Methylmercury Monitoring Plan 2022 Annual Report Appendices C-F

Site C Clean Energy Project

18 July 2024

APPENDIX C: CHARACTERIZATION OF LENGTH-MERCURY RELATIONSHIPS IN FISH

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C.1 INTRODUCTION

As described in the main report (**Section 4**), characterizing length-mercury relationships are critical to understand mercury concentrations in fish by facilitating comparisons over time or space. This approach enables the estimation of mercury concentrations for specific "standardized" sizes[1] for each species/location/year combination, which provides a more intuitive means of tracking changes across space and time.

Rather than fish weight, which can vary depending on when a fish last ate, length is typically used instead as it can be accurately measured and is inherently less variable. Once developed, the length-mercury relationships can be used to estimate tissue mercury concentrations for several standardized sizes for each species/location/year combination. Comparing mercury concentrations at standardized sizes of each species are informative of the difference and/or change in fish mercury concentrations (across space and time).

This appendix provides details regarding:

- *Coarse outlier screening* (**Section C.1.1**) – this process screens for data outliers for three key relationships: length vs weight, nitrogen stable isotopes vs tissue mercury, and length vs tissue mercury.
- *Modelling length-mercury relationships* (**Section C.1.2**) – this section provides an overview of the model-fitting process used to estimate tissue mercury concentrations for specific fish sizes for various species/location/period combinations.
- *Results for targeted MMP species* (**Sections C.2 to C.7**) – these sections provide detailed results for each target species.
- *Results for non-target species* (**Section C.8**) – this section presents available mercury-related results for non-targeted species.

[1] Historically, fish mercury concentrations were compared among sampled populations or sampling events using species-specific means (or averages). The major limitation of that approach was potential bias in the calculated mean when the sizes of fish caught differed across locations and/or years. Once this was realized, fish mercury researchers avoided this potential bias by using the size- or age-mercury relationships to estimate mercury concentrations for a specific sized fish (i.e., the “standardized” size). Where supported by the data, we now use several standardized sizes to provide a more complete understanding of fish mercury concentrations.

C.1.1 Coarse Outlier Screening

After completing the data quality assessment for the new data (i.e., 2021 and 2022; see **Appendix A** for details), the dataset was put through a coarse outlier identification process. Specifically, outliers were identified using three key relationships: length vs weight, nitrogen stable isotope ratios vs mercury concentrations, and length vs mercury concentrations.

Two types of outliers were identified and screened out in this process: 'High Residual' points (studentized residuals ≥ 4) and 'High Leverage' points (Cook's distance ≥ 0.5). This process resulted in exclusion of 20 unique fish samples from further analysis (**Table C1-1**); note that some fish identified more than once. The number of fish available across sampling Sections and years in Peace River (after removal of the coarse outliers) are provided in **Table** C1-2 and **Table C1-3**, respectively. Tissue mercury concentrations varied substantially among species (**Figure C1-1**), with the highest in Walleye (sampled downstream only), followed by Bull Trout and non-target species Goldeye, Burbot, and Northern Pike.

C.1.2 Modelling Length-Mercury Relationships

As described in **Section 4 of the Main Report**, the MMP study design has three key elements:

- *Targeted Species* – Bull Trout, Longnose Sucker, Mountain Whitefish, Rainbow Trout, Walleye, and Redside Shiner
- *Sampling Periods* – fish sampling periods occurred in years 2008, 2010, 2011, 2017, 2018, 2019, 2020, 2021, and 2022. All these years represent pre-flood conditions in the Peace River; reservoir filling is currently scheduled for fall 2024.
- *Sampling Locations* – MMP fish sampling locations include Sections 1/3, 5, 7, 9 of the Peace River.

As described in detail in the MMP (BC Hydro 2022), fish mercury concentrations within the Site C reservoir are expected to increase by an average of three to four times higher than baseline concentrations within 5 to 8 years after its creation before gradually declining to levels similar to natural lakes and rivers in the region. Downstream, potentially as far as Many Islands in Alberta, fish mercury concentrations were predicted to initially double, on average, before returning to a new baseline level. Consequently, modelling efforts are conducted by species and account for potential differences in the length-mercury relationships over both space and time.

