
Birchbank	Silver (Ag)-Dissolved	Summer	7	1.000	1.000
Birchbank	Silver (Ag)-Total	Fall	8	0.071	1.000
Birchbank	Silver (Ag)-Total	Spring	10	1.000	1.000
Birchbank	Silver (Ag)-Total	Summer	7	1.000	1.000
Birchbank	Sodium (Na)-Dissolved	Fall	8	0.546	0.081
Birchbank	Sodium (Na)-Dissolved	Spring	10	-0.067	0.858
Birchbank	Sodium (Na)-Dissolved	Summer	7	0.781	0.023
Birchbank	Sodium (Na)-Total	Fall	8	0.571	0.064
Birchbank	Sodium (Na)-Total	Spring	10	-0.067	0.858
Birchbank	Sodium (Na)-Total	Summer	7	0.714	0.035
Birchbank	Strontium (Sr)-Dissolved	Fall	8	0.036	1.000
Birchbank	Strontium (Sr)-Dissolved	Spring	10	0.644	0.012
Birchbank	Strontium (Sr)-Dissolved	Summer	7	0.714	0.035
Birchbank	Strontium (Sr)-Total	Fall	8	0.214	0.536
Birchbank	Strontium (Sr)-Total	Spring	10	0.584	0.025
Birchbank	Strontium (Sr)-Total	Summer	7	0.688	0.057
Birchbank	Sulfate (SO4)	Fall	7	0.333	0.368
Birchbank	Sulfate (SO4)	Spring	10	0.600	0.020
Birchbank	Sulfate (SO4)	Summer	7	0.586	0.095
Birchbank	Thallium (Tl)-Dissolved	Fall	8	-0.265	0.445
Birchbank	Thallium (Tl)-Dissolved	Spring	10	0.689	0.007
Birchbank	Thallium (Tl)-Dissolved	Summer	7	0.293	0.448
Birchbank	Thallium (Tl)-Total	Fall	8	-0.265	0.445
Birchbank	Thallium (Tl)-Total	Spring	10	0.511	0.049
Birchbank	Thallium (Tl)-Total	Summer	7	-0.056	1.000
Birchbank	Tin (Sn)-Dissolved	Fall	8	0.403	0.232
Birchbank	Tin (Sn)-Dissolved	Spring	10	0.360	0.178
Birchbank	Tin (Sn)-Dissolved	Summer	7	0.050	1.000
Birchbank	Tin (Sn)-Total	Fall	8	0.289	0.421
Birchbank	Tin (Sn)-Total	Spring	10	0.460	0.084
Birchbank	Tin (Sn)-Total	Summer	7	0.329	0.447
Birchbank	Titanium (Ti)-Dissolved	Fall	8	-0.845	0.010
Birchbank	Titanium (Ti)-Dissolved	Spring	10	-0.804	0.004
Birchbank	Titanium (Ti)-Dissolved	Summer	7	-0.816	0.027
Birchbank	Titanium (Ti)-Total	Fall	8	-0.267	0.474
Birchbank	Titanium (Ti)-Total	Spring	10	-0.289	0.283
Birchbank	Titanium (Ti)-Total	Summer	7	0.411	0.272

Site	Analyte	Season	n	Tau	p-Value
Birchbank	Total Dissolved Solids	Spring	8	0.109	0.803
Birchbank	Total Kjeldahl Nitrogen	Fall	8	0.036	1.000
Birchbank	Total Kjeldahl Nitrogen	Spring	9	-0.389	0.175
Birchbank	Total Kjeldahl Nitrogen	Summer	7	-0.143	0.764
Birchbank	Total Organic Carbon	Fall	7	0.905	0.007
Birchbank	Total Organic Carbon	Spring	9	-0.141	0.675
Birchbank	Total Organic Carbon	Summer	7	-0.098	0.879
Birchbank	Total Suspended Solids	Spring	8	-0.367	0.324
Birchbank	Turbidity	Fall	8	-0.546	0.081
Birchbank	Turbidity	Spring	10	-0.733	0.004
Birchbank	Turbidity	Summer	7	-0.098	0.879
Birchbank	Uranium (U)-Dissolved	Fall	8	0.214	0.536
Birchbank	Uranium (U)-Dissolved	Spring	10	0.111	0.721
Birchbank	Uranium (U)-Dissolved	Summer	7	0.683	0.048
Birchbank	Uranium (U)-Total	Fall	8	0.214	0.536
Birchbank	Uranium (U)-Total	Spring	10	0.067	0.858
Birchbank	Uranium (U)-Total	Summer	7	0.238	0.548
Birchbank	Vanadium (V)-Dissolved	Fall	8	0.286	0.386
Birchbank	Vanadium (V)-Dissolved	Spring	10	-0.111	0.721
Birchbank	Vanadium (V)-Dissolved	Summer	7	0.429	0.230
Birchbank	Vanadium (V)-Total	Fall	8	0.143	0.711
Birchbank	Vanadium (V)-Total	Spring	10	-0.022	1.000
Birchbank	Vanadium (V)-Total	Summer	7	0.683	0.048
Birchbank	Zinc (Zn)-Dissolved	Fall	8	-0.109	0.803
Birchbank	Zinc (Zn)-Dissolved	Spring	10	0.111	0.721
Birchbank	Zinc (Zn)-Dissolved	Summer	7	-0.143	0.764
Birchbank	Zinc (Zn)-Total	Fall	8	0.071	0.902
Birchbank	Zinc (Zn)-Total	Spring	10	0.067	0.858
Birchbank	Zinc (Zn)-Total	Summer	7	-0.098	0.879
Birchbank	Zirconium (Zr)-Dissolved	Fall	8	-0.321	0.385
Birchbank	Zirconium (Zr)-Dissolved	Spring	10	-0.542	0.070
Birchbank	Zirconium (Zr)-Dissolved	Summer	7	-0.394	0.315
Birchbank	Zirconium (Zr)-Total	Fall	8	-0.732	0.037
Birchbank	Zirconium (Zr)-Total	Spring	10	-0.542	0.070
Birchbank	Zirconium (Zr)-Total	Summer	7	-0.620	0.094
Maglios	Aluminum (Al)-Dissolved	Fall	7	-0.429	0.230
Maglios	Aluminum (Al)-Dissolved	Spring	8	<0.001	1.000
Maglios	Aluminum (Al)-Dissolved	Summer	7	-0.238	0.548
Maglios	Aluminum (Al)-Total	Fall	7	-0.238	0.548
Maglios	Aluminum (Al)-Total	Spring	8	-0.143	0.711
Maglios	Aluminum (Al)-Total	Summer	7	0.238	0.548
Maglios	Ammonia, Total (as N)	Fall	7	-0.619	0.072
Maglios	Ammonia, Total (as N)	Spring	8	0.143	0.711
Maglios	Ammonia, Total (as N)	Summer	7	-0.524	0.133
Maglios	Antimony (Sb)-Dissolved	Fall	7	0.048	1.000
Maglios	Antimony (Sb)-Dissolved	Spring	8	0.286	0.386
Maglios	Antimony (Sb)-Dissolved	Summer	7	0.429	0.230
Maglios	Antimony (Sb)-Total	Fall	7	0.143	0.764

Site	Analyte	Season	n	Tau	p-Value
Maglios	Antimony (Sb)-Total	Spring	8	0.214	0.536
Maglios	Antimony (Sb)-Total	Summer	7	0.238	0.548
Maglios	Arsenic (As)-Dissolved	Fall	7	0.048	1.000
Maglios	Arsenic (As)-Dissolved	Spring	8	-0.143	0.711
Maglios	Arsenic (As)-Dissolved	Summer	7	-0.048	1.000
Maglios	Arsenic (As)-Total	Fall	7	-0.098	0.879
Maglios	Arsenic (As)-Total	Spring	8	-0.286	0.386
Maglios	Arsenic (As)-Total	Summer	7	0.048	1.000
Maglios	Barium (Ba)-Dissolved	Fall	7	0.143	0.764
Maglios	Barium (Ba)-Dissolved	Spring	8	-0.143	0.711
Maglios	Barium (Ba)-Dissolved	Summer	7	0.683	0.048
Maglios	Barium (Ba)-Total	Fall	7	0.195	0.649
Maglios	Barium (Ba)-Total	Spring	8	-0.143	0.711
Maglios	Barium (Ba)-Total	Summer	7	0.524	0.133
Maglios	Beryllium (Be)-Dissolved	Fall	7	-0.690	0.081
Maglios	Beryllium (Be)-Dissolved	Spring	8	-0.655	0.067
Maglios	Beryllium (Be)-Dissolved	Summer	7	-0.690	0.081
Maglios	Beryllium (Be)-Total	Fall	7	-0.756	0.052
Maglios	Beryllium (Be)-Total	Spring	8	-0.596	0.082
Maglios	Beryllium (Be)-Total	Summer	7	-0.756	0.052
Maglios	Bismuth (Bi)-Dissolved	Fall	7	1.000	1.000
Maglios	Bismuth (Bi)-Dissolved	Spring	8	1.000	1.000
Maglios	Bismuth (Bi)-Dissolved	Summer	7	1.000	1.000
Maglios	Bismuth (Bi)-Total	Fall	7	1.000	1.000
Maglios	Bismuth (Bi)-Total	Spring	8	-0.577	0.100
Maglios	Bismuth (Bi)-Total	Summer	7	1.000	1.000
Maglios	Boron (B)-Dissolved	Fall	7	-0.252	0.596
Maglios	Boron (B)-Dissolved	Spring	8	<0.001	1.000
Maglios	Boron (B)-Dissolved	Summer	7	-0.252	0.596
Maglios	Boron (B)-Total	Fall	7	1.000	1.000
Maglios	Boron (B)-Total	Spring	8	1.000	1.000
Maglios	Boron (B)-Total	Summer	7	1.000	1.000
Maglios	Bromide (Br)	Spring	8	1.000	1.000
Maglios	Bromide (Br)	Summer	7	1.000	1.000
Maglios	Cadmium (Cd)-Dissolved	Fall	7	-0.905	0.007
Maglios	Cadmium (Cd)-Dissolved	Spring	8	-0.643	0.035
Maglios	Cadmium (Cd)-Dissolved	Summer	7	-0.238	0.548
Maglios	Cadmium (Cd)-Total	Fall	7	-0.619	0.072
Maglios	Cadmium (Cd)-Total	Spring	8	-0.571	0.064
Maglios	Cadmium (Cd)-Total	Summer	7	-0.905	0.007
Maglios	Calcium (Ca)-Dissolved	Fall	7	-0.238	0.548
Maglios	Calcium (Ca)-Dissolved	Spring	8	-0.143	0.711
Maglios	Calcium (Ca)-Dissolved	Summer	7	-0.195	0.649
Maglios	Calcium (Ca)-Total	Fall	7	-0.524	0.133
Maglios	Calcium (Ca)-Total	Spring	8	<0.001	1.000
Maglios	Calcium (Ca)-Total	Summer	7	0.333	0.368
Maglios	Chloride (Cl)	Spring	8	-0.143	0.711
Maglios	Chloride (Cl)	Summer	7	0.732	0.044

Site	Analyte	Season	n	Tau	p-Value
Maglios	Chromium (Cr)-Dissolved	Fall	7	1.000	1.000
Maglios	Chromium (Cr)-Dissolved	Spring	8	1.000	1.000
Maglios	Chromium (Cr)-Dissolved	Summer	7	1.000	1.000
Maglios	Chromium (Cr)-Total	Fall	7	1.000	1.000
Maglios	Chromium (Cr)-Total	Spring	8	0.214	0.663
Maglios	Chromium (Cr)-Total	Summer	7	1.000	1.000
Maglios	Cobalt (Co)-Dissolved	Fall	7	0.195	0.649
Maglios	Cobalt (Co)-Dissolved	Spring	8	0.286	0.386
Maglios	Cobalt (Co)-Dissolved	Summer	7	0.238	0.548
Maglios	Cobalt (Co)-Total	Fall	7	0.429	0.230
Maglios	Cobalt (Co)-Total	Spring	8	0.071	0.902
Maglios	Cobalt (Co)-Total	Summer	7	0.238	0.548
Maglios	Copper (Cu)-Dissolved	Fall	7	0.617	0.084
Maglios	Copper (Cu)-Dissolved	Spring	8	-0.714	0.019
Maglios	Copper (Cu)-Dissolved	Summer	7	-0.048	1.000
Maglios	Copper (Cu)-Total	Fall	7	0.048	1.000
Maglios	Copper (Cu)-Total	Spring	8	-0.571	0.064
Maglios	Copper (Cu)-Total	Summer	7	<0.001	1.000
Maglios	Fluoride (F)	Spring	8	-0.071	0.902
Maglios	Fluoride (F)	Summer	7	0.683	0.048
Maglios	Hardness (as CaCO3)	Fall	7	-0.333	0.368
Maglios	Hardness (as CaCO3)	Spring	8	0.071	0.902
Maglios	Hardness (as CaCO3)	Summer	7	0.098	0.879
Maglios	Iron (Fe)-Dissolved	Fall	7	0.098	0.879
Maglios	Iron (Fe)-Dissolved	Spring	8	<0.001	1.000
Maglios	Iron (Fe)-Dissolved	Summer	7	0.103	0.875
Maglios	Iron (Fe)-Total	Fall	7	0.333	0.368
Maglios	Iron (Fe)-Total	Spring	8	-0.143	0.711
Maglios	Iron (Fe)-Total	Summer	7	0.238	0.548
Maglios	Lead (Pb)-Dissolved	Fall	7	-0.293	0.448
Maglios	Lead (Pb)-Dissolved	Spring	8	-0.357	0.266
Maglios	Lead (Pb)-Dissolved	Summer	7	0.238	0.548
Maglios	Lead (Pb)-Total	Fall	7	-0.048	1.000
Maglios	Lead (Pb)-Total	Spring	8	-0.500	0.108
Maglios	Lead (Pb)-Total	Summer	7	0.143	0.764
Maglios	Lithium (Li)-Dissolved	Fall	7	0.150	0.759
Maglios	Lithium (Li)-Dissolved	Spring	8	<0.001	1.000
Maglios	Lithium (Li)-Dissolved	Summer	7	0.524	0.133
Maglios	Lithium (Li)-Total	Fall	7	0.098	0.879
Maglios	Lithium (Li)-Total	Spring	8	0.071	0.902
Maglios	Lithium (Li)-Total	Summer	7	0.619	0.072
Maglios	Magnesium (Mg)-Dissolved	Fall	7	-0.333	0.368
Maglios	Magnesium (Mg)-Dissolved	Spring	8	0.429	0.174
Maglios	Magnesium (Mg)-Dissolved	Summer	7	0.143	0.764
Maglios	Magnesium (Mg)-Total	Fall	7	-0.714	0.035
Maglios	Magnesium (Mg)-Total	Spring	8	0.500	0.108
Maglios	Magnesium (Mg)-Total	Summer	7	0.429	0.230
Maglios	Manganese (Mn)-Dissolved	Fall	7	0.048	1.000

Site	Analyte	Season	n	Tau	p-Value
Maglios	Manganese (Mn)-Dissolved	Spring	8	0.071	0.902
Maglios	Manganese (Mn)-Dissolved	Summer	7	0.048	1.000
Maglios	Manganese (Mn)-Total	Fall	7	-0.143	0.764
Maglios	Manganese (Mn)-Total	Spring	8	<0.001	1.000
Maglios	Manganese (Mn)-Total	Summer	7	-0.048	1.000
Maglios	Mercury (Hg)-Dissolved	Fall	7	1.000	1.000
Maglios	Mercury (Hg)-Dissolved	Spring	8	-0.472	0.188
Maglios	Mercury (Hg)-Dissolved	Summer	7	1.000	1.000
Maglios	Mercury (Hg)-Total	Fall	7	0.066	1.000
Maglios	Mercury (Hg)-Total	Spring	8	-0.571	0.064
Maglios	Mercury (Hg)-Total	Summer	7	0.178	0.803
Maglios	Molybdenum (Mo)-Dissolved	Fall	7	0.143	0.764
Maglios	Molybdenum (Mo)-Dissolved	Spring	8	-0.214	0.536
Maglios	Molybdenum (Mo)-Dissolved	Summer	7	<0.001	1.000
Maglios	Molybdenum (Mo)-Total	Fall	7	0.238	0.548
Maglios	Molybdenum (Mo)-Total	Spring	8	-0.286	0.386
Maglios	Molybdenum (Mo)-Total	Summer	7	-0.048	1.000
Maglios	Nickel (Ni)-Dissolved	Fall	7	-0.143	0.764
Maglios	Nickel (Ni)-Dissolved	Spring	8	0.714	0.019
Maglios	Nickel (Ni)-Dissolved	Summer	7	0.143	0.764
Maglios	Nickel (Ni)-Total	Fall	7	<0.001	1.000
Maglios	Nickel (Ni)-Total	Spring	8	0.643	0.035
Maglios	Nickel (Ni)-Total	Summer	7	0.048	1.000
Maglios	Nitrate (as N)	Spring	8	-0.071	0.902
Maglios	Phosphorus (P)-Dissolved	Spring	7	1.000	1.000
Maglios	Phosphorus (P)-Total	Fall	7	-0.238	0.548
Maglios	Phosphorus (P)-Total	Spring	8	-0.643	0.035
Maglios	Phosphorus (P)-Total	Summer	7	-0.586	0.095
Maglios	Phosphorus (P)-Total Dissolved	Fall	7	0.394	0.315
Maglios	Phosphorus (P)-Total Dissolved	Spring	8	0.945	0.002
Maglios	Phosphorus (P)-Total Dissolved	Summer	7	0.356	0.453
Maglios	Potassium (K)-Dissolved	Fall	7	0.143	0.764
Maglios	Potassium (K)-Dissolved	Spring	8	0.071	0.902
Maglios	Potassium (K)-Dissolved	Summer	7	-0.048	1.000
Maglios	Potassium (K)-Total	Fall	7	-0.048	1.000
Maglios	Potassium (K)-Total	Spring	8	0.214	0.536
Maglios	Potassium (K)-Total	Summer	7	0.429	0.230
Maglios	Selenium (Se)-Dissolved	Fall	7	0.195	0.649
Maglios	Selenium (Se)-Dissolved	Spring	8	-0.143	0.711
Maglios	Selenium (Se)-Dissolved	Summer	7	0.429	0.230
Maglios	Selenium (Se)-Total	Fall	7	0.143	0.764
Maglios	Selenium (Se)-Total	Spring	8	-0.071	0.902
Maglios	Selenium (Se)-Total	Summer	7	0.714	0.035
Maglios	Silicon (Si)-Dissolved	Fall	7	0.048	1.000
Maglios	Silicon (Si)-Dissolved	Spring	8	-0.357	0.266
Maglios	Silicon (Si)-Dissolved	Summer	7	0.143	0.764
Maglios	Silicon (Si)-Total	Fall	7	-0.238	0.548
Maglios	Silicon (Si)-Total	Spring	8	-0.214	0.536

Site	Analyte	Season	n	Tau	p-Value
Maglios	Silicon (Si)-Total	Summer	7	0.333	0.368
Maglios	Silver (Ag)-Dissolved	Fall	7	1.000	1.000
Maglios	Silver (Ag)-Dissolved	Spring	8	1.000	1.000
Maglios	Silver (Ag)-Dissolved	Summer	7	1.000	1.000
Maglios	Silver (Ag)-Total	Fall	7	1.000	1.000
Maglios	Silver (Ag)-Total	Spring	8	-0.713	0.032
Maglios	Silver (Ag)-Total	Summer	7	1.000	1.000
Maglios	Sodium (Na)-Dissolved	Fall	7	0.429	0.230
Maglios	Sodium (Na)-Dissolved	Spring	8	-0.071	0.902
Maglios	Sodium (Na)-Dissolved	Summer	7	0.619	0.072
Maglios	Sodium (Na)-Total	Fall	7	0.488	0.172
Maglios	Sodium (Na)-Total	Spring	8	0.036	1.000
Maglios	Sodium (Na)-Total	Summer	7	0.810	0.016
Maglios	Strontium (Sr)-Dissolved	Fall	7	-0.333	0.368
Maglios	Strontium (Sr)-Dissolved	Spring	8	0.643	0.035
Maglios	Strontium (Sr)-Dissolved	Summer	7	0.976	0.004
Maglios	Strontium (Sr)-Total	Fall	7	-0.390	0.288
Maglios	Strontium (Sr)-Total	Spring	8	0.764	0.013
Maglios	Strontium (Sr)-Total	Summer	7	0.878	0.010
Maglios	Sulfate (SO4)	Spring	8	0.643	0.042
Maglios	Sulfate (SO4)	Summer	7	0.586	0.095
Maglios	Thallium (Tl)-Dissolved	Fall	7	-0.143	0.764
Maglios	Thallium (Tl)-Dissolved	Spring	8	0.214	0.536
Maglios	Thallium (Tl)-Dissolved	Summer	7	0.810	0.016
Maglios	Thallium (Tl)-Total	Fall	7	-0.143	0.764
Maglios	Thallium (Tl)-Total	Spring	8	0.255	0.454
Maglios	Thallium (Tl)-Total	Summer	7	0.905	0.007
Maglios	Tin (Sn)-Dissolved	Fall	7	0.350	0.396
Maglios	Tin (Sn)-Dissolved	Spring	8	0.619	0.061
Maglios	Tin (Sn)-Dissolved	Summer	7	0.690	0.081
Maglios	Tin (Sn)-Total	Fall	7	0.535	0.211
Maglios	Tin (Sn)-Total	Spring	8	0.681	0.048
Maglios	Tin (Sn)-Total	Summer	7	0.535	0.211
Maglios	Titanium (Ti)-Dissolved	Fall	7	-0.816	0.027
Maglios	Titanium (Ti)-Dissolved	Spring	8	-0.845	0.010
Maglios	Titanium (Ti)-Dissolved	Summer	7	-0.816	0.027
Maglios	Titanium (Ti)-Total	Fall	7	-0.206	0.638
Maglios	Titanium (Ti)-Total	Spring	8	-0.255	0.454
Maglios	Titanium (Ti)-Total	Summer	7	0.620	0.094
Maglios	Total Kjeldahl Nitrogen	Fall	7	-0.429	0.230
Maglios	Total Kjeldahl Nitrogen	Spring	8	-0.714	0.019
Maglios	Total Kjeldahl Nitrogen	Summer	7	-0.781	0.023
Maglios	Total Organic Carbon	Fall	7	0.488	0.172
Maglios	Total Organic Carbon	Spring	8	0.036	1.000
Maglios	Total Organic Carbon	Summer	7	<0.001	1.000
Maglios	Turbidity	Fall	7	-0.488	0.172
Maglios	Turbidity	Spring	8	-0.429	0.174
Maglios	Turbidity	Summer	7	-0.429	0.230

Site	Analyte	Season	n	Tau	p-Value
Maglios	Uranium (U)-Dissolved	Fall	7	0.238	0.548
Maglios	Uranium (U)-Dissolved	Spring	8	-0.214	0.536
Maglios	Uranium (U)-Dissolved	Summer	7	0.714	0.035
Maglios	Uranium (U)-Total	Fall	7	0.143	0.764
Maglios	Uranium (U)-Total	Spring	8	-0.143	0.711
Maglios	Uranium (U)-Total	Summer	7	0.238	0.548
Maglios	Vanadium (V)-Dissolved	Fall	7	0.238	0.548
Maglios	Vanadium (V)-Dissolved	Spring	8	-0.214	0.536
Maglios	Vanadium (V)-Dissolved	Summer	7	0.333	0.368
Maglios	Vanadium (V)-Total	Fall	7	0.206	0.638
Maglios	Vanadium (V)-Total	Spring	8	-0.071	0.902
Maglios	Vanadium (V)-Total	Summer	7	0.429	0.230
Maglios	Zinc (Zn)-Dissolved	Fall	7	0.143	0.764
Maglios	Zinc (Zn)-Dissolved	Spring	8	-0.500	0.108
Maglios	Zinc (Zn)-Dissolved	Summer	7	-0.048	1.000
Maglios	Zinc (Zn)-Total	Fall	7	-0.048	1.000
Maglios	Zinc (Zn)-Total	Spring	8	-0.286	0.386
Maglios	Zinc (Zn)-Total	Summer	7	0.238	0.548
Maglios	Zirconium (Zr)-Dissolved	Fall	7	-0.350	0.396
Maglios	Zirconium (Zr)-Dissolved	Spring	8	-0.624	0.062
Maglios	Zirconium (Zr)-Dissolved	Summer	7	-0.394	0.315
Maglios	Zirconium (Zr)-Total	Fall	7	-0.756	0.052
Maglios	Zirconium (Zr)-Total	Spring	8	-0.577	0.100
Maglios	Zirconium (Zr)-Total	Summer	7	-0.620	0.094
New Bridge	Alkalinity, Total (as CaCO3)	Spring	8	-0.214	0.536
New Bridge	Aluminum (Al)-Dissolved	Fall	8	-0.214	0.536
New Bridge	Aluminum (Al)-Dissolved	Spring	10	0.111	0.721
New Bridge	Aluminum (Al)-Dissolved	Summer	7	-0.143	0.764
New Bridge	Aluminum (Al)-Total	Fall	8	-0.214	0.536
New Bridge	Aluminum (Al)-Total	Spring	10	-0.511	0.049
New Bridge	Aluminum (Al)-Total	Summer	7	-0.050	1.000
New Bridge	Ammonia, Total (as N)	Fall	8	-0.473	0.135
New Bridge	Ammonia, Total (as N)	Spring	10	-0.244	0.371
New Bridge	Ammonia, Total (as N)	Summer	7	-0.878	0.010
New Bridge	Antimony (Sb)-Dissolved	Fall	8	0.109	0.803
New Bridge	Antimony (Sb)-Dissolved	Spring	10	0.244	0.371
New Bridge	Antimony (Sb)-Dissolved	Summer	7	0.524	0.133
New Bridge	Antimony (Sb)-Total	Fall	8	0.143	0.711
New Bridge	Antimony (Sb)-Total	Spring	10	0.289	0.283
New Bridge	Antimony (Sb)-Total	Summer	7	0.524	0.133
New Bridge	Arsenic (As)-Dissolved	Fall	8	<0.001	1.000
New Bridge	Arsenic (As)-Dissolved	Spring	10	-0.378	0.152
New Bridge	Arsenic (As)-Dissolved	Summer	7	-0.143	0.764
New Bridge	Arsenic (As)-Total	Fall	8	-0.143	0.711
New Bridge	Arsenic (As)-Total	Spring	10	-0.289	0.283
New Bridge	Arsenic (As)-Total	Summer	7	-0.143	0.764
New Bridge	Barium (Ba)-Dissolved	Fall	8	0.546	0.081
New Bridge	Barium (Ba)-Dissolved	Spring	10	0.022	1.000

Site	Analyte	Season	n	Tau	p-Value
New Bridge	Barium (Ba)-Dissolved	Summer	7	0.714	0.035
New Bridge	Barium (Ba)-Total	Fall	8	0.357	0.266
New Bridge	Barium (Ba)-Total	Spring	10	0.156	0.592
New Bridge	Barium (Ba)-Total	Summer	7	0.390	0.288
New Bridge	Beryllium (Be)-Dissolved	Fall	8	-0.655	0.067
New Bridge	Beryllium (Be)-Dissolved	Spring	10	-0.466	0.117
New Bridge	Beryllium (Be)-Dissolved	Summer	7	-0.690	0.081
New Bridge	Beryllium (Be)-Total	Fall	8	-0.732	0.037
New Bridge	Beryllium (Be)-Total	Spring	10	-0.596	0.050
New Bridge	Beryllium (Be)-Total	Summer	7	-0.756	0.052
New Bridge	Bismuth (Bi)-Dissolved	Fall	8	1.000	1.000
New Bridge	Bismuth (Bi)-Dissolved	Spring	10	1.000	1.000
New Bridge	Bismuth (Bi)-Dissolved	Summer	7	1.000	1.000
New Bridge	Bismuth (Bi)-Total	Fall	8	-0.071	1.000
New Bridge	Bismuth (Bi)-Total	Spring	10	0.076	0.848
New Bridge	Bismuth (Bi)-Total	Summer	7	1.000	1.000
New Bridge	Boron (B)-Dissolved	Fall	8	-0.390	0.272
New Bridge	Boron (B)-Dissolved	Spring	10	0.026	1.000
New Bridge	Boron (B)-Dissolved	Summer	7	-0.252	0.596
New Bridge	Boron (B)-Total	Fall	8	1.000	1.000
New Bridge	Boron (B)-Total	Spring	10	-0.542	0.070
New Bridge	Boron (B)-Total	Summer	7	1.000	1.000
New Bridge	Bromide (Br)	Fall	7	1.000	1.000
New Bridge	Bromide (Br)	Spring	10	0.447	0.164
New Bridge	Bromide (Br)	Summer	7	1.000	1.000
New Bridge	Cadmium (Cd)-Dissolved	Fall	8	-0.643	0.035
New Bridge	Cadmium (Cd)-Dissolved	Spring	10	-0.556	0.032
New Bridge	Cadmium (Cd)-Dissolved	Summer	7	-0.714	0.035
New Bridge	Cadmium (Cd)-Total	Fall	8	-0.571	0.064
New Bridge	Cadmium (Cd)-Total	Spring	10	-0.556	0.032
New Bridge	Cadmium (Cd)-Total	Summer	7	-0.810	0.016
New Bridge	Calcium (Ca)-Dissolved	Fall	8	-0.143	0.711
New Bridge	Calcium (Ca)-Dissolved	Spring	10	0.180	0.530
New Bridge	Calcium (Ca)-Dissolved	Summer	7	-0.429	0.230
New Bridge	Calcium (Ca)-Total	Fall	8	-0.357	0.266
New Bridge	Calcium (Ca)-Total	Spring	10	0.225	0.419
New Bridge	Calcium (Ca)-Total	Summer	7	0.238	0.548
New Bridge	Chloride (Cl)	Fall	7	0.524	0.133
New Bridge	Chloride (Cl)	Spring	10	0.156	0.592
New Bridge	Chloride (Cl)	Summer	7	0.488	0.172
New Bridge	Chromium (Cr)-Dissolved	Fall	8	-0.214	0.663
New Bridge	Chromium (Cr)-Dissolved	Spring	10	0.447	0.164
New Bridge	Chromium (Cr)-Dissolved	Summer	7	1.000	1.000
New Bridge	Chromium (Cr)-Total	Fall	8	0.357	0.383
New Bridge	Chromium (Cr)-Total	Spring	10	0.305	0.307
New Bridge	Chromium (Cr)-Total	Summer	7	1.000	1.000
New Bridge	Cobalt (Co)-Dissolved	Fall	8	-0.357	0.266
New Bridge	Cobalt (Co)-Dissolved	Spring	10	-0.022	1.000

Site	Analyte	Season	n	Tau	p-Value
New Bridge	Cobalt (Co)-Dissolved	Summer	7	-0.524	0.133
New Bridge	Cobalt (Co)-Total	Fall	8	-0.071	0.902
New Bridge	Cobalt (Co)-Total	Spring	10	-0.067	0.858
New Bridge	Cobalt (Co)-Total	Summer	7	0.333	0.368
New Bridge	Conductivity	Spring	8	0.286	0.386
New Bridge	Copper (Cu)-Dissolved	Fall	8	<0.001	1.000
New Bridge	Copper (Cu)-Dissolved	Spring	10	0.244	0.371
New Bridge	Copper (Cu)-Dissolved	Summer	7	-0.551	0.124
New Bridge	Copper (Cu)-Total	Fall	8	-0.327	0.319
New Bridge	Copper (Cu)-Total	Spring	10	0.289	0.283
New Bridge	Copper (Cu)-Total	Summer	7	-0.619	0.072
New Bridge	Fluoride (F)	Fall	7	0.781	0.023
New Bridge	Fluoride (F)	Spring	10	0.315	0.243
New Bridge	Fluoride (F)	Summer	7	0.293	0.448
New Bridge	Hardness (as CaCO3)	Fall	8	-0.143	0.711
New Bridge	Hardness (as CaCO3)	Spring	10	0.289	0.283
New Bridge	Hardness (as CaCO3)	Summer	7	-0.143	0.764
New Bridge	Iron (Fe)-Dissolved	Fall	8	0.429	0.174
New Bridge	Iron (Fe)-Dissolved	Spring	10	0.244	0.371
New Bridge	Iron (Fe)-Dissolved	Summer	7	-0.048	1.000
New Bridge	Iron (Fe)-Total	Fall	8	0.571	0.064
New Bridge	Iron (Fe)-Total	Spring	10	-0.467	0.074
New Bridge	Iron (Fe)-Total	Summer	7	0.195	0.649
New Bridge	Lead (Pb)-Dissolved	Fall	8	-0.286	0.386
New Bridge	Lead (Pb)-Dissolved	Spring	10	-0.333	0.210
New Bridge	Lead (Pb)-Dissolved	Summer	7	-0.048	1.000
New Bridge	Lead (Pb)-Total	Fall	8	0.071	0.902
New Bridge	Lead (Pb)-Total	Spring	10	-0.244	0.371
New Bridge	Lead (Pb)-Total	Summer	7	0.048	1.000
New Bridge	Lithium (Li)-Dissolved	Fall	8	0.357	0.266
New Bridge	Lithium (Li)-Dissolved	Spring	10	0.244	0.371
New Bridge	Lithium (Li)-Dissolved	Summer	7	0.195	0.649
New Bridge	Lithium (Li)-Total	Fall	8	0.071	0.902
New Bridge	Lithium (Li)-Total	Spring	10	0.244	0.371
New Bridge	Lithium (Li)-Total	Summer	7	0.524	0.133
New Bridge	Magnesium (Mg)-Dissolved	Fall	8	0.255	0.454
New Bridge	Magnesium (Mg)-Dissolved	Spring	10	0.333	0.210
New Bridge	Magnesium (Mg)-Dissolved	Summer	7	0.143	0.764
New Bridge	Magnesium (Mg)-Total	Fall	8	-0.071	0.902
New Bridge	Magnesium (Mg)-Total	Spring	10	0.422	0.107
New Bridge	Magnesium (Mg)-Total	Summer	7	0.333	0.368
New Bridge	Manganese (Mn)-Dissolved	Fall	8	-0.357	0.266
New Bridge	Manganese (Mn)-Dissolved	Spring	10	-0.111	0.721
New Bridge	Manganese (Mn)-Dissolved	Summer	7	-0.524	0.133
New Bridge	Manganese (Mn)-Total	Fall	8	-0.109	0.803
New Bridge	Manganese (Mn)-Total	Spring	10	-0.022	1.000
New Bridge	Manganese (Mn)-Total	Summer	7	-0.048	1.000
New Bridge	Mercury (Hg)-Dissolved	Fall	8	0.109	0.803

Site	Analyte	Season	n	Tau	p-Value
New Bridge	Mercury (Hg)-Dissolved	Spring	10	0.111	0.721
New Bridge	Mercury (Hg)-Dissolved	Summer	7	-0.356	0.453
New Bridge	Mercury (Hg)-Total	Fall	8	0.143	0.711
New Bridge	Mercury (Hg)-Total	Spring	10	0.111	0.721
New Bridge	Mercury (Hg)-Total	Summer	7	0.143	0.764
New Bridge	Molybdenum (Mo)-Dissolved	Fall	8	0.143	0.711
New Bridge	Molybdenum (Mo)-Dissolved	Spring	10	-0.244	0.371
New Bridge	Molybdenum (Mo)-Dissolved	Summer	7	-0.143	0.764
New Bridge	Molybdenum (Mo)-Total	Fall	8	0.143	0.711
New Bridge	Molybdenum (Mo)-Total	Spring	10	-0.156	0.592
New Bridge	Molybdenum (Mo)-Total	Summer	7	0.103	0.875
New Bridge	Nickel (Ni)-Dissolved	Fall	8	0.357	0.266
New Bridge	Nickel (Ni)-Dissolved	Spring	10	0.422	0.107
New Bridge	Nickel (Ni)-Dissolved	Summer	7	0.195	0.649
New Bridge	Nickel (Ni)-Total	Fall	8	0.214	0.536
New Bridge	Nickel (Ni)-Total	Spring	10	0.378	0.152
New Bridge	Nickel (Ni)-Total	Summer	7	0.524	0.133
New Bridge	Nitrate (as N)	Fall	7	0.524	0.133
New Bridge	Nitrate (as N)	Spring	10	0.644	0.012
New Bridge	pH	Spring	8	0.143	0.711
New Bridge	Phosphorus (P)-Dissolved	Fall	7	1.000	1.000
New Bridge	Phosphorus (P)-Dissolved	Spring	9	1.000	1.000
New Bridge	Phosphorus (P)-Total	Fall	8	-0.255	0.454
New Bridge	Phosphorus (P)-Total	Spring	10	-0.556	0.032
New Bridge	Phosphorus (P)-Total	Summer	7	-0.238	0.548
New Bridge	Phosphorus (P)-Total Dissolved	Fall	8	0.567	0.075
New Bridge	Phosphorus (P)-Total Dissolved	Spring	10	0.600	0.020
New Bridge	Phosphorus (P)-Total Dissolved	Summer	7	0.197	0.704
New Bridge	Potassium (K)-Dissolved	Fall	8	0.143	0.711
New Bridge	Potassium (K)-Dissolved	Spring	10	0.244	0.371
New Bridge	Potassium (K)-Dissolved	Summer	7	-0.195	0.649
New Bridge	Potassium (K)-Total	Fall	8	<0.001	1.000
New Bridge	Potassium (K)-Total	Spring	10	0.111	0.721
New Bridge	Potassium (K)-Total	Summer	7	0.238	0.548
New Bridge	Selenium (Se)-Dissolved	Fall	8	0.643	0.035
New Bridge	Selenium (Se)-Dissolved	Spring	10	-0.022	1.000
New Bridge	Selenium (Se)-Dissolved	Summer	7	-0.429	0.230
New Bridge	Selenium (Se)-Total	Fall	8	0.500	0.108
New Bridge	Selenium (Se)-Total	Spring	10	-0.022	1.000
New Bridge	Selenium (Se)-Total	Summer	7	-0.333	0.368
New Bridge	Silicon (Si)-Dissolved	Fall	8	-0.214	0.536
New Bridge	Silicon (Si)-Dissolved	Spring	10	0.022	1.000
New Bridge	Silicon (Si)-Dissolved	Summer	7	0.143	0.764
New Bridge	Silicon (Si)-Total	Fall	8	<0.001	1.000
New Bridge	Silicon (Si)-Total	Spring	10	0.111	0.721
New Bridge	Silicon (Si)-Total	Summer	7	0.238	0.548
New Bridge	Silver (Ag)-Dissolved	Fall	8	1.000	1.000
New Bridge	Silver (Ag)-Dissolved	Spring	10	-0.149	0.728

Site	Analyte	Season	n	Tau	p-Value
New Bridge	Silver (Ag)-Dissolved	Summer	7	1.000	1.000
New Bridge	Silver (Ag)-Total	Fall	8	1.000	1.000
New Bridge	Silver (Ag)-Total	Spring	10	0.108	0.796
New Bridge	Silver (Ag)-Total	Summer	7	1.000	1.000
New Bridge	Sodium (Na)-Dissolved	Fall	8	0.357	0.266
New Bridge	Sodium (Na)-Dissolved	Spring	10	0.156	0.592
New Bridge	Sodium (Na)-Dissolved	Summer	7	-0.238	0.548
New Bridge	Sodium (Na)-Total	Fall	8	0.286	0.386
New Bridge	Sodium (Na)-Total	Spring	10	0.156	0.592
New Bridge	Sodium (Na)-Total	Summer	7	-0.429	0.230
New Bridge	Strontium (Sr)-Dissolved	Fall	8	0.214	0.536
New Bridge	Strontium (Sr)-Dissolved	Spring	10	0.556	0.032
New Bridge	Strontium (Sr)-Dissolved	Summer	7	0.524	0.133
New Bridge	Strontium (Sr)-Total	Fall	8	0.113	0.799
New Bridge	Strontium (Sr)-Total	Spring	10	0.584	0.025
New Bridge	Strontium (Sr)-Total	Summer	7	0.951	0.006
New Bridge	Sulfate (SO4)	Fall	7	-0.048	1.000
New Bridge	Sulfate (SO4)	Spring	10	0.333	0.210
New Bridge	Sulfate (SO4)	Summer	7	0.150	0.759
New Bridge	Thallium (Tl)-Dissolved	Fall	8	0.357	0.266
New Bridge	Thallium (Tl)-Dissolved	Spring	10	0.200	0.474
New Bridge	Thallium (Tl)-Dissolved	Summer	7	0.714	0.035
New Bridge	Thallium (Tl)-Total	Fall	8	0.357	0.266
New Bridge	Thallium (Tl)-Total	Spring	10	0.200	0.474
New Bridge	Thallium (Tl)-Total	Summer	7	0.714	0.035
New Bridge	Tin (Sn)-Dissolved	Fall	8	0.403	0.237
New Bridge	Tin (Sn)-Dissolved	Spring	10	0.653	0.025
New Bridge	Tin (Sn)-Dissolved	Summer	7	0.159	0.751
New Bridge	Tin (Sn)-Total	Fall	8	0.596	0.082
New Bridge	Tin (Sn)-Total	Spring	10	0.544	0.053
New Bridge	Tin (Sn)-Total	Summer	7	0.535	0.211
New Bridge	Titanium (Ti)-Dissolved	Fall	8	-0.845	0.010
New Bridge	Titanium (Ti)-Dissolved	Spring	10	-0.843	0.003
New Bridge	Titanium (Ti)-Dissolved	Summer	7	-0.845	0.019
New Bridge	Titanium (Ti)-Total	Fall	8	-0.081	0.894
New Bridge	Titanium (Ti)-Total	Spring	10	-0.360	0.178
New Bridge	Titanium (Ti)-Total	Summer	7	0.620	0.094
New Bridge	Total Dissolved Solids	Spring	8	0.071	0.902
New Bridge	Total Kjeldahl Nitrogen	Fall	8	0.286	0.386
New Bridge	Total Kjeldahl Nitrogen	Spring	9	-0.444	0.118
New Bridge	Total Kjeldahl Nitrogen	Summer	7	-0.619	0.072
New Bridge	Total Organic Carbon	Fall	7	0.619	0.072
New Bridge	Total Organic Carbon	Spring	9	-0.222	0.466
New Bridge	Total Organic Carbon	Summer	7	-0.524	0.133
New Bridge	Total Suspended Solids	Spring	8	-0.500	0.190
New Bridge	Turbidity	Fall	8	-0.764	0.013
New Bridge	Turbidity	Spring	10	-0.600	0.020
New Bridge	Turbidity	Summer	7	-0.429	0.230

Site	Analyte	Season	n	Tau	p-Value
New Bridge	Uranium (U)-Dissolved	Fall	8	0.286	0.386
New Bridge	Uranium (U)-Dissolved	Spring	10	0.111	0.721
New Bridge	Uranium (U)-Dissolved	Summer	7	0.619	0.072
New Bridge	Uranium (U)-Total	Fall	8	0.286	0.386
New Bridge	Uranium (U)-Total	Spring	10	0.244	0.371
New Bridge	Uranium (U)-Total	Summer	7	0.238	0.548
New Bridge	Vanadium (V)-Dissolved	Fall	8	0.214	0.536
New Bridge	Vanadium (V)-Dissolved	Spring	10	-0.244	0.371
New Bridge	Vanadium (V)-Dissolved	Summer	7	0.143	0.764
New Bridge	Vanadium (V)-Total	Fall	8	0.429	0.174
New Bridge	Vanadium (V)-Total	Spring	10	-0.156	0.592
New Bridge	Vanadium (V)-Total	Summer	7	0.524	0.133
New Bridge	Zinc (Zn)-Dissolved	Fall	8	-0.618	0.046
New Bridge	Zinc (Zn)-Dissolved	Spring	10	-0.422	0.107
New Bridge	Zinc (Zn)-Dissolved	Summer	7	-0.524	0.133
New Bridge	Zinc (Zn)-Total	Fall	8	-0.714	0.019
New Bridge	Zinc (Zn)-Total	Spring	10	-0.244	0.371
New Bridge	Zinc (Zn)-Total	Summer	7	-0.810	0.016
New Bridge	Zirconium (Zr)-Dissolved	Fall	8	-0.321	0.385
New Bridge	Zirconium (Zr)-Dissolved	Spring	10	-0.542	0.070
New Bridge	Zirconium (Zr)-Dissolved	Summer	7	-0.394	0.315
New Bridge	Zirconium (Zr)-Total	Fall	8	-0.732	0.037
New Bridge	Zirconium (Zr)-Total	Spring	10	-0.542	0.070
New Bridge	Zirconium (Zr)-Total	Summer	7	-0.620	0.094
Old Bridge	Alkalinity, Total (as CaCO3)	Spring	8	-0.286	0.386
Old Bridge	Aluminum (Al)-Dissolved	Fall	8	-0.714	0.019
Old Bridge	Aluminum (Al)-Dissolved	Spring	10	0.067	0.858
Old Bridge	Aluminum (Al)-Dissolved	Summer	7	-0.098	0.879
Old Bridge	Aluminum (Al)-Total	Fall	8	-0.286	0.386
Old Bridge	Aluminum (Al)-Total	Spring	10	-0.378	0.152
Old Bridge	Aluminum (Al)-Total	Summer	7	0.333	0.368
Old Bridge	Ammonia, Total (as N)	Fall	8	-0.429	0.174
Old Bridge	Ammonia, Total (as N)	Spring	10	-0.022	1.000
Old Bridge	Ammonia, Total (as N)	Summer	7	-0.524	0.133
Old Bridge	Antimony (Sb)-Dissolved	Fall	8	-0.286	0.386
Old Bridge	Antimony (Sb)-Dissolved	Spring	10	0.067	0.858
Old Bridge	Antimony (Sb)-Dissolved	Summer	7	0.488	0.172
Old Bridge	Antimony (Sb)-Total	Fall	8	-0.036	1.000
Old Bridge	Antimony (Sb)-Total	Spring	10	0.111	0.721
Old Bridge	Antimony (Sb)-Total	Summer	7	0.619	0.072
Old Bridge	Arsenic (As)-Dissolved	Fall	8	-0.286	0.386
Old Bridge	Arsenic (As)-Dissolved	Spring	10	-0.333	0.210
Old Bridge	Arsenic (As)-Dissolved	Summer	7	-0.048	1.000
Old Bridge	Arsenic (As)-Total	Fall	8	-0.214	0.536
Old Bridge	Arsenic (As)-Total	Spring	10	-0.244	0.371
Old Bridge	Arsenic (As)-Total	Summer	7	0.238	0.548
Old Bridge	Barium (Ba)-Dissolved	Fall	8	0.357	0.266
Old Bridge	Barium (Ba)-Dissolved	Spring	10	-0.067	0.858

Site	Analyte	Season	n	Tau	p-Value
Old Bridge	Barium (Ba)-Dissolved	Summer	7	0.619	0.072
Old Bridge	Barium (Ba)-Total	Fall	8	0.357	0.266
Old Bridge	Barium (Ba)-Total	Spring	10	0.111	0.721
Old Bridge	Barium (Ba)-Total	Summer	7	0.429	0.230
Old Bridge	Beryllium (Be)-Dissolved	Fall	8	-0.655	0.067
Old Bridge	Beryllium (Be)-Dissolved	Spring	10	-0.591	0.044
Old Bridge	Beryllium (Be)-Dissolved	Summer	7	-0.690	0.081
Old Bridge	Beryllium (Be)-Total	Fall	8	-0.650	0.054
Old Bridge	Beryllium (Be)-Total	Spring	10	-0.596	0.050
Old Bridge	Beryllium (Be)-Total	Summer	7	-0.756	0.052
Old Bridge	Bismuth (Bi)-Dissolved	Fall	8	1.000	1.000
Old Bridge	Bismuth (Bi)-Dissolved	Spring	10	1.000	1.000
Old Bridge	Bismuth (Bi)-Dissolved	Summer	7	1.000	1.000
Old Bridge	Bismuth (Bi)-Total	Fall	8	-0.357	0.383
Old Bridge	Bismuth (Bi)-Total	Spring	10	-0.108	0.796
Old Bridge	Bismuth (Bi)-Total	Summer	7	1.000	1.000
Old Bridge	Boron (B)-Dissolved	Fall	8	<0.001	1.000
Old Bridge	Boron (B)-Dissolved	Spring	10	0.083	0.841
Old Bridge	Boron (B)-Dissolved	Summer	7	-0.252	0.596
Old Bridge	Boron (B)-Total	Fall	8	1.000	1.000
Old Bridge	Boron (B)-Total	Spring	10	-0.447	0.164
Old Bridge	Boron (B)-Total	Summer	7	1.000	1.000
Old Bridge	Bromide (Br)	Fall	7	1.000	1.000
Old Bridge	Bromide (Br)	Spring	10	0.447	0.164
Old Bridge	Bromide (Br)	Summer	7	1.000	1.000
Old Bridge	Cadmium (Cd)-Dissolved	Fall	8	-0.643	0.035
Old Bridge	Cadmium (Cd)-Dissolved	Spring	10	-0.600	0.020
Old Bridge	Cadmium (Cd)-Dissolved	Summer	7	-0.751	0.031
Old Bridge	Cadmium (Cd)-Total	Fall	8	-0.714	0.019
Old Bridge	Cadmium (Cd)-Total	Spring	10	-0.511	0.049
Old Bridge	Cadmium (Cd)-Total	Summer	7	-0.810	0.016
Old Bridge	Calcium (Ca)-Dissolved	Fall	8	-0.214	0.536
Old Bridge	Calcium (Ca)-Dissolved	Spring	10	-0.022	1.000
Old Bridge	Calcium (Ca)-Dissolved	Summer	7	-0.333	0.368
Old Bridge	Calcium (Ca)-Total	Fall	8	-0.445	0.167
Old Bridge	Calcium (Ca)-Total	Spring	10	-0.022	1.000
Old Bridge	Calcium (Ca)-Total	Summer	7	-0.048	1.000
Old Bridge	Chloride (Cl)	Fall	7	0.488	0.172
Old Bridge	Chloride (Cl)	Spring	10	-0.022	1.000
Old Bridge	Chloride (Cl)	Summer	7	0.514	0.158
Old Bridge	Chromium (Cr)-Dissolved	Fall	8	1.000	1.000
Old Bridge	Chromium (Cr)-Dissolved	Spring	10	1.000	1.000
Old Bridge	Chromium (Cr)-Dissolved	Summer	7	1.000	1.000
Old Bridge	Chromium (Cr)-Total	Fall	8	1.000	1.000
Old Bridge	Chromium (Cr)-Total	Spring	10	-0.076	0.848
Old Bridge	Chromium (Cr)-Total	Summer	7	1.000	1.000
Old Bridge	Cobalt (Co)-Dissolved	Fall	8	-0.327	0.319
Old Bridge	Cobalt (Co)-Dissolved	Spring	10	0.156	0.592

Site	Analyte	Season	n	Tau	p-Value
Old Bridge	Cobalt (Co)-Dissolved	Summer	7	0.429	0.230
Old Bridge	Cobalt (Co)-Total	Fall	8	-0.214	0.536
Old Bridge	Cobalt (Co)-Total	Spring	10	-0.200	0.474
Old Bridge	Cobalt (Co)-Total	Summer	7	0.429	0.230
Old Bridge	Conductivity	Spring	8	0.429	0.174
Old Bridge	Copper (Cu)-Dissolved	Fall	8	-0.109	0.803
Old Bridge	Copper (Cu)-Dissolved	Spring	10	0.067	0.858
Old Bridge	Copper (Cu)-Dissolved	Summer	7	-0.048	1.000
Old Bridge	Copper (Cu)-Total	Fall	8	-0.071	0.902
Old Bridge	Copper (Cu)-Total	Spring	10	-0.244	0.371
Old Bridge	Copper (Cu)-Total	Summer	7	-0.238	0.548
Old Bridge	Fluoride (F)	Fall	7	0.143	0.764
Old Bridge	Fluoride (F)	Spring	10	0.067	0.858
Old Bridge	Fluoride (F)	Summer	7	0.514	0.158
Old Bridge	Hardness (as CaCO3)	Fall	8	-0.143	0.711
Old Bridge	Hardness (as CaCO3)	Spring	10	0.111	0.721
Old Bridge	Hardness (as CaCO3)	Summer	7	0.143	0.764
Old Bridge	Iron (Fe)-Dissolved	Fall	8	-0.429	0.174
Old Bridge	Iron (Fe)-Dissolved	Spring	10	0.200	0.474
Old Bridge	Iron (Fe)-Dissolved	Summer	7	0.333	0.368
Old Bridge	Iron (Fe)-Total	Fall	8	0.286	0.386
Old Bridge	Iron (Fe)-Total	Spring	10	-0.156	0.592
Old Bridge	Iron (Fe)-Total	Summer	7	0.333	0.368
Old Bridge	Lead (Pb)-Dissolved	Fall	8	-0.571	0.064
Old Bridge	Lead (Pb)-Dissolved	Spring	10	-0.022	1.000
Old Bridge	Lead (Pb)-Dissolved	Summer	7	0.238	0.548
Old Bridge	Lead (Pb)-Total	Fall	8	-0.214	0.536
Old Bridge	Lead (Pb)-Total	Spring	10	-0.378	0.152
Old Bridge	Lead (Pb)-Total	Summer	7	0.429	0.230
Old Bridge	Lithium (Li)-Dissolved	Fall	8	0.500	0.108
Old Bridge	Lithium (Li)-Dissolved	Spring	10	0.225	0.419
Old Bridge	Lithium (Li)-Dissolved	Summer	7	0.524	0.133
Old Bridge	Lithium (Li)-Total	Fall	8	0.148	0.706
Old Bridge	Lithium (Li)-Total	Spring	10	0.289	0.283
Old Bridge	Lithium (Li)-Total	Summer	7	0.429	0.230
Old Bridge	Magnesium (Mg)-Dissolved	Fall	8	0.036	1.000
Old Bridge	Magnesium (Mg)-Dissolved	Spring	10	0.333	0.210
Old Bridge	Magnesium (Mg)-Dissolved	Summer	7	0.238	0.548
Old Bridge	Magnesium (Mg)-Total	Fall	8	-0.255	0.454
Old Bridge	Magnesium (Mg)-Total	Spring	10	0.556	0.032
Old Bridge	Magnesium (Mg)-Total	Summer	7	0.619	0.072
Old Bridge	Manganese (Mn)-Dissolved	Fall	8	-0.429	0.174
Old Bridge	Manganese (Mn)-Dissolved	Spring	10	0.244	0.371
Old Bridge	Manganese (Mn)-Dissolved	Summer	7	0.238	0.548
Old Bridge	Manganese (Mn)-Total	Fall	8	-0.357	0.266
Old Bridge	Manganese (Mn)-Total	Spring	10	-0.200	0.474
Old Bridge	Manganese (Mn)-Total	Summer	7	0.048	1.000
Old Bridge	Mercury (Hg)-Dissolved	Fall	8	1.000	1.000

Site	Analyte	Season	n	Tau	p-Value
Old Bridge	Mercury (Hg)-Dissolved	Spring	10	<0.001	1.000
Old Bridge	Mercury (Hg)-Dissolved	Summer	7	1.000	1.000
Old Bridge	Mercury (Hg)-Total	Fall	8	-0.161	0.690
Old Bridge	Mercury (Hg)-Total	Spring	10	0.022	1.000
Old Bridge	Mercury (Hg)-Total	Summer	7	0.329	0.447
Old Bridge	Molybdenum (Mo)-Dissolved	Fall	8	0.071	0.902
Old Bridge	Molybdenum (Mo)-Dissolved	Spring	10	-0.067	0.858
Old Bridge	Molybdenum (Mo)-Dissolved	Summer	7	-0.143	0.764
Old Bridge	Molybdenum (Mo)-Total	Fall	8	0.071	0.902
Old Bridge	Molybdenum (Mo)-Total	Spring	10	0.111	0.721
Old Bridge	Molybdenum (Mo)-Total	Summer	7	0.048	1.000
Old Bridge	Nickel (Ni)-Dissolved	Fall	8	-0.143	0.711
Old Bridge	Nickel (Ni)-Dissolved	Spring	10	0.511	0.049
Old Bridge	Nickel (Ni)-Dissolved	Summer	7	0.429	0.230
Old Bridge	Nickel (Ni)-Total	Fall	8	-0.071	0.902
Old Bridge	Nickel (Ni)-Total	Spring	10	0.333	0.210
Old Bridge	Nickel (Ni)-Total	Summer	7	0.238	0.548
Old Bridge	Nitrate (as N)	Fall	7	-0.048	1.000
Old Bridge	Nitrate (as N)	Spring	10	0.111	0.721
Old Bridge	pH	Spring	8	<0.001	1.000
Old Bridge	Phosphorus (P)-Dissolved	Fall	7	1.000	1.000
Old Bridge	Phosphorus (P)-Dissolved	Spring	9	1.000	1.000
Old Bridge	Phosphorus (P)-Total	Fall	8	-0.429	0.174
Old Bridge	Phosphorus (P)-Total	Spring	10	-0.689	0.007
Old Bridge	Phosphorus (P)-Total	Summer	7	-0.524	0.133
Old Bridge	Phosphorus (P)-Total Dissolved	Fall	8	0.367	0.324
Old Bridge	Phosphorus (P)-Total Dissolved	Spring	10	0.358	0.194
Old Bridge	Phosphorus (P)-Total Dissolved	Summer	7	-0.138	0.846
Old Bridge	Potassium (K)-Dissolved	Fall	8	-0.357	0.266
Old Bridge	Potassium (K)-Dissolved	Spring	10	0.111	0.721
Old Bridge	Potassium (K)-Dissolved	Summer	7	0.238	0.548
Old Bridge	Potassium (K)-Total	Fall	8	-0.143	0.711
Old Bridge	Potassium (K)-Total	Spring	10	0.244	0.371
Old Bridge	Potassium (K)-Total	Summer	7	0.048	1.000
Old Bridge	Selenium (Se)-Dissolved	Fall	8	<0.001	1.000
Old Bridge	Selenium (Se)-Dissolved	Spring	10	0.067	0.858
Old Bridge	Selenium (Se)-Dissolved	Summer	7	0.238	0.548
Old Bridge	Selenium (Se)-Total	Fall	8	-0.143	0.711
Old Bridge	Selenium (Se)-Total	Spring	10	0.333	0.210
Old Bridge	Selenium (Se)-Total	Summer	7	0.238	0.548
Old Bridge	Silicon (Si)-Dissolved	Fall	8	-0.182	0.618
Old Bridge	Silicon (Si)-Dissolved	Spring	10	0.067	0.858
Old Bridge	Silicon (Si)-Dissolved	Summer	7	0.048	1.000
Old Bridge	Silicon (Si)-Total	Fall	8	-0.255	0.454
Old Bridge	Silicon (Si)-Total	Spring	10	0.111	0.721
Old Bridge	Silicon (Si)-Total	Summer	7	0.143	0.764
Old Bridge	Silver (Ag)-Dissolved	Fall	8	1.000	1.000
Old Bridge	Silver (Ag)-Dissolved	Spring	10	-0.050	1.000

Site	Analyte	Season	n	Tau	p-Value
Old Bridge	Silver (Ag)-Dissolved	Summer	7	1.000	1.000
Old Bridge	Silver (Ag)-Total	Fall	8	1.000	1.000
Old Bridge	Silver (Ag)-Total	Spring	10	-0.050	1.000
Old Bridge	Silver (Ag)-Total	Summer	7	-0.535	0.211
Old Bridge	Sodium (Na)-Dissolved	Fall	8	0.214	0.536
Old Bridge	Sodium (Na)-Dissolved	Spring	10	0.111	0.721
Old Bridge	Sodium (Na)-Dissolved	Summer	7	0.781	0.023
Old Bridge	Sodium (Na)-Total	Fall	8	0.109	0.803
Old Bridge	Sodium (Na)-Total	Spring	10	0.289	0.283
Old Bridge	Sodium (Na)-Total	Summer	7	0.683	0.048
Old Bridge	Strontium (Sr)-Dissolved	Fall	8	0.071	0.902
Old Bridge	Strontium (Sr)-Dissolved	Spring	10	0.511	0.049
Old Bridge	Strontium (Sr)-Dissolved	Summer	7	0.976	0.004
Old Bridge	Strontium (Sr)-Total	Fall	8	0.071	0.902
Old Bridge	Strontium (Sr)-Total	Spring	10	0.449	0.088
Old Bridge	Strontium (Sr)-Total	Summer	7	0.524	0.133
Old Bridge	Sulfate (SO4)	Fall	7	0.048	1.000
Old Bridge	Sulfate (SO4)	Spring	10	0.422	0.107
Old Bridge	Sulfate (SO4)	Summer	7	0.488	0.172
Old Bridge	Thallium (Tl)-Dissolved	Fall	8	0.071	0.902
Old Bridge	Thallium (Tl)-Dissolved	Spring	10	0.156	0.592
Old Bridge	Thallium (Tl)-Dissolved	Summer	7	0.714	0.035
Old Bridge	Thallium (Tl)-Total	Fall	8	<0.001	1.000
Old Bridge	Thallium (Tl)-Total	Spring	10	0.067	0.858
Old Bridge	Thallium (Tl)-Total	Summer	7	0.619	0.072
Old Bridge	Tin (Sn)-Dissolved	Fall	8	0.077	0.898
Old Bridge	Tin (Sn)-Dissolved	Spring	10	0.415	0.152
Old Bridge	Tin (Sn)-Dissolved	Summer	7	0.690	0.081
Old Bridge	Tin (Sn)-Total	Fall	8	0.504	0.148
Old Bridge	Tin (Sn)-Total	Spring	10	0.747	0.008
Old Bridge	Tin (Sn)-Total	Summer	7	0.535	0.211
Old Bridge	Titanium (Ti)-Dissolved	Fall	8	-0.845	0.010
Old Bridge	Titanium (Ti)-Dissolved	Spring	10	-0.843	0.003
Old Bridge	Titanium (Ti)-Dissolved	Summer	7	-0.816	0.027
Old Bridge	Titanium (Ti)-Total	Fall	8	0.322	0.352
Old Bridge	Titanium (Ti)-Total	Spring	10	-0.270	0.323
Old Bridge	Titanium (Ti)-Total	Summer	7	0.282	0.503
Old Bridge	Total Dissolved Solids	Spring	8	0.214	0.536
Old Bridge	Total Kjeldahl Nitrogen	Fall	8	0.109	0.803
Old Bridge	Total Kjeldahl Nitrogen	Spring	9	-0.500	0.076
Old Bridge	Total Kjeldahl Nitrogen	Summer	7	-0.429	0.230
Old Bridge	Total Organic Carbon	Fall	7	0.390	0.288
Old Bridge	Total Organic Carbon	Spring	9	0.167	0.602
Old Bridge	Total Organic Carbon	Summer	7	0.048	1.000
Old Bridge	Total Suspended Solids	Spring	8	-0.500	0.190
Old Bridge	Turbidity	Fall	8	-0.255	0.454
Old Bridge	Turbidity	Spring	10	-0.556	0.032
Old Bridge	Turbidity	Summer	7	0.143	0.764

Site	Analyte	Season	n	Tau	p-Value
Old Bridge	Uranium (U)-Dissolved	Fall	8	0.071	0.902
Old Bridge	Uranium (U)-Dissolved	Spring	10	0.022	1.000
Old Bridge	Uranium (U)-Dissolved	Summer	7	0.714	0.035
Old Bridge	Uranium (U)-Total	Fall	8	0.143	0.711
Old Bridge	Uranium (U)-Total	Spring	10	0.111	0.721
Old Bridge	Uranium (U)-Total	Summer	7	0.195	0.649
Old Bridge	Vanadium (V)-Dissolved	Fall	8	0.429	0.174
Old Bridge	Vanadium (V)-Dissolved	Spring	10	-0.156	0.592
Old Bridge	Vanadium (V)-Dissolved	Summer	7	0.390	0.288
Old Bridge	Vanadium (V)-Total	Fall	8	0.036	1.000
Old Bridge	Vanadium (V)-Total	Spring	10	-0.156	0.592
Old Bridge	Vanadium (V)-Total	Summer	7	0.429	0.230
Old Bridge	Zinc (Zn)-Dissolved	Fall	8	-0.500	0.108
Old Bridge	Zinc (Zn)-Dissolved	Spring	10	-0.200	0.474
Old Bridge	Zinc (Zn)-Dissolved	Summer	7	0.143	0.764
Old Bridge	Zinc (Zn)-Total	Fall	8	-0.286	0.386
Old Bridge	Zinc (Zn)-Total	Spring	10	-0.111	0.721
Old Bridge	Zinc (Zn)-Total	Summer	7	0.333	0.368
Old Bridge	Zirconium (Zr)-Dissolved	Fall	8	-0.321	0.385
Old Bridge	Zirconium (Zr)-Dissolved	Spring	10	-0.542	0.070
Old Bridge	Zirconium (Zr)-Dissolved	Summer	7	-0.394	0.315
Old Bridge	Zirconium (Zr)-Total	Fall	8	-0.732	0.037
Old Bridge	Zirconium (Zr)-Total	Spring	10	-0.542	0.070
Old Bridge	Zirconium (Zr)-Total	Summer	7	-0.620	0.094
Stoney Creek	Alkalinity, Total (as CaCO3)	Spring	8	-0.357	0.266
Stoney Creek	Aluminum (Al)-Dissolved	Fall	8	-0.400	0.212
Stoney Creek	Aluminum (Al)-Dissolved	Spring	10	0.156	0.592
Stoney Creek	Aluminum (Al)-Dissolved	Summer	7	0.048	1.000
Stoney Creek	Aluminum (Al)-Total	Fall	8	-0.571	0.064
Stoney Creek	Aluminum (Al)-Total	Spring	10	-0.333	0.210
Stoney Creek	Aluminum (Al)-Total	Summer	7	0.333	0.368
Stoney Creek	Ammonia, Total (as N)	Fall	8	0.357	0.266
Stoney Creek	Ammonia, Total (as N)	Spring	10	0.511	0.049
Stoney Creek	Ammonia, Total (as N)	Summer	7	-0.238	0.548
Stoney Creek	Antimony (Sb)-Dissolved	Fall	8	0.182	0.618
Stoney Creek	Antimony (Sb)-Dissolved	Spring	10	-0.067	0.858
Stoney Creek	Antimony (Sb)-Dissolved	Summer	7	<0.001	1.000
Stoney Creek	Antimony (Sb)-Total	Fall	8	0.143	0.711
Stoney Creek	Antimony (Sb)-Total	Spring	10	-0.289	0.283
Stoney Creek	Antimony (Sb)-Total	Summer	7	-0.143	0.764
Stoney Creek	Arsenic (As)-Dissolved	Fall	8	0.357	0.266
Stoney Creek	Arsenic (As)-Dissolved	Spring	10	-0.289	0.283
Stoney Creek	Arsenic (As)-Dissolved	Summer	7	-0.143	0.764
Stoney Creek	Arsenic (As)-Total	Fall	8	0.357	0.266
Stoney Creek	Arsenic (As)-Total	Spring	10	-0.244	0.371
Stoney Creek	Arsenic (As)-Total	Summer	7	0.048	1.000
Stoney Creek	Barium (Ba)-Dissolved	Fall	8	0.286	0.386
Stoney Creek	Barium (Ba)-Dissolved	Spring	10	-0.067	0.858

Site	Analyte	Season	n	Tau	p-Value
Stoney Creek	Barium (Ba)-Dissolved	Summer	7	0.524	0.133
Stoney Creek	Barium (Ba)-Total	Fall	8	0.357	0.266
Stoney Creek	Barium (Ba)-Total	Spring	10	0.111	0.721
Stoney Creek	Barium (Ba)-Total	Summer	7	0.586	0.095
Stoney Creek	Beryllium (Be)-Dissolved	Fall	8	-0.655	0.067
Stoney Creek	Beryllium (Be)-Dissolved	Spring	10	-0.596	0.050
Stoney Creek	Beryllium (Be)-Dissolved	Summer	7	-0.690	0.081
Stoney Creek	Beryllium (Be)-Total	Fall	8	-0.732	0.037
Stoney Creek	Beryllium (Be)-Total	Spring	10	-0.358	0.210
Stoney Creek	Beryllium (Be)-Total	Summer	7	-0.756	0.052
Stoney Creek	Bismuth (Bi)-Dissolved	Fall	8	1.000	1.000
Stoney Creek	Bismuth (Bi)-Dissolved	Spring	10	-0.149	0.728
Stoney Creek	Bismuth (Bi)-Dissolved	Summer	7	1.000	1.000
Stoney Creek	Bismuth (Bi)-Total	Fall	8	-0.071	1.000
Stoney Creek	Bismuth (Bi)-Total	Spring	10	0.031	1.000
Stoney Creek	Bismuth (Bi)-Total	Summer	7	1.000	1.000
Stoney Creek	Boron (B)-Dissolved	Fall	8	<0.001	1.000
Stoney Creek	Boron (B)-Dissolved	Spring	10	-0.138	0.689
Stoney Creek	Boron (B)-Dissolved	Summer	7	-0.252	0.596
Stoney Creek	Boron (B)-Total	Fall	8	1.000	1.000
Stoney Creek	Boron (B)-Total	Spring	10	-0.447	0.164
Stoney Creek	Boron (B)-Total	Summer	7	1.000	1.000
Stoney Creek	Bromide (Br)	Fall	7	1.000	1.000
Stoney Creek	Bromide (Br)	Spring	10	0.447	0.164
Stoney Creek	Bromide (Br)	Summer	7	1.000	1.000
Stoney Creek	Cadmium (Cd)-Dissolved	Fall	8	0.286	0.386
Stoney Creek	Cadmium (Cd)-Dissolved	Spring	10	0.022	1.000
Stoney Creek	Cadmium (Cd)-Dissolved	Summer	7	-0.143	0.764
Stoney Creek	Cadmium (Cd)-Total	Fall	8	0.357	0.266
Stoney Creek	Cadmium (Cd)-Total	Spring	10	-0.156	0.592
Stoney Creek	Cadmium (Cd)-Total	Summer	7	0.238	0.548
Stoney Creek	Calcium (Ca)-Dissolved	Fall	8	-0.182	0.618
Stoney Creek	Calcium (Ca)-Dissolved	Spring	10	0.067	0.858
Stoney Creek	Calcium (Ca)-Dissolved	Summer	7	-0.293	0.448
Stoney Creek	Calcium (Ca)-Total	Fall	8	-0.327	0.319
Stoney Creek	Calcium (Ca)-Total	Spring	10	-0.244	0.371
Stoney Creek	Calcium (Ca)-Total	Summer	7	0.150	0.759
Stoney Creek	Chloride (Cl)	Fall	7	0.488	0.172
Stoney Creek	Chloride (Cl)	Spring	10	0.067	0.858
Stoney Creek	Chloride (Cl)	Summer	7	0.732	0.044
Stoney Creek	Chromium (Cr)-Dissolved	Fall	8	1.000	1.000
Stoney Creek	Chromium (Cr)-Dissolved	Spring	10	1.000	1.000
Stoney Creek	Chromium (Cr)-Dissolved	Summer	7	1.000	1.000
Stoney Creek	Chromium (Cr)-Total	Fall	8	1.000	1.000
Stoney Creek	Chromium (Cr)-Total	Spring	10	-0.358	0.210
Stoney Creek	Chromium (Cr)-Total	Summer	7	1.000	1.000
Stoney Creek	Cobalt (Co)-Dissolved	Fall	8	-0.143	0.711
Stoney Creek	Cobalt (Co)-Dissolved	Spring	10	-0.022	1.000

Site	Analyte	Season	n	Tau	p-Value
Stoney Creek	Cobalt (Co)-Dissolved	Summer	7	0.333	0.368
Stoney Creek	Cobalt (Co)-Total	Fall	8	-0.143	0.711
Stoney Creek	Cobalt (Co)-Total	Spring	10	-0.180	0.530
Stoney Creek	Cobalt (Co)-Total	Summer	7	0.429	0.230
Stoney Creek	Conductivity	Spring	8	0.357	0.266
Stoney Creek	Copper (Cu)-Dissolved	Fall	8	0.694	0.029
Stoney Creek	Copper (Cu)-Dissolved	Spring	10	-0.360	0.178
Stoney Creek	Copper (Cu)-Dissolved	Summer	7	0.143	0.764
Stoney Creek	Copper (Cu)-Total	Fall	8	-0.109	0.803
Stoney Creek	Copper (Cu)-Total	Spring	10	-0.422	0.107
Stoney Creek	Copper (Cu)-Total	Summer	7	0.048	1.000
Stoney Creek	Fluoride (F)	Fall	7	0.524	0.133
Stoney Creek	Fluoride (F)	Spring	10	0.225	0.419
Stoney Creek	Fluoride (F)	Summer	7	0.794	0.026
Stoney Creek	Hardness (as CaCO3)	Fall	8	-0.286	0.386
Stoney Creek	Hardness (as CaCO3)	Spring	10	0.244	0.371
Stoney Creek	Hardness (as CaCO3)	Summer	7	0.048	1.000
Stoney Creek	Iron (Fe)-Dissolved	Fall	8	0.214	0.536
Stoney Creek	Iron (Fe)-Dissolved	Spring	10	0.156	0.592
Stoney Creek	Iron (Fe)-Dissolved	Summer	7	0.293	0.448
Stoney Creek	Iron (Fe)-Total	Fall	8	0.286	0.386
Stoney Creek	Iron (Fe)-Total	Spring	10	-0.244	0.371
Stoney Creek	Iron (Fe)-Total	Summer	7	0.333	0.368
Stoney Creek	Lead (Pb)-Dissolved	Fall	8	-0.429	0.174
Stoney Creek	Lead (Pb)-Dissolved	Spring	10	-0.467	0.074
Stoney Creek	Lead (Pb)-Dissolved	Summer	7	0.238	0.548
Stoney Creek	Lead (Pb)-Total	Fall	8	-0.429	0.174
Stoney Creek	Lead (Pb)-Total	Spring	10	-0.422	0.107
Stoney Creek	Lead (Pb)-Total	Summer	7	0.333	0.368
Stoney Creek	Lithium (Li)-Dissolved	Fall	8	0.429	0.174
Stoney Creek	Lithium (Li)-Dissolved	Spring	10	0.200	0.474
Stoney Creek	Lithium (Li)-Dissolved	Summer	7	0.195	0.649
Stoney Creek	Lithium (Li)-Total	Fall	8	0.400	0.212
Stoney Creek	Lithium (Li)-Total	Spring	10	0.200	0.474
Stoney Creek	Lithium (Li)-Total	Summer	7	0.714	0.035
Stoney Creek	Magnesium (Mg)-Dissolved	Fall	8	-0.036	1.000
Stoney Creek	Magnesium (Mg)-Dissolved	Spring	10	0.422	0.107
Stoney Creek	Magnesium (Mg)-Dissolved	Summer	7	0.238	0.548
Stoney Creek	Magnesium (Mg)-Total	Fall	8	-0.143	0.711
Stoney Creek	Magnesium (Mg)-Total	Spring	10	0.422	0.107
Stoney Creek	Magnesium (Mg)-Total	Summer	7	0.333	0.368
Stoney Creek	Manganese (Mn)-Dissolved	Fall	8	0.071	0.902
Stoney Creek	Manganese (Mn)-Dissolved	Spring	10	0.244	0.371
Stoney Creek	Manganese (Mn)-Dissolved	Summer	7	0.143	0.764
Stoney Creek	Manganese (Mn)-Total	Fall	8	<0.001	1.000
Stoney Creek	Manganese (Mn)-Total	Spring	10	-0.200	0.474
Stoney Creek	Manganese (Mn)-Total	Summer	7	0.048	1.000
Stoney Creek	Mercury (Hg)-Dissolved	Fall	8	1.000	1.000

Site	Analyte	Season	n	Tau	p-Value
Stoney Creek	Mercury (Hg)-Dissolved	Spring	10	-0.061	0.911
Stoney Creek	Mercury (Hg)-Dissolved	Summer	7	1.000	1.000
Stoney Creek	Mercury (Hg)-Total	Fall	8	-0.535	0.115
Stoney Creek	Mercury (Hg)-Total	Spring	10	-0.333	0.210
Stoney Creek	Mercury (Hg)-Total	Summer	7	0.356	0.453
Stoney Creek	Molybdenum (Mo)-Dissolved	Fall	8	0.071	0.902
Stoney Creek	Molybdenum (Mo)-Dissolved	Spring	10	0.111	0.721
Stoney Creek	Molybdenum (Mo)-Dissolved	Summer	7	0.333	0.368
Stoney Creek	Molybdenum (Mo)-Total	Fall	8	-0.036	1.000
Stoney Creek	Molybdenum (Mo)-Total	Spring	10	0.244	0.371
Stoney Creek	Molybdenum (Mo)-Total	Summer	7	0.143	0.764
Stoney Creek	Nickel (Ni)-Dissolved	Fall	8	0.214	0.536
Stoney Creek	Nickel (Ni)-Dissolved	Spring	10	0.467	0.074
Stoney Creek	Nickel (Ni)-Dissolved	Summer	7	0.238	0.548
Stoney Creek	Nickel (Ni)-Total	Fall	8	0.255	0.454
Stoney Creek	Nickel (Ni)-Total	Spring	10	0.422	0.107
Stoney Creek	Nickel (Ni)-Total	Summer	7	0.714	0.035
Stoney Creek	Nitrate (as N)	Fall	7	-0.048	1.000
Stoney Creek	Nitrate (as N)	Spring	10	-0.244	0.371
Stoney Creek	pH	Spring	8	<0.001	1.000
Stoney Creek	Phosphorus (P)-Dissolved	Fall	7	1.000	1.000
Stoney Creek	Phosphorus (P)-Dissolved	Spring	9	1.000	1.000
Stoney Creek	Phosphorus (P)-Total	Fall	8	-0.286	0.386
Stoney Creek	Phosphorus (P)-Total	Spring	10	-0.689	0.007
Stoney Creek	Phosphorus (P)-Total	Summer	7	-0.429	0.230
Stoney Creek	Phosphorus (P)-Total Dissolved	Fall	8	0.645	0.046
Stoney Creek	Phosphorus (P)-Total Dissolved	Spring	10	0.584	0.025
Stoney Creek	Phosphorus (P)-Total Dissolved	Summer	7	0.507	0.180
Stoney Creek	Potassium (K)-Dissolved	Fall	8	-0.214	0.536
Stoney Creek	Potassium (K)-Dissolved	Spring	10	0.156	0.592
Stoney Creek	Potassium (K)-Dissolved	Summer	7	0.293	0.448
Stoney Creek	Potassium (K)-Total	Fall	8	-0.071	0.902
Stoney Creek	Potassium (K)-Total	Spring	10	0.200	0.474
Stoney Creek	Potassium (K)-Total	Summer	7	0.333	0.368
Stoney Creek	Selenium (Se)-Dissolved	Fall	8	0.327	0.319
Stoney Creek	Selenium (Se)-Dissolved	Spring	10	0.200	0.474
Stoney Creek	Selenium (Se)-Dissolved	Summer	7	0.048	1.000
Stoney Creek	Selenium (Se)-Total	Fall	8	0.429	0.174
Stoney Creek	Selenium (Se)-Total	Spring	10	0.200	0.474
Stoney Creek	Selenium (Se)-Total	Summer	7	0.238	0.548
Stoney Creek	Silicon (Si)-Dissolved	Fall	8	-0.143	0.711
Stoney Creek	Silicon (Si)-Dissolved	Spring	10	0.111	0.721
Stoney Creek	Silicon (Si)-Dissolved	Summer	7	0.143	0.764
Stoney Creek	Silicon (Si)-Total	Fall	8	-0.109	0.803
Stoney Creek	Silicon (Si)-Total	Spring	10	0.111	0.721
Stoney Creek	Silicon (Si)-Total	Summer	7	0.238	0.548
Stoney Creek	Silver (Ag)-Dissolved	Fall	8	1.000	1.000
Stoney Creek	Silver (Ag)-Dissolved	Spring	10	-0.248	0.486

Site	Analyte	Season	n	Tau	p-Value
Stoney Creek	Silver (Ag)-Dissolved	Summer	7	1.000	1.000
Stoney Creek	Silver (Ag)-Total	Fall	8	1.000	1.000
Stoney Creek	Silver (Ag)-Total	Spring	10	-0.149	0.728
Stoney Creek	Silver (Ag)-Total	Summer	7	1.000	1.000
Stoney Creek	Sodium (Na)-Dissolved	Fall	8	0.429	0.174
Stoney Creek	Sodium (Na)-Dissolved	Spring	10	-0.111	0.721
Stoney Creek	Sodium (Na)-Dissolved	Summer	7	0.810	0.016
Stoney Creek	Sodium (Na)-Total	Fall	8	0.500	0.108
Stoney Creek	Sodium (Na)-Total	Spring	10	0.111	0.721
Stoney Creek	Sodium (Na)-Total	Summer	7	0.878	0.010
Stoney Creek	Strontium (Sr)-Dissolved	Fall	8	-0.071	0.902
Stoney Creek	Strontium (Sr)-Dissolved	Spring	10	0.467	0.074
Stoney Creek	Strontium (Sr)-Dissolved	Summer	7	0.586	0.095
Stoney Creek	Strontium (Sr)-Total	Fall	8	-0.036	1.000
Stoney Creek	Strontium (Sr)-Total	Spring	10	0.511	0.049
Stoney Creek	Strontium (Sr)-Total	Summer	7	0.810	0.016
Stoney Creek	Sulfate (SO4)	Fall	7	0.333	0.368
Stoney Creek	Sulfate (SO4)	Spring	10	0.556	0.032
Stoney Creek	Sulfate (SO4)	Summer	7	0.619	0.072
Stoney Creek	Thallium (Tl)-Dissolved	Fall	8	-0.400	0.212
Stoney Creek	Thallium (Tl)-Dissolved	Spring	10	0.322	0.238
Stoney Creek	Thallium (Tl)-Dissolved	Summer	7	0.206	0.638
Stoney Creek	Thallium (Tl)-Total	Fall	8	-0.643	0.042
Stoney Creek	Thallium (Tl)-Total	Spring	10	0.180	0.530
Stoney Creek	Thallium (Tl)-Total	Summer	7	0.411	0.272
Stoney Creek	Tin (Sn)-Dissolved	Fall	8	0.413	0.247
Stoney Creek	Tin (Sn)-Dissolved	Spring	10	0.415	0.152
Stoney Creek	Tin (Sn)-Dissolved	Summer	7	-0.050	1.000
Stoney Creek	Tin (Sn)-Total	Fall	8	0.655	0.067
Stoney Creek	Tin (Sn)-Total	Spring	10	0.447	0.109
Stoney Creek	Tin (Sn)-Total	Summer	7	0.329	0.447
Stoney Creek	Titanium (Ti)-Dissolved	Fall	8	-0.845	0.010
Stoney Creek	Titanium (Ti)-Dissolved	Spring	10	-0.843	0.003
Stoney Creek	Titanium (Ti)-Dissolved	Summer	7	-0.816	0.027
Stoney Creek	Titanium (Ti)-Total	Fall	8	-0.267	0.474
Stoney Creek	Titanium (Ti)-Total	Spring	10	-0.422	0.107
Stoney Creek	Titanium (Ti)-Total	Summer	7	0.206	0.638
Stoney Creek	Total Dissolved Solids	Spring	8	0.071	0.902
Stoney Creek	Total Kjeldahl Nitrogen	Fall	8	0.074	0.900
Stoney Creek	Total Kjeldahl Nitrogen	Spring	9	-0.278	0.348
Stoney Creek	Total Kjeldahl Nitrogen	Summer	7	-0.238	0.548
Stoney Creek	Total Organic Carbon	Fall	7	0.524	0.133
Stoney Creek	Total Organic Carbon	Spring	9	<0.001	1.000
Stoney Creek	Total Organic Carbon	Summer	7	0.293	0.448
Stoney Creek	Total Suspended Solids	Spring	8	-0.367	0.324
Stoney Creek	Turbidity	Fall	8	-0.618	0.046
Stoney Creek	Turbidity	Spring	10	-0.511	0.049
Stoney Creek	Turbidity	Summer	7	-0.524	0.133

Site	Analyte	Season	n	Tau	p-Value
Stoney Creek	Uranium (U)-Dissolved	Fall	8	0.143	0.711
Stoney Creek	Uranium (U)-Dissolved	Spring	10	0.022	1.000
Stoney Creek	Uranium (U)-Dissolved	Summer	7	0.619	0.072
Stoney Creek	Uranium (U)-Total	Fall	8	0.286	0.386
Stoney Creek	Uranium (U)-Total	Spring	10	0.090	0.788
Stoney Creek	Uranium (U)-Total	Summer	7	0.429	0.230
Stoney Creek	Vanadium (V)-Dissolved	Fall	8	<0.001	1.000
Stoney Creek	Vanadium (V)-Dissolved	Spring	10	0.067	0.858
Stoney Creek	Vanadium (V)-Dissolved	Summer	7	0.143	0.764
Stoney Creek	Vanadium (V)-Total	Fall	8	0.143	0.711
Stoney Creek	Vanadium (V)-Total	Spring	10	-0.111	0.721
Stoney Creek	Vanadium (V)-Total	Summer	7	0.293	0.448
Stoney Creek	Zinc (Zn)-Dissolved	Fall	8	0.429	0.174
Stoney Creek	Zinc (Zn)-Dissolved	Spring	10	-0.022	1.000
Stoney Creek	Zinc (Zn)-Dissolved	Summer	7	0.238	0.548
Stoney Creek	Zinc (Zn)-Total	Fall	8	0.429	0.174
Stoney Creek	Zinc (Zn)-Total	Spring	10	-0.022	1.000
Stoney Creek	Zinc (Zn)-Total	Summer	7	0.333	0.368
Stoney Creek	Zirconium (Zr)-Dissolved	Fall	8	-0.321	0.385
Stoney Creek	Zirconium (Zr)-Dissolved	Spring	10	-0.542	0.070
Stoney Creek	Zirconium (Zr)-Dissolved	Summer	7	-0.394	0.315
Stoney Creek	Zirconium (Zr)-Total	Fall	8	-0.688	0.043
Stoney Creek	Zirconium (Zr)-Total	Spring	10	-0.542	0.070
Stoney Creek	Zirconium (Zr)-Total	Summer	7	-0.620	0.094

Table 187. Significant Mann Kendall results for analytes in water quality samples taken in the right-hand shallows.

Site	Analyte	Season	n	Tau	p-Value
Birchbank	Aluminum (Al)-Total	Spring	10	-0.511	0.049
Birchbank	Barium (Ba)-Dissolved	Summer	7	0.781	0.023
Birchbank	Beryllium (Be)-Total	Fall	8	-0.732	0.037
Birchbank	Beryllium (Be)-Total	Spring	10	-0.637	0.024
Birchbank	Copper (Cu)-Dissolved	Fall	8	0.691	0.025
Birchbank	Copper (Cu)-Total	Spring	10	-0.584	0.025
Birchbank	Lead (Pb)-Total	Spring	10	-0.556	0.032
Birchbank	Nickel (Ni)-Total	Summer	7	0.810	0.016
Birchbank	Phosphorus (P)-Total	Spring	10	-0.689	0.007
Birchbank	Selenium (Se)-Total	Fall	8	0.714	0.019
Birchbank	Sodium (Na)-Dissolved	Summer	7	0.781	0.023
Birchbank	Sodium (Na)-Total	Summer	7	0.714	0.035
Birchbank	Strontium (Sr)-Dissolved	Spring	10	0.644	0.012
Birchbank	Strontium (Sr)-Dissolved	Summer	7	0.714	0.035
Birchbank	Strontium (Sr)-Total	Spring	10	0.584	0.025
Birchbank	Sulfate (SO4)	Spring	10	0.600	0.020
Birchbank	Thallium (Tl)-Dissolved	Spring	10	0.689	0.007
Birchbank	Thallium (Tl)-Total	Spring	10	0.511	0.049
Birchbank	Titanium (Ti)-Dissolved	Fall	8	-0.845	0.010
Birchbank	Titanium (Ti)-Dissolved	Spring	10	-0.804	0.004
Birchbank	Titanium (Ti)-Dissolved	Summer	7	-0.816	0.027
Birchbank	Total Organic Carbon	Fall	7	0.905	0.007
Birchbank	Turbidity	Spring	10	-0.733	0.004
Birchbank	Uranium (U)-Dissolved	Summer	7	0.683	0.048
Birchbank	Vanadium (V)-Total	Summer	7	0.683	0.048
Birchbank	Zirconium (Zr)-Total	Fall	8	-0.732	0.037
Maglios	Barium (Ba)-Dissolved	Summer	7	0.683	0.048
Maglios	Cadmium (Cd)-Dissolved	Fall	7	-0.905	0.007
Maglios	Cadmium (Cd)-Dissolved	Spring	8	-0.643	0.035
Maglios	Cadmium (Cd)-Total	Summer	7	-0.905	0.007
Maglios	Chloride (Cl)	Summer	7	0.732	0.044
Maglios	Copper (Cu)-Dissolved	Spring	8	-0.714	0.019
Maglios	Fluoride (F)	Summer	7	0.683	0.048
Maglios	Magnesium (Mg)-Total	Fall	7	-0.714	0.035
Maglios	Nickel (Ni)-Dissolved	Spring	8	0.714	0.019
Maglios	Nickel (Ni)-Total	Spring	8	0.643	0.035
Maglios	Phosphorus (P)-Total	Spring	8	-0.643	0.035
Maglios	Phosphorus (P)-Total Dissolved	Spring	8	0.945	0.002
Maglios	Selenium (Se)-Total	Summer	7	0.714	0.035
Maglios	Silver (Ag)-Total	Spring	8	-0.713	0.032
Maglios	Sodium (Na)-Total	Summer	7	0.810	0.016
Maglios	Strontium (Sr)-Dissolved	Spring	8	0.643	0.035
Maglios	Strontium (Sr)-Dissolved	Summer	7	0.976	0.004
Maglios	Strontium (Sr)-Total	Spring	8	0.764	0.013
Maglios	Strontium (Sr)-Total	Summer	7	0.878	0.010

Site	Analyte	Season	n	Tau	p-Value
Maglios	Sulfate (SO4)	Spring	8	0.643	0.042
Maglios	Thallium (Tl)-Dissolved	Summer	7	0.810	0.016
Maglios	Thallium (Tl)-Total	Summer	7	0.905	0.007
Maglios	Tin (Sn)-Total	Spring	8	0.681	0.048
Maglios	Titanium (Ti)-Dissolved	Fall	7	-0.816	0.027
Maglios	Titanium (Ti)-Dissolved	Spring	8	-0.845	0.010
Maglios	Titanium (Ti)-Dissolved	Summer	7	-0.816	0.027
Maglios	Total Kjeldahl Nitrogen	Spring	8	-0.714	0.019
Maglios	Total Kjeldahl Nitrogen	Summer	7	-0.781	0.023
Maglios	Uranium (U)-Dissolved	Summer	7	0.714	0.035
New Bridge	Aluminum (Al)-Total	Spring	10	-0.511	0.049
New Bridge	Ammonia, Total (as N)	Summer	7	-0.878	0.010
New Bridge	Barium (Ba)-Dissolved	Summer	7	0.714	0.035
New Bridge	Beryllium (Be)-Total	Fall	8	-0.732	0.037
New Bridge	Cadmium (Cd)-Dissolved	Fall	8	-0.643	0.035
New Bridge	Cadmium (Cd)-Dissolved	Spring	10	-0.556	0.032
New Bridge	Cadmium (Cd)-Dissolved	Summer	7	-0.714	0.035
New Bridge	Cadmium (Cd)-Total	Spring	10	-0.556	0.032
New Bridge	Cadmium (Cd)-Total	Summer	7	-0.810	0.016
New Bridge	Fluoride (F)	Fall	7	0.781	0.023
New Bridge	Nitrate (as N)	Spring	10	0.644	0.012
New Bridge	Phosphorus (P)-Total	Spring	10	-0.556	0.032
New Bridge	Phosphorus (P)-Total Dissolved	Spring	10	0.600	0.020
New Bridge	Selenium (Se)-Dissolved	Fall	8	0.643	0.035
New Bridge	Strontium (Sr)-Dissolved	Spring	10	0.556	0.032
New Bridge	Strontium (Sr)-Total	Spring	10	0.584	0.025
New Bridge	Strontium (Sr)-Total	Summer	7	0.951	0.006
New Bridge	Thallium (Tl)-Dissolved	Summer	7	0.714	0.035
New Bridge	Thallium (Tl)-Total	Summer	7	0.714	0.035
New Bridge	Tin (Sn)-Dissolved	Spring	10	0.653	0.025
New Bridge	Titanium (Ti)-Dissolved	Fall	8	-0.845	0.010
New Bridge	Titanium (Ti)-Dissolved	Spring	10	-0.843	0.003
New Bridge	Titanium (Ti)-Dissolved	Summer	7	-0.845	0.019
New Bridge	Turbidity	Fall	8	-0.764	0.013
New Bridge	Turbidity	Spring	10	-0.600	0.020
New Bridge	Zinc (Zn)-Dissolved	Fall	8	-0.618	0.046
New Bridge	Zinc (Zn)-Total	Fall	8	-0.714	0.019
New Bridge	Zinc (Zn)-Total	Summer	7	-0.810	0.016
New Bridge	Zirconium (Zr)-Total	Fall	8	-0.732	0.037
Old Bridge	Aluminum (Al)-Dissolved	Fall	8	-0.714	0.019
Old Bridge	Beryllium (Be)-Dissolved	Spring	10	-0.591	0.044
Old Bridge	Cadmium (Cd)-Dissolved	Fall	8	-0.643	0.035
Old Bridge	Cadmium (Cd)-Dissolved	Spring	10	-0.600	0.020
Old Bridge	Cadmium (Cd)-Dissolved	Summer	7	-0.751	0.031
Old Bridge	Cadmium (Cd)-Total	Fall	8	-0.714	0.019
Old Bridge	Cadmium (Cd)-Total	Spring	10	-0.511	0.049
Old Bridge	Cadmium (Cd)-Total	Summer	7	-0.810	0.016
Old Bridge	Magnesium (Mg)-Total	Spring	10	0.556	0.032

Site	Analyte	Season	n	Tau	p-Value
Old Bridge	Nickel (Ni)-Dissolved	Spring	10	0.511	0.049
Old Bridge	Phosphorus (P)-Total	Spring	10	-0.689	0.007
Old Bridge	Sodium (Na)-Dissolved	Summer	7	0.781	0.023
Old Bridge	Sodium (Na)-Total	Summer	7	0.683	0.048
Old Bridge	Strontium (Sr)-Dissolved	Spring	10	0.511	0.049
Old Bridge	Strontium (Sr)-Dissolved	Summer	7	0.976	0.004
Old Bridge	Thallium (Tl)-Dissolved	Summer	7	0.714	0.035
Old Bridge	Tin (Sn)-Total	Spring	10	0.747	0.008
Old Bridge	Titanium (Ti)-Dissolved	Fall	8	-0.845	0.010
Old Bridge	Titanium (Ti)-Dissolved	Spring	10	-0.843	0.003
Old Bridge	Titanium (Ti)-Dissolved	Summer	7	-0.816	0.027
Old Bridge	Turbidity	Spring	10	-0.556	0.032
Old Bridge	Uranium (U)-Dissolved	Summer	7	0.714	0.035
Old Bridge	Zirconium (Zr)-Total	Fall	8	-0.732	0.037
Stoney Creek	Ammonia, Total (as N)	Spring	10	0.511	0.049
Stoney Creek	Beryllium (Be)-Total	Fall	8	-0.732	0.037
Stoney Creek	Chloride (Cl)	Summer	7	0.732	0.044
Stoney Creek	Copper (Cu)-Dissolved	Fall	8	0.694	0.029
Stoney Creek	Fluoride (F)	Summer	7	0.794	0.026
Stoney Creek	Lithium (Li)-Total	Summer	7	0.714	0.035
Stoney Creek	Nickel (Ni)-Total	Summer	7	0.714	0.035
Stoney Creek	Phosphorus (P)-Total	Spring	10	-0.689	0.007
Stoney Creek	Phosphorus (P)-Total Dissolved	Fall	8	0.645	0.046
Stoney Creek	Phosphorus (P)-Total Dissolved	Spring	10	0.584	0.025
Stoney Creek	Sodium (Na)-Dissolved	Summer	7	0.810	0.016
Stoney Creek	Sodium (Na)-Total	Summer	7	0.878	0.010
Stoney Creek	Strontium (Sr)-Total	Spring	10	0.511	0.049
Stoney Creek	Strontium (Sr)-Total	Summer	7	0.810	0.016
Stoney Creek	Sulfate (SO4)	Spring	10	0.556	0.032
Stoney Creek	Thallium (Tl)-Total	Fall	8	-0.643	0.042
Stoney Creek	Titanium (Ti)-Dissolved	Fall	8	-0.845	0.010
Stoney Creek	Titanium (Ti)-Dissolved	Spring	10	-0.843	0.003
Stoney Creek	Titanium (Ti)-Dissolved	Summer	7	-0.816	0.027
Stoney Creek	Turbidity	Fall	8	-0.618	0.046
Stoney Creek	Turbidity	Spring	10	-0.511	0.049
Stoney Creek	Zirconium (Zr)-Total	Fall	8	-0.688	0.043

Table 188: Significant Mann Kendall results for analytes of interest in water quality samples taken in the right-hand shallows.