A selection of four linear models was used to fit length-mercury relationships (**Table C1-4**). In each model, the response variable was total mercury (THg) in muscle tissue (in mg/kg wet weight). Note that in fish most of the mercury included in THg is generally assumed to be methylmercury (MeHg). Fish size (fork length in mm) was the continuous covariate, which was centered to species-specific standard sizes (and is referred to as "LC" in the models), thereby allowing direct interpretation of the regression coefficients of the models.

The model series varied in complexity, from a simple model that assumed similar intercepts and slopes across locations and period, to models that allowed for intercepts and slopes to vary by location or time. The best fitting model was then selected and used to estimate concentrations of mercury at several body sizes (i.e., small, medium, and large) for different locations and periods. Estimated mercury concentrations were finally compared to highlight differences across locations and periods. The following steps provide more details about the statistical analyses:

- **Transformations** – Length-mercury relationships were first plotted by species using all data and a combination of transformations (Y axis, X axis, and/or both) to determine the most suitable transformation for linear modeling.
- **Model fitting** – Models of length-mercury relationships incorporated various levels of complexity. The first model (Fit 1: THg ~ LC) was the simplest and assumed similar intercepts and similar slopes. The second model (Fit 2: THg ~ LC + Location + Periods) considered location- and period-specific intercepts but similar slopes. The third model (Fit 3: THg ~ LC * Location + Period) considered period-specific intercepts and location-specific slopes. The fourth model (Fit 3: THg ~ LC * Period + Location) considered location-specific intercepts and period-specific slopes.
- **Model selection** – Models of length-mercury relationships were compared using Akaike's Information Criterion corrected for small sample sizes (AICc; Burnham and Anderson 2002). The model with the lowest AICc value was selected as the best (i.e., most plausible) model, provided that collinearity among explanatory variables was not problematic (i.e., variation inflation factor < 10) and visual inspection indicated assumptions of linear modeling were not violated (i.e., normal distribution of residuals and homogeneity of variance). In case of problematic collinearity and violation of modeling assumptions, the next best model(s) was considered and investigated to ensure that collinearity and modeling assumption were satisfactorily meet.
- **Outlier Identification** – The best model was used to formally identify outlier(s) according to studentized residuals (if ≥ 4) and Cook's distance (if ≥ 0.5). If present, the outlier(s) was removed from the data and model fitting and selection steps were repeated to reflect any potential changes in the AICc ranking and the model output (e.g., parameter estimation). If no outlier(s) was identified, the analysis proceed to the next step.
- **Mercury estimates** – The best model was eventually used to provide estimates (± 95% confidence intervals) of mercury concentrations at multiple species-specific body sizes. Mercury concentrations were estimated at small, medium, and large body sizes in all

levels of location (Peace River Sections) and period (sampling events/years) where possible, which were then visualized to facilitate spatial and temporal comparisons and to potentially inform health guidelines regarding subsistence consumption of fish in the area.

Table C1-1. Fish samples identified as outlier during coarse investigation.

Coarse Oultiers							
Zone	**Section**	**Fish ID**	**Species**	**Date**	**StudRes**[1]	**CooksD**[1]	**Type**[2]
mercury-size relationships							
Site C	Section 1	581	Rainbow Trout	2018-09-08	6.910	0.287	High Residual
Site C	Section 3	140	Rainbow Trout	2017-09-01	4.834	0.167	High Residual
Site C	Section 3	1082	Lake Trout	2010-08-25	4.648	0.593	Both
Downstream	Section 5	2233	Longnose Sucker	2021-10-13	4.419	0.041	High Residual
Downstream	Section 5	1771	Bull Trout	2022-08-28	4.234	0.027	High Residual
Downstream	Section 5	2214	Bull Trout	2021-07-20	10.002	0.780	Both
Downstream	Section 5	530	Northern Pike	2018-09-05	4.004	0.080	High Residual
Downstream	Section 5	1698	Redside Shiner	2022-08-30	4.386	0.294	High Residual
Downstream	Section 6	365	Northern Pike	2017-10-04	6.356	0.177	High Residual
Downstream	Section 6	571	Walleye	2018-09-06	4.106	0.042	High Residual
Downstream	Section 7	1953	Redside Shiner	2022-09-03	6.524	0.249	High Residual
Downstream	Section 7	2328	Largescale Sucker	2021-08-30	2.823	2.765	High Leverage
Downstream	Section 9	2165	Walleye	2022-09-01	4.554	0.044	High Residual
length-weight relationships							
Downstream	Section 5	2238	Bull Trout	2021-09-14	13.142	0.181	High Residual
Downstream	Section 5	1436	Redside Shiner	2020-09-28	4.788	0.308	High Residual
Downstream	Section 5	2326	Lake Trout	2021-10-13	0.896	0.785	High Leverage
Downstream	Section 6	1371	Northern Pike	2020-09-29	6.426	0.582	Both
Downstream	Section 7	1847	Arctic Grayling	2022-09-03	3.393	1.050	High Leverage
mercury-nitrogen relationships							
Downstream	Section 7	2328	Largescale Sucker	2021-08-30	0.830	0.643	High Leverage
Downstream	Section 9	217	Burbot	2017-09-26	2.496	0.828	High Leverage
Site C	Section 1	581	Rainbow Trout	2018-09-08	5.732	0.257	High Residual
Site C	Section 3	1082	Lake Trout	2010-08-25	2.876	0.756	High Leverage
Downstream	Section 5	2233	Longnose Sucker	2021-10-13	4.026	0.019	High Residual
Downstream	Section 5	530	Northern Pike	2018-09-05	4.427	0.235	High Residual
Downstream	Section 5	1771	Bull Trout	2022-08-28	5.971	0.349	High Residual
Downstream	Section 5	1712	Arctic Grayling	2022-09-30	2.407	0.856	High Leverage
Downstream	Section 5	1698	Redside Shiner	2022-08-30	3.125	0.534	High Leverage
Downstream	Section 7	1953	Redside Shiner	2022-09-03	7.645	1.391	Both

[1] StudRes = studentized residual; CooksD = Cook's distance

[2] Type: 'High Residual' = studentized residual ≥ 4, 'High Leverage' = Cook's distance ≥ 0.5, 'Both' = exceed both criteria.

Table C1-2. Counts of fish species across sampling locations in Peace River.

	Target Species*						Non-target Species†							
Section	**BT**	**LSU**	**MW**	**RB**	**RSC**	**WP**	**BB**	**CSU**	**GE**	**GR**	**LT**	**NP**	**WSU**	**Total**
Zone: Site C														
Sections 1/3	149	139	219	95	36	-	1	11	-	4	4	6	7	**671**
Zone: Downstream														
Section 5	149	100	120	5	50	65	4	5	-	2	1	33	5	**539**
Section 7	21	96	87	1	34	86	5	5	4	1	1	17	7	**365**
Section 9	-	120	106	-	36	81	12	4	26	-	-	6	7	**398**
Total	**319**	**455**	**532**	**101**	**156**	**232**	**22**	**25**	**30**	**7**	**6**	**62**	**26**	**1973**

* MMP Target Species include: BT (Bull Trout), LSU (Longnose Sucker), MW (Mountain Whitefish), RB (Rainbow Trout), RSC (Redside Shiner), and WP (Walleye).
† MMP Non-arget Species include: BB (Burbot), CSU (Largescale Sucker), GE (Goldeye), GR (Arctic Grayling), LT (Lake Trout), NP (Northern Pike), and WSU (White Sucker).

Table C1-3. Counts of fish species across sampling years in Peace River.