Site	Analyte	Season	n	Tau	p-Value
Birchbank	Aluminum (Al)-Total	Spring	10	-0.511	0.049
Birchbank	Copper (Cu)-Dissolved	Fall	8	0.691	0.025
Birchbank	Copper (Cu)-Total	Spring	10	-0.584	0.025
Birchbank	Lead (Pb)-Total	Spring	10	-0.556	0.032
Birchbank	Nickel (Ni)-Total	Summer	7	0.810	0.016
Birchbank	Phosphorus (P)-Total	Spring	10	-0.689	0.007
Birchbank	Selenium (Se)-Total	Fall	8	0.714	0.019
Birchbank	Sulfate (SO4)	Spring	10	0.600	0.020
Birchbank	Thallium (Tl)-Dissolved	Spring	10	0.689	0.007
Birchbank	Thallium (Tl)-Total	Spring	10	0.511	0.049
Birchbank	Total Organic Carbon	Fall	7	0.905	0.007
Maglios	Cadmium (Cd)-Dissolved	Fall	7	-0.905	0.007
Maglios	Cadmium (Cd)-Dissolved	Spring	8	-0.643	0.035
Maglios	Cadmium (Cd)-Total	Summer	7	-0.905	0.007
Maglios	Copper (Cu)-Dissolved	Spring	8	-0.714	0.019
Maglios	Nickel (Ni)-Dissolved	Spring	8	0.714	0.019
Maglios	Nickel (Ni)-Total	Spring	8	0.643	0.035
Maglios	Phosphorus (P)-Total	Spring	8	-0.643	0.035
Maglios	Phosphorus (P)-Total Dissolved	Spring	8	0.945	0.002
Maglios	Selenium (Se)-Total	Summer	7	0.714	0.035
Maglios	Silver (Ag)-Total	Spring	8	-0.713	0.032
Maglios	Sulfate (SO4)	Spring	8	0.643	0.042
Maglios	Thallium (Tl)-Dissolved	Summer	7	0.810	0.016
Maglios	Thallium (Tl)-Total	Summer	7	0.905	0.007
Maglios	Total Kjeldahl Nitrogen	Spring	8	-0.714	0.019
Maglios	Total Kjeldahl Nitrogen	Summer	7	-0.781	0.023
New Bridge	Aluminum (Al)-Total	Spring	10	-0.511	0.049
New Bridge	Ammonia, Total (as N)	Summer	7	-0.878	0.010
New Bridge	Cadmium (Cd)-Dissolved	Fall	8	-0.643	0.035
New Bridge	Cadmium (Cd)-Dissolved	Spring	10	-0.556	0.032
New Bridge	Cadmium (Cd)-Dissolved	Summer	7	-0.714	0.035
New Bridge	Cadmium (Cd)-Total	Spring	10	-0.556	0.032
New Bridge	Cadmium (Cd)-Total	Summer	7	-0.810	0.016
New Bridge	Nitrate (as N)	Spring	10	0.644	0.012
New Bridge	Phosphorus (P)-Total	Spring	10	-0.556	0.032
New Bridge	Phosphorus (P)-Total Dissolved	Spring	10	0.600	0.020
New Bridge	Selenium (Se)-Dissolved	Fall	8	0.643	0.035
New Bridge	Thallium (Tl)-Dissolved	Summer	7	0.714	0.035
New Bridge	Thallium (Tl)-Total	Summer	7	0.714	0.035
New Bridge	Zinc (Zn)-Dissolved	Fall	8	-0.618	0.046
New Bridge	Zinc (Zn)-Total	Fall	8	-0.714	0.019
New Bridge	Zinc (Zn)-Total	Summer	7	-0.810	0.016
Old Bridge	Aluminum (Al)-Dissolved	Fall	8	-0.714	0.019
Old Bridge	Cadmium (Cd)-Dissolved	Fall	8	-0.643	0.035
Old Bridge	Cadmium (Cd)-Dissolved	Spring	10	-0.600	0.020
Old Bridge	Cadmium (Cd)-Dissolved	Summer	7	-0.751	0.031

Site	Analyte	Season	n	Tau	p-Value
Old Bridge	Cadmium (Cd)-Total	Fall	8	-0.714	0.019
Old Bridge	Cadmium (Cd)-Total	Spring	10	-0.511	0.049
Old Bridge	Cadmium (Cd)-Total	Summer	7	-0.810	0.016
Old Bridge	Nickel (Ni)-Dissolved	Spring	10	0.511	0.049
Old Bridge	Phosphorus (P)-Total	Spring	10	-0.689	0.007
Old Bridge	Thallium (Tl)-Dissolved	Summer	7	0.714	0.035
Stoney Creek	Ammonia, Total (as N)	Spring	10	0.511	0.049
Stoney Creek	Copper (Cu)-Dissolved	Fall	8	0.694	0.029
Stoney Creek	Nickel (Ni)-Total	Summer	7	0.714	0.035
Stoney Creek	Phosphorus (P)-Total	Spring	10	-0.689	0.007
Stoney Creek	Phosphorus (P)-Total Dissolved	Fall	8	0.645	0.046
Stoney Creek	Phosphorus (P)-Total Dissolved	Spring	10	0.584	0.025
Stoney Creek	Sulfate (SO4)	Spring	10	0.556	0.032
Stoney Creek	Thallium (Tl)-Total	Fall	8	-0.643	0.042

APPENDIX M FALL 2021 WATER QUALITY PLOTS

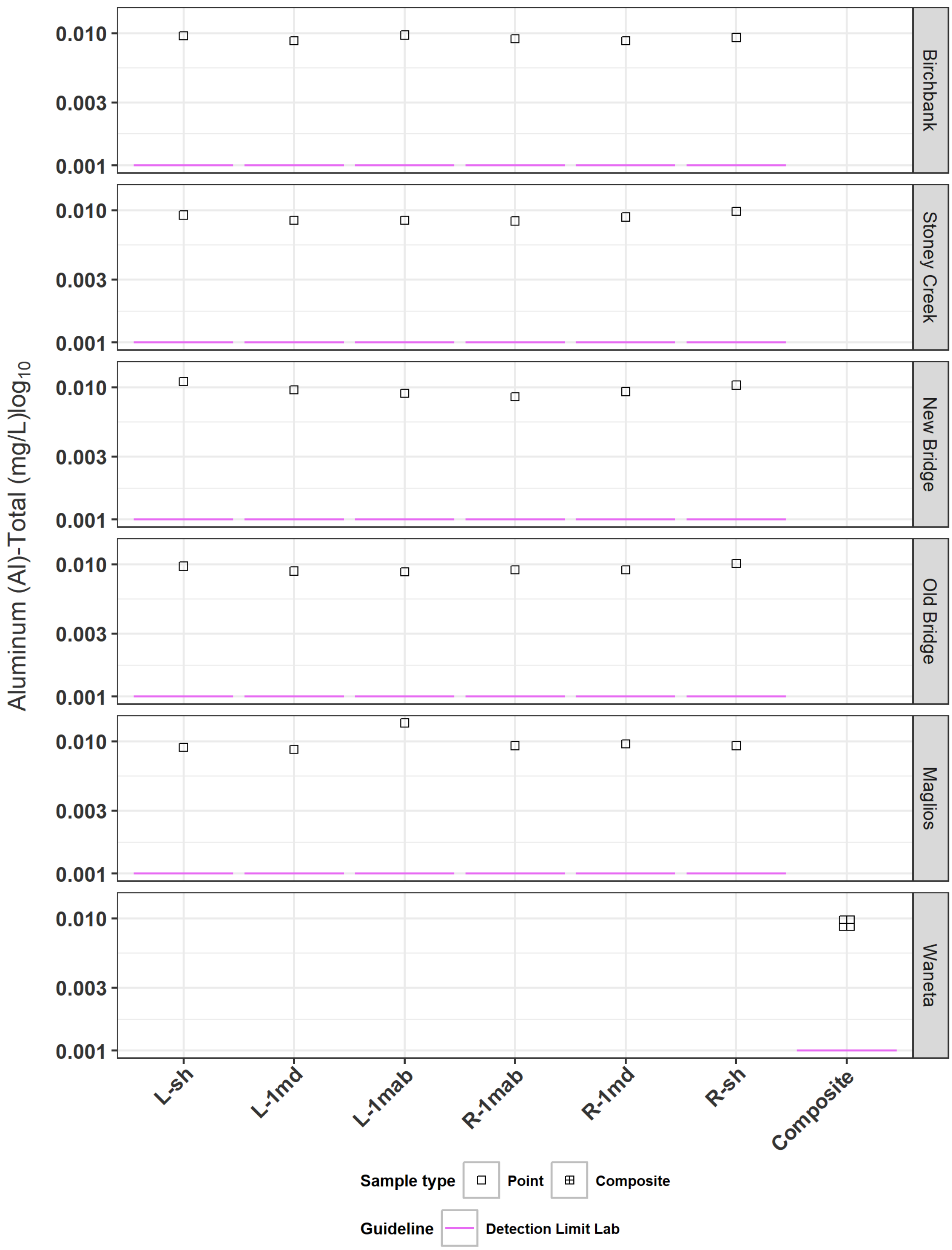


Figure M-24. Total aluminum concentration from transect water quality samples.

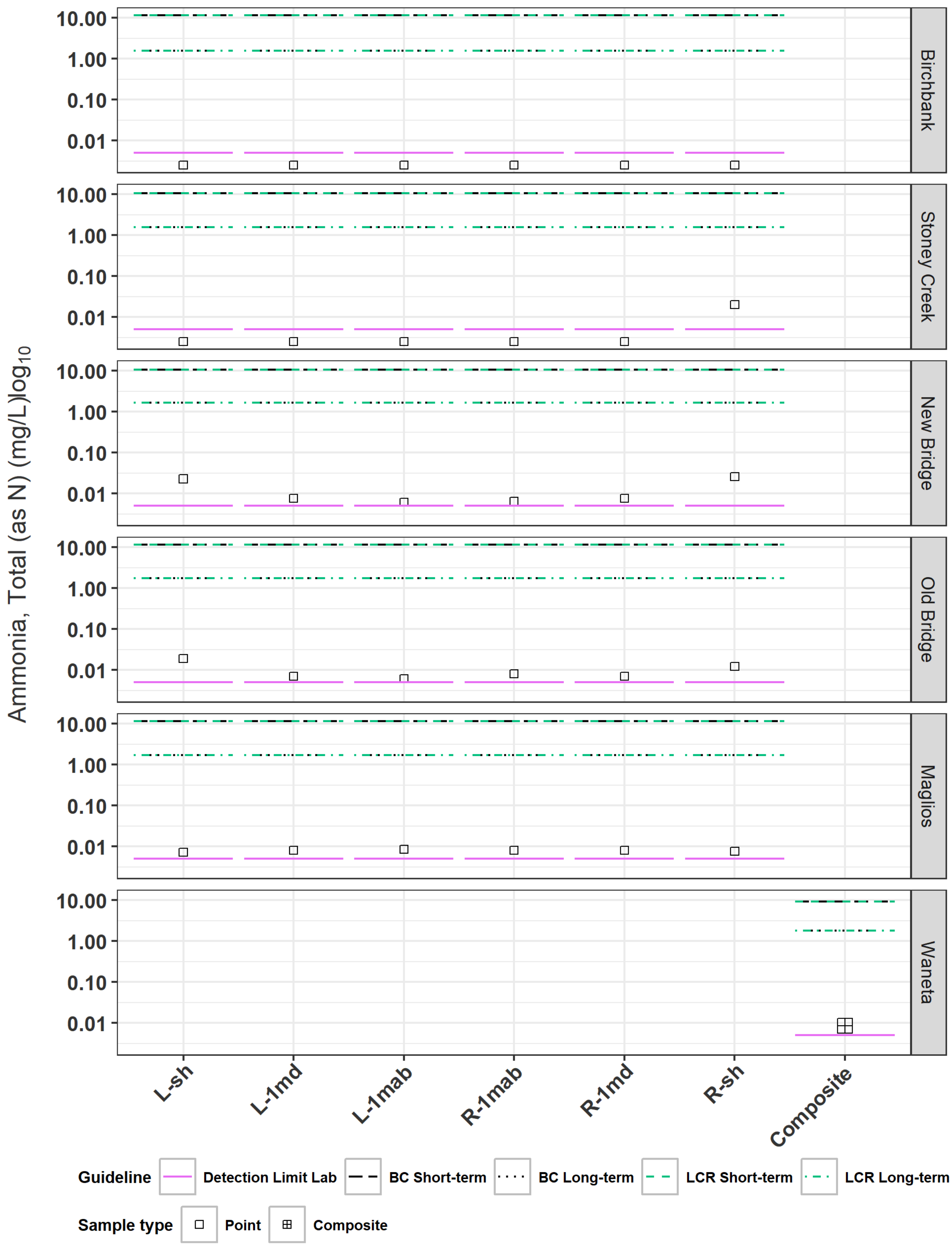


Figure M-25. Total ammonia concentration from transect water quality samples.

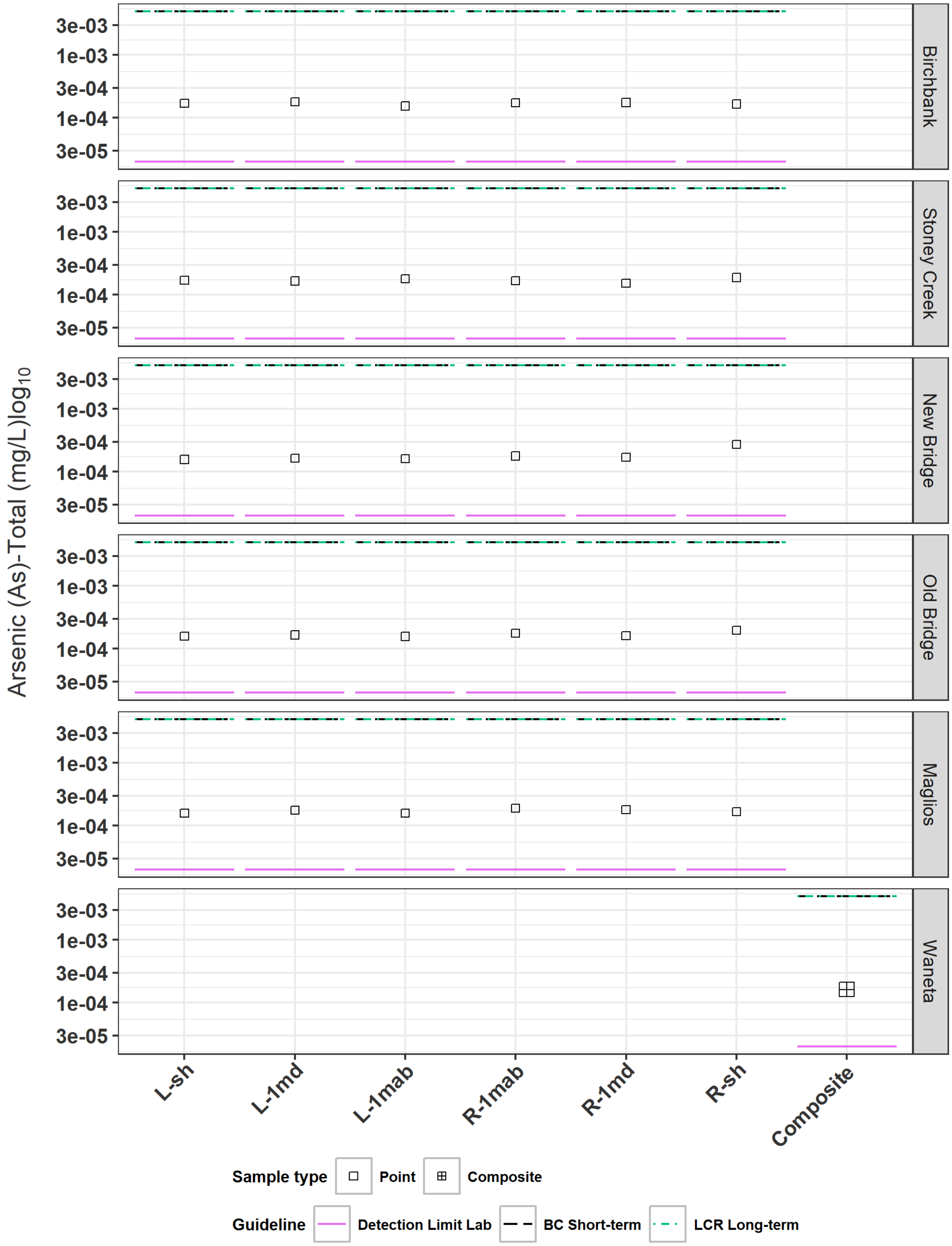


Figure M-26. Total arsenic concentration from transect water quality samples.

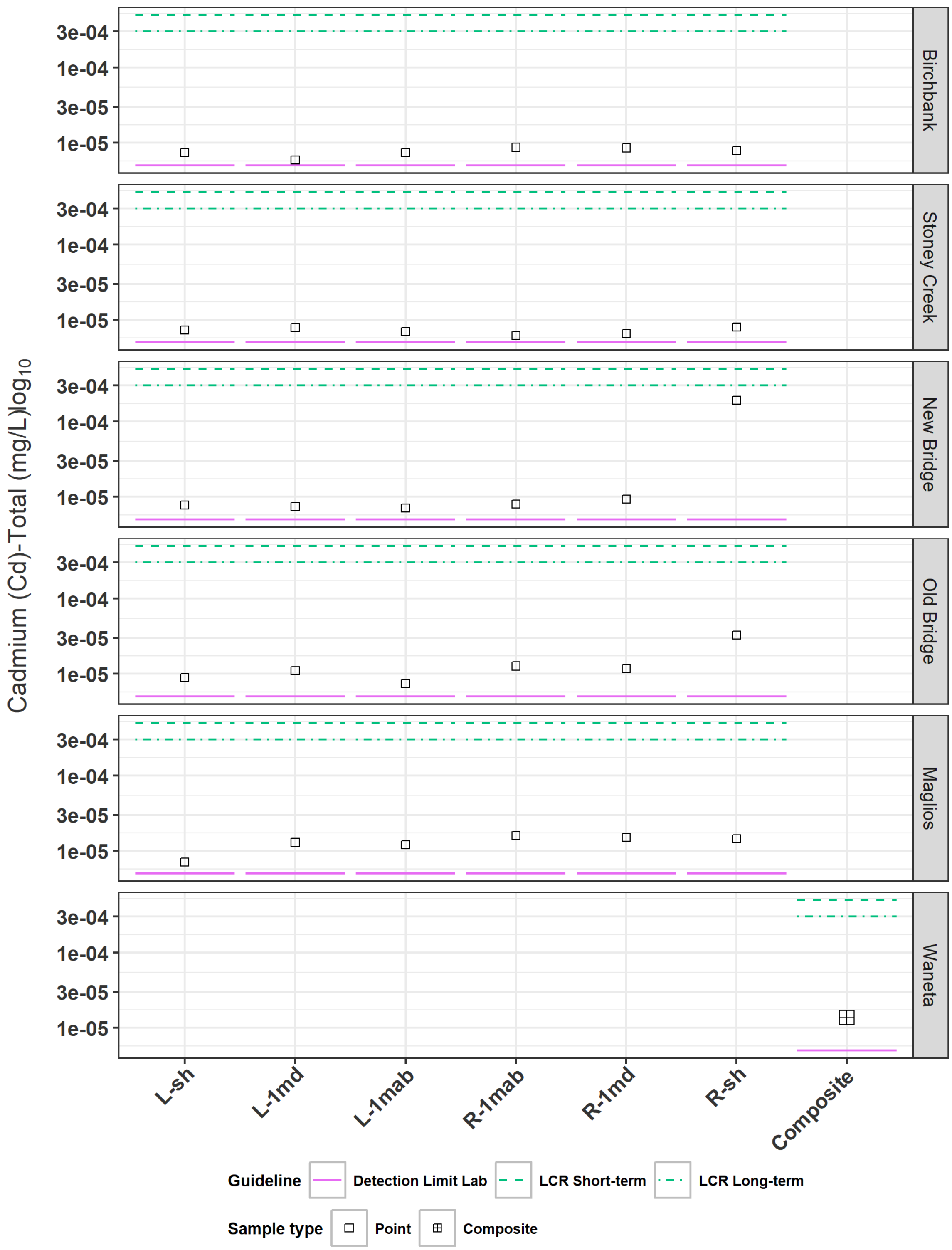


Figure M-27. Total cadmium concentration from transect water quality samples.

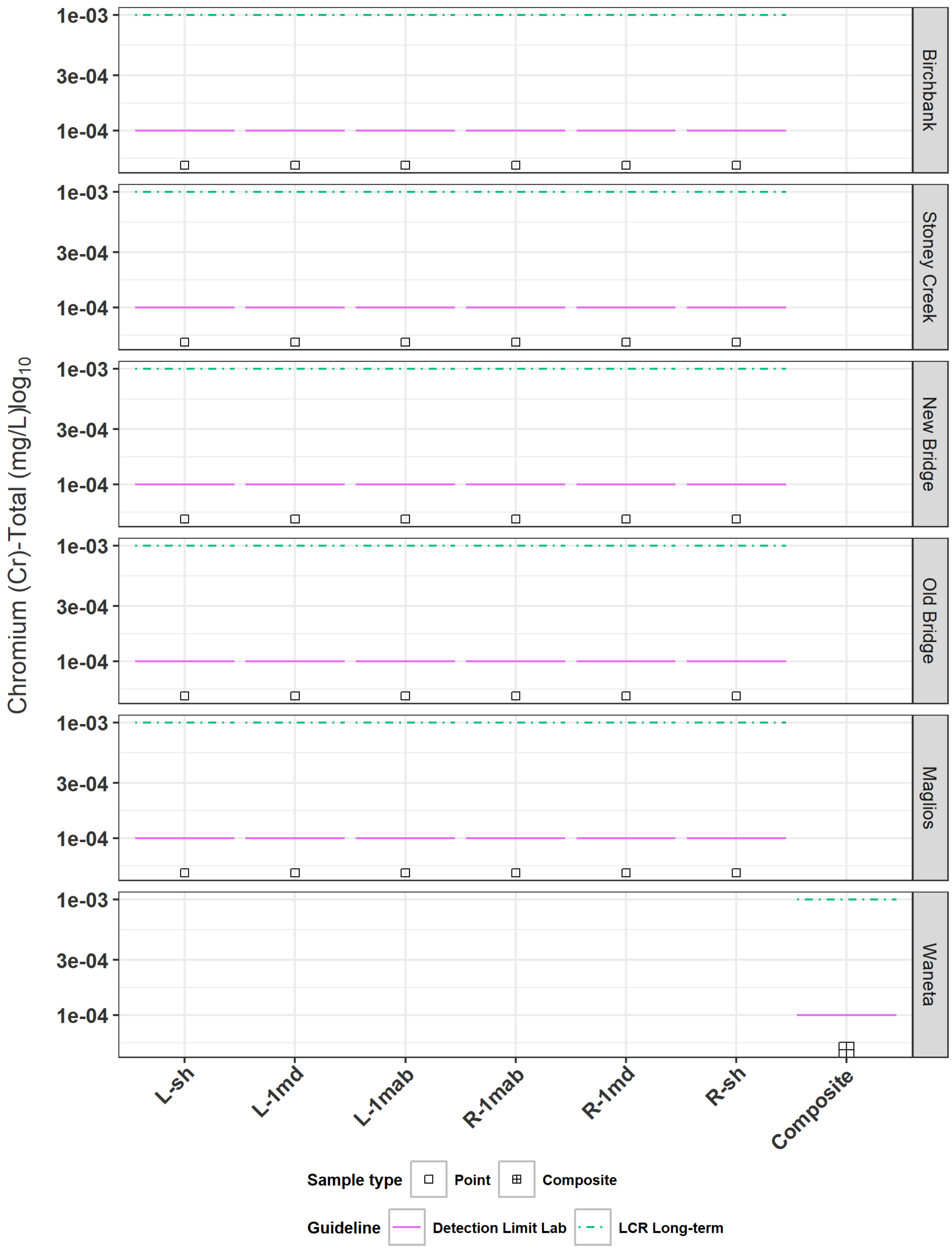


Figure M-28. Total chromium concentration from transect water quality samples.

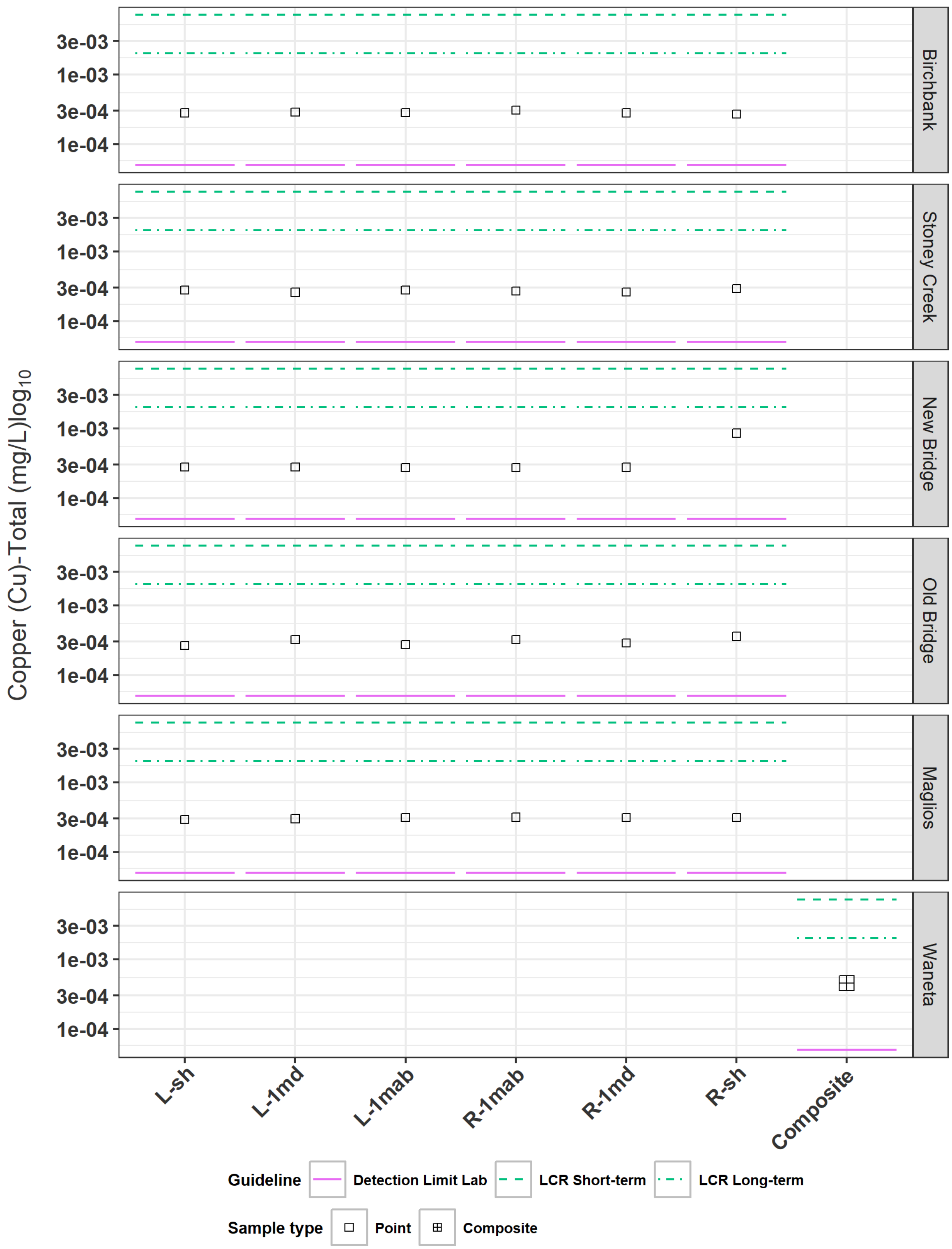


Figure M-29. Total copper concentration from transect water quality samples.

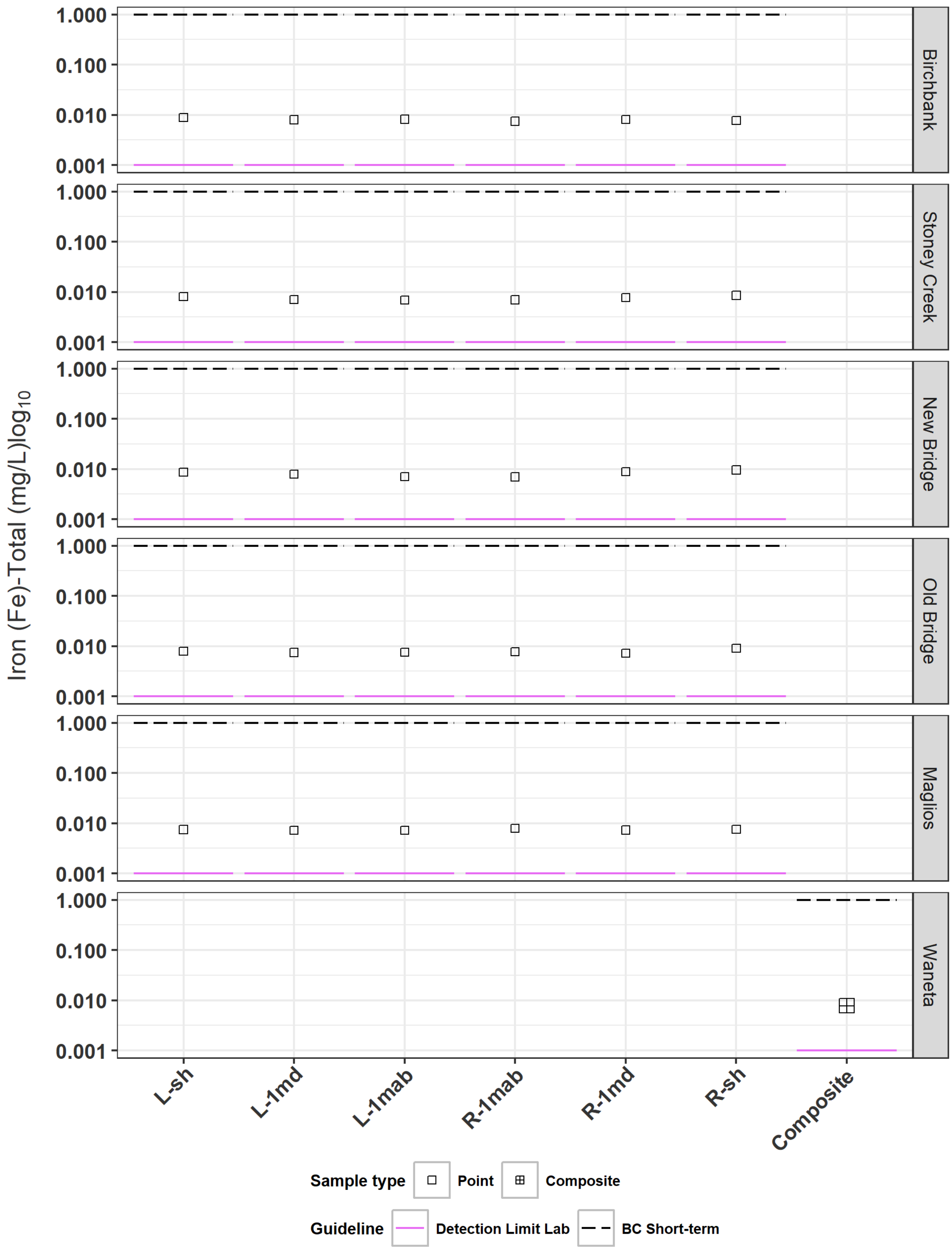


Figure M-30. Total iron concentration from transect water quality samples.

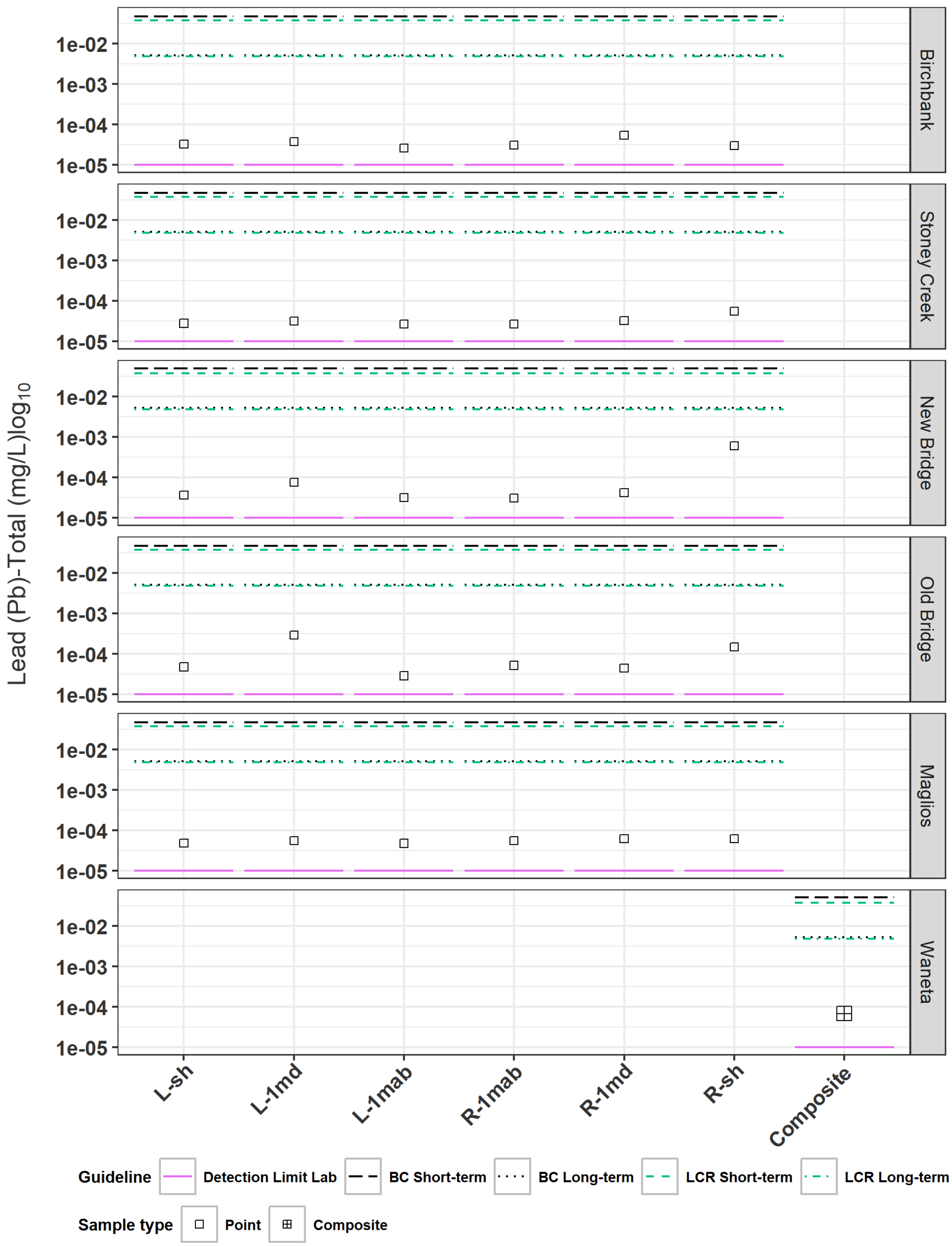


Figure M-31. Total lead concentration from transect water quality samples.

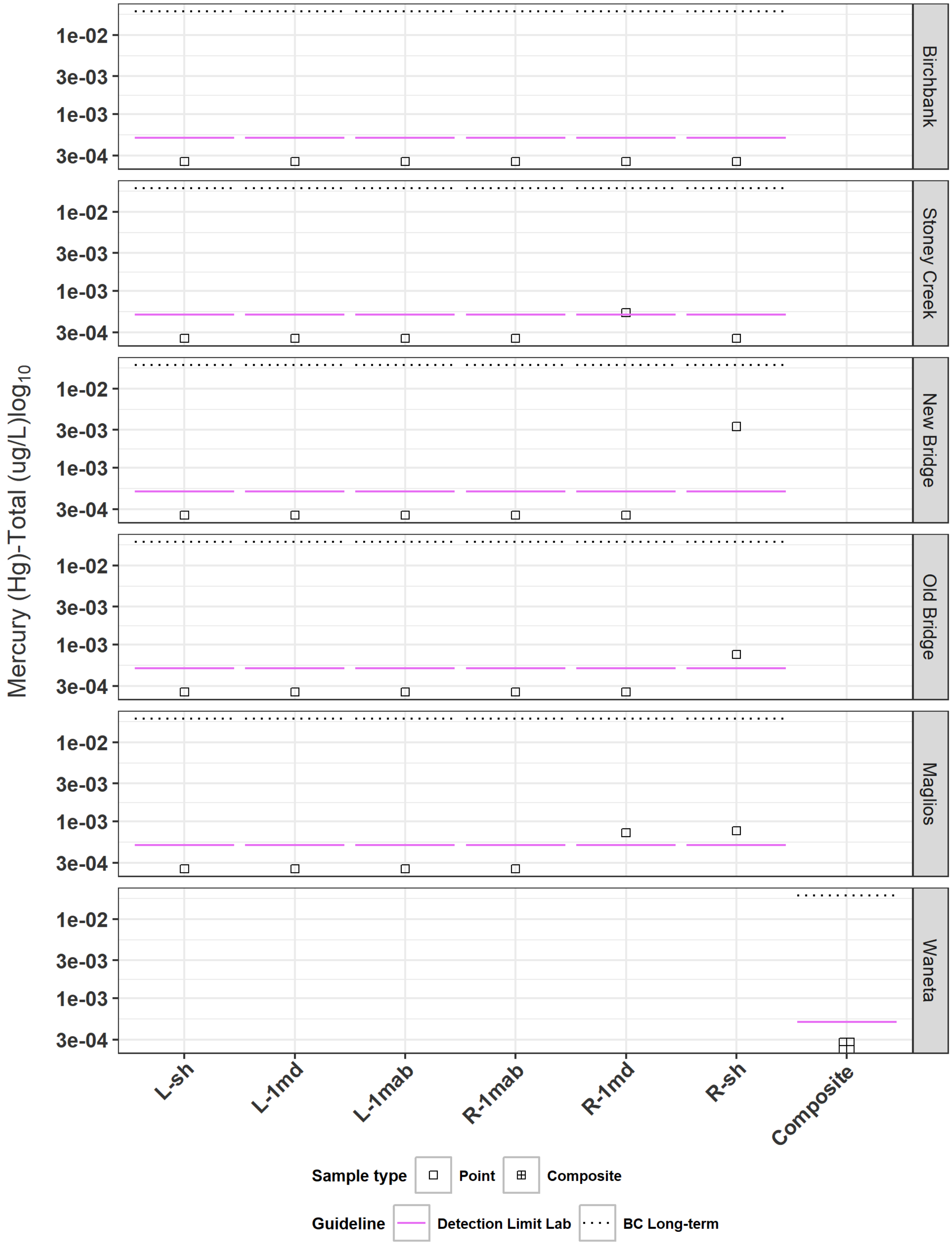


Figure M-32. Total mercury concentration from transect water quality samples.

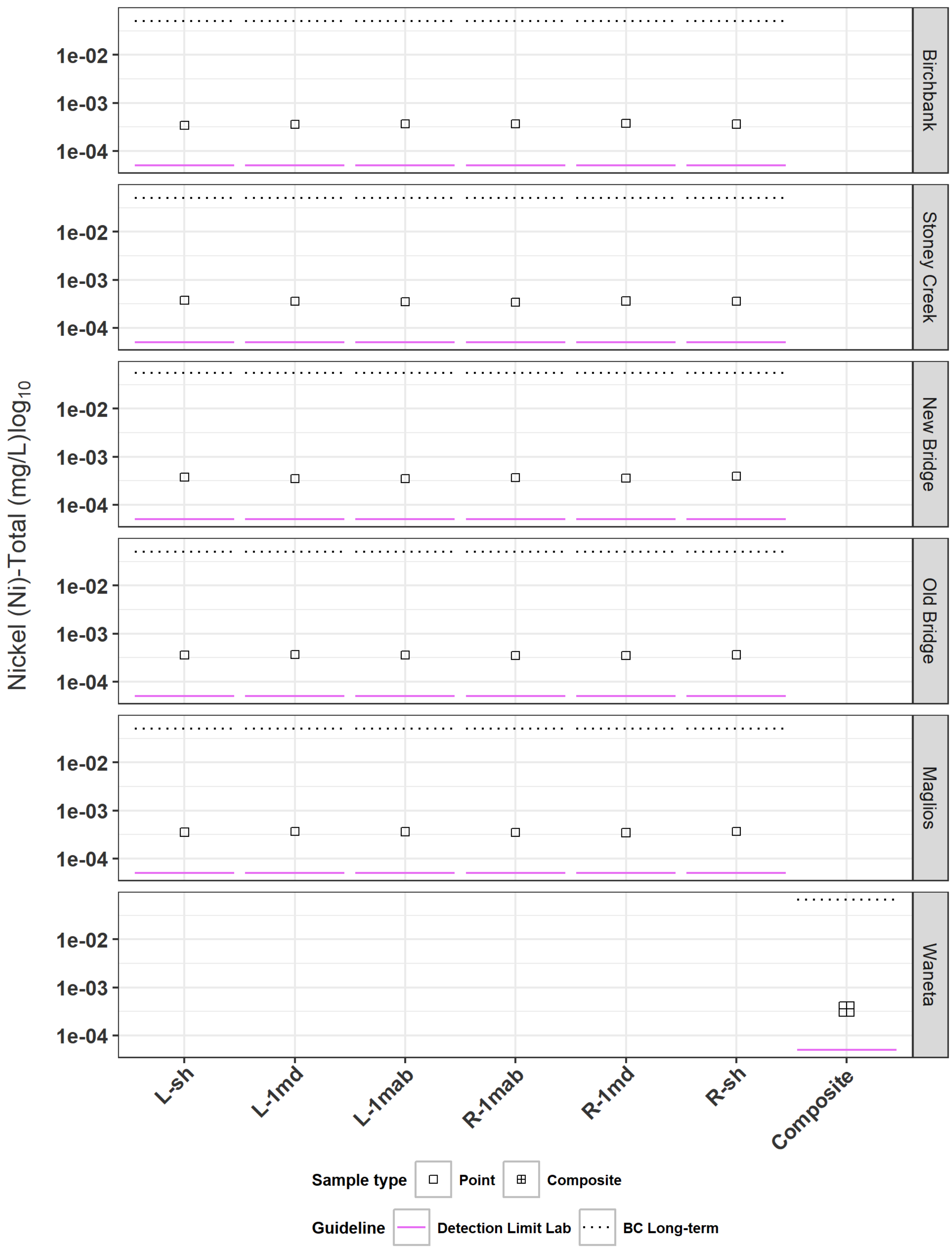


Figure M-33. Total nickel concentration from transect water quality samples.

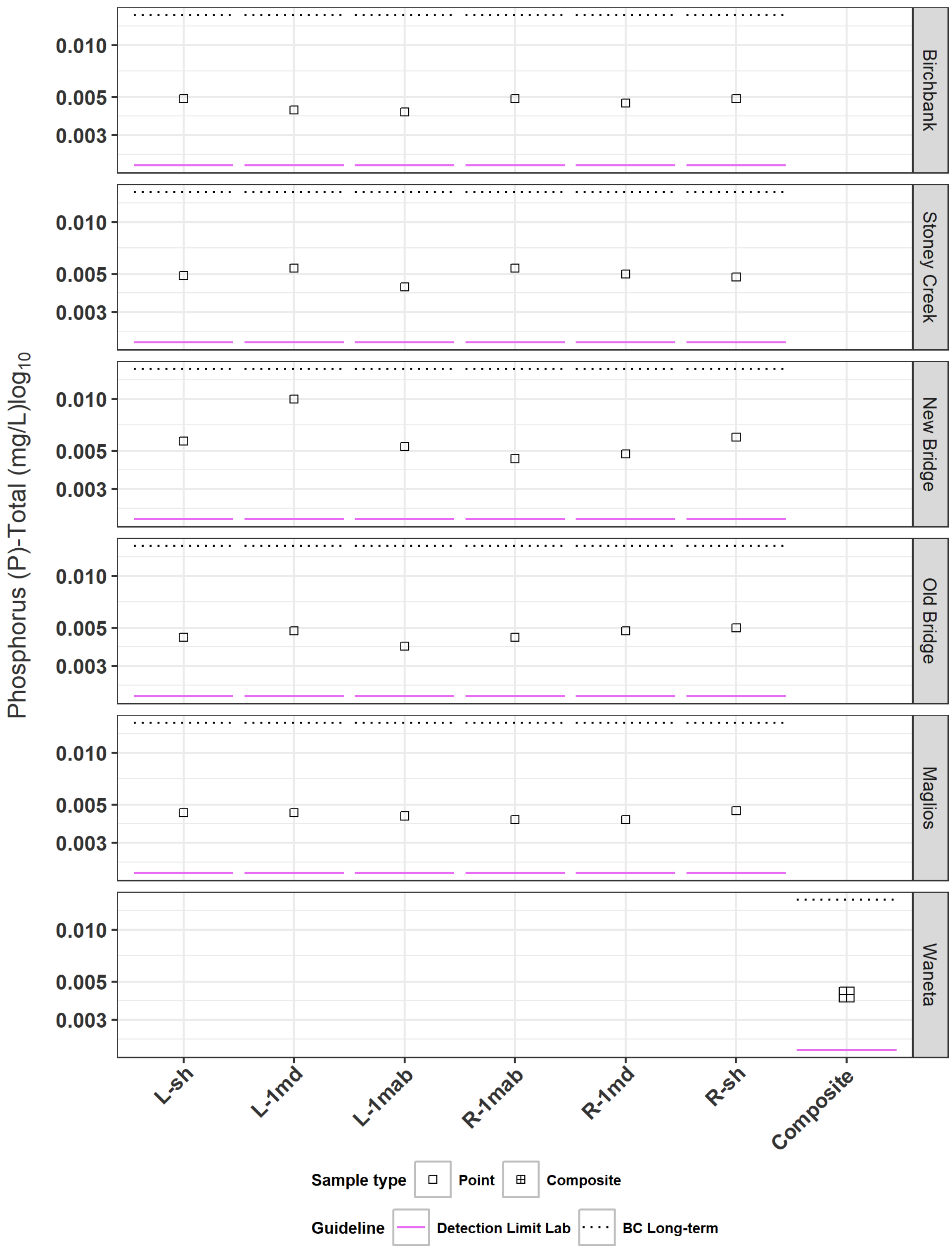


Figure M-34. Total phosphorus concentration from transect water quality samples.

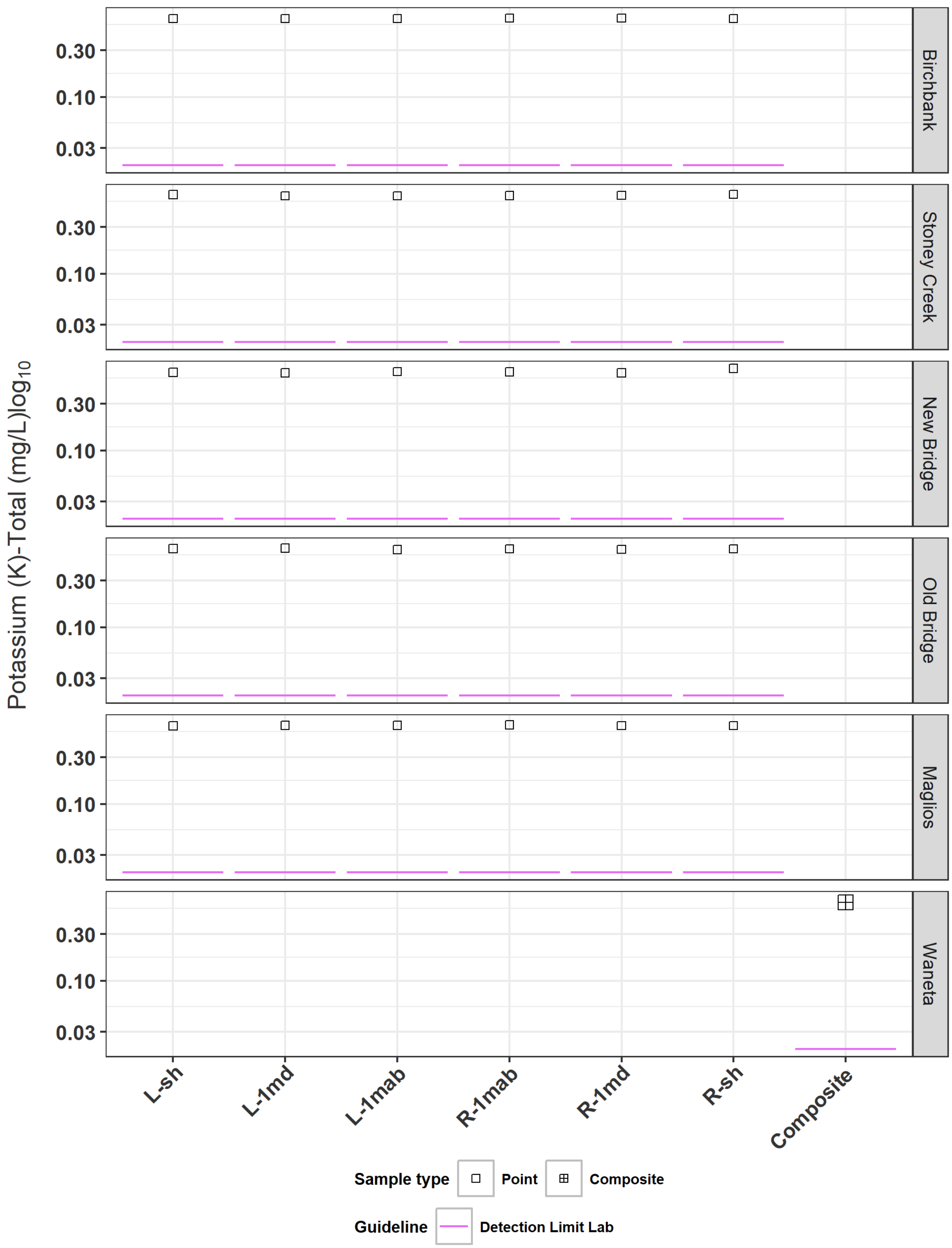


Figure M-35. Total potassium concentration from transect water quality samples.

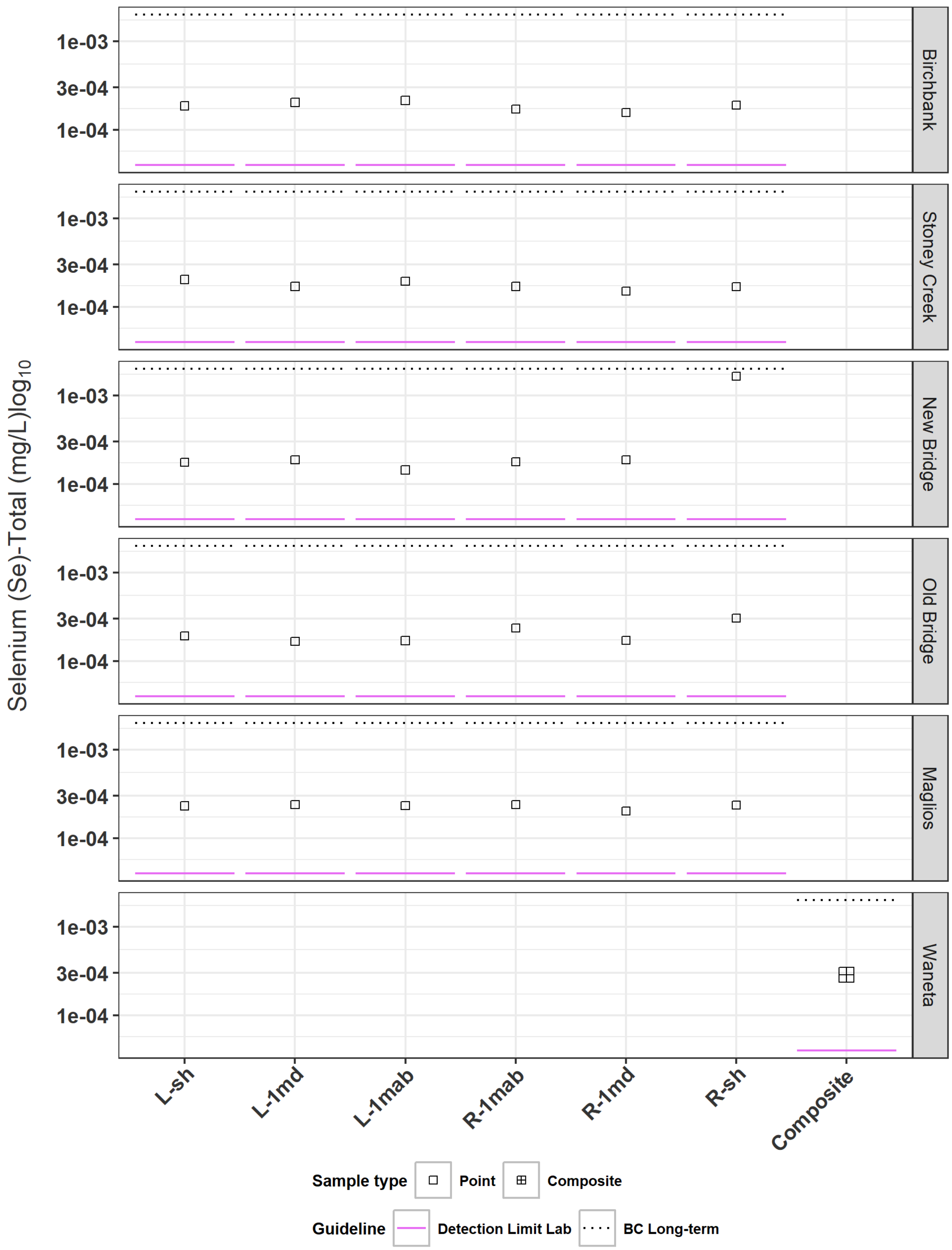


Figure M-36. Total selenium concentration from transect water quality samples.

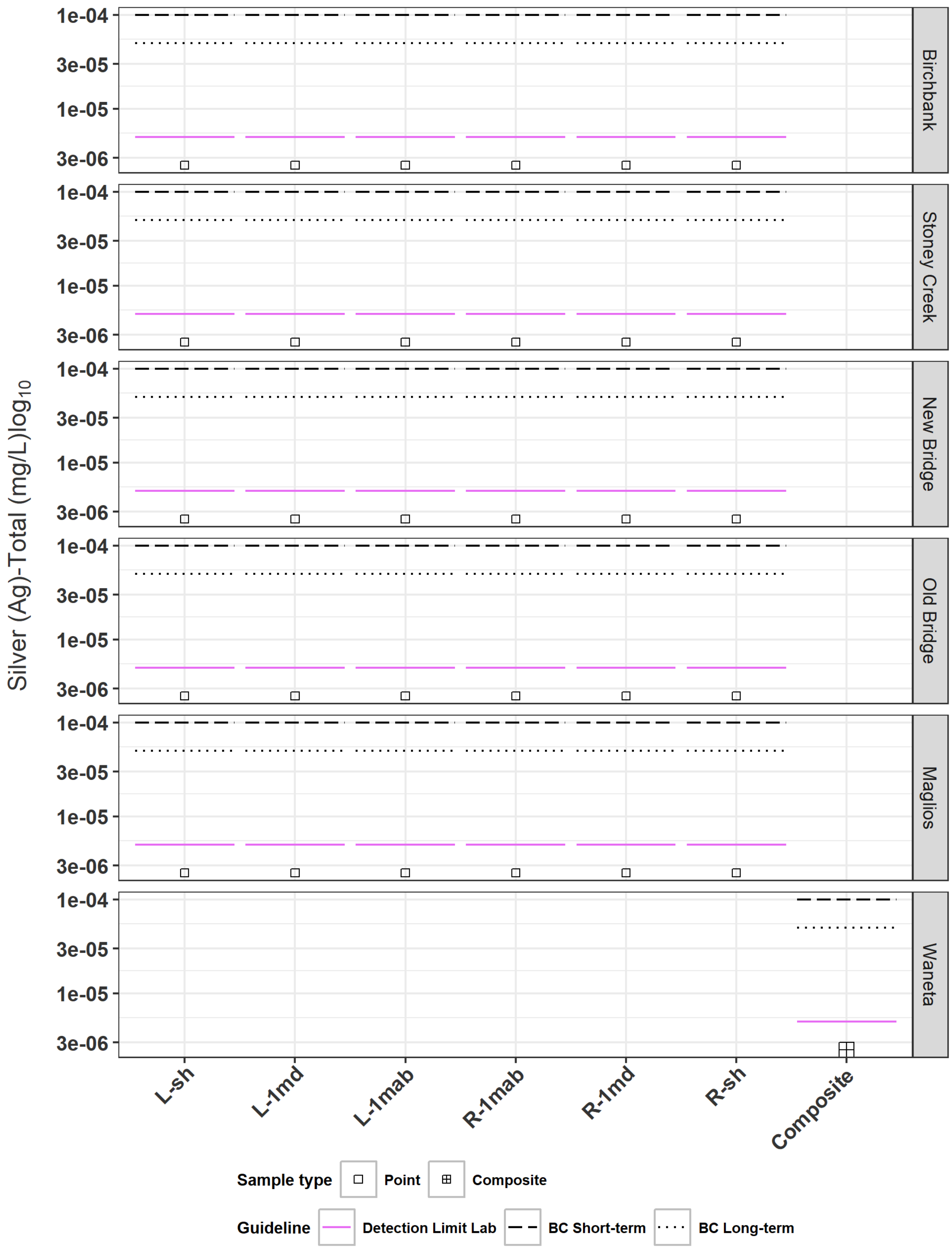


Figure M-37. Total silver concentration from transect water quality samples.

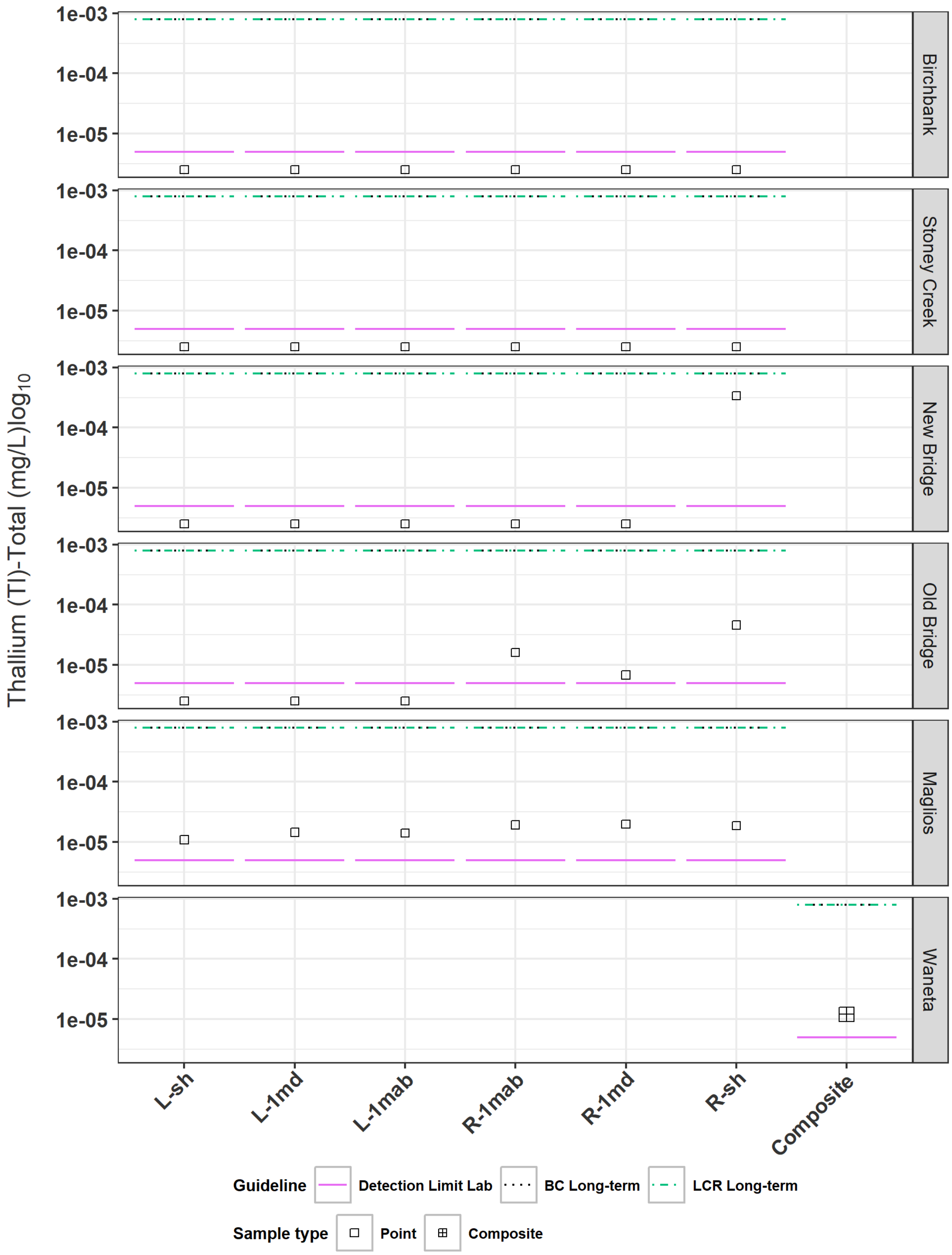


Figure M-38. Total thallium concentration from transect water quality samples.

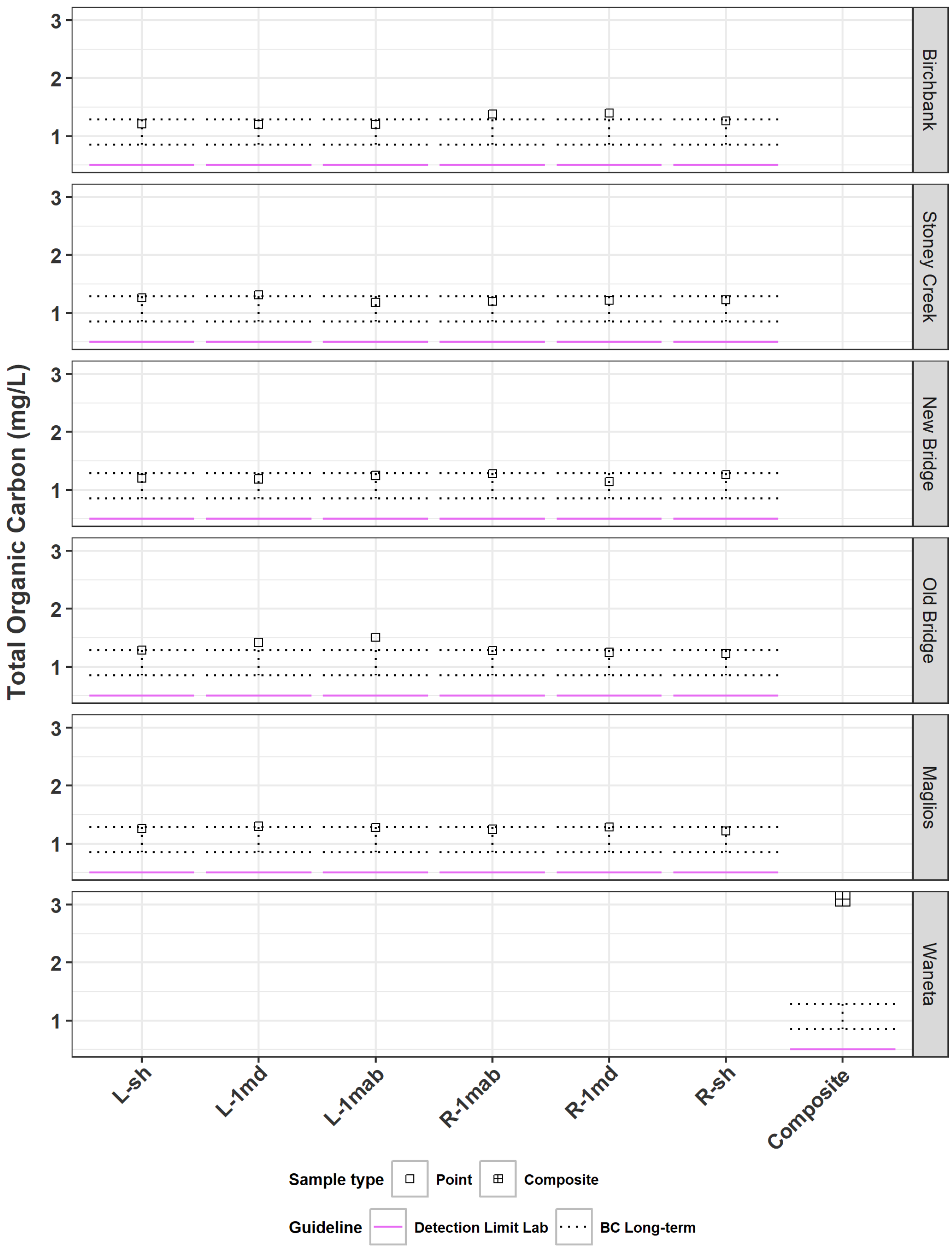


Figure M-39. Total organic carbon concentration from transect water quality samples.

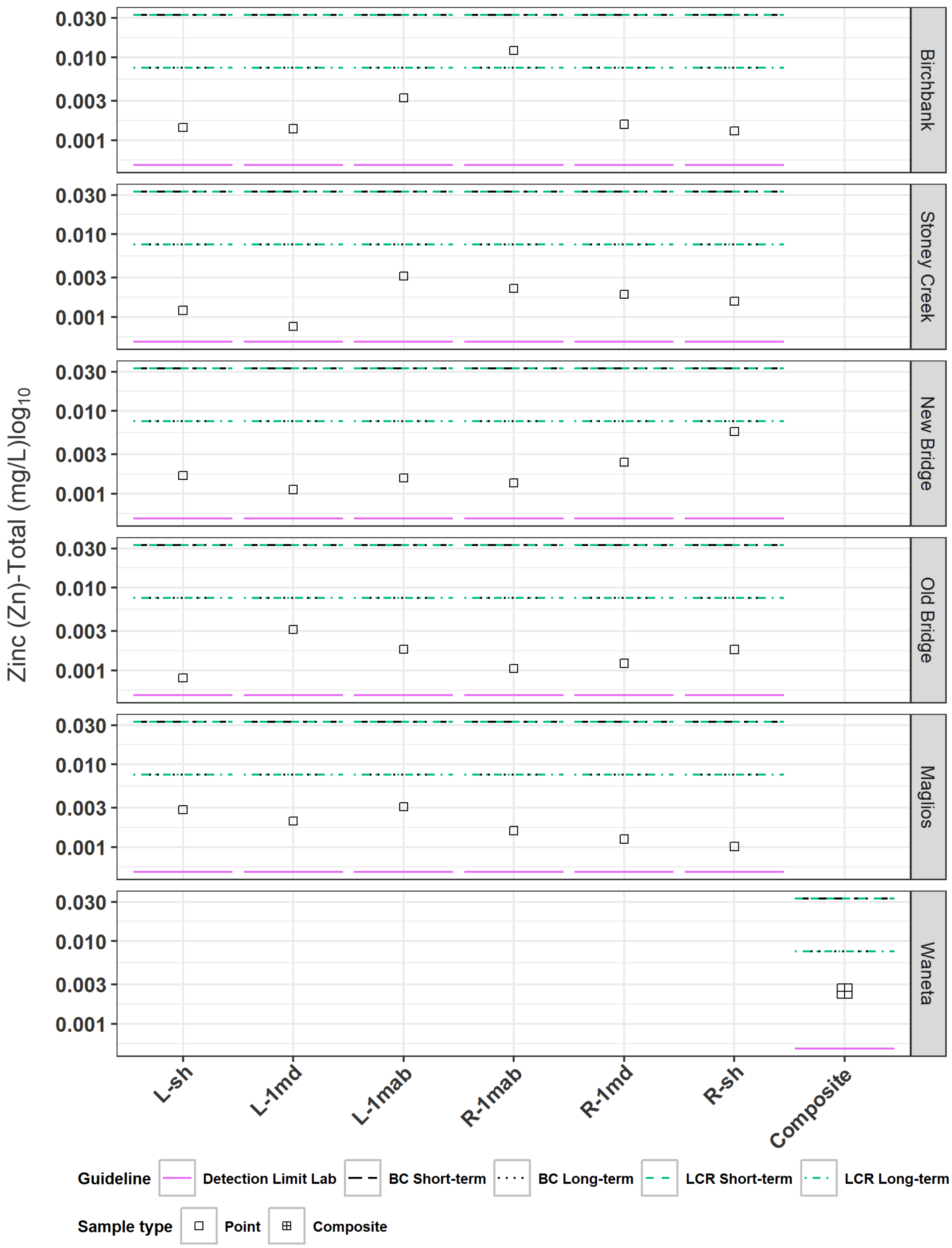


Figure M-40. Total zinc concentration from transect water quality samples.

APPENDIX N SEDIMENT QUALITY SUPPLEMENTAL RESULTS

Table 189. Paired t-test summary of comparison of 2mm and 0.063mm fraction assay for sediment metals in 2021.

Analyte	t Stat	p Value	Mean of differences	Standard error
Aluminum	7.236	<0.001	2 680.500	370.463
Antimony	1.939	0.067	10.544	5.437
Arsenic	3.317	0.004	7.191	2.168
Barium	2.364	0.029	50.970	21.558
Beryllium	9.006	<0.001	0.175	0.019
Boron	<0.001	0.012	-1.790	0.644
Cadmium	3.725	0.001	2.101	0.564
Calcium	2.642	0.016	1 757.000	664.950
Chromium	5.156	<0.001	13.340	2.587
Cobalt	3.061	0.006	2.022	0.660
Copper	1.506	0.148	75.164	49.900
Iron	2.287	0.034	6 066.500	2 652.802
Lead	3.013	0.007	150.812	50.059
Lithium	5.530	<0.001	2.748	0.497
Magnesium	6.165	<0.001	1 606.500	260.602
Manganese	0.989	0.335	31.150	31.490
Mercury	2.432	0.025	1.024	0.421
Molybdenum	<0.001	0.391	-0.186	0.212
Nickel	8.657	<0.001	9.132	1.055
Phosphorus	17.051	<0.001	755.350	44.299
Potassium	5.003	<0.001	246.550	49.276
Selenium	2.529	0.020	0.994	0.393
Silver	2.217	0.039	1.740	0.785
Sodium	3.664	0.002	54.950	14.999
Strontium	9.065	<0.001	19.635	2.166
Sulfur	2.307	0.033	1 266.000	548.828
Thallium	2.687	0.015	0.180	0.067
Thorium	13.888	<0.001	4.166	0.300
Tin	1.504	0.149	11.170	7.425
Titanium	6.222	<0.001	215.650	34.661
Uranium	10.794	<0.001	1.673	0.155
Vanadium	7.424	<0.001	11.575	1.559
Zinc	0.388	0.703	94.490	243.742

APPENDIX O SEDIMENT METALS PRINCIPAL COMPONENT ANALYSIS

Sediment Quality PCA

21-3713.1

Blessing Mangwanda

Started: May 12 2021 - Most recent: Mon Aug 22 10:22:16 2022

1.0 Load libraries

```
#require(ggplot2)
require(plyr)
#require(stringr)
require(openxlsx)
require(vegan)
require(vegetarian)
require(reshape2)
require(tidyverse)
require(grid)
require(ggrepel)
require(gridExtra)
require(data.table)
require(Hmisc)
#require(RPostgreSQL)
#require(stringr)
require(psych)
```

2.0 Load Data

3.0 Load master data files

```
tables_out <- "./tables_out/"

figures <- "./figures/"

fChlaExcel <- "../WD1_Munging/tables_out/sediment_quality_2012-2021_long.xlsx"
```

```
sedsRaw <- read.xlsx(fChlaExcel, sheet = "Sediment Metals")
```

4.0 Munging

5.0 delete 2003 data

```
sedsRaw = sedsRaw %>% filter(year != 2003)
```

6.0 Filter for metals of interest

```
MOI <- c(
 "Arsenic",
 "Cadmium",
 "Chromium",
 "Copper",
 "Lead",
 "Mercury",
 "Selenium",
 "Thallium",
 "Zinc"
)

sedsMOI <- sedsRaw %>% filter(analyte %in% MOI, !duplicate)

sedsMOI

##    label year dep_ero ref_exp site CII_Dist fraction analyte
## 1 2015-dep-ref-1 2015  dep  ref 1 -28364.038  NA Arsenic
## 2 2015-dep-ref-2 2015  dep  ref 2 -12888.812  NA Arsenic
## 3 2015-dep-ref-3 2015  dep  ref 3 8207.956  NA Arsenic
## 4 2015-dep-exp-1 2015  dep  exp 1 3148.140  NA Arsenic
## 5 2015-dep-exp-2 2015  dep  exp 2 5654.120  NA Arsenic
## 6 2015-dep-exp-3 2015  dep  exp 3 10330.200  NA Arsenic
## 7 2015-dep-exp-4 2015  dep  exp 4 10488.120  NA Arsenic
## 8 2015-dep-exp-5 2015  dep  exp 5 13620.200  NA Arsenic
## 9 2015-dep-exp-6 2015  dep  exp 6 15110.120  NA Arsenic
## 10 2015-dep-exp-7 2015  dep  exp 7 16975.120  NA Arsenic
## 11 2012-dep-ref-1 2012  dep  ref 1 -28186.000  NA Arsenic
## 12 2012-dep-ref-2 2012  dep  ref 2 -12820.000  NA Arsenic
```

```
## 13 2012-dep-ref-3 2012  dep  ref 3 -8253.000  NA Arsenic
## 14 2012-dep-exp-1 2012  dep  exp 1 2738.000  NA Arsenic
## 15 2012-dep-exp-2 2012  dep  exp 2 5598.000  NA Arsenic
## 16 2012-dep-exp-3 2012  dep  exp 3 9910.000  NA Arsenic
## 17 2012-dep-exp-4 2012  dep  exp 4 10274.000  NA Arsenic
## 18 2012-dep-exp-5 2012  dep  exp 5 13157.000  NA Arsenic
## 19 2012-dep-exp-6 2012  dep  exp 6 14942.000  NA Arsenic
## 20 2012-dep-exp-7 2012  dep  exp 7 16750.000  NA Arsenic
## 21 2015-dep-ref-1 2015  dep  ref 1 -28364.038  NA Cadmium
## 22 2015-dep-ref-2 2015  dep  ref 2 -12888.812  NA Cadmium
## 23 2015-dep-ref-3 2015  dep  ref 3 8207.956  NA Cadmium
## 24 2015-dep-exp-1 2015  dep  exp 1 3148.140  NA Cadmium
## 25 2015-dep-exp-2 2015  dep  exp 2 5654.120  NA Cadmium
## 26 2015-dep-exp-3 2015  dep  exp 3 10330.200  NA Cadmium
## 27 2015-dep-exp-4 2015  dep  exp 4 10488.120  NA Cadmium
## 28 2015-dep-exp-5 2015  dep  exp 5 13620.200  NA Cadmium
## 29 2015-dep-exp-6 2015  dep  exp 6 15110.120  NA Cadmium
## 30 2015-dep-exp-7 2015  dep  exp 7 16975.120  NA Cadmium
## 31 2012-dep-ref-1 2012  dep  ref 1 -28186.000  NA Cadmium
## 32 2012-dep-ref-2 2012  dep  ref 2 -12820.000  NA Cadmium
## 33 2012-dep-ref-3 2012  dep  ref 3 -8253.000  NA Cadmium
## 34 2012-dep-exp-1 2012  dep  exp 1 2738.000  NA Cadmium
## 35 2012-dep-exp-2 2012  dep  exp 2 5598.000  NA Cadmium
## 36 2012-dep-exp-3 2012  dep  exp 3 9910.000  NA Cadmium
## 37 2012-dep-exp-4 2012  dep  exp 4 10274.000  NA Cadmium
## 38 2012-dep-exp-5 2012  dep  exp 5 13157.000  NA Cadmium
## 39 2012-dep-exp-6 2012  dep  exp 6 14942.000  NA Cadmium
## 40 2012-dep-exp-7 2012  dep  exp 7 16750.000  NA Cadmium
## 41 2015-dep-ref-1 2015  dep  ref 1 -28364.038  NA Chromium
## 42 2015-dep-ref-2 2015  dep  ref 2 -12888.812  NA Chromium
## 43 2015-dep-ref-3 2015  dep  ref 3 8207.956  NA Chromium
## 44 2015-dep-exp-1 2015  dep  exp 1 3148.140  NA Chromium
## 45 2015-dep-exp-2 2015  dep  exp 2 5654.120  NA Chromium
## 46 2015-dep-exp-3 2015  dep  exp 3 10330.200  NA Chromium
## 47 2015-dep-exp-4 2015  dep  exp 4 10488.120  NA Chromium
## 48 2015-dep-exp-5 2015  dep  exp 5 13620.200  NA Chromium
## 49 2015-dep-exp-6 2015  dep  exp 6 15110.120  NA Chromium
## 50 2015-dep-exp-7 2015  dep  exp 7 16975.120  NA Chromium
## 51 2012-dep-ref-1 2012  dep  ref 1 -28186.000  NA Chromium
```

```
## 52 2012-dep-ref-2 2012  dep  ref 2 -12820.000  NA Chromium
## 53 2012-dep-ref-3 2012  dep  ref 3 -8253.000  NA Chromium
## 54 2012-dep-exp-1 2012  dep  exp 1 2738.000  NA Chromium
## 55 2012-dep-exp-2 2012  dep  exp 2 5598.000  NA Chromium
## 56 2012-dep-exp-3 2012  dep  exp 3 9910.000  NA Chromium
## 57 2012-dep-exp-4 2012  dep  exp 4 10274.000  NA Chromium
## 58 2012-dep-exp-5 2012  dep  exp 5 13157.000  NA Chromium
## 59 2012-dep-exp-6 2012  dep  exp 6 14942.000  NA Chromium
## 60 2012-dep-exp-7 2012  dep  exp 7 16750.000  NA Chromium
## 61 2015-dep-ref-1 2015  dep  ref 1 -28364.038  NA Copper
## 62 2015-dep-ref-2 2015  dep  ref 2 -12888.812  NA Copper
## 63 2015-dep-ref-3 2015  dep  ref 3 8207.956  NA Copper
## 64 2015-dep-exp-1 2015  dep  exp 1 3148.140  NA Copper
## 65 2015-dep-exp-2 2015  dep  exp 2 5654.120  NA Copper
## 66 2015-dep-exp-3 2015  dep  exp 3 10330.200  NA Copper
## 67 2015-dep-exp-4 2015  dep  exp 4 10488.120  NA Copper
## 68 2015-dep-exp-5 2015  dep  exp 5 13620.200  NA Copper
## 69 2015-dep-exp-6 2015  dep  exp 6 15110.120  NA Copper
## 70 2015-dep-exp-7 2015  dep  exp 7 16975.120  NA Copper
## 71 2012-dep-ref-1 2012  dep  ref 1 -28186.000  NA Copper
## 72 2012-dep-ref-2 2012  dep  ref 2 -12820.000  NA Copper
## 73 2012-dep-ref-3 2012  dep  ref 3 -8253.000  NA Copper
## 74 2012-dep-exp-1 2012  dep  exp 1 2738.000  NA Copper
## 75 2012-dep-exp-2 2012  dep  exp 2 5598.000  NA Copper
## 76 2012-dep-exp-3 2012  dep  exp 3 9910.000  NA Copper
## 77 2012-dep-exp-4 2012  dep  exp 4 10274.000  NA Copper
## 78 2012-dep-exp-5 2012  dep  exp 5 13157.000  NA Copper
## 79 2012-dep-exp-6 2012  dep  exp 6 14942.000  NA Copper
## 80 2012-dep-exp-7 2012  dep  exp 7 16750.000  NA Copper
## 81 2015-dep-ref-1 2015  dep  ref 1 -28364.038  NA  Lead
## 82 2015-dep-ref-2 2015  dep  ref 2 -12888.812  NA  Lead
## 83 2015-dep-ref-3 2015  dep  ref 3 8207.956  NA  Lead
## 84 2015-dep-exp-1 2015  dep  exp 1 3148.140  NA  Lead
## 85 2015-dep-exp-2 2015  dep  exp 2 5654.120  NA  Lead
## 86 2015-dep-exp-3 2015  dep  exp 3 10330.200  NA  Lead
## 87 2015-dep-exp-4 2015  dep  exp 4 10488.120  NA  Lead
## 88 2015-dep-exp-5 2015  dep  exp 5 13620.200  NA  Lead
## 89 2015-dep-exp-6 2015  dep  exp 6 15110.120  NA  Lead
## 90 2015-dep-exp-7 2015  dep  exp 7 16975.120  NA  Lead
```

```
## 91 2012-dep-ref-1 2012  dep  ref 1 -28186.000  NA  Lead
## 92 2012-dep-ref-2 2012  dep  ref 2 -12820.000  NA  Lead
## 93 2012-dep-ref-3 2012  dep  ref 3 -8253.000  NA  Lead
## 94 2012-dep-exp-1 2012  dep  exp 1 2738.000  NA  Lead
## 95 2012-dep-exp-2 2012  dep  exp 2 5598.000  NA  Lead
## 96 2012-dep-exp-3 2012  dep  exp 3 9910.000  NA  Lead
## 97 2012-dep-exp-4 2012  dep  exp 4 10274.000  NA  Lead
## 98 2012-dep-exp-5 2012  dep  exp 5 13157.000  NA  Lead
## 99 2012-dep-exp-6 2012  dep  exp 6 14942.000  NA  Lead
## 100 2012-dep-exp-7 2012  dep  exp 7 16750.000  NA  Lead
## 101 2015-dep-ref-1 2015  dep  ref 1 -28364.038  NA Mercury
## 102 2015-dep-ref-2 2015  dep  ref 2 -12888.812  NA Mercury
## 103 2015-dep-ref-3 2015  dep  ref 3 8207.956  NA Mercury
## 104 2015-dep-exp-1 2015  dep  exp 1 3148.140  NA Mercury
## 105 2015-dep-exp-2 2015  dep  exp 2 5654.120  NA Mercury
## 106 2015-dep-exp-3 2015  dep  exp 3 10330.200  NA Mercury
## 107 2015-dep-exp-4 2015  dep  exp 4 10488.120  NA Mercury
## 108 2015-dep-exp-5 2015  dep  exp 5 13620.200  NA Mercury
## 109 2015-dep-exp-6 2015  dep  exp 6 15110.120  NA Mercury
## 110 2015-dep-exp-7 2015  dep  exp 7 16975.120  NA Mercury
## 111 2012-dep-ref-1 2012  dep  ref 1 -28186.000  NA Mercury
## 112 2012-dep-ref-2 2012  dep  ref 2 -12820.000  NA Mercury
## 113 2012-dep-ref-3 2012  dep  ref 3 -8253.000  NA Mercury
## 114 2012-dep-exp-1 2012  dep  exp 1 2738.000  NA Mercury
## 115 2012-dep-exp-2 2012  dep  exp 2 5598.000  NA Mercury
## 116 2012-dep-exp-3 2012  dep  exp 3 9910.000  NA Mercury
## 117 2012-dep-exp-4 2012  dep  exp 4 10274.000  NA Mercury
## 118 2012-dep-exp-5 2012  dep  exp 5 13157.000  NA Mercury
## 119 2012-dep-exp-6 2012  dep  exp 6 14942.000  NA Mercury
## 120 2012-dep-exp-7 2012  dep  exp 7 16750.000  NA Mercury
## 121 2015-dep-ref-1 2015  dep  ref 1 -28364.038  NA Selenium
## 122 2015-dep-ref-2 2015  dep  ref 2 -12888.812  NA Selenium
## 123 2015-dep-ref-3 2015  dep  ref 3 8207.956  NA Selenium
## 124 2015-dep-exp-1 2015  dep  exp 1 3148.140  NA Selenium
## 125 2015-dep-exp-2 2015  dep  exp 2 5654.120  NA Selenium
## 126 2015-dep-exp-3 2015  dep  exp 3 10330.200  NA Selenium
## 127 2015-dep-exp-4 2015  dep  exp 4 10488.120  NA Selenium
## 128 2015-dep-exp-5 2015  dep  exp 5 13620.200  NA Selenium
## 129 2015-dep-exp-6 2015  dep  exp 6 15110.120  NA Selenium
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## 130 2015-dep-exp-7 2015  dep  exp 7 16975.120  NA Selenium
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## 132 2012-dep-ref-2 2012  dep  ref 2 -12820.000  NA Selenium
## 133 2012-dep-ref-3 2012  dep  ref 3 -8253.000  NA Selenium
## 134 2012-dep-exp-1 2012  dep  exp 1 2738.000  NA Selenium
## 135 2012-dep-exp-2 2012  dep  exp 2 5598.000  NA Selenium
## 136 2012-dep-exp-3 2012  dep  exp 3 9910.000  NA Selenium
## 137 2012-dep-exp-4 2012  dep  exp 4 10274.000  NA Selenium
## 138 2012-dep-exp-5 2012  dep  exp 5 13157.000  NA Selenium
## 139 2012-dep-exp-6 2012  dep  exp 6 14942.000  NA Selenium
## 140 2012-dep-exp-7 2012  dep  exp 7 16750.000  NA Selenium
## 141 2015-dep-ref-1 2015  dep  ref 1 -28364.038  NA Thallium
## 142 2015-dep-ref-2 2015  dep  ref 2 -12888.812  NA Thallium
## 143 2015-dep-ref-3 2015  dep  ref 3 8207.956  NA Thallium
## 144 2015-dep-exp-1 2015  dep  exp 1 3148.140  NA Thallium
## 145 2015-dep-exp-2 2015  dep  exp 2 5654.120  NA Thallium
## 146 2015-dep-exp-3 2015  dep  exp 3 10330.200  NA Thallium
## 147 2015-dep-exp-4 2015  dep  exp 4 10488.120  NA Thallium
## 148 2015-dep-exp-5 2015  dep  exp 5 13620.200  NA Thallium
## 149 2015-dep-exp-6 2015  dep  exp 6 15110.120  NA Thallium
## 150 2015-dep-exp-7 2015  dep  exp 7 16975.120  NA Thallium
## 151 2012-dep-ref-1 2012  dep  ref 1 -28186.000  NA Thallium
## 152 2012-dep-ref-2 2012  dep  ref 2 -12820.000  NA Thallium
## 153 2012-dep-ref-3 2012  dep  ref 3 -8253.000  NA Thallium
## 154 2012-dep-exp-1 2012  dep  exp 1 2738.000  NA Thallium
## 155 2012-dep-exp-2 2012  dep  exp 2 5598.000  NA Thallium
## 156 2012-dep-exp-3 2012  dep  exp 3 9910.000  NA Thallium
## 157 2012-dep-exp-4 2012  dep  exp 4 10274.000  NA Thallium
## 158 2012-dep-exp-5 2012  dep  exp 5 13157.000  NA Thallium
## 159 2012-dep-exp-6 2012  dep  exp 6 14942.000  NA Thallium
## 160 2012-dep-exp-7 2012  dep  exp 7 16750.000  NA Thallium
## 161 2015-dep-ref-1 2015  dep  ref 1 -28364.038  NA  Zinc
## 162 2015-dep-ref-2 2015  dep  ref 2 -12888.812  NA  Zinc
## 163 2015-dep-ref-3 2015  dep  ref 3 8207.956  NA  Zinc
## 164 2015-dep-exp-1 2015  dep  exp 1 3148.140  NA  Zinc
## 165 2015-dep-exp-2 2015  dep  exp 2 5654.120  NA  Zinc
## 166 2015-dep-exp-3 2015  dep  exp 3 10330.200  NA  Zinc
## 167 2015-dep-exp-4 2015  dep  exp 4 10488.120  NA  Zinc
## 168 2015-dep-exp-5 2015  dep  exp 5 13620.200  NA  Zinc
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## 169 2015-dep-exp-6 2015  dep  exp 6 15110.120  NA  Zinc
## 170 2015-dep-exp-7 2015  dep  exp 7 16975.120  NA  Zinc
## 171 2012-dep-ref-1 2012  dep  ref 1 -28186.000  NA  Zinc
## 172 2012-dep-ref-2 2012  dep  ref 2 -12820.000  NA  Zinc
## 173 2012-dep-ref-3 2012  dep  ref 3 -8253.000  NA  Zinc
## 174 2012-dep-exp-1 2012  dep  exp 1 2738.000  NA  Zinc
## 175 2012-dep-exp-2 2012  dep  exp 2 5598.000  NA  Zinc
## 176 2012-dep-exp-3 2012  dep  exp 3 9910.000  NA  Zinc
## 177 2012-dep-exp-4 2012  dep  exp 4 10274.000  NA  Zinc
## 178 2012-dep-exp-5 2012  dep  exp 5 13157.000  NA  Zinc
## 179 2012-dep-exp-6 2012  dep  exp 6 14942.000  NA  Zinc
## 180 2012-dep-exp-7 2012  dep  exp 7 16750.000  NA  Zinc
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## 182 2018-dep-ref-1 2018  dep  ref 1 -28291.000 6.3e-05 Cadmium
## 183 2018-dep-ref-1 2018  dep  ref 1 -28291.000 6.3e-05 Chromium
## 184 2018-dep-ref-1 2018  dep  ref 1 -28291.000 6.3e-05 Copper
## 185 2018-dep-ref-1 2018  dep  ref 1 -28291.000 6.3e-05  Lead
## 186 2018-dep-ref-1 2018  dep  ref 1 -28291.000 6.3e-05 Mercury
## 187 2018-dep-ref-1 2018  dep  ref 1 -28291.000 6.3e-05 Selenium
## 188 2018-dep-ref-1 2018  dep  ref 1 -28291.000 6.3e-05 Thallium
## 189 2018-dep-ref-1 2018  dep  ref 1 -28291.000 6.3e-05  Zinc
## 190 2018-dep-ref-1 2018  dep  ref 1 -28291.000 2.0e-03 Arsenic
## 191 2018-dep-ref-1 2018  dep  ref 1 -28291.000 2.0e-03 Cadmium
## 192 2018-dep-ref-1 2018  dep  ref 1 -28291.000 2.0e-03 Chromium
## 193 2018-dep-ref-1 2018  dep  ref 1 -28291.000 2.0e-03 Copper
## 194 2018-dep-ref-1 2018  dep  ref 1 -28291.000 2.0e-03  Lead
## 195 2018-dep-ref-1 2018  dep  ref 1 -28291.000 2.0e-03 Mercury
## 196 2018-dep-ref-1 2018  dep  ref 1 -28291.000 2.0e-03 Selenium
## 197 2018-dep-ref-1 2018  dep  ref 1 -28291.000 2.0e-03 Thallium
## 198 2018-dep-ref-1 2018  dep  ref 1 -28291.000 2.0e-03  Zinc
## 199 2018-dep-exp-1 2018  dep  exp 1 2654.000 6.3e-05 Arsenic
## 200 2018-dep-exp-1 2018  dep  exp 1 2654.000 6.3e-05 Cadmium
## 201 2018-dep-exp-1 2018  dep  exp 1 2654.000 6.3e-05 Chromium
## 202 2018-dep-exp-1 2018  dep  exp 1 2654.000 6.3e-05 Copper
## 203 2018-dep-exp-1 2018  dep  exp 1 2654.000 6.3e-05  Lead
## 204 2018-dep-exp-1 2018  dep  exp 1 2654.000 6.3e-05 Mercury
## 205 2018-dep-exp-1 2018  dep  exp 1 2654.000 6.3e-05 Selenium
## 206 2018-dep-exp-1 2018  dep  exp 1 2654.000 6.3e-05 Thallium
## 207 2018-dep-exp-1 2018  dep  exp 1 2654.000 6.3e-05  Zinc
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## 208 2018-dep-exp-1 2018  dep  exp 1 2654.000 2.0e-03 Arsenic
## 209 2018-dep-exp-1 2018  dep  exp 1 2654.000 2.0e-03 Cadmium
## 210 2018-dep-exp-1 2018  dep  exp 1 2654.000 2.0e-03 Chromium
## 211 2018-dep-exp-1 2018  dep  exp 1 2654.000 2.0e-03 Copper
## 212 2018-dep-exp-1 2018  dep  exp 1 2654.000 2.0e-03  Lead
## 213 2018-dep-exp-1 2018  dep  exp 1 2654.000 2.0e-03 Mercury
## 214 2018-dep-exp-1 2018  dep  exp 1 2654.000 2.0e-03 Selenium
## 215 2018-dep-exp-1 2018  dep  exp 1 2654.000 2.0e-03 Thallium
## 216 2018-dep-exp-1 2018  dep  exp 1 2654.000 2.0e-03  Zinc
## 217 2018-dep-exp-2 2018  dep  exp 2 6863.000 6.3e-05 Arsenic
## 218 2018-dep-exp-2 2018  dep  exp 2 6863.000 6.3e-05 Cadmium
## 219 2018-dep-exp-2 2018  dep  exp 2 6863.000 6.3e-05 Chromium
## 220 2018-dep-exp-2 2018  dep  exp 2 6863.000 6.3e-05 Copper
## 221 2018-dep-exp-2 2018  dep  exp 2 6863.000 6.3e-05  Lead
## 222 2018-dep-exp-2 2018  dep  exp 2 6863.000 6.3e-05 Mercury
## 223 2018-dep-exp-2 2018  dep  exp 2 6863.000 6.3e-05 Selenium
## 224 2018-dep-exp-2 2018  dep  exp 2 6863.000 6.3e-05 Thallium
## 225 2018-dep-exp-2 2018  dep  exp 2 6863.000 6.3e-05  Zinc
## 226 2018-dep-exp-2 2018  dep  exp 2 6863.000 2.0e-03 Arsenic
## 227 2018-dep-exp-2 2018  dep  exp 2 6863.000 2.0e-03 Cadmium
## 228 2018-dep-exp-2 2018  dep  exp 2 6863.000 2.0e-03 Chromium
## 229 2018-dep-exp-2 2018  dep  exp 2 6863.000 2.0e-03 Copper
## 230 2018-dep-exp-2 2018  dep  exp 2 6863.000 2.0e-03  Lead
## 231 2018-dep-exp-2 2018  dep  exp 2 6863.000 2.0e-03 Mercury
## 232 2018-dep-exp-2 2018  dep  exp 2 6863.000 2.0e-03 Selenium
## 233 2018-dep-exp-2 2018  dep  exp 2 6863.000 2.0e-03 Thallium
## 234 2018-dep-exp-2 2018  dep  exp 2 6863.000 2.0e-03  Zinc
## 235 2018-dep-ref-3 2018  dep  ref 3 -8238.000 6.3e-05 Arsenic
## 236 2018-dep-ref-3 2018  dep  ref 3 -8238.000 6.3e-05 Cadmium
## 237 2018-dep-ref-3 2018  dep  ref 3 -8238.000 6.3e-05 Chromium
## 238 2018-dep-ref-3 2018  dep  ref 3 -8238.000 6.3e-05 Copper
## 239 2018-dep-ref-3 2018  dep  ref 3 -8238.000 6.3e-05  Lead
## 240 2018-dep-ref-3 2018  dep  ref 3 -8238.000 6.3e-05 Mercury
## 241 2018-dep-ref-3 2018  dep  ref 3 -8238.000 6.3e-05 Selenium
## 242 2018-dep-ref-3 2018  dep  ref 3 -8238.000 6.3e-05 Thallium
## 243 2018-dep-ref-3 2018  dep  ref 3 -8238.000 6.3e-05  Zinc
## 244 2018-dep-ref-3 2018  dep  ref 3 -8238.000 2.0e-03 Arsenic
## 245 2018-dep-ref-3 2018  dep  ref 3 -8238.000 2.0e-03 Cadmium
## 246 2018-dep-ref-3 2018  dep  ref 3 -8238.000 2.0e-03 Chromium
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## 247 2018-dep-ref-3 2018  dep  ref 3 -8238.000 2.0e-03 Copper
## 248 2018-dep-ref-3 2018  dep  ref 3 -8238.000 2.0e-03  Lead
## 249 2018-dep-ref-3 2018  dep  ref 3 -8238.000 2.0e-03 Mercury
## 250 2018-dep-ref-3 2018  dep  ref 3 -8238.000 2.0e-03 Selenium
## 251 2018-dep-ref-3 2018  dep  ref 3 -8238.000 2.0e-03 Thallium
## 252 2018-dep-ref-3 2018  dep  ref 3 -8238.000 2.0e-03  Zinc
## 253 2018-dep-ref-2 2018  dep  ref 2 -12833.000 6.3e-05 Arsenic
## 254 2018-dep-ref-2 2018  dep  ref 2 -12833.000 6.3e-05 Cadmium
## 255 2018-dep-ref-2 2018  dep  ref 2 -12833.000 6.3e-05 Chromium
## 256 2018-dep-ref-2 2018  dep  ref 2 -12833.000 6.3e-05 Copper
## 257 2018-dep-ref-2 2018  dep  ref 2 -12833.000 6.3e-05  Lead
## 258 2018-dep-ref-2 2018  dep  ref 2 -12833.000 6.3e-05 Mercury
## 259 2018-dep-ref-2 2018  dep  ref 2 -12833.000 6.3e-05 Selenium
## 260 2018-dep-ref-2 2018  dep  ref 2 -12833.000 6.3e-05 Thallium
## 261 2018-dep-ref-2 2018  dep  ref 2 -12833.000 6.3e-05  Zinc
## 262 2018-dep-ref-2 2018  dep  ref 2 -12833.000 2.0e-03 Arsenic
## 263 2018-dep-ref-2 2018  dep  ref 2 -12833.000 2.0e-03 Cadmium
## 264 2018-dep-ref-2 2018  dep  ref 2 -12833.000 2.0e-03 Chromium
## 265 2018-dep-ref-2 2018  dep  ref 2 -12833.000 2.0e-03 Copper
## 266 2018-dep-ref-2 2018  dep  ref 2 -12833.000 2.0e-03  Lead
## 267 2018-dep-ref-2 2018  dep  ref 2 -12833.000 2.0e-03 Mercury
## 268 2018-dep-ref-2 2018  dep  ref 2 -12833.000 2.0e-03 Selenium
## 269 2018-dep-ref-2 2018  dep  ref 2 -12833.000 2.0e-03 Thallium
## 270 2018-dep-ref-2 2018  dep  ref 2 -12833.000 2.0e-03  Zinc
## 271 2018-dep-exp-7 2018  dep  exp 7 16791.000 6.3e-05 Arsenic
## 272 2018-dep-exp-7 2018  dep  exp 7 16791.000 6.3e-05 Cadmium
## 273 2018-dep-exp-7 2018  dep  exp 7 16791.000 6.3e-05 Chromium
## 274 2018-dep-exp-7 2018  dep  exp 7 16791.000 6.3e-05 Copper
## 275 2018-dep-exp-7 2018  dep  exp 7 16791.000 6.3e-05  Lead
## 276 2018-dep-exp-7 2018  dep  exp 7 16791.000 6.3e-05 Mercury
## 277 2018-dep-exp-7 2018  dep  exp 7 16791.000 6.3e-05 Selenium
## 278 2018-dep-exp-7 2018  dep  exp 7 16791.000 6.3e-05 Thallium
## 279 2018-dep-exp-7 2018  dep  exp 7 16791.000 6.3e-05  Zinc
## 280 2018-dep-exp-7 2018  dep  exp 7 16791.000 2.0e-03 Arsenic
## 281 2018-dep-exp-7 2018  dep  exp 7 16791.000 2.0e-03 Cadmium
## 282 2018-dep-exp-7 2018  dep  exp 7 16791.000 2.0e-03 Chromium
## 283 2018-dep-exp-7 2018  dep  exp 7 16791.000 2.0e-03 Copper
## 284 2018-dep-exp-7 2018  dep  exp 7 16791.000 2.0e-03  Lead
## 285 2018-dep-exp-7 2018  dep  exp 7 16791.000 2.0e-03 Mercury
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## 286 2018-dep-exp-7 2018  dep  exp 7 16791.000 2.0e-03 Selenium
## 287 2018-dep-exp-7 2018  dep  exp 7 16791.000 2.0e-03 Thallium
## 288 2018-dep-exp-7 2018  dep  exp 7 16791.000 2.0e-03  Zinc
## 289 2018-dep-exp-5 2018  dep  exp 5 13117.000 6.3e-05 Arsenic
## 290 2018-dep-exp-5 2018  dep  exp 5 13117.000 6.3e-05 Cadmium
## 291 2018-dep-exp-5 2018  dep  exp 5 13117.000 6.3e-05 Chromium
## 292 2018-dep-exp-5 2018  dep  exp 5 13117.000 6.3e-05 Copper
## 293 2018-dep-exp-5 2018  dep  exp 5 13117.000 6.3e-05  Lead
## 294 2018-dep-exp-5 2018  dep  exp 5 13117.000 6.3e-05 Mercury
## 295 2018-dep-exp-5 2018  dep  exp 5 13117.000 6.3e-05 Selenium
## 296 2018-dep-exp-5 2018  dep  exp 5 13117.000 6.3e-05 Thallium
## 297 2018-dep-exp-5 2018  dep  exp 5 13117.000 6.3e-05  Zinc
## 298 2018-dep-exp-5 2018  dep  exp 5 13117.000 2.0e-03 Arsenic
## 299 2018-dep-exp-5 2018  dep  exp 5 13117.000 2.0e-03 Cadmium
## 300 2018-dep-exp-5 2018  dep  exp 5 13117.000 2.0e-03 Chromium
## 301 2018-dep-exp-5 2018  dep  exp 5 13117.000 2.0e-03 Copper
## 302 2018-dep-exp-5 2018  dep  exp 5 13117.000 2.0e-03  Lead
## 303 2018-dep-exp-5 2018  dep  exp 5 13117.000 2.0e-03 Mercury
## 304 2018-dep-exp-5 2018  dep  exp 5 13117.000 2.0e-03 Selenium
## 305 2018-dep-exp-5 2018  dep  exp 5 13117.000 2.0e-03 Thallium
## 306 2018-dep-exp-5 2018  dep  exp 5 13117.000 2.0e-03  Zinc
## 307 2018-dep-exp-6 2018  dep  exp 6 14929.000 6.3e-05 Arsenic
## 308 2018-dep-exp-6 2018  dep  exp 6 14929.000 6.3e-05 Cadmium
## 309 2018-dep-exp-6 2018  dep  exp 6 14929.000 6.3e-05 Chromium
## 310 2018-dep-exp-6 2018  dep  exp 6 14929.000 6.3e-05 Copper
## 311 2018-dep-exp-6 2018  dep  exp 6 14929.000 6.3e-05  Lead
## 312 2018-dep-exp-6 2018  dep  exp 6 14929.000 6.3e-05 Mercury
## 313 2018-dep-exp-6 2018  dep  exp 6 14929.000 6.3e-05 Selenium
## 314 2018-dep-exp-6 2018  dep  exp 6 14929.000 6.3e-05 Thallium
## 315 2018-dep-exp-6 2018  dep  exp 6 14929.000 6.3e-05  Zinc
## 316 2018-dep-exp-6 2018  dep  exp 6 14929.000 2.0e-03 Arsenic
## 317 2018-dep-exp-6 2018  dep  exp 6 14929.000 2.0e-03 Cadmium
## 318 2018-dep-exp-6 2018  dep  exp 6 14929.000 2.0e-03 Chromium
## 319 2018-dep-exp-6 2018  dep  exp 6 14929.000 2.0e-03 Copper
## 320 2018-dep-exp-6 2018  dep  exp 6 14929.000 2.0e-03  Lead
## 321 2018-dep-exp-6 2018  dep  exp 6 14929.000 2.0e-03 Mercury
## 322 2018-dep-exp-6 2018  dep  exp 6 14929.000 2.0e-03 Selenium
## 323 2018-dep-exp-6 2018  dep  exp 6 14929.000 2.0e-03 Thallium
## 324 2018-dep-exp-6 2018  dep  exp 6 14929.000 2.0e-03  Zinc
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## 325 2018-dep-exp-3 2018  dep  exp 3 9895.000 6.3e-05 Arsenic
## 326 2018-dep-exp-3 2018  dep  exp 3 9895.000 6.3e-05 Cadmium
## 327 2018-dep-exp-3 2018  dep  exp 3 9895.000 6.3e-05 Chromium
## 328 2018-dep-exp-3 2018  dep  exp 3 9895.000 6.3e-05 Copper
## 329 2018-dep-exp-3 2018  dep  exp 3 9895.000 6.3e-05  Lead
## 330 2018-dep-exp-3 2018  dep  exp 3 9895.000 6.3e-05 Mercury
## 331 2018-dep-exp-3 2018  dep  exp 3 9895.000 6.3e-05 Selenium
## 332 2018-dep-exp-3 2018  dep  exp 3 9895.000 6.3e-05 Thallium
## 333 2018-dep-exp-3 2018  dep  exp 3 9895.000 6.3e-05  Zinc
## 334 2018-dep-exp-3 2018  dep  exp 3 9895.000 2.0e-03 Arsenic
## 335 2018-dep-exp-3 2018  dep  exp 3 9895.000 2.0e-03 Cadmium
## 336 2018-dep-exp-3 2018  dep  exp 3 9895.000 2.0e-03 Chromium
## 337 2018-dep-exp-3 2018  dep  exp 3 9895.000 2.0e-03 Copper
## 338 2018-dep-exp-3 2018  dep  exp 3 9895.000 2.0e-03  Lead
## 339 2018-dep-exp-3 2018  dep  exp 3 9895.000 2.0e-03 Mercury
## 340 2018-dep-exp-3 2018  dep  exp 3 9895.000 2.0e-03 Selenium
## 341 2018-dep-exp-3 2018  dep  exp 3 9895.000 2.0e-03 Thallium
## 342 2018-dep-exp-3 2018  dep  exp 3 9895.000 2.0e-03  Zinc
## 343 2018-dep-exp-4 2018  dep  exp 4 12470.000 6.3e-05 Arsenic
## 344 2018-dep-exp-4 2018  dep  exp 4 12470.000 6.3e-05 Cadmium
## 345 2018-dep-exp-4 2018  dep  exp 4 12470.000 6.3e-05 Chromium
## 346 2018-dep-exp-4 2018  dep  exp 4 12470.000 6.3e-05 Copper
## 347 2018-dep-exp-4 2018  dep  exp 4 12470.000 6.3e-05  Lead
## 348 2018-dep-exp-4 2018  dep  exp 4 12470.000 6.3e-05 Mercury
## 349 2018-dep-exp-4 2018  dep  exp 4 12470.000 6.3e-05 Selenium
## 350 2018-dep-exp-4 2018  dep  exp 4 12470.000 6.3e-05 Thallium
## 351 2018-dep-exp-4 2018  dep  exp 4 12470.000 6.3e-05  Zinc
## 352 2018-dep-exp-4 2018  dep  exp 4 12470.000 2.0e-03 Arsenic
## 353 2018-dep-exp-4 2018  dep  exp 4 12470.000 2.0e-03 Cadmium
## 354 2018-dep-exp-4 2018  dep  exp 4 12470.000 2.0e-03 Chromium
## 355 2018-dep-exp-4 2018  dep  exp 4 12470.000 2.0e-03 Copper
## 356 2018-dep-exp-4 2018  dep  exp 4 12470.000 2.0e-03  Lead
## 357 2018-dep-exp-4 2018  dep  exp 4 12470.000 2.0e-03 Mercury
## 358 2018-dep-exp-4 2018  dep  exp 4 12470.000 2.0e-03 Selenium
## 359 2018-dep-exp-4 2018  dep  exp 4 12470.000 2.0e-03 Thallium
## 360 2018-dep-exp-4 2018  dep  exp 4 12470.000 2.0e-03  Zinc
## 361 2021-dep-exp-1 2021  dep  exp 1 2654.000 2.0e-03 Arsenic
## 362 2021-dep-exp-1 2021  dep  exp 1 2654.000 2.0e-03 Cadmium
## 363 2021-dep-exp-1 2021  dep  exp 1 2654.000 2.0e-03 Chromium
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## 364 2021-dep-exp-1 2021  dep  exp 1 2654.000 2.0e-03 Copper
## 365 2021-dep-exp-1 2021  dep  exp 1 2654.000 2.0e-03  Lead
## 366 2021-dep-exp-1 2021  dep  exp 1 2654.000 2.0e-03 Mercury
## 367 2021-dep-exp-1 2021  dep  exp 1 2654.000 2.0e-03 Selenium
## 368 2021-dep-exp-1 2021  dep  exp 1 2654.000 2.0e-03 Thallium
## 369 2021-dep-exp-1 2021  dep  exp 1 2654.000 2.0e-03  Zinc
## 370 2021-dep-exp-1 2021  dep  exp 1 2654.000 6.3e-05 Arsenic
## 371 2021-dep-exp-1 2021  dep  exp 1 2654.000 6.3e-05 Cadmium
## 372 2021-dep-exp-1 2021  dep  exp 1 2654.000 6.3e-05 Chromium
## 373 2021-dep-exp-1 2021  dep  exp 1 2654.000 6.3e-05 Copper
## 374 2021-dep-exp-1 2021  dep  exp 1 2654.000 6.3e-05  Lead
## 375 2021-dep-exp-1 2021  dep  exp 1 2654.000 6.3e-05 Mercury
## 376 2021-dep-exp-1 2021  dep  exp 1 2654.000 6.3e-05 Selenium
## 377 2021-dep-exp-1 2021  dep  exp 1 2654.000 6.3e-05 Thallium
## 378 2021-dep-exp-1 2021  dep  exp 1 2654.000 6.3e-05  Zinc
## 379 2021-dep-exp-2 2021  dep  exp 2 6863.000 2.0e-03 Arsenic
## 380 2021-dep-exp-2 2021  dep  exp 2 6863.000 2.0e-03 Cadmium
## 381 2021-dep-exp-2 2021  dep  exp 2 6863.000 2.0e-03 Chromium
## 382 2021-dep-exp-2 2021  dep  exp 2 6863.000 2.0e-03 Copper
## 383 2021-dep-exp-2 2021  dep  exp 2 6863.000 2.0e-03  Lead
## 384 2021-dep-exp-2 2021  dep  exp 2 6863.000 2.0e-03 Mercury
## 385 2021-dep-exp-2 2021  dep  exp 2 6863.000 2.0e-03 Selenium
## 386 2021-dep-exp-2 2021  dep  exp 2 6863.000 2.0e-03 Thallium
## 387 2021-dep-exp-2 2021  dep  exp 2 6863.000 2.0e-03  Zinc
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## 390 2021-dep-exp-2 2021  dep  exp 2 6863.000 6.3e-05 Chromium
## 391 2021-dep-exp-2 2021  dep  exp 2 6863.000 6.3e-05 Copper
## 392 2021-dep-exp-2 2021  dep  exp 2 6863.000 6.3e-05  Lead
## 393 2021-dep-exp-2 2021  dep  exp 2 6863.000 6.3e-05 Mercury
## 394 2021-dep-exp-2 2021  dep  exp 2 6863.000 6.3e-05 Selenium
## 395 2021-dep-exp-2 2021  dep  exp 2 6863.000 6.3e-05 Thallium
## 396 2021-dep-exp-2 2021  dep  exp 2 6863.000 6.3e-05  Zinc
## 397 2021-dep-exp-3 2021  dep  exp 3 9895.000 2.0e-03 Arsenic
## 398 2021-dep-exp-3 2021  dep  exp 3 9895.000 2.0e-03 Cadmium
## 399 2021-dep-exp-3 2021  dep  exp 3 9895.000 2.0e-03 Chromium
## 400 2021-dep-exp-3 2021  dep  exp 3 9895.000 2.0e-03 Copper
## 401 2021-dep-exp-3 2021  dep  exp 3 9895.000 2.0e-03  Lead
## 402 2021-dep-exp-3 2021  dep  exp 3 9895.000 2.0e-03 Mercury
```

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## 403 2021-dep-exp-3 2021  dep  exp 3 9895.000 2.0e-03 Selenium
## 404 2021-dep-exp-3 2021  dep  exp 3 9895.000 2.0e-03 Thallium
## 405 2021-dep-exp-3 2021  dep  exp 3 9895.000 2.0e-03  Zinc
## 406 2021-dep-exp-3 2021  dep  exp 3 9895.000 6.3e-05 Arsenic
## 407 2021-dep-exp-3 2021  dep  exp 3 9895.000 6.3e-05 Cadmium
## 408 2021-dep-exp-3 2021  dep  exp 3 9895.000 6.3e-05 Chromium
## 409 2021-dep-exp-3 2021  dep  exp 3 9895.000 6.3e-05 Copper
## 410 2021-dep-exp-3 2021  dep  exp 3 9895.000 6.3e-05  Lead
## 411 2021-dep-exp-3 2021  dep  exp 3 9895.000 6.3e-05 Mercury
## 412 2021-dep-exp-3 2021  dep  exp 3 9895.000 6.3e-05 Selenium
## 413 2021-dep-exp-3 2021  dep  exp 3 9895.000 6.3e-05 Thallium
## 414 2021-dep-exp-3 2021  dep  exp 3 9895.000 6.3e-05  Zinc
## 415 2021-dep-exp-4 2021  dep  exp 4 12470.000 2.0e-03 Arsenic
## 416 2021-dep-exp-4 2021  dep  exp 4 12470.000 2.0e-03 Cadmium
## 417 2021-dep-exp-4 2021  dep  exp 4 12470.000 2.0e-03 Chromium
## 418 2021-dep-exp-4 2021  dep  exp 4 12470.000 2.0e-03 Copper
## 419 2021-dep-exp-4 2021  dep  exp 4 12470.000 2.0e-03  Lead
## 420 2021-dep-exp-4 2021  dep  exp 4 12470.000 2.0e-03 Mercury
## 421 2021-dep-exp-4 2021  dep  exp 4 12470.000 2.0e-03 Selenium
## 422 2021-dep-exp-4 2021  dep  exp 4 12470.000 2.0e-03 Thallium
## 423 2021-dep-exp-4 2021  dep  exp 4 12470.000 2.0e-03  Zinc
## 424 2021-dep-exp-4 2021  dep  exp 4 12470.000 6.3e-05 Arsenic
## 425 2021-dep-exp-4 2021  dep  exp 4 12470.000 6.3e-05 Cadmium
## 426 2021-dep-exp-4 2021  dep  exp 4 12470.000 6.3e-05 Chromium
## 427 2021-dep-exp-4 2021  dep  exp 4 12470.000 6.3e-05 Copper
## 428 2021-dep-exp-4 2021  dep  exp 4 12470.000 6.3e-05  Lead
## 429 2021-dep-exp-4 2021  dep  exp 4 12470.000 6.3e-05 Mercury
## 430 2021-dep-exp-4 2021  dep  exp 4 12470.000 6.3e-05 Selenium
## 431 2021-dep-exp-4 2021  dep  exp 4 12470.000 6.3e-05 Thallium
## 432 2021-dep-exp-4 2021  dep  exp 4 12470.000 6.3e-05  Zinc
## 433 2021-dep-exp-5 2021  dep  exp 5 13117.000 2.0e-03 Arsenic
## 434 2021-dep-exp-5 2021  dep  exp 5 13117.000 2.0e-03 Cadmium
## 435 2021-dep-exp-5 2021  dep  exp 5 13117.000 2.0e-03 Chromium
## 436 2021-dep-exp-5 2021  dep  exp 5 13117.000 2.0e-03 Copper
## 437 2021-dep-exp-5 2021  dep  exp 5 13117.000 2.0e-03  Lead
## 438 2021-dep-exp-5 2021  dep  exp 5 13117.000 2.0e-03 Mercury
## 439 2021-dep-exp-5 2021  dep  exp 5 13117.000 2.0e-03 Selenium
## 440 2021-dep-exp-5 2021  dep  exp 5 13117.000 2.0e-03 Thallium
## 441 2021-dep-exp-5 2021  dep  exp 5 13117.000 2.0e-03  Zinc
```

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## 442 2021-dep-exp-5 2021  dep  exp 5 13117.000 6.3e-05 Arsenic
## 443 2021-dep-exp-5 2021  dep  exp 5 13117.000 6.3e-05 Cadmium
## 444 2021-dep-exp-5 2021  dep  exp 5 13117.000 6.3e-05 Chromium
## 445 2021-dep-exp-5 2021  dep  exp 5 13117.000 6.3e-05 Copper
## 446 2021-dep-exp-5 2021  dep  exp 5 13117.000 6.3e-05  Lead
## 447 2021-dep-exp-5 2021  dep  exp 5 13117.000 6.3e-05 Mercury
## 448 2021-dep-exp-5 2021  dep  exp 5 13117.000 6.3e-05 Selenium
## 449 2021-dep-exp-5 2021  dep  exp 5 13117.000 6.3e-05 Thallium
## 450 2021-dep-exp-5 2021  dep  exp 5 13117.000 6.3e-05  Zinc
## 451 2021-dep-exp-6 2021  dep  exp 6 14929.000 2.0e-03 Arsenic
## 452 2021-dep-exp-6 2021  dep  exp 6 14929.000 2.0e-03 Cadmium
## 453 2021-dep-exp-6 2021  dep  exp 6 14929.000 2.0e-03 Chromium
## 454 2021-dep-exp-6 2021  dep  exp 6 14929.000 2.0e-03 Copper
## 455 2021-dep-exp-6 2021  dep  exp 6 14929.000 2.0e-03  Lead
## 456 2021-dep-exp-6 2021  dep  exp 6 14929.000 2.0e-03 Mercury
## 457 2021-dep-exp-6 2021  dep  exp 6 14929.000 2.0e-03 Selenium
## 458 2021-dep-exp-6 2021  dep  exp 6 14929.000 2.0e-03 Thallium
## 459 2021-dep-exp-6 2021  dep  exp 6 14929.000 2.0e-03  Zinc
## 460 2021-dep-exp-6 2021  dep  exp 6 14929.000 6.3e-05 Arsenic
## 461 2021-dep-exp-6 2021  dep  exp 6 14929.000 6.3e-05 Cadmium
## 462 2021-dep-exp-6 2021  dep  exp 6 14929.000 6.3e-05 Chromium
## 463 2021-dep-exp-6 2021  dep  exp 6 14929.000 6.3e-05 Copper
## 464 2021-dep-exp-6 2021  dep  exp 6 14929.000 6.3e-05  Lead
## 465 2021-dep-exp-6 2021  dep  exp 6 14929.000 6.3e-05 Mercury
## 466 2021-dep-exp-6 2021  dep  exp 6 14929.000 6.3e-05 Selenium
## 467 2021-dep-exp-6 2021  dep  exp 6 14929.000 6.3e-05 Thallium
## 468 2021-dep-exp-6 2021  dep  exp 6 14929.000 6.3e-05  Zinc
## 469 2021-dep-exp-7 2021  dep  exp 7 16791.000 2.0e-03 Arsenic
## 470 2021-dep-exp-7 2021  dep  exp 7 16791.000 2.0e-03 Cadmium
## 471 2021-dep-exp-7 2021  dep  exp 7 16791.000 2.0e-03 Chromium
## 472 2021-dep-exp-7 2021  dep  exp 7 16791.000 2.0e-03 Copper
## 473 2021-dep-exp-7 2021  dep  exp 7 16791.000 2.0e-03  Lead
## 474 2021-dep-exp-7 2021  dep  exp 7 16791.000 2.0e-03 Mercury
## 475 2021-dep-exp-7 2021  dep  exp 7 16791.000 2.0e-03 Selenium
## 476 2021-dep-exp-7 2021  dep  exp 7 16791.000 2.0e-03 Thallium
## 477 2021-dep-exp-7 2021  dep  exp 7 16791.000 2.0e-03  Zinc
## 478 2021-dep-exp-7 2021  dep  exp 7 16791.000 6.3e-05 Arsenic
## 479 2021-dep-exp-7 2021  dep  exp 7 16791.000 6.3e-05 Cadmium
## 480 2021-dep-exp-7 2021  dep  exp 7 16791.000 6.3e-05 Chromium
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## 481 2021-dep-exp-7 2021  dep  exp 7 16791.000 6.3e-05 Copper
## 482 2021-dep-exp-7 2021  dep  exp 7 16791.000 6.3e-05  Lead
## 483 2021-dep-exp-7 2021  dep  exp 7 16791.000 6.3e-05 Mercury
## 484 2021-dep-exp-7 2021  dep  exp 7 16791.000 6.3e-05 Selenium
## 485 2021-dep-exp-7 2021  dep  exp 7 16791.000 6.3e-05 Thallium
## 486 2021-dep-exp-7 2021  dep  exp 7 16791.000 6.3e-05  Zinc
## 487 2021-dep-ref-1 2021  dep  ref 1 -28291.000 2.0e-03 Arsenic
## 488 2021-dep-ref-1 2021  dep  ref 1 -28291.000 2.0e-03 Cadmium
## 489 2021-dep-ref-1 2021  dep  ref 1 -28291.000 2.0e-03 Chromium
## 490 2021-dep-ref-1 2021  dep  ref 1 -28291.000 2.0e-03 Copper
## 491 2021-dep-ref-1 2021  dep  ref 1 -28291.000 2.0e-03  Lead
## 492 2021-dep-ref-1 2021  dep  ref 1 -28291.000 2.0e-03 Mercury
## 493 2021-dep-ref-1 2021  dep  ref 1 -28291.000 2.0e-03 Selenium
## 494 2021-dep-ref-1 2021  dep  ref 1 -28291.000 2.0e-03 Thallium
## 495 2021-dep-ref-1 2021  dep  ref 1 -28291.000 2.0e-03  Zinc
## 496 2021-dep-ref-1 2021  dep  ref 1 -28291.000 6.3e-05 Arsenic
## 497 2021-dep-ref-1 2021  dep  ref 1 -28291.000 6.3e-05 Cadmium
## 498 2021-dep-ref-1 2021  dep  ref 1 -28291.000 6.3e-05 Chromium
## 499 2021-dep-ref-1 2021  dep  ref 1 -28291.000 6.3e-05 Copper
## 500 2021-dep-ref-1 2021  dep  ref 1 -28291.000 6.3e-05  Lead
## 501 2021-dep-ref-1 2021  dep  ref 1 -28291.000 6.3e-05 Mercury
## 502 2021-dep-ref-1 2021  dep  ref 1 -28291.000 6.3e-05 Selenium
## 503 2021-dep-ref-1 2021  dep  ref 1 -28291.000 6.3e-05 Thallium
## 504 2021-dep-ref-1 2021  dep  ref 1 -28291.000 6.3e-05  Zinc
## 505 2021-dep-ref-2 2021  dep  ref 2 -12833.000 2.0e-03 Arsenic
## 506 2021-dep-ref-2 2021  dep  ref 2 -12833.000 2.0e-03 Cadmium
## 507 2021-dep-ref-2 2021  dep  ref 2 -12833.000 2.0e-03 Chromium
## 508 2021-dep-ref-2 2021  dep  ref 2 -12833.000 2.0e-03 Copper
## 509 2021-dep-ref-2 2021  dep  ref 2 -12833.000 2.0e-03  Lead
## 510 2021-dep-ref-2 2021  dep  ref 2 -12833.000 2.0e-03 Mercury
## 511 2021-dep-ref-2 2021  dep  ref 2 -12833.000 2.0e-03 Selenium
## 512 2021-dep-ref-2 2021  dep  ref 2 -12833.000 2.0e-03 Thallium
## 513 2021-dep-ref-2 2021  dep  ref 2 -12833.000 2.0e-03  Zinc
## 514 2021-dep-ref-2 2021  dep  ref 2 -12833.000 6.3e-05 Arsenic
## 515 2021-dep-ref-2 2021  dep  ref 2 -12833.000 6.3e-05 Cadmium
## 516 2021-dep-ref-2 2021  dep  ref 2 -12833.000 6.3e-05 Chromium
## 517 2021-dep-ref-2 2021  dep  ref 2 -12833.000 6.3e-05 Copper
## 518 2021-dep-ref-2 2021  dep  ref 2 -12833.000 6.3e-05  Lead
## 519 2021-dep-ref-2 2021  dep  ref 2 -12833.000 6.3e-05 Mercury
```

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## 520 2021-dep-ref-2 2021  dep  ref 2 -12833.000 6.3e-05 Selenium
## 521 2021-dep-ref-2 2021  dep  ref 2 -12833.000 6.3e-05 Thallium
## 522 2021-dep-ref-2 2021  dep  ref 2 -12833.000 6.3e-05  Zinc
## 523 2021-dep-ref-3 2021  dep  ref 3 -8238.000 2.0e-03 Arsenic
## 524 2021-dep-ref-3 2021  dep  ref 3 -8238.000 2.0e-03 Cadmium
## 525 2021-dep-ref-3 2021  dep  ref 3 -8238.000 2.0e-03 Chromium
## 526 2021-dep-ref-3 2021  dep  ref 3 -8238.000 2.0e-03 Copper
## 527 2021-dep-ref-3 2021  dep  ref 3 -8238.000 2.0e-03  Lead
## 528 2021-dep-ref-3 2021  dep  ref 3 -8238.000 2.0e-03 Mercury
## 529 2021-dep-ref-3 2021  dep  ref 3 -8238.000 2.0e-03 Selenium
## 530 2021-dep-ref-3 2021  dep  ref 3 -8238.000 2.0e-03 Thallium
## 531 2021-dep-ref-3 2021  dep  ref 3 -8238.000 2.0e-03  Zinc
## 532 2021-dep-ref-3 2021  dep  ref 3 -8238.000 6.3e-05 Arsenic
## 533 2021-dep-ref-3 2021  dep  ref 3 -8238.000 6.3e-05 Cadmium
## 534 2021-dep-ref-3 2021  dep  ref 3 -8238.000 6.3e-05 Chromium
## 535 2021-dep-ref-3 2021  dep  ref 3 -8238.000 6.3e-05 Copper
## 536 2021-dep-ref-3 2021  dep  ref 3 -8238.000 6.3e-05  Lead
## 537 2021-dep-ref-3 2021  dep  ref 3 -8238.000 6.3e-05 Mercury
## 538 2021-dep-ref-3 2021  dep  ref 3 -8238.000 6.3e-05 Selenium
## 539 2021-dep-ref-3 2021  dep  ref 3 -8238.000 6.3e-05 Thallium
## 540 2021-dep-ref-3 2021  dep  ref 3 -8238.000 6.3e-05  Zinc
##   duplicate   value_text value dl season
## 1  FALSE     0.9 0.900  fall
## 2  FALSE      1 1.000  fall
## 3  FALSE     0.8 0.800  fall
## 4  FALSE      6 6.000  fall
## 5  FALSE     5.5 5.500  fall
## 6  FALSE     14.1 14.100  fall
## 7  FALSE     5.2 5.200  fall
## 8  FALSE     5.9 5.900  fall
## 9  FALSE     4.1 4.100  fall
## 10  FALSE     3.6 3.600  fall
## 11  FALSE     0.8 0.800  fall
## 12  FALSE     1.1 1.100  fall
## 13  FALSE     0.6 0.600  fall
## 14  FALSE     7.1 7.100  fall
## 15  FALSE     14 14.000  fall
## 16  FALSE     11 11.000  fall
## 17  FALSE      7 7.000  fall
```

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## 18  FALSE     9.6 9.600  fall
## 19  FALSE     5.9 5.900  fall
## 20  FALSE     4.9 4.900  fall
## 21  FALSE     0.19 0.190  fall
## 22  FALSE     0.17 0.170  fall
## 23  FALSE     0.11 0.110  fall
## 24  FALSE     1.39 1.390  fall
## 25  FALSE     0.54 0.540  fall
## 26  FALSE     0.57 0.570  fall
## 27  FALSE     0.46 0.460  fall
## 28  FALSE     1.12 1.120  fall
## 29  FALSE     0.52 0.520  fall
## 30  FALSE     2.81 2.810  fall
## 31  FALSE     0.23 0.230  fall
## 32  FALSE     0.3 0.300  fall
## 33  FALSE     0.09 0.090  fall
## 34  FALSE     1.7 1.700  fall
## 35  FALSE     0.5 0.500  fall
## 36  FALSE     1.1 1.100  fall
## 37  FALSE     0.5 0.500  fall
## 38  FALSE     1.1 1.100  fall
## 39  FALSE     0.71 0.710  fall
## 40  FALSE     1.2 1.200  fall
## 41  FALSE     11.9 11.900  fall
## 42  FALSE     10 10.000  fall
## 43  FALSE     15.6 15.600  fall
## 44  FALSE     20.8 20.800  fall
## 45  FALSE     19.1 19.100  fall
## 46  FALSE     36.6 36.600  fall
## 47  FALSE     22.5 22.500  fall
## 48  FALSE     26.3 26.300  fall
## 49  FALSE     20.7 20.700  fall
## 50  FALSE     31.2 31.200  fall
## 51  FALSE     18 18.000  fall
## 52  FALSE     15 15.000  fall
## 53  FALSE     15 15.000  fall
## 54  FALSE     19 19.000  fall
## 55  FALSE     39 39.000  fall
## 56  FALSE     31 31.000  fall
```

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## 57  FALSE     24 24.000  fall
## 58  FALSE     30 30.000  fall
## 59  FALSE     25 25.000  fall
## 60  FALSE     34 34.000  fall
## 61  FALSE     5.4 5.400  fall
## 62  FALSE     5.1 5.100  fall
## 63  FALSE     5.1 5.100  fall
## 64  FALSE     95.9 95.900  fall
## 65  FALSE     161 161.000  fall
## 66  FALSE     514 514.000  fall
## 67  FALSE     139 139.000  fall
## 68  FALSE     196 196.000  fall
## 69  FALSE     176 176.000  fall
## 70  FALSE     36 36.000  fall
## 71  FALSE     5.8 5.800  fall
## 72  FALSE     6.3 6.300  fall
## 73  FALSE      4 4.000  fall
## 74  FALSE     120 120.000  fall
## 75  FALSE     670 670.000  fall
## 76  FALSE     370 370.000  fall
## 77  FALSE     180 180.000  fall
## 78  FALSE     320 320.000  fall
## 79  FALSE     250 250.000  fall
## 80  FALSE     100 100.000  fall
## 81  FALSE     6.8 6.800  fall
## 82  FALSE     7.3 7.300  fall
## 83  FALSE      7 7.000  fall
## 84  FALSE     160 160.000  fall
## 85  FALSE     141 141.000  fall
## 86  FALSE     136 136.000  fall
## 87  FALSE     48.9 48.900  fall
## 88  FALSE     109 109.000  fall
## 89  FALSE     52.8 52.800  fall
## 90  FALSE     91.9 91.900  fall
## 91  FALSE     7.8 7.800  fall
## 92  FALSE     9.9 9.900  fall
## 93  FALSE     4.9 4.900  fall
## 94  FALSE     170 170.000  fall
## 95  FALSE     100 100.000  fall
```

```
## 96  FALSE     160 160.000  fall
## 97  FALSE     62 62.000  fall
## 98  FALSE     130 130.000  fall
## 99  FALSE     83 83.000  fall
## 100  FALSE     73 73.000  fall
## 101  FALSE     0.05 0.050  fall
## 102  FALSE     <0.05 0.025 < fall
## 103  FALSE     <0.05 0.025 < fall
## 104  FALSE     0.23 0.230  fall
## 105  FALSE     0.13 0.130  fall
## 106  FALSE     0.12 0.120  fall
## 107  FALSE     0.08 0.080  fall
## 108  FALSE     0.25 0.250  fall
## 109  FALSE     0.17 0.170  fall
## 110  FALSE     0.14 0.140  fall
## 111  FALSE     0.001 0.001  fall
## 112  FALSE     0.001 0.001  fall
## 113  FALSE     0.001 0.001  fall
## 114  FALSE     0.19 0.190  fall
## 115  FALSE     0.12 0.120  fall
## 116  FALSE     0.21 0.210  fall
## 117  FALSE     0.08 0.080  fall
## 118  FALSE     0.16 0.160  fall
## 119  FALSE     0.07 0.070  fall
## 120  FALSE     0.05 0.050  fall
## 121  FALSE     <0.5 0.250 < fall
## 122  FALSE     <0.5 0.250 < fall
## 123  FALSE     <0.5 0.250 < fall
## 124  FALSE     <0.5 0.250 < fall
## 125  FALSE     <0.5 0.250 < fall
## 126  FALSE     <0.5 0.250 < fall
## 127  FALSE     <0.5 0.250 < fall
## 128  FALSE     0.6 0.600  fall
## 129  FALSE     <0.5 0.250 < fall
## 130  FALSE     <0.5 0.250 < fall
## 131  FALSE     0.01 0.010  fall
## 132  FALSE     0.01 0.010  fall
## 133  FALSE     0.01 0.010  fall
## 134  FALSE     0.6 0.600  fall
```

```
## 135  FALSE      1 1.000  fall
## 136  FALSE     0.8 0.800  fall
## 137  FALSE     0.01 0.010  fall
## 138  FALSE     0.8 0.800  fall
## 139  FALSE     0.6 0.600  fall
## 140  FALSE     0.01 0.010  fall
## 141  FALSE     <0.1 0.050 < fall
## 142  FALSE     <0.1 0.050 < fall
## 143  FALSE     <0.1 0.050 < fall
## 144  FALSE     0.3 0.300  fall
## 145  FALSE     <0.1 0.050 < fall
## 146  FALSE     <0.1 0.050 < fall
## 147  FALSE     0.1 0.100  fall
## 148  FALSE     0.2 0.200  fall
## 149  FALSE     0.2 0.200  fall
## 150  FALSE     0.2 0.200  fall
## 151  FALSE     <0.1 0.050 < fall
## 152  FALSE     <0.1 0.050 < fall
## 153  FALSE     <0.1 0.050 < fall
## 154  FALSE     0.4 0.400  fall
## 155  FALSE     <0.1 0.050 < fall
## 156  FALSE     0.2 0.200  fall
## 157  FALSE     0.1 0.100  fall
## 158  FALSE     0.2 0.200  fall
## 159  FALSE     0.2 0.200  fall
## 160  FALSE     0.2 0.200  fall
## 161  FALSE     59 59.000  fall
## 162  FALSE     48 48.000  fall
## 163  FALSE     31 31.000  fall
## 164  FALSE     645 645.000  fall
## 165  FALSE     1190 1190.000  fall
## 166  FALSE     2550 2550.000  fall
## 167  FALSE     770 770.000  fall
## 168  FALSE     1160 1160.000  fall
## 169  FALSE     793 793.000  fall
## 170  FALSE     594 594.000  fall
## 171  FALSE     71 71.000  fall
## 172  FALSE     70 70.000  fall
## 173  FALSE     38 38.000  fall
```

```
## 174  FALSE     650 650.000  fall
## 175  FALSE     4200 4200.000  fall
## 176  FALSE     2200 2200.000  fall
## 177  FALSE     930 930.000  fall
## 178  FALSE     2400 2400.000  fall
## 179  FALSE     1400 1400.000  fall
## 180  FALSE     780 780.000  fall
## 181  FALSE     2.46 2.460  fall
## 182  FALSE 0.58499999999999996 0.585  fall
## 183  FALSE     23.9 23.900  fall
## 184  FALSE     13.6 13.600  fall
## 185  FALSE     12.6 12.600  fall
## 186  FALSE    <0.040 0.020 < fall
## 187  FALSE     0.42 0.420  fall
## 188  FALSE     0.1 0.100  fall
## 189  FALSE     96.2 96.200  fall
## 190  FALSE     1.38 1.380  fall
## 191  FALSE 0.20799999999999999 0.208  fall
## 192  FALSE     14.4 14.400  fall
## 193  FALSE     5.4 5.400  fall
## 194  FALSE     6.26 6.260  fall
## 195  FALSE    <0.040 0.020 < fall
## 196  FALSE     <0.20 0.100 < fall
## 197  FALSE     <0.10 0.050 < fall
## 198  FALSE     60.8 60.800  fall
## 199  FALSE     23.6 23.600  fall
## 200  FALSE     4.63 4.630  fall
## 201  FALSE     45.5 45.500  fall
## 202  FALSE     243 243.000  fall
## 203  FALSE     526 526.000  fall
## 204  FALSE 1.1499999999999999 1.150  fall
## 205  FALSE     1.57 1.570  fall
## 206  FALSE     0.48 0.480  fall
## 207  FALSE     1400 1400.000  fall
## 208  FALSE     8.66 8.660  fall
## 209  FALSE     1.68 1.680  fall
## 210  FALSE     21.7 21.700  fall
## 211  FALSE     188 188.000  fall
## 212  FALSE     194 194.000  fall
```

```
## 213  FALSE 0.13300000000000001 0.133  fall
## 214  FALSE     0.43 0.430  fall
## 215  FALSE     0.25 0.250  fall
## 216  FALSE     1100 1100.000  fall
## 217  FALSE     37.4 37.400  fall
## 218  FALSE 10.199999999999999 10.200  fall
## 219  FALSE     56.2 56.200  fall
## 220  FALSE     681 681.000  fall
## 221  FALSE     900 900.000  fall
## 222  FALSE     7.41 7.410  fall
## 223  FALSE     8.73 8.730  fall
## 224  FALSE     1.25 1.250  fall
## 225  FALSE     4380 4380.000  fall
## 226  FALSE     11 11.000  fall
## 227  FALSE     2.15 2.150  fall
## 228  FALSE 38.700000000000003 38.700  fall
## 229  FALSE     467 467.000  fall
## 230  FALSE     220 220.000  fall
## 231  FALSE 0.55000000000000004 0.550  fall
## 232  FALSE     1.82 1.820  fall
## 233  FALSE     0.37 0.370  fall
## 234  FALSE     3790 3790.000  fall
## 235  FALSE     2.78 2.780  fall
## 236  FALSE 0.57299999999999995 0.573  fall
## 237  FALSE     26.5 26.500  fall
## 238  FALSE     14.2 14.200  fall
## 239  FALSE     15.5 15.500  fall
## 240  FALSE     0.185 0.185  fall
## 241  FALSE 0.28999999999999998 0.290  fall
## 242  FALSE     <0.10 0.050 < fall
## 243  FALSE     92.5 92.500  fall
## 244  FALSE     1.27 1.270  fall
## 245  FALSE 0.16500000000000001 0.165  fall
## 246  FALSE     13.6 13.600  fall
## 247  FALSE     5.38 5.380  fall
## 248  FALSE     5.54 5.540  fall
## 249  FALSE    <0.040 0.020 < fall
## 250  FALSE     <0.20 0.100 < fall
## 251  FALSE     <0.10 0.050 < fall
```

```
## 252  FALSE     56.2 56.200  fall
## 253  FALSE 2.2200000000000002 2.220  fall
## 254  FALSE 0.58099999999999996 0.581  fall
## 255  FALSE     21.1 21.100  fall
## 256  FALSE     12.4 12.400  fall
## 257  FALSE     10.7 10.700  fall
## 258  FALSE    5.5E-2 0.055  fall
## 259  FALSE     0.3 0.300  fall
## 260  FALSE     <0.10 0.050 < fall
## 261  FALSE     78.2 78.200  fall
## 262  FALSE     1.07 1.070  fall
## 263  FALSE     0.248 0.248  fall
## 264  FALSE     10.9 10.900  fall
## 265  FALSE     5.89 5.890  fall
## 266  FALSE     7.19 7.190  fall
## 267  FALSE    <0.040 0.020 < fall
## 268  FALSE     <0.20 0.100 < fall
## 269  FALSE     <0.10 0.050 < fall
## 270  FALSE 64.900000000000006 64.900  fall
## 271  FALSE     6.79 6.790  fall
## 272  FALSE     2.48 2.480  fall
## 273  FALSE     27.1 27.100  fall
## 274  FALSE     43.8 43.800  fall
## 275  FALSE     116 116.000  fall
## 276  FALSE 0.42299999999999999 0.423  fall
## 277  FALSE     0.45 0.450  fall
## 278  FALSE     0.18 0.180  fall
## 279  FALSE     482 482.000  fall
## 280  FALSE     3.63 3.630  fall
## 281  FALSE     1.42 1.420  fall
## 282  FALSE     28.6 28.600  fall
## 283  FALSE     46.9 46.900  fall
## 284  FALSE     61.9 61.900  fall
## 285  FALSE 5.3999999999999999E-2 0.054  fall
## 286  FALSE     0.22 0.220  fall
## 287  FALSE     0.15 0.150  fall
## 288  FALSE     506 506.000  fall
## 289  FALSE     23.7 23.700  fall
## 290  FALSE     7.4 7.400  fall
```

```
## 291  FALSE     44.7 44.700  fall
## 292  FALSE     408 408.000  fall
## 293  FALSE     543 543.000  fall
## 294  FALSE     5.21 5.210  fall
## 295  FALSE     4.12 4.120  fall
## 296  FALSE     0.89 0.890  fall
## 297  FALSE     2660 2660.000  fall
## 298  FALSE     7.88 7.880  fall
## 299  FALSE     1.53 1.530  fall
## 300  FALSE     29.3 29.300  fall
## 301  FALSE     315 315.000  fall
## 302  FALSE     129 129.000  fall
## 303  FALSE     0.245 0.245  fall
## 304  FALSE     0.63 0.630  fall
## 305  FALSE     0.22 0.220  fall
## 306  FALSE     2160 2160.000  fall
## 307  FALSE     10.5 10.500  fall
## 308  FALSE     2.15 2.150  fall
## 309  FALSE 34.299999999999997 34.300  fall
## 310  FALSE     158 158.000  fall
## 311  FALSE     134 134.000  fall
## 312  FALSE     0.879 0.879  fall
## 313  FALSE     0.6 0.600  fall
## 314  FALSE     0.2 0.200  fall
## 315  FALSE     803 803.000  fall
## 316  FALSE     6.64 6.640  fall
## 317  FALSE 0.57299999999999995 0.573  fall
## 318  FALSE     21.9 21.900  fall
## 319  FALSE     165 165.000  fall
## 320  FALSE     56 56.000  fall
## 321  FALSE 7.5999999999999998E-2 0.076  fall
## 322  FALSE     0.22 0.220  fall
## 323  FALSE 0.14000000000000001 0.140  fall
## 324  FALSE     902 902.000  fall
## 325  FALSE     16 16.000  fall
## 326  FALSE 2.0299999999999998 2.030  fall
## 327  FALSE     34.4 34.400  fall
## 328  FALSE     416 416.000  fall
## 329  FALSE     221 221.000  fall
```

```
## 330  FALSE     1.9 1.900  fall
## 331  FALSE     0.64 0.640  fall
## 332  FALSE     0.22 0.220  fall
## 333  FALSE     1200 1200.000  fall
## 334  FALSE     11.1 11.100  fall
## 335  FALSE 0.36099999999999999 0.361  fall
## 336  FALSE     26.6 26.600  fall
## 337  FALSE     251 251.000  fall
## 338  FALSE     71.8 71.800  fall
## 339  FALSE 4.2000000000000003E-2 0.042  fall
## 340  FALSE     0.21 0.210  fall
## 341  FALSE     <0.10 0.050 < fall
## 342  FALSE     949 949.000  fall
## 343  FALSE     7.05 7.050  fall
## 344  FALSE     1.76 1.760  fall
## 345  FALSE     29.1 29.100  fall
## 346  FALSE     109 109.000  fall
## 347  FALSE     84.6 84.600  fall
## 348  FALSE 0.41499999999999998 0.415  fall
## 349  FALSE     0.39 0.390  fall
## 350  FALSE     0.18 0.180  fall
## 351  FALSE     697 697.000  fall
## 352  FALSE     6.76 6.760  fall
## 353  FALSE     1.41 1.410  fall
## 354  FALSE     30.2 30.200  fall
## 355  FALSE     322 322.000  fall
## 356  FALSE 70.400000000000006 70.400  fall
## 357  FALSE     0.106 0.106  fall
## 358  FALSE     0.37 0.370  fall
## 359  FALSE     0.2 0.200  fall
## 360  FALSE     1800 1800.000  fall
## 361  FALSE     2.77 2.770  fall
## 362  FALSE 0.46200000000000002 0.462  fall
## 363  FALSE     14.3 14.300  fall
## 364  FALSE     17.8 17.800  fall
## 365  FALSE     40.9 40.900  fall
## 366  FALSE    <0.040 0.020 < fall
## 367  FALSE     <0.20 0.100 < fall
## 368  FALSE     0.16 0.160  fall
```

```
## 369  FALSE     176 176.000  fall
## 370  FALSE     3.89 3.890  fall
## 371  FALSE 1.1599999999999999 1.160  fall
## 372  FALSE     21.2 21.200  fall
## 373  FALSE     19.3 19.300  fall
## 374  FALSE     45 45.000  fall
## 375  FALSE     0.06 0.060  fall
## 376  FALSE 0.28000000000000003 0.280  fall
## 377  FALSE     0.16 0.160  fall
## 378  FALSE     188 188.000  fall
## 379  FALSE 5.1100000000000003 5.110  fall
## 380  FALSE 0.47399999999999998 0.474  fall
## 381  FALSE     22.6 22.600  fall
## 382  FALSE     130 130.000  fall
## 383  FALSE     60.4 60.400  fall
## 384  FALSE     0.06 0.060  fall
## 385  FALSE     0.33 0.330  fall
## 386  FALSE     0.12 0.120  fall
## 387  FALSE     934 934.000  fall
## 388  FALSE     4.5 4.500  fall
## 389  FALSE 0.97799999999999998 0.978  fall
## 390  FALSE     28 28.000  fall
## 391  FALSE     54.1 54.100  fall
## 392  FALSE     55 55.000  fall
## 393  FALSE     0.129 0.129  fall
## 394  FALSE     0.54 0.540  fall
## 395  FALSE 0.14000000000000001 0.140  fall
## 396  FALSE     380 380.000  fall
## 397  FALSE     9.19 9.190  fall
## 398  FALSE 0.94699999999999995 0.947  fall
## 399  FALSE     49.1 49.100  fall
## 400  FALSE     738 738.000  fall
## 401  FALSE     140 140.000  fall
## 402  FALSE    <0.040 0.020 < fall
## 403  FALSE     0.95 0.950  fall
## 404  FALSE     <0.10 0.050 < fall
## 405  FALSE     8070 8070.000  fall
## 406  FALSE 36.700000000000003 36.700  fall
## 407  FALSE     5.61 5.610  fall
```

```
## 408  FALSE     62.1 62.100  fall
## 409  FALSE     1130 1130.000  fall
## 410  FALSE     533 533.000  fall
## 411  FALSE 0.41799999999999998 0.418  fall
## 412  FALSE     0.93 0.930  fall
## 413  FALSE     0.31 0.310  fall
## 414  FALSE     6140 6140.000  fall
## 415  FALSE     5.15 5.150  fall
## 416  FALSE 0.55800000000000005 0.558  fall
## 417  FALSE     26.6 26.600  fall
## 418  FALSE     265 265.000  fall
## 419  FALSE     57.6 57.600  fall
## 420  FALSE 4.4999999999999998E-2 0.045  fall
## 421  FALSE     0.25 0.250  fall
## 422  FALSE     0.16 0.160  fall
## 423  FALSE     1440 1440.000  fall
## 424  FALSE     3.99 3.990  fall
## 425  FALSE 0.89700000000000002 0.897  fall
## 426  FALSE     28.9 28.900  fall
## 427  FALSE     78.5 78.500  fall
## 428  FALSE     49.8 49.800  fall
## 429  FALSE 0.14099999999999999 0.141  fall
## 430  FALSE     0.4 0.400  fall
## 431  FALSE     0.13 0.130  fall
## 432  FALSE     593 593.000  fall
## 433  FALSE     6.44 6.440  fall
## 434  FALSE     1.35 1.350  fall
## 435  FALSE     27.6 27.600  fall
## 436  FALSE     221 221.000  fall
## 437  FALSE     110 110.000  fall
## 438  FALSE     0.158 0.158  fall
## 439  FALSE     0.69 0.690  fall
## 440  FALSE 0.28000000000000003 0.280  fall
## 441  FALSE     1520 1520.000  fall
## 442  FALSE     34.1 34.100  fall
## 443  FALSE 9.2899999999999991 9.290  fall
## 444  FALSE 79.599999999999994 79.600  fall
## 445  FALSE     1070 1070.000  fall
## 446  FALSE     788 788.000  fall
```

```
## 447  FALSE     3.47 3.470  fall
## 448  FALSE     4.66 4.660  fall
## 449  FALSE     1.25 1.250  fall
## 450  FALSE     5500 5500.000  fall
## 451  FALSE     3.65 3.650  fall
## 452  FALSE 0.38200000000000001 0.382  fall
## 453  FALSE     23.8 23.800  fall
## 454  FALSE     94.9 94.900  fall
## 455  FALSE     41 41.000  fall
## 456  FALSE 7.1999999999999995E-2 0.072  fall
## 457  FALSE     0.21 0.210  fall
## 458  FALSE 0.14000000000000001 0.140  fall
## 459  FALSE     639 639.000  fall
## 460  FALSE 8.7200000000000006 8.720  fall
## 461  FALSE     1.37 1.370  fall
## 462  FALSE     44.2 44.200  fall
## 463  FALSE     189 189.000  fall
## 464  FALSE     109 109.000  fall
## 465  FALSE     0.112 0.112  fall
## 466  FALSE     0.66 0.660  fall
## 467  FALSE     0.21 0.210  fall
## 468  FALSE     885 885.000  fall
## 469  FALSE     4.49 4.490  fall
## 470  FALSE 0.61699999999999999 0.617  fall
## 471  FALSE     27.6 27.600  fall
## 472  FALSE     127 127.000  fall
## 473  FALSE     53.5 53.500  fall
## 474  FALSE    <0.040 0.020 < fall
## 475  FALSE     0.23 0.230  fall
## 476  FALSE     0.12 0.120  fall
## 477  FALSE     1030 1030.000  fall
## 478  FALSE     10.5 10.500  fall
## 479  FALSE     3.2 3.200  fall
## 480  FALSE     51.9 51.900  fall
## 481  FALSE     195 195.000  fall
## 482  FALSE     164 164.000  fall
## 483  FALSE     0.157 0.157  fall
## 484  FALSE 0.55000000000000004 0.550  fall
## 485  FALSE     0.23 0.230  fall
```

```
## 486  FALSE     1370 1370.000  fall
## 487  FALSE     1.47 1.470  fall
## 488  FALSE 0.24399999999999999 0.244  fall
## 489  FALSE     18 18.000  fall
## 490  FALSE     6.47 6.470  fall
## 491  FALSE     7.68 7.680  fall
## 492  FALSE    <0.040 0.020 < fall
## 493  FALSE     <0.20 0.100 < fall
## 494  FALSE     <0.10 0.050 < fall
## 495  FALSE     86.3 86.300  fall
## 496  FALSE     2.94 2.940  fall
## 497  FALSE 0.81599999999999995 0.816  fall
## 498  FALSE     30.1 30.100  fall
## 499  FALSE 17.899999999999999 17.900  fall
## 500  FALSE 17.899999999999999 17.900  fall
## 501  FALSE    <0.040 0.020 < fall
## 502  FALSE     0.66 0.660  fall
## 503  FALSE     0.13 0.130  fall
## 504  FALSE     146 146.000  fall
## 505  FALSE     2.1 2.100  fall
## 506  FALSE 0.51900000000000002 0.519  fall
## 507  FALSE     20.3 20.300  fall
## 508  FALSE 9.1199999999999992 9.120  fall
## 509  FALSE     12 12.000  fall
## 510  FALSE    <0.040 0.020 < fall
## 511  FALSE     <0.20 0.100 < fall
## 512  FALSE     0.15 0.150  fall
## 513  FALSE     117 117.000  fall
## 514  FALSE     3.53 3.530  fall
## 515  FALSE 0.99399999999999999 0.994  fall
## 516  FALSE     28.2 28.200  fall
## 517  FALSE 18.899999999999999 18.900  fall
## 518  FALSE     24.6 24.600  fall
## 519  FALSE    <0.040 0.020 < fall
## 520  FALSE     0.45 0.450  fall
## 521  FALSE     0.12 0.120  fall
## 522  FALSE     141 141.000  fall
## 523  FALSE     1.23 1.230  fall
## 524  FALSE 0.17899999999999999 0.179  fall
```

```
## 525  FALSE     14.9 14.900  fall
## 526  FALSE     5.75 5.750  fall
## 527  FALSE     6.39 6.390  fall
## 528  FALSE    <0.040 0.020 < fall
## 529  FALSE     <0.20 0.100 < fall
## 530  FALSE     <0.10 0.050 < fall
## 531  FALSE     63.9 63.900  fall
## 532  FALSE     3.44 3.440  fall
## 533  FALSE 0.78500000000000003 0.785  fall
## 534  FALSE     30.5 30.500  fall
## 535  FALSE     18.2 18.200  fall
## 536  FALSE 18.100000000000001 18.100  fall
## 537  FALSE    <0.040 0.020 < fall
## 538  FALSE     0.51 0.510  fall
## 539  FALSE     0.13 0.130  fall
## 540  FALSE     123 123.000  fall
```

```
sedsMOI %>%
 group_by(label, analyte, value_text) %>% filter(n() > 1)
```

```
## # A tibble: 14 × 13
## # Groups: label, analyte, value_text [7]
## label   year dep_ero ref_exp site CII_Dist fraction analyte duplicate
## <chr>   <dbl> <chr> <chr> <chr> <dbl> <dbl> <chr> <lgl>
## 1 2018-dep-ref… 2018 dep  ref  1  -28291 0.000063 Mercury FALSE
## 2 2018-dep-ref… 2018 dep  ref  1  -28291 0.002 Mercury FALSE
## 3 2018-dep-ref… 2018 dep  ref  3  -8238 0.000063 Thalli… FALSE
## 4 2018-dep-ref… 2018 dep  ref  3  -8238 0.002 Thalli… FALSE
## 5 2018-dep-ref… 2018 dep  ref  2  -12833 0.000063 Thalli… FALSE
## 6 2018-dep-ref… 2018 dep  ref  2  -12833 0.002 Thalli… FALSE
## 7 2021-dep-exp… 2021 dep  exp  1   2654 0.002 Thalli… FALSE
## 8 2021-dep-exp… 2021 dep  exp  1   2654 0.000063 Thalli… FALSE
## 9 2021-dep-ref… 2021 dep  ref  1  -28291 0.002 Mercury FALSE
## 10 2021-dep-ref… 2021 dep  ref  1  -28291 0.000063 Mercury FALSE
## 11 2021-dep-ref… 2021 dep  ref  2  -12833 0.002 Mercury FALSE
## 12 2021-dep-ref… 2021 dep  ref  2  -12833 0.000063 Mercury FALSE
## 13 2021-dep-ref… 2021 dep  ref  3  -8238 0.002 Mercury FALSE
## 14 2021-dep-ref… 2021 dep  ref  3  -8238 0.000063 Mercury FALSE
```

```
## # … with 4 more variables: value_text <chr>, value <dbl>, dl <chr>,
## # season <chr>
```

7.0 Drop unneeded variables

Note: Need to keep fraction or there are 'duplicate' rows for the conversion to wide due to the multiple fraction sizes present in 2018

```
sedsClean <- sedsMOI %>% select(label, analyte, value, fraction)
sedsClean

##    label analyte value fraction
## 1 2015-dep-ref-1 Arsenic 0.900  NA
## 2 2015-dep-ref-2 Arsenic 1.000  NA
## 3 2015-dep-ref-3 Arsenic 0.800  NA
## 4 2015-dep-exp-1 Arsenic 6.000  NA
## 5 2015-dep-exp-2 Arsenic 5.500  NA
## 6 2015-dep-exp-3 Arsenic 14.100  NA
## 7 2015-dep-exp-4 Arsenic 5.200  NA
## 8 2015-dep-exp-5 Arsenic 5.900  NA
## 9 2015-dep-exp-6 Arsenic 4.100  NA
## 10 2015-dep-exp-7 Arsenic 3.600  NA
## 11 2012-dep-ref-1 Arsenic 0.800  NA
## 12 2012-dep-ref-2 Arsenic 1.100  NA
## 13 2012-dep-ref-3 Arsenic 0.600  NA
## 14 2012-dep-exp-1 Arsenic 7.100  NA
## 15 2012-dep-exp-2 Arsenic 14.000  NA
## 16 2012-dep-exp-3 Arsenic 11.000  NA
## 17 2012-dep-exp-4 Arsenic 7.000  NA
## 18 2012-dep-exp-5 Arsenic 9.600  NA
## 19 2012-dep-exp-6 Arsenic 5.900  NA
## 20 2012-dep-exp-7 Arsenic 4.900  NA
## 21 2015-dep-ref-1 Cadmium 0.190  NA
## 22 2015-dep-ref-2 Cadmium 0.170  NA
## 23 2015-dep-ref-3 Cadmium 0.110  NA
## 24 2015-dep-exp-1 Cadmium 1.390  NA
## 25 2015-dep-exp-2 Cadmium 0.540  NA
## 26 2015-dep-exp-3 Cadmium 0.570  NA
## 27 2015-dep-exp-4 Cadmium 0.460  NA
## 28 2015-dep-exp-5 Cadmium 1.120  NA
## 29 2015-dep-exp-6 Cadmium 0.520  NA
```

```
## 30 2015-dep-exp-7 Cadmium 2.810  NA
## 31 2012-dep-ref-1 Cadmium 0.230  NA
## 32 2012-dep-ref-2 Cadmium 0.300  NA
## 33 2012-dep-ref-3 Cadmium 0.090  NA
## 34 2012-dep-exp-1 Cadmium 1.700  NA
## 35 2012-dep-exp-2 Cadmium 0.500  NA
## 36 2012-dep-exp-3 Cadmium 1.100  NA
## 37 2012-dep-exp-4 Cadmium 0.500  NA
## 38 2012-dep-exp-5 Cadmium 1.100  NA
## 39 2012-dep-exp-6 Cadmium 0.710  NA
## 40 2012-dep-exp-7 Cadmium 1.200  NA
## 41 2015-dep-ref-1 Chromium 11.900  NA
## 42 2015-dep-ref-2 Chromium 10.000  NA
## 43 2015-dep-ref-3 Chromium 15.600  NA
## 44 2015-dep-exp-1 Chromium 20.800  NA
## 45 2015-dep-exp-2 Chromium 19.100  NA
## 46 2015-dep-exp-3 Chromium 36.600  NA
## 47 2015-dep-exp-4 Chromium 22.500  NA
## 48 2015-dep-exp-5 Chromium 26.300  NA
## 49 2015-dep-exp-6 Chromium 20.700  NA
## 50 2015-dep-exp-7 Chromium 31.200  NA
## 51 2012-dep-ref-1 Chromium 18.000  NA
## 52 2012-dep-ref-2 Chromium 15.000  NA
## 53 2012-dep-ref-3 Chromium 15.000  NA
## 54 2012-dep-exp-1 Chromium 19.000  NA
## 55 2012-dep-exp-2 Chromium 39.000  NA
## 56 2012-dep-exp-3 Chromium 31.000  NA
## 57 2012-dep-exp-4 Chromium 24.000  NA
## 58 2012-dep-exp-5 Chromium 30.000  NA
## 59 2012-dep-exp-6 Chromium 25.000  NA
## 60 2012-dep-exp-7 Chromium 34.000  NA
## 61 2015-dep-ref-1 Copper 5.400  NA
## 62 2015-dep-ref-2 Copper 5.100  NA
## 63 2015-dep-ref-3 Copper 5.100  NA
## 64 2015-dep-exp-1 Copper 95.900  NA
## 65 2015-dep-exp-2 Copper 161.000  NA
## 66 2015-dep-exp-3 Copper 514.000  NA
## 67 2015-dep-exp-4 Copper 139.000  NA
## 68 2015-dep-exp-5 Copper 196.000  NA
```

```
## 69 2015-dep-exp-6 Copper 176.000  NA
## 70 2015-dep-exp-7 Copper 36.000  NA
## 71 2012-dep-ref-1 Copper 5.800  NA
## 72 2012-dep-ref-2 Copper 6.300  NA
## 73 2012-dep-ref-3 Copper 4.000  NA
## 74 2012-dep-exp-1 Copper 120.000  NA
## 75 2012-dep-exp-2 Copper 670.000  NA
## 76 2012-dep-exp-3 Copper 370.000  NA
## 77 2012-dep-exp-4 Copper 180.000  NA
## 78 2012-dep-exp-5 Copper 320.000  NA
## 79 2012-dep-exp-6 Copper 250.000  NA
## 80 2012-dep-exp-7 Copper 100.000  NA
## 81 2015-dep-ref-1  Lead 6.800  NA
## 82 2015-dep-ref-2  Lead 7.300  NA
## 83 2015-dep-ref-3  Lead 7.000  NA
## 84 2015-dep-exp-1  Lead 160.000  NA
## 85 2015-dep-exp-2  Lead 141.000  NA
## 86 2015-dep-exp-3  Lead 136.000  NA
## 87 2015-dep-exp-4  Lead 48.900  NA
## 88 2015-dep-exp-5  Lead 109.000  NA
## 89 2015-dep-exp-6  Lead 52.800  NA
## 90 2015-dep-exp-7  Lead 91.900  NA
## 91 2012-dep-ref-1  Lead 7.800  NA
## 92 2012-dep-ref-2  Lead 9.900  NA
## 93 2012-dep-ref-3  Lead 4.900  NA
## 94 2012-dep-exp-1  Lead 170.000  NA
## 95 2012-dep-exp-2  Lead 100.000  NA
## 96 2012-dep-exp-3  Lead 160.000  NA
## 97 2012-dep-exp-4  Lead 62.000  NA
## 98 2012-dep-exp-5  Lead 130.000  NA
## 99 2012-dep-exp-6  Lead 83.000  NA
## 100 2012-dep-exp-7  Lead 73.000  NA
## 101 2015-dep-ref-1 Mercury 0.050  NA
## 102 2015-dep-ref-2 Mercury 0.025  NA
## 103 2015-dep-ref-3 Mercury 0.025  NA
## 104 2015-dep-exp-1 Mercury 0.230  NA
## 105 2015-dep-exp-2 Mercury 0.130  NA
## 106 2015-dep-exp-3 Mercury 0.120  NA
## 107 2015-dep-exp-4 Mercury 0.080  NA
```

```
## 108 2015-dep-exp-5 Mercury 0.250  NA
## 109 2015-dep-exp-6 Mercury 0.170  NA
## 110 2015-dep-exp-7 Mercury 0.140  NA
## 111 2012-dep-ref-1 Mercury 0.001  NA
## 112 2012-dep-ref-2 Mercury 0.001  NA
## 113 2012-dep-ref-3 Mercury 0.001  NA
## 114 2012-dep-exp-1 Mercury 0.190  NA
## 115 2012-dep-exp-2 Mercury 0.120  NA
## 116 2012-dep-exp-3 Mercury 0.210  NA
## 117 2012-dep-exp-4 Mercury 0.080  NA
## 118 2012-dep-exp-5 Mercury 0.160  NA
## 119 2012-dep-exp-6 Mercury 0.070  NA
## 120 2012-dep-exp-7 Mercury 0.050  NA
## 121 2015-dep-ref-1 Selenium 0.250  NA
## 122 2015-dep-ref-2 Selenium 0.250  NA
## 123 2015-dep-ref-3 Selenium 0.250  NA
## 124 2015-dep-exp-1 Selenium 0.250  NA
## 125 2015-dep-exp-2 Selenium 0.250  NA
## 126 2015-dep-exp-3 Selenium 0.250  NA
## 127 2015-dep-exp-4 Selenium 0.250  NA
## 128 2015-dep-exp-5 Selenium 0.600  NA
## 129 2015-dep-exp-6 Selenium 0.250  NA
## 130 2015-dep-exp-7 Selenium 0.250  NA
## 131 2012-dep-ref-1 Selenium 0.010  NA
## 132 2012-dep-ref-2 Selenium 0.010  NA
## 133 2012-dep-ref-3 Selenium 0.010  NA
## 134 2012-dep-exp-1 Selenium 0.600  NA
## 135 2012-dep-exp-2 Selenium 1.000  NA
## 136 2012-dep-exp-3 Selenium 0.800  NA
## 137 2012-dep-exp-4 Selenium 0.010  NA
## 138 2012-dep-exp-5 Selenium 0.800  NA
## 139 2012-dep-exp-6 Selenium 0.600  NA
## 140 2012-dep-exp-7 Selenium 0.010  NA
## 141 2015-dep-ref-1 Thallium 0.050  NA
## 142 2015-dep-ref-2 Thallium 0.050  NA
## 143 2015-dep-ref-3 Thallium 0.050  NA
## 144 2015-dep-exp-1 Thallium 0.300  NA
## 145 2015-dep-exp-2 Thallium 0.050  NA
## 146 2015-dep-exp-3 Thallium 0.050  NA
```

```
## 147 2015-dep-exp-4 Thallium 0.100  NA
## 148 2015-dep-exp-5 Thallium 0.200  NA
## 149 2015-dep-exp-6 Thallium 0.200  NA
## 150 2015-dep-exp-7 Thallium 0.200  NA
## 151 2012-dep-ref-1 Thallium 0.050  NA
## 152 2012-dep-ref-2 Thallium 0.050  NA
## 153 2012-dep-ref-3 Thallium 0.050  NA
## 154 2012-dep-exp-1 Thallium 0.400  NA
## 155 2012-dep-exp-2 Thallium 0.050  NA
## 156 2012-dep-exp-3 Thallium 0.200  NA
## 157 2012-dep-exp-4 Thallium 0.100  NA
## 158 2012-dep-exp-5 Thallium 0.200  NA
## 159 2012-dep-exp-6 Thallium 0.200  NA
## 160 2012-dep-exp-7 Thallium 0.200  NA
## 161 2015-dep-ref-1  Zinc 59.000  NA
## 162 2015-dep-ref-2  Zinc 48.000  NA
## 163 2015-dep-ref-3  Zinc 31.000  NA
## 164 2015-dep-exp-1  Zinc 645.000  NA
## 165 2015-dep-exp-2  Zinc 1190.000  NA
## 166 2015-dep-exp-3  Zinc 2550.000  NA
## 167 2015-dep-exp-4  Zinc 770.000  NA
## 168 2015-dep-exp-5  Zinc 1160.000  NA
## 169 2015-dep-exp-6  Zinc 793.000  NA
## 170 2015-dep-exp-7  Zinc 594.000  NA
## 171 2012-dep-ref-1  Zinc 71.000  NA
## 172 2012-dep-ref-2  Zinc 70.000  NA
## 173 2012-dep-ref-3  Zinc 38.000  NA
## 174 2012-dep-exp-1  Zinc 650.000  NA
## 175 2012-dep-exp-2  Zinc 4200.000  NA
## 176 2012-dep-exp-3  Zinc 2200.000  NA
## 177 2012-dep-exp-4  Zinc 930.000  NA
## 178 2012-dep-exp-5  Zinc 2400.000  NA
## 179 2012-dep-exp-6  Zinc 1400.000  NA
## 180 2012-dep-exp-7  Zinc 780.000  NA
## 181 2018-dep-ref-1 Arsenic 2.460 6.3e-05
## 182 2018-dep-ref-1 Cadmium 0.585 6.3e-05
## 183 2018-dep-ref-1 Chromium 23.900 6.3e-05
## 184 2018-dep-ref-1 Copper 13.600 6.3e-05
## 185 2018-dep-ref-1  Lead 12.600 6.3e-05
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## 186 2018-dep-ref-1 Mercury 0.020 6.3e-05
## 187 2018-dep-ref-1 Selenium 0.420 6.3e-05
## 188 2018-dep-ref-1 Thallium 0.100 6.3e-05
## 189 2018-dep-ref-1  Zinc 96.200 6.3e-05
## 190 2018-dep-ref-1 Arsenic 1.380 2.0e-03
## 191 2018-dep-ref-1 Cadmium 0.208 2.0e-03
## 192 2018-dep-ref-1 Chromium 14.400 2.0e-03
## 193 2018-dep-ref-1 Copper 5.400 2.0e-03
## 194 2018-dep-ref-1  Lead 6.260 2.0e-03
## 195 2018-dep-ref-1 Mercury 0.020 2.0e-03
## 196 2018-dep-ref-1 Selenium 0.100 2.0e-03
## 197 2018-dep-ref-1 Thallium 0.050 2.0e-03
## 198 2018-dep-ref-1  Zinc 60.800 2.0e-03
## 199 2018-dep-exp-1 Arsenic 23.600 6.3e-05
## 200 2018-dep-exp-1 Cadmium 4.630 6.3e-05
## 201 2018-dep-exp-1 Chromium 45.500 6.3e-05
## 202 2018-dep-exp-1 Copper 243.000 6.3e-05
## 203 2018-dep-exp-1  Lead 526.000 6.3e-05
## 204 2018-dep-exp-1 Mercury 1.150 6.3e-05
## 205 2018-dep-exp-1 Selenium 1.570 6.3e-05
## 206 2018-dep-exp-1 Thallium 0.480 6.3e-05
## 207 2018-dep-exp-1  Zinc 1400.000 6.3e-05
## 208 2018-dep-exp-1 Arsenic 8.660 2.0e-03
## 209 2018-dep-exp-1 Cadmium 1.680 2.0e-03
## 210 2018-dep-exp-1 Chromium 21.700 2.0e-03
## 211 2018-dep-exp-1 Copper 188.000 2.0e-03
## 212 2018-dep-exp-1  Lead 194.000 2.0e-03
## 213 2018-dep-exp-1 Mercury 0.133 2.0e-03
## 214 2018-dep-exp-1 Selenium 0.430 2.0e-03
## 215 2018-dep-exp-1 Thallium 0.250 2.0e-03
## 216 2018-dep-exp-1  Zinc 1100.000 2.0e-03
## 217 2018-dep-exp-2 Arsenic 37.400 6.3e-05
## 218 2018-dep-exp-2 Cadmium 10.200 6.3e-05
## 219 2018-dep-exp-2 Chromium 56.200 6.3e-05
## 220 2018-dep-exp-2 Copper 681.000 6.3e-05
## 221 2018-dep-exp-2  Lead 900.000 6.3e-05
## 222 2018-dep-exp-2 Mercury 7.410 6.3e-05
## 223 2018-dep-exp-2 Selenium 8.730 6.3e-05
## 224 2018-dep-exp-2 Thallium 1.250 6.3e-05
```

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## 225 2018-dep-exp-2  Zinc 4380.000 6.3e-05
## 226 2018-dep-exp-2 Arsenic 11.000 2.0e-03
## 227 2018-dep-exp-2 Cadmium 2.150 2.0e-03
## 228 2018-dep-exp-2 Chromium 38.700 2.0e-03
## 229 2018-dep-exp-2 Copper 467.000 2.0e-03
## 230 2018-dep-exp-2  Lead 220.000 2.0e-03
## 231 2018-dep-exp-2 Mercury 0.550 2.0e-03
## 232 2018-dep-exp-2 Selenium 1.820 2.0e-03
## 233 2018-dep-exp-2 Thallium 0.370 2.0e-03
## 234 2018-dep-exp-2  Zinc 3790.000 2.0e-03
## 235 2018-dep-ref-3 Arsenic 2.780 6.3e-05
## 236 2018-dep-ref-3 Cadmium 0.573 6.3e-05
## 237 2018-dep-ref-3 Chromium 26.500 6.3e-05
## 238 2018-dep-ref-3 Copper 14.200 6.3e-05
## 239 2018-dep-ref-3  Lead 15.500 6.3e-05
## 240 2018-dep-ref-3 Mercury 0.185 6.3e-05
## 241 2018-dep-ref-3 Selenium 0.290 6.3e-05
## 242 2018-dep-ref-3 Thallium 0.050 6.3e-05
## 243 2018-dep-ref-3  Zinc 92.500 6.3e-05
## 244 2018-dep-ref-3 Arsenic 1.270 2.0e-03
## 245 2018-dep-ref-3 Cadmium 0.165 2.0e-03
## 246 2018-dep-ref-3 Chromium 13.600 2.0e-03
## 247 2018-dep-ref-3 Copper 5.380 2.0e-03
## 248 2018-dep-ref-3  Lead 5.540 2.0e-03
## 249 2018-dep-ref-3 Mercury 0.020 2.0e-03
## 250 2018-dep-ref-3 Selenium 0.100 2.0e-03
## 251 2018-dep-ref-3 Thallium 0.050 2.0e-03
## 252 2018-dep-ref-3  Zinc 56.200 2.0e-03
## 253 2018-dep-ref-2 Arsenic 2.220 6.3e-05
## 254 2018-dep-ref-2 Cadmium 0.581 6.3e-05
## 255 2018-dep-ref-2 Chromium 21.100 6.3e-05
## 256 2018-dep-ref-2 Copper 12.400 6.3e-05
## 257 2018-dep-ref-2  Lead 10.700 6.3e-05
## 258 2018-dep-ref-2 Mercury 0.055 6.3e-05
## 259 2018-dep-ref-2 Selenium 0.300 6.3e-05
## 260 2018-dep-ref-2 Thallium 0.050 6.3e-05
## 261 2018-dep-ref-2  Zinc 78.200 6.3e-05
## 262 2018-dep-ref-2 Arsenic 1.070 2.0e-03
## 263 2018-dep-ref-2 Cadmium 0.248 2.0e-03
```

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## 264 2018-dep-ref-2 Chromium 10.900 2.0e-03
## 265 2018-dep-ref-2 Copper 5.890 2.0e-03
## 266 2018-dep-ref-2  Lead 7.190 2.0e-03
## 267 2018-dep-ref-2 Mercury 0.020 2.0e-03
## 268 2018-dep-ref-2 Selenium 0.100 2.0e-03
## 269 2018-dep-ref-2 Thallium 0.050 2.0e-03
## 270 2018-dep-ref-2  Zinc 64.900 2.0e-03
## 271 2018-dep-exp-7 Arsenic 6.790 6.3e-05
## 272 2018-dep-exp-7 Cadmium 2.480 6.3e-05
## 273 2018-dep-exp-7 Chromium 27.100 6.3e-05
## 274 2018-dep-exp-7 Copper 43.800 6.3e-05
## 275 2018-dep-exp-7  Lead 116.000 6.3e-05
## 276 2018-dep-exp-7 Mercury 0.423 6.3e-05
## 277 2018-dep-exp-7 Selenium 0.450 6.3e-05
## 278 2018-dep-exp-7 Thallium 0.180 6.3e-05
## 279 2018-dep-exp-7  Zinc 482.000 6.3e-05
## 280 2018-dep-exp-7 Arsenic 3.630 2.0e-03
## 281 2018-dep-exp-7 Cadmium 1.420 2.0e-03
## 282 2018-dep-exp-7 Chromium 28.600 2.0e-03
## 283 2018-dep-exp-7 Copper 46.900 2.0e-03
## 284 2018-dep-exp-7  Lead 61.900 2.0e-03
## 285 2018-dep-exp-7 Mercury 0.054 2.0e-03
## 286 2018-dep-exp-7 Selenium 0.220 2.0e-03
## 287 2018-dep-exp-7 Thallium 0.150 2.0e-03
## 288 2018-dep-exp-7  Zinc 506.000 2.0e-03
## 289 2018-dep-exp-5 Arsenic 23.700 6.3e-05
## 290 2018-dep-exp-5 Cadmium 7.400 6.3e-05
## 291 2018-dep-exp-5 Chromium 44.700 6.3e-05
## 292 2018-dep-exp-5 Copper 408.000 6.3e-05
## 293 2018-dep-exp-5  Lead 543.000 6.3e-05
## 294 2018-dep-exp-5 Mercury 5.210 6.3e-05
## 295 2018-dep-exp-5 Selenium 4.120 6.3e-05
## 296 2018-dep-exp-5 Thallium 0.890 6.3e-05
## 297 2018-dep-exp-5  Zinc 2660.000 6.3e-05
## 298 2018-dep-exp-5 Arsenic 7.880 2.0e-03
## 299 2018-dep-exp-5 Cadmium 1.530 2.0e-03
## 300 2018-dep-exp-5 Chromium 29.300 2.0e-03
## 301 2018-dep-exp-5 Copper 315.000 2.0e-03
## 302 2018-dep-exp-5  Lead 129.000 2.0e-03
```

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## 303 2018-dep-exp-5 Mercury 0.245 2.0e-03
## 304 2018-dep-exp-5 Selenium 0.630 2.0e-03
## 305 2018-dep-exp-5 Thallium 0.220 2.0e-03
## 306 2018-dep-exp-5  Zinc 2160.000 2.0e-03
## 307 2018-dep-exp-6 Arsenic 10.500 6.3e-05
## 308 2018-dep-exp-6 Cadmium 2.150 6.3e-05
## 309 2018-dep-exp-6 Chromium 34.300 6.3e-05
## 310 2018-dep-exp-6 Copper 158.000 6.3e-05
## 311 2018-dep-exp-6  Lead 134.000 6.3e-05
## 312 2018-dep-exp-6 Mercury 0.879 6.3e-05
## 313 2018-dep-exp-6 Selenium 0.600 6.3e-05
## 314 2018-dep-exp-6 Thallium 0.200 6.3e-05
## 315 2018-dep-exp-6  Zinc 803.000 6.3e-05
## 316 2018-dep-exp-6 Arsenic 6.640 2.0e-03
## 317 2018-dep-exp-6 Cadmium 0.573 2.0e-03
## 318 2018-dep-exp-6 Chromium 21.900 2.0e-03
## 319 2018-dep-exp-6 Copper 165.000 2.0e-03
## 320 2018-dep-exp-6  Lead 56.000 2.0e-03
## 321 2018-dep-exp-6 Mercury 0.076 2.0e-03
## 322 2018-dep-exp-6 Selenium 0.220 2.0e-03
## 323 2018-dep-exp-6 Thallium 0.140 2.0e-03
## 324 2018-dep-exp-6  Zinc 902.000 2.0e-03
## 325 2018-dep-exp-3 Arsenic 16.000 6.3e-05
## 326 2018-dep-exp-3 Cadmium 2.030 6.3e-05
## 327 2018-dep-exp-3 Chromium 34.400 6.3e-05
## 328 2018-dep-exp-3 Copper 416.000 6.3e-05
## 329 2018-dep-exp-3  Lead 221.000 6.3e-05
## 330 2018-dep-exp-3 Mercury 1.900 6.3e-05
## 331 2018-dep-exp-3 Selenium 0.640 6.3e-05
## 332 2018-dep-exp-3 Thallium 0.220 6.3e-05
## 333 2018-dep-exp-3  Zinc 1200.000 6.3e-05
## 334 2018-dep-exp-3 Arsenic 11.100 2.0e-03
## 335 2018-dep-exp-3 Cadmium 0.361 2.0e-03
## 336 2018-dep-exp-3 Chromium 26.600 2.0e-03
## 337 2018-dep-exp-3 Copper 251.000 2.0e-03
## 338 2018-dep-exp-3  Lead 71.800 2.0e-03
## 339 2018-dep-exp-3 Mercury 0.042 2.0e-03
## 340 2018-dep-exp-3 Selenium 0.210 2.0e-03
## 341 2018-dep-exp-3 Thallium 0.050 2.0e-03
```

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## 342 2018-dep-exp-3  Zinc 949.000 2.0e-03
## 343 2018-dep-exp-4 Arsenic 7.050 6.3e-05
## 344 2018-dep-exp-4 Cadmium 1.760 6.3e-05
## 345 2018-dep-exp-4 Chromium 29.100 6.3e-05
## 346 2018-dep-exp-4 Copper 109.000 6.3e-05
## 347 2018-dep-exp-4  Lead 84.600 6.3e-05
## 348 2018-dep-exp-4 Mercury 0.415 6.3e-05
## 349 2018-dep-exp-4 Selenium 0.390 6.3e-05
## 350 2018-dep-exp-4 Thallium 0.180 6.3e-05
## 351 2018-dep-exp-4  Zinc 697.000 6.3e-05
## 352 2018-dep-exp-4 Arsenic 6.760 2.0e-03
## 353 2018-dep-exp-4 Cadmium 1.410 2.0e-03
## 354 2018-dep-exp-4 Chromium 30.200 2.0e-03
## 355 2018-dep-exp-4 Copper 322.000 2.0e-03
## 356 2018-dep-exp-4  Lead 70.400 2.0e-03
## 357 2018-dep-exp-4 Mercury 0.106 2.0e-03
## 358 2018-dep-exp-4 Selenium 0.370 2.0e-03
## 359 2018-dep-exp-4 Thallium 0.200 2.0e-03
## 360 2018-dep-exp-4  Zinc 1800.000 2.0e-03
## 361 2021-dep-exp-1 Arsenic 2.770 2.0e-03
## 362 2021-dep-exp-1 Cadmium 0.462 2.0e-03
## 363 2021-dep-exp-1 Chromium 14.300 2.0e-03
## 364 2021-dep-exp-1 Copper 17.800 2.0e-03
## 365 2021-dep-exp-1  Lead 40.900 2.0e-03
## 366 2021-dep-exp-1 Mercury 0.020 2.0e-03
## 367 2021-dep-exp-1 Selenium 0.100 2.0e-03
## 368 2021-dep-exp-1 Thallium 0.160 2.0e-03
## 369 2021-dep-exp-1  Zinc 176.000 2.0e-03
## 370 2021-dep-exp-1 Arsenic 3.890 6.3e-05
## 371 2021-dep-exp-1 Cadmium 1.160 6.3e-05
## 372 2021-dep-exp-1 Chromium 21.200 6.3e-05
## 373 2021-dep-exp-1 Copper 19.300 6.3e-05
## 374 2021-dep-exp-1  Lead 45.000 6.3e-05
## 375 2021-dep-exp-1 Mercury 0.060 6.3e-05
## 376 2021-dep-exp-1 Selenium 0.280 6.3e-05
## 377 2021-dep-exp-1 Thallium 0.160 6.3e-05
## 378 2021-dep-exp-1  Zinc 188.000 6.3e-05
## 379 2021-dep-exp-2 Arsenic 5.110 2.0e-03
## 380 2021-dep-exp-2 Cadmium 0.474 2.0e-03
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## 381 2021-dep-exp-2 Chromium 22.600 2.0e-03
## 382 2021-dep-exp-2 Copper 130.000 2.0e-03
## 383 2021-dep-exp-2  Lead 60.400 2.0e-03
## 384 2021-dep-exp-2 Mercury 0.060 2.0e-03
## 385 2021-dep-exp-2 Selenium 0.330 2.0e-03
## 386 2021-dep-exp-2 Thallium 0.120 2.0e-03
## 387 2021-dep-exp-2  Zinc 934.000 2.0e-03
## 388 2021-dep-exp-2 Arsenic 4.500 6.3e-05
## 389 2021-dep-exp-2 Cadmium 0.978 6.3e-05
## 390 2021-dep-exp-2 Chromium 28.000 6.3e-05
## 391 2021-dep-exp-2 Copper 54.100 6.3e-05
## 392 2021-dep-exp-2  Lead 55.000 6.3e-05
## 393 2021-dep-exp-2 Mercury 0.129 6.3e-05
## 394 2021-dep-exp-2 Selenium 0.540 6.3e-05
## 395 2021-dep-exp-2 Thallium 0.140 6.3e-05
## 396 2021-dep-exp-2  Zinc 380.000 6.3e-05
## 397 2021-dep-exp-3 Arsenic 9.190 2.0e-03
## 398 2021-dep-exp-3 Cadmium 0.947 2.0e-03
## 399 2021-dep-exp-3 Chromium 49.100 2.0e-03
## 400 2021-dep-exp-3 Copper 738.000 2.0e-03
## 401 2021-dep-exp-3  Lead 140.000 2.0e-03
## 402 2021-dep-exp-3 Mercury 0.020 2.0e-03
## 403 2021-dep-exp-3 Selenium 0.950 2.0e-03
## 404 2021-dep-exp-3 Thallium 0.050 2.0e-03
## 405 2021-dep-exp-3  Zinc 8070.000 2.0e-03
## 406 2021-dep-exp-3 Arsenic 36.700 6.3e-05
## 407 2021-dep-exp-3 Cadmium 5.610 6.3e-05
## 408 2021-dep-exp-3 Chromium 62.100 6.3e-05
## 409 2021-dep-exp-3 Copper 1130.000 6.3e-05
## 410 2021-dep-exp-3  Lead 533.000 6.3e-05
## 411 2021-dep-exp-3 Mercury 0.418 6.3e-05
## 412 2021-dep-exp-3 Selenium 0.930 6.3e-05
## 413 2021-dep-exp-3 Thallium 0.310 6.3e-05
## 414 2021-dep-exp-3  Zinc 6140.000 6.3e-05
## 415 2021-dep-exp-4 Arsenic 5.150 2.0e-03
## 416 2021-dep-exp-4 Cadmium 0.558 2.0e-03
## 417 2021-dep-exp-4 Chromium 26.600 2.0e-03
## 418 2021-dep-exp-4 Copper 265.000 2.0e-03
## 419 2021-dep-exp-4  Lead 57.600 2.0e-03
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## 420 2021-dep-exp-4 Mercury 0.045 2.0e-03
## 421 2021-dep-exp-4 Selenium 0.250 2.0e-03
## 422 2021-dep-exp-4 Thallium 0.160 2.0e-03
## 423 2021-dep-exp-4  Zinc 1440.000 2.0e-03
## 424 2021-dep-exp-4 Arsenic 3.990 6.3e-05
## 425 2021-dep-exp-4 Cadmium 0.897 6.3e-05
## 426 2021-dep-exp-4 Chromium 28.900 6.3e-05
## 427 2021-dep-exp-4 Copper 78.500 6.3e-05
## 428 2021-dep-exp-4  Lead 49.800 6.3e-05
## 429 2021-dep-exp-4 Mercury 0.141 6.3e-05
## 430 2021-dep-exp-4 Selenium 0.400 6.3e-05
## 431 2021-dep-exp-4 Thallium 0.130 6.3e-05
## 432 2021-dep-exp-4  Zinc 593.000 6.3e-05
## 433 2021-dep-exp-5 Arsenic 6.440 2.0e-03
## 434 2021-dep-exp-5 Cadmium 1.350 2.0e-03
## 435 2021-dep-exp-5 Chromium 27.600 2.0e-03
## 436 2021-dep-exp-5 Copper 221.000 2.0e-03
## 437 2021-dep-exp-5  Lead 110.000 2.0e-03
## 438 2021-dep-exp-5 Mercury 0.158 2.0e-03
## 439 2021-dep-exp-5 Selenium 0.690 2.0e-03
## 440 2021-dep-exp-5 Thallium 0.280 2.0e-03
## 441 2021-dep-exp-5  Zinc 1520.000 2.0e-03
## 442 2021-dep-exp-5 Arsenic 34.100 6.3e-05
## 443 2021-dep-exp-5 Cadmium 9.290 6.3e-05
## 444 2021-dep-exp-5 Chromium 79.600 6.3e-05
## 445 2021-dep-exp-5 Copper 1070.000 6.3e-05
## 446 2021-dep-exp-5  Lead 788.000 6.3e-05
## 447 2021-dep-exp-5 Mercury 3.470 6.3e-05
## 448 2021-dep-exp-5 Selenium 4.660 6.3e-05
## 449 2021-dep-exp-5 Thallium 1.250 6.3e-05
## 450 2021-dep-exp-5  Zinc 5500.000 6.3e-05
## 451 2021-dep-exp-6 Arsenic 3.650 2.0e-03
## 452 2021-dep-exp-6 Cadmium 0.382 2.0e-03
## 453 2021-dep-exp-6 Chromium 23.800 2.0e-03
## 454 2021-dep-exp-6 Copper 94.900 2.0e-03
## 455 2021-dep-exp-6  Lead 41.000 2.0e-03
## 456 2021-dep-exp-6 Mercury 0.072 2.0e-03
## 457 2021-dep-exp-6 Selenium 0.210 2.0e-03
## 458 2021-dep-exp-6 Thallium 0.140 2.0e-03
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## 459 2021-dep-exp-6  Zinc 639.000 2.0e-03
## 460 2021-dep-exp-6 Arsenic 8.720 6.3e-05
## 461 2021-dep-exp-6 Cadmium 1.370 6.3e-05
## 462 2021-dep-exp-6 Chromium 44.200 6.3e-05
## 463 2021-dep-exp-6 Copper 189.000 6.3e-05
## 464 2021-dep-exp-6  Lead 109.000 6.3e-05
## 465 2021-dep-exp-6 Mercury 0.112 6.3e-05
## 466 2021-dep-exp-6 Selenium 0.660 6.3e-05
## 467 2021-dep-exp-6 Thallium 0.210 6.3e-05
## 468 2021-dep-exp-6  Zinc 885.000 6.3e-05
## 469 2021-dep-exp-7 Arsenic 4.490 2.0e-03
## 470 2021-dep-exp-7 Cadmium 0.617 2.0e-03
## 471 2021-dep-exp-7 Chromium 27.600 2.0e-03
## 472 2021-dep-exp-7 Copper 127.000 2.0e-03
## 473 2021-dep-exp-7  Lead 53.500 2.0e-03
## 474 2021-dep-exp-7 Mercury 0.020 2.0e-03
## 475 2021-dep-exp-7 Selenium 0.230 2.0e-03
## 476 2021-dep-exp-7 Thallium 0.120 2.0e-03
## 477 2021-dep-exp-7  Zinc 1030.000 2.0e-03
## 478 2021-dep-exp-7 Arsenic 10.500 6.3e-05
## 479 2021-dep-exp-7 Cadmium 3.200 6.3e-05
## 480 2021-dep-exp-7 Chromium 51.900 6.3e-05
## 481 2021-dep-exp-7 Copper 195.000 6.3e-05
## 482 2021-dep-exp-7  Lead 164.000 6.3e-05
## 483 2021-dep-exp-7 Mercury 0.157 6.3e-05
## 484 2021-dep-exp-7 Selenium 0.550 6.3e-05
## 485 2021-dep-exp-7 Thallium 0.230 6.3e-05
## 486 2021-dep-exp-7  Zinc 1370.000 6.3e-05
## 487 2021-dep-ref-1 Arsenic 1.470 2.0e-03
## 488 2021-dep-ref-1 Cadmium 0.244 2.0e-03
## 489 2021-dep-ref-1 Chromium 18.000 2.0e-03
## 490 2021-dep-ref-1 Copper 6.470 2.0e-03
## 491 2021-dep-ref-1  Lead 7.680 2.0e-03
## 492 2021-dep-ref-1 Mercury 0.020 2.0e-03
## 493 2021-dep-ref-1 Selenium 0.100 2.0e-03
## 494 2021-dep-ref-1 Thallium 0.050 2.0e-03
## 495 2021-dep-ref-1  Zinc 86.300 2.0e-03
## 496 2021-dep-ref-1 Arsenic 2.940 6.3e-05
## 497 2021-dep-ref-1 Cadmium 0.816 6.3e-05
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## 498 2021-dep-ref-1 Chromium 30.100 6.3e-05
## 499 2021-dep-ref-1 Copper 17.900 6.3e-05
## 500 2021-dep-ref-1  Lead 17.900 6.3e-05
## 501 2021-dep-ref-1 Mercury 0.020 6.3e-05
## 502 2021-dep-ref-1 Selenium 0.660 6.3e-05
## 503 2021-dep-ref-1 Thallium 0.130 6.3e-05
## 504 2021-dep-ref-1  Zinc 146.000 6.3e-05
## 505 2021-dep-ref-2 Arsenic 2.100 2.0e-03
## 506 2021-dep-ref-2 Cadmium 0.519 2.0e-03
## 507 2021-dep-ref-2 Chromium 20.300 2.0e-03
## 508 2021-dep-ref-2 Copper 9.120 2.0e-03
## 509 2021-dep-ref-2  Lead 12.000 2.0e-03
## 510 2021-dep-ref-2 Mercury 0.020 2.0e-03
## 511 2021-dep-ref-2 Selenium 0.100 2.0e-03
## 512 2021-dep-ref-2 Thallium 0.150 2.0e-03
## 513 2021-dep-ref-2  Zinc 117.000 2.0e-03
## 514 2021-dep-ref-2 Arsenic 3.530 6.3e-05
## 515 2021-dep-ref-2 Cadmium 0.994 6.3e-05
## 516 2021-dep-ref-2 Chromium 28.200 6.3e-05
## 517 2021-dep-ref-2 Copper 18.900 6.3e-05
## 518 2021-dep-ref-2  Lead 24.600 6.3e-05
## 519 2021-dep-ref-2 Mercury 0.020 6.3e-05
## 520 2021-dep-ref-2 Selenium 0.450 6.3e-05
## 521 2021-dep-ref-2 Thallium 0.120 6.3e-05
## 522 2021-dep-ref-2  Zinc 141.000 6.3e-05
## 523 2021-dep-ref-3 Arsenic 1.230 2.0e-03
## 524 2021-dep-ref-3 Cadmium 0.179 2.0e-03
## 525 2021-dep-ref-3 Chromium 14.900 2.0e-03
## 526 2021-dep-ref-3 Copper 5.750 2.0e-03
## 527 2021-dep-ref-3  Lead 6.390 2.0e-03
## 528 2021-dep-ref-3 Mercury 0.020 2.0e-03
## 529 2021-dep-ref-3 Selenium 0.100 2.0e-03
## 530 2021-dep-ref-3 Thallium 0.050 2.0e-03
## 531 2021-dep-ref-3  Zinc 63.900 2.0e-03
## 532 2021-dep-ref-3 Arsenic 3.440 6.3e-05
## 533 2021-dep-ref-3 Cadmium 0.785 6.3e-05
## 534 2021-dep-ref-3 Chromium 30.500 6.3e-05
## 535 2021-dep-ref-3 Copper 18.200 6.3e-05
## 536 2021-dep-ref-3  Lead 18.100 6.3e-05
```

```
## 537 2021-dep-ref-3 Mercury 0.020 6.3e-05
## 538 2021-dep-ref-3 Selenium 0.510 6.3e-05
## 539 2021-dep-ref-3 Thallium 0.130 6.3e-05
## 540 2021-dep-ref-3  Zinc 123.000 6.3e-05
```

8.0 Convert to wide

```
sedsWide <- sedsClean %>%
 spread(analyte, value)

sedsWide

##    label fraction Arsenic Cadmium Chromium Copper Lead Mercury
## 1 2012-dep-exp-1  NA 7.10 1.700  19.0 120.00 170.00 0.190
## 2 2012-dep-exp-2  NA 14.00 0.500  39.0 670.00 100.00 0.120
## 3 2012-dep-exp-3  NA 11.00 1.100  31.0 370.00 160.00 0.210
## 4 2012-dep-exp-4  NA 7.00 0.500  24.0 180.00 62.00 0.080
## 5 2012-dep-exp-5  NA 9.60 1.100  30.0 320.00 130.00 0.160
## 6 2012-dep-exp-6  NA 5.90 0.710  25.0 250.00 83.00 0.070
## 7 2012-dep-exp-7  NA 4.90 1.200  34.0 100.00 73.00 0.050
## 8 2012-dep-ref-1  NA 0.80 0.230  18.0 5.80 7.80 0.001
## 9 2012-dep-ref-2  NA 1.10 0.300  15.0 6.30 9.90 0.001
## 10 2012-dep-ref-3  NA 0.60 0.090  15.0 4.00 4.90 0.001
## 11 2015-dep-exp-1  NA 6.00 1.390  20.8 95.90 160.00 0.230
## 12 2015-dep-exp-2  NA 5.50 0.540  19.1 161.00 141.00 0.130
## 13 2015-dep-exp-3  NA 14.10 0.570  36.6 514.00 136.00 0.120
## 14 2015-dep-exp-4  NA 5.20 0.460  22.5 139.00 48.90 0.080
## 15 2015-dep-exp-5  NA 5.90 1.120  26.3 196.00 109.00 0.250
## 16 2015-dep-exp-6  NA 4.10 0.520  20.7 176.00 52.80 0.170
## 17 2015-dep-exp-7  NA 3.60 2.810  31.2 36.00 91.90 0.140
## 18 2015-dep-ref-1  NA 0.90 0.190  11.9 5.40 6.80 0.050
## 19 2015-dep-ref-2  NA 1.00 0.170  10.0 5.10 7.30 0.025
## 20 2015-dep-ref-3  NA 0.80 0.110  15.6 5.10 7.00 0.025
## 21 2018-dep-exp-1 6.3e-05 23.60 4.630  45.5 243.00 526.00 1.150
## 22 2018-dep-exp-1 2.0e-03 8.66 1.680  21.7 188.00 194.00 0.133
## 23 2018-dep-exp-2 6.3e-05 37.40 10.200  56.2 681.00 900.00 7.410
## 24 2018-dep-exp-2 2.0e-03 11.00 2.150  38.7 467.00 220.00 0.550
## 25 2018-dep-exp-3 6.3e-05 16.00 2.030  34.4 416.00 221.00 1.900
## 26 2018-dep-exp-3 2.0e-03 11.10 0.361  26.6 251.00 71.80 0.042
## 27 2018-dep-exp-4 6.3e-05 7.05 1.760  29.1 109.00 84.60 0.415
```

```
## 28 2018-dep-exp-4 2.0e-03 6.76 1.410  30.2 322.00 70.40 0.106
## 29 2018-dep-exp-5 6.3e-05 23.70 7.400  44.7 408.00 543.00 5.210
## 30 2018-dep-exp-5 2.0e-03 7.88 1.530  29.3 315.00 129.00 0.245
## 31 2018-dep-exp-6 6.3e-05 10.50 2.150  34.3 158.00 134.00 0.879
## 32 2018-dep-exp-6 2.0e-03 6.64 0.573  21.9 165.00 56.00 0.076
## 33 2018-dep-exp-7 6.3e-05 6.79 2.480  27.1 43.80 116.00 0.423
## 34 2018-dep-exp-7 2.0e-03 3.63 1.420  28.6 46.90 61.90 0.054
## 35 2018-dep-ref-1 6.3e-05 2.46 0.585  23.9 13.60 12.60 0.020
## 36 2018-dep-ref-1 2.0e-03 1.38 0.208  14.4 5.40 6.26 0.020
## 37 2018-dep-ref-2 6.3e-05 2.22 0.581  21.1 12.40 10.70 0.055
## 38 2018-dep-ref-2 2.0e-03 1.07 0.248  10.9 5.89 7.19 0.020
## 39 2018-dep-ref-3 6.3e-05 2.78 0.573  26.5 14.20 15.50 0.185
## 40 2018-dep-ref-3 2.0e-03 1.27 0.165  13.6 5.38 5.54 0.020
## 41 2021-dep-exp-1 6.3e-05 3.89 1.160  21.2 19.30 45.00 0.060
## 42 2021-dep-exp-1 2.0e-03 2.77 0.462  14.3 17.80 40.90 0.020
## 43 2021-dep-exp-2 6.3e-05 4.50 0.978  28.0 54.10 55.00 0.129
## 44 2021-dep-exp-2 2.0e-03 5.11 0.474  22.6 130.00 60.40 0.060
## 45 2021-dep-exp-3 6.3e-05 36.70 5.610  62.1 1130.00 533.00 0.418
## 46 2021-dep-exp-3 2.0e-03 9.19 0.947  49.1 738.00 140.00 0.020
## 47 2021-dep-exp-4 6.3e-05 3.99 0.897  28.9 78.50 49.80 0.141
## 48 2021-dep-exp-4 2.0e-03 5.15 0.558  26.6 265.00 57.60 0.045
## 49 2021-dep-exp-5 6.3e-05 34.10 9.290  79.6 1070.00 788.00 3.470
## 50 2021-dep-exp-5 2.0e-03 6.44 1.350  27.6 221.00 110.00 0.158
## 51 2021-dep-exp-6 6.3e-05 8.72 1.370  44.2 189.00 109.00 0.112
## 52 2021-dep-exp-6 2.0e-03 3.65 0.382  23.8 94.90 41.00 0.072
## 53 2021-dep-exp-7 6.3e-05 10.50 3.200  51.9 195.00 164.00 0.157
## 54 2021-dep-exp-7 2.0e-03 4.49 0.617  27.6 127.00 53.50 0.020
## 55 2021-dep-ref-1 6.3e-05 2.94 0.816  30.1 17.90 17.90 0.020
## 56 2021-dep-ref-1 2.0e-03 1.47 0.244  18.0 6.47 7.68 0.020
## 57 2021-dep-ref-2 6.3e-05 3.53 0.994  28.2 18.90 24.60 0.020
## 58 2021-dep-ref-2 2.0e-03 2.10 0.519  20.3 9.12 12.00 0.020
## 59 2021-dep-ref-3 6.3e-05 3.44 0.785  30.5 18.20 18.10 0.020
## 60 2021-dep-ref-3 2.0e-03 1.23 0.179  14.9 5.75 6.39 0.020
## Selenium Thallium Zinc
## 1  0.60  0.40 650.0
## 2  1.00  0.05 4200.0
## 3  0.80  0.20 2200.0
## 4  0.01  0.10 930.0
## 5  0.80  0.20 2400.0
```

```
## 6  0.60  0.20 1400.0
## 7  0.01  0.20 780.0
## 8  0.01  0.05 71.0
## 9  0.01  0.05 70.0
## 10  0.01  0.05 38.0
## 11  0.25  0.30 645.0
## 12  0.25  0.05 1190.0
## 13  0.25  0.05 2550.0
## 14  0.25  0.10 770.0
## 15  0.60  0.20 1160.0
## 16  0.25  0.20 793.0
## 17  0.25  0.20 594.0
## 18  0.25  0.05 59.0
## 19  0.25  0.05 48.0
## 20  0.25  0.05 31.0
## 21  1.57  0.48 1400.0
## 22  0.43  0.25 1100.0
## 23  8.73  1.25 4380.0
## 24  1.82  0.37 3790.0
## 25  0.64  0.22 1200.0
## 26  0.21  0.05 949.0
## 27  0.39  0.18 697.0
## 28  0.37  0.20 1800.0
## 29  4.12  0.89 2660.0
## 30  0.63  0.22 2160.0
## 31  0.60  0.20 803.0
## 32  0.22  0.14 902.0
## 33  0.45  0.18 482.0
## 34  0.22  0.15 506.0
## 35  0.42  0.10 96.2
## 36  0.10  0.05 60.8
## 37  0.30  0.05 78.2
## 38  0.10  0.05 64.9
## 39  0.29  0.05 92.5
## 40  0.10  0.05 56.2
## 41  0.28  0.16 188.0
## 42  0.10  0.16 176.0
## 43  0.54  0.14 380.0
## 44  0.33  0.12 934.0
```

```
## 45  0.93  0.31 6140.0
## 46  0.95  0.05 8070.0
## 47  0.40  0.13 593.0
## 48  0.25  0.16 1440.0
## 49  4.66  1.25 5500.0
## 50  0.69  0.28 1520.0
## 51  0.66  0.21 885.0
## 52  0.21  0.14 639.0
## 53  0.55  0.23 1370.0
## 54  0.23  0.12 1030.0
## 55  0.66  0.13 146.0
## 56  0.10  0.05 86.3
## 57  0.45  0.12 141.0
## 58  0.10  0.15 117.0
## 59  0.51  0.13 123.0
## 60  0.10  0.05 63.9
```

9.0 Split datasets into two

10.0 Make df with only 2mm fractions

```
sedsWide$fraction[is.na(sedsWide$fraction)] <- 2.0e-03

seds2mm <- sedsWide %>% filter(is.na(fraction) | fraction == 2.0e-03)

row.names(seds2mm) <- seds2mm$label

seds2mm <- seds2mm %>% select(-label, -fraction)

seds2mm
```

```
##    Arsenic Cadmium Chromium Copper Lead Mercury Selenium Thallium
## 2012-dep-exp-1 7.10 1.700  19.0 120.00 170.00 0.190  0.60  0.40
## 2012-dep-exp-2 14.00 0.500  39.0 670.00 100.00 0.120  1.00  0.05
## 2012-dep-exp-3 11.00 1.100  31.0 370.00 160.00 0.210  0.80  0.20
## 2012-dep-exp-4 7.00 0.500  24.0 180.00 62.00 0.080  0.01  0.10
## 2012-dep-exp-5 9.60 1.100  30.0 320.00 130.00 0.160  0.80  0.20
## 2012-dep-exp-6 5.90 0.710  25.0 250.00 83.00 0.070  0.60  0.20
## 2012-dep-exp-7 4.90 1.200  34.0 100.00 73.00 0.050  0.01  0.20
## 2012-dep-ref-1 0.80 0.230  18.0 5.80 7.80 0.001  0.01  0.05
```

```
## 2012-dep-ref-2 1.10 0.300  15.0 6.30 9.90 0.001  0.01  0.05
## 2012-dep-ref-3 0.60 0.090  15.0 4.00 4.90 0.001  0.01  0.05
## 2015-dep-exp-1 6.00 1.390  20.8 95.90 160.00 0.230  0.25  0.30
## 2015-dep-exp-2 5.50 0.540  19.1 161.00 141.00 0.130  0.25  0.05
## 2015-dep-exp-3 14.10 0.570  36.6 514.00 136.00 0.120  0.25  0.05
## 2015-dep-exp-4 5.20 0.460  22.5 139.00 48.90 0.080  0.25  0.10
## 2015-dep-exp-5 5.90 1.120  26.3 196.00 109.00 0.250  0.60  0.20
## 2015-dep-exp-6 4.10 0.520  20.7 176.00 52.80 0.170  0.25  0.20
## 2015-dep-exp-7 3.60 2.810  31.2 36.00 91.90 0.140  0.25  0.20
## 2015-dep-ref-1 0.90 0.190  11.9 5.40 6.80 0.050  0.25  0.05
## 2015-dep-ref-2 1.00 0.170  10.0 5.10 7.30 0.025  0.25  0.05
## 2015-dep-ref-3 0.80 0.110  15.6 5.10 7.00 0.025  0.25  0.05
## 2018-dep-exp-1 8.66 1.680  21.7 188.00 194.00 0.133  0.43  0.25
## 2018-dep-exp-2 11.00 2.150  38.7 467.00 220.00 0.550  1.82  0.37
## 2018-dep-exp-3 11.10 0.361  26.6 251.00 71.80 0.042  0.21  0.05
## 2018-dep-exp-4 6.76 1.410  30.2 322.00 70.40 0.106  0.37  0.20
## 2018-dep-exp-5 7.88 1.530  29.3 315.00 129.00 0.245  0.63  0.22
## 2018-dep-exp-6 6.64 0.573  21.9 165.00 56.00 0.076  0.22  0.14
## 2018-dep-exp-7 3.63 1.420  28.6 46.90 61.90 0.054  0.22  0.15
## 2018-dep-ref-1 1.38 0.208  14.4 5.40 6.26 0.020  0.10  0.05
## 2018-dep-ref-2 1.07 0.248  10.9 5.89 7.19 0.020  0.10  0.05
## 2018-dep-ref-3 1.27 0.165  13.6 5.38 5.54 0.020  0.10  0.05
## 2021-dep-exp-1 2.77 0.462  14.3 17.80 40.90 0.020  0.10  0.16
## 2021-dep-exp-2 5.11 0.474  22.6 130.00 60.40 0.060  0.33  0.12
## 2021-dep-exp-3 9.19 0.947  49.1 738.00 140.00 0.020  0.95  0.05
## 2021-dep-exp-4 5.15 0.558  26.6 265.00 57.60 0.045  0.25  0.16
## 2021-dep-exp-5 6.44 1.350  27.6 221.00 110.00 0.158  0.69  0.28
## 2021-dep-exp-6 3.65 0.382  23.8 94.90 41.00 0.072  0.21  0.14
## 2021-dep-exp-7 4.49 0.617  27.6 127.00 53.50 0.020  0.23  0.12
## 2021-dep-ref-1 1.47 0.244  18.0 6.47 7.68 0.020  0.10  0.05
## 2021-dep-ref-2 2.10 0.519  20.3 9.12 12.00 0.020  0.10  0.15
## 2021-dep-ref-3 1.23 0.179  14.9 5.75 6.39 0.020  0.10  0.05
##     Zinc
## 2012-dep-exp-1 650.0
## 2012-dep-exp-2 4200.0
## 2012-dep-exp-3 2200.0
## 2012-dep-exp-4 930.0
## 2012-dep-exp-5 2400.0
## 2012-dep-exp-6 1400.0
```

```
## 2012-dep-exp-7 780.0
## 2012-dep-ref-1 71.0
## 2012-dep-ref-2 70.0
## 2012-dep-ref-3 38.0
## 2015-dep-exp-1 645.0
## 2015-dep-exp-2 1190.0
## 2015-dep-exp-3 2550.0
## 2015-dep-exp-4 770.0
## 2015-dep-exp-5 1160.0
## 2015-dep-exp-6 793.0
## 2015-dep-exp-7 594.0
## 2015-dep-ref-1 59.0
## 2015-dep-ref-2 48.0
## 2015-dep-ref-3 31.0
## 2018-dep-exp-1 1100.0
## 2018-dep-exp-2 3790.0
## 2018-dep-exp-3 949.0
## 2018-dep-exp-4 1800.0
## 2018-dep-exp-5 2160.0
## 2018-dep-exp-6 902.0
## 2018-dep-exp-7 506.0
## 2018-dep-ref-1 60.8
## 2018-dep-ref-2 64.9
## 2018-dep-ref-3 56.2
## 2021-dep-exp-1 176.0
## 2021-dep-exp-2 934.0
## 2021-dep-exp-3 8070.0
## 2021-dep-exp-4 1440.0
## 2021-dep-exp-5 1520.0
## 2021-dep-exp-6 639.0
## 2021-dep-exp-7 1030.0
## 2021-dep-ref-1 86.3
## 2021-dep-ref-2 117.0
## 2021-dep-ref-3 63.9
```

11.0 Make df with all fractions and Concatenate label and fraction to use as rownames

```
row.names(sedsWide) <- with(sedsWide, paste(label, fraction))

sedsAll <- sedsWide %>% select(-label, -fraction)
```

```
sedsWide %>% filter(fraction != 0.002 & grepl("exp", label))
```

```
##         label fraction Arsenic Cadmium Chromium Copper
## 2018-dep-exp-1 6.3e-05 2018-dep-exp-1 6.3e-05 23.60 4.630  45.5 243.0
## 2018-dep-exp-2 6.3e-05 2018-dep-exp-2 6.3e-05 37.40 10.200  56.2 681.0
## 2018-dep-exp-3 6.3e-05 2018-dep-exp-3 6.3e-05 16.00 2.030  34.4 416.0
## 2018-dep-exp-4 6.3e-05 2018-dep-exp-4 6.3e-05 7.05 1.760  29.1 109.0
## 2018-dep-exp-5 6.3e-05 2018-dep-exp-5 6.3e-05 23.70 7.400  44.7 408.0
## 2018-dep-exp-6 6.3e-05 2018-dep-exp-6 6.3e-05 10.50 2.150  34.3 158.0
## 2018-dep-exp-7 6.3e-05 2018-dep-exp-7 6.3e-05 6.79 2.480  27.1 43.8
## 2021-dep-exp-1 6.3e-05 2021-dep-exp-1 6.3e-05 3.89 1.160  21.2 19.3
## 2021-dep-exp-2 6.3e-05 2021-dep-exp-2 6.3e-05 4.50 0.978  28.0 54.1
## 2021-dep-exp-3 6.3e-05 2021-dep-exp-3 6.3e-05 36.70 5.610  62.1 1130.0
## 2021-dep-exp-4 6.3e-05 2021-dep-exp-4 6.3e-05 3.99 0.897  28.9 78.5
## 2021-dep-exp-5 6.3e-05 2021-dep-exp-5 6.3e-05 34.10 9.290  79.6 1070.0
## 2021-dep-exp-6 6.3e-05 2021-dep-exp-6 6.3e-05 8.72 1.370  44.2 189.0
## 2021-dep-exp-7 6.3e-05 2021-dep-exp-7 6.3e-05 10.50 3.200  51.9 195.0
##       Lead Mercury Selenium Thallium Zinc
## 2018-dep-exp-1 6.3e-05 526.0 1.150  1.57  0.48 1400
## 2018-dep-exp-2 6.3e-05 900.0 7.410  8.73  1.25 4380
## 2018-dep-exp-3 6.3e-05 221.0 1.900  0.64  0.22 1200
## 2018-dep-exp-4 6.3e-05 84.6 0.415  0.39  0.18 697
## 2018-dep-exp-5 6.3e-05 543.0 5.210  4.12  0.89 2660
## 2018-dep-exp-6 6.3e-05 134.0 0.879  0.60  0.20 803
## 2018-dep-exp-7 6.3e-05 116.0 0.423  0.45  0.18 482
## 2021-dep-exp-1 6.3e-05 45.0 0.060  0.28  0.16 188
## 2021-dep-exp-2 6.3e-05 55.0 0.129  0.54  0.14 380
## 2021-dep-exp-3 6.3e-05 533.0 0.418  0.93  0.31 6140
## 2021-dep-exp-4 6.3e-05 49.8 0.141  0.40  0.13 593
## 2021-dep-exp-5 6.3e-05 788.0 3.470  4.66  1.25 5500
## 2021-dep-exp-6 6.3e-05 109.0 0.112  0.66  0.21 885
## 2021-dep-exp-7 6.3e-05 164.0 0.157  0.55  0.23 1370
```

12.0 Clustering before PCA

13.0 All years

```
analyte_distance_all <- vegdist(seds2mm)
```

```
analyte_clusters_all <- factoextra::eclust(as.matrix(analyte_distance_all), FUNcluster = "hclust", k.max = 3)

## Registered S3 method overwritten by 'dendextend':
## method  from
## rev.hclust vegan

## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.

analyte_groups_all <- data.frame(factor(analyte_clusters_all$cluster))
names(analyte_groups_all) <- "group"

analyte_simper_all<- with(analyte_groups_all, simper(seds2mm, group))

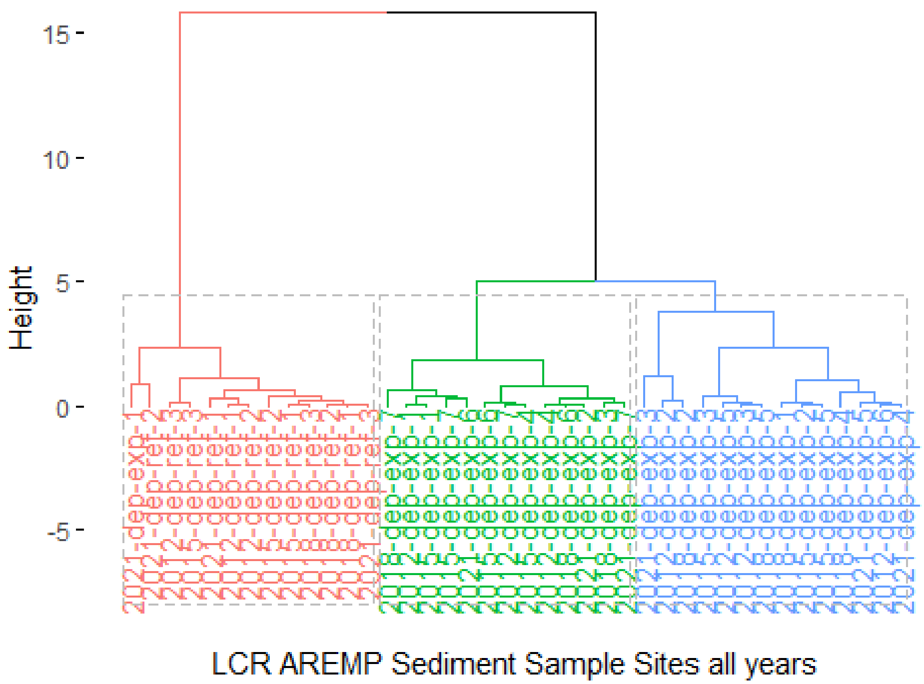
#summary(analyte_simper_all)

h_dendro <- factoextra::fviz_dend(analyte_clusters_all, rect = TRUE, lower_rect = -8, main = "" , k = 4, xlab = "LCR AREMP Sediment Sample Sites all years")

## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.

 ggsave(file.path(figures, "Cluster_all years.png"), device = "png",dpi = 300, units = "cm", height = 10, width = 12)

h_dendro
```



14.0 2021

```
seds2mm2021 <- seds2mm %>% filter(grepl("2021",rownames(.)))
seds2mm2021

##    Arsenic Cadmium Chromium Copper Lead Mercury Selenium Thallium
## 2021-dep-exp-1 2.77 0.462  14.3 17.80 40.90 0.020  0.10  0.16
## 2021-dep-exp-2 5.11 0.474  22.6 130.00 60.40 0.060  0.33  0.12
## 2021-dep-exp-3 9.19 0.947  49.1 738.00 140.00 0.020  0.95  0.05
## 2021-dep-exp-4 5.15 0.558  26.6 265.00 57.60 0.045  0.25  0.16
## 2021-dep-exp-5 6.44 1.350  27.6 221.00 110.00 0.158  0.69  0.28
## 2021-dep-exp-6 3.65 0.382  23.8 94.90 41.00 0.072  0.21  0.14
## 2021-dep-exp-7 4.49 0.617  27.6 127.00 53.50 0.020  0.23  0.12
## 2021-dep-ref-1 1.47 0.244  18.0 6.47 7.68 0.020  0.10  0.05
```

```
## 2021-dep-ref-2 2.10 0.519  20.3 9.12 12.00 0.020  0.10  0.15
## 2021-dep-ref-3 1.23 0.179  14.9 5.75 6.39 0.020  0.10  0.05
##     Zinc
## 2021-dep-exp-1 176.0
## 2021-dep-exp-2 934.0
## 2021-dep-exp-3 8070.0
## 2021-dep-exp-4 1440.0
## 2021-dep-exp-5 1520.0
## 2021-dep-exp-6 639.0
## 2021-dep-exp-7 1030.0
## 2021-dep-ref-1 86.3
## 2021-dep-ref-2 117.0
## 2021-dep-ref-3 63.9

row.names(seds2mm2021) <- gsub("2021-", "", row.names(seds2mm2021))
analyte_distance <- vegdist(seds2mm2021)




analyte_clusters <- factoextra::eclust(as.matrix(analyte_distance), FUNcluster = "hclust", k.max = 3)

## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.

analyte_groups <- data.frame(factor(analyte_clusters$cluster))
names(analyte_groups) <- "group"

analyte_simper<- with(analyte_groups, simper(seds2mm2021, group))

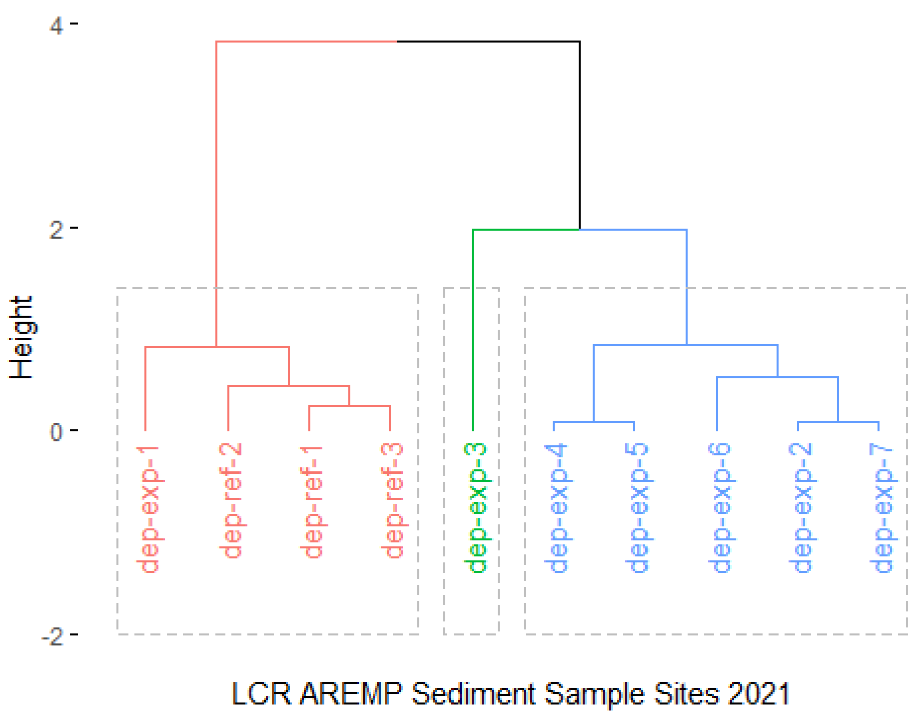
#summary(analyte_simper)

h_dendro_2021 <- factoextra::fviz_dend(analyte_clusters, rect = TRUE, lower_rect = -2, main = "" , k = 4, xlab = "LCR
AREMP Sediment Sample Sites 2021")

## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.
```

```
ggsave(file.path(figures, "Cluster_2021.png"), device = "png",dpi = 300, units = "cm", height = 10, width = 12)

h_dendro_2021
```



15.0 2018

```
seds2mm2018 <- seds2mm %>% filter(grepl("2018",rownames(.)))

seds2mm2018

##    Arsenic Cadmium Chromium Copper Lead Mercury Selenium Thallium
## 2018-dep-exp-1 8.66 1.680  21.7 188.00 194.00 0.133  0.43  0.25
## 2018-dep-exp-2 11.00 2.150  38.7 467.00 220.00 0.550  1.82  0.37
## 2018-dep-exp-3 11.10 0.361  26.6 251.00 71.80 0.042  0.21  0.05
## 2018-dep-exp-4 6.76 1.410  30.2 322.00 70.40 0.106  0.37  0.20
```

```
## 2018-dep-exp-5 7.88 1.530  29.3 315.00 129.00 0.245  0.63  0.22
## 2018-dep-exp-6 6.64 0.573  21.9 165.00 56.00 0.076  0.22  0.14
## 2018-dep-exp-7 3.63 1.420  28.6 46.90 61.90 0.054  0.22  0.15
## 2018-dep-ref-1 1.38 0.208  14.4 5.40 6.26 0.020  0.10  0.05
## 2018-dep-ref-2 1.07 0.248  10.9 5.89 7.19 0.020  0.10  0.05
## 2018-dep-ref-3 1.27 0.165  13.6 5.38 5.54 0.020  0.10  0.05
##     Zinc
## 2018-dep-exp-1 1100.0
## 2018-dep-exp-2 3790.0
## 2018-dep-exp-3 949.0
## 2018-dep-exp-4 1800.0
## 2018-dep-exp-5 2160.0
## 2018-dep-exp-6 902.0
## 2018-dep-exp-7 506.0
## 2018-dep-ref-1 60.8
## 2018-dep-ref-2 64.9
## 2018-dep-ref-3 56.2
```

```
row.names(seds2mm2018) <- gsub("2018-", "", row.names(seds2mm2018))
analyte_distance <- vegdist(seds2mm2018)

analyte_distance
```

```
##   dep-exp-1 dep-exp-2 dep-exp-3 dep-exp-4 dep-exp-5 dep-exp-6
## dep-exp-2 0.49892755
## dep-exp-3 0.12225417 0.55148292
## dep-exp-4 0.25849699 0.34010524 0.26337266
## dep-exp-5 0.30319204 0.26309144 0.33892080 0.08782297
## dep-exp-6 0.13597650 0.59446840 0.06428117 0.31882346 0.39281268
## dep-exp-7 0.40660351 0.74949194 0.34080571 0.54945006 0.60586866 0.29453882
## dep-ref-1 0.88946729 0.96163896 0.87329253 0.92360728 0.93513596 0.85720213
## dep-ref-2 0.88740740 0.96089623 0.87095180 0.92215742 0.93389738 0.85458723
## dep-ref-3 0.89691193 0.96431447 0.88175841 0.92883911 0.93960303 0.86666656
##   dep-exp-7 dep-ref-1 dep-ref-2
## dep-exp-2
## dep-exp-3
## dep-exp-4
## dep-exp-5
## dep-exp-6
```

```
## dep-exp-7
## dep-ref-1 0.75967739
## dep-ref-2 0.75551173 0.05235046
## dep-ref-3 0.77482190 0.03681344 0.08015959
```

```
analyte_clusters <- factoextra::eclust(as.matrix(analyte_distance), FUNcluster = "hclust", k.max = 3)
```

```
## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.
```

```
analyte_groups <- data.frame(factor(analyte_clusters$cluster))
names(analyte_groups) <- "group"

analyte_simper<- with(analyte_groups, simper(seds2mm2018, group))

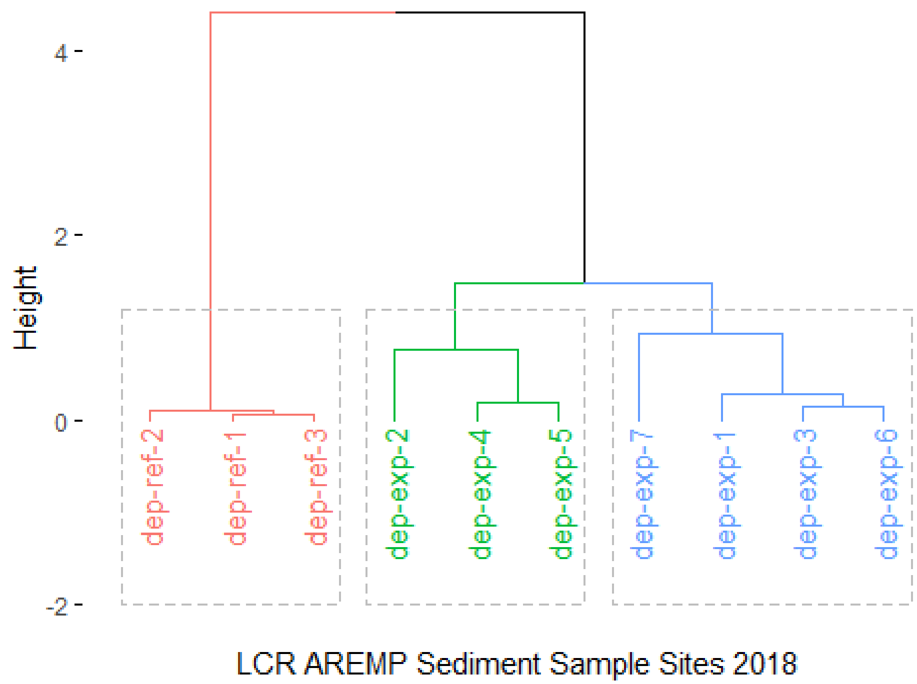
#summary(analyte_simper)

h_dendro_2018 <- factoextra::fviz_dend(analyte_clusters, rect = TRUE, lower_rect = -2, main = "" , k = 4, xlab = "LCR AREMP Sediment Sample Sites 2018")
```

```
## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.
```

```
 ggsave(file.path(figures, "Cluster_2018.png"), device = "png",dpi = 300, units = "cm", height = 10, width = 12)

h_dendro_2018
```



16.0 2015

```
seds2mm2015 <- seds2mm %>% filter(grepl("2015",rownames(.)))

seds2mm2015

##    Arsenic Cadmium Chromium Copper Lead Mercury Selenium Thallium
## 2015-dep-exp-1   6.0 1.39   20.8 95.9 160.0 0.230  0.25  0.30
## 2015-dep-exp-2   5.5 0.54   19.1 161.0 141.0 0.130  0.25  0.05
## 2015-dep-exp-3 14.1 0.57   36.6 514.0 136.0 0.120  0.25  0.05
## 2015-dep-exp-4   5.2 0.46   22.5 139.0 48.9 0.080  0.25  0.10
## 2015-dep-exp-5   5.9 1.12   26.3 196.0 109.0 0.250  0.60  0.20
## 2015-dep-exp-6   4.1 0.52   20.7 176.0 52.8 0.170  0.25  0.20
## 2015-dep-exp-7   3.6 2.81   31.2 36.0 91.9 0.140  0.25  0.20
```

```
## 2015-dep-ref-1  0.9 0.19  11.9 5.4 6.8 0.050  0.25  0.05
## 2015-dep-ref-2  1.0 0.17  10.0 5.1 7.3 0.025  0.25  0.05
## 2015-dep-ref-3  0.8 0.11  15.6 5.1 7.0 0.025  0.25  0.05
##    Zinc
## 2015-dep-exp-1 645
## 2015-dep-exp-2 1190
## 2015-dep-exp-3 2550
## 2015-dep-exp-4 770
## 2015-dep-exp-5 1160
## 2015-dep-exp-6 793
## 2015-dep-exp-7 594
## 2015-dep-ref-1 59
## 2015-dep-ref-2 48
## 2015-dep-ref-3 31
```

```
row.names(seds2mm2015) <- gsub("2015-", "", row.names(seds2mm2015))
analyte_distance <- vegdist(seds2mm2015)

analyte_distance
```

```
##   dep-exp-1 dep-exp-2 dep-exp-3 dep-exp-4 dep-exp-5 dep-exp-6
## dep-exp-2 0.25843330
## dep-exp-3 0.56729546 0.36570453
## dep-exp-4 0.14766537 0.21484309 0.53449830
## dep-exp-5 0.27681085 0.03506865 0.36932390 0.20631894
## dep-exp-6 0.17108024 0.19623749 0.51270750 0.03296087 0.17731076
## dep-exp-7 0.11444582 0.34532219 0.62226836 0.19169353 0.33302058 0.21651252
## dep-ref-1 0.83332183 0.89446418 0.94932004 0.84213327 0.89325151 0.85067298
## dep-ref-2 0.85646334 0.90953560 0.95673648 0.86414207 0.90848775 0.87157422
## dep-ref-3 0.87889534 0.92401292 0.96380327 0.88544807 0.92312601 0.89178234
##   dep-exp-7 dep-ref-1 dep-ref-2
## dep-exp-2
## dep-exp-3
## dep-exp-4
## dep-exp-5
## dep-exp-6
## dep-exp-7
## dep-ref-1 0.79982004
```

```
## dep-ref-2 0.82717444 0.08850321
## dep-ref-3 0.85382331 0.22429486 0.17568080

analyte_clusters <- factoextra::eclust(as.matrix(analyte_distance), FUNcluster = "hclust", k.max = 3)

## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.

analyte_groups <- data.frame(factor(analyte_clusters$cluster))
names(analyte_groups) <- "group"

analyte_simper<- with(analyte_groups, simper(seds2mm2018, group))

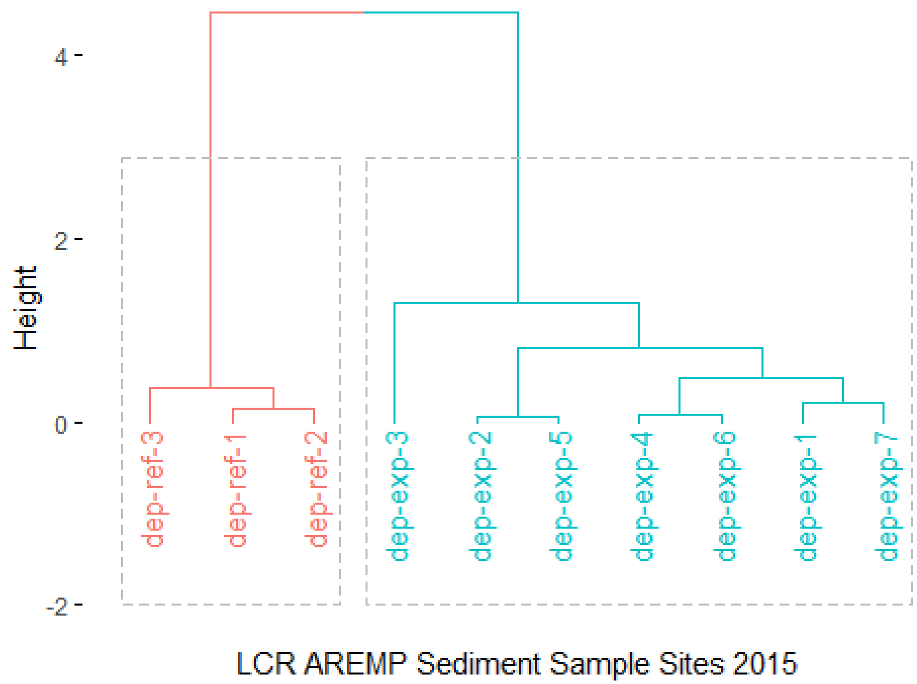
#summary(analyte_simper)

h_dendro_2015 <- factoextra::fviz_dend(analyte_clusters, rect = TRUE, lower_rect = -2, main = "" , k = 4, xlab = "LCR AREMP Sediment Sample Sites 2015")

## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.

 ggsave(file.path(figures, "Cluster_2015.png"), device = "png",dpi = 300, units = "cm", height = 10, width = 12)

h_dendro_2015
```



2012

```
seds2mm2012 <- seds2mm %>% filter(grepl("2012",rownames(.)))

seds2mm2012

##    Arsenic Cadmium Chromium Copper Lead Mercury Selenium Thallium
## 2012-dep-exp-1  7.1 1.70  19 120.0 170.0 0.190  0.60  0.40
## 2012-dep-exp-2 14.0 0.50  39 670.0 100.0 0.120  1.00  0.05
## 2012-dep-exp-3 11.0 1.10  31 370.0 160.0 0.210  0.80  0.20
## 2012-dep-exp-4  7.0 0.50  24 180.0 62.0 0.080  0.01  0.10
## 2012-dep-exp-5  9.6 1.10  30 320.0 130.0 0.160  0.80  0.20
## 2012-dep-exp-6  5.9 0.71  25 250.0 83.0 0.070  0.60  0.20
## 2012-dep-exp-7  4.9 1.20  34 100.0 73.0 0.050  0.01  0.20
## 2012-dep-ref-1  0.8 0.23  18 5.8 7.8 0.001  0.01  0.05
```

```
## 2012-dep-ref-2  1.1 0.30  15 6.3 9.9 0.001  0.01  0.05
## 2012-dep-ref-3  0.6 0.09  15 4.0 4.9 0.001  0.01  0.05
##    Zinc
## 2012-dep-exp-1 650
## 2012-dep-exp-2 4200
## 2012-dep-exp-3 2200
## 2012-dep-exp-4 930
## 2012-dep-exp-5 2400
## 2012-dep-exp-6 1400
## 2012-dep-exp-7 780
## 2012-dep-ref-1 71
## 2012-dep-ref-2 70
## 2012-dep-ref-3 38
```

```
row.names(seds2mm2012) <- gsub("2012-", "", row.names(seds2mm2012))
analyte_distance <- vegdist(seds2mm2012)

analyte_distance
```

```
##   dep-exp-1 dep-exp-2 dep-exp-3 dep-exp-4 dep-exp-5 dep-exp-6
## dep-exp-2 0.70056026
## dep-exp-3 0.48805065 0.30414747
## dep-exp-4 0.20955686 0.61349697 0.39482655
## dep-exp-5 0.51919396 0.27719089 0.04984849 0.41219616
## dep-exp-6 0.35674555 0.48009396 0.22221953 0.18995544 0.24185050
## dep-exp-7 0.13536321 0.67015452 0.47433825 0.11557771 0.49075728 0.28675095
## dep-ref-1 0.80666946 0.95956174 0.92794235 0.84137600 0.93077000 0.88905135
## dep-ref-2 0.80840591 0.95995538 0.92863258 0.84282785 0.93143411 0.89009288
## dep-ref-3 0.87854108 0.97536975 0.95583231 0.90105193 0.95758960 0.93145896
##   dep-exp-7 dep-ref-1 dep-ref-2
## dep-exp-2
## dep-exp-3
## dep-exp-4
## dep-exp-5
## dep-exp-6
## dep-exp-7
## dep-ref-1 0.81096412
## dep-ref-2 0.81266600 0.03377724
## dep-ref-3 0.88134404 0.24672061 0.24202720
```

```
analyte_clusters <- factoextra::eclust(as.matrix(analyte_distance), FUNcluster = "hclust", k.max = 3)

## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.

analyte_groups <- data.frame(factor(analyte_clusters$cluster))
names(analyte_groups) <- "group"

analyte_simper<- with(analyte_groups, simper(seds2mm2018, group))

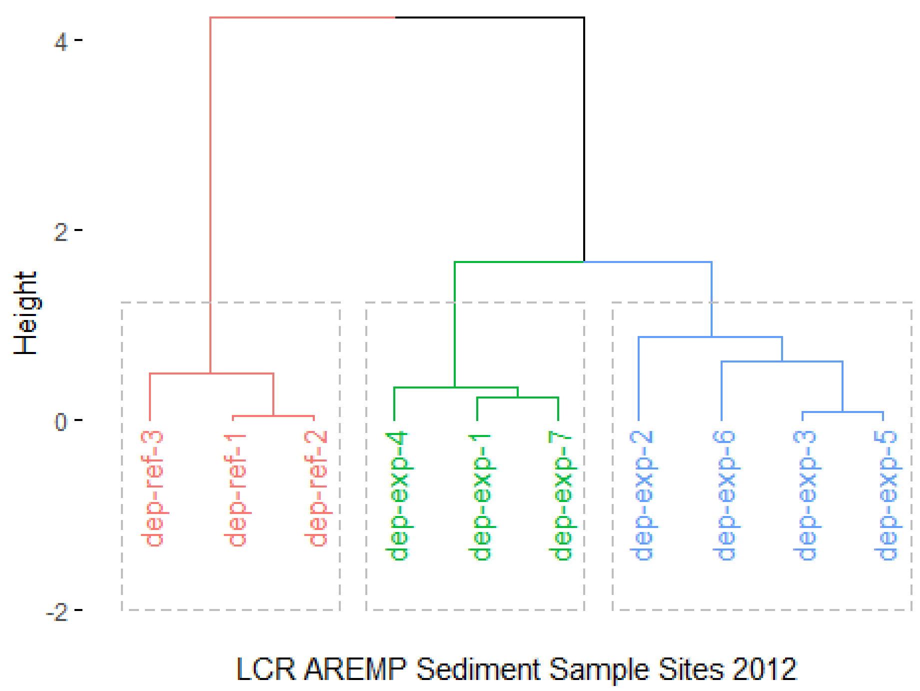
#summary(analyte_simper)

h_dendro_2012 <- factoextra::fviz_dend(analyte_clusters, rect = TRUE, lower_rect = -2, main = "" , k = 4, xlab = "LCR AREMP Sediment Sample Sites 2012")

## Warning: `guides(<scale> = FALSE)` is deprecated. Please use `guides(<scale> =
## "none")` instead.

 ggsave(file.path(figures, "Cluster_2012.png"), device = "png",dpi = 300, units = "cm", height = 10, width = 12)

h_dendro_2012
```



17.0 Check Shapiro

18.0 For 2mm (2012, 2015, 2018-2mm, 2021-2mm)

```
shapChecker <- function(df_) {
 data.frame(t(apply(df_, 2, function(x){
 res = shapiro.test(x)
 return(unlist(res[names(res)[1:3]]))
 })), stringsAsFactors = FALSE)
}

shap2mm <- shapChecker(seds2mm)
```

```
shap2mm %>% head()

##    statistic.W    p.value      method
## Arsenic 0.925391971383339 0.0114248557584908 Shapiro-Wilk normality test
## Cadmium 0.862885695195097 0.000187822865219505 Shapiro-Wilk normality test
## Chromium 0.961646815442384 0.190617120414326 Shapiro-Wilk normality test
## Copper 0.83074784398139 3.17021962878032e-05 Shapiro-Wilk normality test
## Lead  0.910309726852511 0.00386783151161408 Shapiro-Wilk normality test
## Mercury 0.762976639259734 1.24786877517428e-06 Shapiro-Wilk normality test
```

19.0 Some departures from normality. Check with log transformation, and sqrt

```
violators <- (shap2mm %>%
 rownames_to_column("analyte") %>%
 filter(as.numeric(p.value) < 0.05) %>%
 select(analyte))[,1]

violators

## [1] "Arsenic" "Cadmium" "Copper" "Lead"  "Mercury" "Selenium" "Thallium"
## [8] "Zinc"
```

20.0 Filter for violating analytes

blesing : explore all_of

```
toTrans <- seds2mm %>%
 select(one_of(violators))

toTrans

##    Arsenic Cadmium Copper Lead Mercury Selenium Thallium Zinc
## 2012-dep-exp-1 7.10 1.700 120.00 170.00 0.190  0.60  0.40 650.0
## 2012-dep-exp-2 14.00 0.500 670.00 100.00 0.120  1.00  0.05 4200.0
## 2012-dep-exp-3 11.00 1.100 370.00 160.00 0.210  0.80  0.20 2200.0
## 2012-dep-exp-4 7.00 0.500 180.00 62.00 0.080  0.01  0.10 930.0
## 2012-dep-exp-5 9.60 1.100 320.00 130.00 0.160  0.80  0.20 2400.0
## 2012-dep-exp-6 5.90 0.710 250.00 83.00 0.070  0.60  0.20 1400.0
## 2012-dep-exp-7 4.90 1.200 100.00 73.00 0.050  0.01  0.20 780.0
## 2012-dep-ref-1 0.80 0.230 5.80 7.80 0.001  0.01  0.05 71.0
## 2012-dep-ref-2 1.10 0.300 6.30 9.90 0.001  0.01  0.05 70.0
```

```
## 2012-dep-ref-3 0.60 0.090 4.00 4.90 0.001  0.01  0.05 38.0
## 2015-dep-exp-1 6.00 1.390 95.90 160.00 0.230  0.25  0.30 645.0
## 2015-dep-exp-2 5.50 0.540 161.00 141.00 0.130  0.25  0.05 1190.0
## 2015-dep-exp-3 14.10 0.570 514.00 136.00 0.120  0.25  0.05 2550.0
## 2015-dep-exp-4 5.20 0.460 139.00 48.90 0.080  0.25  0.10 770.0
## 2015-dep-exp-5 5.90 1.120 196.00 109.00 0.250  0.60  0.20 1160.0
## 2015-dep-exp-6 4.10 0.520 176.00 52.80 0.170  0.25  0.20 793.0
## 2015-dep-exp-7 3.60 2.810 36.00 91.90 0.140  0.25  0.20 594.0
## 2015-dep-ref-1 0.90 0.190 5.40 6.80 0.050  0.25  0.05 59.0
## 2015-dep-ref-2 1.00 0.170 5.10 7.30 0.025  0.25  0.05 48.0
## 2015-dep-ref-3 0.80 0.110 5.10 7.00 0.025  0.25  0.05 31.0
## 2018-dep-exp-1 8.66 1.680 188.00 194.00 0.133  0.43  0.25 1100.0
## 2018-dep-exp-2 11.00 2.150 467.00 220.00 0.550  1.82  0.37 3790.0
## 2018-dep-exp-3 11.10 0.361 251.00 71.80 0.042  0.21  0.05 949.0
## 2018-dep-exp-4 6.76 1.410 322.00 70.40 0.106  0.37  0.20 1800.0
## 2018-dep-exp-5 7.88 1.530 315.00 129.00 0.245  0.63  0.22 2160.0
## 2018-dep-exp-6 6.64 0.573 165.00 56.00 0.076  0.22  0.14 902.0
## 2018-dep-exp-7 3.63 1.420 46.90 61.90 0.054  0.22  0.15 506.0
## 2018-dep-ref-1 1.38 0.208 5.40 6.26 0.020  0.10  0.05 60.8
## 2018-dep-ref-2 1.07 0.248 5.89 7.19 0.020  0.10  0.05 64.9
## 2018-dep-ref-3 1.27 0.165 5.38 5.54 0.020  0.10  0.05 56.2
## 2021-dep-exp-1 2.77 0.462 17.80 40.90 0.020  0.10  0.16 176.0
## 2021-dep-exp-2 5.11 0.474 130.00 60.40 0.060  0.33  0.12 934.0
## 2021-dep-exp-3 9.19 0.947 738.00 140.00 0.020  0.95  0.05 8070.0
## 2021-dep-exp-4 5.15 0.558 265.00 57.60 0.045  0.25  0.16 1440.0
## 2021-dep-exp-5 6.44 1.350 221.00 110.00 0.158  0.69  0.28 1520.0
## 2021-dep-exp-6 3.65 0.382 94.90 41.00 0.072  0.21  0.14 639.0
## 2021-dep-exp-7 4.49 0.617 127.00 53.50 0.020  0.23  0.12 1030.0
## 2021-dep-ref-1 1.47 0.244 6.47 7.68 0.020  0.10  0.05 86.3
## 2021-dep-ref-2 2.10 0.519 9.12 12.00 0.020  0.10  0.15 117.0
## 2021-dep-ref-3 1.23 0.179 5.75 6.39 0.020  0.10  0.05 63.9
```

21.0 Rerun shapiro test with transformations

```
shapTransformChecker <- function(df_) {
 df_ <- data.frame(apply(df_, 2, function(x) {
 noTrans = shapiro.test(x)
 resLog = shapiro.test(log10(x))
 resSqrt = shapiro.test(sqrt(x))
 resSqr = shapiro.test(x^2)
```

```
resRecip = shapiro.test(1/x)
resExp = shapiro.test(exp(x))

y = as.numeric(x)

lenLogi = all(y > 0 & y < 1)

print(lenLogi)

if (lenLogi > 3) {
 resArc = shapiro.test(asin(sqrt(x)))
} else {
 resArc = NA
}


out <-
 data.frame(
 noTrans = unlist(noTrans),
 logTrans = unlist(resLog),
 sqrtTrans = unlist(resSqrt),
 sqrTrans = unlist(resSqr),
 recipTrans = unlist(resRecip),
 expTrans = unlist(resExp),
 arcTrans = unlist(resArc)
 )
return(out)
}), stringsAsFactors = FALSE) #%>%
# rownames_to_column("metric")# %>%
# gather(key, value, -metric)
newColNames <- rownames(df_)
newRowNames <- colnames(df_)

tdf <- transpose(df_)
names(tdf) <- newColNames
rownames(tdf) <- newRowNames

tdf <- tdf %>% rownames_to_column(var = "analyte") %>%
mutate(analyte = gsub("\\..*", "", analyte))
```

```
 return(tdf)
}

shap2mmTransform <- shapTransformChecker(toTrans)

## [1] FALSE
## [1] FALSE
## [1] FALSE
## [1] FALSE
## [1] TRUE
## [1] FALSE
## [1] TRUE
## [1] FALSE

shap2mmTransform

##  analyte  statistic.W    p.value      method
## 1 Arsenic 0.925391971383339 0.0114248557584908 Shapiro-Wilk normality test
## 2 Arsenic 0.913393500243468 0.00480206242341501 Shapiro-Wilk normality test
## 3 Arsenic 0.948462479072791 0.067141043498397 Shapiro-Wilk normality test
## 4 Arsenic 0.770592353878421 1.74414943472157e-06 Shapiro-Wilk normality test
## 5 Arsenic 0.762394693675564 1.21666305084984e-06 Shapiro-Wilk normality test
## 6 Arsenic 0.259692731605587 6.00597009039002e-13 Shapiro-Wilk normality test
## 7 Arsenic    <NA>     <NA>      <NA>
## 8 Cadmium 0.862885695195097 0.000187822865219505 Shapiro-Wilk normality test
## 9 Cadmium 0.971096553103141 0.389612707122925 Shapiro-Wilk normality test
## 10 Cadmium 0.946324594711037 0.0567150933961961 Shapiro-Wilk normality test
## 11 Cadmium 0.64244461210101 1.24708576126323e-08 Shapiro-Wilk normality test
## 12 Cadmium 0.792541535234706 4.75314731784735e-06 Shapiro-Wilk normality test
## 13 Cadmium 0.572922305424988 1.36064060945374e-09 Shapiro-Wilk normality test
## 14 Cadmium    <NA>     <NA>      <NA>
## 15 Copper 0.83074784398139 3.17021962878032e-05 Shapiro-Wilk normality test
## 16 Copper 0.852474751701649 0.000103368073132137 Shapiro-Wilk normality test
## 17 Copper 0.91674658750664 0.00609371185895542 Shapiro-Wilk normality test
## 18 Copper 0.56658948255122 1.12558903456641e-09 Shapiro-Wilk normality test
## 19 Copper 0.689744702047327 6.63530213825138e-08 Shapiro-Wilk normality test
## 20 Copper    NaN     NaN Shapiro-Wilk normality test
## 21 Copper    <NA>     <NA>      <NA>
```

```
## 22  Lead 0.910309726852511 0.00386783151161408 Shapiro-Wilk normality test
## 23  Lead 0.855943654712914 0.00012582982571489 Shapiro-Wilk normality test
## 24  Lead 0.920098819126572 0.00775638204454119 Shapiro-Wilk normality test
## 25  Lead 0.769745977999846 1.67990706005811e-06 Shapiro-Wilk normality test
## 26  Lead 0.709073521248663 1.37587632341992e-07 Shapiro-Wilk normality test
## 27  Lead 0.147030934473295 6.63988672325573e-14 Shapiro-Wilk normality test
## 28  Lead    <NA>     <NA>      <NA>
## 29 Mercury 0.762976639259734 1.24786877517428e-06 Shapiro-Wilk normality test
## 30 Mercury 0.868629386519802 0.000263568490600284 Shapiro-Wilk normality test
## 31 Mercury 0.943448888156357 0.0452475172198604 Shapiro-Wilk normality test
## 32 Mercury 0.392057320168347 1.1105910875091e-11 Shapiro-Wilk normality test
## 33 Mercury 0.346854275592418 3.91509867555655e-12 Shapiro-Wilk normality test
## 34 Mercury 0.687918171400291 6.20261072618435e-08 Shapiro-Wilk normality test
## 35 Mercury    <NA>     <NA>      <NA>
## 36 Selenium 0.774223114910913 2.05068672789775e-06 Shapiro-Wilk normality test
## 37 Selenium 0.857677922392607 0.00013894913321974 Shapiro-Wilk normality test
## 38 Selenium 0.932495329189414 0.0194432194845474 Shapiro-Wilk normality test
## 39 Selenium 0.445756951357021 4.12201468485157e-11 Shapiro-Wilk normality test
## 40 Selenium 0.464813449073708 6.70494550189208e-11 Shapiro-Wilk normality test
## 41 Selenium 0.531239746475356 4.03457733986836e-10 Shapiro-Wilk normality test
## 42 Selenium    <NA>     <NA>      <NA>
## 43 Thallium 0.850796360549199 9.40641730583521e-05 Shapiro-Wilk normality test
## 44 Thallium 0.840128415251855 5.22762421768921e-05 Shapiro-Wilk normality test
## 45 Thallium 0.863362677523592 0.000193132538634184 Shapiro-Wilk normality test
## 46 Thallium 0.719358199812051 2.05318157285366e-07 Shapiro-Wilk normality test
## 47 Thallium 0.754514822645854 8.66517992924875e-07 Shapiro-Wilk normality test
## 48 Thallium 0.836281954728115 4.25066677278969e-05 Shapiro-Wilk normality test
## 49 Thallium    <NA>     <NA>      <NA>
## 50  Zinc 0.687919081139068 6.20281867323586e-08 Shapiro-Wilk normality test
## 51  Zinc 0.904947918397137 0.00267157178473313 Shapiro-Wilk normality test
## 52  Zinc 0.904614015772454 0.00261138055746074 Shapiro-Wilk normality test
## 53  Zinc 0.338483755756222 3.24585315259813e-12 Shapiro-Wilk normality test
## 54  Zinc 0.707205637136702 1.28059950503987e-07 Shapiro-Wilk normality test
## 55  Zinc    NaN     NaN Shapiro-Wilk normality test
## 56  Zinc    <NA>     <NA>      <NA>
## data.name
## 1   x
## 2 log10(x)
## 3 sqrt(x)
```

```
## 4  x^2
## 5  1/x
## 6  exp(x)
## 7  <NA>
## 8   x
## 9 log10(x)
## 10 sqrt(x)
## 11  x^2
## 12  1/x
## 13 exp(x)
## 14  <NA>
## 15   x
## 16 log10(x)
## 17 sqrt(x)
## 18  x^2
## 19  1/x
## 20 exp(x)
## 21  <NA>
## 22   x
## 23 log10(x)
## 24 sqrt(x)
## 25  x^2
## 26  1/x
## 27 exp(x)
## 28  <NA>
## 29   x
## 30 log10(x)
## 31 sqrt(x)
## 32  x^2
## 33  1/x
## 34 exp(x)
## 35  <NA>
## 36   x
## 37 log10(x)
## 38 sqrt(x)
## 39  x^2
## 40  1/x
## 41 exp(x)
## 42  <NA>
```

```
## 43    x
## 44 log10(x)
## 45 sqrt(x)
## 46   x^2
## 47   1/x
## 48 exp(x)
## 49   <NA>
## 50    x
## 51 log10(x)
## 52 sqrt(x)
## 53   x^2
## 54   1/x
## 55 exp(x)
## 56   <NA>
```

22.0 Pull out effective transformations

```
shap2mmTransform %>% filter(as.numeric(p.value) > 0.05)

## analyte  statistic.W   p.value      method
## 1 Arsenic 0.948462479072791 0.067141043498397 Shapiro-Wilk normality test
## 2 Cadmium 0.971096553103141 0.389612707122925 Shapiro-Wilk normality test
## 3 Cadmium 0.946324594711037 0.0567150933961961 Shapiro-Wilk normality test
## data.name
## 1 sqrt(x)
## 2 log10(x)
## 3 sqrt(x)
```

23.0 Transform Cadmium and Arsenic according to the appropriate transformations

```
seds2mm$Cadmium <- log10(seds2mm$Cadmium)
seds2mm$Arsenic <- sqrt(seds2mm$Arsenic)
```

24.0 For all samples, all years

```
shapAll <- shapChecker(sedsAll)
shapAll

##    statistic.W    p.value      method
## Arsenic 0.708767137047645 1.31408247250049e-09 Shapiro-Wilk normality test
## Cadmium 0.603574434584241 1.82103004286926e-11 Shapiro-Wilk normality test
## Chromium 0.881480953940231 2.96709529815171e-05 Shapiro-Wilk normality test
## Copper 0.746021785471503 7.64602646428543e-09 Shapiro-Wilk normality test
```

```
## Lead  0.608456242103511 2.18076865000052e-11 Shapiro-Wilk normality test
## Mercury 0.359646412696824 9.92712242981263e-15 Shapiro-Wilk normality test
## Selenium 0.427432463223683 6.29624191589135e-14 Shapiro-Wilk normality test
## Thallium 0.567759070959641 5.07391524275345e-12 Shapiro-Wilk normality test
## Zinc  0.70715857741457 1.22200717791267e-09 Shapiro-Wilk normality test
```

Almost all violate assumptions of normality (save for Chromium). Try a slew of transformations

25.0 Rerun shapiro with a variety of transformations

```
shapAllTransform <- shapTransformChecker(sedsAll)

## [1] FALSE
## [1] FALSE
## [1] FALSE
## [1] FALSE
## [1] FALSE
## [1] FALSE
## [1] FALSE
## [1] FALSE
## [1] FALSE

shapAllTransform

##  analyte  statistic.W    p.value      method
## 1 Arsenic 0.708767137047645 1.31408247250049e-09 Shapiro-Wilk normality test
## 2 Arsenic 0.976291214810692  0.29226605422056 Shapiro-Wilk normality test
## 3 Arsenic 0.898334033419815 0.000114438951625431 Shapiro-Wilk normality test
## 4 Arsenic 0.435054136214988 7.82527412672766e-14 Shapiro-Wilk normality test
## 5 Arsenic 0.742388954623892 6.39425344066915e-09 Shapiro-Wilk normality test
## 6 Arsenic 0.177151575223648 1.28401826935601e-16 Shapiro-Wilk normality test
## 7 Arsenic    <NA>     <NA>      <NA>
## 8 Cadmium 0.603574434584241 1.82103004286926e-11 Shapiro-Wilk normality test
## 9 Cadmium 0.982682122755438 0.551823057957081 Shapiro-Wilk normality test
## 10 Cadmium 0.829462570041215 7.94335673591291e-07 Shapiro-Wilk normality test
## 11 Cadmium 0.356910564681243 9.24194799122624e-15 Shapiro-Wilk normality test
## 12 Cadmium 0.741058428791966 5.9913915956135e-09 Shapiro-Wilk normality test
## 13 Cadmium 0.177295680873374 1.28805307366677e-16 Shapiro-Wilk normality test
## 14 Cadmium    <NA>     <NA>      <NA>
## 15 Chromium 0.881480953940231 2.96709529815171e-05 Shapiro-Wilk normality test
## 16 Chromium 0.987392804267244 0.792340118725548 Shapiro-Wilk normality test
```

```
## 17 Chromium 0.955657791379096 0.0289605110383573 Shapiro-Wilk normality test
## 18 Chromium 0.668986138938157 2.3431815078967e-10 Shapiro-Wilk normality test
## 19 Chromium 0.922827939582543 0.000998629028510578 Shapiro-Wilk normality test
## 20 Chromium 0.109912636035331 3.09992814043981e-17 Shapiro-Wilk normality test
## 21 Chromium    <NA>     <NA>      <NA>
## 22 Copper 0.746021785471503 7.64602646428543e-09 Shapiro-Wilk normality test
## 23 Copper 0.918035255975855 0.000639813073529511 Shapiro-Wilk normality test
## 24 Copper 0.913853814159371 0.000437738385139056 Shapiro-Wilk normality test
## 25 Copper 0.449820625825477 1.19966835675957e-13 Shapiro-Wilk normality test
## 26 Copper 0.691648623992061 6.14567689121374e-10 Shapiro-Wilk normality test
## 27 Copper    NaN     NaN Shapiro-Wilk normality test
## 28 Copper    <NA>     <NA>      <NA>
## 29  Lead 0.608456242103511 2.18076865000052e-11 Shapiro-Wilk normality test
## 30  Lead 0.948530795841097 0.0132924204184731 Shapiro-Wilk normality test
## 31  Lead 0.850767817627264 3.20950884009824e-06 Shapiro-Wilk normality test
## 32  Lead 0.355704640726125 8.95577721151642e-15 Shapiro-Wilk normality test
## 33  Lead 0.716836847404048 1.89951306096747e-09 Shapiro-Wilk normality test
## 34  Lead    NaN     NaN Shapiro-Wilk normality test
## 35  Lead    <NA>     <NA>      <NA>
## 36 Mercury 0.359646412696824 9.92712242981263e-15 Shapiro-Wilk normality test
## 37 Mercury 0.939869143823539 0.00534273362818108 Shapiro-Wilk normality test
## 38 Mercury 0.616549130797666 2.95045667073873e-11 Shapiro-Wilk normality test
## 39 Mercury 0.22267520229063 3.53282495693762e-16 Shapiro-Wilk normality test
## 40 Mercury 0.290782004499961 1.7488090524251e-15 Shapiro-Wilk normality test
## 41 Mercury 0.132437944156624 4.94447245130114e-17 Shapiro-Wilk normality test
## 42 Mercury    <NA>     <NA>      <NA>
## 43 Selenium 0.427432463223683 6.29624191589135e-14 Shapiro-Wilk normality test
## 44 Selenium 0.89508002005785 8.74653294673724e-05 Shapiro-Wilk normality test
## 45 Selenium 0.743580998909343 6.7793818933808e-09 Shapiro-Wilk normality test
## 46 Selenium 0.210373375162801 2.67607432935216e-16 Shapiro-Wilk normality test
## 47 Selenium 0.389092245734665 2.17460419759372e-14 Shapiro-Wilk normality test
## 48 Selenium 0.114735199351813 3.42324122329367e-17 Shapiro-Wilk normality test
## 49 Selenium    <NA>     <NA>      <NA>
## 50 Thallium 0.567759070959641 5.07391524275345e-12 Shapiro-Wilk normality test
## 51 Thallium 0.89279535612652 7.2597829636408e-05 Shapiro-Wilk normality test
## 52 Thallium 0.776853412042991 3.73891062379967e-08 Shapiro-Wilk normality test
## 53 Thallium 0.314475892801781 3.13256893560056e-15 Shapiro-Wilk normality test
## 54 Thallium 0.786532728717664 6.32968773316157e-08 Shapiro-Wilk normality test
## 55 Thallium 0.428773269697104 6.54072273142265e-14 Shapiro-Wilk normality test
```

```
## 56 Thallium    <NA>     <NA>      <NA>
## 57  Zinc 0.70715857741457 1.22200717791267e-09 Shapiro-Wilk normality test
## 58  Zinc 0.940660293417772 0.00579690703394718 Shapiro-Wilk normality test
## 59  Zinc 0.901695172061772 0.000151723583867182 Shapiro-Wilk normality test
## 60  Zinc 0.420365415763874 5.15629649127461e-14 Shapiro-Wilk normality test
## 61  Zinc 0.713566269294621 1.63468000728742e-09 Shapiro-Wilk normality test
## 62  Zinc    NaN     NaN Shapiro-Wilk normality test
## 63  Zinc    <NA>     <NA>      <NA>
## data.name
## 1   x
## 2 log10(x)
## 3 sqrt(x)
## 4  x^2
## 5  1/x
## 6  exp(x)
## 7  <NA>
## 8   x
## 9 log10(x)
## 10 sqrt(x)
## 11  x^2
## 12  1/x
## 13 exp(x)
## 14  <NA>
## 15   x
## 16 log10(x)
## 17 sqrt(x)
## 18  x^2
## 19  1/x
## 20 exp(x)
## 21  <NA>
## 22   x
## 23 log10(x)
## 24 sqrt(x)
## 25  x^2
## 26  1/x
## 27 exp(x)
## 28  <NA>
## 29   x
## 30 log10(x)
```

```
## 31 sqrt(x)
## 32  x^2
## 33  1/x
## 34 exp(x)
## 35  <NA>
## 36    x
## 37 log10(x)
## 38 sqrt(x)
## 39  x^2
## 40  1/x
## 41 exp(x)
## 42  <NA>
## 43    x
## 44 log10(x)
## 45 sqrt(x)
## 46  x^2
## 47  1/x
## 48 exp(x)
## 49  <NA>
## 50    x
## 51 log10(x)
## 52 sqrt(x)
## 53  x^2
## 54  1/x
## 55 exp(x)
## 56  <NA>
## 57    x
## 58 log10(x)
## 59 sqrt(x)
## 60  x^2
## 61  1/x
## 62 exp(x)
## 63  <NA>
```

26.0 Pull out any effective transformations

```
shapAllTransform %>% filter(as.numeric(p.value) > 0.05)

## analyte  statistic.W   p.value      method
## 1 Arsenic 0.976291214810692 0.29226605422056 Shapiro-Wilk normality test
```

```
## 2 Cadmium 0.982682122755438 0.551823057957081 Shapiro-Wilk normality test
## 3 Chromium 0.987392804267244 0.792340118725548 Shapiro-Wilk normality test
## data.name
## 1 log10(x)
## 2 log10(x)
## 3 log10(x)
```

Old Comment > Only Arsenic and Cadmium can be transformed. Chromium is also potentially improved- check histogram for a visual check.

Blessing : check if you have multiple columns for the same metal “” : Below hey heck for chronium transformations

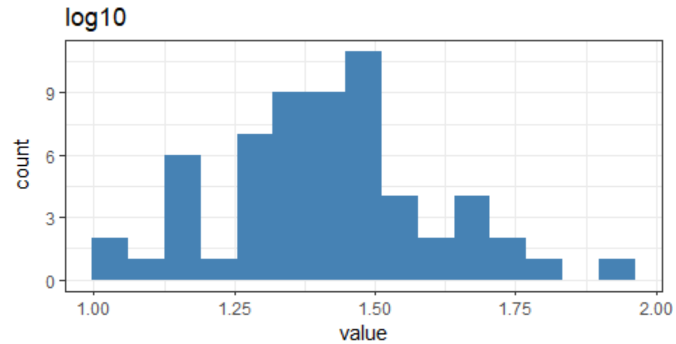
```
toHist <- data.frame(
 noTrans = sedsAll$Chromium,
 log10 = log10(sedsAll$Chromium),
 sqrt = sqrt(sedsAll$Chromium)
) %>%
 gather(transformation, value)

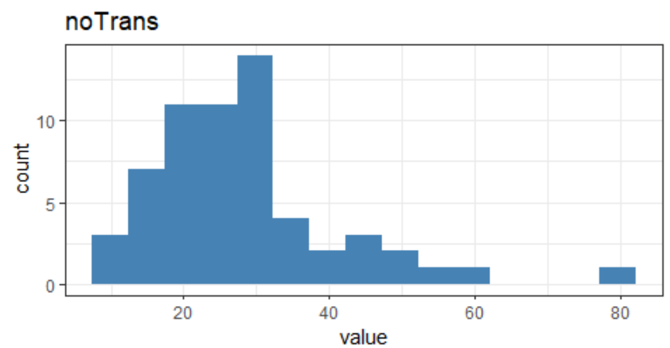
plotList <- dlply(toHist, "transformation", function(df_) {
 ttl = unique(df_$transformation)
 p <- ggplot(df_, aes(x = value)) +
 geom_histogram(bins = 15, fill = "steelblue") +
 ggplot2::ggtitle(label = ttl) + theme_bw()
})

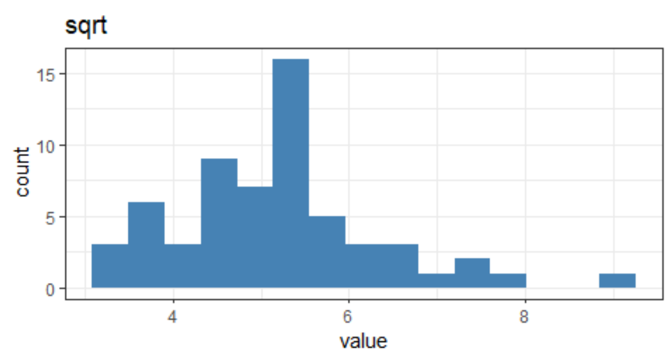
threePlots <- lapply(plotList, ggplotGrob)

threePlots <- do.call(rbind, threePlots)

grid.newpage()
grid.draw(threePlots)
```







Somewhat subjective, but the sqrt transformation appears closes to normal visually. This is supported by a high p-value in the shapiro wilks test for that transformation.

27.0 Transform Arsenic, Cadmium, Chromium

```
shapAllTransform %>% filter(as.numeric(p.value) > 0.05)

## analyte  statistic.W   p.value      method
## 1 Arsenic 0.976291214810692 0.29226605422056 Shapiro-Wilk normality test
## 2 Cadmium 0.982682122755438 0.551823057957081 Shapiro-Wilk normality test
## 3 Chromium 0.987392804267244 0.792340118725548 Shapiro-Wilk normality test
## data.name
## 1 log10(x)
## 2 log10(x)
## 3 log10(x)

sedsAll$Arsenic <- log10(sedsAll$Arsenic)
sedsAll$Cadmium <- log10(sedsAll$Cadmium)
sedsAll$Chromium <- log10(sedsAll$Chromium)
```

28.0 Standardize values

29.0 2mm

```
seds2mmStd <- data.frame(apply(seds2mm, 2, function(col) {
 mCol = mean(col)
 sdCol = sd(col)

 z = (col - mCol) / sdCol
}))
```

30.0 All

```
sedsAllStd <- data.frame(apply(sedsAll, 2, function(col) {
 mCol = mean(col)
 sdCol = sd(col)

 z = (col - mCol) / sdCol
}))
```

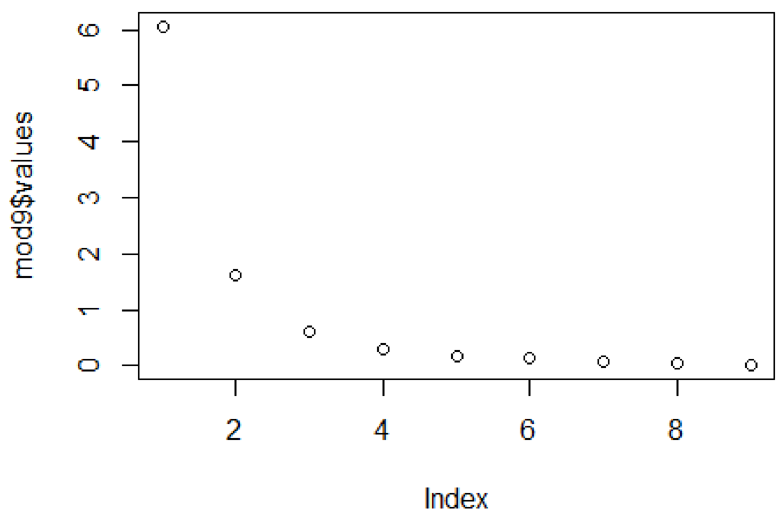
31.0 Run PCA

32.0 For 2mm fractions only

```
mod9 = principal(seds2mmStd, nfactors = 9, scores = TRUE)
round(mod9$values, 1)

## [1] 6.1 1.6 0.6 0.3 0.2 0.1 0.1 0.0 0.0

plot(mod9$values)
```




```
mod2 <- principal(seds2mmStd, nfactors = 2, scores = TRUE)
mod2

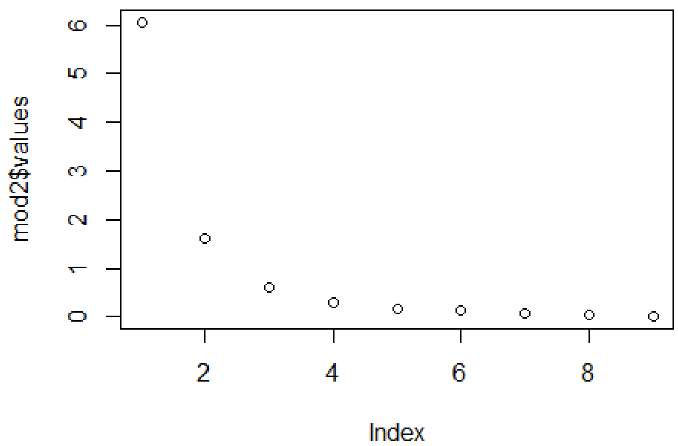
## Principal Components Analysis
## Call: principal(r = seds2mmStd, nfactors = 2, scores = TRUE)
## Standardized loadings (pattern matrix) based upon correlation matrix
##   RC1 RC2 h2 u2 com
```

```
## Arsenic 0.76 0.49 0.81 0.188 1.7
## Cadmium 0.36 0.82 0.80 0.202 1.4
## Chromium 0.88 0.29 0.85 0.148 1.2
## Copper 0.97 0.18 0.97 0.033 1.1
## Lead  0.54 0.77 0.88 0.121 1.8
## Mercury 0.28 0.85 0.80 0.202 1.2
## Selenium 0.65 0.56 0.73 0.270 2.0
## Thallium 0.00 0.96 0.91 0.087 1.0
## Zinc  0.95 0.11 0.92 0.076 1.0
##
##      RC1 RC2
## SS loadings   4.11 3.56
## Proportion Var  0.46 0.40
## Cumulative Var  0.46 0.85
## Proportion Explained 0.54 0.46
## Cumulative Proportion 0.54 1.00
##
## Mean item complexity = 1.4
## Test of the hypothesis that 2 components are sufficient.
##
## The root mean square of the residuals (RMSR) is 0.06
## with the empirical chi square 10.64 with prob < 0.94
##
## Fit based upon off diagonal values = 0.99
```

```
round(mod2$values, 1)
```

```
## [1] 6.1 1.6 0.6 0.3 0.2 0.1 0.1 0.0 0.0
```

```
plot(mod2$values)
```



33.0 Output

34.0 Loadings

```
seds2mmLoadings <- data.frame(matrix(
 as.numeric(mod2$loadings),
 attributes(mod2$loadings)$dim,
 dimnames = attributes(mod2$loadings)$dimnames
))

seds2mmLoadings

##       RC1   RC2
## Arsenic 0.757421352 0.4881927
## Cadmium 0.360191516 0.8177573
## Chromium 0.877123755 0.2870231
## Copper 0.967359175 0.1764416
## Lead  0.537066499 0.7684425
## Mercury 0.280259884 0.8481741
## Selenium 0.649158724 0.5552180
```

```
## Thallium -0.004890572 0.9555671
## Zinc  0.954767086 0.1099634

write.csv(seds2mmLoadings, paste0(tables_out, "loadings_sed_2mm_2021.csv"))
```

35.0 Scores

```
df1.2mm <- data.frame(label1 = rownames(seds2mmStd), round(mod2$scores[, c(1:2)], 2))
df1.2mm

##       label1 RC1 RC2
## 2012-dep-exp-1 2012-dep-exp-1 -0.85 2.26
## 2012-dep-exp-2 2012-dep-exp-2 2.68 -0.89
## 2012-dep-exp-3 2012-dep-exp-3 0.91 0.91
## 2012-dep-exp-4 2012-dep-exp-4 0.08 -0.33
## 2012-dep-exp-5 2012-dep-exp-5 0.83 0.68
## 2012-dep-exp-6 2012-dep-exp-6 0.24 0.27
## 2012-dep-exp-7 2012-dep-exp-7 -0.13 0.29
## 2012-dep-ref-1 2012-dep-ref-1 -0.71 -0.97
## 2012-dep-ref-2 2012-dep-ref-2 -0.78 -0.85
## 2012-dep-ref-3 2012-dep-ref-3 -0.77 -1.24
## 2015-dep-exp-1 2015-dep-exp-1 -0.79 1.77
## 2015-dep-exp-2 2015-dep-exp-2 0.07 -0.03
## 2015-dep-exp-3 2015-dep-exp-3 1.76 -0.59
## 2015-dep-exp-4 2015-dep-exp-4 -0.06 -0.29
## 2015-dep-exp-5 2015-dep-exp-5 -0.04 1.06
## 2015-dep-exp-6 2015-dep-exp-6 -0.41 0.42
## 2015-dep-exp-7 2015-dep-exp-7 -0.47 1.01
## 2015-dep-ref-1 2015-dep-ref-1 -0.84 -0.77
## 2015-dep-ref-2 2015-dep-ref-2 -0.86 -0.86
## 2015-dep-ref-3 2015-dep-ref-3 -0.69 -1.04
## 2018-dep-exp-1 2018-dep-exp-1 -0.16 1.38
## 2018-dep-exp-2 2018-dep-exp-2 1.27 2.92
## 2018-dep-exp-3 2018-dep-exp-3 0.65 -0.72
## 2018-dep-exp-4 2018-dep-exp-4 0.49 0.34
## 2018-dep-exp-5 2018-dep-exp-5 0.50 1.09
## 2018-dep-exp-6 2018-dep-exp-6 -0.06 -0.06
## 2018-dep-exp-7 2018-dep-exp-7 -0.33 0.26
## 2018-dep-ref-1 2018-dep-ref-1 -0.75 -0.88
## 2018-dep-ref-2 2018-dep-ref-2 -0.88 -0.80
```

```
## 2018-dep-ref-3 2018-dep-ref-3 -0.77 -0.95
## 2021-dep-exp-1 2021-dep-exp-1 -0.89 -0.06
## 2021-dep-exp-2 2021-dep-exp-2 -0.05 -0.21
## 2021-dep-exp-3 2021-dep-exp-3 3.83 -1.46
## 2021-dep-exp-4 2021-dep-exp-4 0.30 -0.25
## 2021-dep-exp-5 2021-dep-exp-5 0.06 1.16
## 2021-dep-exp-6 2021-dep-exp-6 -0.29 -0.21
## 2021-dep-exp-7 2021-dep-exp-7 0.07 -0.35
## 2021-dep-ref-1 2021-dep-ref-1 -0.63 -0.86
## 2021-dep-ref-2 2021-dep-ref-2 -0.78 -0.21
## 2021-dep-ref-3 2021-dep-ref-3 -0.73 -0.94

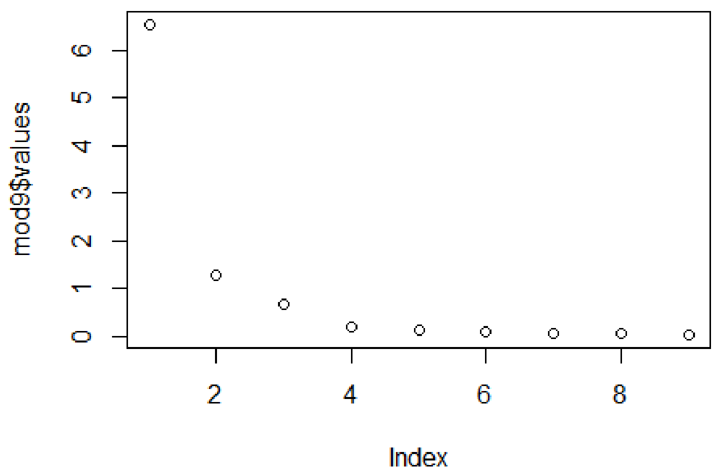
write.csv(df1.2mm, paste0(tables_out, "pcs_sed_metals_2mm_2021.csv"), row.names = FALSE)
```

36.0 For all fractions

```
mod9 = principal(sedsAllStd, nfactors = 9, scores = TRUE)
round(mod9$values, 1)

## [1] 6.5 1.3 0.7 0.2 0.1 0.1 0.1 0.0 0.0

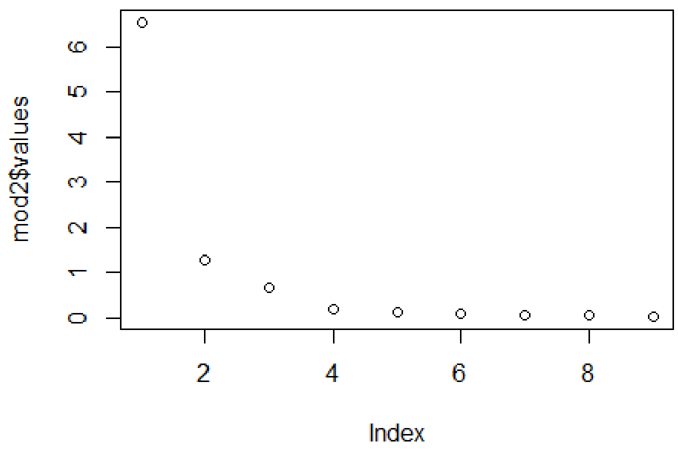
plot(mod9$values)
```




```
mod2 <- principal(sedsAllStd, nfactors = 2, scores = TRUE)
round(mod2$values, 1)

## [1] 6.5 1.3 0.7 0.2 0.1 0.1 0.1 0.0 0.0

plot(mod2$values)
```



37.0 Output

38.0 Loadings

```
sedsAllLoadings <- data.frame(matrix(
 as.numeric(mod2$loadings),
 attributes(mod2$loadings)$dim,
 dimnames = attributes(mod2$loadings)$dimnames
))
write.csv(sedsAllLoadings, paste0(tables_out, "loadings_sed_allfrac_2021.csv"))
```

39.0 Scores

```
df1.All <- data.frame(label1 = rownames(sedsAllStd), round(mod2$scores[, c(1:2)], 2))
df1.All

##           label1 RC1 RC2
## 2012-dep-exp-1 0.002  2012-dep-exp-1 0.002 -0.26 0.40
## 2012-dep-exp-2 0.002  2012-dep-exp-2 0.002 1.79 -1.05
## 2012-dep-exp-3 0.002  2012-dep-exp-3 0.002 0.83 -0.31
## 2012-dep-exp-4 0.002  2012-dep-exp-4 0.002 0.09 -0.48
## 2012-dep-exp-5 0.002  2012-dep-exp-5 0.002 0.76 -0.33
```

```
## 2012-dep-exp-6 0.002  2012-dep-exp-6 0.002 0.19 -0.25
## 2012-dep-exp-7 0.002  2012-dep-exp-7 0.002 0.17 -0.31
## 2012-dep-ref-1 0.002  2012-dep-ref-1 0.002 -1.16 -0.20
## 2012-dep-ref-2 0.002  2012-dep-ref-2 0.002 -1.16 -0.16
## 2012-dep-ref-3 0.002  2012-dep-ref-3 0.002 -1.49 -0.16
## 2015-dep-exp-1 0.002  2015-dep-exp-1 0.002 -0.22 0.18
## 2015-dep-exp-2 0.002  2015-dep-exp-2 0.002 -0.10 -0.31
## 2015-dep-exp-3 0.002  2015-dep-exp-3 0.002 1.32 -0.92
## 2015-dep-exp-4 0.002  2015-dep-exp-4 0.002 -0.16 -0.35
## 2015-dep-exp-5 0.002  2015-dep-exp-5 0.002 0.14 -0.10
## 2015-dep-exp-6 0.002  2015-dep-exp-6 0.002 -0.28 -0.16
## 2015-dep-exp-7 0.002  2015-dep-exp-7 0.002 -0.02 -0.06
## 2015-dep-ref-1 0.002  2015-dep-ref-1 0.002 -1.47 -0.03
## 2015-dep-ref-2 0.002  2015-dep-ref-2 0.002 -1.57 0.00
## 2015-dep-ref-3 0.002  2015-dep-ref-3 0.002 -1.39 -0.12
## 2018-dep-exp-1 6.3e-05 2018-dep-exp-1 6.3e-05 0.81 1.01
## 2018-dep-exp-1 0.002  2018-dep-exp-1 0.002 0.16 0.03
## 2018-dep-exp-2 6.3e-05 2018-dep-exp-2 6.3e-05 0.20 5.61
## 2018-dep-exp-2 0.002  2018-dep-exp-2 0.002 1.27 0.09
## 2018-dep-exp-3 6.3e-05 2018-dep-exp-3 6.3e-05 0.68 0.32
## 2018-dep-exp-3 0.002  2018-dep-exp-3 0.002 0.34 -0.62
## 2018-dep-exp-4 6.3e-05 2018-dep-exp-4 6.3e-05 0.12 -0.08
## 2018-dep-exp-4 0.002  2018-dep-exp-4 0.002 0.63 -0.43
## 2018-dep-exp-5 6.3e-05 2018-dep-exp-5 6.3e-05 0.20 3.29
## 2018-dep-exp-5 0.002  2018-dep-exp-5 0.002 0.67 -0.26
## 2018-dep-exp-6 6.3e-05 2018-dep-exp-6 6.3e-05 0.34 0.09
## 2018-dep-exp-6 0.002  2018-dep-exp-6 0.002 -0.04 -0.33
## 2018-dep-exp-7 6.3e-05 2018-dep-exp-7 6.3e-05 -0.03 0.07
## 2018-dep-exp-7 0.002  2018-dep-exp-7 0.002 -0.13 -0.19
## 2018-dep-ref-1 6.3e-05 2018-dep-ref-1 6.3e-05 -0.59 -0.16
## 2018-dep-ref-1 0.002  2018-dep-ref-1 0.002 -1.19 -0.16
## 2018-dep-ref-2 6.3e-05 2018-dep-ref-2 6.3e-05 -0.68 -0.21
## 2018-dep-ref-2 0.002  2018-dep-ref-2 0.002 -1.43 -0.05
## 2018-dep-ref-3 6.3e-05 2018-dep-ref-3 6.3e-05 -0.48 -0.25
## 2018-dep-ref-3 0.002  2018-dep-ref-3 0.002 -1.28 -0.15
## 2021-dep-exp-1 6.3e-05 2021-dep-exp-1 6.3e-05 -0.45 -0.07
## 2021-dep-exp-1 0.002  2021-dep-exp-1 0.002 -0.91 -0.03
## 2021-dep-exp-2 6.3e-05 2021-dep-exp-2 6.3e-05 -0.19 -0.13
## 2021-dep-exp-2 0.002  2021-dep-exp-2 0.002 -0.15 -0.31
```

```
## 2021-dep-exp-3 6.3e-05 2021-dep-exp-3 6.3e-05 3.50 -0.72
## 2021-dep-exp-3 0.002  2021-dep-exp-3 0.002 2.81 -1.50
## 2021-dep-exp-4 6.3e-05 2021-dep-exp-4 6.3e-05 -0.12 -0.22
## 2021-dep-exp-4 0.002  2021-dep-exp-4 0.002 0.25 -0.45
## 2021-dep-exp-5 6.3e-05 2021-dep-exp-5 6.3e-05 2.18 2.79
## 2021-dep-exp-5 0.002  2021-dep-exp-5 0.002 0.29 -0.06
## 2021-dep-exp-6 6.3e-05 2021-dep-exp-6 6.3e-05 0.57 -0.25
## 2021-dep-exp-6 0.002  2021-dep-exp-6 0.002 -0.34 -0.27
## 2021-dep-exp-7 6.3e-05 2021-dep-exp-7 6.3e-05 0.94 -0.26
## 2021-dep-exp-7 0.002  2021-dep-exp-7 0.002 0.02 -0.40
## 2021-dep-ref-1 6.3e-05 2021-dep-ref-1 6.3e-05 -0.37 -0.13
## 2021-dep-ref-1 0.002  2021-dep-ref-1 0.002 -0.99 -0.22
## 2021-dep-ref-2 6.3e-05 2021-dep-ref-2 6.3e-05 -0.31 -0.18
## 2021-dep-ref-2 0.002  2021-dep-ref-2 0.002 -0.75 -0.13
## 2021-dep-ref-3 6.3e-05 2021-dep-ref-3 6.3e-05 -0.31 -0.19
## 2021-dep-ref-3 0.002  2021-dep-ref-3 0.002 -1.22 -0.17

write.csv(df1.All, paste0(tables_out, "pcs_sed_metals_allfrac_2021.csv"), row.names = FALSE)
```

40.0 Plotting

41.0 2mm

42.0 Check axis contribution

43.0 PC1

```
seds2mmLoadings %>% rownames_to_column("analyte") %>% filter(RC1 > 0.7) %>% select(-RC2)

## analyte  RC1
## 1 Arsenic 0.7574214
## 2 Chromium 0.8771238
## 3 Copper 0.9673592
## 4  Zinc 0.9547671

PC1Lab_2mm <- "PC1 (As, Cr, Cu, Zn)"
```

44.0 PC2

```
seds2mmLoadings %>% rownames_to_column("analyte") %>% filter(RC2 > 0.7) %>% select(-RC1)
```

```
## analyte  RC2
## 1 Cadmium 0.8177573
## 2  Lead 0.7684425
## 3 Mercury 0.8481741
## 4 Thallium 0.9555671

PC2Lab_2mm <- "PC2 (Cd, Pb, Hg, Tl)"

cleanAndPlot <- function(ld, scr, xlab_, ylab_) {
 ## extract reference and exposure
 scr$site_type=rep("Null",nrow(scr))
 scr$site_type[grep("ref",scr$label1)]="Reference"
 scr$site_type[grep("exp",scr$label1)]="Exposure"
 names(scr)[4]="Ref_Exp"

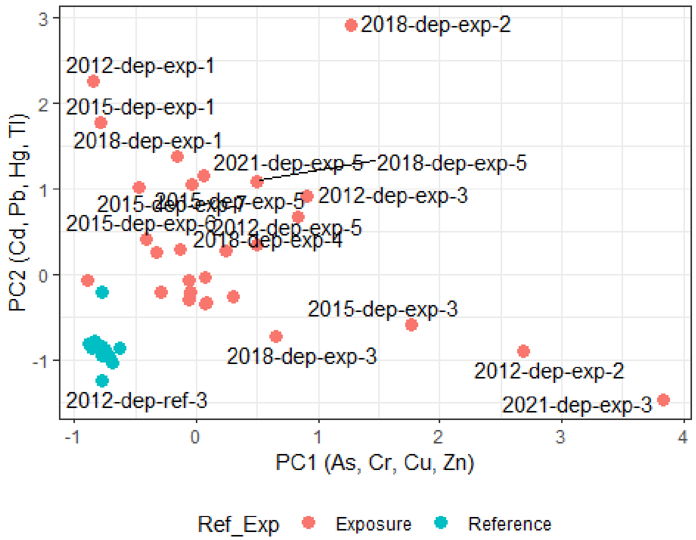
 ggplot(data = ld, aes (RC1,RC2)) +
 theme_bw() +
 geom_point (data = scr, (aes (RC1, RC2,colour=Ref_Exp)),size=3) +
 # subset according to optimal position
 geom_text_repel(scr,mapping=aes(x=RC1,y=RC2,label=label1)) +
 theme (legend.position="bottom") +
 xlab(xlab_) +
 ylab(ylab_)
}
```

45.0 Plot

```
p2mm <- cleanAndPlot(
 ld = seds2mmLoadings,
 scr = df1.2mm,
 xlab_ = PC1Lab_2mm,
 ylab_ = PC2Lab_2mm
)

p2mm

## Warning: ggrepel: 23 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps
```




```
png(
 filename = paste0(figures,"pca_sed_metals_2mm_2021.png"),
 width = 8,
 height = 6,
 units = "in",
 res = 200,
 pointsize = 12
)
plot(p2mm)

## Warning: ggrepel: 14 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps

dev.off()

## png
## 2
```

46.0 All fractions

47.0 Check axis contribution

48.0 PC1

```
sedsAllLoadings %>% rownames_to_column("analyte") %>% filter(RC1 > 0.7) %>% select(-RC2)

## analyte  RC1
## 1 Arsenic 0.8503063
## 2 Chromium 0.8605030
## 3 Copper 0.8801606
## 4  Zinc 0.8700303

PC1Lab_all <- "PC1 (As, Cr, Cu, Zn)"
```

49.0 PC2

```
sedsAllLoadings %>% rownames_to_column("analyte") %>% filter(RC2 > 0.7) %>% select(-RC1)

## analyte  RC2
## 1  Lead 0.7908381
## 2 Mercury 0.9481571
## 3 Selenium 0.9145580
## 4 Thallium 0.8980378

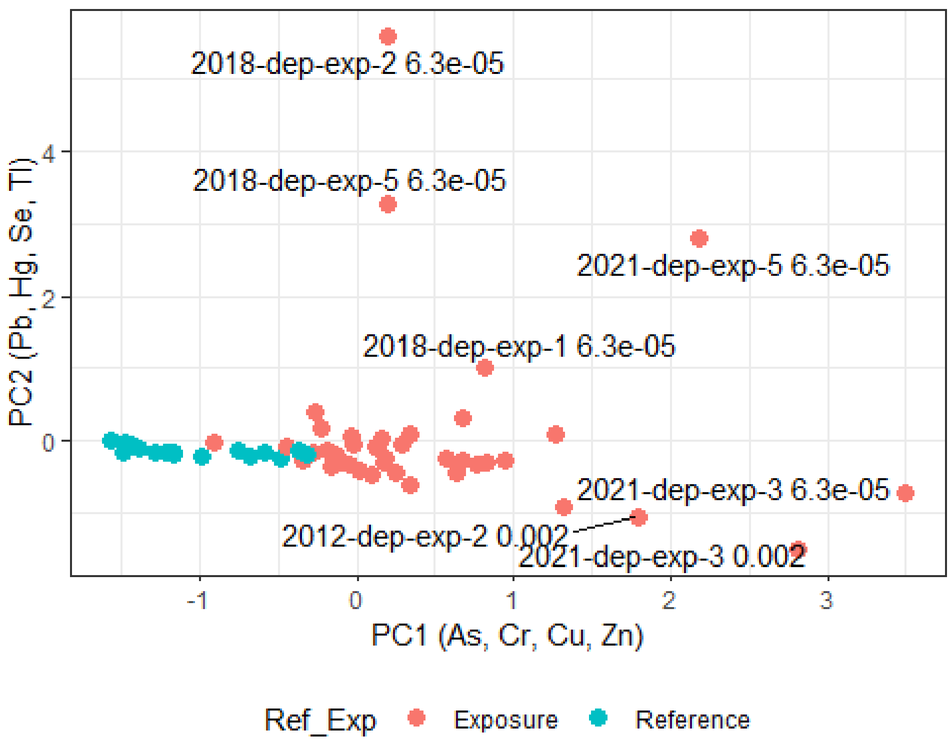
PC2Lab_all <- "PC2 (Pb, Hg, Se, Tl)"
```

50.0 Plot

```
pAll <- cleanAndPlot(
 ld = sedsAllLoadings,
 scr = df1.All,
 xlab_ = PC1Lab_all,
 ylab_ = PC2Lab_all
)

pAll

## Warning: ggrepel: 53 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps
```




```
png(
 filename = paste0(figures,"pca_sed_metals_all_2021.png"),
 width = 8,
 height = 6,
 units = "in",
 res = 200,
 pointsize = 12
)
plot(pAll)

## Warning: ggrepel: 49 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps

dev.off()
```

png
2

APPENDIX P SMALL-BODIED FISH TISSUE METALS AND CONDITION

Table 190. Small-bodied fish body condition data from 2021 samples.

Sample ID	Label	Site	Bank	Date	Total Length (mm)	Lab Weight (g)	Liver Weight (g)	Gut Weight (g)	Gonad Weight (g)	Sex	Age	Common Name	FK	GSI	HSI
1	Koot-Ref-1	NA	Left	19-04-2021	122	31.463	0.455	1.651	0.346	M	3+	Torrent Sculpin	1.732689	1.160606	1.526231
2	Koot-Ref-1	NA	Left	19-04-2021	48	1.315	0.039	0.087	NA	U	1+	Torrent Sculpin	1.189055	NA	3.175896
3	Koot-Ref-1	NA	Left	19-04-2021	51	1.306	0.024	0.111	NA	U	1+	Torrent Sculpin	0.984538	NA	2.008368
4	Koot-Ref-1	NA	Left	19-04-2021	51	1.26	0.011	0.078	NA	U	1+	Torrent Sculpin	0.949861	NA	0.930626
5	Koot-Ref-1	NA	Left	19-04-2021	46	1.291	0.007	0.116	NA	U	1+	Torrent Sculpin	1.326334	NA	0.595745
6	Koot-Ref-1	NA	Left	19-04-2021	43	0.809	0.006	0.103	NA	U	1+	Torrent Sculpin	1.01752	NA	0.849858
7	Koot-Ref-1	NA	Left	19-04-2021	152	43.915	0.918	4.171	2.718	F	5+	Prickly Sculpin	1.250495	6.838768	2.309783
20	Koot-Ref-1	NA	Left	19-04-2021	80	7.035	0.089	0.295	1.171	F	4+	Columbia Sculpin	1.374023	17.37389	1.320475
21	Koot-Ref-1	NA	Left	19-04-2021	69	4.316	0.045	0.16	0.723	F	3+	Columbia Sculpin	1.313815	17.39654	1.082772
23	Koot-Ref-1	NA	Left	19-04-2021	60	2.54	0.013	0.103	NA	U	2+	Columbia Sculpin	1.175926	NA	0.533443
24	Koot-Ref-1	NA	Left	19-04-2021	46	1.251	0.005	0.079	NA	U	-	Torrent Sculpin	1.285239	NA	0.426621
25	Koot-Ref-1	NA	Left	19-04-2021	42	0.772	NA	0.085	NA	U	1+	Torrent Sculpin	1.042004	NA	NA
26	Koot-Ref-1	NA	Left	19-04-2021	46	1.11	0.01	0.041	NA	U	1+	Torrent Sculpin	1.14038	NA	0.935454
27	Koot-Ref-1	NA	Left	19-04-2021	61	2.347	0.028	0.208	NA	U	2+	Torrent Sculpin	1.034007	NA	1.309023
29	Koot-Ref-1	NA	Left	19-04-2021	51	1.514	0.115	0.077	NA	U	1+	Torrent Sculpin	1.141341	NA	8.002784
30	Koot-Ref-1	NA	Left	19-04-2021	51	1.355	0.012	0.117	NA	U	1+	Torrent Sculpin	1.021477	NA	0.969305
31	Koot-Ref-1	NA	Left	19-04-2021	62	2.432	0.027	0.184	NA	U	2+	Prickly Sculpin	1.020442	NA	1.201068
54	Koot-Ref-1	NA	Left	19-04-2021	57	1.961	0.018	0.164	NA	U	1+	Torrent Sculpin	1.058895	NA	1.001669
55	Koot-Ref-1	NA	Left	19-04-2021	83	7.422	0.024	0.439	0.136	M	3+	Columbia Sculpin	1.298036	1.947587	0.343692
56	Koot-Ref-1	NA	Left	19-04-2021	82	8.086	0.031	0.303	1.403	F	3+	Columbia Sculpin	1.466534	18.02647	0.398304
58	Koot-Ref-1	NA	Left	19-04-2021	63	3.132	0.016	0.118	0.289	F	2+	Columbia Sculpin	1.252565	9.588587	0.530856
59	Koot-Ref-1	NA	Left	19-04-2021	77	6.896	0.033	0.277	0.985	F	3+	Columbia Sculpin	1.510515	14.8814	0.498565
61	Koot-Ref-1	NA	Left	19-04-2021	54	1.315	0.11	0.101	NA	U	1+	Torrent Sculpin	0.835112	NA	9.060956
62	Koot-Ref-1	NA	Left	19-04-2021	78	6.604	0.034	0.372	0.959	F	3+	Columbia Sculpin	1.391628	15.38832	0.545571
63	Koot-Ref-1	NA	Left	19-04-2021	75	5.188	0.042	0.234	0.779	F	2+	Columbia Sculpin	1.229748	15.72467	0.8478
64	Koot-Ref-1	NA	Left	19-04-2021	90	10.352	0.038	0.404	0.225	M	3+	Columbia Sculpin	1.420027	2.261761	0.381986
65	Koot-Ref-1	NA	Left	19-04-2021	58	2.053	0.005	0.81	0.18	F	2+	Columbia Sculpin	1.052216	14.48109	0.402253
66	Koot-Ref-1	NA	Left	19-04-2021	47	0.916	0.001	0.081	NA	U	1+	Torrent Sculpin	0.882271	NA	0.11976
67	Koot-Ref-1	NA	Left	19-04-2021	48	1.183	0.007	0.091	NA	U	1+	Torrent Sculpin	1.069698	NA	0.641026
68	Koot-Ref-1	NA	Left	19-04-2021	65	4.299	0.029	0.144	0.591	F	2+	Columbia Sculpin	1.565407	14.22383	0.697954

Sample ID	Label	Site	Bank	Date	Total Length (mm)	Lab Weight (g)	Liver Weight (g)	Gut Weight (g)	Gonad Weight (g)	Sex	Age	Common Name	FK	GSI	HSI
69	Koot-Ref-1	NA	Left	19-04-2021	60	2.26	0.02	0.17	NA	M	2+	Torrent Sculpin	1.046296	NA	0.956938
81	Ero-Ref-2	NA	NA	20-04-2021	120	27.155	0.673	2.418	0.178	M	6+	Torrent Sculpin	1.57147	0.71957	2.720621
82	Ero-Ref-2	NA	NA	20-04-2021	85	6.581	0.108	0.569	NA	M	4+	Torrent Sculpin	1.071606	NA	1.796407
83	Ero-Ref-2	NA	NA	20-04-2021	88	10.448	0.178	0.579	0.131	M	4+	Torrent Sculpin	1.533152	1.327389	1.803628
84	Ero-Ref-2	NA	NA	20-04-2021	63	2.934	0.052	0.281	NA	M	2+	Torrent Sculpin	1.173379	NA	1.960045
85	Ero-Ref-2	NA	NA	20-04-2021	68	3.45	0.062	0.145	NA	F	3+	Torrent Sculpin	1.097217	NA	1.875946
86	Ero-Ref-2	NA	NA	20-04-2021	75	5.209	0.086	0.372	NA	F	3+	Torrent Sculpin	1.234726	NA	1.777962
87	Ero-Ref-2	NA	NA	20-04-2021	76	5.135	0.068	0.553	NA	F	3+	Torrent Sculpin	1.169768	NA	1.484068
88	Ero-Ref-2	NA	NA	20-04-2021	83	6.246	0.034	0.253	0.097	M	3+	Columbia Sculpin	1.092365	1.618555	0.567329
89	Ero-Ref-2	NA	NA	20-04-2021	86	8.08	0.125	0.314	0.866	F	3+	Columbia Sculpin	1.270328	11.15117	1.60958
90	Ero-Ref-2	NA	NA	20-04-2021	64	3.621	0.04	0.698	NA	F	2+	Torrent Sculpin	1.381302	NA	1.368457
92	Ero-Ref-2	NA	NA	20-04-2021	69	3.406	0.033	0.237	NA	U	3+	Torrent Sculpin	1.036806	NA	1.041338
93	Ero-Ref-2	NA	NA	20-04-2021	74	4.814	0.064	0.447	NA	U	3+	Torrent Sculpin	1.187985	NA	1.465537
94	Ero-Ref-2	NA	NA	20-04-2021	70	3.709	0.046	0.312	NA	F	3+	Torrent Sculpin	1.081341	NA	1.354136
95	Ero-Ref-2	NA	NA	20-04-2021	76	4.548	0.079	0.552	NA	F	3+	Torrent Sculpin	1.036048	NA	1.976977
96	Ero-Ref-2	NA	NA	20-04-2021	70	3.758	0.062	0.327	NA	F	2+	Torrent Sculpin	1.095627	NA	1.807053
97	Ero-Ref-2	NA	NA	20-04-2021	90	10.086	0.038	0.629	0.169	M	3+	Columbia Sculpin	1.383539	1.787036	0.401819
98	Ero-Ref-2	NA	NA	20-04-2021	75	6.063	0.101	0.278	0.655	F	3+	Columbia Sculpin	1.437156	11.32239	1.745895
99	Ero-Ref-2	NA	NA	20-04-2021	100	13.6	0.301	0.674	1.448	F	5+	Columbia Sculpin	1.36	11.20223	2.32864
100	Ero-Ref-2	NA	NA	20-04-2021	72	4.654	0.151	0.28	NA	F	2+	Torrent Sculpin	1.246892	NA	3.452218
102	Ero-Ref-2	NA	NA	20-04-2021	73	4.948	0.063	0.512	NA	F	3+	Torrent Sculpin	1.271924	NA	1.420198
103	Ero-Ref-2	NA	NA	20-04-2021	84	6.817	0.109	0.611	NA	F	3+	Torrent Sculpin	1.150153	NA	1.756365
108	Ero-Ref-2	NA	NA	20-04-2021	81	6.799	0.072	0.26	0.896	F	5+	Columbia Sculpin	1.279352	13.7024	1.101086
112	Ero-Ref-2	NA	NA	20-04-2021	72	4.692	0.047	0.166	0.074	M	2+	Columbia Sculpin	1.257073	1.634998	1.038445
114	Ero-Ref-2	NA	NA	20-04-2021	69	3.322	0.015	0.228	NA	M	2+	Columbia Sculpin	1.011236	NA	0.484809
118	Ero-Ref-2	NA	NA	20-04-2021	60	2.143	0.023	0.116	0.015	M	2+	Columbia Sculpin	0.99213	0.74001	1.134682
119	Ero-Ref-2	NA	NA	20-04-2021	60	2.176	0.001	0.164	NA	F	2+	Columbia Sculpin	1.007407	NA	0.049702
120	Ero-Ref-2	NA	NA	20-04-2021	63	2.373	0.018	0.108	NA	F	2+	Columbia Sculpin	0.949022	NA	0.794702
121	Ero-Ref-2	NA	NA	20-04-2021	64	3.246	0.047	0.345	NA	F	2+	Columbia Sculpin	1.238251	NA	1.620131
122	Ero-Ref-2	NA	NA	20-04-2021	65	3.33	0.053	0.465	NA	F	2+	Torrent Sculpin	1.212563	NA	1.849913
123	Ero-Ref-2	NA	NA	20-04-2021	62	2.26	0.025	0.23	NA	F	1+	Torrent Sculpin	0.948273	NA	1.231527
166	Ero-Exp-1	NA	NA	21-04-2021	147	58.14	2.312	5.529	0.383	M	6+	Columbia Sculpin	1.830303	0.727985	4.394518

Sample ID	Label	Site	Bank	Date	Total Length (mm)	Lab Weight (g)	Liver Weight (g)	Gut Weight (g)	Gonad Weight (g)	Sex	Age	Common Name	FK	GSI	HSI
167	Ero-Exp-1	NA	NA	21-04-2021	70	3.876	0.04	0.372	NA	F	2+	Torrent Sculpin	1.130029	NA	1.141553
168	Ero-Exp-1	NA	NA	21-04-2021	70	3.333	0.099	0.185	NA	U	2+	Torrent Sculpin	0.97172	NA	3.144854
170	Ero-Exp-1	NA	NA	21-04-2021	75	4.594	0.039	0.373	NA	U	2+	Torrent Sculpin	1.088948	NA	0.923952
171	Ero-Exp-1	NA	NA	21-04-2021	87	9.26	0.167	0.366	0.895	F	4+	Columbia Sculpin	1.40622	10.06296	1.87767
172	Ero-Exp-1	NA	NA	21-04-2021	89	9.665	0.083	0.553	0.165	F	3+	Columbia Sculpin	1.370982	1.810799	0.910887
173	Ero-Exp-1	NA	NA	20-04-2021	82	8.309	0.138	0.452	0.71	F	3+	Columbia Sculpin	1.506979	9.036528	1.756396
174	Ero-Exp-1	NA	NA	20-04-2021	90	11.244	0.089	0.446	0.126	M	4+	Columbia Sculpin	1.542387	1.166883	0.824227
175	Ero-Exp-1	NA	NA	21-04-2021	77	4.586	0.063	0.402	NA	U	3+	Torrent Sculpin	1.004528	NA	1.505736
176	Ero-Exp-1	NA	NA	21-04-2021	81	0.7588	0.068	0.32	0.144	M	3+	Columbia Sculpin	0.142782	32.81677	15.49681
178	Ero-Exp-1	NA	NA	21-04-2021	81	7.123	0.087	0.354	0.087	M	3+	Columbia Sculpin	1.340318	1.285271	1.285271
179	Ero-Exp-1	NA	NA	21-04-2021	94	9.952	0.021	0.596	0.129	M	4+	Columbia Sculpin	1.198193	1.378794	0.224455
180	Ero-Exp-1	NA	NA	20-04-2021	61	2.432	0.018	0.226	NA	U	2+	Columbia Sculpin	1.071455	NA	0.815956
181	Ero-Exp-1	NA	NA	21-04-2021	90	11.611	0.286	0.378	1.522	F	4+	Columbia Sculpin	1.59273	13.54936	2.54607
183	Ero-Exp-1	NA	NA	20-04-2021	70	3.825	0.044	0.286	0.146	F	4+	Columbia Sculpin	1.11516	4.125459	1.243289
184	Ero-Exp-1	NA	NA	20-04-2021	92	8.326	0.085	0.316	0.132	M	5+	Columbia Sculpin	1.069234	1.64794	1.061174
186	Ero-Exp-1	NA	NA	20-04-2021	72	4.77	0.058	0.323	NA	U	3+	Columbia Sculpin	1.277971	NA	1.30425
189	Ero-Exp-1	NA	NA	20-04-2021	78	6.096	0.086	0.332	0.111	M	5+	Columbia Sculpin	1.28458	1.925746	1.492019
190	Ero-Exp-1	NA	NA	21-04-2021	84	5.04	0.064	0.185	0.205	F	3+	Columbia Sculpin	0.85034	4.222451	1.318229
191	Ero-Exp-1	NA	NA	20-04-2021	72	5.011	0.123	0.149	0.564	F	3+	Columbia Sculpin	1.342539	11.60016	2.529823
192	Ero-Exp-1	NA	NA	20-04-2021	72	4.975	0.045	0.195	0.425	F	3+	Columbia Sculpin	1.332894	8.891213	0.941423
194	Ero-Exp-1	NA	NA	21-04-2021	52	1.868	0.006	0.107	NA	U	2+	Columbia Sculpin	1.328516	NA	0.340716
195	Ero-Exp-1	NA	NA	21-04-2021	69	4.043	0.096	0.135	0.441	U	2+	Columbia Sculpin	1.230712	11.28454	2.456499
196	Ero-Exp-1	NA	NA	20-04-2021	82	6.665	0.202	0.312	0.748	F	5+	Columbia Sculpin	1.208812	11.77397	3.1796
198	Ero-Exp-1	NA	NA	20-04-2021	61	1.997	0.018	0.128	NA	U	2+	Columbia Sculpin	0.879809	NA	0.963082
200	Ero-Exp-1	NA	NA	20-04-2021	81	6.342	0.191	0.179	1.03	F	5+	Columbia Sculpin	1.193359	16.71264	3.09914
201	Ero-Exp-1	NA	NA	21-04-2021	79	4.648	0.08	0.216	0.23	F	4+	Columbia Sculpin	0.942725	5.189531	1.805054
202	Ero-Exp-1	NA	NA	21-04-2021	78	5.81	0.165	0.161	0.442	F	5+	Columbia Sculpin	1.224313	7.824394	2.920871
205	Ero-Exp-1	NA	NA	21-04-2021	71	4.879	0.017	0.505	NA	M	NA	Columbia Sculpin	1.363188	NA	0.38866
224	Ero-Exp-2	NA	NA	21-04-2021	106	14.579	0.114	0.94	0.289	M	4+	Columbia Sculpin	1.224081	2.118924	0.835838
225	Ero-Exp-2	NA	NA	21-04-2021	77	6.471	0.102	0.235	0.955	F	4+	Columbia Sculpin	1.417422	15.3143	1.635664
226	Ero-Exp-2	NA	NA	21-04-2021	88	7.719	0.142	0.379	0.082	M	4+	Columbia Sculpin	1.132695	1.117166	1.934605
227	Ero-Exp-2	NA	NA	21-04-2021	90	8.945	0.108	0.139	0.198	M	3+	Columbia Sculpin	1.227023	2.248467	1.226437

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228	Ero-Exp-2	NA	NA	21-04-2021	69	3.555	0.036	0.1	0.149	M	-	Torrent Sculpin	1.082162	4.31259	1.041968
229	Ero-Exp-2	NA	NA	21-04-2021	87	8.235	0.091	0.176	1.287	F	5+	Columbia Sculpin	1.250564	15.96972	1.129172
231	Ero-Exp-2	NA	NA	21-04-2021	75	5.213	0.172	0.182	0.77	F	2+	Columbia Sculpin	1.235674	15.30511	3.418803
232	Ero-Exp-2	NA	NA	21-04-2021	77	5.655	0.17	0.179	0.868	F	5+	Columbia Sculpin	1.238684	15.85099	3.104456
233	Ero-Exp-2	NA	NA	21-04-2021	84	6.426	0.038	0.454	0.12	M	3+	Columbia Sculpin	1.084184	2.009377	0.636303
235	Ero-Exp-2	NA	NA	21-04-2021	73	5.616	0.067	0.184	0.907	F	4+	Columbia Sculpin	1.443639	16.69735	1.233432
236	Ero-Exp-2	NA	NA	21-04-2021	71	4.828	0.059	0.216	0.723	F	4+	Columbia Sculpin	1.348939	15.6765	1.279271
237	Ero-Exp-2	NA	NA	21-04-2021	91	10.062	0.106	0.373	0.191	F	-	Columbia Sculpin	1.335242	1.971308	1.094024
238	Ero-Exp-2	NA	NA	21-04-2021	60	3.521	0.029	0.102	0.112	M	NA	Columbia Sculpin	1.630093	3.275812	0.848201
239	Ero-Exp-2	NA	NA	21-04-2021	79	6.467	0.107	0.201	0.193	M	3+	Columbia Sculpin	1.311661	3.080115	1.707628
240	Ero-Exp-2	NA	NA	21-04-2021	69	3.7	0.055	0.164	0.462	F	2+	Columbia Sculpin	1.126301	13.06561	1.55543
241	Ero-Exp-2	NA	NA	21-04-2021	69	3.588	0.024	0.121	NA	F	2+	Columbia Sculpin	1.092208	NA	0.692241
242	Ero-Exp-2	NA	NA	21-04-2021	61	3.424	0.075	0.172	0.502	M	2+	Columbia Sculpin	1.508496	15.43665	2.306273
243	Ero-Exp-2	NA	NA	21-04-2021	68	3.358	0.044	0.131	NA	F	2+	Columbia Sculpin	1.067957	NA	1.363496
244	Ero-Exp-2	NA	NA	21-04-2021	98	10.685	0.083	0.318	0.15	M	4+	Columbia Sculpin	1.135263	1.446899	0.800617
245	Ero-Exp-2	NA	NA	21-04-2021	81	6.978	0.193	0.255	1.267	F	4+	Columbia Sculpin	1.313034	18.84575	2.870742
246	Ero-Exp-2	NA	NA	21-04-2021	80	7.12	0.201	0.218	1.005	F	5+	Columbia Sculpin	1.390625	14.561	2.912199
247	Ero-Exp-2	NA	NA	21-04-2021	65	4.136	0.097	0.082	0.582	F	3+	Columbia Sculpin	1.506054	14.35619	2.392699
248	Ero-Exp-2	NA	NA	21-04-2021	64	2.918	0.005	0.169	NA	F	2+	Columbia Sculpin	1.113129	NA	0.181884
249	Ero-Exp-2	NA	NA	21-04-2021	66	3.795	0.057	0.158	0.602	F	2+	Columbia Sculpin	1.320018	16.5521	1.567226
250	Ero-Exp-2	NA	NA	21-04-2021	71	4.456	0.024	0.196	0.094	F	3+	Columbia Sculpin	1.245002	2.206573	0.56338
251	Ero-Exp-2	NA	NA	21-04-2021	73	4.345	0.03	0.177	NA	M	2+	Columbia Sculpin	1.116918	NA	0.71977
252	Ero-Exp-2	NA	NA	21-04-2021	65	3.223	0.388	0.099	0.367	F	3+	Columbia Sculpin	1.1736	11.74776	12.41997
253	Ero-Exp-2	NA	NA	21-04-2021	64	3.915	0.064	0.106	0.562	F	2+	Columbia Sculpin	1.493454	14.75453	1.680231
263	Ero-Exp-2	NA	NA	21-04-2021	52	3.609	0.111	0.115	0.698	F	-	Shorthead Sculpin	2.56671	19.9771	3.176875
338	Ero-Exp-3-1-R	1-R	Right	21-04-2021	95	10.78	0.018	0.578	0.173	M	5+	Columbia Sculpin	1.257326	1.695746	0.176436
339	Ero-Exp-3-1-R	1-R	Right	21-04-2021	84	8.271	0.092	0.668	0.103	M	3+	Columbia Sculpin	1.395469	1.354728	1.210049
340	Ero-Exp-3-1-R	1-R	Right	21-04-2021	75	5.541	0.146	0.198	0.443	F	3+	Columbia Sculpin	1.313422	8.291222	2.732547
341	Ero-Exp-3-1-R	1-R	Right	21-04-2021	75	6.371	0.126	0.232	1.067	F	3+	Columbia Sculpin	1.510163	17.38068	2.052452
342	Ero-Exp-3-1-R	1-R	Right	21-04-2021	89	8.415	0.068	0.44	0.123	M	4+	Columbia Sculpin	1.19367	1.54232	0.852665
343	Ero-Exp-3-1-R	1-R	Right	21-04-2021	78	5.778	0.174	0.289	0.462	M	3+	Columbia Sculpin	1.217569	8.416834	3.169976
344	Ero-Exp-3-1-R	1-R	Right	21-04-2021	61	2.807	0.052	0.141	0.299	F	2+	Columbia Sculpin	1.236667	11.2153	1.950488

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345	Ero-Exp-3-1-R	1-R	Right	21-04-2021	72	4.177	0.03	0.383	NA	M	2+	Torrent Sculpin	1.119095	NA	0.790722
346	Ero-Exp-3-1-R	1-R	Right	21-04-2021	70	4.994	0.099	0.189	0.62	F	3+	Columbia Sculpin	1.455977	12.90323	2.060354
347	Ero-Exp-3-1-R	1-R	Right	21-04-2021	63	2.95	0.066	0.152	0.264	F	2+	Columbia Sculpin	1.179778	9.435311	2.358828
348	Ero-Exp-3-1-R	1-R	Right	21-04-2021	61	2.862	0.075	0.552	0.056	F	2+	Columbia Sculpin	1.260898	2.424242	3.246753
349	Ero-Exp-3-1-R	1-R	Right	21-04-2021	62	2.97	0.055	0.102	0.047	M	2+	Columbia Sculpin	1.246182	1.638773	1.917713
350	Ero-Exp-3-1-R	1-R	Right	21-04-2021	63	2.369	0.058	0.134	0.066	F	2+	Columbia Sculpin	0.947422	2.95302	2.595078
351	Ero-Exp-3-1-R	1-R	Right	21-04-2021	52	1.374	0.062	0.078	NA	M	2+	Columbia Sculpin	0.977185	NA	4.783951
352	Ero-Exp-3-1-R	1-R	Right	21-04-2021	50	1.284	0.016	0.085	NA	M	1+	Columbia Sculpin	1.0272	NA	1.334445
356	Ero-Exp-3-2-R	2-R	Right	21-04-2021	90	9.836	0.101	0.743	0.179	M	4+	Columbia Sculpin	1.349246	1.968547	1.110745
357	Ero-Exp-3-2-R	2-R	Right	21-04-2021	85	8.77	0.254	0.484	0.885	F	4+	Columbia Sculpin	1.428048	10.68067	3.065412
358	Ero-Exp-3-2-R	2-R	Right	21-04-2021	80	6.848	0.207	0.548	1.028	F	4+	Columbia Sculpin	1.3375	16.31746	3.285714
359	Ero-Exp-3-2-R	2-R	Right	21-04-2021	85	7.772	0.273	0.453	1.002	F	4+	Columbia Sculpin	1.26554	13.69039	3.730018
360	Ero-Exp-3-2-R	2-R	Right	21-04-2021	78	6.316	0.05	0.235	0.626	F	3+	Columbia Sculpin	1.330939	10.29436	0.822233
361	Ero-Exp-3-2-R	2-R	Right	21-04-2021	92	9.891	0.114	0.78	0.122	M	4+	Columbia Sculpin	1.270213	1.339041	1.251235
362	Ero-Exp-3-2-R	2-R	Right	21-04-2021	68	4.513	0.075	0.279	0.545	F	-	Columbia Sculpin	1.435286	12.87199	1.771375
363	Ero-Exp-3-2-R	2-R	Right	21-04-2021	79	6.802	0.21	0.455	1.31	F	3+	Columbia Sculpin	1.379607	20.63967	3.30865
364	Ero-Exp-3-2-R	2-R	Right	21-04-2021	67	4.419	0.013	0.183	0.489	F	2+	Columbia Sculpin	1.469263	11.54391	0.306893
365	Ero-Exp-3-2-R	2-R	Right	21-04-2021	80	7.787	0.117	0.466	0.106	M	3+	Columbia Sculpin	1.520898	1.44789	1.598142
366	Ero-Exp-3-2-R	2-R	Right	21-04-2021	89	8.249	0.116	0.752	0.152	M	4+	Columbia Sculpin	1.170122	2.027478	1.547286
367	Ero-Exp-3-2-R	2-R	Right	21-04-2021	74	5.077	0.074	0.405	NA	M	3+	Columbia Sculpin	1.252887	NA	1.583904
369	Ero-Exp-3-2-R	2-R	Right	21-04-2021	79	6.153	0.048	0.506	0.116	M	3+	Columbia Sculpin	1.247974	2.054188	0.850009
370	Ero-Exp-3-2-R	2-R	Right	21-04-2021	80	5.935	0.132	0.436	0.525	F	-	Columbia Sculpin	1.15918	9.54719	2.400436
371	Ero-Exp-3-2-R	2-R	Right	21-04-2021	75	6.243	0.195	0.285	0.736	F	4+	Columbia Sculpin	1.479822	12.35314	3.27291
373	Ero-Exp-3-2-R	2-R	Right	21-04-2021	58	1.79	0.022	0.112	NA	U	1+	Columbia Sculpin	0.917422	NA	1.311085
374	Ero-Exp-3-2-R	2-R	Right	21-04-2021	58	2.544	0.066	0.123	0.279	F	2+	Columbia Sculpin	1.303866	11.52416	2.726146
377	Ero-Exp-3-2-L	2-L	Left	21-04-2021	90	10.399	0.115	0.388	0.172	M	4+	Columbia Sculpin	1.426475	1.71811	1.148736
378	Ero-Exp-3-2-L	2-L	Left	21-04-2021	86	7.246	0.039	0.299	0.124	M	4+	Columbia Sculpin	1.139208	1.784943	0.561393
379	Ero-Exp-3-2-L	2-L	Left	21-04-2021	83	7.493	0.193	0.263	0.842	F	6+	Columbia Sculpin	1.310453	11.64592	2.669433
380	Ero-Exp-3-2-L	2-L	Left	21-04-2021	89	10.629	0.101	0.305	0.202	M	4+	Columbia Sculpin	1.507726	1.956606	0.978303
381	Ero-Exp-3-2-L	2-L	Left	21-04-2021	79	6.277	0.087	0.206	0.122	M	3+	Columbia Sculpin	1.273124	2.009554	1.433042
382	Ero-Exp-3-2-L	2-L	Left	21-04-2021	91	9.153	0.087	0.508	0.119	M	4+	Columbia Sculpin	1.214617	1.376518	1.006362
384	Ero-Exp-3-2-L	2-L	Left	21-04-2021	81	7.609	0.061	0.249	0.168	M	4+	Columbia Sculpin	1.431768	2.282609	0.828804

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385	Ero-Exp-3-2-L	2-L	Left	21-04-2021	83	6.118	0.075	0.202	0.128	M	4+	Columbia Sculpin	1.069979	2.163624	1.267748
386	Ero-Exp-3-2-L	2-L	Left	21-04-2021	62	2.849	0.089	0.104	0.248	F	3+	Columbia Sculpin	1.195411	9.034608	3.242259
387	Ero-Exp-3-2-L	2-L	Left	21-04-2021	79	6.492	0.024	0.195	0.098	M	5+	Columbia Sculpin	1.316732	1.556297	0.381134
388	Ero-Exp-3-2-L	2-L	Left	21-04-2021	82	7.057	0.055	0.246	0.063	M	4+	Columbia Sculpin	1.279907	0.924974	0.807517
389	Ero-Exp-3-2-L	2-L	Left	21-04-2021	79	6.836	0.048	0.287	0.087	M	3+	Columbia Sculpin	1.386503	1.328447	0.732936
390	Ero-Exp-3-2-L	2-L	Left	21-04-2021	71	3.955	0.011	0.153	0.106	M	3+	Columbia Sculpin	1.105023	2.788006	0.289321
392	Ero-Exp-3-2-L	2-L	Left	21-04-2021	53	1.701	0.038	0.061	NA	M	2+	Columbia Sculpin	1.142554	NA	2.317073
394	Ero-Exp-3-1-L	1-L	Left	21-04-2021	90	8.979	0.118	0.594	0.126	M	5+	Columbia Sculpin	1.231687	1.502683	1.407275
395	Ero-Exp-3-1-L	1-L	Left	21-04-2021	92	9.362	0.065	0.375	0.182	M	5+	Columbia Sculpin	1.202279	2.025147	0.723267
396	Ero-Exp-3-1-L	1-L	Left	21-04-2021	85	8.232	0.077	0.498	0.156	M	3+	Columbia Sculpin	1.340444	2.017067	0.995604
397	Ero-Exp-3-1-L	1-L	Left	21-04-2021	84	7.501	0.09	0.289	0.159	M	3+	Columbia Sculpin	1.265556	2.204659	1.24792
399	Ero-Exp-3-1-L	1-L	Left	21-04-2021	75	5.479	0.062	0.227	0.122	M	3+	Columbia Sculpin	1.298726	2.322925	1.180503
400	Ero-Exp-3-1-L	1-L	Left	21-04-2021	70	4.243	0.107	0.175	0.515	F	4+	Columbia Sculpin	1.237026	12.65978	2.630285
401	Ero-Exp-3-1-L	1-L	Left	21-04-2021	84	8.04	0.068	0.285	NA	M	3+	Columbia Sculpin	1.356495	NA	0.876854
402	Ero-Exp-3-1-L	1-L	Left	21-04-2021	70	3.841	0.084	0.172	NA	F	3+	Columbia Sculpin	1.119825	NA	2.289452
403	Ero-Exp-3-1-L	1-L	Left	21-04-2021	72	4.863	0.119	0.508	0.534	F	4+	Columbia Sculpin	1.302887	12.26177	2.732491
404	Ero-Exp-3-1-L	1-L	Left	21-04-2021	85	5.925	0.038	0.268	NA	M	3+	Columbia Sculpin	0.964787	NA	0.671734
405	Ero-Exp-3-1-L	1-L	Left	21-04-2021	68	4.441	0.103	0.227	0.629	F	3+	Columbia Sculpin	1.412388	14.92644	2.444234
406	Ero-Exp-3-1-L	1-L	Left	21-04-2021	62	3.328	0.054	NA	0.522	F	3+	Columbia Sculpin	1.396395	NA	NA
407	Ero-Exp-3-1-L	1-L	Left	21-04-2021	58	2.69	0.058	0.126	0.365	F	3+	Columbia Sculpin	1.378695	14.23557	2.26209
408	Ero-Exp-3-1-L	1-L	Left	21-04-2021	60	2.346	0.03	0.128	0.029	M	2+	Columbia Sculpin	1.086111	1.307484	1.35257
409	Ero-Exp-3-1-L	1-L	Left	21-04-2021	54	1.639	0.006	0.091	NA	U	2+	Columbia Sculpin	1.040873	NA	0.387597
411	Ero-Exp-3-3-L	3-L	Left	22-04-2021	90	8.541	0.12	0.675	0.156	M	4+	Columbia Sculpin	1.171605	1.983219	1.525553
412	Ero-Exp-3-3-L	3-L	Left	22-04-2021	86	8.909	0.054	0.247	0.159	M	4+	Columbia Sculpin	1.400663	1.835604	0.623413
413	Ero-Exp-3-3-L	3-L	Left	22-04-2021	65	4.089	0.081	0.594	NA	U	2+	Torrent Sculpin	1.488939	NA	2.317597
414	Ero-Exp-3-3-L	3-L	Left	22-04-2021	75	5.367	0.092	0.628	NA	M	2+	Torrent Sculpin	1.272178	NA	1.941338
415	Ero-Exp-3-3-L	3-L	Left	22-04-2021	75	4.793	0.036	0.746	NA	F	3+	Torrent Sculpin	1.136119	NA	0.889548
416	Ero-Exp-3-3-L	3-L	Left	22-04-2021	91	10.091	0.056	0.465	0.223	M	4+	Columbia Sculpin	1.339091	2.316642	0.581758
417	Ero-Exp-3-3-L	3-L	Left	22-04-2021	65	3.774	0.025	0.283	0.458	F	2+	Columbia Sculpin	1.374238	13.11945	0.716127
418	Ero-Exp-3-3-L	3-L	Left	22-04-2021	86	8.214	0.036	0.316	0.202	M	4+	Columbia Sculpin	1.291396	2.55761	0.455812
419	Ero-Exp-3-3-L	3-L	Left	22-04-2021	78	5.309	0.117	0.209	0.556	F	2+	Columbia Sculpin	1.118739	10.90196	2.294118
420	Ero-Exp-3-3-L	3-L	Left	22-04-2021	76	6.513	0.047	0.257	0.118	M	3+	Columbia Sculpin	1.48368	1.886189	0.751279

Sample ID	Label	Site	Bank	Date	Total Length (mm)	Lab Weight (g)	Liver Weight (g)	Gut Weight (g)	Gonad Weight (g)	Sex	Age	Common Name	FK	GSI	HSI
421	Ero-Exp-3-3-L	3-L	Left	22-04-2021	80	7.306	0.079	0.294	0.168	M	4+	Columbia Sculpin	1.426953	2.395893	1.12664
422	Ero-Exp-3-3-L	3-L	Left	22-04-2021	70	4.857	0.018	0.141	0.079	F	-	Columbia Sculpin	1.416035	1.675148	0.381679
423	Ero-Exp-3-3-L	3-L	Left	22-04-2021	94	9.415	0.065	0.338	0.223	M	4+	Columbia Sculpin	1.13354	2.456759	0.716096
424	Ero-Exp-3-3-L	3-L	Left	22-04-2021	62	2.66	0.056	0.109	0.172	F	2+	Columbia Sculpin	1.116109	6.742454	2.195218
425	Ero-Exp-3-3-L	3-L	Left	22-04-2021	63	3.275	0.066	0.104	0.153	F	2+	Columbia Sculpin	1.309754	4.824976	2.081362
426	Ero-Exp-3-3-L	3-L	Left	22-04-2021	86	7.711	0.024	0.308	0.148	M	3+	Columbia Sculpin	1.212315	1.99919	0.324193
427	Ero-Exp-3-3-L	3-L	Left	22-04-2021	73	4.956	0.057	0.341	0.043	F	3+	Columbia Sculpin	1.27398	0.931744	1.235103
428	Ero-Exp-3-4-L	4-L	Left	22-04-2021	84	7.093	0.074	1.222	0.054	F	4+	Columbia Sculpin	1.196719	0.919775	1.260433
429	Ero-Exp-3-4-L	4-L	Left	22-04-2021	78	5.183	0.126	0.181	0.573	F	4+	Columbia Sculpin	1.092188	11.45542	2.518992
430	Ero-Exp-3-4-L	4-L	Left	22-04-2021	80	5.917	0.051	0.197	0.13	M	4+	Columbia Sculpin	1.155664	2.272727	0.891608
431	Ero-Exp-3-4-L	4-L	Left	22-04-2021	100	12.943	0.002	1.008	0.252	M	5+	Columbia Sculpin	1.2943	2.111437	0.016757
432	Ero-Exp-3-4-L	4-L	Left	22-04-2021	79	6.372	0.149	0.331	0.789	F	4+	Columbia Sculpin	1.292393	13.06075	2.466479
433	Ero-Exp-3-4-L	4-L	Left	22-04-2021	83	6.963	0.199	0.855	0.127	F	4+	Columbia Sculpin	1.217761	2.07924	3.258022
434	Ero-Exp-3-4-L	4-L	Left	22-04-2021	86	6.433	0.034	0.29	0.112	M	5+	Columbia Sculpin	1.011389	1.823213	0.553476
435	Ero-Exp-3-4-L	4-L	Left	22-04-2021	80	7.192	0.05	0.638	0.119	M	4+	Columbia Sculpin	1.404688	1.815685	0.762893
436	Ero-Exp-3-4-L	4-L	Left	22-04-2021	85	6.696	0.062	0.263	0.139	M	4+	Columbia Sculpin	1.090332	2.160734	0.963781
437	Ero-Exp-3-4-L	4-L	Left	22-04-2021	78	5.339	0.066	0.509	0.141	F	3+	Columbia Sculpin	1.125061	2.919255	1.36646
438	Ero-Exp-3-4-L	4-L	Left	22-04-2021	95	8.118	0.075	0.912	0.107	M	4+	Columbia Sculpin	0.946844	1.484874	1.040799
439	Ero-Exp-3-4-L	4-L	Left	22-04-2021	82	4.051	0.047	0.309	0.079	M	3+	Columbia Sculpin	0.734718	2.11117	1.256013
440	Ero-Exp-3-4-L	4-L	Left	22-04-2021	75	4.757	0.067	0.213	0.606	F	3+	Columbia Sculpin	1.127585	13.33627	1.474472
441	Ero-Exp-3-4-L	4-L	Left	22-04-2021	96	8.764	0.043	0.512	0.194	M	4+	Columbia Sculpin	0.990578	2.350945	0.521086
442	Ero-Exp-3-4-L	4-L	Left	22-04-2021	69	4.058	0.055	0.2	0.328	F	3+	Columbia Sculpin	1.235278	8.501814	1.425609
449	Ero-Exp-3-3-R	3-R	Right	22-04-2021	73	4.715	0.073	0.146	NA	M	3+	Torrent Sculpin	1.212029	NA	1.597724
450	Ero-Exp-3-3-R	3-R	Right	22-04-2021	68	4.284	0.072	0.117	0.614	F	4+	Columbia Sculpin	1.362457	14.73482	1.727862
451	Ero-Exp-3-3-R	3-R	Right	22-04-2021	88	8.639	0.039	0.447	0.162	M	3+	Columbia Sculpin	1.267697	1.977539	0.476074
452	Ero-Exp-3-3-R	3-R	Right	22-04-2021	70	3.976	0.049	0.136	0.503	F	4+	Columbia Sculpin	1.159184	13.09896	1.276042
453	Ero-Exp-3-3-R	3-R	Right	22-04-2021	75	4.894	0.116	0.102	0.689	F	4+	Columbia Sculpin	1.160059	14.37813	2.420701
454	Ero-Exp-3-3-R	3-R	Right	22-04-2021	76	5.692	0.156	0.161	0.536	F	4+	Columbia Sculpin	1.296654	9.690833	2.820466
455	Ero-Exp-3-3-R	3-R	Right	22-04-2021	86	8.111	0.074	0.351	0.191	M	4+	Columbia Sculpin	1.275202	2.46134	0.953608
456	Ero-Exp-3-3-R	3-R	Right	22-04-2021	70	4.594	0.077	0.176	0.661	F	3+	Columbia Sculpin	1.339359	14.96152	1.74287
457	Ero-Exp-3-3-R	3-R	Right	22-04-2021	75	5.439	0.096	0.218	0.567	F	3+	Columbia Sculpin	1.289244	10.85999	1.838728
458	Ero-Exp-3-3-R	3-R	Right	22-04-2021	83	6.307	0.123	0.17	0.471	F	4+	Columbia Sculpin	1.103033	7.67476	2.004237

Sample ID	Label	Site	Bank	Date	Total Length (mm)	Lab Weight (g)	Liver Weight (g)	Gut Weight (g)	Gonad Weight (g)	Sex	Age	Common Name	FK	GSI	HSI
459	Ero-Exp-3-3-R	3-R	Right	22-04-2021	79	5.757	0.028	0.224	0.114	M	-	Columbia Sculpin	1.167656	2.060365	0.506055
460	Ero-Exp-3-3-R	3-R	Right	22-04-2021	89	7.809	0.054	0.297	0.143	M	3+	Columbia Sculpin	1.107708	1.903621	0.71885
461	Ero-Exp-3-3-R	3-R	Right	22-04-2021	79	5.567	0.091	0.141	0.625	F	4+	Columbia Sculpin	1.12912	11.51861	1.67711
462	Ero-Exp-3-3-R	3-R	Right	22-04-2021	62	2.511	0.006	0.118	NA	U	2+	Columbia Sculpin	1.05359	NA	0.250731
463	Ero-Exp-3-3-R	3-R	Right	22-04-2021	73	4.682	0.023	0.185	0.241	F	3+	Columbia Sculpin	1.203546	5.359128	0.511452
478	Ero-Exp-3-4-R	4-R	Right	22-04-2021	85	7.258	0.053	0.235	0.155	M	4+	Columbia Sculpin	1.181844	2.207034	0.754663
479	Ero-Exp-3-4-R	4-R	Right	22-04-2021	82	7.786	0.061	0.281	0.144	M	3+	Columbia Sculpin	1.412124	1.918721	0.812791
480	Ero-Exp-3-4-R	4-R	Right	22-04-2021	60	2.062	0.034	0.159	NA	U	2+	Torrent Sculpin	0.95463	NA	1.786653
481	Ero-Exp-3-4-R	4-R	Right	22-04-2021	63	2.632	0.049	0.239	NA	M	3+	Torrent Sculpin	1.052602	NA	2.047639
482	Ero-Exp-3-4-R	4-R	Right	22-04-2021	82	6.911	0.119	0.174	0.127	M	3+	Columbia Sculpin	1.253428	1.885112	1.766365
483	Ero-Exp-3-4-R	4-R	Right	22-04-2021	62	3.091	0.104	0.143	0.319	F	2+	Columbia Sculpin	1.296952	10.8209	3.527815
484	Ero-Exp-3-4-R	4-R	Right	22-04-2021	88	7.375	0.102	0.361	0.111	M	3+	Columbia Sculpin	1.082216	1.582549	1.454234
485	Ero-Exp-3-4-R	4-R	Right	22-04-2021	60	2.314	0.001	0.11	NA	U	-	Columbia Sculpin	1.071296	NA	0.045372
486	Ero-Exp-3-4-R	4-R	Right	22-04-2021	80	5.911	0.063	0.308	0.028	M	4+	Columbia Sculpin	1.154492	0.499732	1.124398
487	Ero-Exp-3-4-R	4-R	Right	22-04-2021	63	3.109	0.134	0.137	0.393	F	3+	Columbia Sculpin	1.243366	13.22342	4.508748
488	Ero-Exp-3-4-R	4-R	Right	22-04-2021	70	4.231	0.06	0.282	0.071	F	3+	Columbia Sculpin	1.233528	1.797924	1.519372
489	Ero-Exp-3-4-R	4-R	Right	22-04-2021	62	2.213	0.026	0.096	0.04	M	-	Columbia Sculpin	0.928552	1.889466	1.228153
490	Ero-Exp-3-4-R	4-R	Right	22-04-2021	51	1.505	0.001	0.076	NA	M	-	Columbia Sculpin	1.134556	NA	0.069979
491	Ero-Exp-3-4-R	4-R	Right	22-04-2021	50	1.036	0.025	0.053	NA	U	2+	Columbia Sculpin	0.8288	NA	2.543235
496	Ero-Exp-5	NA	NA	22-04-2021	79	6.637	0.028	0.509	0.145	M	4+	Columbia Sculpin	1.346141	2.366188	0.456919
497	Ero-Exp-5	NA	NA	22-04-2021	80	5.934	0.056	0.409	0.128	M	2+	Columbia Sculpin	1.158984	2.316742	1.013575
498	Ero-Exp-5	NA	NA	22-04-2021	107	11.697	0.114	0.439	0.181	M	5+	Columbia Sculpin	0.954824	1.607746	1.012613
499	Ero-Exp-5	NA	NA	22-04-2021	86	8.349	0.038	0.311	0.2	M	4+	Columbia Sculpin	1.31262	2.488181	0.472754
500	Ero-Exp-5	NA	NA	22-04-2021	87	6.067	0.046	0.257	0.15	M	3+	Columbia Sculpin	0.921332	2.581756	0.791738
501	Ero-Exp-5	NA	NA	22-04-2021	95	9.097	0.037	0.354	0.162	M	5+	Columbia Sculpin	1.061029	1.852911	0.423196
502	Ero-Exp-5	NA	NA	22-04-2021	76	5.476	0.149	0.16	0.923	F	4+	Columbia Sculpin	1.247449	17.36268	2.802859
503	Ero-Exp-5	NA	NA	22-04-2021	92	8.798	0.084	0.274	0.184	M	5+	Columbia Sculpin	1.129849	2.158611	0.985453
504	Ero-Exp-5	NA	NA	22-04-2021	72	4.039	0.092	0.104	0.473	F	2+	Columbia Sculpin	1.082122	12.02033	2.337992
506	Ero-Exp-5	NA	NA	22-04-2021	70	3.927	0.103	0.214	0.373	F	2+	Columbia Sculpin	1.144898	10.04579	2.774037
507	Ero-Exp-5	NA	NA	22-04-2021	89	7.381	0.029	0.235	0.117	M	5+	Columbia Sculpin	1.046996	1.63728	0.405821
508	Ero-Exp-5	NA	NA	22-04-2021	90	9.898	0.081	0.334	0.175	M	4+	Columbia Sculpin	1.35775	1.829778	0.846926
509	Ero-Exp-5	NA	NA	22-04-2021	71	4.854	0.115	0.117	0.631	F	4+	Columbia Sculpin	1.356203	13.32067	2.427697

Sample ID	Label	Site	Bank	Date	Total Length (mm)	Lab Weight (g)	Liver Weight (g)	Gut Weight (g)	Gonad Weight (g)	Sex	Age	Common Name	FK	GSI	HSI
510	Ero-Exp-5	NA	NA	22-04-2021	57	1.569	0.022	0.169	NA	U	2+	Torrent Sculpin	0.847224	NA	1.571429
511	Ero-Exp-5	NA	NA	22-04-2021	61	3.078	0.058	0.197	0.313	F	2+	Columbia Sculpin	1.356061	10.86428	2.01319
512	Ero-Exp-5	NA	NA	22-04-2021	90	8.755	0.074	0.435	0.185	M	3+	Columbia Sculpin	1.20096	2.223558	0.889423
513	Ero-Exp-5	NA	NA	22-04-2021	75	5.637	0.032	0.263	0.092	M	2+	Columbia Sculpin	1.336178	1.711946	0.59546
514	Ero-Exp-5	NA	NA	22-04-2021	90	8.363	0.1	0.408	0.128	M	5+	Columbia Sculpin	1.147188	1.609051	1.257071
515	Ero-Exp-5	NA	NA	22-04-2021	88	5.649	0.036	0.204	0.066	M	5+	Columbia Sculpin	0.828941	1.212121	0.661157
516	Ero-Exp-5	NA	NA	22-04-2021	79	4.549	0.024	0.219	0.082	M	4+	Columbia Sculpin	0.922645	1.893764	0.554273
517	Ero-Exp-5	NA	NA	22-04-2021	57	1.926	0.001	0.171	0.033	F	2+	Columbia Sculpin	1.039996	1.880342	0.05698
518	Ero-Exp-5	NA	NA	22-04-2021	86	5.809	0.136	0.178	0.509	F	4+	Columbia Sculpin	0.913284	9.039247	2.415202
519	Ero-Exp-5	NA	NA	22-04-2021	85	6.427	0.035	0.3	0.124	M	3+	Columbia Sculpin	1.04653	2.023829	0.571242
520	Ero-Exp-5	NA	NA	22-04-2021	70	4.145	0.044	0.152	0.388	F	3+	Columbia Sculpin	1.208455	9.717005	1.101928
521	Ero-Exp-5	NA	NA	22-04-2021	75	4.434	0.014	0.144	0.113	M	3+	Columbia Sculpin	1.051022	2.634033	0.32634
522	Ero-Exp-5	NA	NA	22-04-2021	69	3.531	0.041	0.113	0.159	F	2+	Columbia Sculpin	1.074856	4.651843	1.199532
523	Ero-Exp-5	NA	NA	22-04-2021	60	1.586	0.04	0.128	NA	U	2+	Torrent Sculpin	0.734259	NA	2.743484
524	Ero-Exp-5	NA	NA	22-04-2021	51	1.606	0.05	0.066	0.091	F	2+	Columbia Sculpin	1.210696	5.909091	3.246753
525	Ero-Exp-5	NA	NA	22-04-2021	62	2.537	0.005	0.151	0.061	M	2+	Columbia Sculpin	1.064499	2.55658	0.209556
526	Ero-Exp-5	NA	NA	22-04-2021	64	3.013	0.018	0.187	NA	F	3+	Columbia Sculpin	1.149368	NA	0.636943
546	Ero-Ref-3	NA	Right	23-04-2021	129	35.8	1.56	2.274	0.361	M	5+	Torrent Sculpin	1.667685	1.076776	4.653105
547	Ero-Ref-3	NA	Right	23-04-2021	90	13.793	0.305	1.025	3.046	F	5+	Torrent Sculpin	1.892044	23.85652	2.388784
548	Ero-Ref-3	NA	Right	23-04-2021	110	20.48	0.49	1.235	0.68	M	4+	Torrent Sculpin	1.538693	3.533385	2.546116
549	Ero-Ref-3	NA	Right	23-04-2021	127	29.334	0.391	1.547	0.242	M	6+	Torrent Sculpin	1.432056	0.870911	1.407133
550	Ero-Ref-3	NA	Right	23-04-2021	98	15.734	0.465	1.417	2.435	F	4+	Torrent Sculpin	1.67171	17.00775	3.247887
551	Ero-Ref-3	NA	Right	23-04-2021	95	11.831	0.155	1.397	0.1	F	5+	Torrent Sculpin	1.37991	0.958405	1.485528
552	Ero-Ref-3	NA	Right	23-04-2021	91	12.605	0.401	0.964	0.103	F	4+	Torrent Sculpin	1.672702	0.884804	3.444721
553	Ero-Ref-3	NA	Right	23-04-2021	110	18.35	0.268	0.998	0.216	M	4+	Torrent Sculpin	1.378663	1.244813	1.544491
554	Ero-Ref-3	NA	Right	23-04-2021	80	7.107	0.138	0.683	NA	F	3+	Torrent Sculpin	1.388086	NA	2.148194
555	Ero-Ref-3	NA	Right	23-04-2021	90	10.573	0.152	1.453	0.075	F	3+	Torrent Sculpin	1.450343	0.822368	1.666667
556	Ero-Ref-3	NA	Right	23-04-2021	90	11.043	0.267	1.051	1.163	F	4+	Torrent Sculpin	1.514815	11.63931	2.672138
557	Ero-Ref-3	NA	Right	23-04-2021	90	11.967	0.373	0.972	0.112	M	4+	Torrent Sculpin	1.641564	1.018645	3.392451
558	Ero-Ref-3	NA	Right	23-04-2021	69	3.545	0.045	0.297	NA	M	2+	Torrent Sculpin	1.079118	NA	1.385468
559	Ero-Ref-3	NA	Right	23-04-2021	87	10.216	0.328	0.837	1.807	F	3+	Torrent Sculpin	1.551398	19.26645	3.497175
560	Ero-Ref-3	NA	Right	23-04-2021	83	8.349	0.058	0.892	0.102	M	3+	Torrent Sculpin	1.460159	1.367842	0.777793

Sample ID	Label	Site	Bank	Date	Total Length (mm)	Lab Weight (g)	Liver Weight (g)	Gut Weight (g)	Gonad Weight (g)	Sex	Age	Common Name	FK	GSI	HSI
561	Ero-Ref-3	NA	Right	23-04-2021	99	13.471	0.217	1.417	0.173	M	3+	Torrent Sculpin	1.388335	1.435208	1.800232
562	Ero-Ref-3	NA	Right	23-04-2021	76	5.738	0.206	0.805	NA	M	3+	Torrent Sculpin	1.307133	NA	4.175958
563	Ero-Ref-3	NA	Right	23-04-2021	79	5.789	0.082	0.778	NA	F	2+	Torrent Sculpin	1.174146	NA	1.6364
564	Ero-Ref-3	NA	Right	23-04-2021	80	5.824	0.094	0.435	NA	M	4+	Torrent Sculpin	1.1375	NA	1.744294
567	Ero-Ref-3	NA	Right	23-04-2021	82	8.216	0.168	0.78	0.093	M	4+	Torrent Sculpin	1.490112	1.250672	2.259279
569	Ero-Ref-3	NA	Right	23-04-2021	76	5.05	0.111	0.574	NA	F	3+	Torrent Sculpin	1.150405	NA	2.479893
570	Ero-Ref-3	NA	Right	23-04-2021	78	5.412	0.106	0.523	NA	U	3+	Torrent Sculpin	1.140444	NA	2.168133
571	Ero-Ref-3	NA	Right	23-04-2021	69	3.443	0.038	0.426	NA	F	4+	Torrent Sculpin	1.048069	NA	1.259529
572	Ero-Ref-3	NA	Right	23-04-2021	98	3.518	0.048	0.234	NA	U	2+	Torrent Sculpin	0.373781	NA	1.461632
573	Ero-Ref-3	NA	Right	23-04-2021	70	4.149	0.114	0.373	NA	U	2+	Torrent Sculpin	1.209621	NA	3.019068
574	Ero-Ref-3	NA	Right	23-04-2021	70	4.176	0.08	0.5	NA	F	2+	Torrent Sculpin	1.217493	NA	2.176279
575	Ero-Ref-3	NA	Right	23-04-2021	40	0.719	0.008	0.064	NA	U	1+	Torrent Sculpin	1.123438	NA	1.221374
169	Ero-Exp-1	NA	NA	NA	NA	NA	NA	NA	NA	M	2+	NA	NA	NA	NA
383	Ero-Exp-3-2-L	2-L	NA	NA	NA	NA	NA	NA	NA	M	3+	NA	NA	NA	NA

Table-191: Small-bodied fish tissue metals (mg/kg ww)

Client Sample ID	1-Koot-Ref1	2-Koot-Ref1	3-Koot-Ref1	4-Koot-Ref1	5-Koot-Ref1	6-Koot-Ref1	7-Koot-Ref1	20-Koot-Ref1	21-Koot-Ref1	23-Koot-Ref1	24-Koot-Ref1	25-Koot-Ref1	26-Koot-Ref1
moisture	74.2	76.9	78.5	78.4	78.6	78.3	75.2	71.2	73.6	76.0	79.4	80.2	80.5
aluminum	<1.0	2.5	5.1	7.0	1.3	2.5	3.6	<1.0	<1.0	<1.0	1.1	1.4	1.6
antimony	<0.0020	<0.0020	0.0025	0.0037	<0.0020	0.0022	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
arsenic	0.0256	0.0587	0.0588	0.0478	0.0577	0.0625	0.0842	0.0473	0.0525	0.0642	0.0456	0.0554	0.0413
barium	1.42	6.70	7.24	5.81	4.71	6.76	0.925	4.24	5.33	6.59	8.54	5.85	7.00
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	<0.20	0.44	0.46	0.49	0.35	0.69	<0.20	<0.20	<0.20	0.23	0.30	0.25	0.30
cadmium	0.0126	0.0382	0.0566	0.0326	0.0302	0.0572	0.0694	0.0224	0.0231	0.0216	0.0158	0.0227	0.0227
calcium	8550	13700	12500	11700	8400	12800	4810	18100	15500	15600	12000	10300	9620
cesium	0.0169	0.0138	0.0159	0.0103	0.0098	0.0122	0.0201	0.0126	0.0126	0.0200	0.0123	0.0143	0.0123
chromium	0.079	0.072	0.060	0.123	0.059	0.096	<0.040	<0.040	<0.040	<0.040	0.045	<0.040	0.089
cobalt	0.0072	0.0299	0.0420	0.0223	0.0259	0.0320	0.0210	0.0170	0.0163	0.0228	0.0158	0.0294	0.0213
copper	0.370	0.618	0.805	0.534	0.552	0.636	0.423	0.402	0.415	0.396	0.382	0.520	0.413
iron	8.8	18.3	22.7	27.8	13.1	12.1	15.8	14.2	9.3	10.2	7.9	15.9	12.5
lead	0.038	0.150	0.145	0.114	0.033	0.170	0.063	0.134	0.072	0.093	0.039	0.048	0.052
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	307	454	401	354	308	386	238	531	494	463	352	345	314
manganese	1.06	9.25	8.07	7.77	7.48	9.69	0.731	5.61	5.48	8.76	12.1	8.58	10.4
mercury	0.0182	0.0101	0.0089	0.0104	0.0083	0.0118	0.0423	0.0152	0.0139	0.0118	0.0061	0.0096	0.0082
molybdenum	<0.0080	0.0247	0.0210	0.0219	0.0121	0.0195	0.0136	0.0217	0.0167	0.0120	0.0082	0.0161	0.0174
nickel	<0.040	0.072	0.047	0.064	0.048	0.051	0.042	<0.040	<0.040	<0.040	<0.040	0.043	0.046
phosphorus	6240	9080	8320	7660	5940	8440	3850	12200	10100	10100	7740	6620	6350
potassium	2360	2000	1680	1700	1800	1710	2100	2320	2120	2300	1400	1810	1580
rubidium	1.83	1.48	1.51	1.22	0.812	1.39	2.04	1.28	1.26	1.89	1.07	1.34	1.06
selenium	0.814	0.885	0.793	0.823	0.768	0.673	0.730	0.863	1.01	0.841	0.675	0.690	0.687
silver	<0.0010	0.0020	0.0021	0.0019	0.0016	0.0016	<0.0010	<0.0010	<0.0010	0.0010	0.0013	0.0012	0.0012
sodium	1030	836	779	752	704	808	844	1010	932	854	609	790	657
strontium	14.7	25.3	23.6	20.7	15.1	24.5	6.39	34.0	26.7	28.4	21.4	19.7	17.7
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.00132	0.00478	0.00390	0.00228	0.00196	0.00490	0.00577	0.00372	0.00357	0.00362	0.00419	0.00234	0.00212
tin	0.177	0.177	0.627	0.310	0.263	0.402	0.193	0.158	0.220	0.140	0.410	0.253	0.237
uranium	0.00300	0.00799	0.00866	0.00944	0.00401	0.00813	0.00659	0.00560	0.00751	0.00497	0.00301	0.00697	0.00431
vanadium	<0.020	0.064	0.102	0.057	0.032	0.090	0.032	0.101	0.105	0.124	0.041	0.045	0.045
zinc	13.4	29.3	31.1	24.2	18.5	29.5	14.3	16.0	14.7	22.6	20.4	21.1	20.0
zirconium	<0.040	<0.040	<0.040	0.084	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040

Client Sample ID	27-Koot-Ref1	29-Koot-Ref1	30-Koot-Ref1	31-Koot-Ref1	54-Koot-Ref1	55-Koot-Ref1	56-Koot-Ref1	58-Koot-Ref1	59-Koot-Ref1	61-Koot-Ref1	62-Koot-Ref1	63-Koot-Ref1
moisture	74.4	77.8	77.4	74.4	79.4	74.2	73.1	77.2	71.9	82.0	72.3	74.3
aluminum	2.1	1.8	2.9	1.2	2.4	<1.0	<1.0	<1.0	<1.0	2.1	1.3	<1.0
antimony	<0.0020	<0.0020	0.0071	<0.0020	0.0031	<0.0020	<0.0020	<0.0020	<0.0020	0.0023	0.0020	<0.0020
arsenic	0.0732	0.0575	0.0574	0.0719	0.0523	0.0599	0.0394	0.0530	0.0414	0.0399	0.0586	0.0421
barium	7.19	6.98	7.42	7.22	4.34	7.07	4.83	4.89	3.32	4.42	6.81	4.27
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	<0.20	0.23	0.35	<0.20	0.24	<0.20	<0.20	<0.20	<0.20	0.41	<0.20	<0.20
cadmium	0.0519	0.0277	0.0423	0.0453	0.0512	0.0241	0.0171	0.0198	0.0224	0.0327	0.0379	0.0167
calcium	12600	11200	15400	14000	12900	15300	16400	11900	19000	14800	18300	9810
cesium	0.0084	0.0150	0.0177	0.0144	0.0162	0.0119	0.0110	0.0167	0.0143	0.0126	0.0151	0.0126
chromium	0.143	0.048	0.059	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.056	<0.040	<0.040
cobalt	0.0280	0.0365	0.0306	0.0294	0.0353	0.0176	0.0150	0.0194	0.0214	0.0231	0.0217	0.0228
copper	0.565	0.651	0.671	0.615	0.579	0.367	0.410	0.360	0.339	0.522	0.366	0.476
iron	16.5	14.6	16.8	11.2	13.1	9.8	9.2	6.0	8.4	11.7	11.2	9.9
lead	0.118	0.116	0.176	0.048	0.174	0.134	0.073	0.135	0.104	0.159	0.128	0.060
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	398	361	450	461	384	408	453	370	459	382	463	350
manganese	9.73	7.63	10.2	6.18	8.84	6.44	4.90	5.50	3.35	4.70	8.24	5.49
mercury	0.0076	0.0124	0.0101	0.0101	0.0092	0.0116	0.0112	0.0110	0.0127	0.0156	0.0124	0.0096
molybdenum	0.0182	0.0180	0.0250	0.0172	0.0252	0.0280	0.0150	0.0144	0.0146	0.0156	0.0254	0.0147
nickel	0.080	<0.040	0.046	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.042	<0.040	<0.040
phosphorus	8080	7410	9730	9380	8670	9780	10700	8420	12500	9620	12200	7330
potassium	1770	2340	1980	2460	2140	2090	2240	2260	2320	1690	2160	2330
rubidium	1.34	1.87	1.71	1.38	1.77	1.32	1.19	1.60	1.62	1.26	1.48	1.42
selenium	0.933	0.838	0.811	0.663	0.938	0.881	0.969	0.823	0.996	0.753	0.844	1.04
silver	0.0018	0.0018	0.0021	0.0014	0.0017	<0.0010	<0.0010	<0.0010	<0.0010	0.0012	<0.0010	<0.0010
sodium	864	909	817	828	1020	928	991	795	1110	931	872	864
strontium	22.9	20.7	28.8	23.2	26.2	31.0	32.4	22.7	36.4	30.2	35.7	18.7
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.00382	0.00390	0.00366	0.00645	0.00317	0.00191	0.00298	0.00411	0.00275	0.00200	0.00336	0.00221
tin	0.348	0.209	0.957	0.344	0.599	0.254	0.243	0.252	0.215	0.363	0.180	0.277
uranium	0.00649	0.00470	0.00874	0.00576	0.00636	0.00554	0.00343	0.00483	0.00571	0.00690	0.00502	0.00383
vanadium	0.074	0.068	0.093	0.048	0.072	0.099	0.089	0.067	0.146	0.077	0.123	0.075
zinc	23.3	27.5	34.8	26.5	30.9	21.6	13.6	17.4	16.7	28.8	15.9	15.4
zirconium	0.056	<0.040	<0.040	<0.040	0.048	<0.040	<0.040	<0.040	<0.040	0.042	<0.040	<0.040

Client Sample ID	64-Koot-Ref1	65-Koot-Ref1	66-Koot-Ref1	67-Koot-Ref1	68-Koot-Ref1	69-Koot-Ref1	81-Ero-Ref2	82-Ero-Ref2	83-Ero-Ref2	84-Ero-Ref2	85-Ero-Ref2	86-Ero-Ref2	87-Ero-Ref2
moisture	73.2	75.2	80.9	79.4	72.3	77.5	70.5	74.3	70.8	76.4	78.4	77.0	75.1
aluminum	<1.0	1.2	1.5	<1.0	1.7	<1.0	<1.0	1.0	1.1	4.4	1.9	<1.0	1.5
antimony	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0023	<0.0020	<0.0020	<0.0020
arsenic	0.0472	0.0476	0.0530	0.0456	0.0589	0.0462	0.0241	0.0703	0.0255	0.106	0.0478	0.0480	0.0651
barium	4.24	4.57	9.62	4.52	4.12	4.88	3.80	7.12	4.12	5.50	3.19	3.94	5.29
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	<0.20	<0.20	0.47	0.29	<0.20	<0.20	<0.20	<0.20	<0.20	0.25	<0.20	<0.20	<0.20
cadmium	0.0131	0.0174	0.0536	0.0424	0.0269	0.0241	0.0376	0.0773	0.0273	0.0782	0.0417	0.0427	0.0782
calcium	11500	15500	14900	13800	13900	11700	17500	19100	14000	18400	17200	14600	16000
cesium	0.0136	0.0130	0.0108	0.0117	0.0180	0.0117	0.0239	0.0160	0.0131	0.0248	0.0137	0.0128	0.0182
chromium	<0.040	<0.040	0.046	<0.040	<0.040	<0.040	<0.040	0.041	<0.040	0.064	0.047	<0.040	0.045
cobalt	0.0170	0.0194	0.0263	0.0222	0.0189	0.0209	0.0111	0.0271	0.0192	0.0484	0.0184	0.0223	0.0399
copper	0.401	0.320	0.630	0.520	0.378	0.518	0.398	0.787	0.282	0.592	0.748	0.631	0.742
iron	8.0	10.3	9.8	9.7	9.6	10.3	8.0	12.0	6.9	23.3	9.9	9.5	11.9
lead	0.088	0.091	0.161	0.132	0.080	0.115	0.140	0.171	0.223	0.178	0.094	0.126	0.184
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	388	423	386	332	424	375	465	431	314	499	400	391	392
manganese	4.58	5.62	8.39	4.93	4.83	6.21	1.79	5.14	7.16	4.76	3.14	3.52	6.04
mercury	0.0127	0.0130	0.0114	0.0066	0.0120	0.0111	0.0327	0.0146	0.0264	0.0144	0.0119	0.0126	0.0157
molybdenum	0.0165	0.0221	0.0224	0.0182	0.0118	0.0129	0.0108	0.0239	0.0145	0.0190	0.0263	0.0163	0.0231
nickel	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.051	0.042	0.084	<0.040	<0.040	0.066
phosphorus	8830	10100	9900	9250	10000	8120	11800	12500	8740	12000	10800	9080	10100
potassium	2620	2050	1520	1660	2490	1850	2210	2050	1200	2320	2030	1820	2030
rubidium	1.67	1.30	1.14	1.23	2.02	1.46	2.67	2.75	1.49	4.10	2.54	2.35	3.06
selenium	0.945	0.850	0.680	0.762	1.03	0.852	0.677	0.568	0.285	0.726	0.507	0.570	0.641
silver	<0.0010	<0.0010	0.0019	0.0019	<0.0010	0.0012	<0.0010	0.0019	<0.0010	0.0013	0.0018	0.0015	0.0020
sodium	952	795	891	722	915	873	1190	1040	650	1110	917	927	940
strontium	23.6	31.1	29.3	26.3	24.9	22.6	37.8	43.8	30.0	41.4	38.0	34.2	35.3
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.00308	0.00264	0.00262	0.00280	0.00414	0.00354	0.00245	0.00499	0.00311	0.0111	0.00561	0.00429	0.00669
tin	0.127	0.302	0.331	0.649	0.384	0.291	0.136	0.232	0.101	0.502	0.391	0.303	0.440
uranium	0.00663	0.00468	0.0100	0.00854	0.00374	0.00684	0.00790	0.0123	0.0191	0.0273	0.0106	0.0128	0.0175
vanadium	0.106	0.102	0.096	0.091	0.068	0.046	0.042	0.049	0.080	0.194	0.066	0.036	0.067
zinc	16.1	20.2	31.0	25.5	16.7	23.9	23.9	32.3	19.5	31.5	28.0	26.7	39.5
zirconium	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040

Client Sample ID	88-Ero-Ref2	89-Ero-Ref2	90-Ero-Ref2	92-Ero-Ref2	93-Ero-Ref2	94-Ero-Ref2	95-Ero-Ref2	96-Ero-Ref2	97-Ero-Ref2	98-Ero-Ref2	99-Ero-Ref2	100-Ero-Ref2	103-Ero-Ref2
moisture	77.2	74.0	74.6	78.2	76.8	78.5	74.2	74.5	74.6	77.3	74.5	77.9	83.1
aluminum	<1.0	1.5	<1.0	<1.0	<1.0	3.6	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.8
antimony	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
arsenic	0.0216	0.0350	0.0451	0.0568	0.0429	0.0675	0.0797	0.0771	0.0341	0.0354	0.0238	0.0606	0.0539
barium	5.98	6.10	3.14	3.04	3.18	6.16	3.39	4.13	4.04	3.58	4.98	4.03	4.07
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	<0.20	<0.20	<0.20	0.24	0.25	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
cadmium	0.0164	0.0190	0.0635	0.0707	0.0332	0.0677	0.0828	0.0691	0.0171	0.0109	0.0251	0.0806	0.0614
calcium	17900	15700	17200	12900	10700	15300	14500	13200	14100	9760	16700	15400	9530
cesium	0.0151	0.0234	0.0210	0.0132	0.0212	0.0113	0.0157	0.0190	0.0211	0.0235	0.0158	0.0164	0.0103
chromium	<0.040	<0.040	<0.040	<0.040	<0.040	0.053	<0.040	<0.040	<0.040	0.078	<0.040	<0.040	<0.040
cobalt	0.0193	0.0214	0.0285	0.0247	0.0244	0.0216	0.0250	0.0282	0.0252	0.0153	0.0176	0.0278	0.0263
copper	0.332	0.412	0.741	0.646	0.627	0.577	0.622	0.594	0.400	0.337	0.329	0.692	0.513
iron	7.5	9.4	9.2	10.6	7.0	11.3	10.1	9.6	9.2	7.4	6.4	8.2	9.3
lead	0.077	0.119	0.089	0.110	0.201	0.111	0.214	0.126	0.080	0.062	0.096	0.155	0.098
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	419	402	406	345	307	376	390	366	371	295	376	398	280
manganese	7.10	8.60	3.99	3.27	3.51	4.90	5.99	4.84	7.14	3.93	5.45	4.97	4.13
mercury	0.0124	0.0137	0.0130	0.0152	0.0111	0.0118	0.0100	0.0105	0.0096	0.0135	0.0214	0.0129	0.0101
molybdenum	0.0215	0.0227	0.0170	0.0175	0.0212	0.0190	0.0249	0.0180	0.0139	0.0161	0.0163	0.0138	0.0140
nickel	<0.040	0.055	0.044	<0.040	<0.040	0.048	0.050	0.040	<0.040	0.049	<0.040	0.042	0.058
phosphorus	10500	10200	10500	8480	7180	9310	9820	8360	9220	6530	10100	9330	6230
potassium	2040	2220	1910	1930	2090	2060	2140	2120	2100	2220	1930	1890	1760
rubidium	2.06	3.00	3.27	2.68	3.50	2.17	3.15	3.37	2.99	3.43	2.12	3.20	2.05
selenium	0.475	0.676	0.709	0.626	0.624	0.572	0.643	0.617	0.600	0.568	0.621	0.577	0.481
silver	<0.0010	<0.0010	0.0013	0.0016	0.0010	0.0013	0.0010	0.0013	<0.0010	<0.0010	<0.0010	0.0018	<0.0010
sodium	974	987	883	863	853	968	855	922	974	878	1120	920	857
strontium	41.5	36.2	36.8	28.0	23.4	33.7	31.8	29.0	35.2	26.5	41.7	33.3	22.0
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.00239	0.00556	0.00533	0.00800	0.00453	0.00528	0.00661	0.00579	0.00400	0.00293	0.00289	0.00731	0.00509
tin	0.266	0.243	0.539	0.348	0.369	0.563	0.390	0.442	0.131	0.187	0.119	0.262	0.207
uranium	0.00925	0.00964	0.0103	0.00786	0.00657	0.0106	0.0114	0.00793	0.00656	0.0115	0.00806	0.0117	0.00725
vanadium	0.062	0.062	0.042	0.042	0.050	0.066	0.066	0.059	0.036	0.027	0.050	0.056	0.045
zinc	22.0	20.7	26.6	31.4	26.7	29.6	25.8	26.8	20.6	20.0	18.7	29.7	26.7
zirconium	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040

Client Sample ID	108-Ero-Ref2	112-Ero-Ref2	114-Ero-Ref2	118-Ero-Ref2	119-Ero-Ref2	120-Ero-Ref2	121-Ero-Ref2	122-Ero-Ref2	123-Ero-Ref2	166-Ero-Exp1	167-Ero-Exp1	168-Ero-Exp1
moisture	71.9	76.3	78.2	75.5	79.1	78.8	76.5	77.8	79.2	75.0	78.3	76.5
aluminum	<1.0	<1.0	<1.0	7.8	<1.0	<1.0	1.1	3.6	<1.0	<1.0	1.4	17.7
antimony	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0052	<0.0020	<0.0020	0.0076	0.0036
arsenic	0.0637	0.0498	0.0441	0.0331	0.0343	0.0417	0.0731	0.0842	0.0798	0.0157	0.0671	0.0907
barium	5.96	5.87	4.13	6.22	6.60	5.84	5.43	3.89	3.07	0.896	4.73	4.01
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	<0.20	0.20	0.24
cadmium	0.0390	0.0174	0.0216	0.0508	0.0213	0.0262	0.0639	0.0921	0.135	0.0805	0.109	0.0921
calcium	21400	15800	10700	19100	14200	11900	17900	14200	15500	5050	14000	19400
cesium	0.0175	0.0116	0.0187	0.0186	0.0216	0.0198	0.0208	0.0243	0.0183	0.0337	0.0155	0.0175
chromium	<0.040	<0.040	0.051	0.049	0.044	0.057	0.051	0.066	<0.040	<0.040	0.043	0.052
cobalt	0.0202	0.0159	0.0301	0.0348	0.0247	0.0216	0.0404	0.0347	0.0438	0.0135	0.0370	0.0278
copper	0.369	0.473	0.405	0.453	0.471	0.424	0.490	0.652	0.740	0.451	0.580	0.917
iron	9.3	8.7	9.5	25.2	8.0	7.7	13.5	12.6	11.5	8.9	11.7	27.8
lead	0.099	0.037	0.058	0.097	0.059	0.048	0.203	0.737	0.147	0.403	0.873	0.982
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	519	397	307	461	358	369	458	363	379	241	365	453
manganese	5.46	7.21	6.47	10.2	9.47	8.33	5.77	5.28	3.70	0.465	4.86	4.92
mercury	0.0209	0.0118	0.0100	0.0122	0.0097	0.0162	0.0194	0.0131	0.0237	0.103	0.0179	0.0197
molybdenum	0.0254	0.0170	0.0160	0.0188	0.0206	0.0171	0.0218	0.0161	0.0173	<0.0080	0.0180	0.0227
nickel	<0.040	<0.040	0.047	0.084	0.041	0.041	0.089	0.088	0.055	<0.040	0.052	0.048
phosphorus	12500	9310	7000	11500	9050	7540	10300	8980	8870	3660	8380	10400
potassium	2230	1950	2140	2390	1900	2170	1970	2260	1920	1990	1790	1610
rubidium	2.70	1.93	3.32	2.91	3.52	2.95	2.41	4.38	3.01	2.36	2.34	2.51
selenium	0.788	0.425	0.554	0.642	0.546	0.527	0.823	0.660	0.695	0.729	0.587	0.504
silver	<0.0010	<0.0010	<0.0010	<0.0010	0.0011	<0.0010	0.0013	0.0015	0.0017	<0.0010	0.0025	0.0030
sodium	932	804	831	1060	860	939	1080	994	888	1030	844	810
strontium	50.6	35.2	23.2	44.0	31.9	25.9	39.5	31.5	35.5	10.7	29.9	42.4
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.00946	0.00353	0.00391	0.00745	0.00420	0.00403	0.00522	0.00948	0.00769	0.00286	0.00634	0.00802
tin	0.190	0.117	0.246	0.523	0.370	0.312	0.517	0.220	0.266	0.053	0.232	0.207
uranium	0.0149	0.00678	0.00488	0.0199	0.0103	0.00663	0.0306	0.0201	0.0110	0.00145	0.00985	0.0186
vanadium	0.116	0.042	0.039	0.098	0.050	0.039	0.175	0.071	0.060	<0.020	0.058	0.105
zinc	24.9	22.6	18.2	27.8	25.3	20.7	30.5	20.0	26.5	18.1	28.0	25.9
zirconium	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040

Client Sample ID	170-Ero-Exp1	171-Ero-Exp1	172-Ero-Exp1	169 - Ero-Exp1	173-Ero-Exp1	174-Ero-Exp1	175-Ero-Exp1	176-Ero-Exp1	178-Ero-Exp1	179-Ero-Exp1	180-Ero-Exp1	181-Ero-Exp1
moisture	76.3	76.1	75.6	81.4	76.0	73.6	77.7	81.2	76.3	74.6	79.5	75.9
aluminum	1.2	1.1	<1.0	1.0	1.7	2.1	<1.0	<1.0	<1.0	2.1	<1.0	<1.0
antimony	0.0050	0.0072	0.0055	0.0040	0.0134	0.0085	0.0325	0.0145	0.0091	0.0239	0.0032	0.0085
arsenic	0.0602	0.0496	0.0521	0.0470	0.0467	0.0538	0.0760	0.0596	0.111	0.0835	0.0850	0.0640
barium	5.46	4.35	4.64	2.25	7.06	6.45	5.25	3.36	3.57	6.82	5.56	2.58
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.38	<0.20
cadmium	0.0759	0.0524	0.0328	0.0552	0.0614	0.0729	0.0718	0.125	0.0823	0.106	0.0577	0.0684
calcium	16600	13900	15700	10200	17800	21400	12500	13100	13000	29700	15200	7660
cesium	0.0148	0.0210	0.0195	0.0289	0.0364	0.0318	0.0143	0.0317	0.0567	0.0188	0.0235	0.0282
chromium	<0.040	<0.040	<0.040	<0.040	0.055	0.042	0.046	0.050	<0.040	0.043	0.055	<0.040
cobalt	0.0268	0.0269	0.0438	0.0239	0.0341	0.0439	0.0320	0.0529	0.0373	0.0408	0.0418	0.0378
copper	0.656	0.482	0.459	0.523	0.498	0.516	0.794	0.495	0.540	0.461	0.683	0.659
iron	10.4	9.8	11.8	8.2	24.5	14.5	8.8	10.7	9.2	14.1	10.8	12.0
lead	0.922	0.732	0.814	0.586	3.17	1.17	1.51	1.12	2.58	3.31	0.613	1.09
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	445	364	423	288	473	535	339	349	373	703	391	291
manganese	5.10	6.33	8.20	3.28	10.8	11.6	4.86	8.51	6.72	8.47	9.96	5.33
mercury	0.0236	0.0217	0.0175	0.0252	0.0180	0.0165	0.0260	0.0218	0.0201	0.0681	0.0130	0.0208
molybdenum	0.0206	0.0127	0.0191	0.0082	0.0252	0.0293	0.0170	0.0146	0.0197	0.0443	0.0280	0.0220
nickel	0.049	0.054	0.081	<0.040	0.083	0.076	0.054	0.064	0.079	0.101	0.060	0.053
phosphorus	10200	8590	9760	6440	12000	14400	8510	8540	9010	18200	10100	6290
potassium	2100	2090	2220	1390	2680	3180	1880	1980	2800	2590	2310	2560
rubidium	2.49	2.37	2.18	2.09	2.43	2.45	2.78	2.39	2.99	2.21	3.67	2.47
selenium	0.592	0.591	0.602	0.517	0.735	0.712	0.567	0.567	0.648	0.642	0.541	0.862
silver	0.0020	0.0013	<0.0010	0.0015	0.0013	0.0013	0.0026	0.0018	0.0016	0.0018	0.0019	0.0025
sodium	994	936	1040	690	1220	1340	825	1050	1060	1560	1070	1010
strontium	36.5	30.6	34.4	20.9	38.6	53.0	28.7	29.7	27.9	77.6	34.9	18.5
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	0.0046	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.00463	0.00350	0.00655	0.0350	0.00687	0.00482	0.00797	0.00530	0.00647	0.0110	0.00659	0.0175
tin	0.326	0.169	0.099	0.168	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.235	<0.020
uranium	0.0125	0.00869	0.0159	0.00943	0.0189	0.0217	0.0152	0.00703	0.00999	0.0899	0.0105	0.00412
vanadium	0.094	0.040	0.062	0.022	0.072	0.089	0.065	0.033	0.055	0.199	0.066	0.023
zinc	34.6	25.0	26.0	20.4	22.8	35.1	28.6	29.8	33.7	33.2	32.0	23.2
zirconium	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040

Client Sample ID	183-Ero-Exp1	184-Ero-Exp1	186-Ero-Exp1	189-Ero-Exp1	190-Ero-Exp1	191-Ero-Exp1	192-Ero-Exp1	194-Ero-Exp1	195-Ero-Exp1	196-Ero-Exp1	198-Ero-Exp1	200-Ero-Exp1
moisture	74.1	76.4	77.1	74.0	75.0	74.5	74.0	82.4	78.8	74.0	78.0	78.8
aluminum	3.2	1.1	3.6	1.2	1.8	1.8	1.3	<1.0	<1.0	<1.0	<1.0	<1.0
antimony	0.0090	0.0026	0.0054	0.0057	0.0023	0.0021	0.0144	0.0026	<0.0020	0.0046	0.0033	<0.0020
arsenic	0.107	0.0408	0.0964	0.0927	0.0297	0.0506	0.103	0.0502	0.0597	0.0784	0.0880	0.0473
barium	24.0	8.94	2.82	6.17	11.9	4.92	3.14	5.45	5.35	4.74	7.11	3.84
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
cadmium	0.253	0.0361	0.0528	0.113	0.0680	0.0522	0.0477	0.0234	0.0383	0.0612	0.0904	0.0282
calcium	22000	27200	10100	25300	37900	14500	14700	15100	14500	22600	17900	18300
cesium	0.0194	0.0238	0.0312	0.0217	0.0226	0.0262	0.0424	0.0120	0.0241	0.0192	0.0254	0.0148
chromium	0.119	<0.040	0.073	<0.040	<0.040	<0.040	<0.040	0.053	0.043	<0.040	0.044	<0.040
cobalt	0.0419	0.0289	0.0482	0.0405	0.0324	0.0336	0.0471	0.0184	0.0272	0.0328	0.0438	0.0232
copper	0.496	0.561	0.887	0.531	0.580	0.532	0.402	0.345	0.352	0.530	0.673	0.334
iron	37.0	14.1	29.4	21.5	11.6	14.3	11.2	7.2	9.6	16.8	10.5	9.0
lead	0.363	0.892	0.178	0.715	0.273	0.337	2.34	0.487	0.353	1.21	0.322	0.257
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	515	652	355	634	794	438	442	397	414	560	476	474
manganese	10.6	10.4	5.78	8.37	8.83	8.13	7.55	7.29	8.59	4.62	14.4	5.03
mercury	0.0321	0.0250	0.0127	0.0369	0.0478	0.0193	0.0196	0.0113	0.0239	0.0552	0.0164	0.0344
molybdenum	0.0270	0.0278	0.0202	0.0250	0.0344	0.0232	0.0247	0.0174	0.0262	0.0417	0.0360	0.0281
nickel	0.068	0.061	0.062	0.059	0.043	0.052	0.064	0.042	0.046	0.053	0.086	<0.040
phosphorus	14200	16300	7340	16700	22700	10600	10300	9590	9300	14800	12000	11800
potassium	2260	2800	2680	3390	2040	2790	2920	1570	1870	2390	2720	2020
rubidium	2.05	2.17	4.80	2.79	2.09	3.14	3.28	1.80	2.31	1.98	3.91	1.90
selenium	1.01	0.759	0.658	0.897	0.737	0.795	0.688	0.418	0.686	0.827	0.669	0.669
silver	0.0022	0.0017	0.0021	0.0020	0.0019	<0.0010	<0.0010	<0.0010	<0.0010	0.0018	0.0022	<0.0010
sodium	1400	1700	1070	1760	1600	1270	1260	766	914	1610	1220	1080
strontium	51.5	65.8	22.9	54.2	95.9	33.7	30.1	36.0	34.2	49.3	39.7	40.3
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.00409	0.00373	0.00769	0.00734	0.00449	0.00368	0.00564	0.00336	0.00394	0.00492	0.00538	0.00392
tin	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.039	<0.020	0.031
uranium	0.0143	0.0248	0.00999	0.0136	0.0353	0.00589	0.00786	0.00686	0.00988	0.0162	0.0148	0.00822
vanadium	0.167	0.214	0.052	0.143	0.238	0.040	0.058	0.056	0.096	0.137	0.075	0.135
zinc	34.8	35.1	22.8	39.9	37.7	26.5	25.1	17.8	23.2	37.7	33.5	18.8
zirconium	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.042	<0.040	<0.040	<0.040

Client Sample ID	201-Ero-Exp1	202-Ero-Exp1	224-Ero-Exp2	225-Ero-Exp2	226-Ero-Exp2	227-Ero-Exp2	228-Ero-Exp2	229-Ero-Exp2	231-Ero-Exp2	232-Ero-Exp2	233-Ero-Exp2	235-Ero-Exp2
moisture	74.5	77.8	74.5	73.9	73.1	76.7	78.4	71.7	75.0	74.3	73.6	73.5
aluminum	1.9	<1.0	1.7	<1.0	<1.0	<1.0	2.6	<1.0	2.0	4.5	1.5	<1.0
antimony	0.0029	0.0045	0.0168	0.0148	0.0266	0.0072	0.0646	0.0197	0.0414	0.0389	0.0312	0.0513
arsenic	0.0501	0.0600	0.111	0.0672	0.101	0.0620	0.206	0.105	0.113	0.0920	0.201	0.173
barium	8.64	7.64	5.07	3.35	4.89	2.76	4.90	3.50	3.28	4.80	3.61	3.75
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	0.0121	<0.0020	0.0066	<0.0020	<0.0020	0.0032	0.0024	<0.0020
boron	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
cadmium	0.0757	0.0681	0.0702	0.0626	0.0562	0.0480	0.156	0.0646	0.132	0.190	0.141	0.191
calcium	30600	17600	21000	19600	23300	13100	17600	23000	18100	27200	18400	21200
cesium	0.0297	0.0199	0.0404	0.134	0.106	0.107	0.139	0.113	0.118	0.242	0.116	0.131
chromium	0.054	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.045	0.043	<0.040	0.041
cobalt	0.0518	0.0279	0.0171	0.0396	0.0470	0.0299	0.0306	0.0341	0.0322	0.0681	0.0432	0.0483
copper	0.600	0.446	0.491	0.514	0.453	0.438	0.560	0.418	0.450	0.539	0.559	0.609
iron	16.3	9.8	11.9	12.5	11.8	7.5	11.0	10.3	11.6	15.8	9.6	11.7
lead	0.259	0.764	0.359	4.19	7.57	2.94	4.92	4.95	7.51	13.2	6.91	9.68
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	680	470	570	470	559	384	454	567	493	576	487	486
manganese	9.27	6.88	1.56	6.19	3.57	4.31	4.64	6.04	5.14	9.58	6.73	6.07
mercury	0.0425	0.0528	0.0525	0.0430	0.0457	0.0291	0.0355	0.0402	0.103	0.125	0.0321	0.0425
molybdenum	0.0263	0.0305	0.0235	0.0384	0.0439	0.0204	0.0196	0.0461	0.0470	0.0465	0.0384	0.0389
nickel	0.108	0.051	0.045	0.054	0.054	0.042	0.056	0.042	0.041	0.084	0.063	0.064
phosphorus	18800	11800	14400	13300	14900	9230	11700	15200	12300	16100	11800	14000
potassium	2370	2190	2600	2960	2870	2610	2560	2790	2540	2640	2630	2390
rubidium	2.56	2.39	4.29	2.94	3.26	3.08	4.06	2.79	2.38	3.60	2.73	2.42
selenium	0.876	0.690	0.524	1.20	0.897	0.821	1.61	1.04	1.02	1.35	0.986	1.22
silver	0.0022	0.0021	<0.0010	0.0024	0.0028	0.0028	0.0049	0.0015	0.0028	0.0070	0.0052	0.0031
sodium	1900	1200	1280	1510	1480	1140	1240	1410	1240	1650	1110	1330
strontium	74.4	46.7	33.9	42.8	59.5	30.6	40.2	48.7	39.9	55.0	39.8	45.9
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	0.0132	0.0079	<0.0040	0.0050	0.0048	0.0109	0.0118	0.0066
thallium	0.00487	0.00444	0.0349	0.212	0.145	0.167	0.330	0.249	0.205	0.268	0.268	0.175
tin	<0.020	0.155	<0.020	<0.020	<0.020	<0.020	0.024	0.027	<0.020	<0.020	0.051	<0.020
uranium	0.0287	0.0128	0.0245	0.0119	0.0182	0.00491	0.0137	0.00982	0.0141	0.0113	0.0172	0.0132
vanadium	0.146	0.115	0.108	0.086	0.166	0.056	0.115	0.126	0.119	0.169	0.112	0.120
zinc	49.7	32.1	25.3	36.9	35.0	22.1	37.0	26.7	32.0	40.1	28.0	33.9
zirconium	<0.040	0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040

Client Sample ID	236-Ero-Exp2	237-Ero-Exp2	239-Ero-Exp2	240-Ero-Exp2	241-Ero-Exp2	242-Ero-Exp2	243-Ero-Exp2	244-Ero-Exp2	245-Ero-Exp2	246-Ero-Exp2	247-Ero-Exp2	248-Ero-Exp2
moisture	76.6	77.7	74.4	77.6	77.9	74.2	77.9	78.4	72.0	73.8	76.7	81.4
aluminum	<1.0	<1.0	<1.0	<1.0	1.6	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
antimony	0.0256	0.0140	0.0408	0.0114	0.0078	0.0133	0.0332	0.0155	0.0156	0.0190	0.0284	0.0587
arsenic	0.0904	0.102	0.0838	0.0730	0.0567	0.0597	0.109	0.0598	0.0720	0.0682	0.0596	0.267
barium	3.48	1.30	2.03	3.79	3.72	4.24	2.88	3.05	2.56	6.38	2.30	2.66
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0049
boron	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.31	<0.20
cadmium	0.0854	0.0968	0.121	0.0818	0.0779	0.112	0.0652	0.0729	0.118	0.0864	0.0653	0.121
calcium	19100	7070	11500	15000	14800	15000	14400	13700	15900	27600	15000	12300
cesium	0.196	0.100	0.0990	0.136	0.0892	0.127	0.0839	0.0725	0.176	0.143	0.114	0.136
chromium	<0.040	<0.040	<0.040	<0.040	<0.040	0.046	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
cobalt	0.0280	0.0385	0.0430	0.0370	0.0384	0.0335	0.0258	0.0361	0.0536	0.0418	0.0390	0.0454
copper	0.332	0.467	0.548	0.452	0.473	0.469	0.460	0.352	0.500	0.455	0.424	0.554
iron	7.6	7.9	11.4	11.0	11.2	8.7	7.5	8.4	12.1	10.0	7.7	11.0
lead	7.77	2.48	3.29	3.60	2.83	3.31	5.90	4.60	2.85	6.79	3.18	6.49
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	486	296	422	428	409	420	413	410	448	603	389	335
manganese	6.91	3.89	3.95	6.03	8.95	8.80	6.27	7.29	5.33	9.51	5.67	8.99
mercury	0.0595	0.0547	0.0280	0.0210	0.0223	0.0258	0.0352	0.0441	0.0446	0.0407	0.0318	0.0554
molybdenum	0.0363	0.0161	0.0269	0.0317	0.0290	0.0470	0.0237	0.0195	0.0522	0.0600	0.0239	0.0347
nickel	<0.040	0.048	0.055	0.058	0.068	0.050	<0.040	0.053	0.051	0.050	<0.040	0.044
phosphorus	12400	6620	10600	10300	9950	10500	10100	9200	11300	17700	10100	8240
potassium	2380	2220	2430	2440	1720	2430	2820	2080	3030	2220	2150	2220
rubidium	3.30	2.20	2.26	3.08	2.19	2.75	2.41	1.93	3.47	3.37	2.49	2.87
selenium	1.06	0.928	0.952	0.726	0.780	1.34	1.04	0.700	1.45	0.865	0.896	0.714
silver	0.0027	0.0042	0.0056	0.0032	0.0040	0.0032	0.0041	0.0022	0.0031	0.0026	0.0025	0.0103
sodium	1240	870	975	1080	750	980	1090	1000	1400	1220	988	968
strontium	41.3	15.3	25.5	32.9	32.6	32.0	31.2	30.6	32.8	63.2	30.0	25.1
tellurium	0.0052	<0.0040	0.0044	<0.0040	<0.0040	<0.0040	0.0044	<0.0040	0.0051	0.0071	<0.0040	<0.0040
thallium	0.593	0.162	0.170	0.275	0.250	0.338	0.232	0.0792	0.353	0.445	0.229	0.199
tin	<0.020	<0.020	<0.020	0.034	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.152	<0.020
uranium	0.00719	0.00331	0.00610	0.00726	0.00630	0.0125	0.00446	0.00909	0.0115	0.0147	0.00427	0.00542
vanadium	0.115	0.040	0.065	0.046	0.081	0.077	0.075	0.125	0.118	0.182	0.074	0.048
zinc	29.7	21.7	23.0	30.2	23.7	27.9	22.8	23.6	32.5	27.5	19.2	30.2
zirconium	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040

Client Sample ID	249-Ero-Exp2	250-Ero-Exp2	251-Ero-Exp2	252-Ero-Exp2	253-Ero-Exp2	263-Ero-Exp2	338-Ero-Exp-3-1-R	339-Ero-Exp-3-1-R	340-Ero-Exp-3-1-R	341-Ero-Exp-3-1-R
moisture	76.1	74.2	75.6	75.6	74.6	82.8	76.3	76.3	73.4	76.1
aluminum	<1.0	<1.0	1.3	3.4	<1.0	<1.0	<1.0	<1.0	1.6	<1.0
antimony	0.0278	0.0134	0.0104	0.0448	0.0275	0.0120	0.214	0.0316	0.0209	0.0389
arsenic	0.143	0.0928	0.120	0.136	0.191	0.0940	0.0948	0.131	0.0982	0.274
barium	2.27	2.05	2.13	3.51	2.15	1.20	3.02	3.13	5.61	2.92
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	0.0022	0.0023	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	0.22	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.48	<0.20
cadmium	0.0544	0.0778	0.108	0.104	0.0879	0.0953	0.171	0.255	0.140	0.360
calcium	12600	11800	11900	16300	13000	7050	20700	12400	27700	15500
cesium	0.129	0.135	0.117	0.106	0.117	0.102	0.0560	0.170	0.0408	0.140
chromium	0.040	0.076	<0.040	<0.040	<0.040	<0.040	0.070	<0.040	<0.040	0.084
cobalt	0.0363	0.0534	0.0484	0.0442	0.0379	0.0319	0.0356	0.0739	0.0409	0.0557
copper	0.394	0.537	0.594	0.779	0.502	0.392	1.32	0.907	0.394	0.788
iron	6.9	9.6	14.5	13.4	8.7	5.2	14.9	12.3	13.0	12.1
lead	5.23	3.89	3.03	5.16	5.12	2.64	7.11	5.00	2.52	9.75
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	414	426	378	441	375	222	462	400	610	423
manganese	4.32	5.52	7.22	10.6	5.06	3.54	5.00	10.9	6.89	8.17
mercury	0.0338	0.0292	0.0369	0.0386	0.143	0.0348	0.0314	0.0308	0.0378	0.0211
molybdenum	0.0302	0.0550	0.0356	0.0441	0.0332	0.0192	0.0396	0.0411	0.0387	0.0515
nickel	0.052	0.073	0.058	0.059	0.045	<0.040	0.073	0.114	0.060	0.047
phosphorus	8700	8700	8270	10500	9170	4660	13200	8280	17700	10100
potassium	2430	2790	2640	2340	2440	1530	2310	2840	2220	2200
rubidium	3.08	3.33	3.24	2.83	2.60	2.17	1.50	3.87	1.99	3.20
selenium	0.875	1.01	1.11	0.939	0.975	0.725	0.620	0.868	0.676	0.928
silver	0.0017	0.0046	0.0055	0.0056	0.0081	0.0027	0.0045	0.0027	0.0013	0.0030
sodium	1020	1060	1050	1070	1060	678	1160	1190	1400	979
strontium	26.4	23.9	24.2	32.3	26.2	14.6	47.1	25.6	65.2	31.6
tellurium	<0.0040	<0.0040	0.0065	<0.0040	0.0044	<0.0040	0.0043	<0.0040	0.0042	0.0062
thallium	0.197	0.190	0.260	0.0930	0.194	0.148	0.0626	0.178	0.0204	0.196
tin	0.069	<0.020	0.068	0.030	0.023	0.024	0.078	0.148	0.101	<0.020
uranium	0.00699	0.00505	0.00469	0.00762	0.00498	0.00290	0.0139	0.00799	0.0133	0.00813
vanadium	0.063	0.076	0.085	0.120	0.070	0.048	0.091	0.045	0.162	0.044
zinc	22.2	25.1	28.6	27.0	23.9	18.3	41.9	41.4	33.3	40.8
zirconium	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040

Client Sample ID	342-Ero-Exp-3-1-R	343-Ero-Exp-3-1-R	345-Ero-Exp-3-1-R	346-Ero-Exp-3-1-R	347-Ero-Exp-3-1-R	348-Ero-Exp-3-1-R	349-Ero-Exp-3-1-R	350-Ero-Exp-3-1-R	351-Ero-Exp-3-1-R
moisture	76.4	71.4	77.6	74.8	76.5	79.2	78.1	73.0	76.0
aluminum	1.0	<1.0	1.0	<1.0	<1.0	2.0	<1.0	1.2	1.1
antimony	0.0839	0.0304	0.269	0.0407	0.0187	0.0480	0.0556	0.0200	0.0861
arsenic	0.220	0.130	0.396	0.0963	0.138	0.0723	0.0929	0.0546	0.0973
barium	3.19	4.74	5.45	3.32	2.38	2.78	2.91	6.52	2.71
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	0.21	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
cadmium	0.290	0.727	0.354	0.176	0.254	0.171	0.180	0.126	0.108
calcium	17500	21100	18500	17000	12500	12600	15200	21700	11700
cesium	0.171	0.0979	0.158	0.0828	0.0864	0.0805	0.108	0.0387	0.0652
chromium	<0.040	<0.040	0.048	0.062	<0.040	<0.040	0.044	<0.040	0.041
cobalt	0.0589	0.0659	0.0597	0.0607	0.0559	0.0327	0.0451	0.0360	0.0443
copper	0.743	0.634	1.04	0.534	0.614	1.10	0.755	0.610	1.10
iron	10.7	15.7	17.9	9.6	10.8	8.6	9.8	11.0	9.6
lead	7.69	12.4	14.7	4.71	4.33	4.02	8.48	1.10	4.89
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	429	509	469	459	388	343	400	530	367
manganese	10.3	14.6	9.03	8.51	7.34	8.34	10.2	16.0	4.69
mercury	0.0299	0.0252	0.0333	0.0241	0.0175	0.0171	0.0244	0.0127	0.0224
molybdenum	0.0352	0.0509	0.0340	0.0549	0.0299	0.0385	0.0270	0.0222	0.0271
nickel	0.068	0.062	0.064	0.055	0.054	0.046	<0.040	0.040	0.040
phosphorus	11300	14000	12200	11600	8930	7990	9360	14000	7890
potassium	2030	3010	2630	2200	2350	1780	2010	2310	2120
rubidium	2.53	3.20	4.36	2.59	2.49	2.50	3.24	2.58	2.36
selenium	0.863	1.16	0.902	0.797	1.04	0.634	0.654	0.744	0.629
silver	0.0035	0.0036	0.0036	0.0016	0.0018	0.0027	0.0056	0.0017	0.0037
sodium	925	1330	1340	904	922	745	835	882	884
strontium	36.2	45.4	39.5	34.8	24.2	27.0	32.5	52.4	26.1
tellurium	0.0050	0.0041	<0.0040	0.0041	0.0042	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.367	0.0922	0.314	0.194	0.148	0.165	0.364	0.123	0.0812
tin	0.138	<0.020	<0.020	<0.020	<0.020	0.070	0.045	0.032	0.038
uranium	0.00868	0.00686	0.0113	0.00659	0.00406	0.00532	0.0110	0.00855	0.00684
vanadium	0.056	0.068	0.094	0.100	0.048	0.070	0.086	0.128	0.066
zinc	44.6	43.9	58.5	28.4	31.2	23.8	29.1	22.4	34.5
zirconium	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040

Client Sample ID	352-Ero-Exp-3-1-R	356-Ero-Exp-3-2-R	357-Ero-Exp-3-2-R	358-Ero-Exp-3-2-R	359-Ero-Exp-3-2-R	360-Ero-Exp-3-2-R	361-Ero-Exp-3-2-R	362-Ero-Exp-3-2-R	363-Ero-Exp-3-2-R
moisture	76.9	72.7	74.6	70.1	75.7	71.2	75.0	77.0	69.8
aluminum	<1.0	<1.0	<1.0	<1.0	1.1	57.4	<1.0	1.5	<1.0
antimony	0.0232	0.0453	0.0203	0.0307	0.0258	0.0709	0.0375	0.0426	0.0430
arsenic	0.0768	0.0559	0.0549	0.0843	0.0560	0.0742	0.0603	0.0730	0.0960
barium	6.92	2.83	1.20	4.37	2.30	4.27	3.43	3.30	2.08
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0024	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0025	<0.0020	<0.0020	<0.0020
boron	0.61	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.28	<0.20
cadmium	0.214	0.124	0.116	0.213	0.193	0.236	0.284	0.0871	0.171
calcium	19300	15300	6270	21000	13000	11100	15900	11300	12300
cesium	0.0755	0.0562	0.0551	0.0538	0.0586	0.0562	0.0377	0.0299	0.0551
chromium	0.066	<0.040	<0.040	<0.040	<0.040	0.210	<0.040	<0.040	<0.040
cobalt	0.0452	0.0488	0.0429	0.0599	0.0518	0.0947	0.0514	0.0516	0.0660
copper	1.45	0.552	0.547	0.963	0.759	1.57	0.823	1.21	1.14
iron	10.8	9.2	8.8	11.0	10.1	108	9.2	10.4	10.3
lead	1.30	1.64	0.730	1.31	0.974	1.56	2.22	1.82	0.902
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	0.15	<0.10	<0.10	<0.10
magnesium	459	394	246	490	358	383	428	326	346
manganese	12.7	2.50	1.12	4.95	2.43	9.80	4.35	6.43	3.75
mercury	0.0168	0.0420	0.0459	0.0394	0.0383	0.0256	0.0370	0.0228	0.0478
molybdenum	0.0596	0.0380	0.0267	0.0366	0.0349	0.0739	0.0243	0.0355	0.0487
nickel	0.069	<0.040	<0.040	<0.040	<0.040	0.140	<0.040	<0.040	<0.040
phosphorus	11600	9890	4790	13300	8710	7940	9870	7550	7980
potassium	1860	2380	2210	2450	2200	2660	2180	1890	2800
rubidium	2.40	2.33	2.22	2.12	2.26	2.90	1.53	1.69	2.12
selenium	0.917	0.757	0.672	0.853	0.648	0.716	0.572	0.582	1.00
silver	0.0037	<0.0010	<0.0010	0.0017	0.0017	0.0059	0.0016	0.0021	0.0016
sodium	887	1100	956	1140	1000	1030	1080	878	1170
strontium	44.7	38.3	15.9	56.5	32.8	28.2	44.3	27.1	28.6
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.192	0.0858	0.0551	0.0843	0.0768	0.0935	0.0316	0.0485	0.0681
tin	0.343	0.022	<0.020	<0.020	<0.020	<0.020	<0.020	0.110	0.076
uranium	0.0123	0.00653	0.00289	0.00712	0.00507	0.0650	0.00829	0.00569	0.00516
vanadium	0.112	0.083	0.040	0.096	0.078	0.239	0.081	0.073	0.094
zinc	40.2	20.4	18.5	33.7	20.5	29.0	37.5	24.2	30.2
zirconium	0.086	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.047	0.045

Client Sample ID	364-Ero-Exp-3-2-R	365-Ero-Exp-3-2-R	366-Ero-Exp-3-2-R	367-Ero-Exp-3-2-R	369-Ero-Exp-3-2-R	370-Ero-Exp-3-2-R	371-Ero-Exp-3-2-R	373-Ero-Exp-3-2-R	374-Ero-Exp-3-2-R
moisture	70.6	74.1	75.8	72.7	69.8	71.6	69.8	78.3	75.9
aluminum	<1.0	1.7	1.3	<1.0	<1.0	<1.0	1.8	<1.0	<1.0
antimony	0.0269	0.0256	0.111	0.0560	0.0162	0.106	0.0378	0.0531	0.0098
arsenic	0.0944	0.0632	0.0811	0.0674	0.0467	0.0463	0.0496	0.0612	0.0460
barium	5.86	3.78	4.12	2.67	7.97	6.65	5.46	5.55	3.37
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	0.31	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
cadmium	0.276	0.201	0.101	0.131	0.103	0.165	0.117	0.143	0.0495
calcium	21100	13100	14500	15000	28800	22900	27200	16400	13200
cesium	0.0503	0.0438	0.0300	0.0391	0.0170	0.0287	0.0276	0.0485	0.0340
chromium	0.934	<0.040	<0.040	<0.040	<0.040	<0.040	0.086	0.073	0.081
cobalt	0.0662	0.0544	0.0638	0.0537	0.0312	0.0444	0.0529	0.0384	0.0401
copper	0.863	0.857	1.11	1.07	0.589	0.800	0.728	0.936	0.710
iron	16.6	10.1	11.6	10.2	12.4	12.8	16.8	9.0	9.2
lead	2.77	1.81	2.85	1.20	0.567	1.68	1.66	0.959	0.982
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	544	362	380	417	643	520	645	413	367
manganese	8.15	6.95	8.02	6.53	11.9	6.61	6.57	13.2	5.42
mercury	0.0242	0.0201	0.0196	0.0225	0.0143	0.0397	0.0223	0.0105	0.0203
molybdenum	0.0427	0.0314	0.0207	0.0397	0.0299	0.0393	0.0368	0.0300	0.0193
nickel	<0.040	<0.040	<0.040	0.040	<0.040	0.079	0.050	0.045	0.048
phosphorus	13400	8640	9360	9790	17500	13800	16000	10400	8560
potassium	2330	2160	2340	2560	2660	2080	2670	1730	2270
rubidium	2.30	1.64	2.23	2.06	1.87	1.79	2.27	3.12	2.51
selenium	0.905	0.673	0.506	0.705	0.714	0.629	0.739	0.522	0.698
silver	0.0026	0.0056	0.0024	0.0020	0.0011	0.0017	0.0012	0.0012	0.0014
sodium	997	829	1040	1080	1240	1300	1260	769	1050
strontium	46.9	30.6	36.0	35.6	67.9	69.3	59.7	37.3	30.6
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.133	0.0756	0.0195	0.0473	0.0313	0.0264	0.0323	0.0756	0.0271
tin	0.135	0.027	0.064	0.022	<0.020	0.030	<0.020	<0.020	<0.020
uranium	0.00940	0.00692	0.00766	0.00559	0.0117	0.0139	0.0148	0.0125	0.00562
vanadium	0.117	0.086	0.119	0.073	0.132	0.120	0.168	0.074	0.070
zinc	32.8	27.0	23.8	29.2	26.6	32.2	26.8	34.2	22.7
zirconium	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040

Client Sample ID	377-Ero-Exp-3-2-L	378-Ero-Exp-3-2-L	379-Ero-Exp-3-2-L	380-Ero-Exp-3-2-L	381-Ero-Exp-3-2-L	382-Ero-Exp-3-2-L	383- Ero-Exp-3-2-L	344-Ero-Exp-3-1-R	384-Ero-Exp-3-2-L
moisture	70.1	72.0	73.7	73.2	78.1	75.5	76.4	75.8	78.1
aluminum	<1.0	<1.0	<1.0	<1.0	<1.0	2.2	<1.0	<1.0	<1.0
antimony	0.0161	0.0140	<0.0020	0.0098	<0.0020	0.0269	0.0027	0.0280	<0.0020
arsenic	0.0360	0.0376	0.0533	0.0224	0.0430	0.0681	0.0302	0.136	0.0262
barium	4.88	6.01	4.27	3.26	3.58	4.01	6.91	3.23	4.02
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
cadmium	0.0244	0.0501	0.0392	0.0160	0.0290	0.0771	0.0643	0.164	0.0238
calcium	15900	24700	13200	11800	11900	15900	25800	13100	22600
cesium	0.0253	0.0284	0.0276	0.0192	0.0123	0.0288	0.0214	0.113	0.0168
chromium	<0.040	<0.040	0.043	<0.040	<0.040	<0.040	0.045	0.056	0.074
cobalt	0.0337	0.0302	0.0331	0.0207	0.0238	0.0247	0.0357	0.0478	0.0191
copper	0.518	0.434	0.442	0.437	0.347	0.342	0.495	0.469	0.438
iron	9.9	12.8	10.6	5.7	7.6	10.0	12.3	6.2	7.8
lead	0.824	0.482	0.282	0.388	0.099	0.789	0.404	7.11	0.115
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	415	534	391	372	347	427	589	389	492
manganese	7.35	8.82	4.47	4.24	6.50	6.66	6.39	9.18	4.77
mercury	0.0164	0.0178	0.0354	0.0193	0.0129	0.0289	0.0462	0.0243	0.0276
molybdenum	0.0263	0.0264	0.0278	0.0169	0.0173	0.0234	0.0152	0.0293	0.0122
nickel	<0.040	0.057	<0.040	<0.040	<0.040	0.048	<0.040	0.045	0.044
phosphorus	10200	14300	8740	8210	7880	9720	14700	8500	13400
potassium	2540	2560	2500	2470	1930	1980	1640	2000	2250
rubidium	2.35	2.43	2.72	2.08	1.97	2.11	1.93	2.78	1.94
selenium	0.631	0.686	0.924	0.542	0.561	0.505	0.718	0.815	0.645
silver	0.0014	0.0014	<0.0010	<0.0010	<0.0010	<0.0010	0.0012	0.0014	<0.0010
sodium	1110	1230	1040	990	756	878	1250	784	1050
strontium	37.2	52.8	35.6	29.1	28.1	38.8	63.3	29.3	52.4
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.00389	0.00618	0.00521	0.00664	0.00491	0.00476	0.00312	0.278	0.00328
tin	0.093	0.224	<0.020	<0.020	<0.020	<0.020	<0.020	0.141	0.204
uranium	0.00758	0.0133	0.00679	0.00510	0.00456	0.0231	0.0113	0.00673	0.00884
vanadium	0.098	0.132	0.090	0.079	0.086	0.075	0.140	0.069	0.122
zinc	25.9	28.7	28.8	15.1	20.2	34.9	34.0	29.6	21.1
zirconium	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.079	<0.040	<0.040

Client Sample ID	385-Ero-Exp-3-2-L	386-Ero-Exp-3-2-L	387-Ero-Exp-3-2-L	388-Ero-Exp-3-2-L	389-Ero-Exp-3-2-L	390-Ero-Exp-3-2-L	392-Ero-Exp-3-2-L	394-Ero-Exp-3-1-L	395-Ero-Exp-3-1-L
moisture	79.2	78.6	75.2	77.0	73.4	75.9	79.5	75.5	77.8
aluminum	<1.0	<1.0	1.1	<1.0	<1.0	<1.0	1.4	1.1	<1.0
antimony	0.0044	0.0056	0.0255	0.0034	<0.0020	<0.0020	<0.0020	0.0040	<0.0020
arsenic	0.0347	0.0636	0.0406	0.0510	0.0830	0.0510	0.0483	0.0753	0.0432
barium	3.50	6.77	6.52	5.83	4.59	5.18	6.35	5.61	4.20
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
cadmium	0.0266	0.0316	0.0750	0.0275	0.0751	0.0454	0.0331	0.0758	0.0390
calcium	13600	22700	23500	18600	18400	16500	14200	21900	18100
cesium	0.0162	0.0165	0.0338	0.0178	0.0188	0.0266	0.0196	0.0224	0.0175
chromium	<0.040	<0.040	0.088	<0.040	0.050	0.046	0.080	0.098	0.196
cobalt	0.0235	0.0260	0.0417	0.0286	0.0370	0.0309	0.0234	0.0357	0.0393
copper	0.385	0.498	0.510	0.433	0.435	0.522	0.406	0.443	0.508
iron	8.3	12.4	12.3	9.3	12.4	12.9	10.6	13.6	12.5
lead	0.250	0.361	0.939	0.652	0.240	0.194	0.202	0.717	0.120
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	399	570	601	513	553	507	446	550	538
manganese	5.29	10.1	7.47	6.45	8.40	6.39	12.6	5.44	6.99
mercury	0.0143	0.0157	0.0267	0.0216	0.0111	0.0151	0.0121	0.0237	0.0348
molybdenum	0.0168	0.0408	0.0279	0.0185	0.0162	0.0248	0.0258	0.0283	0.0229
nickel	0.043	0.051	0.078	0.066	0.060	0.059	0.060	0.092	0.231
phosphorus	9650	15100	14400	12200	13000	12100	9840	14400	12300
potassium	2390	2160	2490	2020	2780	3160	2730	3110	2620
rubidium	2.03	1.95	2.26	2.14	3.24	3.16	2.91	2.70	2.00
selenium	0.650	0.774	0.812	0.520	0.745	0.892	0.722	0.818	0.690
silver	<0.0010	0.0014	0.0013	0.0012	<0.0010	0.0020	<0.0010	0.0014	0.0012
sodium	917	1070	1420	1040	948	1270	1030	1550	1440
strontium	30.0	51.8	59.9	45.3	37.2	36.0	30.6	47.5	41.0
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.00654	0.00414	0.0101	0.00312	0.0106	0.00333	0.00530	0.00587	0.00320
tin	0.186	<0.020	0.354	<0.020	0.215	<0.020	<0.020	<0.020	0.170
uranium	0.00529	0.00961	0.0109	0.0106	0.00799	0.00686	0.00690	0.00838	0.00935
vanadium	0.077	0.125	0.140	0.136	0.152	0.091	0.116	0.159	0.164
zinc	26.4	30.6	46.5	31.4	21.7	26.1	22.5	34.9	31.8
zirconium	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.046	0.043	<0.040

Client Sample ID	396-Ero-Exp-3-1-L	397-Ero-Exp-3-1-L	399-Ero-Exp-3-1-L	400-Ero-Exp-3-1-L	401-Ero-Exp-3-1-L	402-Ero-Exp-3-1-L	403-Ero-Exp-3-1-L	404-Ero-Exp-3-1-L	405-Ero-Exp-3-1-L
moisture	76.5	74.2	77.1	77.0	75.8	77.1	81.0	78.2	75.9
aluminum	<1.0	1.4	<1.0	3.0	<1.0	6.2	2.0	<1.0	<1.0
antimony	0.0022	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
arsenic	0.0495	0.0486	0.0326	0.0386	0.0286	0.0681	0.0688	0.0272	0.0436
barium	3.88	7.95	5.95	4.26	5.48	6.86	7.23	3.92	4.06
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	<0.20	<0.20	<0.20	<0.20	<0.20	0.24	<0.20	<0.20	<0.20
cadmium	0.0358	0.0353	0.0207	0.0383	0.0130	0.0458	0.0402	0.0200	0.0279
calcium	15600	20500	18000	18200	17300	23000	17600	15400	14800
cesium	0.0260	0.0209	0.0130	0.0191	0.0130	0.0168	0.0134	0.0209	0.0168
chromium	0.067	0.056	0.053	0.086	0.051	0.059	<0.040	0.094	0.043
cobalt	0.0414	0.0302	0.0212	0.0279	0.0294	0.0309	0.0259	0.0258	0.0265
copper	0.541	0.530	0.369	0.457	0.411	0.404	0.342	0.423	0.328
iron	10.4	12.9	12.0	11.6	10.5	20.9	19.0	9.2	9.1
lead	0.217	0.112	0.105	0.107	0.097	0.118	0.124	0.103	0.073
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	496	574	471	503	477	512	438	443	418
manganese	7.50	10.4	9.87	4.82	8.45	8.57	8.44	5.07	6.55
mercury	0.0167	0.0151	0.0129	0.0265	0.0154	0.0161	0.0203	0.0192	0.0138
molybdenum	0.0187	0.0280	0.0146	0.0264	0.0195	0.0198	0.0196	0.0141	0.0114
nickel	0.114	0.076	0.066	0.056	0.064	0.089	0.059	0.068	0.070
phosphorus	11200	14400	12300	12100	11700	14100	11100	10100	10300
potassium	3220	3030	2440	2680	2530	2210	1620	2630	2580
rubidium	3.79	2.58	2.11	2.56	2.22	2.02	1.57	2.72	2.62
selenium	0.792	0.867	0.704	0.662	0.598	0.699	0.556	0.645	0.804
silver	<0.0010	0.0017	<0.0010	<0.0010	<0.0010	0.0011	<0.0010	<0.0010	<0.0010
sodium	1370	1360	1070	1290	1030	1240	873	1290	1010
strontium	36.9	45.7	39.1	41.3	37.0	55.7	39.9	35.2	34.2
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.00528	0.00500	0.00351	0.00536	0.00320	0.00618	0.00385	0.00253	0.00694
tin	<0.020	<0.020	0.367	<0.020	0.380	0.205	<0.020	0.330	<0.020
uranium	0.0115	0.00866	0.00771	0.00830	0.00559	0.0137	0.0105	0.00480	0.00709
vanadium	0.044	0.120	0.074	0.136	0.105	0.136	0.127	0.090	0.073
zinc	25.1	25.3	21.4	20.4	19.9	28.8	26.5	20.6	21.3
zirconium	<0.040	0.060	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040

Client Sample ID	406-Ero-Exp-3-1-L	407-Ero-Exp-3-1-L	408-Ero-Exp-3-1-L	409-Ero-Exp-3-1-L	411-Ero-Exp-3-3-L	412-Ero-Exp-3-3-L	413-Ero-Exp-3-3-L	414-Ero-Exp-3-3-L	415-Ero-Exp-3-3-L
moisture	79.0	80.3	79.6	82.0	77.4	81.6	79.8	77.8	79.9
aluminum	11.5	<1.0	<1.0	1.4	2.6	<1.0	2.1	1.4	3.1
antimony	<0.0020	<0.0020	<0.0020	0.0022	0.0434	0.0163	0.0026	0.0060	0.0048
arsenic	0.0555	0.0474	0.0350	0.0392	0.0673	0.0241	0.0569	0.0920	0.0901
barium	5.64	3.06	6.28	4.93	4.09	2.67	3.48	5.94	4.35
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	<0.20	0.27	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
cadmium	0.0374	0.0247	0.0222	0.0474	0.0391	0.0189	0.131	0.0781	0.230
calcium	20300	10300	15100	13000	17600	9610	11500	13700	11000
cesium	0.0173	0.0149	0.0110	0.0171	0.0130	0.0163	0.0125	0.0124	0.0150
chromium	0.042	0.081	0.050	0.440	<0.040	<0.040	0.058	0.047	0.075
cobalt	0.0387	0.0274	0.0229	0.0421	0.0257	0.0187	0.0277	0.0249	0.0469
copper	0.396	0.351	0.375	0.399	0.410	0.352	0.664	0.776	0.733
iron	36.3	8.0	8.8	11.5	13.5	7.2	29.3	8.4	36.0
lead	0.117	0.085	0.114	0.217	0.527	0.194	0.328	0.713	1.15
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	473	325	396	360	409	291	326	396	315
manganese	9.05	4.96	10.8	6.89	4.88	3.79	4.36	4.78	5.15
mercury	0.0143	0.0144	0.0098	0.0128	0.0433	0.0142	0.0124	0.0122	0.0119
molybdenum	0.0276	0.0248	0.0176	0.0251	0.0250	0.0163	0.0177	0.0147	0.0169
nickel	0.077	0.058	0.043	0.236	0.051	<0.040	0.065	0.062	0.120
phosphorus	13100	7160	10200	8460	10700	6420	7740	9350	7480
potassium	1760	1840	1820	1960	1600	1500	1760	2220	1990
rubidium	2.41	2.07	1.92	2.38	1.32	1.47	1.76	2.56	2.56
selenium	0.626	0.583	0.535	0.441	0.689	0.474	0.625	0.763	0.869
silver	0.0010	<0.0010	0.0011	0.0020	0.0015	<0.0010	0.0028	0.0026	0.0026
sodium	873	714	734	1060	1040	600	855	1020	1010
strontium	44.8	24.3	35.0	31.3	44.9	24.7	26.6	32.5	28.2
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.00551	0.00538	0.00550	0.00378	0.00585	0.0127	0.00396	0.0110	0.00375
tin	0.192	0.248	0.381	0.022	0.297	<0.020	0.135	<0.020	<0.020
uranium	0.0107	0.00712	0.00694	0.00855	0.0136	0.00481	0.00555	0.0102	0.00752
vanadium	0.201	0.077	0.092	0.049	0.168	0.075	0.116	0.079	0.167
zinc	15.5	19.0	20.1	27.8	49.5	22.8	29.5	27.9	28.9
zirconium	<0.040	<0.040	0.064	0.309	<0.040	<0.040	<0.040	<0.040	<0.040

Client Sample ID	416-Ero-Exp-3-3-L	417-Ero-Exp-3-3-L	418-Ero-Exp-3-3-L	419-Ero-Exp-3-3-L	420-Ero-Exp-3-3-L	421-Ero-Exp-3-3-L	422-Ero-Exp-3-3-L	423-Ero-Exp-3-3-L	424-Ero-Exp-3-3-L
moisture	76.6	80.4	77.7	77.0	75.5	75.3	78.7	79.1	79.4
aluminum	1.2	5.1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
antimony	0.0163	0.0028	0.0115	0.0100	<0.0020	0.0080	0.0128	<0.0020	0.0140
arsenic	0.0304	0.0490	0.0225	0.0405	0.0254	0.0336	0.0301	0.0194	0.0341
barium	3.53	3.60	5.76	4.62	3.64	4.61	4.51	3.57	6.55
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
cadmium	0.0295	0.0766	0.0309	0.0328	0.0120	0.0229	0.0276	0.0202	0.0305
calcium	17200	10400	14600	14800	16000	16400	13800	14000	16300
cesium	0.0249	0.0118	0.0212	0.0186	0.0153	0.0159	0.0209	0.0146	0.0185
chromium	0.059	0.050	0.046	0.047	<0.040	<0.040	0.078	<0.040	0.061
cobalt	0.0315	0.0267	0.0287	0.0247	0.0232	0.0230	0.0452	0.0207	0.0292
copper	0.535	0.381	0.420	0.398	0.404	0.529	0.415	0.391	0.374
iron	12.7	29.3	11.2	10.4	13.3	8.9	9.7	10.3	9.8
lead	0.409	0.244	0.948	0.423	0.217	0.348	0.377	0.129	0.493
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	462	310	403	428	476	447	347	372	442
manganese	5.35	5.11	8.22	3.54	6.00	4.66	6.01	2.59	9.59
mercury	0.0140	0.0208	0.0179	0.0346	0.0148	0.0210	0.0156	0.0229	0.0146
molybdenum	0.0222	0.0255	0.0186	0.0173	0.0285	0.0252	0.0282	0.0145	0.0272
nickel	0.057	0.056	0.056	0.055	0.046	0.045	0.056	<0.040	0.063
phosphorus	11100	6960	9180	10300	11400	11200	8500	9210	10700
potassium	2360	1620	2260	2370	2770	2220	1970	1920	2100
rubidium	2.32	1.52	1.91	2.26	2.00	2.07	1.71	1.64	2.09
selenium	0.639	0.677	0.575	0.656	0.634	0.694	0.710	0.516	0.562
silver	0.0012	0.0015	0.0012	0.0011	<0.0010	0.0010	<0.0010	0.0012	<0.0010
sodium	1120	719	1210	1210	1070	1070	888	978	974
strontium	42.0	25.6	37.3	42.2	39.8	44.8	35.7	37.8	40.5
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.00507	0.00467	0.00319	0.00392	0.00402	0.00360	0.0110	0.00369	0.0102
tin	0.154	<0.020	<0.020	<0.020	<0.020	<0.020	0.344	<0.020	<0.020
uranium	0.00820	0.00767	0.0112	0.00920	0.00961	0.0111	0.00562	0.00414	0.00874
vanadium	0.121	0.147	0.088	0.115	0.120	0.096	0.090	0.089	0.130
zinc	26.4	23.6	31.7	27.5	19.5	33.3	25.6	28.5	25.8
zirconium	<0.040	0.150	<0.040	<0.040	<0.040	<0.040	<0.040	0.233	<0.040

Client Sample ID	425-Ero-Exp-3-3-L	426-Ero-Exp-3-3-L	427-Ero-Exp-3-3-L	428-Ero-Exp-3-4-L	429-Ero-Exp-3-4-L	430-Ero-Exp-3-4-L	431-Ero-Exp-3-4-L	432-Ero-Exp-3-4-L	433-Ero-Exp-3-4-L
moisture	77.6	81.6	78.5	75.8	77.7	79.8	75.0	73.8	77.1
aluminum	<1.0	<1.0	1.0	3.4	<1.0	<1.0	<1.0	2.4	5.2
antimony	0.0083	0.0088	0.0060	0.0206	0.0098	0.0031	0.0194	0.0196	0.0594
arsenic	0.0408	0.0341	0.0382	0.0641	0.0358	0.0275	0.0372	0.0560	0.0624
barium	4.02	4.71	3.14	8.36	5.49	2.10	3.40	5.36	8.61
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
cadmium	0.0517	0.0110	0.0677	0.165	0.0468	0.0257	0.154	0.0849	0.340
calcium	14800	11200	13600	27300	17400	9360	19600	24000	30500
cesium	0.0311	0.0143	0.0142	0.0197	0.0212	0.0148	0.0186	0.0283	0.0173
chromium	<0.040	<0.040	<0.040	0.062	<0.040	<0.040	<0.040	0.053	0.063
cobalt	0.0351	0.0180	0.0262	0.0265	0.0316	0.0240	0.0345	0.0337	0.0242
copper	0.597	0.461	0.427	0.457	0.514	0.488	0.494	0.375	0.870
iron	13.4	7.8	9.8	35.7	9.4	9.8	10.2	11.4	24.9
lead	0.465	0.237	0.163	0.968	0.346	0.104	0.360	0.565	2.20
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	401	341	344	647	446	346	513	545	672
manganese	5.51	7.32	4.25	6.94	4.53	3.46	4.89	5.42	8.28
mercury	0.0175	0.0131	0.0198	0.0361	0.0332	0.0198	0.0204	0.0280	0.0579
molybdenum	0.0225	0.0159	0.0118	0.0148	0.0166	0.0128	0.0293	0.0184	0.0478
nickel	0.044	<0.040	0.049	0.066	0.040	0.046	0.042	<0.040	0.050
phosphorus	9500	7450	8650	16300	10800	6640	12500	14800	17600
potassium	2310	1900	1840	2290	1960	2120	2470	2250	1430
rubidium	2.32	1.60	1.41	2.25	2.31	1.84	2.15	2.40	1.26
selenium	0.780	0.441	0.641	0.462	0.775	0.646	0.632	0.664	0.659
silver	0.0018	0.0011	0.0011	0.0015	0.0015	0.0011	0.0014	0.0012	0.0022
sodium	1020	783	937	1440	1100	865	1130	1130	1240
strontium	37.1	26.6	32.7	67.4	43.0	20.7	40.4	62.4	76.4
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	0.0045
thallium	0.00716	0.00404	0.00357	0.00533	0.00358	0.00298	0.00799	0.0139	0.00784
tin	<0.020	<0.020	0.228	<0.020	<0.020	0.174	<0.020	0.158	0.156
uranium	0.00518	0.00590	0.00653	0.0162	0.00739	0.00429	0.00749	0.0114	0.0322
vanadium	0.104	0.094	0.079	0.228	0.084	0.051	0.119	0.140	0.224
zinc	30.6	19.8	25.8	41.2	21.8	19.8	18.5	25.7	46.8
zirconium	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.046	<0.040	<0.040

Client Sample ID	434-Ero-Exp-3-4-L	435-Ero-Exp-3-4-L	436-Ero-Exp-3-4-L	437-Ero-Exp-3-4-L	438-Ero-Exp-3-4-L	439-Ero-Exp-3-4-L	440-Ero-Exp-3-4-L	441-Ero-Exp-3-4-L	442-Ero-Exp-3-4-L
moisture	77.2	79.7	78.6	78.3	77.6	77.7	77.4	76.8	79.0
aluminum	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.4	1.1	<1.0
antimony	0.0149	0.0154	0.0151	0.0239	0.0152	0.0121	0.0064	0.0119	0.0089
arsenic	0.0353	0.0247	0.0358	0.0466	0.0738	0.0324	0.0247	0.0293	0.0332
barium	7.05	3.28	4.00	5.43	6.77	4.04	5.66	4.06	3.14
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
cadmium	0.0314	0.0860	0.0206	0.322	0.447	0.0319	0.0558	0.104	0.0276
calcium	27100	16600	20000	21200	23300	20900	23400	15200	15300
cesium	0.0137	0.0120	0.0173	0.0143	0.0205	0.0144	0.0127	0.0155	0.0160
chromium	0.077	<0.040	0.068	0.058	0.056	0.040	<0.040	<0.040	<0.040
cobalt	0.0284	0.0202	0.0292	0.0219	0.0362	0.0222	0.0189	0.0167	0.0290
copper	0.452	0.370	0.421	0.331	0.642	0.435	0.364	0.457	0.465
iron	14.0	7.4	10.2	8.0	10.6	11.2	9.8	8.7	9.0
lead	0.719	0.328	0.340	0.930	0.562	0.228	0.282	0.237	0.184
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	593	396	466	430	502	502	521	440	358
manganese	7.52	5.20	4.96	8.95	6.61	6.90	4.93	5.58	3.87
mercury	0.0236	0.0107	0.0241	0.0229	0.0339	0.0163	0.0200	0.0206	0.0249
molybdenum	0.0396	0.0130	0.0190	0.0185	0.0197	0.0218	0.0117	<0.0080	0.0285
nickel	0.051	<0.040	0.067	0.051	0.066	0.044	<0.040	0.047	0.047
phosphorus	15500	10000	12300	11300	13800	12900	14200	9840	9030
potassium	1690	1460	1830	1430	1890	2560	1810	2300	1810
rubidium	1.23	1.34	1.69	1.07	1.65	1.69	1.83	1.97	1.58
selenium	0.602	0.528	0.546	0.364	0.522	0.588	0.661	0.606	0.635
silver	0.0013	<0.0010	0.0011	0.0014	0.0037	0.0019	<0.0010	0.0011	0.0012
sodium	1220	742	1180	997	1310	1320	1060	1020	935
strontium	64.5	37.9	46.6	51.2	54.2	45.0	59.2	38.7	32.8
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.00386	0.00603	0.00261	0.00382	0.00474	0.00312	0.00381	0.00430	0.0134
tin	0.251	0.163	0.319	0.175	0.253	<0.020	<0.020	0.194	0.128
uranium	0.0178	0.00500	0.00898	0.0133	0.0103	0.00726	0.00690	0.00778	0.00585
vanadium	0.158	0.088	0.177	0.124	0.135	0.106	0.098	0.094	0.078
zinc	37.6	16.5	29.8	31.8	41.6	26.3	19.5	21.9	21.0
zirconium	<0.040	<0.040	<0.040	<0.040	<0.040	0.068	0.041	<0.040	<0.040

Client Sample ID	449-Ero-Exp-3-3-R	450-Ero-Exp-3-3-R	451-Ero-Exp-3-3-R	452-Ero-Exp-3-3-R	453-Ero-Exp-3-3-R	454-Ero-Exp-3-3-R	455-Ero-Exp-3-3-R	456-Ero-Exp-3-3-R	457-Ero-Exp-3-3-R
moisture	83.4	76.8	75.0	81.6	77.9	78.3	76.8	75.4	78.6
aluminum	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
antimony	0.0038	0.0155	0.0486	0.0067	0.0045	0.0116	0.0119	0.0120	0.0158
arsenic	0.0286	0.0445	0.0461	0.0242	0.0222	0.0243	0.0288	0.0338	0.0448
barium	1.94	3.81	2.77	1.93	3.49	3.82	4.31	4.82	3.75
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
cadmium	0.0882	0.0450	0.0353	0.0273	0.0488	0.0485	0.0426	0.0445	0.0631
calcium	9380	22100	13000	10700	18000	21600	18300	22500	15600
cesium	0.0176	0.0217	0.0361	0.0216	0.0185	0.0214	0.0188	0.0211	0.0224
chromium	<0.040	0.068	<0.040	0.067	0.052	<0.040	0.047	0.044	0.066
cobalt	0.0202	0.0285	0.0379	0.0201	0.0232	0.0316	0.0182	0.0197	0.0285
copper	0.432	0.378	0.559	0.307	0.436	0.406	0.398	0.332	0.348
iron	7.3	8.6	10.1	7.2	9.7	10.1	8.3	9.9	9.2
lead	0.351	0.423	0.318	0.207	0.231	0.423	0.329	0.388	0.451
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	267	466	363	298	414	458	433	487	361
manganese	2.27	4.77	5.04	2.48	4.14	3.46	4.42	5.35	3.82
mercury	0.0128	0.0282	0.0160	0.0302	0.0232	0.0235	0.0253	0.0176	0.0207
molybdenum	0.0186	0.0169	0.0281	0.0116	0.0146	0.0350	0.0249	0.0231	0.0185
nickel	0.043	0.054	0.084	0.053	0.050	<0.040	<0.040	<0.040	<0.040
phosphorus	5720	13200	8430	6460	10900	12000	10800	13600	9180
potassium	1320	1780	2540	1600	1770	1580	1930	1970	1600
rubidium	1.72	2.01	2.91	1.85	1.73	1.79	1.39	1.88	1.69
selenium	0.490	0.727	0.622	0.586	0.725	0.466	0.553	0.629	0.644
silver	<0.0010	<0.0010	0.0015	<0.0010	0.0010	<0.0010	0.0010	<0.0010	<0.0010
sodium	660	1060	1030	859	966	967	1010	993	894
strontium	20.4	51.5	29.7	25.9	42.6	50.6	49.6	57.5	40.1
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.0166	0.00702	0.0172	0.00751	0.0123	0.0207	0.0214	0.0298	0.0123
tin	<0.020	0.247	<0.020	0.167	0.198	<0.020	0.216	0.151	<0.020
uranium	0.00574	0.00658	0.00904	0.00412	0.00588	0.00855	0.00821	0.0111	0.00844
vanadium	0.023	0.094	0.043	0.057	0.064	0.086	0.094	0.114	0.110
zinc	19.3	26.0	21.2	22.8	18.8	24.9	27.8	26.0	26.8
zirconium	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040

Client Sample ID	458-Ero-Exp-3-3-R	459-Ero-Exp-3-3-R	460-Ero-Exp-3-3-R	461-Ero-Exp-3-3-R	462-Ero-Exp-3-3-R	463-Ero-Exp-3-3-R	478-Ero-Exp-3-4-R	479-Ero-Exp-3-4-R	480-Ero-Exp-3-4-R
moisture	75.9	78.0	77.1	80.7	81.9	78.8	75.3	77.2	83.1
aluminum	<1.0	<1.0	<1.0	<1.0	<1.0	1.2	<1.0	<1.0	2.5
antimony	0.0172	0.0042	0.0154	0.0114	0.0051	0.0143	0.0287	0.0182	0.0102
arsenic	0.0265	0.0280	0.0227	0.0275	0.0460	0.0486	0.0250	0.0433	0.0567
barium	4.61	3.76	3.52	3.59	3.70	5.46	4.58	2.71	3.21
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
cadmium	0.0604	0.0220	0.0245	0.0395	0.0346	0.0877	0.0263	0.0350	0.0495
calcium	27900	13700	15700	14900	11000	19400	23500	10200	13900
cesium	0.0237	0.0189	0.0217	0.0223	0.0218	0.0292	0.0175	0.0173	0.0214
chromium	0.055	<0.040	<0.040	0.055	0.060	0.060	<0.040	0.047	<0.040
cobalt	0.0266	0.0214	0.0200	0.0268	0.0259	0.0384	0.0281	0.0190	0.0198
copper	0.345	0.362	0.335	0.304	0.404	0.638	0.393	0.481	0.354
iron	9.8	7.6	8.5	7.8	10.4	25.3	11.4	10.5	10.2
lead	0.946	0.228	0.410	0.306	0.220	0.496	0.561	0.457	0.534
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	525	350	388	344	315	452	530	330	348
manganese	3.19	4.61	4.21	3.44	6.35	7.14	3.72	4.73	3.58
mercury	0.0278	0.0150	0.0178	0.0236	0.0106	0.0213	0.0214	0.0114	0.0155
molybdenum	0.0189	0.0171	0.0234	0.0141	0.0167	0.0179	0.0340	0.0228	0.0160
nickel	<0.040	<0.040	<0.040	<0.040	0.046	0.058	<0.040	<0.040	<0.040
phosphorus	16600	8700	9710	8990	7150	11400	13500	6830	8490
potassium	1650	1860	1980	1470	2060	1630	2100	1980	1440
rubidium	1.64	1.45	1.63	1.62	1.93	1.76	1.68	1.37	2.18
selenium	0.615	0.586	0.561	0.592	0.477	0.681	0.535	0.669	0.470
silver	<0.0010	<0.0010	<0.0010	<0.0010	0.0011	0.0018	0.0011	0.0014	<0.0010
sodium	1210	970	972	928	1000	985	1070	758	712
strontium	63.0	31.5	36.5	36.1	26.0	45.9	57.9	22.4	30.9
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.0172	0.0171	0.0221	0.00943	0.00917	0.0224	0.0122	0.0149	0.0289
tin	0.101	<0.020	0.170	0.141	<0.020	0.149	<0.020	0.307	0.342
uranium	0.00640	0.00482	0.00749	0.00406	0.00329	0.00912	0.0130	0.00653	0.0138
vanadium	0.128	0.078	0.068	0.074	0.035	0.086	0.092	0.087	0.077
zinc	26.4	20.8	23.1	24.2	24.8	26.2	28.0	18.7	25.3
zirconium	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.088	<0.040	<0.040

Client Sample ID	481-Ero-Exp-3-4-R	482-Ero-Exp-3-4-R	483-Ero-Exp-3-4-R	484-Ero-Exp-3-4-R	485-Ero-Exp-3-4-R	486-Ero-Exp-3-4-R	487-Ero-Exp-3-4-R	488-Ero-Exp-3-4-R	489-Ero-Exp-3-4-R
moisture	80.2	78.2	76.9	74.9	83.4	72.3	76.0	76.3	78.1
aluminum	3.0	<1.0	2.4	<1.0	3.8	1.4	1.9	<1.0	<1.0
antimony	0.0056	0.0088	0.0241	0.0055	0.0070	0.0186	0.0116	0.0137	0.0099
arsenic	0.0654	0.0511	0.0864	0.0540	0.0307	0.0714	0.0649	0.0830	0.0744
barium	2.24	2.14	3.94	2.38	8.24	3.82	3.26	3.71	3.96
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	0.27	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
cadmium	0.0494	0.0343	0.0576	0.0369	0.0183	0.0496	0.0850	0.0578	0.0501
calcium	11000	13200	13700	16400	14600	15000	15200	15800	12100
cesium	0.0266	0.0206	0.0334	0.0202	0.0049	0.0283	0.0375	0.0304	0.0321
chromium	0.049	<0.040	0.072	0.053	0.044	0.049	0.081	0.048	0.050
cobalt	0.0249	0.0267	0.0472	0.0255	0.0104	0.0372	0.0473	0.0423	0.0375
copper	0.644	0.381	0.577	0.562	0.333	0.595	0.573	0.575	0.465
iron	8.2	9.9	25.5	13.3	9.5	11.5	11.9	10.7	9.4
lead	0.400	0.233	0.706	0.255	0.383	0.529	0.640	0.344	0.448
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	288	371	406	439	342	433	400	461	401
manganese	2.95	3.44	6.24	3.59	10.3	6.40	5.67	4.89	7.64
mercury	0.0136	0.0117	0.0138	0.0131	0.0094	0.0181	0.0220	0.0128	0.0129
molybdenum	0.0186	0.0230	0.0303	0.0272	0.0128	0.0293	0.0294	0.0334	0.0256
nickel	0.050	<0.040	0.073	0.041	0.052	0.062	0.076	0.061	0.053
phosphorus	6760	8450	9190	10200	8080	9830	9300	9960	8150
potassium	1840	2000	2410	2300	381	2860	2070	2500	2900
rubidium	2.81	2.25	3.33	2.08	0.362	2.93	3.11	3.10	3.54
selenium	0.650	0.635	0.774	0.792	0.250	0.676	0.908	0.763	0.729
silver	0.0012	<0.0010	<0.0010	0.0016	<0.0010	0.0014	0.0013	0.0018	<0.0010
sodium	816	726	960	878	194	1030	943	904	937
strontium	23.7	29.7	32.1	35.2	32.1	39.5	34.8	33.3	25.6
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.0405	0.0391	0.0429	0.0348	0.00906	0.0356	0.0423	0.0393	0.0449
tin	0.194	0.329	0.045	0.167	0.330	<0.020	0.158	<0.020	<0.020
uranium	0.00832	0.00816	0.0125	0.00779	0.0225	0.0117	0.0111	0.0128	0.00541
vanadium	0.044	0.063	0.107	0.101	0.063	0.147	0.120	0.101	0.086
zinc	20.5	15.7	22.9	18.6	17.6	30.0	30.7	25.8	22.9
zirconium	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.079	<0.040

Client Sample ID	490-Ero-Exp-3-4-R	491-Ero-Exp-3-4-R	496-Ero-Exp-5	497-Ero-Exp-5	498-Ero-Exp-5	499-Ero-Exp-5	500-Ero-Exp-5	501-Ero-Exp-5	502-Ero-Exp-5	503-Ero-Exp-5	504-Ero-Exp-5
moisture	79.9	81.7	77.0	78.2	74.9	73.9	76.2	78.5	76.4	76.1	77.5
aluminum	1.0	<1.0	2.5	<1.0	1.0	<1.0	1.3	1.9	<1.0	2.5	3.0
antimony	0.0113	0.0165	0.0125	0.0088	0.0331	0.0129	0.0363	0.0103	0.0169	0.0271	0.0398
arsenic	0.0458	0.0451	0.0482	0.0639	0.0285	0.0327	0.0433	0.0309	0.0277	0.0331	0.0422
barium	6.01	6.16	6.10	2.72	4.95	4.60	4.01	2.31	3.86	5.30	3.44
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	<0.20	0.21	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.28
cadmium	0.0535	0.0853	0.100	0.0290	0.0229	0.0221	0.0208	0.0638	0.0741	0.0221	0.0483
calcium	20600	19800	23200	16100	30000	27900	26100	16400	15600	24500	16400
cesium	0.0303	0.0176	0.0165	0.0230	0.0234	0.0167	0.0248	0.0243	0.0199	0.0182	0.0161
chromium	0.072	0.085	0.070	0.043	0.062	<0.040	0.058	<0.040	0.054	0.049	0.113
cobalt	0.0518	0.0252	0.0297	0.0283	0.0246	0.0190	0.0289	0.0243	0.0182	0.0227	0.0280
copper	0.424	0.499	0.489	0.534	0.311	0.390	0.446	0.439	0.472	0.454	0.404
iron	12.2	8.8	16.6	9.0	12.4	11.4	12.3	12.3	13.1	15.1	34.9
lead	0.458	0.352	0.235	0.082	0.237	0.152	0.138	0.077	0.221	0.258	0.268
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	489	443	538	439	632	619	593	406	397	550	372
manganese	9.47	11.3	6.86	4.62	8.02	6.17	6.56	2.00	3.80	5.72	3.96
mercury	0.0131	0.0115	0.0188	0.0169	0.0383	0.0238	0.0177	0.0202	0.0346	0.0418	0.0283
molybdenum	0.0327	0.0238	0.0247	0.0225	0.0298	0.0188	0.0713	0.0169	0.0319	0.0211	0.0481
nickel	0.069	0.054	0.064	0.065	0.052	<0.040	0.052	0.041	0.041	<0.040	0.047
phosphorus	12200	11900	14000	9700	16900	16200	15300	10100	9680	14900	9940
potassium	2010	1720	2040	2450	2290	2720	2500	2520	2150	2570	2010
rubidium	2.74	1.88	1.78	2.24	1.48	1.24	1.99	1.53	1.52	1.47	1.09
selenium	0.534	0.634	0.581	0.587	0.602	0.617	0.715	0.650	0.773	0.547	0.617
silver	0.0012	0.0018	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	0.0012	<0.0010
sodium	930	823	994	992	1500	1320	1270	1150	1180	1420	1200
strontium	42.9	41.0	50.7	33.6	61.9	66.2	56.6	35.2	41.6	49.4	40.0
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.0222	0.0122	0.0187	0.0184	0.00978	0.0151	0.0206	0.00903	0.0132	0.00905	0.00832
tin	0.217	0.230	0.176	0.158	0.177	<0.020	0.195	0.306	0.216	0.193	0.180
uranium	0.0136	0.00904	0.0212	0.00454	0.0102	0.00815	0.00666	0.00440	0.0101	0.0112	0.00933
vanadium	0.168	0.100	0.138	0.095	0.246	0.218	0.196	0.070	0.129	0.212	0.202
zinc	26.7	25.3	34.5	20.2	33.8	31.2	28.4	23.5	26.6	34.9	24.8
zirconium	0.045	<0.040	<0.040	<0.040	<0.040	0.045	<0.040	<0.040	0.084	<0.040	<0.040

Client Sample ID	506-Ero-Exp-5	507-Ero-Exp-5	508-Ero-Exp-5	509-Ero-Exp-5	510-Ero-Exp-5	511-Ero-Exp-5	512-Ero-Exp-5	513-Ero-Exp-5	514-Ero-Exp-5	515-Ero-Exp-5	516-Ero-Exp-5
moisture	75.0	78.9	78.0	77.2	81.6	75.9	80.8	76.4	76.2	77.1	81.7
aluminum	1.8	<1.0	<1.0	<1.0	1.9	2.2	<1.0	<1.0	1.7	1.0	<1.0
antimony	0.0316	0.0248	0.0127	0.0107	0.0257	0.0275	0.0120	0.0214	0.0304	0.0104	0.0371
arsenic	0.0433	0.0192	0.0269	0.0325	0.0896	0.0521	0.0264	0.0364	0.0545	0.0297	0.0397
barium	4.28	4.11	2.19	3.22	4.45	4.45	2.46	4.72	3.85	4.33	4.51
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	0.31	<0.20	<0.20	<0.20	0.54	0.42	<0.20	<0.20	<0.20	<0.20	<0.20
cadmium	0.0432	0.0236	0.0340	0.0228	0.0634	0.0189	0.0210	0.0131	0.0799	0.0622	0.0340
calcium	22900	20500	14500	11300	15300	19300	8280	17600	29100	22800	18300
cesium	0.0260	0.0196	0.0161	0.0270	0.0161	0.0227	0.0263	0.0197	0.0131	0.0256	0.0128
chromium	0.095	<0.040	<0.040	0.079	<0.040	<0.040	<0.040	<0.040	<0.040	0.308	<0.040
cobalt	0.0324	0.0153	0.0196	0.0226	0.0518	0.0229	0.0219	0.0152	0.0176	0.0258	0.0177
copper	0.749	0.263	0.622	0.421	0.620	0.401	0.537	0.350	0.582	0.414	0.322
iron	34.5	9.4	7.3	11.0	21.0	13.0	7.6	8.0	10.6	14.0	9.3
lead	0.173	0.238	0.096	0.135	0.259	0.162	0.194	0.230	0.213	0.151	0.248
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	520	447	366	314	359	432	268	446	593	495	408
manganese	7.44	4.43	2.67	4.21	4.69	9.15	3.32	6.28	4.78	3.92	4.56
mercury	0.0164	0.0302	0.0226	0.0204	0.0146	0.0156	0.0148	0.0152	0.0219	0.0319	0.0212
molybdenum	0.0520	0.0198	0.0199	0.0253	0.0447	0.0252	0.0153	0.0424	0.0392	0.0210	0.0257
nickel	0.078	<0.040	<0.040	0.054	0.040	0.052	0.073	<0.040	<0.040	0.054	0.042
phosphorus	14300	11700	8730	7840	9060	11700	5480	10700	17200	13500	10300
potassium	2680	1720	2060	2350	1830	2380	2250	2500	1920	2100	1290
rubidium	2.44	1.28	1.07	2.29	2.20	2.33	2.61	2.17	1.11	1.72	1.00
selenium	0.724	0.497	0.566	0.736	0.596	0.673	0.547	0.547	0.544	0.700	0.428
silver	0.0015	<0.0010	0.0020	<0.0010	0.0015	<0.0010	0.0016	<0.0010	0.0012	0.0012	<0.0010
sodium	1190	1110	932	1040	1010	1130	1020	959	1130	1430	811
strontium	50.2	51.3	34.8	31.0	33.4	42.6	20.1	41.9	66.4	53.1	45.3
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.0241	0.00726	0.0110	0.0134	0.0132	0.0161	0.00863	0.0148	0.0150	0.00928	0.0110
tin	0.265	0.286	0.211	0.134	0.318	0.255	0.105	0.159	0.287	0.229	0.231
uranium	0.0109	0.0129	0.00672	0.00541	0.00828	0.0107	0.00381	0.00904	0.0108	0.0139	0.0183
vanadium	0.170	0.150	0.086	0.080	0.085	0.120	0.022	0.110	0.200	0.122	0.146
zinc	21.1	28.5	22.9	22.2	45.6	26.6	17.2	24.0	33.8	43.7	27.2
zirconium	<0.040	0.041	<0.040	0.078	0.222	0.128	0.058	<0.040	<0.040	0.069	<0.040

Client Sample ID	517-Ero-Exp-5	518-Ero-Exp-5	519-Ero-Exp-5	520-Ero-Exp-5	521-Ero-Exp-5	522-Ero-Exp-5	523-Ero-Exp-5	525-Ero-Exp-5	526-Ero-Exp-5	546-Ero-Ref-3	547-Ero-Ref-3
moisture	77.3	77.8	76.4	77.1	79.1	79.3	81.5	79.1	80.3	75.9	73.5
aluminum	12.0	<1.0	2.8	1.3	<1.0	1.0	1.4	33.0	<1.0	<1.0	1.9
antimony	0.0382	0.0124	0.0109	0.0303	0.0216	0.0244	0.0207	0.0906	0.0122	<0.0020	<0.0020
arsenic	0.0814	0.0390	0.0460	0.0534	0.0363	0.0386	0.0734	0.0670	0.0438	0.0221	0.0910
barium	4.25	3.89	3.53	4.28	3.64	4.55	2.29	4.01	4.74	0.691	5.91
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	0.21	<0.20	<0.20	<0.20	0.21	<0.20	0.43	0.57	<0.20	<0.20	<0.20
cadmium	0.163	0.0972	0.0534	0.0360	0.0164	0.0554	0.0496	0.215	0.0690	0.0151	0.0711
calcium	15800	15100	16600	20700	14100	21500	10200	11000	15800	3260	17400
cesium	0.0250	0.0194	0.0156	0.0294	0.0175	0.0213	0.0290	0.0220	0.0192	0.0278	0.0136
chromium	0.130	<0.040	<0.040	0.065	0.064	0.086	<0.040	0.178	<0.040	<0.040	<0.040
cobalt	0.0467	0.0270	0.0207	0.0352	0.0220	0.0282	0.0433	0.0668	0.0217	0.0117	0.0342
copper	0.570	0.641	0.431	0.388	0.347	0.616	0.593	3.59	0.380	0.465	0.411
iron	46.1	10.3	16.9	12.8	13.6	14.7	9.6	301	9.4	5.7	20.8
lead	0.188	0.190	0.096	0.390	0.097	0.311	0.236	0.238	0.151	0.021	0.131
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	429	380	464	387	357	477	324	304	365	235	467
manganese	6.92	2.54	4.86	5.86	5.07	5.14	3.00	9.69	5.05	0.536	4.16
mercury	0.0116	0.0804	0.0128	0.0127	0.0162	0.0310	0.0206	0.0213	0.0232	0.0460	0.0153
molybdenum	0.0373	0.0194	0.0172	0.0328	0.0206	0.0424	0.0208	0.0600	0.0251	0.0096	0.0333
nickel	0.080	<0.040	<0.040	0.056	0.049	0.057	0.051	0.066	0.042	<0.040	0.052
phosphorus	9890	9240	10800	10300	8830	12200	7410	6800	9510	3350	12500
potassium	2380	2230	2440	2080	2240	1840	2420	2330	1800	2530	3000
rubidium	3.10	1.66	1.24	2.52	1.53	1.39	3.08	1.70	1.58	3.17	2.78
selenium	0.805	0.587	0.705	0.626	0.571	0.720	0.584	0.802	0.583	0.764	0.630
silver	0.0018	<0.0010	<0.0010	0.0013	<0.0010	0.0018	<0.0010	0.0018	0.0013	<0.0010	<0.0010
sodium	906	1360	1100	1080	989	1120	980	977	914	1090	1260
strontium	38.6	31.6	39.7	48.1	34.1	56.5	21.9	25.0	35.8	6.91	38.3
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.0242	0.0150	0.0134	0.00552	0.00920	0.0106	0.0137	0.0163	0.0109	0.00216	0.00899
tin	0.271	0.273	0.269	0.247	0.182	0.211	0.286	0.298	0.308	0.083	0.118
uranium	0.00972	0.00453	0.00648	0.0116	0.00398	0.0118	0.0106	0.0158	0.0180	0.00113	0.0116
vanadium	0.141	0.120	0.085	0.064	0.078	0.156	0.060	0.150	0.102	<0.020	0.085
zinc	26.8	18.3	20.6	29.9	21.7	35.7	42.2	50.0	31.2	13.7	25.0
zirconium	0.123	0.063	0.126	0.133	0.081	0.113	0.078	0.184	0.096	<0.040	<0.040

Client Sample ID	548-Ero-Ref-3	549-Ero-Ref-3	550-Ero-Ref-3	551-Ero-Ref-3	552-Ero-Ref-3	553-Ero-Ref-3	554-Ero-Ref-3	555-Ero-Ref-3	556-Ero-Ref-3	557-Ero-Ref-3	558-Ero-Ref-3
moisture	73.9	78.0	75.0	78.6	75.8	76.4	78.2	77.2	76.2	76.6	79.7
aluminum	<1.0	<1.0	1.1	2.9	1.1	1.2	1.1	9.5	<1.0	<1.0	2.7
antimony	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0022	<0.0020	<0.0020	<0.0020
arsenic	0.0192	0.0175	0.0635	0.0503	0.0881	0.0154	0.0406	0.0704	0.0599	0.0599	0.0413
barium	3.80	1.30	2.42	3.15	2.11	1.82	3.23	5.35	3.51	4.68	4.15
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.26
cadmium	0.0176	0.0114	0.0309	0.0772	0.0357	0.0177	0.0254	0.0911	0.0584	0.0255	0.0362
calcium	15700	10200	14300	11100	8470	11100	12300	17900	14100	14200	16400
cesium	0.0242	0.0284	0.0164	0.0107	0.0114	0.0324	0.0103	0.0153	0.0134	0.0108	0.0164
chromium	<0.040	<0.040	<0.040	0.056	<0.040	<0.040	<0.040	0.080	<0.040	<0.040	0.102
cobalt	0.0100	0.0084	0.0219	0.0298	0.0232	0.0132	0.0205	0.0395	0.0266	0.0164	0.0454
copper	0.361	0.407	0.444	0.536	0.509	0.404	0.549	0.485	0.438	0.469	0.583
iron	6.5	7.0	14.5	12.5	11.8	9.7	7.8	61.6	9.0	6.5	25.4
lead	0.072	0.032	0.102	0.101	0.040	0.060	0.048	0.314	0.107	0.078	0.060
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	390	296	382	346	284	314	327	444	377	373	400
manganese	2.54	0.959	2.21	3.20	2.59	1.37	3.55	4.85	2.77	2.59	4.55
mercury	0.0232	0.0371	0.0164	0.0215	0.0184	0.0330	0.0171	0.0231	0.0157	0.0138	0.0169
molybdenum	<0.0080	<0.0080	0.0146	0.0130	0.0138	<0.0080	0.0095	0.0135	0.0172	0.0143	0.0180
nickel	<0.040	<0.040	<0.040	0.059	0.047	<0.040	<0.040	0.074	0.043	0.040	0.142
phosphorus	10300	6680	10000	7610	6160	7310	7830	11300	9520	9300	10000
potassium	2120	2010	2410	2470	2610	2500	2300	2480	2490	2110	2270
rubidium	2.74	2.70	2.76	2.00	2.16	3.11	2.34	2.56	2.65	1.88	2.42
selenium	0.506	0.547	0.672	0.540	0.606	0.593	0.523	0.800	0.657	0.519	0.556
silver	<0.0010	<0.0010	<0.0010	0.0012	0.0011	<0.0010	0.0012	0.0012	<0.0010	<0.0010	0.0015
sodium	982	991	1130	1060	968	1200	988	1200	1060	872	1220
strontium	34.6	20.4	30.4	24.5	18.0	23.4	27.6	36.0	33.7	30.8	36.4
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.00279	0.00240	0.00555	0.00285	0.00637	0.00121	0.00430	0.00396	0.00657	0.00735	0.00294
tin	0.146	0.247	0.187	0.155	0.109	0.161	0.348	0.211	0.178	0.172	0.300
uranium	0.00543	0.00199	0.0113	0.00912	0.00548	0.00243	0.00700	0.0151	0.00857	0.00665	0.0137
vanadium	0.041	<0.020	0.066	0.043	0.041	0.024	0.034	0.108	0.044	0.038	0.084
zinc	15.9	14.2	19.1	25.6	19.4	20.2	26.6	24.2	21.0	20.6	28.9
zirconium	<0.040	<0.040	<0.040	<0.040	0.052	<0.040	0.056	0.096	0.054	<0.040	<0.040

Client Sample ID	559-Ero-Ref-3	560-Ero-Ref-3	561-Ero-Ref-3	562-Ero-Ref-3	563-Ero-Ref-3	564-Ero-Ref-3	567-Ero-Ref-3	569-Ero-Ref-3	570-Ero-Ref-3	571-Ero-Ref-3	572-Ero-Ref-3
moisture	77.3	76.4	78.7	75.8	79.7	78.7	74.7	77.5	78.3	81.2	78.6
aluminum	3.3	9.0	<1.0	1.1	1.1	1.7	2.1	<1.0	<1.0	<1.0	3.4
antimony	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0027	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
arsenic	0.0761	0.0780	0.0690	0.0895	0.0644	0.0666	0.0595	0.0490	0.0670	0.0392	0.0393
barium	4.33	5.35	1.66	4.71	6.44	3.70	2.65	4.70	3.34	4.67	3.95
beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
boron	<0.20	0.20	<0.20	<0.20	0.22	<0.20	<0.20	<0.20	<0.20	<0.20	0.22
cadmium	0.0538	0.0435	0.0563	0.0304	0.0579	0.0546	0.0483	0.0428	0.0617	0.0352	0.0270
calcium	8930	15400	6370	16200	12900	10500	9440	15700	10900	10900	11100
cesium	0.0152	0.0185	0.0204	0.0092	0.0063	0.0090	0.0127	0.0098	0.0143	0.0081	0.0118
chromium	<0.040	0.050	<0.040	<0.040	0.040	0.077	0.044	<0.040	<0.040	<0.040	<0.040
cobalt	0.0351	0.0291	0.0221	0.0237	0.0193	0.0214	0.0269	0.0225	0.0308	0.0219	0.0200
copper	0.627	0.486	0.586	0.422	0.404	0.418	0.694	0.362	0.571	0.568	0.516
iron	12.3	19.3	7.8	17.7	19.0	9.9	31.4	7.4	9.5	6.3	13.0
lead	0.084	0.127	0.110	0.070	0.084	0.070	0.056	0.055	0.068	0.076	0.069
lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
magnesium	277	402	267	418	326	304	307	406	322	272	333
manganese	3.36	4.10	1.54	4.14	5.59	2.88	2.71	3.85	3.08	5.80	4.26
mercury	0.0153	0.0147	0.0236	0.0094	0.0096	0.0142	0.0151	0.0113	0.0169	0.0135	0.0119
molybdenum	0.0265	0.0174	0.0151	0.0205	0.0126	0.0170	0.0151	0.0122	0.0128	0.0178	0.0164
nickel	0.066	0.050	0.051	0.046	0.043	0.061	0.059	<0.040	0.049	0.041	0.049
phosphorus	6650	10500	5010	10000	7950	6480	6710	9800	7140	6560	7400
potassium	2470	2620	2840	1880	1380	1670	2100	1780	1940	1480	2040
rubidium	3.10	2.87	3.13	1.64	1.42	1.81	2.11	1.64	2.45	1.58	2.22
selenium	0.628	0.603	0.659	0.494	0.459	0.547	0.660	0.495	0.630	0.436	0.521
silver	0.0019	<0.0010	0.0010	0.0011	0.0010	<0.0010	0.0018	<0.0010	0.0015	0.0013	0.0012
sodium	1090	1190	1090	824	682	764	921	792	920	719	834
strontium	20.4	32.0	13.3	36.7	30.9	23.3	22.2	36.2	24.5	25.0	25.8
tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
thallium	0.00875	0.00384	0.00323	0.00902	0.00663	0.00662	0.00616	0.00636	0.00568	0.00255	0.00525
tin	0.110	0.133	0.123	0.245	0.250	0.213	0.138	0.462	0.185	0.299	0.246
uranium	0.00669	0.00702	0.00526	0.00783	0.0108	0.00989	0.00888	0.00738	0.00763	0.00675	0.00996
vanadium	0.046	0.086	<0.020	0.091	0.107	0.063	0.115	0.061	0.050	0.048	0.052
zinc	21.5	25.2	19.8	24.6	21.6	16.8	15.0	22.4	23.6	22.7	23.1
zirconium	<0.040	<0.040	<0.040	0.064	0.055	0.045	0.068	<0.040	0.064	0.040	0.104

Client Sample ID	573-Ero-Ref-3	574-Ero-Ref-3	575-Ero-Ref-3
moisture	79.2	77.7	84.3
aluminum	2.2	4.0	5.6
antimony	<0.0020	<0.0020	<0.0020
arsenic	0.0876	0.0612	0.0400
barium	3.74	2.11	3.89
beryllium	<0.0020	<0.0020	<0.0020
bismuth	<0.0020	<0.0020	<0.0020
boron	<0.20	<0.20	1.13
cadmium	0.0413	0.0453	0.0508
calcium	7130	8440	11700
cesium	0.0074	0.0137	0.0108
chromium	<0.040	<0.040	0.114
cobalt	0.0242	0.0323	0.0190
copper	0.508	0.498	0.334
iron	10.5	15.5	15.3
lead	0.049	0.046	0.055
lithium	<0.10	<0.10	<0.10
magnesium	232	270	298
manganese	4.05	1.91	7.07
mercury	0.0110	0.0216	0.0089
molybdenum	0.0152	0.0120	0.0171
nickel	<0.040	0.051	0.069
phosphorus	4820	5710	7330
potassium	1540	2150	1480
rubidium	1.07	2.48	1.76
selenium	0.505	0.581	0.423
silver	0.0011	0.0012	0.0010
sodium	649	986	792
strontium	16.1	20.1	27.2
tellurium	<0.0040	<0.0040	<0.0040
thallium	0.00420	0.00412	0.00542
tin	0.218	0.185	0.260
uranium	0.00725	0.00564	0.0124
vanadium	0.042	0.062	0.072
zinc	18.2	21.4	25.0
zirconium	<0.040	0.144	<0.040

APPENDIX Q SMALL-BODIED FISH ANCOVA OUTPUTS

Table 192. Small-bodied fish body condition indices ANCOVA summary by treatment group and sex.

Index	term	estimate	std.error	statistic	p.value
FK	(Intercept)	1.324487	0.026733	49.54472	5.92E-131
FK	IDZ Right Bank	-0.0327	0.033538	-0.97505	0.330482
FK	IDZ Left Bank	-0.02865	0.039733	-0.72115	0.471494
FK	Downstream IDZ	-0.14649	0.035205	-4.16098	4.37E-05
FK	Sex Male	-0.03957	0.025757	-1.53622	0.125755
FK	model_t_group_Sex	0.091061	0.07646	6.236442	8.49E-05
GSI	(Intercept)	11.37446	0.762768	14.91208	1.89E-34
GSI	IDZ Right Bank	0.425617	0.883459	0.481762	0.630494
GSI	IDZ Left Bank	-1.38139	1.020576	-1.35354	0.177387
GSI	Downstream IDZ	-1.37716	0.901265	-1.52803	0.128062
GSI	Sex Male	-8.32331	0.62425	-13.3333	1.53E-29
GSI	model_t_group_Sex	0.511259	0.501629	53.08832	1.46E-30
HSI	(Intercept)	1.882411	0.188682	9.976637	6.31E-20
HSI	IDZ Right Bank	0.479355	0.236592	2.026085	0.043827
HSI	IDZ Left Bank	-0.18633	0.28272	-0.65906	0.51047
HSI	Downstream IDZ	-0.24252	0.248375	-0.97643	0.329804
HSI	Sex Male	-0.5729	0.182383	-3.14117	0.001887
HSI	model_t_group_Sex	0.094638	0.080035	6.480876	5.64E-05

Table 193. Small-bodied fish tissue metal concentrations ANCOVA summary by treatment group and distance to outfall included as a quadratic factor.

ANALYTE	term	estimate	std.error	statistic	p.value
Arsenic	(Intercept)	-2.9979	0.094987	-31.5613	2.72E-88
Arsenic	poly(Dist_frm_CII.m./1000, 2, raw = TRUE)1	0.001151	0.005536	0.208016	0.835389
Arsenic	poly(Dist_frm_CII.m./1000, 2, raw = TRUE)2	5.07E-06	0.000177	0.028697	0.977129
Arsenic	IDZ Right Bank	0.435262	0.105088	4.14187	4.74E-05
Arsenic	IDZ Left Bank	-0.17948	0.115609	-1.55247	0.121841
Arsenic	Downstream IDZ	-0.23909	0.141287	-1.69223	0.091874
Arsenic	model_poly_dist_t_group	0.30882	0.294714	21.89323	4.09E-18
Cadmium	(Intercept)	-3.0561	0.13152	-23.2368	8.84E-64
Cadmium	poly(Dist_frm_CII.m./1000, 2, raw = TRUE)1	0.005841	0.007758	0.752959	0.4522
Cadmium	poly(Dist_frm_CII.m./1000, 2, raw = TRUE)2	-0.00072	0.000246	-2.90932	0.003957
Cadmium	IDZ Right Bank	0.794361	0.144995	5.478546	1.07E-07
Cadmium	IDZ Left Bank	-0.30623	0.159969	-1.91429	0.056753
Cadmium	Downstream IDZ	-0.00577	0.199283	-0.02896	0.97692
Cadmium	model_poly_dist_t_group	0.426909	0.415166	36.35233	9.30E-28
Copper	(Intercept)	-0.60797	0.056713	-10.72	3.08E-22
Copper	poly(Dist_frm_CII.m./1000, 2, raw = TRUE)1	0.006345	0.00333	1.905668	0.057864
Copper	poly(Dist_frm_CII.m./1000, 2, raw = TRUE)2	-0.00019	0.000106	-1.78149	0.076071
Copper	IDZ Right Bank	0.053089	0.0626	0.848074	0.397224
Copper	IDZ Left Bank	-0.21914	0.069	-3.1759	0.001685
Copper	Downstream IDZ	-0.22845	0.084334	-2.7089	0.007227
Copper	model_poly_dist_t_group	0.200474	0.184157	12.28629	1.22E-10
Iron	(Intercept)	2.387296	0.067673	35.277	2.71E-96
Iron	poly(Dist_frm_CII.m./1000, 2, raw = TRUE)1	0.004661	0.004041	1.153411	0.249904
Iron	poly(Dist_frm_CII.m./1000, 2, raw = TRUE)2	6.53E-05	0.000127	0.513607	0.608005
Iron	IDZ Right Bank	0.011202	0.0743	0.15077	0.880285
Iron	IDZ Left Bank	-0.02786	0.082674	-0.33694	0.736457
Iron	Downstream IDZ	-0.05301	0.10042	-0.52786	0.598092
Iron	model_poly_dist_t_group	0.012296	-0.00854	0.59009	0.707582
Lead	(Intercept)	-2.55034	0.143731	-17.7439	1.41E-43
Lead	poly(Dist_frm_CII.m./1000, 2, raw = TRUE)1	-0.03123	0.008379	-3.7272	0.000249
Lead	poly(Dist_frm_CII.m./1000, 2, raw = TRUE)2	-0.00107	0.000267	-4.0207	8.10E-05
Lead	IDZ Right Bank	2.663021	0.173393	15.35826	3.91E-36
Lead	IDZ Left Bank	1.212334	0.174925	6.930587	5.11E-11
Lead	Downstream IDZ	1.68675	0.213818	7.888707	1.68E-13
Lead	model_poly_dist_t_group	0.663495	0.655445	82.41802	1.66E-47
Mercury	(Intercept)	-4.11918	0.087166	-47.2569	2.06E-125
Mercury	poly(Dist_frm_CII.m./1000, 2, raw = TRUE)1	0.003786	0.00508	0.74528	0.456814
Mercury	poly(Dist_frm_CII.m./1000, 2, raw = TRUE)2	-1.64E-05	0.000162	-0.10099	0.919642

ANALYTE	term	estimate	std.error	statistic	p.value
Mercury	IDZ Right Bank	0.602079	0.096403	6.245447	1.84E-09
Mercury	IDZ Left Bank	0.11268	0.10609	1.062117	0.289224
Mercury	Downstream IDZ	0.218892	0.129655	1.688269	0.092627
Mercury	model_poly_dist_t_group	0.316102	0.302202	22.74054	9.61E-19
Selenium	(Intercept)	-0.6615	0.045036	-14.6884	1.23E-35
Selenium	poly(Dist_frm_CII.m./1000, 2, raw = TRUE)1	-0.0061	0.002624	-2.32389	0.020934
Selenium	poly(Dist_frm_CII.m./1000, 2, raw = TRUE)2	0.00043	8.38E-05	5.138968	5.57E-07
Selenium	IDZ Right Bank	0.443759	0.049533	8.958856	7.76E-17
Selenium	IDZ Left Bank	0.252964	0.054814	4.614945	6.29E-06
Selenium	Downstream IDZ	0.18557	0.066987	2.770221	0.006022
Selenium	model_poly_dist_t_group	0.340799	0.327615	25.84941	5.18E-21
Thallium	(Intercept)	-5.13489	0.153286	-33.4987	8.02E-83
Thallium	poly(Dist_frm_CII.m./1000, 2, raw = TRUE)1	0.016409	0.008619	1.90393	0.058392
Thallium	poly(Dist_frm_CII.m./1000, 2, raw = TRUE)2	-0.00028	0.000275	-1.0167	0.310557
Thallium	IDZ Right Bank	0.795104	0.191478	4.152462	4.91E-05
Thallium	IDZ Left Bank	-0.16929	0.184265	-0.91873	0.359373
Thallium	Downstream IDZ	0.637021	0.223736	2.847191	0.004883
Thallium	model_poly_dist_t_group	0.408833	0.393675	26.97124	1.09E-20
Zinc	(Intercept)	3.297943	0.0539	61.18683	1.93E-152
Zinc	poly(Dist_frm_CII.m./1000, 2, raw = TRUE)1	0.011789	0.003141	3.753325	0.000217
Zinc	poly(Dist_frm_CII.m./1000, 2, raw = TRUE)2	-0.0002	0.0001	-1.9856	0.04817
Zinc	IDZ Right Bank	0.071088	0.059282	1.199158	0.231602
Zinc	IDZ Left Bank	-0.05941	0.065602	-0.90563	0.366006
Zinc	Downstream IDZ	-0.12954	0.080171	-1.61576	0.107407
Zinc	model_poly_dist_t_group	0.259883	0.245081	17.55691	6.72E-15

Table 194: ANOVA summary table for SBF 2013 - 2016 - 2021 Arsenic-Reference

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	0.1340252	0.06701261	0.3543022	0.7021136
Residuals	195	36.8822403	0.18913969		

Table 195: ANOVA summary table for SBF 2013 - 2016 - 2021 Arsenic-IDZ Right Bank

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	2.677706	1.3388532	6.071007	0.0028569
Residuals	165	36.387830	0.2205323		

Table 196: Significant Tukey HSD results for arsenic concentration comparisons between years 2013, 2016, and 2021 in IDZ Right Bank areas

Higher	Lower	Adjusted p Value
2013	2021	0.003

Table 197: Tukey HSD for SBF 2013 - 2016 - 2021 Arsenic-IDZ Right Bank

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	-0.1946808	-0.4544542	0.06509249	0.182
year	2021 : 2013	0	-0.3609984	-0.6174923	-0.10450461	0.003
year	2021 : 2016	0	-0.1663176	-0.3522951	0.01965994	0.090

Table 198: ANOVA summary table for SBF 2013 - 2016 - 2021 Arsenic-IDZ Left Bank

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	3.282785	1.6413926	10.40399	<0.001
Residuals	82	12.936785	0.1577657		

Table 199: Significant Tukey HSD results for arsenic concentration comparisons between years 2013, 2016, and 2021 in IDZ Left Bank areas

Higher	Lower	Adjusted p Value
2013	2016	0.010
2013	2021	<0.001

Table 200: Tukey HSD for SBF 2013 - 2016 - 2021 Arsenic-IDZ Left Bank

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	-0.4341137	-0.7803151	-0.08791226	0.010
year	2021 : 2013	0	-0.6226981	-0.9541607	-0.29123550	<0.001
year	2021 : 2016	0	-0.1885844	-0.4120565	0.03488760	0.115

Table 201: ANOVA summary table for SBF 2013 - 2016 - 2021 Arsenic-Downstream IDZ

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	6.965904	3.4829520	18.69264	<0.001
Residuals	212	39.501415	0.1863274		

Table 202: Significant Tukey HSD results for arsenic concentration comparisons between years 2013, 2016, and 2021 in Downstream IDZ areas

Higher	Lower	Adjusted p Value
2016	2013	0.012
2013	2021	0.015
2016	2021	<0.001

Table 203: Tukey HSD for SBF 2013 - 2016 - 2021 Arsenic-Downstream IDZ

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	0.2091205	0.03807399	0.38016706	0.012
year	2021 : 2013	0	-0.2168733	-0.39877066	-0.03497602	0.015
year	2021 : 2016	0	-0.4259939	-0.59078519	-0.26120255	<0.001

Table 204: ANOVA summary table for SBF 2013 - 2016 - 2021 Cadmium-Reference

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	2.579446	1.2897228	3.894485	0.0219477
Residuals	196	64.908631	0.3311665		

Table 205: Significant Tukey HSD results for Cadmium concentration comparisons between years 2013, 2016, and 2021 in Reference areas

Higher	Lower	Adjusted p Value
2016	2013	0.028

Table 206: Tukey HSD for SBF 2013 - 2016 - 2021 Cadmium-Reference

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	0.25671941	0.02199968	0.49143914	0.028
year	2021 : 2013	0	0.02559558	-0.20713254	0.25832369	0.964
year	2021 : 2016	0	-0.23112383	-0.47330447	0.01105681	0.065

Table 207: ANOVA summary table for SBF 2013 - 2016 - 2021 Cadmium-IDZ Right Bank

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	0.7512914	0.3756457	1.019053	0.3630802
Residuals	174	64.1402605	0.3686222		

Table 208: ANOVA summary table for SBF 2013 - 2016 - 2021 Cadmium-IDZ Left Bank

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	2.201898	1.1009488	3.483945	0.03536017
Residuals	81	25.596518	0.3160064		

Table 209: Significant Tukey HSD results for Cadmium concentration comparisons between years 2013, 2016, and 2021 in IDZ Left Bank areas

Higher	Lower	Adjusted p Value
2013	2021	0.027

Table 210: Tukey HSD for SBF 2013 - 2016 - 2021 Cadmium-IDZ Left Bank

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	-0.46486727	-0.9749614	0.04522685	0.081
year	2021 : 2013	0	-0.54138996	-1.0314725	-0.05130737	0.027
year	2021 : 2016	0	-0.07652268	-0.3928696	0.23982426	0.832

Table 211: ANOVA summary table for SBF 2013 - 2016 - 2021 Cadmium-Downstream IDZ

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	12.81266	6.4063286	20.5906	<0.001
Residuals	210	65.33705	0.3111288		

Table 212: Significant Tukey HSD results for Cadmium concentration comparisons between years 2013, 2016, and 2021 in Downstream IDZ areas

Higher	Lower	Adjusted p Value
2016	2013	0.009
2013	2021	0.007
2016	2021	<0.001

Table 213: Tukey HSD for SBF 2013 - 2016 - 2021 Cadmium-Downstream IDZ

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	0.2779101	0.05735797	0.49846224	0.009
year	2021 : 2013	0	-0.3061699	-0.54380030	-0.06853954	0.007
year	2021 : 2016	0	-0.5840800	-0.79936539	-0.36879466	<0.001

Table 214: ANOVA summary table for SBF 2013 - 2016 - 2021 Chromium-Reference

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	35.54094	17.770472	12.22612	<0.001
Residuals	181	263.08065	1.453484		

Table 215: Significant Tukey HSD results for chromium concentration comparisons between years 2013, 2016, and 2021 in IDZ Reference areas

Higher	Lower	Adjusted p Value
2021	2013	<0.001
2021	2016	0.002

Table 216: Tukey HSD for SBF 2013 - 2016 - 2021 Chromium-Reference

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	0.2916207	-0.2063944	0.7896358	0.352
year	2021 : 2013	0	1.0696360	0.5511460	1.5881259	<0.001
year	2021 : 2016	0	0.7780153	0.2382199	1.3178106	0.002

Table 217: ANOVA summary table for SBF 2013 - 2016 - 2021 Chromium-IDZ Right Bank

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	68.80906	34.40453	32.11715	<0.001
Residuals	172	184.24981	1.07122		

Table 218: Significant Tukey HSD results for chromium concentration comparisons between years 2013, 2016, and 2021 in IDZ Right Bank areas

Higher	Lower	Adjusted p Value
2016	2013	<0.001
2021	2013	<0.001
2021	2016	<0.001

Table 219: Tukey HSD for SBF 2013 - 2016 - 2021 Chromium-IDZ Right Bank

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	0.8329200	0.3124381	1.353402	<0.001
year	2021 : 2013	0	1.7310711	1.1995571	2.262585	<0.001
year	2021 : 2016	0	0.8981511	0.4893440	1.306958	<0.001

Table 220: ANOVA summary table for SBF 2013 - 2016 - 2021 Chromium-IDZ Left Bank

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	32.10210	16.0510478	19.48938	<0.001
Residuals	65	53.53265	0.8235793		

Table 221: Significant Tukey HSD results for chromium concentration comparisons between years 2013, 2016, and 2021 in IDZ Left Bank areas

Higher	Lower	Adjusted p Value
2021	2013	<0.001
2021	2016	<0.001

Table 222: Tukey HSD for SBF 2013 - 2016 - 2021 Chromium-IDZ Left Bank

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	0.3935473	-0.4012763	1.188371	0.465
year	2021 : 2013	0	1.6657554	0.8638665	2.467644	<0.001
year	2021 : 2016	0	1.2722081	0.7002348	1.844181	<0.001

Table 223: ANOVA summary table for SBF 2013 - 2016 - 2021 Chromium-Downstream IDZ

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	27.49345	13.746724	11.39525	<0.001
Residuals	171	206.28690	1.206356		

Table 224: Significant Tukey HSD results for chromium concentration comparisons between years 2013, 2016, and 2021 in Downstream IDZ areas

Higher	Lower	Adjusted p Value
2021	2013	<0.001
2021	2016	<0.001

Table 225: Tukey HSD for SBF 2013 - 2016 - 2021 Chromium-Downstream IDZ

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	-0.02319618	-0.4604526	0.4140602	0.991
year	2021 : 2013	0	1.10050121	0.4876154	1.7133870	<0.001
year	2021 : 2016	0	1.12369738	0.5455193	1.7018755	<0.001

Table 226: ANOVA summary table for SBF 2013 - 2016 - 2021 Copper-Reference

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	0.5346469	0.26732344	5.538762	0.004574971
Residuals	195	9.4115020	0.04826411		

Table 227: Significant Tukey HSD results for copper concentration comparisons between years 2013, 2016, and 2021 in Reference areas

Higher	Lower	Adjusted p Value
2016	2021	0.003

Table 228: Tukey HSD for SBF 2013 - 2016 - 2021 Copper-Reference

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	0.06856629	-0.02132887	0.15846145	0.172
year	2021 : 2013	0	-0.06169810	-0.15083535	0.02743914	0.234
year	2021 : 2016	0	-0.13026439	-0.22272260	-0.03780619	0.003

Table 229: ANOVA summary table for SBF 2013 - 2016 - 2021 Copper-IDZ Right Bank

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	0.849172	0.4245860	5.087958	0.007120784
Residuals	174	14.520160	0.0834492		

Table 230: Significant Tukey HSD results for copper concentration comparisons between years 2013, 2016, and 2021 in IDZ Right Bank areas

Higher	Lower	Adjusted p Value
2013	2016	0.005

Table 231: Tukey HSD for SBF 2013 - 2016 - 2021 Copper-IDZ Right Bank

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	-0.20498818	-0.3585245	-0.05145186	0.005
year	2021 : 2013	0	-0.12986065	-0.2828560	0.02313466	0.114
year	2021 : 2016	0	0.07512753	-0.0363972	0.18665225	0.252

Table 232: ANOVA summary table for SBF 2013 - 2016 - 2021 Copper-IDZ Left Bank

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	0.7764828	0.38824140	8.742256	<0.001
Residuals	82	3.6415994	0.04440975		

Table 233: Significant Tukey HSD results for copper concentration comparisons between years 2013, 2016, and 2021 in IDZ Left Bank areas

Higher	Lower	Adjusted p Value
2013	2016	0.047
2013	2021	<0.001

Table 234: Tukey HSD for SBF 2013 - 2016 - 2021 Copper-IDZ Left Bank

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	-0.1853337	-0.3690136	-0.001653718	0.047
year	2021 : 2013	0	-0.2955318	-0.4713919	-0.119671646	<0.001
year	2021 : 2016	0	-0.1101981	-0.2287630	0.008366747	0.074

Table 235: ANOVA summary table for SBF 2013 - 2016 - 2021 Copper-Downstream IDZ

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	2.609884	1.30494181	20.30928	<0.001
Residuals	207	13.300468	0.06425347		

Table 236: Significant Tukey HSD results for copper concentration comparisons between years 2013, 2016, and 2021 in Downstream IDZ areas.

Higher	Lower	Adjusted p Value
2013	2021	<0.001
2016	2021	<0.001

Table 237: Tukey HSD for SBF 2013 - 2016 - 2021 Copper-Downstream IDZ

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	-0.01369905	-0.1163336	0.08893546	0.947
year	2021 : 2013	0	-0.24831449	-0.3575661	-0.13906287	<0.001
year	2021 : 2016	0	-0.23461544	-0.3318202	-0.13741071	<0.001

Table 238: ANOVA summary table for SBF 2013 - 2016 - 2021 Iron-Reference

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	2.614216	1.30710815	17.04303	<0.001
Residuals	192	14.725361	0.07669459		

Table 239: Significant Tukey HSD results for iron concentration comparisons between years 2013, 2016, and 2021 in Reference areas.

Higher	Lower	Adjusted p Value
2016	2013	<0.001
2016	2021	0.001

Table 240: Tukey HSD for SBF 2013 - 2016 - 2021 Iron-Reference

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	0.27837239	0.16489890	0.39184589	<0.001
year	2021 : 2013	0	0.09618821	-0.01728529	0.20966171	0.114
year	2021 : 2016	0	-0.18218418	-0.30062965	-0.06373871	0.001

Table 241: ANOVA summary table for SBF 2013 - 2016 - 2021 Iron-IDZ Right Bank

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	0.02230262	0.01115131	0.09034588	0.9136556
Residuals	184	22.71095656	0.12342911		

Table 242: ANOVA summary table for SBF 2013 - 2016 - 2021 Iron-IDZ Left Bank

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	0.7215126	0.36075628	5.971885	0.003843601
Residuals	79	4.7723197	0.06040911		

Table 243: Significant Tukey HSD results for iron concentration comparisons between years 2013, 2016, and 2021 in IDZ Left Bank areas.

Higher	Lower	Adjusted p Value
2016	2013	0.005

Table 244: Tukey HSD for SBF 2013 - 2016 - 2021 Iron-IDZ Left Bank

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	0.2891672	0.07479051	0.5035439627	0.005
year	2021 : 2013	0	0.1490032	-0.05757536	0.3555818020	0.203
year	2021 : 2016	0	-0.1401640	-0.28050653	0.0001784931	0.050

Table 245: ANOVA summary table for SBF 2013 - 2016 - 2021 Iron-Downstream IDZ

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	2.07255	1.03627479	13.85775	<0.001
Residuals	208	15.55412	0.07477944		

Table 246: Significant Tukey HSD results for iron concentration comparisons between years 2013, 2016, and 2021 in Downstream IDZ areas.

Higher	Lower	Adjusted p Value
2016	2013	<0.001
2016	2021	<0.001

Table 247: Tukey HSD for SBF 2013 - 2016 - 2021 Iron-Downstream IDZ

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	0.17606841	0.06793446	0.28420236	<0.001
year	2021 : 2013	0	-0.04232597	-0.15973108	0.07507915	0.672
year	2021 : 2016	0	-0.21839437	-0.32493639	-0.11185236	<0.001

Table 248: ANOVA summary table for SBF 2013 - 2016 - 2021 Lead-Reference

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	9.197528	4.5987642	12.57156	<0.001
Residuals	196	71.698157	0.3658069		

Table 249: Significant Tukey HSD results for lead concentration comparisons between years 2013, 2016, and 2021 in Reference areas.

Higher	Lower	Adjusted p Value
2013	2021	<0.001
2016	2021	0.006

Table 250: Tukey HSD for SBF 2013 - 2016 - 2021 Lead-Reference

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	-0.1774410	-0.4241314	0.06924950	0.208
year	2021 : 2013	0	-0.5145374	-0.7591347	-0.26994010	<0.001
year	2021 : 2016	0	-0.3370964	-0.5916283	-0.08256452	0.006

Table 251: ANOVA summary table for SBF 2013 - 2016 - 2021 Lead-IDZ Right Bank

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	0.9255346	0.4627673	0.83269	0.4377022
Residuals	106	58.9094774	0.5557498		

Table 252: ANOVA summary table for SBF 2013 - 2016 - 2021 Lead-IDZ Left Bank

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	9.408868	4.7044338	8.941407	<0.001
Residuals	80	42.091217	0.5261402		

Table 253: Significant Tukey HSD results for lead concentration comparisons between years 2013, 2016, and 2021 in IDZ Left Bank areas.

Higher	Lower	Adjusted p Value
2013	2021	0.001
2016	2021	0.014

Table 254: Tukey HSD for SBF 2013 - 2016 - 2021 Lead-IDZ Left Bank

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	-0.5380428	-1.2273140	0.15122842	0.156
year	2021 : 2013	0	-1.0313536	-1.6959999	-0.36670718	0.001
year	2021 : 2016	0	-0.4933108	-0.9015998	-0.08502174	0.014

Table 255: ANOVA summary table for SBF 2013 - 2016 - 2021 Lead-Downstream IDZ

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	20.86923	10.4346167	27.09362	<0.001
Residuals	212	81.64795	0.3851318		

Table 256: Significant Tukey HSD results for lead concentration comparisons between years 2013, 2016, and 2021 in Downstream IDZ areas.

Higher	Lower	Adjusted p Value
2013	2021	<0.001
2016	2021	<0.001

Table 257: Tukey HSD for SBF 2013 - 2016 - 2021 Lead-Downstream IDZ

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	-0.2061682	-0.4528099	0.04047337	0.121
year	2021 : 2013	0	-0.7734344	-1.0361430	-0.51072576	<0.001
year	2021 : 2016	0	-0.5672662	-0.8036196	-0.33091272	<0.001

Table 258: ANOVA summary table for SBF 2013 - 2016 - 2021 Mercury-Reference

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	11.35830	5.6791497	44.56903	<0.001
Residuals	196	24.97504	0.1274237		

Table 259: Significant Tukey HSD results for mercury concentration comparisons between years 2013, 2016, and 2021 in Reference areas.

Higher	Lower	Adjusted p Value
2013	2021	<0.001
2016	2021	<0.001

Table 260: Tukey HSD for SBF 2013 - 2016 - 2021 Mercury-Reference

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	0.0006265568	-0.1449701	0.1462232	1.000
year	2021 : 2013	0	-0.5111892034	-0.6555505	-0.3668279	<0.001
year	2021 : 2016	0	-0.5118157602	-0.6620404	-0.3615911	<0.001

Table 261: ANOVA summary table for SBF 2013 - 2016 - 2021 Mercury-IDZ Right Bank

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	0.2827945	0.1413972	0.759985	0.4691681
Residuals	180	33.4894768	0.1860526		

Table 262: ANOVA summary table for SBF 2013 - 2016 - 2021 Mercury-IDZ Left Bank

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	1.302022	0.6510108	4.046288	0.02109205
Residuals	82	13.193052	0.1608909		

Table 263: Significant Tukey HSD results for mercury concentration comparisons between years 2013, 2016, and 2021 in IDZ Left Bank areas.

Higher	Lower	Adjusted p Value
2013	2021	0.021

Table 264: Tukey HSD for SBF 2013 - 2016 - 2021 Mercury-IDZ Left Bank

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	-0.2382495	-0.5878630	0.11136411	0.240
year	2021 : 2013	0	-0.3821100	-0.7168395	-0.04738046	0.021
year	2021 : 2016	0	-0.1438605	-0.3695351	0.08181407	0.286

Table 265: ANOVA summary table for SBF 2013 - 2016 - 2021 Mercury-Downstream IDZ

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	2.883388	1.4416939	9.187988	<0.001
Residuals	212	33.265077	0.1569107		

Table 266: Significant Tukey HSD results for mercury concentration comparisons between years 2013, 2016, and 2021 in Downstream IDZ areas.

Higher	Lower	Adjusted p Value
2013	2016	<0.001
2013	2021	<0.001

Table 267: Tukey HSD for SBF 2013 - 2016 - 2021 Mercury-Downstream IDZ

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	-0.24849491	-0.4059251	-0.09106473	<0.001
year	2021 : 2013	0	-0.27478814	-0.4424738	-0.10710246	<0.001
year	2021 : 2016	0	-0.02629324	-0.1771565	0.12457004	0.911

Table 268: ANOVA summary table for SBF 2013 - 2016 - 2021 Selenium-Reference

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	3.615388	1.80769412	31.43287	<0.001
Residuals	196	11.271895	0.05750967		

Table 269: Significant Tukey HSD results for selenium concentration comparisons between years 2013, 2016, and 2021 in Reference areas.

Higher	Lower	Adjusted p Value
2016	2013	<0.001
2016	2021	<0.001

Table 270: Tukey HSD for SBF 2013 - 2016 - 2021 Selenium-Reference

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	0.27403719	0.1762241	0.37185024	<0.001
year	2021 : 2013	0	-0.03315206	-0.1301352	0.06383105	0.699
year	2021 : 2016	0	-0.30718925	-0.4081114	-0.20626706	<0.001

Table 271: ANOVA summary table for SBF 2013 - 2016 - 2021 Selenium-IDZ Right Bank

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	1.363289	0.68164446	8.143107	<0.001
Residuals	185	15.486009	0.08370815		

Table 272: Significant Tukey HSD results for selenium concentration comparisons between years 2013, 2016, and 2021 in IDZ right Bank areas.

Higher	Lower	Adjusted p Value
2016	2013	<0.001
2021	2013	0.028

Table 273: Tukey HSD for SBF 2013 - 2016 - 2021 Selenium-IDZ Right Bank

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	0.24703753	0.10163098	0.39244408	<0.001
year	2021 : 2013	0	0.15838609	0.01376423	0.30300795	0.028
year	2021 : 2016	0	-0.08865144	-0.19778486	0.02048198	0.136

Table 274: ANOVA summary table for SBF 2013 - 2016 - 2021 Selenium-IDZ Left Bank

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	3.711385	1.85569252	56.60117	<0.001
Residuals	82	2.688403	0.03278541		

Table 275: Significant Tukey HSD results for selenium concentration comparisons between years 2013, 2016, and 2021 in IDZ Left Bank areas.

Higher	Lower	Adjusted p Value
2016	2013	<0.001
2016	2021	<0.001

Table 276: Tukey HSD for SBF 2013 - 2016 - 2021 Selenium-IDZ Left Bank

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	0.3548685	0.1970482	0.51268884	<0.001
year	2021 : 2013	0	-0.0953165	-0.2464179	0.05578493	0.294
year	2021 : 2016	0	-0.4501850	-0.5520576	-0.34831248	<0.001

Table 277: ANOVA summary table for SBF 2013 - 2016 - 2021 Selenium-Downstream IDZ

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	4.601296	2.3006482	58.6024	<0.001
Residuals	213	8.362081	0.0392586		

Table 278: Significant Tukey HSD results for selenium concentration comparisons between years 2013, 2016, and 2021 in Downstream IDZ areas.

Higher	Lower	Adjusted p Value
2016	2013	<0.001
2016	2021	<0.001

Table 279: Tukey HSD for SBF 2013 - 2016 - 2021 Selenium-Downstream IDZ

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	0.28381480	0.2054782	0.36215143	<0.001
year	2021 : 2013	0	-0.02207766	-0.1055689	0.06141357	0.807
year	2021 : 2016	0	-0.30589246	-0.3813513	-0.23043361	<0.001

Table 280: ANOVA summary table for SBF 2013 - 2016 - 2021 Thallium-Reference

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	1.365521	0.6827605	1.753575	0.1759155
Residuals	192	74.755882	0.3893536		

Table 281: ANOVA summary table for SBF 2013 - 2016 - 2021 Thallium-IDZ Right Bank

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	2.034625	1.0173125	1.145018	0.3224811
Residuals	97	86.181469	0.8884688		

Table 282: ANOVA summary table for SBF 2013 - 2016 - 2021 Thallium-IDZ Left Bank

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	1.647218	0.8236088	2.339434	0.102784
Residuals	82	28.868494	0.3520548		

Table 283: ANOVA summary table for SBF 2013 - 2016 - 2021 Thallium-Downstream IDZ

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	0.9755718	0.4877859	1.089326	0.3383277
Residuals	211	94.4830648	0.4477870		

Table 284: ANOVA summary table for SBF 2013 - 2016 - 2021 Zinc-Reference

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	1.914552	0.95727576	15.37108	<0.001
Residuals	196	12.206435	0.06227773		

Table 285: Significant Tukey HSD results for zinc concentration comparisons between years 2013, 2016, and 2021 in Reference areas.

Higher	Lower	Adjusted p Value
2016	2013	0.040
2013	2021	0.004
2016	2021	<0.001

Table 286: Tukey HSD for SBF 2013 - 2016 - 2021 Zinc-Reference

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	0.1056621	0.003874974	0.20744920	0.040
year	2021 : 2013	0	-0.1398237	-0.240747127	-0.03890024	0.004
year	2021 : 2016	0	-0.2454858	-0.350508339	-0.14046321	<0.001

Table 287: ANOVA summary table for SBF 2013 - 2016 - 2021 Zinc-IDZ Right Bank

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	0.2348246	0.11741230	1.802836	0.1676991
Residuals	186	12.1135199	0.06512645		

Table 288: ANOVA summary table for SBF 2013 - 2016 - 2021 Zinc-IDZ Left Bank

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	0.3506249	0.17531243	3.041413	0.05318965
Residuals	82	4.7266252	0.05764177		

Table 289: ANOVA summary table for SBF 2013 - 2016 - 2021 Zinc-Downstream IDZ

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
year	2	0.7846906	0.39234529	5.520801	0.004599372
Residuals	212	15.0661480	0.07106674		

Table 290: Significant Tukey HSD results for zinc concentration comparisons between years 2013, 2016, and 2021 in Downstream IDZ.

Higher	Lower	Adjusted p Value
2013	2021	0.004

Table 291: Tukey HSD for SBF 2013 - 2016 - 2021 Zinc-Downstream IDZ

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
year	2016 : 2013	0	-0.05483214	-0.1607806	0.051116366	0.442
year	2021 : 2013	0	-0.15464737	-0.2674977	-0.041797043	0.004
year	2021 : 2016	0	-0.09981523	-0.2013443	0.001713833	0.055

APPENDIX R LARGE-BODIED FISH TISSUE METALS AND CONDITION

Table 292. Condition indices of large-bodied fish sampled in 2021.

Date	Ref_Exp	Site	Sample	Species	Sex	Age	Fork Length (mm)	Total Length (mm)	Field Weight (g)	Lab. Weight (g)	FK	GSI	HSI
10-25	Ref	C00.0-R	1489	RB	F	3+	345.0	358.0	512.0	525.0	1.3	2.9	0.9
10-25	Ref	C00.0-R	1490	RB	F	4+	440.0	455.0	889.0	915.0	1.1	2.4	1.1
10-25	Ref	C00.7-L	1496	WP	M	6+	450.0	463.0	914.0	933.0	1.0	0.5	1.0
10-25	Ref	C01.3-L	1523	RB	U	1+	330.0	343.0	405.0	415.0	1.2		0.9
10-25	Ref	C01.3-L	1524	WP	M	4+	364.0	374.0	522.0	526.0	1.1	0.3	0.8
10-25	Ref	C01.3-L	1525	WP	M	4+	377.0	385.0	624.0	623.0	1.2	0.4	0.7
10-25	Ref	C02.8-L	1537	WP	M	5+	424.0	435.0	951.0	960.0	1.3	0.4	1.5
10-25	Ref	C03.6-L	1553	RB	F	3+	397.0	415.0	912.0	908.0	1.5	0.2	0.9
10-25	Ref	C03.6-L	1554	RB	F	3+	370.0	387.0	618.0	621.0	1.2	0.1	0.9
10-25	Ref	C03.6-L	1555	RB	M	2+	366.0	378.0	592.0	603.0	1.2	3.3	0.8
10-25	Ref	C03.6-L	1557	WP	M	5+	389.0	395.0	663.0	660.0	1.1	0.5	1.3
10-25	Ref	C03.6-L	1558	WP	M	5+	381.0	385.0	639.0	640.0	1.2	0.4	0.9
10-25	Ref	C03.6-L	1567	RB	F	2+	356.0	366.0	488.0	494.0	1.1	0.1	0.8
10-25	Ref	C03.6-L	1570	WP	M	5+	356.0	361.0	560.0	575.0	1.3	2.8	1.1
10-26	Ref	C04.6-R	1575	WP	M	5+	374.0	382.0	580.0	585.0	1.1	0.4	1.4
10-26	Ref	C04.6-R	1576	WP	M	4+	363.0	371.0	543.0	537.0	1.1	2.2	1.5
10-26	Ref	C05.6-L	1582	RB	F	2+	398.0	400.0	556.0	550.0	0.9	0.3	0.7
10-26	Ref	C05.6-L	1583	WP	M	4+	403.0	418.0	772.0	781.0	1.2	0.3	1.2
10-26	Ref	K01.8-R	1605	MW	M	5+	396.0	411.0	870.0	882.0	1.4	6.8	0.5
10-26	Ref	K01.8-R	1606	MW	M	2+	325.0	341.0	608.0	612.0	1.8	8.8	0.5
10-26	Ref	K01.8-R	1607	MW	F	2+	305.0	322.0	542.0	544.0	1.9	13.3	0.9
10-26	Ref	K01.8-R	1608	RB	M	1+	294.0	314.0	363.0	358.0	1.4	0.0	0.6
10-26	Ref	K01.8-R	1610	WP	M	5+	377.0	390.0	640.0	650.0	1.2	3.3	0.6
10-26	Ref	K01.8-R	1611	WP	M	4+	334.0	352.0	417.0	425.0	1.1	0.3	0.9
10-26	Ref	K01.8-R	1617	RB	M	2+	385.0	399.0	766.0	784.0	1.4	0.0	0.8
10-26	Ref	K01.8-L	1637	WP	M	5+	374.0	391.0	686.0	689.0	1.3	0.4	2.1
10-26	Ref	K01.8-L	1638	WP	M	5+	388.0	396.0	639.0	642.0	1.1	2.0	1.0
10-26	Ref	K01.8-L	1639	WP	M	6+	379.0	392.0	663.0	683.0	1.3	4.2	1.2
10-26	Ref	K01.8-L	1640	MW	F	5+	408.0	425.0	1,389.0	1,405.0	2.1	21.8	1.6
10-26	Ref	K01.8-L	1641	MW	M	4+	392.0	405.0	957.0	968.0	1.6	10.3	0.8
10-26	Ref	K01.8-L	1646	RB	F	2+	344.0	354.0	583.0	591.0	1.5	6.1	1.0

Date	Ref_Exp	Site	Sample	Species	Sex	Age	Fork Length (mm)	Total Length (mm)	Field Weight (g)	Lab. Weight (g)	FK	GSI	HSI
10-26	Ref	K01.8-L	1650	MW	M	4+	360.0	367.0	688.0	693.0	1.5	9.9	0.5
10-26	Ref	K01.8-L	1651	RB	M	1+	340.0	353.0	516.0	519.0	1.3	0.0	0.7
10-27	Ref	C07.4-L	1695	MW	M	4+	343.0	357.0	656.0	654.0	1.6	13.6	0.3
10-27	Ref	C07.4-L	1696	MW	M	4+	361.0	380.0	757.0	760.0	1.6	2.8	0.7
10-27	Ref	C07.4-L	1697	MW	F	6+	404.0	421.0	800.0	799.0	1.2	2.0	1.1
10-27	Ref	C07.4-L	1705	RB	M	2+	278.0	290.0	288.0	284.0	1.3	0.1	0.8
10-27	Ref	C07.4-L	1706	WP	M	-	328.0	338.0	400.0	405.0	1.1	0.5	1.1
10-27	Ref	C07.3-R	1726	MW	F	6+	399.0	412.0	797.0	800.0	1.3	1.7	0.7
10-27	Ref	C07.3-R	1727	RB	F	3+	355.0	361.0	458.0	466.0	1.0	0.2	0.9
10-27	Ref	C07.3-R	1729	WP	M	4+	355.0	361.0	504.0	512.0	1.1	0.6	1.7
11-02	Exp	C40.0-R	2131	RB	F	3+	402.0	423.0	862.0	873.0	1.3	6.9	1.3
11-02	Exp	C40.0-R	2133	RB	U	1+	292.0	305.0	375.0	369.0	1.5		0.7
11-02	Exp	C40.0-R	2134	RB	U	-	309.0	328.0	459.0	446.0	1.5		0.8
11-02	Exp	C40.0-R	2135	RB	U	1+	274.0	289.0	290.0	290.0	1.4		0.6
11-02	Exp	C40.0-R	2136	RB	U	1+	314.0	327.0	405.0	418.0	1.4		0.8
11-02	Exp	C40.0-R	2137	RB	F	3+	440.0	448.0	979.0	974.0	1.1	3.7	1.1
11-02	Exp	C40.0-R	2138	RB	F	2+	412.0	441.0	1,019.0	1,041.0	1.5	12.0	1.4
11-02	Exp	C40.0-R	2139	RB	U	2+	271.0	284.0	294.0	296.0	1.5		0.6
11-02	Exp	C40.0-R	2140	RB	M	3+	438.0	445.0	1,071.0	1,098.0	1.3	0.4	0.7
11-02	Exp	C40.0-R	2141	RB	M	2+	286.0	300.0	324.0	333.0	1.4	0.4	0.8
11-02	Exp	C40.0-R	2142	RB	F	2+	395.0	409.0	821.0	825.0	1.3	6.3	0.9
11-02	Exp	C40.0-R	2143	RB	M	1+	318.0	334.0	440.0	460.0	1.4	0.2	0.8
11-02	Exp	C40.0-R	2144	RB	F	2+	416.0	429.0	887.0	926.0	1.3	5.8	1.0
11-02	Exp	C40.0-R	2146	RB	F	2+	410.0	431.0	849.0	880.0	1.3	4.0	0.9
11-02	Exp	C40.0-R	2147	RB	U	1+	278.0	291.0	366.0	376.0	1.8		1.0
11-02	Exp	C40.0-R	2167	MW	F	8+	469.0	483.0	1,592.0	1,614.0	1.6	18.6	1.5
11-02	Exp	C40.0-R	2168	MW	F	4+	354.0	367.0	625.0	636.0	1.4	1.3	1.0
11-02	Exp	C40.0-R	2169	MW	F	2+	321.0	329.0	424.0	430.0	1.3	0.5	0.7
11-02	Exp	C40.0-R	2170	MW	M	1+	273.0	280.0	306.0	305.7	1.5	0.8	0.8
11-02	Exp	C41.5-R	2247	RB	U	3+	411.0	430.0	645.0	645.0	0.9		0.9
11-02	Exp	C41.5-R	2248	RB	M	2+	303.0	321.0	373.0	376.0	1.4	0.2	0.9
11-02	Exp	C41.5-R	2249	RB	U	1+	252.0	264.0	227.0	222.0	1.4		0.6

Date	Ref_Exp	Site	Sample	Species	Sex	Age	Fork Length (mm)	Total Length (mm)	Field Weight (g)	Lab. Weight (g)	FK	GSI	HSI
11-02	Exp	C41.5-R	2250	RB	M	2+	297.0	310.0	375.0	381.0	1.5	0.5	1.2
11-02	Exp	C41.5-R	2251	RB	M	1+	315.0	327.0	443.0	444.0	1.4	0.5	0.8
11-02	Exp	C41.5-R	2252	MW	F	6+	433.0	448.0	1,165.0	1,168.0	1.4	18.7	2.0
11-02	Exp	C41.5-R	2253	MW	F	4+	359.0	370.0	411.0	514.0	1.1	0.8	1.0
11-02	Exp	C41.5-R	2254	MW	M	2+	311.0	324.0	517.0	518.0	1.7	0.9	0.6
11-02	Exp	C41.5-R	2255	MW	F	4+	359.0	370.0	529.0	530.0	1.1	1.4	1.6
11-02	Exp	C41.5-R	2256	MW	F	5+	363.0	376.0	605.0	610.0	1.3	0.8	1.1
11-02	Exp	C41.5-R	2257	MW	U	0+	112.0	128.0	22.0	21.0	1.5		0.6
11-02	Exp	C41.5-R	2258	WP	M	6+	383.0	395.0	662.0	666.0	1.2	2.9	1.0
11-02	Exp	C41.5-R	2259	WP	M	5+	374.0	380.0	627.0	631.0	1.2	0.5	1.0
11-02	Exp	C41.5-R	2260	WP	M	5+	379.0	394.0	647.0	654.0	1.2	2.1	0.8
11-02	Exp	C41.5-R	2261	WP	M	6+	339.0	345.0	485.0	493.0	1.3	0.5	1.0
11-02	Exp	C41.5-R	2262	WP	M	4+	342.0	353.0	443.0	442.0	1.1	0.5	1.3
11-02	Exp	C41.5-R	2263	WP	M	6+	395.0	403.0	703.0	712.0	1.2	0.5	0.7
11-04	Exp	C36.9-R	2580	WP	F	5+	462.0	490.0	1,400.0	1,435.0	1.5	5.3	1.8
11-04	Exp	C36.9-R	2581	MW	U	1+	224.0	239.0	209.0	214.0	1.9	0.1	0.7
11-04	Exp	C36.9-R	2582	MW	F	4+	348.0	357.0	469.0	484.0	1.1	0.6	0.7
11-04	Exp	C36.9-R	2583	MW	F	5+	357.0	372.0	559.0	566.0	1.2	0.8	0.9
11-04	Exp	C36.9-R	2584	MW	F	5+	390.0	402.0	718.0	730.0	1.2	0.9	1.2
11-04	Ref	C10.9-L	2618	WP	M	6+	415.0	425.0	911.0	928.0	1.3	4.6	1.5
11-04	Ref	C10.9-L	2619	WP	M	4+	370.0	384.0	548.0	564.0	1.1	2.4	1.0
11-04	Ref	C10.9-L	2620	WP	M	7+	425.0	436.0	1,025.0	1,044.0	1.4	3.5	1.4
11-04	Ref	C10.9-L	2621	MW	M	4+	377.0	389.0	927.0	947.0	1.8	10.8	0.5
11-04	Ref	C10.9-L	2622	MW	M	1+	231.0	235.0	220.0	227.0	1.8	0.6	0.9
11-04	Ref	C10.9-L	2623	MW	F	5+	371.0	384.0	938.0	963.0	1.9	21.1	1.0
11-04	Ref	C10.9-L	2624	RB	F	1+	253.0	262.0	204.0	219.0	1.4	0.1	0.6
11-04	Ref	C10.9-L	2666	MW	M	2+	314.0	327.0	550.0	557.0	1.8	10.1	0.4
11-04	Ref	C10.9-L	2667	MW	M	1+	234.0	245.0	193.0	197.0	1.5	1.2	0.4
11-04	Ref	C10.9-L	2668	MW	M	6+	415.0	429.0	1,166.0	1,192.0	1.7	14.1	0.6
11-04	Ref	C10.9-L	2669	MW	F	6+	383.0	398.0	726.0	746.0	1.3	1.1	1.5
11-04	Ref	C10.9-L	2670	MW	F	6+	386.0	398.0	791.0	813.0	1.4	1.3	1.1
11-04	Ref	C10.9-L	2671	MW	F	3+	315.0	325.0	554.0	565.0	1.8	15.2	1.1

Date	Ref_Exp	Site	Sample	Species	Sex	Age	Fork Length (mm)	Total Length (mm)	Field Weight (g)	Lab. Weight (g)	FK	GSI	HSI
11-04	Ref	C10.9-L	2672	MW	F	3+	334.0	343.0	632.0	655.0	1.8	13.4	0.5
11-04	Ref	C10.9-L	2673	RB	M	1+	319.0	328.0	413.0	431.0	1.3	0.0	0.7
11-04	Ref	C10.9-L	2674	RB	M	2+	368.0	382.0	635.0	647.0	1.3	0.1	0.7
11-04	Ref	C10.9-L	2675	RB	F	2+	407.0	428.0	968.0	991.0	1.5	0.1	0.9
11-04	Ref	C10.9-L	2676	RB	F	4+	440.0	453.0	1,122.0	1,149.0	1.3	8.7	1.4
11-04	Ref	C10.9-L	2677	RB	F	2+	393.0	412.0	906.0	925.0	1.5	0.1	0.8

Table 293:Tissue metals (mg/kg ww) of large-bodied fish sampled in 2021.

Sample	1489	1489	1490	1490	1496	1496	1523	1523	1524
Treatment	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Species	RB	RB	RB	RB	WP	WP	RB	RB	WP
Tissue Type	Fillet	Fillet	Fillet	Fillet	Fillet	Fillet	Whole	Gut	Whole
Moisture	71.2	71.5	73.2	75.3	75.7	73.4	76.6	83	74.6
Aluminum	0.288	0.285	0.268	0.247	0.243	0.266	0.234	3.91	0.254
Antimony	0.00144	0.001425	0.00134	0.001235	0.001215	0.00133	0.00117	8.50E-04	0.00127
Arsenic	0.044928	0.04161	0.07504	0.080522	0.061236	0.060648	0.020358	0.02533	0.102616
Barium	0.35136	0.243675	0.35376	0.54093	1.16883	1.18636	0.30654	0.4114	1.06426
Beryllium	0.00144	0.001425	0.00134	0.001235	0.001215	0.00133	0.00117	8.50E-04	0.00127
Bismuth	0.00144	0.001425	0.00134	0.001235	0.001215	0.00133	0.00117	8.50E-04	0.00127
Boron	0.144	0.1425	0.134	0.1235	0.1215	0.133	0.117	0.085	0.127
Cadmium	0.0016416	7.12E-04	6.70E-04	6.18E-04	0.0023571	0.0021546	0.0066222	0.04794	0.005334
Calcium	1946.88	1484.85	1637.48	2447.77	13948.2	13512.8	2808	178.5	18973.8
Cesium	0.0263232	0.027588	0.068608	0.071136	0.081162	0.081396	0.0171054	0.01598	0.06223
Chromium	0.0072	0.007125	0.0067	0.006175	0.006075	0.00665	0.00585	0.01343	0.00635
Cobalt	0.00288	0.00285	0.00268	0.00247	0.00243	0.00266	0.009828	0.02346	0.00254
Copper	0.61056	0.6213	0.43684	0.47671	0.40095	0.38304	0.35334	1.2682	0.23368
Iron	6.6816	5.6715	9.4604	10.2505	2.5515	2.5802	9.3366	39.1	4.1148
Lead	0.00288	0.00285	0.00268	0.006422	0.009234	0.009842	0.00234	0.0102	0.018034
Lithium	0.072	0.07125	0.067	0.06175	0.06075	0.0665	0.0585	0.0425	0.0635
Magnesium	316.8	313.5	246.024	279.11	466.56	446.88	283.14	131.58	571.5
Manganese	0.44064	0.33345	0.253796	0.36803	0.72414	0.72884	0.48672	2.074	1.32842
Mercury	0.065088	0.067545	0.173396	0.21242	0.169857	0.15827	0.04797	0.02499	0.115824
Molybdenum	0.00288	0.00285	0.00268	0.00247	0.00243	0.00266	0.005148	0.04012	0.00254
Nickel	0.0288	0.0285	0.0268	0.0247	0.0243	0.0266	0.0234	0.0765	0.0254
Phosphorus	3283.2	3049.5	2760.4	3260.4	10157.4	10054.8	3884.4	1887	12852.4
Potassium	3427.2	3591	3028.4	3038.1	3645	3644.2	3556.8	2210	3454.4
Rubidium	5.4432	5.6715	8.3884	8.5462	10.1574	10.1612	3.8376	3.179	8.4074
Selenium	0.29952	0.3078	0.264516	0.25441	0.34506	0.31654	0.34398	0.6273	0.46736
Silver	7.20E-04	7.12E-04	6.70E-04	6.18E-04	6.08E-04	6.65E-04	0.0018018	0.004505	6.35E-04
Sodium	394.56	319.2	479.72	516.23	741.15	699.58	765.18	1096.5	934.72
Strontium	2.76192	2.08335	2.61836	4.2978	11.2509	10.906	3.51	0.3604	15.875
Thallium	0.0098496	0.010203	0.0162676	0.0176111	0.0165483	0.0153216	0.0042588	0.009486	0.0133604
Tin	0.0144	0.01425	0.0134	0.01235	0.01215	0.0133	0.0117	0.0731	0.0127
Tellurium	0.00288	0.00285	0.00268	0.00247	0.00243	0.00266	0.00234	0.0017	0.00254
Uranium	2.88E-04	2.85E-04	8.58E-04	0.0011362	9.72E-04	0.0011172	9.83E-04	0.005015	8.13E-04
Vanadium	0.0144	0.01425	0.0134	0.01235	0.01215	0.0133	0.0117	0.0085	0.0127
Zinc	20.1024	15.1335	16.9108	19.8835	10.5219	11.438	14.8122	175.1	14.1224
Zirconium	0.0288	0.0285	0.0268	0.0247	0.0243	0.0266	0.0234	0.017	0.0254
Total.Lipids	7.08	4.93	2.22	2.69	1.04	1.21	2.57	2	1.91

Sample	1524	1525	1525	1537	1537	1553	1554	1555
Treatment	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Species	WP	WP	WP	WP	WP	RB	RB	RB
Tissue Type	Gut	Whole	Gut	Whole	Gut	Fillet	Fillet	Fillet
Moisture	72.2	74.8	57.1	75	35.3	68.7	71.9	73.2
Aluminum	0.5838	0.252	0.429	0.25	0.647	0.313	0.281	0.268
Antimony	0.00139	0.00126	0.002145	0.00125	0.003235	0.001565	0.001405	0.00134
Arsenic	0.149842	0.101304	0.209781	0.072	0.163044	0.085136	0.091887	0.075308
Barium	0.158738	0.3024	0.054912	0.2625	0.016175	0.53836	0.210469	0.19162
Beryllium	0.00139	0.00126	0.002145	0.00125	0.003235	0.001565	0.001405	0.00134
Bismuth	0.00139	0.00126	0.002145	0.00125	0.003235	0.001565	0.001405	0.00134
Boron	0.139	0.126	0.2145	0.125	0.3235	0.1565	0.1405	0.134
Cadmium	0.085068	0.002142	0.04719	0.003725	0.0463899	7.82E-04	0.0018827	0.0013668
Calcium	1039.72	5720.4	165.165	4450	73.111	2378.8	1677.57	1640.16
Cesium	0.045314	0.08442	0.0403689	0.07875	0.0436725	0.070425	0.053952	0.066196
Chromium	0.014178	0.0063	0.021879	0.00625	0.016175	0.007825	0.007025	0.0067
Cobalt	0.018348	0.00252	0.009867	0.0025	0.016175	0.00313	0.00281	0.00268
Copper	0.74226	0.23436	0.48048	0.2275	0.53701	0.45698	0.47489	0.7504
Iron	30.024	4.2336	15.6585	2.425	12.8106	7.0112	4.9456	6.7536
Lead	0.00278	0.00252	0.00429	0.0075	0.00647	0.00939	0.00281	0.00268
Lithium	0.0695	0.063	0.10725	0.0625	0.16175	0.07825	0.07025	0.067
Magnesium	176.252	398.16	84.942	405	81.522	319.26	289.43	270.68
Manganese	0.72002	0.40824	0.419991	0.4075	0.501425	0.42255	0.235197	0.155172
Mercury	0.0203218	0.145656	0.0120978	0.17125	0.0153986	0.071364	0.055638	0.04154
Molybdenum	0.019182	0.00252	0.018018	0.0025	0.01294	0.00313	0.00281	0.00268
Nickel	0.0278	0.0252	0.0429	0.025	0.0647	0.0313	0.0281	0.0268
Phosphorus	2082.22	5594.4	1123.98	5175	1138.72	3536.9	3034.8	2787.2
Potassium	2001.6	3729.6	1419.99	4200	1423.4	3474.3	3428.2	3162.4
Rubidium	5.7268	13.608	6.006	13	5.90064	8.6701	8.2895	9.112
Selenium	0.5977	0.33012	0.365079	0.355	0.441901	0.31613	0.281	0.30016
Silver	6.95E-04	6.30E-04	0.0038181	6.25E-04	0.0016175	0.0023162	7.02E-04	6.70E-04
Sodium	847.9	771.12	660.66	652.5	705.23	359.95	342.82	391.28
Strontium	1.6124	5.7204	0.283569	3.75	0.108696	4.0064	2.53462	2.31552
Thallium	0.0125378	0.0101304	0.0097812	0.01185	0.0138458	0.0168707	0.0166914	0.0143916
Tin	0.03614	0.0126	0.02145	0.0125	0.03235	0.01565	0.01405	0.0134
Tellurium	0.00278	0.00252	0.00429	0.0025	0.00647	0.00313	0.00281	0.00268
Uranium	2.78E-04	2.52E-04	4.29E-04	2.50E-04	6.47E-04	0.0017841	2.81E-04	2.68E-04
Vanadium	0.0139	0.0126	0.02145	0.0125	0.03235	0.01565	0.01405	0.0134
Zinc	16.4576	12.4236	9.9957	10.35	11.5166	17.8097	11.802	7.638
Zirconium	0.0278	0.0252	0.0429	0.025	0.0647	0.0313	0.0281	0.0268
Total.Lipids	10.9	3.08	42	1.17	23.1	8.83	7.63	6.02

Sample	1557	1557	1558	1558	1567	1570	1570	1575
Treatment	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Species	WP	WP	WP	WP	RB	WP	WP	WP
Tissue Type	Whole	Gut	Whole	Gut	Fillet	Gut	Whole	Fillet
Moisture	75.2	55.2	75.4	51	77.2	71.5	75	75
Aluminum	0.248	3.8976	0.246	0.49	0.228	0.285	0.25	0.25
Antimony	0.00124	0.00224	0.00123	0.00245	0.00114	0.001425	0.00125	0.00125
Arsenic	0.104904	0.216832	0.07503	0.25137	0.015504	0.087495	0.03875	0.04375
Barium	0.65472	0.164416	0.39606	0.06272	0.28728	0.22287	1.0425	0.6825
Beryllium	0.00124	0.00224	0.00123	0.00245	0.00114	0.001425	0.00125	0.00125
Bismuth	0.00124	0.00224	0.00123	0.00245	0.00114	0.001425	0.00125	0.00125
Boron	0.124	0.224	0.123	0.245	0.114	0.1425	0.125	0.125
Cadmium	0.0067456	0.105728	0.007134	0.08036	0.0014136	0.106875	0.01045	0.0019
Calcium	7142.4	739.2	5289	354.27	1527.6	1804.05	10150	9275
Cesium	0.0868	0.05376	0.068142	0.034594	0.0216828	0.04389	0.06675	0.0495
Chromium	0.0062	0.0112	0.00615	0.01225	0.0057	0.007125	0.00625	0.00625
Cobalt	0.005208	0.031808	0.00246	0.0147	0.00228	0.023085	0.0025	0.0025
Copper	0.30504	1.1424	0.23124	0.5488	0.3762	0.627	0.3225	0.335
Iron	3.8936	25.1776	3.0504	14.749	5.1756	36.765	6.25	1.875
Lead	0.015872	0.00448	0.00246	0.0049	0.00228	0.00285	0.023	0.00575
Lithium	0.062	0.112	0.0615	0.1225	0.057	0.07125	0.0625	0.0625
Magnesium	386.88	121.408	356.7	95.06	298.68	158.46	415	380
Manganese	0.89528	0.65408	0.35178	0.5047	0.26448	1.05735	0.815	0.925
Mercury	0.222208	0.016352	0.141942	0.013818	0.077748	0.03135	0.2875	0.08975
Molybdenum	0.00248	0.018816	0.00246	0.0147	0.00228	0.020235	0.0025	0.0025
Nickel	0.0248	0.0448	0.0246	0.049	0.0228	0.0285	0.025	0.025
Phosphorus	6398.4	1505.28	5436.6	1200.5	3009.6	2473.8	8025	7750
Potassium	3769.6	1576.96	4108.2	1367.1	3762	1900.95	3575	3525
Rubidium	13.888	7.2128	12.792	5.341	3.534	4.617	6.725	6.85
Selenium	0.3596	0.46144	0.31242	0.38563	0.26448	0.5187	0.415	0.4225
Silver	6.20E-04	0.0052416	6.15E-04	0.001225	5.70E-04	7.12E-04	6.25E-04	6.25E-04
Sodium	763.84	725.76	654.36	656.6	328.32	812.25	937.5	577.5
Strontium	7.3656	1.46048	5.2152	0.7497	2.27316	4.0755	9.975	8.925
Thallium	0.0167152	0.0185024	0.0105288	0.009898	0.0057912	0.010659	0.0071	0.008
Tin	0.0124	0.0224	0.0123	0.0245	0.0114	0.01425	0.0125	0.0125
Tellurium	0.00248	0.00448	0.00246	0.0049	0.00228	0.00285	0.0025	0.0025
Uranium	2.48E-04	4.48E-04	2.46E-04	4.90E-04	0.0033972	2.85E-04	7.00E-04	2.50E-04
Vanadium	0.0124	0.0224	0.0123	0.0245	0.0114	0.01425	0.0125	0.0125
Zinc	11.3584	13.3056	8.364	11.172	14.2728	21.5745	17.225	9.825
Zirconium	0.0248	0.0448	0.0246	0.049	0.0228	0.0285	0.025	0.025
Total.Lipids	2.31	20.4	1.17	31.6	1.18	17	2.33	1.47

Sample	1576	1576	1582	1583	1605	1605	1606	1606
Treatment	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Species	WP	WP	RB	WP	MW	MW	MW	MW
Tissue Type	Whole	Gut	Fillet	Fillet	Whole	Gut	Whole	Gut
Moisture	70.2	60.4	77	72.5	67.1	75.6	64.6	63.2
Aluminum	0.298	3.564	0.23	0.275	0.329	3.2208	0.354	24.7296
Antimony	0.00149	0.00198	0.00115	0.001375	0.003948	0.004392	0.00177	0.00184
Arsenic	0.14751	0.248688	0.02783	0.0429	0.036519	0.035136	0.049914	0.102304
Barium	0.75096	0.242352	0.7383	0.638	0.285901	0.17446	0.166026	0.9752
Beryllium	0.00149	0.00198	0.00115	0.001375	0.001645	0.00122	0.00177	0.00184
Bismuth	0.00149	0.00198	0.00115	0.001375	0.001645	0.00122	0.00177	0.00184
Boron	0.149	0.198	0.115	0.1375	0.1645	0.122	0.177	0.184
Cadmium	0.011324	0.070488	0.001748	6.88E-04	0.0186543	0.211792	8.85E-04	0.046368
Calcium	7420.2	942.48	2214.9	11825	4375.7	114.436	3348.84	110.032
Cesium	0.047978	0.0296208	0.03036	0.044	0.033558	0.024644	0.0195408	0.0141312
Chromium	0.00745	0.0099	0.00575	0.006875	0.023359	0.016104	0.00885	0.071392
Cobalt	0.00298	0.020196	0.00644	0.00275	0.026978	0.054656	0.023718	0.061088
Copper	0.3129	0.6336	0.4646	0.363	0.51653	0.78812	0.52392	1.07088
Iron	4.9766	19.2852	10.994	2.2275	13.5548	71.492	6.903	65.136
Lead	0.014602	0.010692	0.00736	0.010725	0.10857	0.101748	0.00354	0.06992
Lithium	0.0745	0.099	0.0575	0.06875	0.08225	0.061	0.0885	0.092
Magnesium	408.26	115.632	305.9	445.5	342.16	135.176	339.84	132.112
Manganese	0.97744	0.8316	0.3979	0.7315	0.82579	2.17404	0.80712	4.7472
Mercury	0.164794	0.014652	0.18653	0.213125	0.058891	0.046848	0.0153282	0.011776
Molybdenum	0.00298	0.011088	0.0023	0.00275	0.00329	0.026352	0.00354	0.020608
Nickel	0.0298	0.0396	0.023	0.0275	0.0329	0.07808	0.0354	0.11776
Phosphorus	6764.6	1675.08	3312	8305	5593	1983.72	4991.4	1641.28
Potassium	3963.4	1520.64	3427	3657.5	3553.2	2313.12	3430.26	1707.52
Rubidium	8.8804	4.5144	4.025	8.91	1.72396	1.65188	2.87448	2.1528
Selenium	0.37846	0.41976	0.2829	0.4675	0.83895	1.97396	0.4602	1.05984
Silver	7.45E-04	9.90E-04	5.75E-04	6.88E-04	8.23E-04	6.10E-04	8.85E-04	0.0034592
Sodium	834.4	657.36	441.6	665.5	822.5	1010.16	658.44	743.36
Strontium	7.8672	1.84536	3.335	13.5025	4.277	0.219112	4.248	0.68816
Thallium	0.0184164	0.0165924	0.007061	0.01507	0.0050666	0.0115656	0.0031506	0.0091632
Tin	0.0149	0.0198	0.0115	0.01375	0.01645	0.05612	0.0177	0.05152
Tellurium	0.00298	0.00396	0.0023	0.00275	0.00329	0.00244	0.00354	0.00368
Uranium	2.98E-04	0.0014652	0.001127	6.33E-04	0.005264	0.0049532	7.79E-04	0.013248
Vanadium	0.0149	0.0198	0.0115	0.01375	0.01645	0.0122	0.0177	0.09936
Zinc	11.6816	12.3156	23	13.3375	15.2656	268.4	12.0006	544.64
Zirconium	0.0298	0.0396	0.023	0.0275	0.0329	0.0244	0.0354	0.0368
Total.Lipids	2.05	20.5	1.18	1.72	7.29	6.57	13.3	12.3

Sample	1607	1607	1608	1608	1610	1610	1611	1617
Treatment	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Species	MW	MW	RB	RB	WP	WP	WP	RB
Tissue Type	Whole	Gut	Whole	Gut	Whole	Gut	Fillet	Fillet
Moisture	68.1	66.2	68.9	78	75.2	75.1	80.4	69.5
Aluminum	0.319	43.264	0.311	86.02	0.248	0.249	0.196	0.305
Antimony	0.001595	0.00169	0.001555	0.00418	0.00124	0.001245	9.80E-04	0.001525
Arsenic	0.034452	0.153452	0.021148	0.08052	0.029512	0.05727	0.085064	0.01769
Barium	0.111331	1.3182	1.03563	2.035	0.25544	0.08217	0.73304	0.3172
Beryllium	0.001595	0.00169	0.001555	0.00484	0.00124	0.001245	9.80E-04	0.001525
Bismuth	0.001595	0.00169	0.001555	0.00264	0.00124	0.001245	9.80E-04	0.001525
Boron	0.1595	0.169	0.1555	0.11	0.124	0.1245	0.098	0.1525
Cadmium	0.002552	0.06591	0.002177	0.07348	0.0035216	0.034362	0.0024892	7.63E-04
Calcium	2583.9	194.012	7588.4	183.26	3472	50.298	7232.4	1653.1
Cesium	0.0187572	0.0203138	0.0109161	0.0242	0.052328	0.0174798	0.045276	0.017995
Chromium	0.007975	0.134186	0.007775	0.3322	0.0062	0.006225	0.0049	0.007625
Cobalt	0.013398	0.05915	0.008708	0.08426	0.00248	0.011952	0.00196	0.008845
Copper	0.58058	1.05118	0.7464	2.53	0.29264	0.39342	0.2842	0.55815
Iron	6.1886	100.048	8.6458	172.92	4.5136	9.3624	1.666	4.4225
Lead	0.00319	0.09126	0.009019	0.21208	0.00248	0.00249	0.012348	0.00732
Lithium	0.07975	0.0845	0.07775	0.1386	0.062	0.06225	0.049	0.07625
Magnesium	354.09	153.79	419.85	163.68	317.44	62.997	346.92	276.94
Manganese	1.77364	4.8672	1.48347	6.71	0.39928	0.55029	0.9604	0.4087
Mercury	0.0114202	0.011661	0.0128132	0.006116	0.129704	0.0078186	0.1176	0.0229665
Molybdenum	0.00319	0.036504	0.00311	0.06864	0.00248	0.012201	0.00196	0.00305
Nickel	0.0319	0.15886	0.0311	0.297	0.0248	0.0249	0.0196	0.0305
Phosphorus	4529.8	1710.28	7370.7	1564.2	4935.2	976.08	6076	2952.4
Potassium	3477.1	1967.16	3794.2	1766.6	3670.4	1073.19	3332	3202.5
Rubidium	2.5839	2.14292	1.91887	1.3486	5.208	1.90983	7.6832	3.6295
Selenium	0.95381	0.92612	0.73085	0.8096	0.68448	0.47061	0.33908	0.5002
Silver	7.98E-04	0.0035828	0.0102008	0.017358	6.20E-04	6.23E-04	4.90E-04	7.63E-04
Sodium	599.72	709.8	702.86	596.2	744	535.35	517.44	338.55
Strontium	3.2857	1.1999	10.6984	1.1066	3.6208	0.074451	6.762	2.68705
Thallium	0.002552	0.0076726	0.0028301	0.005412	0.0032984	0.0037599	0.0183456	0.0055205
Tin	0.01595	0.07436	0.01555	0.099	0.0124	0.05727	0.0294	0.01525
Tellurium	0.00319	0.00338	0.00311	0.0022	0.00248	0.00249	0.00196	0.00305
Uranium	3.19E-04	0.0190294	0.0021148	0.11814	2.48E-04	2.49E-04	1.96E-04	0.001159
Vanadium	0.01595	0.15548	0.01555	0.2838	0.0124	0.01245	0.0098	0.01525
Zinc	13.6851	216.658	17.0117	108.68	9.9696	7.9431	8.722	9.6075
Zirconium	0.0319	0.0338	0.0311	0.066	0.0248	0.0249	0.0196	0.0305
Total.Lipids	6.66	11.3	5.54	5.24	2.68	17.4	0.74	8.73

Sample	1637	1637	1638	1638	1639	1640	1640	1641	1641
Treatment	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Species	WP	WP	WP	WP	WP	MW	MW	MW	MW
Tissue Type	Fillet	Fillet	Whole	Gut	Fillet	Whole	Gut	Whole	Gut
Moisture	75.5	77	75.5	59.6	74.4	63.2	78.5	64.4	53.9
Aluminum	0.245	0.23	0.245	0.404	0.256	0.368	1.849	0.356	13.0002
Antimony	0.001225	0.00115	0.001225	0.00202	0.00128	0.00184	0.001075	0.00178	0.002305
Arsenic	0.028175	0.02599	0.09163	0.203616	0.030464	0.080224	0.03913	0.053044	0.130002
Barium	0.5145	0.5865	0.539	0.035552	0.704	0.124384	0.093525	0.119972	0.393694
Beryllium	0.001225	0.00115	0.001225	0.00202	0.00128	0.00184	0.001075	0.00178	0.002305
Bismuth	0.001225	0.00115	0.001225	0.00202	0.00128	0.00184	0.001075	0.00178	0.002305
Boron	0.1225	0.115	0.1225	0.202	0.128	0.184	0.1075	0.178	0.2305
Cadmium	6.13E-04	5.75E-04	0.0141365	0.119988	0.002048	0.007912	0.10363	0.0060876	0.068689
Calcium	7668.5	8602	5929	170.488	11008	2024	95.46	1641.16	89.895
Cesium	0.06762	0.06509	0.050715	0.0292496	0.05248	0.0361376	0.02279	0.0252048	0.0196847
Chromium	0.006125	0.00575	0.006125	0.0101	0.0064	0.0092	0.005375	0.0089	0.039646
Cobalt	0.00245	0.0023	0.00245	0.015352	0.00256	0.030912	0.075465	0.007832	0.027199
Copper	0.3479	0.3749	0.27195	0.44036	0.41728	0.47472	0.60415	0.49128	0.82519
Iron	1.8865	1.978	3.283	11.6756	2.4832	7.2864	70.305	10.1104	102.803
Lead	0.007105	0.00782	0.01078	0.00404	0.00768	0.016928	0.021285	0.009612	0.044256
Lithium	0.06125	0.0575	0.06125	0.101	0.064	0.092	0.05375	0.089	0.11525
Magnesium	384.65	384.1	345.45	102.212	458.24	301.024	130.72	275.544	132.768
Manganese	0.68845	0.7429	0.5047	0.65044	1.08288	0.63664	1.12445	0.4272	4.2873
Mercury	0.13279	0.12351	0.183505	0.0128472	0.120064	0.052256	0.056975	0.04272	0.048866
Molybdenum	0.00245	0.0023	0.00245	0.009696	0.00256	0.00368	0.01505	0.00356	0.018901
Nickel	0.0245	0.023	0.0245	0.0404	0.0256	0.0368	0.0215	0.0356	0.0461
Phosphorus	6860	6647	5537	1264.52	8704	3665.28	1881.25	6230	1871.66
Potassium	3944.5	3634	3773	1652.36	3686.4	3231.04	2171.5	3314.36	2208.19
Rubidium	6.1985	5.681	8.281	4.6864	5.6064	3.7536	3.741	3.7736	3.52204
Selenium	0.6272	0.5773	0.3822	0.50096	0.64	0.59616	1.0234	0.60164	2.83976
Silver	6.13E-04	5.75E-04	6.13E-04	0.00101	6.40E-04	9.20E-04	5.38E-04	8.90E-04	0.0011525
Sodium	502.25	517.5	668.85	622.16	599.04	691.84	928.8	669.28	866.68
Strontium	8.0605	8.671	5.194	0.255328	10.24	1.9504	0.15351	1.68744	0.274295
Thallium	0.006174	0.006601	0.019845	0.0215332	0.0059392	0.002576	0.0090515	0.0031328	0.0065001
Tin	0.01225	0.0115	0.01225	0.0202	0.0128	0.0184	0.02795	0.0178	0.05071
Tellurium	0.00245	0.0023	0.00245	0.00404	0.00256	0.00368	0.00215	0.00356	0.00461
Uranium	2.45E-04	2.30E-04	5.15E-04	4.04E-04	2.56E-04	0.004048	0.007138	0.0020292	0.0114789
Vanadium	0.01225	0.0115	0.01225	0.0202	0.0128	0.0184	0.01075	0.0178	0.05071
Zinc	8.6975	9.315	8.2075	12.1604	11.9296	11.1504	201.24	9.1848	130.924
Zirconium	0.0245	0.023	0.0245	0.0404	0.0256	0.0368	0.0215	0.0356	0.0461
Total.Lipids	1.63	0.65	2.48	26.8	1.94	11.2	4.14	11.1	12.7

Sample	1646	1646	1650	1650	1651	1651	1695	1695	1696
Treatment	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Species	RB	RB	MW	MW	RB	RB	MW	MW	MW
Tissue Type	Whole	Gut	Whole	Gut	Whole	Gut	Whole	Gut	Whole
Moisture	68.6	77.6	61.8	54.9	68.3	77.7	67.4	62	67.1
Aluminum	0.314	18.5696	0.382	2.1648	0.317	222.108	0.326	0.38	0.329
Antimony	0.00157	0.00112	0.00191	0.002255	0.001585	0.005798	0.00163	0.0019	0.001645
Arsenic	0.027318	0.050624	0.06303	0.09471	0.027896	0.136253	0.037816	0.08284	0.077644
Barium	0.35482	0.90048	0.296814	0.119966	0.170546	4.0809	0.225918	0.07942	0.150682
Beryllium	0.00157	0.00112	0.00191	0.002255	0.001585	0.013826	0.00163	0.0019	0.001645
Bismuth	0.00157	0.00112	0.00191	0.002255	0.001585	0.00446	0.00163	0.0019	0.001645
Boron	0.157	0.112	0.191	0.2255	0.1585	0.1115	0.163	0.19	0.1645
Cadmium	0.0059032	0.05264	0.0043548	0.0368918	0.0026628	0.118636	0.0031948	0.04142	0.009541
Calcium	1758.4	142.688	5424.4	96.514	1185.58	680.15	3211.1	111.72	2411.57
Cesium	0.0124972	0.011872	0.0257086	0.0151536	0.0189249	0.053074	0.0173432	0.009804	0.045402
Chromium	0.00785	0.063616	0.00955	0.011275	0.007925	0.68684	0.00815	0.0095	0.008225
Cobalt	0.006908	0.031584	0.016044	0.029766	0.008876	0.195571	0.00978	0.02204	0.008225
Copper	0.60288	1.36864	0.48896	0.59532	1.14437	2.8544	0.54768	0.6498	0.57904
Iron	8.9804	52.64	5.6154	14.3418	7.1008	437.08	5.6724	15.314	8.2908
Lead	0.008792	0.05936	0.014134	0.00451	0.00317	0.49729	0.009128	0.0038	0.010528
Lithium	0.0785	0.056	0.0955	0.11275	0.07925	0.36572	0.0815	0.095	0.08225
Magnesium	297.672	136.64	389.64	128.535	244.407	249.76	355.34	110.58	335.58
Manganese	0.277576	3.8528	1.20712	1.42967	0.36455	18.6874	0.69438	1.5504	0.70077
Mercury	0.0258422	0.0086464	0.0292612	0.0195734	0.0212073	0.00892	0.0254932	0.014744	0.040138
Molybdenum	0.00314	0.041216	0.00382	0.009922	0.00317	0.070468	0.00326	0.01178	0.00329
Nickel	0.0314	0.06944	0.0382	0.0451	0.0317	0.78496	0.0326	0.038	0.0329
Phosphorus	3391.2	1697.92	7831	3779.38	2894.21	1726.02	6194	1941.8	3684.8
Potassium	3422.6	1861.44	3430.36	1898.71	3328.5	1899.96	3618.6	1881	3783.5
Rubidium	1.59198	1.20512	4.4312	3.61251	3.2968	2.6537	2.88836	2.1052	3.9809
Selenium	0.5652	0.83776	0.56918	1.01926	0.77031	0.90761	0.45966	1.026	0.64813
Silver	7.85E-04	0.0069888	9.55E-04	0.0011275	0.009193	0.0154985	8.15E-04	9.50E-04	8.23E-04
Sodium	599.74	819.84	691.42	748.66	643.51	769.35	694.38	763.8	588.91
Strontium	2.25766	0.49952	5.5008	0.161458	1.79739	2.6314	3.9772	0.16682	2.82282
Thallium	0.0014758	0.0044576	0.004011	0.0073062	0.0029798	0.0087416	0.0029014	0.005928	0.0029281
Tin	0.0157	0.08064	0.0191	0.04961	0.01585	0.04014	0.0163	0.0532	0.01645
Tellurium	0.00314	0.00224	0.00382	0.00451	0.00317	0.00223	0.00326	0.0038	0.00329
Uranium	7.85E-04	0.035616	0.0037436	0.009471	3.17E-04	0.28544	0.0011084	3.80E-04	0.0037835
Vanadium	0.0157	0.06048	0.0191	0.02255	0.01585	0.7582	0.0163	0.019	0.01645
Zinc	14.601	226.24	14.4396	193.028	11.2535	112.392	12.4206	295.64	9.0475
Zirconium	0.0314	0.0224	0.0382	0.0451	0.0317	0.10704	0.0326	0.038	0.0329
Total.Lipids	9.84	8.07	12.8	20.9	10.1	3.76	11.8	13.5	11.7

Sample	1696	1697	1697	1705	1706	1726	1726	1727	1729
Treatment	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Species	MW	MW	MW	RB	WP	MW	MW	RB	WP
Tissue Type	Gut	Whole	Gut	Fillet	Fillet	Whole	Gut	Fillet	Fillet
Moisture	59.9	70.4	80.7	73.6	74.6	70.7	80.8	74.9	76.3
Aluminum	0.9223	0.296	12.8538	0.264	0.254	0.879	7.9488	0.251	0.237
Antimony	0.002005	0.003848	9.65E-04	0.00132	0.00127	0.006446	0.002688	0.001255	0.001185
Arsenic	0.15238	0.101528	0.054619	0.057552	0.061976	0.050689	0.030912	0.017319	0.041712
Barium	0.053333	0.179376	0.25476	0.13068	0.57912	0.34574	0.2496	0.44678	0.68493
Beryllium	0.002005	0.00148	9.65E-04	0.00132	0.00127	0.001465	9.60E-04	0.001255	0.001185
Bismuth	0.002005	0.00148	9.65E-04	0.00132	0.00127	0.001465	9.60E-04	0.001255	0.001185
Boron	0.2005	0.148	0.0965	0.132	0.127	0.1465	0.096	0.1255	0.1185
Cadmium	0.158796	0.05772	0.148996	6.60E-04	0.0023114	0.0193966	0.114816	6.27E-04	0.0013509
Calcium	57.343	3433.6	115.8	1045.44	7543.8	8379.8	149.184	1430.7	11328.6
Cesium	0.0218144	0.07548	0.035705	0.04488	0.054102	0.077059	0.032064	0.02761	0.065175
Chromium	0.0401	0.0074	0.034161	0.0066	0.00635	0.007325	0.021696	0.006275	0.005925
Cobalt	0.03208	0.031968	0.064655	0.00264	0.00254	0.039262	0.088128	0.00251	0.00237
Copper	0.65764	0.45288	0.56549	0.46464	0.32258	0.42192	0.53376	0.41917	0.32706
Iron	50.125	7.3112	48.057	2.7984	1.8542	8.6728	70.848	5.9487	1.7301
Lead	0.012832	0.150664	0.054812	0.00264	0.009652	0.3809	0.069504	0.00251	0.013746
Lithium	0.10025	0.074	0.04825	0.066	0.0635	0.07325	0.048	0.06275	0.05925
Magnesium	109.874	283.864	119.66	282.48	383.54	427.78	110.784	293.67	433.71
Manganese	0.74987	0.592	1.9686	0.3168	0.70612	1.42691	1.4016	0.502	0.86268
Mercury	0.0313983	0.080808	0.051917	0.034848	0.134112	0.05567	0.032448	0.09538	0.12324
Molybdenum	0.013634	0.00296	0.010422	0.00264	0.00254	0.00293	0.013824	0.00251	0.00237
Nickel	0.0401	0.0296	0.04053	0.0264	0.0254	0.0293	0.0192	0.0251	0.0237
Phosphorus	1535.83	4262.4	1642.43	2719.2	6045.2	7178.5	1762.56	3062.2	8105.4
Potassium	2009.01	3492.8	1738.93	3484.8	3606.8	3603.9	1582.08	3739.9	3507.6
Rubidium	2.7268	4.6176	2.8564	9.6888	8.3058	4.5708	2.6112	4.4929	8.6979
Selenium	2.43808	0.39664	0.77393	0.233112	0.30734	0.49224	0.90432	0.251	0.41001
Silver	0.0010025	7.40E-04	0.0010808	6.60E-04	6.35E-04	7.33E-04	0.0010368	6.27E-04	5.93E-04
Sodium	834.08	950.16	1053.78	330	441.96	843.84	933.12	401.6	635.16
Strontium	0.111077	3.6112	0.41881	1.59456	7.3152	7.8231	0.55296	2.16362	10.6887
Thallium	0.0091829	0.0043216	0.0071989	0.0187176	0.0151892	0.0046587	0.0065472	0.0051706	0.0133668
Tin	0.05614	0.0148	0.0386	0.0132	0.0127	0.01465	0.03072	0.01255	0.01185
Tellurium	0.00401	0.00296	0.00193	0.00264	0.00254	0.00293	0.00192	0.00251	0.00237
Uranium	0.0028872	0.0161616	0.02702	6.34E-04	2.54E-04	0.0259891	0.0184512	5.52E-04	2.37E-04
Vanadium	0.02005	0.0148	0.04439	0.0132	0.0127	0.01465	0.02688	0.01255	0.01185
Zinc	222.555	11.0112	81.832	9.5832	10.7442	15.2946	96	19.3019	9.8355
Zirconium	0.0401	0.0296	0.0193	0.0264	0.0254	0.0293	0.0192	0.0251	0.0237
Total.Lipids	16.4	7.74	4	4.15	0.25	6.52	3.89	2.03	0.25

Sample	2131	2131	2133	2133	2134	2134	2135	2136	2136
Treatment	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure
Species	RB	RB	RB	RB	RB	RB	RB	RB	RB
Tissue Type	Whole	Gut	Whole	Gut	Whole	Gut	Fillet	Whole	Gut
Moisture	70.6	83.2	69.6	72.2	70.4	74.6	75	68	63
Aluminum	0.294	8.3832	0.304	7.1446	0.296	29.972	0.25	0.32	5.55
Antimony	0.00147	0.002016	0.00152	0.003892	0.00148	0.005334	0.00125	0.0016	0.0037
Arsenic	0.023814	0.128352	0.04712	0.25576	0.06808	0.230378	0.0915	0.09248	0.3811
Barium	0.71148	1.8816	0.38	1.6541	0.296	2.9718	0.2475	0.7136	2.2792
Beryllium	0.00147	8.40E-04	0.00152	0.00139	0.00148	0.00127	0.00125	0.0016	0.00185
Bismuth	0.00147	8.40E-04	0.00152	0.00139	0.00148	0.00127	0.00125	0.0016	0.00999
Boron	0.147	0.084	0.152	0.139	0.148	0.127	0.125	0.16	0.185
Cadmium	0.0072912	0.041496	0.0042864	0.06811	0.008732	0.087376	0.006375	0.005152	0.05402
Calcium	5203.8	1008	3617.6	739.48	3137.6	2461.26	1512.5	9920	1121.1
Cesium	0.054684	0.03864	0.046512	0.036418	0.046768	0.04699	0.01545	0.05088	0.0555
Chromium	0.00735	0.096432	0.0076	0.048372	0.0074	0.10033	0.00625	0.008	0.05106
Cobalt	0.00294	0.014784	0.013072	0.038364	0.010064	0.047244	0.0125	0.0112	0.03034
Copper	0.49098	2.5536	0.52592	4.2256	1.61024	3.9116	0.5625	0.5824	4.625
Iron	9.3786	47.208	6.2016	19.6268	8.8504	65.532	5.45	8.736	23.976
Lead	0.145236	0.13356	0.04712	0.195712	0.029008	0.2794	0.02675	0.06656	0.15392
Lithium	0.0735	0.042	0.076	0.0695	0.074	0.0635	0.0625	0.08	0.0925
Magnesium	320.46	189.84	316.16	154.012	292.448	191.516	176.25	419.2	205.72
Manganese	0.82908	1.9488	0.74784	2.8356	0.47952	5.207	0.3775	1.488	2.8527
Mercury	0.057036	0.029568	0.0204896	0.0155958	0.0197728	0.017018	0.01405	0.025312	0.019425
Molybdenum	0.00294	0.04032	0.00304	0.053932	0.007696	0.060198	0.0025	0.00672	0.04958
Nickel	0.0294	0.07728	0.0304	0.10008	0.0296	0.13208	0.025	0.032	0.0851
Phosphorus	5174.4	2066.4	4620.8	1848.7	4232.8	2286	2035	8448	2208.9
Potassium	3616.2	2133.6	3556.8	1873.72	3581.6	2293.62	1167.5	3360	2249.6
Rubidium	6.3798	5.3256	7.448	4.8372	7.8144	6.2738	2.445	8.448	7.326
Selenium	0.36456	0.60816	0.38912	0.60326	0.65712	0.74676	0.2975	0.5024	0.888
Silver	7.35E-04	0.00672	7.60E-04	0.0083122	0.0065712	0.0127254	6.25E-04	8.00E-04	0.01147
Sodium	973.14	1125.6	680.96	650.52	692.64	789.94	194	697.6	876.9
Strontium	6.3504	3.8136	5.4112	3.3638	4.3512	6.731	2.195	13.536	5.18
Thallium	0.0132006	0.024528	0.0227088	0.024742	0.0258408	0.037338	0.013375	0.027776	0.031339
Tin	0.0147	0.03024	0.0152	0.03892	0.0148	0.04064	0.1375	0.016	0.0185
Tellurium	0.00294	0.00168	0.00304	0.00278	0.00296	0.00254	0.0025	0.0032	0.0037
Uranium	0.0049392	0.0148512	9.73E-04	0.0073392	2.96E-04	0.039878	9.25E-04	0.002688	0.0074
Vanadium	0.0147	0.0336	0.0152	0.0139	0.0148	0.09652	0.0125	0.016	0.0185
Zinc	14.994	167.328	11.7952	83.956	10.4784	101.6	13.9	17.28	108.78
Zirconium	0.0294	0.0168	0.0304	0.0278	0.0296	0.0254	0.025	0.032	0.037
Total.Lipids	6.66	5.46	8.09	23.7	9.8	14.3	7.55	11.2	25.3

Sample	2137	2137	2138	2138	2139	2139	2140	2140	2141	2142
Treatment	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure
Species	RB	RB	RB	RB	RB	RB	RB	RB	RB	RB
Tissue Type	Whole	Gut	Gut	Whole	Whole	Gut	Whole	Gut	Fillet	Whole
Moisture	72.3	78.1	76.3	71.1	72	80.3	63	55.3	77.6	68.9
Aluminum	0.277	194.91	1.6827	0.289	0.28	34.081	0.37	69.285	0.224	0.311
Antimony	0.001385	0.048618	0.001185	0.001445	0.0014	0.006501	0.00185	0.022797	0.00112	0.001555
Arsenic	0.043212	0.192939	0.153813	0.04624	0.06216	0.20488	0.06401	0.146616	0.069888	0.052248
Barium	0.158998	4.6428	0.98355	0.61846	0.56	2.5216	0.09435	1.97127	0.28672	0.279589
Beryllium	0.001385	0.007884	0.001185	0.001445	0.0014	9.85E-04	0.00185	0.002235	0.00112	0.001555
Bismuth	0.001385	0.005913	0.001185	0.001445	0.0014	0.002758	0.00185	0.002235	0.00112	0.001555
Boron	0.1385	0.1095	0.1185	0.1445	0.14	0.0985	0.185	0.2235	0.112	0.1555
Cadmium	0.0050968	0.200166	0.064464	0.0034102	0.007672	0.115639	0.003959	0.160026	0.0012992	0.0018038
Calcium	1096.92	1990.71	535.62	4884.1	4004	977.12	762.2	447	1391.04	2823.88
Cesium	0.05817	0.104025	0.042423	0.059534	0.04648	0.045901	0.0592	0.060792	0.02576	0.037009
Chromium	0.006925	0.60006	0.022752	0.007225	0.007	0.120958	0.00925	0.21009	0.012992	0.022392
Cobalt	0.020775	0.181989	0.027492	0.012138	0.01764	0.056736	0.01147	0.110856	0.006496	0.010263
Copper	0.82546	5.1684	2.8914	0.64158	0.5908	4.1173	0.4403	2.86527	0.56672	0.61578
Iron	10.3598	389.82	18.4623	8.4388	6.916	76.83	6.105	166.731	4.144	6.3444
Lead	0.019667	0.8979	0.104043	0.072828	0.06356	0.38809	0.02405	0.61686	0.030464	0.031722
Lithium	0.06925	0.40515	0.05925	0.07225	0.07	0.04925	0.0925	0.11175	0.056	0.07775
Magnesium	244.314	354.78	229.653	343.91	296.8	200.94	258.63	186.846	157.248	323.44
Manganese	0.31578	13.7094	1.86282	0.76874	1.0276	6.5995	0.14245	11.3538	0.37856	0.56291
Mercury	0.055677	0.029784	0.0175617	0.035836	0.01848	0.0179861	0.07104	0.022797	0.0140896	0.0290474
Molybdenum	0.00277	0.077745	0.040053	0.00289	0.0028	0.052599	0.0037	0.041571	0.00224	0.00311
Nickel	0.0277	0.58692	0.0237	0.0289	0.028	0.54372	0.037	0.43806	0.0224	0.0311
Phosphorus	2736.76	2584.2	2237.28	5115.3	4536	2029.1	2582.6	1841.64	2262.4	4105.2
Potassium	3324	2628	2182.77	3381.3	3248	2068.5	3263.4	2033.85	1821.12	3763.1
Rubidium	7.0635	7.884	6.2568	7.8897	6.888	5.1811	5.402	4.7829	4.1888	5.8157
Selenium	0.46536	0.89133	0.76788	0.48552	0.462	0.78603	0.4847	0.73308	0.30016	0.56291
Silver	6.93E-04	0.0210678	0.0059961	7.23E-04	7.00E-04	0.0105001	9.25E-04	0.0083589	5.60E-04	7.77E-04
Sodium	725.74	1027.11	729.96	771.63	652.4	610.7	506.9	929.76	255.36	566.02
Strontium	1.3573	6.0444	2.4174	6.4447	6.832	4.3143	0.999	1.6539	2.6208	3.5143
Thallium	0.0140993	0.049275	0.034602	0.0266747	0.023296	0.033687	0.015466	0.0298149	0.0140896	0.0173227
Tin	0.01385	0.07008	0.04503	0.01445	0.014	0.06698	0.0185	0.02235	0.0672	0.01555
Tellurium	0.00277	0.00219	0.00237	0.00289	0.0028	0.00197	0.0037	0.00447	0.00224	0.00311
Uranium	0.0010526	0.210678	0.0041475	0.0015317	0.001624	0.041173	7.40E-04	0.132312	0.001008	9.95E-04
Vanadium	0.01385	0.65481	0.01185	0.01445	0.014	0.10047	0.0185	0.25479	0.0112	0.01555
Zinc	13.9054	106.872	176.802	13.583	14.252	84.907	8.954	80.46	13.5744	12.5644
Zirconium	0.0277	0.05256	0.0237	0.0289	0.028	0.0197	0.037	0.0447	0.0224	0.0311
Total.Lipids	7.33	5.95	6.37	6.3	9.42	7.18	18.3	28.8	11.5	9.47

Sample	2142	2143	2144	2146	2147	2147	2167	2168	2168
Treatment	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure
Species	RB	RB	RB	RB	RB	RB	MW	MW	MW
Tissue Type	Gut	Fillet	Fillet	Fillet	Fillet	Fillet	Fillet	Whole	Gut
Moisture	76.7	71.4	73.2	72.4	75.5	72.9	70.4	64.7	76.6
Aluminum	7.4793	0.286	0.268	0.276	0.245	0.271	0.296	0.353	94.068
Antimony	0.003262	0.00143	0.00134	0.00138	0.001225	0.001355	0.003256	0.001765	0.04329
Arsenic	0.21902	0.056628	0.031088	0.046092	0.07301	0.063414	0.04588	0.087191	0.205218
Barium	2.8193	0.171028	0.212792	0.51612	0.119315	0.161516	0.139416	0.227685	2.808
Beryllium	0.001165	0.00143	0.00134	0.00138	0.001225	0.001355	0.00148	0.001765	0.004212
Bismuth	0.001165	0.00143	0.00134	0.00138	0.001225	0.001355	0.00148	0.001765	0.004212
Boron	0.1165	0.143	0.134	0.138	0.1225	0.1355	0.148	0.1765	0.117
Cadmium	0.071531	0.0027456	6.70E-04	0.0036708	0.0054635	0.002168	0.0141488	0.0128845	0.62244
Calcium	1314.12	1118.26	986.24	2188.68	578.2	867.2	1690.16	5047.9	386.1
Cesium	0.035183	0.038324	0.063516	0.04278	0.0392	0.047425	0.114848	0.040242	0.043056
Chromium	0.053823	0.00715	0.0067	0.0069	0.006125	0.006775	0.0074	0.008825	0.39312
Cobalt	0.036581	0.012584	0.009648	0.017112	0.013475	0.01355	0.040848	0.022239	0.33462
Copper	4.5202	0.6721	0.64588	0.97704	0.70315	0.60975	0.54464	0.60363	4.0482
Iron	31.222	6.4922	7.2896	9.9912	4.7285	4.3902	7.9624	7.6248	236.34
Lead	0.23999	0.018304	0.041808	0.134688	0.026705	0.034417	0.264328	0.039889	1.0764
Lithium	0.05825	0.0715	0.067	0.069	0.06125	0.06775	0.074	0.08825	0.14274
Magnesium	258.63	263.978	313.56	239.292	234.71	279.13	291.856	352.647	204.516
Manganese	4.3571	0.236808	0.210648	0.57684	0.20041	0.30623	0.3256	0.89662	19.9134
Mercury	0.0178944	0.020306	0.051992	0.039744	0.0198695	0.0237938	0.107744	0.041301	0.023634
Molybdenum	0.063609	0.00286	0.00268	0.00276	0.00245	0.00271	0.00296	0.00353	0.089388
Nickel	0.12349	0.0286	0.0268	0.0276	0.0245	0.0271	0.0296	0.0353	0.5733
Phosphorus	2376.6	2831.4	3001.6	3063.6	2261.35	2899.7	3196.8	5118.5	1729.26
Potassium	2239.13	3174.6	3778.8	2401.2	2719.5	3441.7	3581.6	3477.05	2003.04
Rubidium	5.0095	6.2062	6.5928	4.2504	6.1005	7.7777	4.3808	2.86283	2.8782
Selenium	0.94365	0.41184	0.47168	0.45264	0.3675	0.39295	0.44992	0.44478	0.88452
Silver	0.0138868	7.15E-04	6.70E-04	6.90E-04	6.13E-04	6.77E-04	7.40E-04	8.82E-04	0.0102492
Sodium	841.13	477.62	498.48	433.32	333.2	392.95	485.44	638.93	1022.58
Strontium	6.0813	1.81038	1.53832	3.312	1.00205	1.4634	1.88848	6.3893	2.14344
Thallium	0.03262	0.0193908	0.027336	0.028704	0.03185	0.036585	0.038184	0.0115078	0.052182
Tin	0.0233	0.0143	0.0134	0.03588	0.01225	0.0271	0.0148	0.01765	0.06318
Tellurium	0.00233	0.00286	0.00268	0.00276	0.00245	0.00271	0.00296	0.00353	0.00234
Uranium	0.011184	2.86E-04	2.68E-04	0.0014628	2.45E-04	2.71E-04	0.00592	0.002471	0.090558
Vanadium	0.02563	0.0143	0.0134	0.0138	0.01225	0.01355	0.0148	0.01765	0.28548
Zinc	170.789	11.8118	10.318	10.35	7.987	9.0243	10.2712	14.4024	119.574
Zirconium	0.0233	0.0286	0.0268	0.0276	0.0245	0.0271	0.0296	0.0353	0.06786
Total.Lipids	9.81	6.63	5.26	8.69	7.03	7.45	6.98	13.3	7.59

Sample	2169	2169	2170	2247	2247	2248	2248	2249	2250
Treatment	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure
Species	MW	MW	MW	RB	RB	RB	RB	RB	RB
Tissue Type	Whole	Gut	Fillet	Whole	Fillet	Fillet	Fillet	Fillet	Fillet
Moisture	73.5	71.9	71	76.4	82.9	73.3	71.9	80	75.7
Aluminum	0.265	143.029	0.29	0.4956	2.6505	0.267	0.281	0.2	0.243
Antimony	0.001325	0.128698	0.00145	0.003068	0.004104	0.001335	0.001405	0.001	0.001215
Arsenic	0.05247	0.28381	0.0493	0.03304	0.118845	0.020025	0.022761	0.0466	0.066096
Barium	0.2968	2.9786	0.06032	1.95644	1.03455	0.214401	0.229015	0.1108	0.35964
Beryllium	0.001325	0.007025	0.00145	0.00118	8.55E-04	0.001335	0.001405	0.001	0.001215
Bismuth	0.001325	0.001405	0.00145	0.00118	8.55E-04	0.001335	0.001405	0.001	0.001215
Boron	0.1325	0.1405	0.145	0.118	0.0855	0.1335	0.1405	0.1	0.1215
Cadmium	0.0090895	0.119987	0.003074	0.0227032	0.08721	6.68E-04	7.02E-04	0.00476	0.0013608
Calcium	9089.5	483.32	1484.8	11965.2	644.67	1351.02	1508.97	892	1992.6
Cesium	0.03657	0.054233	0.026187	0.042952	0.03249	0.0258723	0.024447	0.0288	0.0193914
Chromium	0.006625	0.40745	0.02117	0.0118	0.144666	0.006675	0.007025	0.005	0.006075
Cobalt	0.013515	0.217494	0.01218	0.019116	0.045486	0.008277	0.00843	0.0086	0.00243
Copper	0.4876	4.0183	0.5568	0.4602	2.8044	0.46725	0.49456	0.62	0.73143
Iron	5.565	455.22	3.654	19.9892	123.633	5.6871	4.4117	3.14	7.3386
Lead	0.10706	2.45594	0.0029	0.37052	0.17955	0.02937	0.031753	0.0154	0.030132
Lithium	0.06625	0.22761	0.0725	0.059	0.04275	0.06675	0.07025	0.05	0.06075
Magnesium	437.25	206.254	264.19	481.44	159.201	263.796	249.247	260	219.186
Manganese	1.3515	13.0103	0.3277	1.35936	1.7271	0.36312	0.40183	0.252	0.64152
Mercury	0.0232405	0.0184336	0.017951	0.108088	0.061731	0.0229353	0.022199	0.015	0.0180306
Molybdenum	0.00265	0.048894	0.0029	0.008968	0.037962	0.00267	0.00281	0.002	0.00243
Nickel	0.0265	0.35406	0.029	0.0236	0.08892	0.0267	0.0281	0.02	0.0243
Phosphorus	7208	1632.61	2586.8	9156.8	1966.5	2803.5	2894.3	2480	2721.6
Potassium	3127	2031.63	2862.3	3186	2257.2	3097.2	3034.8	2880	1710.72
Rubidium	2.915	3.0348	2.6071	4.366	3.5055	4.0317	3.8216	4.7	3.1347
Selenium	0.4611	1.73939	0.464	0.50032	0.74898	0.43788	0.43274	0.348	0.39366
Silver	6.63E-04	0.0059291	7.25E-04	5.90E-04	0.0079857	6.68E-04	7.02E-04	5.00E-04	6.08E-04
Sodium	572.4	694.07	290	1321.6	1128.6	424.53	427.12	416	264.87
Strontium	11.183	2.28172	1.9053	17.1808	2.1717	2.2161	2.38569	1.326	3.4506
Thallium	0.009328	0.0168038	0.012296	0.0230808	0.022743	0.0129228	0.0126731	0.01418	0.0166455
Tin	0.01325	0.15174	0.0145	0.0118	0.0342	0.02937	0.04777	0.036	0.04374
Tellurium	0.00265	0.00281	0.0029	0.00236	0.00171	0.00267	0.00281	0.002	0.00243
Uranium	0.0018285	0.046646	2.90E-04	0.011092	0.0078318	7.48E-04	8.71E-04	5.20E-04	9.96E-04
Vanadium	0.01325	0.62382	0.0145	0.0118	0.00855	0.01335	0.01405	0.01	0.01215
Zinc	12.7995	128.979	8.062	25.488	164.502	10.0926	11.9425	7.58	18.3951
Zirconium	0.0265	0.12083	0.029	0.0236	0.0171	0.0267	0.0281	0.02	0.0243
Total.Lipids	6.71	13	7.04	1.03	6.16	5.65	8.64	4.3	7.83

Sample	2251	2252	2252	2253	2254	2254	2255	2256	2257
Treatment	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure
Species	RB	MW	MW	MW	MW	MW	MW	MW	MW
Tissue Type	Fillet	Gut	Whole	Fillet	Whole	Gut	Fillet	Fillet	Whole
Moisture	73	81.2	70.6	69.1	67.1	66.6	72.1	73.4	77.2
Aluminum	0.27	678.68	0.294	0.309	0.329	105.878	0.279	0.266	0.228
Antimony	0.00135	0.150776	0.00294	0.001545	0.001645	0.011022	0.001395	0.00133	0.00114
Arsenic	0.07749	0.25004	0.025872	0.132252	0.06251	0.17034	0.0558	0.066766	0.140448
Barium	0.12852	12.9156	0.138474	0.184164	0.100674	1.5698	0.152613	0.27398	0.342
Beryllium	0.00135	0.028012	0.00147	0.001545	0.001645	0.004342	0.001395	0.00133	0.00114
Bismuth	0.00135	0.011092	0.00147	0.001545	0.001645	0.00167	0.001395	0.00133	0.00114
Boron	0.135	0.094	0.147	0.1545	0.1645	0.167	0.1395	0.133	0.114
Cadmium	6.75E-04	0.7426	0.06321	0.002781	0.0239183	0.67134	0.0096813	0.0120498	0.0151164
Calcium	793.8	3026.8	2005.08	3151.8	3072.86	149.632	3292.2	5027.4	6794.4
Cesium	0.05805	0.21244	0.060858	0.060255	0.065471	0.056446	0.061101	0.067564	0.024168
Chromium	0.00675	2.2748	0.00735	0.02163	0.008225	0.312958	0.006975	0.00665	0.0057
Cobalt	0.00729	0.61852	0.037338	0.01545	0.033229	0.251168	0.028737	0.018354	0.010488
Copper	0.4887	5.734	0.56448	0.59328	0.46718	2.33466	0.60822	0.5852	0.54948
Iron	3.888	1361.12	9.0846	9.2391	6.4813	200.4	6.0543	5.852	7.2732
Lead	0.01323	3.6096	0.17493	0.02163	0.024675	0.73814	0.019251	0.099218	0.008664
Lithium	0.0675	1.60928	0.0735	0.07725	0.08225	0.19706	0.06975	0.0665	0.057
Magnesium	263.52	663.64	302.82	292.005	326.039	162.324	315.27	348.46	339.72
Manganese	0.17199	75.388	1.24068	0.59019	0.61523	11.69	0.48825	0.79002	1.083
Mercury	0.022734	0.053956	0.070266	0.074778	0.0155617	0.0103206	0.04464	0.04788	0.031008
Molybdenum	0.0027	0.132352	0.00294	0.00309	0.00329	0.04676	0.00279	0.00266	0.005472
Nickel	0.027	2.3312	0.0294	0.0309	0.0329	0.42752	0.0279	0.0266	0.0228
Phosphorus	2454.3	3120.8	3439.8	3646.2	4079.6	1346.02	4045.5	4841.2	6087.6
Potassium	3078	2218.4	2751.84	3244.5	3421.6	1332.66	3822.3	3351.6	3123.6
Rubidium	8.532	6.2604	3.822	4.6041	5.4285	3.1229	5.9427	3.8038	4.9704
Selenium	0.3753	1.03588	1.60818	0.41715	0.83237	1.503	0.38502	0.3724	0.2964
Silver	6.75E-04	0.022936	7.35E-04	7.73E-04	8.23E-04	0.004175	6.98E-04	6.65E-04	5.70E-04
Sodium	337.5	1205.08	752.64	435.69	582.33	557.78	504.99	436.24	595.08
Strontium	1.188	9.6068	2.1462	3.708	3.8164	0.85838	3.906	5.9052	9.8496
Thallium	0.022086	0.053768	0.0061152	0.006489	0.0212863	0.039412	0.0124992	0.0161994	0.0154128
Tin	0.0459	0.37412	0.0147	0.01545	0.01645	0.03674	0.01395	0.0133	0.0456
Tellurium	0.0027	0.005264	0.00294	0.00309	0.00329	0.00334	0.00279	0.00266	0.00228
Uranium	2.70E-04	0.72568	0.0150234	0.0045423	8.55E-04	0.088844	0.0022041	0.0070756	0.0011856
Vanadium	0.0135	2.4064	0.0147	0.01545	0.01645	0.31396	0.01395	0.0133	0.0114
Zinc	9.342	193.64	14.1414	12.8235	9.9358	106.212	14.0058	14.3906	22.8
Zirconium	0.027	0.1786	0.0294	0.0309	0.0329	0.0334	0.0279	0.0266	0.0228
Total.Lipids	7.23	2.33	5.88	9.5	12	14.2	4.84	4.35	2.4

Sample	2257	2258	2258	2259	2259	2260	2261	2262	2262
Treatment	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure
Species	MW	WP	WP	WP	WP	WP	WP	WP	WP
Tissue Type	Gut	Fillet	Fillet	Whole	Gut	Fillet	Fillet	Whole	Gut
Moisture	88.8	77.4	69.9	75.5	53.6	73.4	70	73.4	65.2
Aluminum	83.216	0.226	0.301	0.245	0.464	0.266	0.3	0.266	0.348
Antimony	0.021616	0.00113	0.001505	0.001225	0.00232	0.00133	0.0015	0.00133	0.00174
Arsenic	0.092288	0.021018	0.024682	0.035035	0.107184	0.035378	0.0255	0.075278	0.17226
Barium	2.016	0.75936	1.04748	0.3773	0.090944	0.79268	0.813	0.36442	0.086304
Beryllium	0.00392	0.00113	0.001505	0.001225	0.00232	0.00133	0.0015	0.00133	0.00174
Bismuth	0.004256	0.00113	0.001505	0.001225	0.00232	0.00133	0.0015	0.00133	0.00174
Boron	0.056	0.113	0.1505	0.1225	0.232	0.133	0.15	0.133	0.174
Cadmium	0.32368	0.0019662	0.0027993	0.007595	0.067744	0.0027132	0.00315	0.0100016	0.117624
Calcium	594.72	11526	17397.8	6296.5	252.416	13326.6	12300	5586	414.12
Cesium	0.02184	0.073902	0.070133	0.099715	0.043848	0.04256	0.0585	0.079268	0.054636
Chromium	0.26992	0.00565	0.007525	0.006125	0.0116	0.00665	0.0075	0.00665	0.0087
Cobalt	0.050176	0.005424	0.007525	0.006615	0.017168	0.00266	0.0066	0.006384	0.030972
Copper	0.93296	0.37968	0.58093	0.25235	0.68672	0.43624	0.486	0.34314	0.98136
Iron	145.6	2.7346	3.2508	5.2185	25.984	3.192	3.45	5.2668	31.9464
Lead	0.53984	0.014464	0.024983	0.00588	0.012992	0.014364	0.0093	0.009576	0.026796
Lithium	0.10416	0.0565	0.07525	0.06125	0.116	0.0665	0.075	0.0665	0.087
Magnesium	153.44	379.68	427.42	360.15	83.056	364.42	375	343.14	132.24
Manganese	10.9088	0.7345	1.00233	0.5243	0.99296	0.76608	0.552	0.52402	0.75168
Mercury	0.014784	0.153228	0.124012	0.15729	0.0188848	0.122626	0.0966	0.142044	0.019488
Molybdenum	0.048832	0.00226	0.00301	0.00245	0.0116	0.00266	0.003	0.00266	0.015312
Nickel	0.21728	0.0226	0.0301	0.0245	0.0464	0.0266	0.03	0.0266	0.0348
Phosphorus	818.72	8045.6	11227.3	5733	1266.72	8724.8	8460	5320	1552.08
Potassium	820.96	2228.36	2100.98	3552.5	1452.32	1577.38	2274	3564.4	1896.6
Rubidium	1.5456	5.2658	4.9665	10.878	5.2896	3.7506	6.3	10.2144	6.5772
Selenium	0.34832	0.39776	0.46053	0.4361	0.54752	0.399	0.426	0.48146	0.66468
Silver	0.01176	5.65E-04	7.52E-04	6.13E-04	0.00116	6.65E-04	7.50E-04	6.65E-04	8.70E-04
Sodium	174.72	513.02	626.08	788.9	668.16	444.22	504	800.66	793.44
Strontium	2.2064	10.8254	15.5617	6.3455	0.6496	11.8104	11.64	5.6924	0.65772
Thallium	0.011984	0.0164302	0.0192339	0.0123235	0.0123424	0.047082	0.01989	0.020748	0.0278748
Tin	0.01344	0.03842	0.12341	0.01225	0.0232	0.0798	0.09	0.0133	0.0522
Tellurium	0.00112	0.00226	0.00301	0.00245	0.00464	0.00266	0.003	0.00266	0.00348
Uranium	0.051296	7.46E-04	9.03E-04	2.45E-04	4.64E-04	2.66E-04	8.10E-04	2.66E-04	3.48E-04
Vanadium	0.22736	0.0113	0.01505	0.01225	0.0232	0.0133	0.015	0.0133	0.0174
Zinc	43.008	10.9836	16.4647	11.564	14.5232	15.1886	12.81	10.7464	14.3028
Zirconium	0.05264	0.0226	0.0301	0.0245	0.0464	0.0266	0.03	0.0266	0.0348
Total.Lipids	NA	3.81	4.28	2.75	29.7	3.9	2.16	3.68	20.1

Sample	2263	2580	2580	2581	2581	2582	2583	2583	2584
Treatment	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure
Species	WP	WP	WP	MW	MW	MW	MW	MW	MW
Tissue Type	Fillet	Fillet	Fillet	Whole	Gut	Fillet	Whole	Gut	Fillet
Moisture	72.6	70.8	66.3	67.2	59.5	74.6	71.4	79.5	75.6
Aluminum	0.274	0.292	0.337	0.328	37.341	0.254	0.286	805.65	0.244
Antimony	0.00137	0.00146	0.001685	0.00164	0.02592	0.00127	0.00143	0.30545	0.00122
Arsenic	0.02466	0.033288	0.03033	0.061664	0.18306	0.060706	0.069498	1.34275	0.067588
Barium	1.2056	0.75336	1.14243	0.286344	0.7614	0.157226	0.19019	10.578	0.26352
Beryllium	0.00137	0.00146	0.001685	0.00164	0.002025	0.00127	0.00143	0.03157	0.00122
Bismuth	0.00137	0.00146	0.001685	0.00164	0.002025	0.00127	0.00143	0.03075	0.00122
Boron	0.137	0.146	0.1685	0.164	0.2025	0.127	0.143	0.1025	0.122
Cadmium	0.002877	7.30E-04	8.43E-04	0.0146616	0.40905	0.0068326	0.018304	0.4879	0.015616
Calcium	21262.4	14249.6	21534.3	8528	405	4064	3832.4	10455	4806.8
Cesium	0.090968	0.078256	0.080206	0.0275192	0.0221535	0.056896	0.067496	0.127305	0.082716
Chromium	0.00685	0.0073	0.01685	0.0082	0.09558	0.00635	0.00715	2.173	0.0061
Cobalt	0.00274	0.006132	0.00337	0.048544	0.166455	0.017018	0.015158	0.5904	0.03416
Copper	0.33976	0.50516	0.44821	0.5412	1.56735	0.5588	0.46618	4.592	0.55876
Iron	2.74	3.6792	3.6733	8.9872	86.67	4.4704	6.7782	1381.7	6.71
Lead	0.025756	0.00292	0.00337	0.007216	0.13284	0.04064	0.103818	15.3135	0.36356
Lithium	0.0685	0.073	0.08425	0.082	0.10125	0.0635	0.0715	1.51495	0.061
Magnesium	580.88	473.04	596.49	436.24	133.245	317.5	291.72	615	302.56
Manganese	1.3152	0.68912	0.97056	1.7876	5.0625	0.51562	0.86086	78.72	0.62708
Mercury	0.11919	0.092272	0.089642	0.0120376	0.008586	0.043688	0.063778	0.03075	0.06466
Molybdenum	0.00274	0.00292	0.00337	0.00328	0.043335	0.00254	0.00286	0.14965	0.00244
Nickel	0.0274	0.0292	0.0337	0.0328	0.19845	0.0254	0.0286	1.65845	0.0244
Phosphorus	13398.6	10044.8	13682.2	7412.8	1680.75	4089.4	4175.6	2152.5	4636
Potassium	2822.2	3007.6	3201.5	3739.2	1555.2	3302	3517.8	1713.8	3220.8
Rubidium	7.809	7.7088	7.9869	5.3136	2.92005	5.4102	4.147	3.813	6.0756
Selenium	0.38908	0.32704	0.317454	0.81672	1.73745	0.36322	0.54626	0.8446	0.41968
Silver	6.85E-04	7.30E-04	8.43E-04	8.20E-04	0.0049005	6.35E-04	7.15E-04	0.04141	6.10E-04
Sodium	698.7	765.04	855.98	685.52	615.6	396.24	652.08	994.25	507.52
Strontium	21.098	10.1032	14.8954	9.7088	1.24335	4.7498	4.6618	20.91	5.6364
Thallium	0.029592	0.016206	0.0190742	0.0046904	0.0064395	0.0047752	0.021879	0.06027	0.0104432
Tin	0.0137	0.0146	0.01685	0.0164	0.02025	0.0127	0.0143	0.0738	0.0122
Tellurium	0.00274	0.00292	0.00337	0.00328	0.00405	0.00254	0.00286	0.005125	0.00244
Uranium	0.0010138	6.72E-04	9.77E-04	0.0011152	0.013932	0.0028194	0.0029458	0.35465	0.0072224
Vanadium	0.0137	0.0146	0.01685	0.0164	0.1053	0.0127	0.0143	2.7675	0.0122
Zinc	16.851	14.308	21.231	16.892	55.485	12.9032	11.726	457.15	13.7128
Zirconium	0.0274	0.0292	0.0337	0.0328	0.0405	0.0254	0.0286	0.15785	0.0244
Total.Lipids	1.91	4.34	2.99	9.13	26.1	5.12	7.65	3.57	3.42

Sample	2618	2618	2619	2620	2621	2621	2622	2623	2624
Treatment	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Species	WP	WP	WP	WP	MW	MW	MW	MW	RB
Tissue Type	Gut	Whole	Fillet	Fillet	Fillet	Fillet	Fillet	Fillet	Whole
Moisture	41.5	75.2	76	73.5	61.6	59	75.3	65.9	73.3
Aluminum	0.585	0.248	0.24	0.265	0.384	0.41	0.247	0.341	0.267
Antimony	0.002925	0.00124	0.0012	0.001325	0.00192	0.00205	0.001235	0.001705	0.001335
Arsenic	0.09477	0.03472	0.06696	0.01166	0.1248	0.14678	0.031616	0.07843	0.02136
Barium	0.014625	0.5084	0.4632	0.47435	0.204672	0.1599	0.084968	0.229152	1.00659
Beryllium	0.002925	0.00124	0.0012	0.001325	0.00192	0.00205	0.001235	0.001705	0.001335
Bismuth	0.002925	0.00124	0.0012	0.001325	0.00192	0.00205	0.001235	0.001705	0.001335
Boron	0.2925	0.124	0.12	0.1325	0.192	0.205	0.1235	0.1705	0.1335
Cadmium	0.0468585	0.0042408	0.002472	6.63E-04	0.0048768	0.005658	6.18E-04	0.0019778	0.0028569
Calcium	114.075	7489.6	6384	8374	3290.88	2382.1	1183.13	3614.6	7235.7
Cesium	0.0280215	0.063984	0.05424	0.0795	0.0296448	0.026404	0.0121277	0.0318153	0.0129762
Chromium	0.014625	0.0062	0.006	0.006625	0.0096	0.01025	0.006175	0.008525	0.006675
Cobalt	0.00585	0.00248	0.0024	0.00265	0.014592	0.01681	0.008645	0.019437	0.005874
Copper	0.29835	0.31744	0.372	0.4346	0.77952	0.8938	0.51129	0.76384	0.38181
Iron	13.3965	6.696	2.04	3.127	7.6032	8.897	3.5074	7.9112	7.1289
Lead	0.00585	0.005704	0.01152	0.007685	0.010752	0.00902	0.00247	0.015004	0.009612
Lithium	0.14625	0.062	0.06	0.06625	0.096	0.1025	0.06175	0.08525	0.06675
Magnesium	68.445	354.64	362.4	389.55	324.48	264.86	256.88	336.567	387.15
Manganese	0.36036	0.54808	0.2976	0.4823	0.64512	0.5207	0.27417	0.6479	1.30029
Mercury	0.009477	0.214768	0.14976	0.28355	0.0318336	0.027552	0.0156351	0.050809	0.0108936
Molybdenum	0.0117	0.00248	0.0024	0.00265	0.00384	0.0041	0.00247	0.00341	0.00267
Nickel	0.0585	0.0248	0.024	0.0265	0.0384	0.041	0.0247	0.0341	0.0267
Phosphorus	1023.75	6348.8	5928	6969.5	4070.4	3239	2544.1	3887.4	6888.6
Potassium	1281.15	3422.4	3936	3763	2883.84	2521.5	3013.4	3161.07	3657.9
Rubidium	2.1294	4.3152	7.728	7.2875	4.0704	3.649	1.64996	3.9897	2.43237
Selenium	0.493155	0.64232	0.4944	0.45315	0.52608	0.5863	0.51376	0.36828	0.69153
Silver	0.0014625	6.20E-04	6.00E-04	6.63E-04	9.60E-04	0.001025	6.18E-04	8.53E-04	6.68E-04
Sodium	558.675	870.48	547.2	543.25	332.544	334.56	311.22	398.97	582.06
Strontium	0.160875	6.2	5.712	7.261	3.75552	2.624	1.17819	3.6146	10.0926
Thallium	0.003276	0.0027776	0.01284	0.008374	0.0052992	0.005494	0.0017784	0.005797	0.0030705
Tin	0.02925	0.0124	0.012	0.01325	0.0192	0.0205	0.01235	0.01705	0.01335
Tellurium	0.00585	0.00248	0.0024	0.00265	0.00384	0.0041	0.00247	0.00341	0.00267
Uranium	5.85E-04	2.48E-04	2.40E-04	2.65E-04	0.002304	0.002132	2.47E-04	0.0036146	0.0017355
Vanadium	0.02925	0.0124	0.012	0.01325	0.0192	0.0205	0.01235	0.01705	0.01335
Zinc	8.7165	11.0608	8.304	12.508	10.4832	9.799	6.5455	12.958	17.6754
Zirconium	0.0585	0.0248	0.024	0.0265	0.0384	0.041	0.0247	0.1023	0.0267
Total.Lipids	35.2	3.67	0.7	2.23	24.4	20.2	8.45	12	5.32

Sample	2624	2666	2667	2668	2669	2669	2670	2671	2672
Treatment	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Species	RB	MW	MW	MW	MW	MW	MW	MW	MW
Tissue Type	Gut	Fillet	Fillet	Fillet	Fillet	Fillet	Fillet	Fillet	Fillet
Moisture	81.2	67.3	75	58.7	69.4	67.5	62.1	67.9	68.3
Aluminum	70.124	0.327	0.25	1.5694	0.306	0.325	0.379	0.321	0.317
Antimony	0.004324	0.001635	0.00125	0.002065	0.00153	0.001625	0.001895	0.001605	0.001585
Arsenic	0.085728	0.074556	0.033	0.165613	0.067626	0.0897	0.090581	0.05136	0.063717
Barium	2.444	0.11772	0.14025	0.286209	0.266832	0.4745	0.256204	0.149265	0.070057
Beryllium	0.00376	0.001635	0.00125	0.002065	0.00153	0.001625	0.001895	0.001605	0.001585
Bismuth	0.002632	0.001635	0.00125	0.002065	0.00153	0.001625	0.001895	0.001605	0.001585
Boron	0.094	0.1635	0.125	0.2065	0.153	0.1625	0.1895	0.1605	0.1585
Cadmium	0.115996	8.18E-04	0.001725	0.0036757	0.0030906	0.0040625	0.0020087	0.0016692	0.0051988
Calcium	3026.8	2341.32	2157.5	3622.01	4467.6	7605	4699.6	2372.19	1882.98
Cesium	0.02068	0.0318498	0.0149	0.0256886	0.0261324	0.0229775	0.0217925	0.0259368	0.047867
Chromium	0.28764	0.008175	0.00625	0.010325	0.00765	0.008125	0.009475	0.008025	0.007925
Cobalt	0.06298	0.007848	0.0095	0.016933	0.018054	0.021775	0.017055	0.019902	0.021873
Copper	2.9328	0.6213	0.525	0.75166	0.89046	1.04	0.95508	0.65484	0.67521
Iron	143.068	4.7088	3.575	8.673	9.2106	12.09	10.5362	4.8471	6.023
Lead	0.16732	0.00327	0.0025	0.018998	0.01071	0.01755	0.03032	0.00321	0.007925
Lithium	0.1128	0.08175	0.0625	0.10325	0.0765	0.08125	0.09475	0.08025	0.07925
Magnesium	140.624	340.08	270	286.622	304.776	347.75	317.981	309.765	273.254
Manganese	6.5612	0.59514	0.535	0.63602	0.72522	1.25125	0.84896	0.48792	0.32651
Mercury	0.0049632	0.0241326	0.022575	0.0373765	0.059976	0.056875	0.046996	0.0171735	0.0187981
Molybdenum	0.09024	0.00327	0.0025	0.00413	0.00306	0.00325	0.00379	0.00321	0.00317
Nickel	0.22184	0.0327	0.025	0.0413	0.0306	0.0325	0.0379	0.0321	0.0317
Phosphorus	1466.4	3695.1	3100	3964.8	4773.6	6630	4927	3306.3	3059.05
Potassium	1481.44	3564.3	3050	2647.33	3243.6	2853.5	3168.44	3088.02	3074.9
Rubidium	1.36488	3.4335	3.15	3.11402	2.66832	2.34975	2.35359	3.2742	4.3746
Selenium	0.71628	0.5232	0.4	0.49973	0.47124	0.47125	0.43206	0.41088	0.43429
Silver	0.019176	8.18E-04	6.25E-04	0.0010325	7.65E-04	8.13E-04	9.48E-04	8.02E-04	7.93E-04
Sodium	475.64	317.19	370	386.568	532.44	568.75	504.07	321	355.04
Strontium	3.9292	2.65524	2.495	3.80786	4.9878	8.71	5.6471	2.36577	2.00978
Thallium	0.0063356	0.0030084	0.003925	0.0049973	0.0061506	0.007605	0.0062535	0.00321	0.0078933
Tin	0.1222	0.01635	0.05	0.02065	0.0153	0.01625	0.01895	0.01605	0.01585
Tellurium	0.00188	0.00327	0.0025	0.00413	0.00306	0.00325	0.00379	0.00321	0.00317
Uranium	0.090428	3.27E-04	2.50E-04	0.0032214	0.0052632	0.00884	0.0042448	3.21E-04	3.17E-04
Vanadium	0.22936	0.01635	0.0125	0.02065	0.0153	0.01625	0.01895	0.01605	0.01585
Zinc	111.296	10.464	10.375	11.4401	10.8018	14.755	15.4253	8.5707	9.5734
Zirconium	0.03948	0.0327	0.025	0.0413	0.0306	0.0325	0.0379	0.0321	0.0317
Total.Lipids	4.81	14.1	5.67	21.4	10.1	14.6	17.6	11	13

Sample	2673	2673	2674	2674	2675	2675	2676	2676	2677	2677
Treatment	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Species	RB	RB	RB	RB	RB	RB	RB	RB	RB	RB
Tissue Type	Whole	Gut	Whole	Gut	Whole	Gut	Whole	Gut	Whole	Gut
Moisture	71.6	75.8	69.2	80	65.6	76.9	72.9	81.6	65.6	73.2
Aluminum	0.284	34.122	0.308	106.8	0.344	7.0224	0.271	7.6176	0.344	57.352
Antimony	0.00142	0.003872	0.00154	0.0042	0.00172	0.001155	0.001355	9.20E-04	0.00172	0.00134
Arsenic	0.057368	0.152944	0.029568	0.098	0.090816	0.166089	0.024661	0.045264	0.035432	0.15946
Barium	0.58788	1.68432	0.56672	2.54	0.50224	0.96096	0.265851	0.414	0.317168	3.4036
Beryllium	0.00142	0.00121	0.00154	0.0052	0.00172	0.001155	0.001355	9.20E-04	0.00172	0.00134
Bismuth	0.00142	0.00121	0.00154	0.0024	0.00172	0.001155	0.001355	9.20E-04	0.00172	0.00134
Boron	0.142	0.121	0.154	0.1	0.172	0.1155	0.1355	0.092	0.172	0.134
Cadmium	0.0024992	0.037752	0.0019712	0.088	0.0023392	0.043428	0.0070189	0.032016	0.0020296	0.080936
Calcium	5310.8	416.24	2140.6	6840	6329.6	1122.66	1246.6	669.76	1898.88	15142
Cesium	0.032376	0.030008	0.0196504	0.0346	0.038528	0.033726	0.030081	0.023	0.0218096	0.030284
Chromium	0.0071	0.110352	0.0077	0.4	0.0086	0.036036	0.006775	0.021712	0.0086	0.221368
Cobalt	0.01278	0.053966	0.01078	0.114	0.01032	0.045738	0.01084	0.02852	0.017544	0.094068
Copper	0.78952	3.4364	0.462	3.04	0.39216	3.465	0.44986	1.38368	0.38528	3.9128
Iron	9.2584	77.682	6.5604	238	8.0496	50.82	11.0026	42.136	8.1184	120.064
Lead	0.007384	0.090508	0.008624	0.206	0.014448	0.038115	0.009485	0.02484	0.007912	0.108808
Lithium	0.071	0.0605	0.077	0.224	0.086	0.05775	0.06775	0.046	0.086	0.067
Magnesium	360.68	154.396	281.512	204	357.76	157.311	273.71	151.064	279.672	184.116
Manganese	1.11044	6.0742	0.63756	10.86	1.0836	2.7489	0.35501	1.9872	0.4988	8.2276
Mercury	0.0216692	0.0149072	0.0254716	0.01418	0.036808	0.0230307	0.039566	0.0178848	0.0293432	0.0167768
Molybdenum	0.00284	0.064856	0.00308	0.0884	0.00344	0.053592	0.00542	0.039008	0.00344	0.068072
Nickel	0.0284	0.18392	0.0308	0.572	0.0344	0.10626	0.0271	0.06992	0.0344	0.35644
Phosphorus	5651.6	1594.78	3572.8	2160	5985.6	1988.91	2981	1950.4	3305.84	1975.16
Potassium	3550	1761.76	3480.4	2220	3398.72	2018.94	3360.4	2079.2	3274.88	2023.4
Rubidium	6.5036	4.2592	4.0964	3.72	6.5016	5.5209	4.9322	4.3424	4.9536	4.2612
Selenium	0.63616	0.89056	0.54824	0.914	0.4644	0.99099	0.57994	0.75992	0.4816	0.871
Silver	0.004118	0.00847	7.70E-04	0.0117	8.60E-04	0.0092631	6.77E-04	0.0037904	8.60E-04	0.015678
Sodium	695.8	747.78	671.44	1186	657.04	1127.28	674.79	921.84	588.24	1053.24
Strontium	6.816	2.0086	3.2032	8.32	6.9488	2.6334	1.4634	1.30272	2.666	16.4284
Thallium	0.0089744	0.012826	0.0029876	0.0111	0.0066736	0.0133749	0.0043902	0.0097704	0.0051944	0.0135608
Tin	0.0142	0.08954	0.0154	0.062	0.0172	0.04851	0.01355	0.04232	0.0172	0.04556
Tellurium	0.00284	0.00242	0.00308	0.002	0.00344	0.00231	0.00271	0.00184	0.00344	0.00268
Uranium	7.95E-04	0.027104	0.0016016	0.1444	0.0019264	0.0175329	0.0010027	0.0117576	0.0014448	0.062444
Vanadium	0.0142	0.10648	0.0154	0.38	0.0172	0.02772	0.01355	0.02024	0.0172	0.18224
Zinc	16.0176	102.124	12.5048	136.8	15.7208	139.062	8.0487	105.248	9.3568	108.808
Zirconium	0.0284	0.0242	0.0308	0.046	0.0344	0.0231	0.0271	0.0184	0.0344	0.0268
Total.Lipids	8.98	9.57	9.44	3.61	11.9	7.89	6.04	4.07	13.3	6.25

APPENDIX S LARGE-BODIED FISH ANCOVA OUTPUTS

Table 294. Large-bodied fish body condition indices ANCOVA summary by treatment group.

Index	Species	term	estimate	std.error	statistic	p.value
Condition	RB	(Intercept)	0.095974	0.053324	1.799833	0.076833
Condition	RB	Exposure	0.01531	0.078595	0.194793	0.846203
Condition	RB	model	0.000622	-0.01576	0.037944	0.846203
Condition	MW	(Intercept)	0.293968	0.040715	7.220069	1.64E-09
Condition	MW	Exposure	-0.041	0.059158	-0.69314	0.491138
Condition	MW	model	0.00866	-0.00936	0.480445	0.491138
Condition	WP	(Intercept)	0.12808	0.050137	2.554585	0.014255
Condition	WP	Exposure	-0.17977	0.073393	-2.44941	0.018458
Condition	WP	model	0.122442	0.102034	5.999621	0.018458
Hepatosomatic.Index	RB	(Intercept)	0.057276	0.116933	0.489817	0.626812
Hepatosomatic.Index	RB	Exposure	0.044208	0.173439	0.254888	0.800054
Hepatosomatic.Index	RB	model	0.001544	-0.02223	0.064968	0.800054
Hepatosomatic.Index	MW	(Intercept)	-0.26649	0.112906	-2.36024	0.023967
Hepatosomatic.Index	MW	Exposure	0.154461	0.166569	0.927305	0.360119
Hepatosomatic.Index	MW	model	0.023979	-0.00391	0.859895	0.360119
Hepatosomatic.Index	WP	(Intercept)	0.018162	0.129429	0.140321	0.889628
Hepatosomatic.Index	WP	Exposure	0.43174	0.195122	2.21267	0.037122
Hepatosomatic.Index	WP	model	0.175506	0.139659	4.895909	0.037122
Gonadosomatic.Index	RB	(Intercept)	-1.30022	0.457723	-2.84063	0.007552
Gonadosomatic.Index	RB	Exposure	1.470647	0.73399	2.003632	0.05313
Gonadosomatic.Index	RB	model	0.105605	0.0793	4.014542	0.05313
Gonadosomatic.Index	MW	(Intercept)	0.959185	0.45808	2.093922	0.044539
Gonadosomatic.Index	MW	Exposure	-1.67356	0.679443	-2.46314	0.019527
Gonadosomatic.Index	MW	model	0.163678	0.136699	6.067041	0.019527
Gonadosomatic.Index	WP	(Intercept)	-0.08387	0.337416	-0.24856	0.805906
Gonadosomatic.Index	WP	Exposure	-0.23401	0.508674	-0.46004	0.649809
Gonadosomatic.Index	WP	model	0.009118	-0.03396	0.211635	0.649809

Table 295. Large-bodied fish metal concentrations ANCOVA summary table with treatment, species, fork length, and year included as covariates.

Metal	Tissue	term	estimate	Std error	statistic	p value
Arsenic	Fillet	(Intercept)	-3.59805	0.28576	-12.5912	4.98E-25
Arsenic	Fillet	treatmentReference	0.021095	0.092114	0.229014	0.819181
Arsenic	Fillet	Fork.Length.mm	0.002292	0.000727	3.151981	0.001971
Arsenic	Fillet	SpeciesRB	-0.25652	0.113378	-2.26249	0.025153
Arsenic	Fillet	SpeciesWP	-0.19869	0.117643	-1.68888	0.093391
Arsenic	Fillet	year2016	-0.55864	0.114392	-4.88357	2.72E-06
Arsenic	Fillet	year2021	-0.12762	0.110929	-1.15049	0.251835
Arsenic	Fillet	model	0.245775	0.214566	7.875066	2.36E-07
Arsenic	Gut	(Intercept)	-0.97983	0.388805	-2.52009	0.012924
Arsenic	Gut	treatmentReference	-0.45271	0.137684	-3.28804	0.001293
Arsenic	Gut	Fork.Length.mm	-0.00281	0.001038	-2.70202	0.007798
Arsenic	Gut	SpeciesRB	0.185776	0.165546	1.122198	0.263815
Arsenic	Gut	SpeciesWP	0.441454	0.178187	2.477468	0.014495
Arsenic	Gut	year2016	0.124777	0.162655	0.767125	0.444377
Arsenic	Gut	year2021	0.095599	0.167757	0.569866	0.569737
Arsenic	Gut	model	0.147396	0.108641	3.803289	0.001579
Arsenic	Whole	(Intercept)	-2.49796	0.270165	-9.24605	5.32E-16
Arsenic	Whole	treatmentReference	0.11213	0.095671	1.172045	0.24329
Arsenic	Whole	Fork.Length.mm	-0.00065	0.000721	-0.90244	0.368468
Arsenic	Whole	SpeciesRB	-0.16488	0.115031	-1.43334	0.154126
Arsenic	Whole	SpeciesWP	0.020498	0.123815	0.165551	0.868764
Arsenic	Whole	year2016	-0.73423	0.113022	-6.49634	1.54E-09
Arsenic	Whole	year2021	-0.27051	0.116567	-2.32063	0.02184
Arsenic	Whole	model	0.274034	0.241035	8.304445	1.22E-07
Cadmium	Fillet	(Intercept)	-6.73725	0.54256	-12.4175	1.43E-24
Cadmium	Fillet	treatmentReference	-0.44389	0.174894	-2.53807	0.012203
Cadmium	Fillet	Fork.Length.mm	0.001827	0.001381	1.323171	0.187861
Cadmium	Fillet	SpeciesRB	-1.52934	0.215267	-7.10438	5.03E-11
Cadmium	Fillet	SpeciesWP	-1.6865	0.223365	-7.55046	4.44E-12
Cadmium	Fillet	year2016	1.625205	0.217191	7.482841	6.45E-12
Cadmium	Fillet	year2021	1.127371	0.210616	5.352734	3.31E-07
Cadmium	Fillet	model	0.471165	0.449282	21.53128	5.47E-18
Cadmium	Gut	(Intercept)	-0.3324	0.386889	-0.85916	0.391808
Cadmium	Gut	treatmentReference	-1.17756	0.137005	-8.59502	2.08E-14
Cadmium	Gut	Fork.Length.mm	-0.00327	0.001033	-3.16271	0.00194
Cadmium	Gut	SpeciesRB	-0.13352	0.164731	-0.81052	0.419102
Cadmium	Gut	SpeciesWP	-0.06434	0.177309	-0.36284	0.717301
Cadmium	Gut	year2016	0.081697	0.161854	0.50476	0.614569
Cadmium	Gut	year2021	0.081192	0.16693	0.486384	0.627502
Cadmium	Gut	model	0.408042	0.381135	15.16479	3.71E-13
Cadmium	Whole	(Intercept)	-4.65409	0.374269	-12.4352	5.58E-24
Cadmium	Whole	treatmentReference	-0.64194	0.132536	-4.84354	3.51E-06
Cadmium	Whole	Fork.Length.mm	0.00184	0.000999	1.841711	0.067762
Cadmium	Whole	SpeciesRB	-0.85802	0.159357	-5.38424	3.23E-07
Cadmium	Whole	SpeciesWP	-0.60077	0.171525	-3.50251	0.00063
Cadmium	Whole	year2016	0.01526	0.156574	0.097464	0.922505

Metal	Tissue	term	estimate	Std error	statistic	p value
Cadmium	Whole	year2021	-0.23335	0.161485	-1.44502	0.150822
Cadmium	Whole	model	0.314555	0.283399	10.09595	3.59E-09
Chromium	Fillet	(Intercept)	-8.90232	0.522014	-17.0538	1.80E-36
Chromium	Fillet	treatmentReference	0.125021	0.168271	0.742972	0.4587
Chromium	Fillet	Fork.Length.mm	0.000601	0.001328	0.45251	0.651578
Chromium	Fillet	SpeciesRB	-0.22272	0.207115	-1.07535	0.284005
Chromium	Fillet	SpeciesWP	-0.2436	0.214906	-1.1335	0.258874
Chromium	Fillet	year2016	4.588832	0.208966	21.95971	5.79E-48
Chromium	Fillet	year2021	3.837236	0.20264	18.93622	4.92E-41
Chromium	Fillet	model	0.807789	0.799835	101.5632	2.13E-49
Chromium	Gut	(Intercept)	-2.2511	0.979936	-2.29719	0.023182
Chromium	Gut	treatmentReference	-1.43786	0.347015	-4.14351	6.07E-05
Chromium	Gut	Fork.Length.mm	-0.00448	0.002617	-1.71285	0.089088
Chromium	Gut	SpeciesRB	0.609001	0.417239	1.459596	0.146777
Chromium	Gut	SpeciesWP	-2.46984	0.449099	-5.49954	1.90E-07
Chromium	Gut	year2016	3.954226	0.409952	9.645575	5.46E-17
Chromium	Gut	year2021	2.516852	0.42281	5.952681	2.24E-08
Chromium	Gut	model	0.59891	0.580678	32.85048	5.43E-24
Chromium	Whole	(Intercept)	-8.88033	0.482897	-18.3897	3.16E-38
Chromium	Whole	treatmentReference	-0.00171	0.171004	-0.01	0.992038
Chromium	Whole	Fork.Length.mm	0.000523	0.001289	0.405554	0.685727
Chromium	Whole	SpeciesRB	0.155663	0.205609	0.757084	0.450349
Chromium	Whole	SpeciesWP	-0.2825	0.221309	-1.27649	0.204022
Chromium	Whole	year2016	4.267579	0.202018	21.12471	3.58E-44
Chromium	Whole	year2021	3.860237	0.208354	18.52728	1.55E-38
Chromium	Whole	model	0.812998	0.804498	95.64566	1.33E-45
Copper	Fillet	(Intercept)	-0.86042	0.110252	-7.80417	1.09E-12
Copper	Fillet	treatmentReference	0.030793	0.03554	0.866434	0.387684
Copper	Fillet	Fork.Length.mm	0.000291	0.000281	1.035825	0.302008
Copper	Fillet	SpeciesRB	-0.18214	0.043744	-4.16386	5.35E-05
Copper	Fillet	SpeciesWP	-0.62878	0.045389	-13.8531	2.48E-28
Copper	Fillet	year2016	0.118543	0.044135	2.685946	0.008076
Copper	Fillet	year2021	0.331777	0.042799	7.75208	1.45E-12
Copper	Fillet	model	0.660428	0.646377	47.00139	1.19E-31
Copper	Gut	(Intercept)	2.147935	0.38775	5.539478	1.63E-07
Copper	Gut	treatmentReference	-0.81268	0.133284	-6.09735	1.16E-08
Copper	Gut	Fork.Length.mm	-0.00299	0.001035	-2.8908	0.00451
Copper	Gut	SpeciesRB	0.991138	0.163009	6.080251	1.27E-08
Copper	Gut	SpeciesWP	-0.56162	0.171856	-3.26797	0.001388
Copper	Gut	year2016	-0.08664	0.159591	-0.5429	0.588137
Copper	Gut	year2021	-0.34138	0.162715	-2.098	0.037856
Copper	Gut	model	0.55141	0.530546	26.428	2.38E-20
Copper	Whole	(Intercept)	-0.89252	0.144861	-6.1612	8.14E-09
Copper	Whole	treatmentReference	0.026842	0.051298	0.523249	0.601678
Copper	Whole	Fork.Length.mm	-0.00025	0.000387	-0.63795	0.524611
Copper	Whole	SpeciesRB	0.216548	0.061679	3.51087	0.000612
Copper	Whole	SpeciesWP	-0.46259	0.066389	-6.9678	1.38E-10
Copper	Whole	year2016	0.25913	0.060602	4.275918	3.62E-05
Copper	Whole	year2021	0.207921	0.062503	3.326584	0.001139

Metal	Tissue	term	estimate	Std error	statistic	p value
Copper	Whole	model	0.541389	0.520543	25.97098	3.10E-20
Lead	Fillet	(Intercept)	-4.36584	0.457102	-9.55113	4.53E-17
Lead	Fillet	treatmentReference	-1.37215	0.147347	-9.31239	1.86E-16
Lead	Fillet	Fork.Length.mm	0.003912	0.001163	3.363029	0.000986
Lead	Fillet	SpeciesRB	-0.52856	0.181361	-2.9144	0.00413
Lead	Fillet	SpeciesWP	-0.93822	0.188183	-4.98569	1.74E-06
Lead	Fillet	year2016	-0.49879	0.182982	-2.72588	0.007204
Lead	Fillet	year2021	-0.22905	0.177442	-1.29082	0.198822
Lead	Fillet	model	0.466037	0.443942	21.09237	1.08E-17
Lead	Gut	(Intercept)	1.758928	0.722754	2.433646	0.016285
Lead	Gut	treatmentReference	-2.86835	0.255942	-11.207	6.75E-21
Lead	Gut	Fork.Length.mm	-0.00701	0.00193	-3.63163	0.000402
Lead	Gut	SpeciesRB	0.370826	0.307736	1.205015	0.230354
Lead	Gut	SpeciesWP	-2.5059	0.331235	-7.56533	5.88E-12
Lead	Gut	year2016	1.193393	0.302362	3.946908	0.000128
Lead	Gut	year2021	0.58444	0.311845	1.874139	0.063122
Lead	Gut	model	0.685862	0.671583	48.03287	7.01E-31
Lead	Whole	(Intercept)	-4.19242	0.587599	-7.13483	5.77E-11
Lead	Whole	treatmentReference	-1.58513	0.208081	-7.61787	4.43E-12
Lead	Whole	Fork.Length.mm	0.004278	0.001569	2.726399	0.007273
Lead	Whole	SpeciesRB	-0.60534	0.250189	-2.41954	0.016902
Lead	Whole	SpeciesWP	-1.14915	0.269294	-4.26727	3.75E-05
Lead	Whole	year2016	0.027776	0.24582	0.112993	0.910208
Lead	Whole	year2021	0.135248	0.253529	0.533462	0.594611
Lead	Whole	model	0.375983	0.347618	13.25544	1.03E-11
Mercury	Fillet	(Intercept)	-5.28482	0.214885	-24.5937	1.35E-53
Mercury	Fillet	treatmentReference	0.247272	0.069268	3.569782	0.000485
Mercury	Fillet	Fork.Length.mm	0.005613	0.000547	10.26434	6.43E-19
Mercury	Fillet	SpeciesRB	0.017898	0.085258	0.209928	0.834019
Mercury	Fillet	SpeciesWP	1.288854	0.088465	14.56905	3.46E-30
Mercury	Fillet	year2016	-0.14724	0.08602	-1.71164	0.089101
Mercury	Fillet	year2021	-0.13369	0.083416	-1.60267	0.111184
Mercury	Fillet	model	0.774398	0.765063	82.95427	2.17E-44
Mercury	Gut	(Intercept)	-4.29877	0.260381	-16.5095	1.32E-33
Mercury	Gut	treatmentReference	0.060532	0.089295	0.677881	0.499061
Mercury	Gut	Fork.Length.mm	0.002476	0.000715	3.465415	0.000719
Mercury	Gut	SpeciesRB	-0.22881	0.107484	-2.12879	0.035173
Mercury	Gut	SpeciesWP	-0.20607	0.11541	-1.78551	0.076528
Mercury	Gut	year2016	-0.42684	0.104931	-4.06777	8.21E-05
Mercury	Gut	year2021	-0.5271	0.109096	-4.83154	3.78E-06
Mercury	Gut	model	0.24837	0.213411	7.104517	1.48E-06
Mercury	Whole	(Intercept)	-4.85003	0.221667	-21.8799	9.65E-46
Mercury	Whole	treatmentReference	0.157939	0.078497	2.012045	0.04625
Mercury	Whole	Fork.Length.mm	0.004537	0.000592	7.665672	3.43E-12
Mercury	Whole	SpeciesRB	-0.07257	0.094382	-0.76891	0.443319
Mercury	Whole	SpeciesWP	1.19722	0.101589	11.78498	2.38E-22
Mercury	Whole	year2016	-0.36649	0.092733	-3.95214	0.000126
Mercury	Whole	year2021	-0.21716	0.095642	-2.27056	0.024794
Mercury	Whole	model	0.747382	0.735899	65.0879	4.70E-37

Metal	Tissue	term	estimate	Std error	statistic	p value
Selenium	Fillet	(Intercept)	-0.66056	0.104687	-6.30985	3.20E-09
Selenium	Fillet	treatmentReference	-0.17756	0.033746	-5.26157	5.04E-07
Selenium	Fillet	Fork.Length.mm	0.000265	0.000266	0.993104	0.322314
Selenium	Fillet	SpeciesRB	-0.21553	0.041536	-5.18889	7.01E-07
Selenium	Fillet	SpeciesWP	-0.11144	0.043098	-2.58574	0.010702
Selenium	Fillet	year2016	-0.11467	0.041907	-2.73621	0.006992
Selenium	Fillet	year2021	-0.15222	0.040639	-3.74562	0.000259
Selenium	Fillet	model	0.353708	0.326965	13.22615	6.49E-12
Selenium	Gut	(Intercept)	0.875065	0.178548	4.900994	2.79E-06
Selenium	Gut	treatmentReference	-0.32019	0.061407	-5.21427	7.07E-07
Selenium	Gut	Fork.Length.mm	0.000147	0.000478	0.306907	0.759406
Selenium	Gut	SpeciesRB	-0.35071	0.075045	-4.67336	7.30E-06
Selenium	Gut	SpeciesWP	-0.81828	0.079226	-10.3283	1.26E-18
Selenium	Gut	year2016	-0.53579	0.073429	-7.2967	2.60E-11
Selenium	Gut	year2021	-0.54958	0.075216	-7.30669	2.46E-11
Selenium	Gut	model	0.639381	0.622737	38.41524	1.48E-26
Selenium	Whole	(Intercept)	-0.28789	0.147242	-1.95524	0.052667
Selenium	Whole	treatmentReference	-0.14626	0.052141	-2.80509	0.005791
Selenium	Whole	Fork.Length.mm	-0.00013	0.000393	-0.33938	0.734866
Selenium	Whole	SpeciesRB	-0.34659	0.062693	-5.52835	1.66E-07
Selenium	Whole	SpeciesWP	-0.48448	0.06748	-7.17954	4.56E-11
Selenium	Whole	year2016	0.190033	0.061598	3.085049	0.00248
Selenium	Whole	year2021	0.066502	0.06353	1.046787	0.297111
Selenium	Whole	model	0.392262	0.364638	14.19981	1.95E-12
Thallium	Fillet	(Intercept)	-5.13034	0.262576	-19.5385	1.87E-42
Thallium	Fillet	treatmentReference	-0.47458	0.084641	-5.60692	1.01E-07
Thallium	Fillet	Fork.Length.mm	0.000843	0.000668	1.262051	0.208957
Thallium	Fillet	SpeciesRB	0.562258	0.10418	5.396991	2.70E-07
Thallium	Fillet	SpeciesWP	0.856171	0.108099	7.92026	5.68E-13
Thallium	Fillet	year2016	-0.11393	0.105111	-1.0839	0.280207
Thallium	Fillet	year2021	0.123388	0.101929	1.210527	0.228046
Thallium	Fillet	model	0.440383	0.417227	19.01767	2.90E-16
Thallium	Gut	(Intercept)	-2.80004	0.291839	-9.59447	7.77E-17
Thallium	Gut	treatmentReference	-0.73093	0.101706	-7.18669	4.51E-11
Thallium	Gut	Fork.Length.mm	-0.00265	0.00078	-3.39218	0.000917
Thallium	Gut	SpeciesRB	0.163131	0.123287	1.323183	0.188079
Thallium	Gut	SpeciesWP	0.190417	0.131481	1.448247	0.149937
Thallium	Gut	year2016	-0.08318	0.120878	-0.68814	0.492578
Thallium	Gut	year2021	-0.14241	0.124228	-1.14633	0.253748
Thallium	Gut	model	0.352036	0.322358	11.86193	1.33E-10
Thallium	Whole	(Intercept)	-3.97572	0.239282	-16.6152	3.75E-34
Thallium	Whole	treatmentReference	-0.64828	0.084734	-7.65077	3.71E-12
Thallium	Whole	Fork.Length.mm	-0.00216	0.000639	-3.37871	0.000958
Thallium	Whole	SpeciesRB	0.390933	0.101882	3.83712	0.000192
Thallium	Whole	SpeciesWP	0.879729	0.109662	8.02221	4.94E-13
Thallium	Whole	year2016	-0.08444	0.100103	-0.84352	0.400464
Thallium	Whole	year2021	-0.12946	0.103242	-1.25391	0.212091
Thallium	Whole	model	0.502841	0.480242	22.2514	5.52E-18
Zinc	Fillet	(Intercept)	2.134219	0.123368	17.29966	4.46E-37

Metal	Tissue	term	estimate	Std error	statistic	p value
Zinc	Fillet	treatmentReference	0.012543	0.039768	0.315416	0.752899
Zinc	Fillet	Fork.Length.mm	0.000276	0.000314	0.880425	0.380086
Zinc	Fillet	SpeciesRB	0.029081	0.048948	0.594121	0.553357
Zinc	Fillet	SpeciesWP	-0.05454	0.050789	-1.07378	0.284704
Zinc	Fillet	year2016	-0.00861	0.049385	-0.17444	0.86176
Zinc	Fillet	year2021	0.235714	0.04789	4.921991	2.30E-06
Zinc	Fillet	model	0.197856	0.164663	5.960907	1.37E-05
Zinc	Gut	(Intercept)	4.777494	0.276034	17.30763	1.52E-35
Zinc	Gut	treatmentReference	-0.22145	0.09791	-2.26174	0.025374
Zinc	Gut	Fork.Length.mm	-0.00083	0.000737	-1.13106	0.260114
Zinc	Gut	SpeciesRB	0.262346	0.118453	2.214778	0.028517
Zinc	Gut	SpeciesWP	-1.73237	0.127267	-13.6121	8.86E-27
Zinc	Gut	year2016	0.140644	0.116395	1.208326	0.229115
Zinc	Gut	year2021	0.412968	0.118519	3.484405	0.000673
Zinc	Gut	model	0.734825	0.722586	60.0404	4.09E-35
Zinc	Whole	(Intercept)	2.819355	0.128151	22.00018	5.46E-46
Zinc	Whole	treatmentReference	0.11684	0.045381	2.574653	0.011136
Zinc	Whole	Fork.Length.mm	-0.00107	0.000342	-3.13753	0.002102
Zinc	Whole	SpeciesRB	0.077756	0.054565	1.425033	0.156508
Zinc	Whole	SpeciesWP	-0.03303	0.058731	-0.56242	0.574787
Zinc	Whole	year2016	0.074159	0.053612	1.38326	0.16892
Zinc	Whole	year2021	-0.02049	0.055293	-0.37051	0.711598
Zinc	Whole	model	0.177693	0.140315	4.753988	0.000204

Table 296. Large-bodied fish metal concentrations ANCOVA summary table for 2021 data only with treatment and species as covariates.

metal	Tissue Analysed	term	estimate	Std error	statistic	p value
Arsenic	Fillet	(Intercept)	-2.75742	0.159745	-17.2614	1.81E-21
Arsenic	Fillet	treatmentReference	0.096924	0.157667	0.614739	0.541823
Arsenic	Fillet	SpeciesRB	-0.42245	0.183939	-2.29669	0.026344
Arsenic	Fillet	SpeciesWP	-0.6197	0.190373	-3.25518	0.002156
Arsenic	Fillet	model	0.203097	0.14997	3.822873	0.015986
Arsenic	Gut	(Intercept)	-1.59509	0.211003	-7.55956	5.16E-09
Arsenic	Gut	treatmentReference	-0.76751	0.211845	-3.62298	0.000869
Arsenic	Gut	SpeciesRB	-0.04638	0.225684	-0.20553	0.838284
Arsenic	Gut	SpeciesWP	0.333801	0.237788	1.403774	0.168724
Arsenic	Gut	model	0.278054	0.219518	4.750123	0.006693
Arsenic	Whole	(Intercept)	-2.86782	0.160112	-17.9113	8.06E-20
Arsenic	Whole	treatmentReference	-0.04627	0.160751	-0.28781	0.775095
Arsenic	Whole	SpeciesRB	-0.4136	0.171253	-2.41515	0.020787
Arsenic	Whole	SpeciesWP	0.204888	0.180437	1.135505	0.263466
Arsenic	Whole	model	0.24748	0.186465	4.056047	0.013731
Cadmium	Fillet	(Intercept)	-5.27091	0.197487	-26.69	3.15E-29
Cadmium	Fillet	treatmentReference	-0.61852	0.194918	-3.17324	0.002717

metal	Tissue Analysed	term	estimate	Std error	statistic	p value
Cadmium	Fillet	SpeciesRB	-1.14186	0.227396	-5.02145	8.56E-06
Cadmium	Fillet	SpeciesWP	-0.72724	0.235351	-3.09004	0.003427
Cadmium	Fillet	model	0.446344	0.409434	12.09264	6.23E-06
Cadmium	Gut	(Intercept)	-1.3381	0.219006	-6.10987	4.46E-07
Cadmium	Gut	treatmentReference	-0.86167	0.21988	-3.91883	0.00037
Cadmium	Gut	SpeciesRB	-0.72531	0.234244	-3.09638	0.003725
Cadmium	Gut	SpeciesWP	-0.5796	0.246807	-2.34841	0.024307
Cadmium	Gut	model	0.426794	0.380318	9.183066	0.000113
Cadmium	Whole	(Intercept)	-4.19649	0.267814	-15.6694	6.47E-18
Cadmium	Whole	treatmentReference	-0.61531	0.268883	-2.28839	0.027923
Cadmium	Whole	SpeciesRB	-1.13776	0.286448	-3.97194	0.000317
Cadmium	Whole	SpeciesWP	-0.35844	0.301811	-1.18762	0.242552
Cadmium	Whole	model	0.358878	0.306895	6.903776	0.00083
Chromium	Fillet	(Intercept)	-4.6925	0.074852	-62.6899	1.94E-45
Chromium	Fillet	treatmentReference	-0.11081	0.073879	-1.49992	0.140618
Chromium	Fillet	SpeciesRB	-0.20849	0.086189	-2.41895	0.019671
Chromium	Fillet	SpeciesWP	-0.29564	0.089204	-3.31424	0.001821
Chromium	Fillet	model	0.246238	0.195987	4.900187	0.004956
Chromium	Gut	(Intercept)	-1.72535	0.433832	-3.97701	0.000312
Chromium	Gut	treatmentReference	-1.23107	0.435564	-2.82638	0.007549
Chromium	Gut	SpeciesRB	0.489967	0.464018	1.055924	0.297849
Chromium	Gut	SpeciesWP	-1.72847	0.488904	-3.5354	0.001114
Chromium	Gut	model	0.487739	0.446204	11.74292	1.50E-05
Chromium	Whole	(Intercept)	-4.74429	0.089067	-53.2666	1.40E-36
Chromium	Whole	treatmentReference	-0.00471	0.089422	-0.05267	0.958276
Chromium	Whole	SpeciesRB	-0.05054	0.095264	-0.53051	0.598929
Chromium	Whole	SpeciesWP	-0.31189	0.100373	-3.10728	0.003618
Chromium	Whole	model	0.229579	0.167112	3.675225	0.020566
Copper	Fillet	(Intercept)	-0.40096	0.060842	-6.59018	4.14E-08
Copper	Fillet	treatmentReference	-0.06692	0.06005	-1.11433	0.271056
Copper	Fillet	SpeciesRB	-0.16645	0.070056	-2.37595	0.021821
Copper	Fillet	SpeciesWP	-0.52523	0.072507	-7.24386	4.44E-09
Copper	Fillet	model	0.557933	0.528462	18.93154	4.36E-08
Copper	Gut	(Intercept)	0.827875	0.15897	5.207732	7.41E-06
Copper	Gut	treatmentReference	-0.88929	0.159605	-5.57182	2.39E-06
Copper	Gut	SpeciesRB	0.804374	0.170031	4.730738	3.23E-05
Copper	Gut	SpeciesWP	-0.62013	0.17915	-3.46151	0.001371
Copper	Gut	model	0.748064	0.727636	36.62081	3.62E-11
Copper	Whole	(Intercept)	-0.64481	0.077792	-8.28889	5.87E-10
Copper	Whole	treatmentReference	-0.04725	0.078103	-0.605	0.54887
Copper	Whole	SpeciesRB	0.10548	0.083205	1.26772	0.212818

metal	Tissue Analysed	term	estimate	Std error	statistic	p value
Copper	Whole	SpeciesWP	-0.60377	0.087667	-6.88702	4.01E-08
Copper	Whole	model	0.673986	0.647552	25.49733	4.07E-09
Lead	Fillet	(Intercept)	-3.28207	0.287414	-11.4193	6.93E-15
Lead	Fillet	treatmentReference	-1.47127	0.283676	-5.18644	4.93E-06
Lead	Fillet	SpeciesRB	-0.56423	0.330944	-1.70492	0.095105
Lead	Fillet	SpeciesWP	-0.37047	0.342521	-1.08159	0.285196
Lead	Fillet	model	0.402152	0.362296	10.09	3.34E-05
Lead	Gut	(Intercept)	-0.38343	0.418992	-0.91512	0.366053
Lead	Gut	treatmentReference	-2.47752	0.420665	-5.88953	8.86E-07
Lead	Gut	SpeciesRB	0.096241	0.448145	0.214755	0.831138
Lead	Gut	SpeciesWP	-2.72813	0.47218	-5.77774	1.26E-06
Lead	Gut	model	0.720119	0.697426	31.73303	2.49E-10
Lead	Whole	(Intercept)	-2.6894	0.363815	-7.39221	8.56E-09
Lead	Whole	treatmentReference	-1.1528	0.365268	-3.15603	0.003174
Lead	Whole	SpeciesRB	-0.7762	0.389129	-1.99472	0.053479
Lead	Whole	SpeciesWP	-1.2268	0.409999	-2.9922	0.004909
Lead	Whole	model	0.376319	0.32575	7.441733	0.000509
Mercury	Fillet	(Intercept)	-3.44014	0.173864	-19.7863	7.82E-24
Mercury	Fillet	treatmentReference	0.232673	0.171603	1.355879	0.181903
Mercury	Fillet	SpeciesRB	0.195997	0.200197	0.979022	0.332803
Mercury	Fillet	SpeciesWP	1.27889	0.2072	6.172253	1.73E-07
Mercury	Fillet	model	0.509424	0.476719	15.57631	4.35E-07
Mercury	Gut	(Intercept)	-3.45995	0.180891	-19.1273	8.94E-21
Mercury	Gut	treatmentReference	-0.265	0.181613	-1.45916	0.152958
Mercury	Gut	SpeciesRB	-0.59099	0.193477	-3.05457	0.004164
Mercury	Gut	SpeciesWP	-0.51399	0.203854	-2.52135	0.016128
Mercury	Gut	model	0.269505	0.210276	4.550197	0.008213
Mercury	Whole	(Intercept)	-3.14951	0.171468	-18.3679	3.48E-20
Mercury	Whole	treatmentReference	-0.26843	0.172152	-1.55925	0.127452
Mercury	Whole	SpeciesRB	-0.19314	0.183398	-1.05313	0.29911
Mercury	Whole	SpeciesWP	1.587335	0.193234	8.214558	7.30E-10
Mercury	Whole	model	0.722674	0.700188	32.13895	2.11E-10
Selenium	Fillet	(Intercept)	-0.80923	0.059749	-13.5438	1.75E-17
Selenium	Fillet	treatmentReference	-0.03873	0.058972	-0.65674	0.514691
Selenium	Fillet	SpeciesRB	-0.26544	0.068798	-3.85817	0.000362
Selenium	Fillet	SpeciesWP	-0.03183	0.071205	-0.44707	0.656966
Selenium	Fillet	model	0.283366	0.235591	5.931194	0.00169
Selenium	Gut	(Intercept)	0.189829	0.097253	1.951899	0.05855
Selenium	Gut	treatmentReference	0.016459	0.097642	0.168561	0.86706
Selenium	Gut	SpeciesRB	-0.39265	0.10402	-3.77476	0.000562
Selenium	Gut	SpeciesWP	-0.93291	0.109599	-8.51208	3.05E-10

metal	Tissue Analysed	term	estimate	Std error	statistic	p value
Selenium	Gut	model	0.665858	0.638765	24.57708	6.38E-09
Selenium	Whole	(Intercept)	-0.49628	0.101242	-4.90197	1.91E-05
Selenium	Whole	treatmentReference	0.011458	0.101646	0.112722	0.91086
Selenium	Whole	SpeciesRB	-0.11145	0.108286	-1.02922	0.310058
Selenium	Whole	SpeciesWP	-0.37045	0.114094	-3.24692	0.002481
Selenium	Whole	model	0.228791	0.16626	3.658863	0.020929
Thallium	Fillet	(Intercept)	-4.55248	0.141703	-32.1269	1.13E-32
Thallium	Fillet	treatmentReference	-0.78375	0.13986	-5.60384	1.20E-06
Thallium	Fillet	SpeciesRB	0.700885	0.163165	4.295566	9.19E-05
Thallium	Fillet	SpeciesWP	0.828225	0.168872	4.904442	1.26E-05
Thallium	Fillet	model	0.562369	0.533194	19.27546	3.49E-08
Thallium	Gut	(Intercept)	-3.4293	0.164211	-20.8835	4.53E-22
Thallium	Gut	treatmentReference	-1.30285	0.164866	-7.90246	1.84E-09
Thallium	Gut	SpeciesRB	0.013161	0.175637	0.07493	0.940674
Thallium	Gut	SpeciesWP	0.044269	0.185056	0.239219	0.812256
Thallium	Gut	model	0.633467	0.603748	21.3153	3.45E-08
Thallium	Whole	(Intercept)	-4.43606	0.179007	-24.7815	1.22E-24
Thallium	Whole	treatmentReference	-1.21188	0.179722	-6.74307	6.25E-08
Thallium	Whole	SpeciesRB	0.168649	0.191462	0.880846	0.384087
Thallium	Whole	SpeciesWP	0.885774	0.201731	4.390869	9.09E-05
Thallium	Whole	model	0.608925	0.577216	19.20369	1.12E-07
Zinc	Fillet	(Intercept)	2.446689	0.07874	31.07285	4.76E-32
Zinc	Fillet	treatmentReference	-0.07063	0.077716	-0.9088	0.368297
Zinc	Fillet	SpeciesRB	0.165041	0.090666	1.820318	0.075365
Zinc	Fillet	SpeciesWP	0.033247	0.093837	0.354301	0.724768
Zinc	Fillet	model	0.092504	0.032005	1.529007	0.219935
Zinc	Gut	(Intercept)	5.239962	0.141083	37.14108	6.84E-31
Zinc	Gut	treatmentReference	-0.01232	0.141646	-0.08697	0.931161
Zinc	Gut	SpeciesRB	-0.38458	0.150899	-2.54857	0.015099
Zinc	Gut	SpeciesWP	-2.71281	0.158992	-17.0626	4.02E-19
Zinc	Gut	model	0.900799	0.892756	111.9936	1.28E-18
Zinc	Whole	(Intercept)	2.502272	0.073833	33.89084	1.84E-29
Zinc	Whole	treatmentReference	0.006391	0.074128	0.086217	0.931759
Zinc	Whole	SpeciesRB	0.05476	0.078971	0.69342	0.492377
Zinc	Whole	SpeciesWP	-0.09151	0.083206	-1.09977	0.278537
Zinc	Whole	model	0.076187	0.001283	1.017126	0.396119

Table 297. ANOVA summary table for large-bodied fish fillet arsenic concentrations in reference sites for years 2000 – 2021.

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
Year	8	27.5799365	3.44749206	93.74981	<0.001
Residuals	10	0.3677332	0.03677332		

Table 298. Significant differences in arsenic concentrations between year pairings from Tukey HSD on large-bodied fish fillet samples from reference sites for years 2000 – 2021.

Higher	Lower	Adjusted p Value
2000	2002	<0.001
2000	2003	<0.001
2000	2005	<0.001
2000	2012	<0.001
2000	2016	<0.001
2000	2021	<0.001
2001	2002	0.001
2001	2003	<0.001
2001	2005	0.001
2001	2012	<0.001
2001	2016	<0.001
2001	2021	<0.001
2004	2002	0.027
2002	2012	0.014
2002	2016	<0.001
2002	2021	0.003
2004	2003	0.003
2003	2012	0.001
2003	2016	<0.001
2003	2021	<0.001
2004	2005	0.020
2004	2012	<0.001
2004	2016	<0.001
2004	2021	<0.001
2005	2012	0.019
2005	2016	<0.001
2005	2021	0.004
2012	2016	0.007

Table 299. Tukey HSD year comparison for large-bodied fish fillet samples from reference sites for 2000 – 2021 arsenic concentrations.

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
Year	2001 : 2000	0	0.16703756	-0.73979976	1.0738749	0.997
Year	2002 : 2000	0	-1.61675374	-2.52359106	-0.7099164	<0.001
Year	2003 : 2000	0	-1.64928052	-2.32519714	-0.9733639	<0.001
Year	2004 : 2000	0	-0.61216757	-1.35259714	0.1282620	0.131
Year	2005 : 2000	0	-1.66554391	-2.57238122	-0.7587066	<0.001
Year	2012 : 2000	0	-2.67110287	-3.34701950	-1.9951862	<0.001
Year	2016 : 2000	0	-3.48933836	-4.16525499	-2.8134217	<0.001
Year	2021 : 2000	0	-2.91550931	-3.59142593	-2.2395927	<0.001
Year	2002 : 2001	0	-1.78379130	-2.83091683	-0.7366658	0.001
Year	2003 : 2001	0	-1.81631808	-2.67129249	-0.9613437	<0.001
Year	2004 : 2001	0	-0.77920513	-1.68604244	0.1276322	0.110
Year	2005 : 2001	0	-1.83258146	-2.87970700	-0.7854559	0.001
Year	2012 : 2001	0	-2.83814043	-3.69311484	-1.9831660	<0.001

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
Year	2016 : 2001	0	-3.65637592	-4.51135034	-2.8014015	<0.001
Year	2021 : 2001	0	-3.08254686	-3.93752128	-2.2275724	<0.001
Year	2003 : 2002	0	-0.03252678	-0.88750119	0.8224476	1.000
Year	2004 : 2002	0	1.00458617	0.09774886	1.9114235	0.027
Year	2005 : 2002	0	-0.04879016	-1.09591570	0.9983354	1.000
Year	2012 : 2002	0	-1.05434913	-1.90932354	-0.1993747	0.014
Year	2016 : 2002	0	-1.87258462	-2.72755904	-1.0176102	<0.001
Year	2021 : 2002	0	-1.29875556	-2.15372998	-0.4437811	0.003
Year	2004 : 2003	0	1.03711295	0.36119632	1.7130296	0.003
Year	2005 : 2003	0	-0.01626339	-0.87123781	0.8387110	1.000
Year	2012 : 2003	0	-1.02182235	-1.62638056	-0.4172641	0.001
Year	2016 : 2003	0	-1.84005784	-2.44461605	-1.2354996	<0.001
Year	2021 : 2003	0	-1.26622879	-1.87078700	-0.6616706	<0.001
Year	2005 : 2004	0	-1.05337634	-1.96021365	-0.1465390	0.020
Year	2012 : 2004	0	-2.05893530	-2.73485192	-1.3830187	<0.001
Year	2016 : 2004	0	-2.87717079	-3.55308742	-2.2012542	<0.001
Year	2021 : 2004	0	-2.30334174	-2.97925836	-1.6274251	<0.001
Year	2012 : 2005	0	-1.00555896	-1.86053338	-0.1505845	0.019
Year	2016 : 2005	0	-1.82379446	-2.67876887	-0.9688200	<0.001
Year	2021 : 2005	0	-1.24996540	-2.10493982	-0.3949910	0.004
Year	2016 : 2012	0	-0.81823549	-1.42279370	-0.2136773	0.007
Year	2021 : 2012	0	-0.24440644	-0.84896464	0.3601518	0.806
Year	2021 : 2016	0	0.57382906	-0.03072915	1.1783873	0.066

Table 300. ANOVA summary table for large-bodied fish fillet arsenic concentrations in exposure sites for years 2000 – 2021.

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
Year	8	27.3589920	3.41987400	56.09172	<0.001
Residuals	10	0.6096932	0.06096932		

Table 301. Significant differences in arsenic concentrations between year pairings from Tukey HSD on large-bodied fish fillet samples from exposure sites for years 2000 – 2021.

Higher	Lower	Adjusted p Value
2000	2002	0.006
2000	2003	<0.001
2000	2005	0.006
2000	2012	<0.001
2000	2016	<0.001
2000	2021	<0.001
2001	2002	0.033
2001	2003	0.009
2001	2005	0.033
2001	2012	<0.001
2001	2016	<0.001
2001	2021	<0.001
2002	2012	0.022
2002	2016	0.002
2002	2021	0.011
2004	2003	0.017
2003	2012	0.002
2003	2016	<0.001
2003	2021	<0.001
2004	2012	<0.001
2004	2016	<0.001

Higher	Lower	Adjusted p Value
2004	2021	<0.001
2005	2012	0.022
2005	2016	0.002
2005	2021	0.011

Table 302. Tukey HSD year comparison for large-bodied fish fillet samples from exposure sites for 2000 – 2021 arsenic concentrations.

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
Year	2001 : 2000	0	-0.1580740227143923037900	-1.3257400	1.0095920	1.000
Year	2002 : 2000	0	-1.6096878499549247543143	-2.7773538	-0.4420219	0.006
Year	2003 : 2000	0	-1.6096878499549251984035	-2.4800147	-0.7393610	<0.001
Year	2004 : 2000	0	-0.5668518042396887279821	-1.5202471	0.3865435	0.421
Year	2005 : 2000	0	-1.6096878499549247543143	-2.7773538	-0.4420219	0.006
Year	2012 : 2000	0	-2.8757387213521670155103	-3.7460656	-2.0054119	<0.001
Year	2016 : 2000	0	-3.3898024465566503060643	-4.2601293	-2.5194756	<0.001
Year	2021 : 2000	0	-3.0064496022360707172538	-3.8767764	-2.1361228	<0.001
Year	2002 : 2001	0	-1.4516138272405323395020	-2.7999184	-0.1033093	0.033
Year	2003 : 2001	0	-1.4516138272405330056358	-2.5524999	-0.3507278	0.009
Year	2004 : 2001	0	-0.4087777815252964241921	-1.5764438	0.7588882	0.893
Year	2005 : 2001	0	-1.4516138272405325615466	-2.7999184	-0.1033093	0.033
Year	2012 : 2001	0	-2.7176646986377743786534	-3.8185508	-1.6167786	<0.001
Year	2016 : 2001	0	-3.2317284238422576692074	-4.3326145	-2.1308424	<0.001
Year	2021 : 2001	0	-2.8483755795216785244861	-3.9492616	-1.7474895	<0.001
Year	2003 : 2002	0	-0.0000000000000006661338	-1.1008861	1.1008861	1.000
Year	2004 : 2002	0	1.0428360457152359153099	-0.1248299	2.2105020	0.091
Year	2005 : 2002	0	-0.0000000000000002220446	-1.3483045	1.3483045	1.000
Year	2012 : 2002	0	-1.2660508713972422611960	-2.3669369	-0.1651648	0.022
Year	2016 : 2002	0	-1.7801145966017255517500	-2.8810007	-0.6792285	0.002
Year	2021 : 2002	0	-1.3967617522811459629395	-2.4976478	-0.2958757	0.011
Year	2004 : 2003	0	1.0428360457152365814437	0.1725092	1.9131629	0.017
Year	2005 : 2003	0	0.0000000000000004440892	-1.1008861	1.1008861	1.000
Year	2012 : 2003	0	-1.2660508713972415950622	-2.0444949	-0.4876069	0.002
Year	2016 : 2003	0	-1.7801145966017248856161	-2.5585586	-1.0016706	<0.001
Year	2021 : 2003	0	-1.3967617522811452968057	-2.1752057	-0.6183178	<0.001
Year	2005 : 2004	0	-1.0428360457152361373545	-2.2105020	0.1248299	0.091
Year	2012 : 2004	0	-2.3088869171124781765059	-3.1792138	-1.4385601	<0.001
Year	2016 : 2004	0	-2.8229506423169614670599	-3.6932775	-1.9526238	<0.001
Year	2021 : 2004	0	-2.4395977979963818782494	-3.3099246	-1.5692710	<0.001
Year	2012 : 2005	0	-1.2660508713972420391514	-2.3669369	-0.1651648	0.022
Year	2016 : 2005	0	-1.7801145966017253297053	-2.8810007	-0.6792285	0.002
Year	2021 : 2005	0	-1.3967617522811457408949	-2.4976478	-0.2958757	0.011
Year	2016 : 2012	0	-0.5140637252044832905540	-1.2925077	0.2643803	0.311
Year	2021 : 2012	0	-0.1307108808839037017435	-0.9091549	0.6477331	0.999
Year	2021 : 2016	0	0.3833528443205795888105	-0.3950911	1.1617968	0.627

Table 303. ANOVA summary table for large-bodied fish fillet cadmium concentrations in reference sites for years 2000 – 2021.

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
Year	8	58.806280	7.3507849	31.66957	<0.001
Residuals	10	2.321088	0.2321088		

Table 304. Significant differences in cadmium concentrations between year pairings from Tukey HSD on large-bodied fish fillet samples from reference sites for years 2000 – 2021.

Higher	Lower	Adjusted p Value
2000	2005	0.041
2000	2012	<0.001
2000	2016	<0.001
2000	2021	<0.001
2001	2012	<0.001
2001	2016	<0.001
2001	2021	<0.001
2002	2012	0.002
2002	2016	0.006
2002	2021	0.002
2003	2012	<0.001
2003	2016	<0.001
2003	2021	<0.001
2004	2012	<0.001
2004	2016	<0.001
2004	2021	<0.001

Table 305. Tukey HSD year comparison for large-bodied fish fillet samples from reference sites for 2000 – 2021 cadmium concentrations.

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
Year	2001 : 2000	0	0.1670375560107446588631	-2.111251	2.44532598	1.000
Year	2002 : 2000	0	-0.7492531758634104477323	-3.027542	1.52903524	0.920
Year	2003 : 2000	0	-0.7492531758634113359108	-2.447389	0.94888275	0.734
Year	2004 : 2000	0	-0.7492531758634095595539	-2.609468	1.11096153	0.808
Year	2005 : 2000	0	-2.3586910882975100633985	-4.636980	-0.08040267	0.041
Year	2012 : 2000	0	-4.2562800898623418532907	-5.954416	-2.55814416	<0.001
Year	2016 : 2000	0	-3.7449854494174017460750	-5.443121	-2.04684952	<0.001
Year	2021 : 2000	0	-4.1242738635788445122898	-5.822410	-2.42613794	<0.001
Year	2002 : 2001	0	-0.9162907318741551065955	-3.547032	1.71445013	0.895
Year	2003 : 2001	0	-0.9162907318741559947739	-3.064282	1.23170019	0.763
Year	2004 : 2001	0	-0.9162907318741542184171	-3.194579	1.36199769	0.809
Year	2005 : 2001	0	-2.5257286443082547222616	-5.156470	0.10501222	0.063
Year	2012 : 2001	0	-4.4233176458730865121538	-6.571309	-2.27532673	<0.001
Year	2016 : 2001	0	-3.9120230054281464049382	-6.060014	-1.76403208	<0.001
Year	2021 : 2001	0	-4.2913114195895891711530	-6.439302	-2.14332050	<0.001
Year	2003 : 2002	0	-0.0000000000000008881784	-2.147991	2.14799092	1.000
Year	2004 : 2002	0	0.0000000000000008881784	-2.278288	2.27828842	1.000
Year	2005 : 2002	0	-1.6094379124340996156661	-4.240179	1.02130295	0.390
Year	2012 : 2002	0	-3.5070269139989314055583	-5.655018	-1.35903599	0.002
Year	2016 : 2002	0	-2.9957322735539912983427	-5.143723	-0.84774135	0.006
Year	2021 : 2002	0	-3.3750206877154340645575	-5.523012	-1.22702977	0.002
Year	2004 : 2003	0	0.0000000000000017763568	-1.698136	1.69813593	1.000
Year	2005 : 2003	0	-1.6094379124340987274877	-3.757429	0.53855301	0.199
Year	2012 : 2003	0	-3.5070269139989305173799	-5.025886	-1.98816797	<0.001
Year	2016 : 2003	0	-2.9957322735539904101643	-4.514591	-1.47687333	<0.001
Year	2021 : 2003	0	-3.3750206877154331763791	-4.893880	-1.85616174	<0.001
Year	2005 : 2004	0	-1.6094379124341005038445	-3.887726	0.66885051	0.248
Year	2012 : 2004	0	-3.5070269139989322937367	-5.205163	-1.80889099	<0.001
Year	2016 : 2004	0	-2.9957322735539921865211	-4.693868	-1.29759635	<0.001
Year	2021 : 2004	0	-3.3750206877154349527359	-5.073157	-1.67688476	<0.001
Year	2012 : 2005	0	-1.8975890015648317898922	-4.045580	0.25040192	0.096
Year	2016 : 2005	0	-1.3862943611198916826766	-3.534285	0.76169656	0.334
Year	2021 : 2005	0	-1.7655827752813344488914	-3.913574	0.38240815	0.135

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
Year	2016 : 2012	0	0.5112946404449401072156	-1.007564	2.03015359	0.910
Year	2021 : 2012	0	0.1320062262834973410008	-1.386853	1.65086517	1.000
Year	2021 : 2016	0	-0.3792884141614427662148	-1.898147	1.13957053	0.982

Table 306. ANOVA summary table for large-bodied fish fillet cadmium concentrations in exposure sites for years 2000 – 2021.

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
Year	8	42.201539	5.2751924	7.989076	0.001775601
Residuals	10	6.603007	0.6603007		

Table 307. Significant differences in cadmium concentrations between year pairings from Tukey HSD on large-bodied fish fillet samples from exposure sites for years 2000 – 2021.

Higher	Lower	Adjusted p Value
2000	2012	0.004
2000	2016	0.024
2001	2012	0.028
2003	2012	0.007
2004	2012	0.016

Table 308. Tukey HSD year comparison for large-bodied fish fillet samples from exposure sites for 2000 – 2021 cadmium concentrations.

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
Year	2001 : 2000	0	-0.1580740227143917486785	-4.000750	3.68460236	1.000
Year	2002 : 2000	0	-0.6933971180807696477189	-4.536073	3.14927926	0.998
Year	2003 : 2000	0	-0.6933971180807705358973	-3.557559	2.17076475	0.985
Year	2004 : 2000	0	-0.6933971180807692036296	-3.830929	2.44413501	0.991
Year	2005 : 2000	0	-2.3028350305148697074742	-6.145511	1.53984135	0.413
Year	2012 : 2000	0	-4.1568633689477882953156	-7.021025	-1.29270150	0.004
Year	2016 : 2000	0	-3.2363606167748546482699	-6.100522	-0.37219875	0.024
Year	2021 : 2000	0	-2.8089722430525450036498	-5.673134	0.05518962	0.056
Year	2002 : 2001	0	-0.5353230953663778990403	-4.972464	3.90181739	1.000
Year	2003 : 2001	0	-0.5353230953663787872188	-4.158233	3.08758694	0.999
Year	2004 : 2001	0	-0.5353230953663774549511	-4.377999	3.30735328	1.000
Year	2005 : 2001	0	-2.1447610078004779587957	-6.581901	2.29237948	0.647
Year	2012 : 2001	0	-3.9987893462333965466371	-7.621699	-0.37587931	0.028
Year	2016 : 2001	0	-3.0782865940604628995914	-6.701197	0.54462344	0.116
Year	2021 : 2001	0	-2.6508982203381532549713	-6.273808	0.97201181	0.218
Year	2003 : 2002	0	-0.0000000000000008881784	-3.622910	3.62291003	1.000
Year	2004 : 2002	0	0.0000000000000004440892	-3.842676	3.84267638	1.000
Year	2005 : 2002	0	-1.6094379124341000597553	-6.046578	2.82770257	0.875
Year	2012 : 2002	0	-3.4634662508670186475968	-7.086376	0.15944378	0.064
Year	2016 : 2002	0	-2.5429634986940850005510	-6.165874	1.07994654	0.253
Year	2021 : 2002	0	-2.1155751249717753559310	-5.738485	1.50733491	0.441
Year	2004 : 2003	0	0.0000000000000013322676	-2.864162	2.86416187	1.000
Year	2005 : 2003	0	-1.6094379124340991715769	-5.232348	2.01347212	0.728
Year	2012 : 2003	0	-3.4634662508670177594183	-6.025251	-0.90168200	0.007
Year	2016 : 2003	0	-2.5429634986940841123726	-5.104748	0.01882075	0.052
Year	2021 : 2003	0	-2.1155751249717744677525	-4.677359	0.44620913	0.132
Year	2005 : 2004	0	-1.6094379124341005038445	-5.452114	2.23323847	0.778

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
Year	2012 : 2004	0	-3.4634662508670190916860	-6.327628	-0.59930438	0.016
Year	2016 : 2004	0	-2.5429634986940854446402	-5.407125	0.32119837	0.094
Year	2021 : 2004	0	-2.1155751249717758000202	-4.979737	0.74858674	0.210
Year	2012 : 2005	0	-1.8540283384329185878414	-5.476938	1.76888170	0.587
Year	2016 : 2005	0	-0.9335255862599849407957	-4.556436	2.68938445	0.978
Year	2021 : 2005	0	-0.5061372125376752961756	-4.129047	3.11677282	1.000
Year	2016 : 2012	0	0.9205027521729336470457	-1.641282	3.48228701	0.880
Year	2021 : 2012	0	1.3478911258952432916658	-1.213893	3.90967538	0.556
Year	2021 : 2016	0	0.4273883737223096446201	-2.134396	2.98917263	0.999

Table 309. ANOVA summary table for large-bodied fish fillet chromium concentrations in reference sites for years 2000 – 2021.

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
Year	8	133.90856	16.738569	14.61942	<0.001
Residuals	10	11.44955	1.144955		

Table 310. Significant differences in chromium concentrations between year pairings from Tukey HSD on large-bodied fish fillet samples from reference sites for years 2000 – 2021.

Higher	Lower	Adjusted p Value
2000	2012	<0.001
2000	2016	0.036
2000	2021	0.008
2001	2012	0.042
2002	2012	0.028
2003	2012	<0.001
2003	2016	0.019
2003	2021	0.004
2004	2012	<0.001
2004	2016	0.038
2004	2021	0.008
2005	2012	0.005
2005	2021	0.040

Table 311. Tukey HSD year comparison for large-bodied fish fillet samples from reference sites for 2000 – 2021 chromium concentrations.

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
Year	2001 : 2000	0	-2.033771505	-7.093848	3.0263047	0.810
Year	2002 : 2000	0	-1.677096561	-6.737173	3.3829797	0.917
Year	2003 : 2000	0	-0.035888589	-3.807447	3.7356695	1.000
Year	2004 : 2000	0	-0.029178128	-4.160713	4.1023568	1.000
Year	2005 : 2000	0	-0.067658648	-5.127735	4.9924176	1.000
Year	2012 : 2000	0	-6.944031972	-10.715590	-3.1724738	<0.001
Year	2016 : 2000	0	-3.993264874	-7.764823	-0.2217067	0.036
Year	2021 : 2000	0	-5.031888657	-8.803447	-1.2603305	0.008
Year	2002 : 2001	0	0.356674944	-5.486198	6.1995477	1.000
Year	2003 : 2001	0	1.997882916	-2.772803	6.7685685	0.778
Year	2004 : 2001	0	2.004593377	-3.055483	7.0646696	0.820
Year	2005 : 2001	0	1.966112856	-3.876760	7.8089856	0.911
Year	2012 : 2001	0	-4.910260467	-9.680946	-0.1395749	0.042
Year	2016 : 2001	0	-1.959493369	-6.730179	2.8111922	0.794

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
Year	2021 : 2001	0	-2.998117152	-7.768803	1.7725685	0.362
Year	2003 : 2002	0	1.641207972	-3.129478	6.4118936	0.901
Year	2004 : 2002	0	1.647918433	-3.412158	6.7079946	0.923
Year	2005 : 2002	0	1.609437912	-4.233435	7.4523106	0.968
Year	2012 : 2002	0	-5.266935411	-10.037621	-0.4962498	0.028
Year	2016 : 2002	0	-2.316168313	-7.086854	2.4545173	0.642
Year	2021 : 2002	0	-3.354792096	-8.125478	1.4158935	0.252
Year	2004 : 2003	0	0.006710461	-3.764848	3.7782686	1.000
Year	2005 : 2003	0	-0.031770060	-4.802456	4.7389155	1.000
Year	2012 : 2003	0	-6.908143384	-10.281528	-3.5347592	<0.001
Year	2016 : 2003	0	-3.957376285	-7.330760	-0.5839921	0.019
Year	2021 : 2003	0	-4.996000068	-8.369384	-1.6226159	0.004
Year	2005 : 2004	0	-0.038480521	-5.098557	5.0215957	1.000
Year	2012 : 2004	0	-6.914853844	-10.686412	-3.1432957	<0.001
Year	2016 : 2004	0	-3.964086746	-7.735645	-0.1925286	0.038
Year	2021 : 2004	0	-5.002710529	-8.774269	-1.2311524	0.008
Year	2012 : 2005	0	-6.876373324	-11.647059	-2.1056877	0.005
Year	2016 : 2005	0	-3.925606225	-8.696292	0.8450794	0.134
Year	2021 : 2005	0	-4.964230008	-9.734916	-0.1935444	0.040
Year	2016 : 2012	0	2.950767099	-0.422617	6.3241512	0.101
Year	2021 : 2012	0	1.912143315	-1.461241	5.2855275	0.474
Year	2021 : 2016	0	-1.038623783	-4.412008	2.3347604	0.942

Table 312. ANOVA summary table for large-bodied fish fillet chromium concentrations in exposure sites for years 2000 – 2021.

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
Year	8	148.684307	18.5855383	39.70946	<0.001
Residuals	10	4.680381	0.4680381		

Table 313. Significant differences in chromium concentrations between year pairings from Tukey HSD on large-bodied fish fillet samples from exposure sites for years 2000 – 2021.

Higher	Lower	Adjusted p Value
2000	2012	<0.001
2000	2016	0.002
2000	2021	<0.001
2001	2012	<0.001
2002	2012	<0.001
2003	2012	<0.001
2003	2016	<0.001
2003	2021	<0.001
2004	2012	<0.001
2004	2016	0.002
2004	2021	<0.001
2005	2012	<0.001
2005	2016	0.012
2005	2021	0.004
2016	2012	<0.001
2021	2012	0.004

Table 314. Tukey HSD year comparison for large-bodied fish fillet samples from exposure sites for 2000 – 2021 chromium concentrations.

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
Year	2001 : 2000	0	-2.3214973392141744490402	-5.5567152	0.9137205	0.234
Year	2002 : 2000	0	-1.7145278548952784802850	-4.9497457	1.5206900	0.548
Year	2003 : 2000	0	0.0070674697458913832149	-2.4043216	2.4184565	1.000
Year	2004 : 2000	0	-0.1050899424611773103067	-2.7466343	2.5364544	1.000
Year	2005 : 2000	0	-0.1050899424611766441728	-3.3403078	3.1301279	1.000
Year	2012 : 2000	0	-7.7229217882806278083763	-10.1343108	-5.3115328	<0.001
Year	2016 : 2000	0	-3.9383166885345821661701	-6.3497057	-1.5269277	0.002
Year	2021 : 2000	0	-4.5868638241162393853756	-6.9982529	-2.1754748	<0.001
Year	2002 : 2001	0	0.6069694843188959687552	-3.1287383	4.3426773	0.999
Year	2003 : 2001	0	2.3285648089600656795994	-0.7216279	5.3787575	0.184
Year	2004 : 2001	0	2.2164073967529969166890	-1.0188105	5.4516253	0.276
Year	2005 : 2001	0	2.2164073967529978048674	-1.5193004	5.9521152	0.423
Year	2012 : 2001	0	-5.4014244490664538034252	-8.4516171	-2.3512318	<0.001
Year	2016 : 2001	0	-1.6168193493204077171299	-4.6670120	1.4333733	0.548
Year	2021 : 2001	0	-2.2653664849020653804246	-5.3155591	0.7848262	0.205
Year	2003 : 2002	0	1.7215953246411699328888	-1.3285973	4.7717880	0.479
Year	2004 : 2002	0	1.6094379124341011699784	-1.6257800	4.8446558	0.617
Year	2005 : 2002	0	1.6094379124341018361122	-2.1262699	5.3451457	0.755
Year	2012 : 2002	0	-6.0083939333853493280913	-9.0585866	-2.9582013	<0.001
Year	2016 : 2002	0	-2.2237888336393036858851	-5.2739815	0.8264038	0.221
Year	2021 : 2002	0	-2.8723359692209613491798	-5.9225286	0.1778567	0.069
Year	2004 : 2003	0	-0.1121574122070686935215	-2.5235464	2.2992316	1.000
Year	2005 : 2003	0	-0.1121574122070680273877	-3.1623501	2.9380353	1.000
Year	2012 : 2003	0	-7.7299892580265199271139	-9.8868012	-5.5731773	<0.001
Year	2016 : 2003	0	-3.9453841582804733967293	-6.1021961	-1.7885722	<0.001
Year	2021 : 2003	0	-4.5939312938621315041132	-6.7507432	-2.4371194	<0.001
Year	2005 : 2004	0	0.0000000000000006661338	-3.2352179	3.2352179	1.000
Year	2012 : 2004	0	-7.6178318458194507201142	-10.0292209	-5.2064428	<0.001
Year	2016 : 2004	0	-3.8332267460734046338189	-6.2446158	-1.4218377	0.002
Year	2021 : 2004	0	-4.4817738816550622971135	-6.8931629	-2.0703849	<0.001
Year	2012 : 2005	0	-7.6178318458194516082926	-10.6680245	-4.5676392	<0.001
Year	2016 : 2005	0	-3.8332267460734055219973	-6.8834194	-0.7830341	0.012
Year	2021 : 2005	0	-4.4817738816550631852920	-7.5319665	-1.4315812	0.004
Year	2016 : 2012	0	3.7846050997460460862953	1.6277932	5.9414170	<0.001
Year	2021 : 2012	0	3.1360579641643884230007	0.9792460	5.2928699	0.004
Year	2021 : 2016	0	-0.6485471355816576632947	-2.8053591	1.5082648	0.949

Table 315. ANOVA summary table for large-bodied fish fillet lead concentrations in reference sites for years 2000 – 2021.

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
Year	8	62.794366	7.8492958	57.23011	<0.001
Residuals	10	1.371533	0.1371533		

Table 316. Significant differences in lead concentrations between year pairings from Tukey HSD on large-bodied fish fillet samples from reference sites for years 2000 – 2021.

Higher	Lower	Adjusted p Value
2000	2002	0.010
2000	2003	<0.001

Higher	Lower	Adjusted p Value
2000	2004	0.002
2000	2005	<0.001
2000	2012	<0.001
2000	2016	<0.001
2000	2021	<0.001
2001	2002	0.016
2001	2003	0.003
2001	2004	0.005
2001	2005	<0.001
2001	2012	<0.001
2001	2016	<0.001
2001	2021	<0.001
2002	2005	0.023
2002	2012	0.008
2002	2016	0.001
2002	2021	0.002
2003	2005	0.008
2003	2012	<0.001
2003	2016	<0.001
2003	2021	<0.001
2004	2005	0.011
2004	2012	0.002
2004	2016	<0.001
2004	2021	<0.001

Table 317. Tukey HSD year comparison for large-bodied fish fillet samples from reference sites for 2000 – 2021 lead concentrations.

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
Year	2001 : 2000	0	0.16703756	-1.584284	1.9183596	1.000
Year	2002 : 2000	0	-2.26338091	-4.014703	-0.5120589	0.010
Year	2003 : 2000	0	-2.35869109	-3.664049	-1.0533327	<0.001
Year	2004 : 2000	0	-2.32021057	-3.750159	-0.8902621	0.002
Year	2005 : 2000	0	-4.56596600	-6.317288	-2.8146440	<0.001
Year	2012 : 2000	0	-4.46142347	-5.766782	-3.1560651	<0.001
Year	2016 : 2000	0	-5.08992498	-6.395283	-3.7845666	<0.001
Year	2021 : 2000	0	-4.94487853	-6.250237	-3.6395202	<0.001
Year	2002 : 2001	0	-2.43041846	-4.452671	-0.4081660	0.016
Year	2003 : 2001	0	-2.52572864	-4.176891	-0.8745664	0.003
Year	2004 : 2001	0	-2.48724812	-4.238570	-0.7359261	0.005
Year	2005 : 2001	0	-4.73300356	-6.755256	-2.7107511	<0.001
Year	2012 : 2001	0	-4.62846102	-6.279623	-2.9772988	<0.001
Year	2016 : 2001	0	-5.25696253	-6.908125	-3.6058003	<0.001
Year	2021 : 2001	0	-5.11191609	-6.763078	-3.4607538	<0.001
Year	2003 : 2002	0	-0.09531018	-1.746472	1.5558521	1.000
Year	2004 : 2002	0	-0.05682966	-1.808152	1.6944924	1.000
Year	2005 : 2002	0	-2.30258509	-4.324838	-0.2803326	0.023
Year	2012 : 2002	0	-2.19804256	-3.849205	-0.5468803	0.008
Year	2016 : 2002	0	-2.82654407	-4.477706	-1.1753818	0.001
Year	2021 : 2002	0	-2.68149762	-4.332660	-1.0303354	0.002
Year	2004 : 2003	0	0.03848052	-1.266878	1.3438389	1.000
Year	2005 : 2003	0	-2.20727491	-3.858437	-0.5561127	0.008
Year	2012 : 2003	0	-2.10273238	-3.270280	-0.9351844	<0.001
Year	2016 : 2003	0	-2.73123389	-3.898782	-1.5636859	<0.001
Year	2021 : 2003	0	-2.58618744	-3.753735	-1.4186394	<0.001
Year	2005 : 2004	0	-2.24575543	-3.997077	-0.4944334	0.011
Year	2012 : 2004	0	-2.14121290	-3.446571	-0.8358545	0.002
Year	2016 : 2004	0	-2.76971441	-4.075073	-1.4643560	<0.001

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
Year	2021 : 2004	0	-2.62466796	-3.930026	-1.3193096	<0.001
Year	2012 : 2005	0	0.10454253	-1.546620	1.7557048	1.000
Year	2016 : 2005	0	-0.52395898	-2.175121	1.1272033	0.932
Year	2021 : 2005	0	-0.37891253	-2.030075	1.2722497	0.989
Year	2016 : 2012	0	-0.62850151	-1.796050	0.5390465	0.531
Year	2021 : 2012	0	-0.48345506	-1.651003	0.6840930	0.787
Year	2021 : 2016	0	0.14504645	-1.022502	1.3125945	1.000

Table 318. ANOVA summary table for large-bodied fish fillet lead concentrations in exposure sites for years 2000 – 2021.

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
Year	8	32.187497	4.0234372	9.052829	0.001070427
Residuals	10	4.444398	0.4444398		

Table 319. Significant differences in lead concentrations between year pairings from Tukey HSD on large-bodied fish fillet samples from exposure sites for years 2000 – 2021

Higher	Lower	Adjusted p Value
2000	2005	0.004
2000	2012	0.009
2000	2016	0.001
2000	2021	0.008
2001	2005	0.015
2001	2016	0.009
2001	2021	0.047

Table 320. Tukey HSD year comparison for large-bodied fish fillet samples from exposure sites for 2000 – 2021 lead concentrations.

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
Year	2001 : 2000	0	-0.15807402	-3.310678	2.99452986	1.000
Year	2002 : 2000	0	-2.30283503	-5.455439	0.84976885	0.219
Year	2003 : 2000	0	-2.30283503	-4.652647	0.04697716	0.056
Year	2004 : 2000	0	-2.26435451	-4.838445	0.30973578	0.098
Year	2005 : 2000	0	-4.60542012	-7.758024	-1.45281624	0.004
Year	2012 : 2000	0	-3.06597113	-5.415783	-0.71615893	0.009
Year	2016 : 2000	0	-4.07418074	-6.423993	-1.72436855	0.001
Year	2021 : 2000	0	-3.15774174	-5.507554	-0.80792955	0.008
Year	2002 : 2001	0	-2.14476101	-5.785074	1.49555239	0.431
Year	2003 : 2001	0	-2.14476101	-5.117064	0.82754243	0.229
Year	2004 : 2001	0	-2.10628049	-5.258884	1.04632339	0.300
Year	2005 : 2001	0	-4.44734610	-8.087659	-0.80703270	0.015
Year	2012 : 2001	0	-2.90789710	-5.880201	0.06440634	0.056
Year	2016 : 2001	0	-3.91610672	-6.888410	-0.94380328	0.009
Year	2021 : 2001	0	-2.99966772	-5.971971	-0.02736428	0.047
Year	2003 : 2002	0	0.00000000	-2.972303	2.97230344	1.000
Year	2004 : 2002	0	0.03848052	-3.114123	3.19108440	1.000
Year	2005 : 2002	0	-2.30258509	-5.942898	1.33772830	0.355

Term	contrast	null.value	Estimate	Conf (low)	Conf (high)	Adjusted p Value
Year	2012 : 2002	0	-0.76313610	-3.735440	2.20916734	0.978
Year	2016 : 2002	0	-1.77134571	-4.743649	1.20095773	0.419
Year	2021 : 2002	0	-0.85490671	-3.827210	2.11739673	0.959
Year	2004 : 2003	0	0.03848052	-2.311332	2.38829271	1.000
Year	2005 : 2003	0	-2.30258509	-5.274889	0.66971835	0.174
Year	2012 : 2003	0	-0.76313610	-2.864872	1.33859982	0.874
Year	2016 : 2003	0	-1.77134571	-3.873082	0.33039021	0.120
Year	2021 : 2003	0	-0.85490671	-2.956643	1.24682921	0.801
Year	2005 : 2004	0	-2.34106561	-5.493669	0.81153827	0.206
Year	2012 : 2004	0	-0.80161662	-3.151429	1.54819558	0.905
Year	2016 : 2004	0	-1.80982623	-4.159638	0.53998596	0.178
Year	2021 : 2004	0	-0.89338723	-3.243199	1.45642496	0.847
Year	2012 : 2005	0	1.53944900	-1.432854	4.51175244	0.574
Year	2016 : 2005	0	0.53123938	-2.441064	3.50354282	0.998
Year	2021 : 2005	0	1.44767838	-1.524625	4.41998182	0.639
Year	2016 : 2012	0	-1.00820961	-3.109946	1.09352631	0.654
Year	2021 : 2012	0	-0.09177062	-2.193507	2.00996530	1.000
Year	2021 : 2016	0	0.91643900	-1.185297	3.01817492	0.745

Table 321. ANOVA summary table for large-bodied fish fillet mercury concentrations in reference sites for years 2000 – 2021.

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
Year	8	5.672036	0.7090045	0.8684109	0.5709284
Residuals	10	8.164389	0.8164389		

Table 322. ANOVA summary table for large-bodied fish fillet mercury concentrations in exposure sites for years 2000 – 2021.

Term	Df	Sum of Squares	Mean of Squares	Statistic	p Value
Year	8	6.990118	0.8737647	0.9593462	0.5139285
Residuals	10	9.107919	0.9107919		