	Target Species*						Non-target Species†							
Year	**BT**	**LSU**	**MW**	**RB**	**RSC**	**WP**	**BB**	**CSU**	**GE**	**GR**	**LT**	**NP**	**WSU**	**Total**
Period: 2008-2011														
2008	28	-	67	-	-	-	-	-	-	-	-	-	-	**95**
2010	15	10	17	-	11	-	-	-	-	-	-	-	-	**53**
2011	6	31	32	10	-	6	-	-	3	-	-	-	-	**88**
Sub-total	49	41	116	10	11	6	-	-	3	-	-	-	-	**236**
Period: 2017-2021														
2017	53	91	74	25	1	51	2	-	3	1	-	7	-	**308**
2018	57	93	87	22	-	42	5	-	-	-	1	18	-	**325**
2019	13	16	54	-	-	9	12	-	14	3	2	9	-	**132**
2020	4	25	41	12	-	21	2	-	4	-	1	10	-	**120**
2021	73	25	31	9	-	15	1	25	5	-	2	18	26	**230**
Sub-total	200	250	287	68	1	138	22	25	26	4	6	62	26	**1115**
Period: 2022														
2022	70	164	129	23	144	88	-	-	1	3	-	-	-	**622**
Total	**319**	**455**	**532**	**101**	**156**	**232**	**22**	**25**	**30**	**7**	**6**	**62**	**26**	**1973**

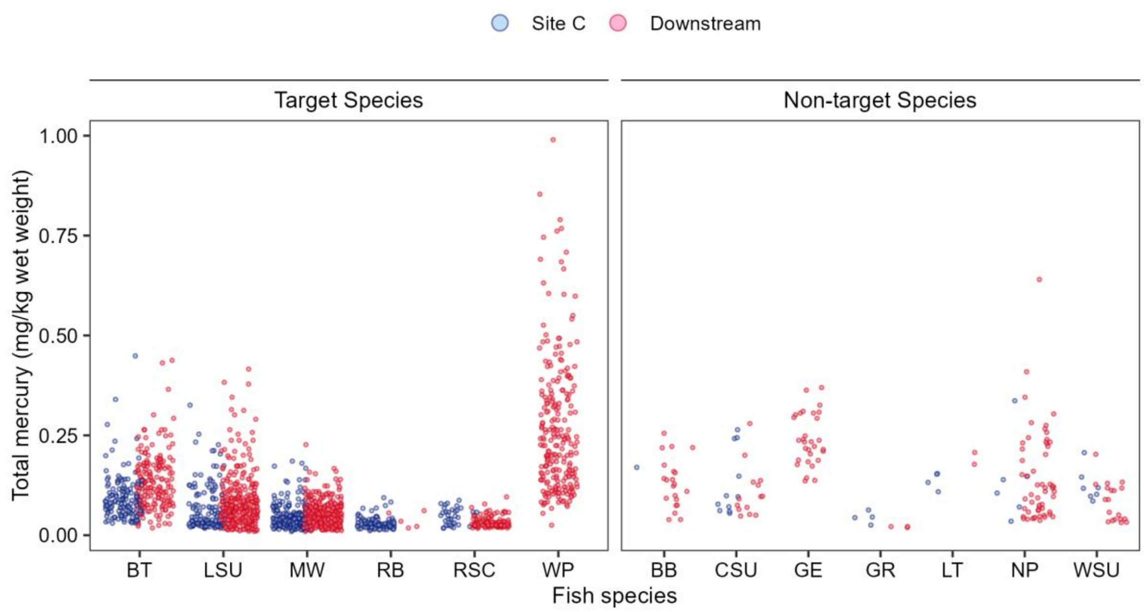
* MMP Target Species include: BT (Bull Trout), LSU (Longnose Sucker), MW (Mountain Whitefish), RB (Rainbow Trout), RSC (Redside Shiner), and WP (Walleye).
† MMP Non-arget Species include: BB (Burbot), CSU (Largescale Sucker), GE (Goldeye), GR (Arctic Grayling), LT (Lake Trout), NP (Northern Pike), and WSU (White Sucker).

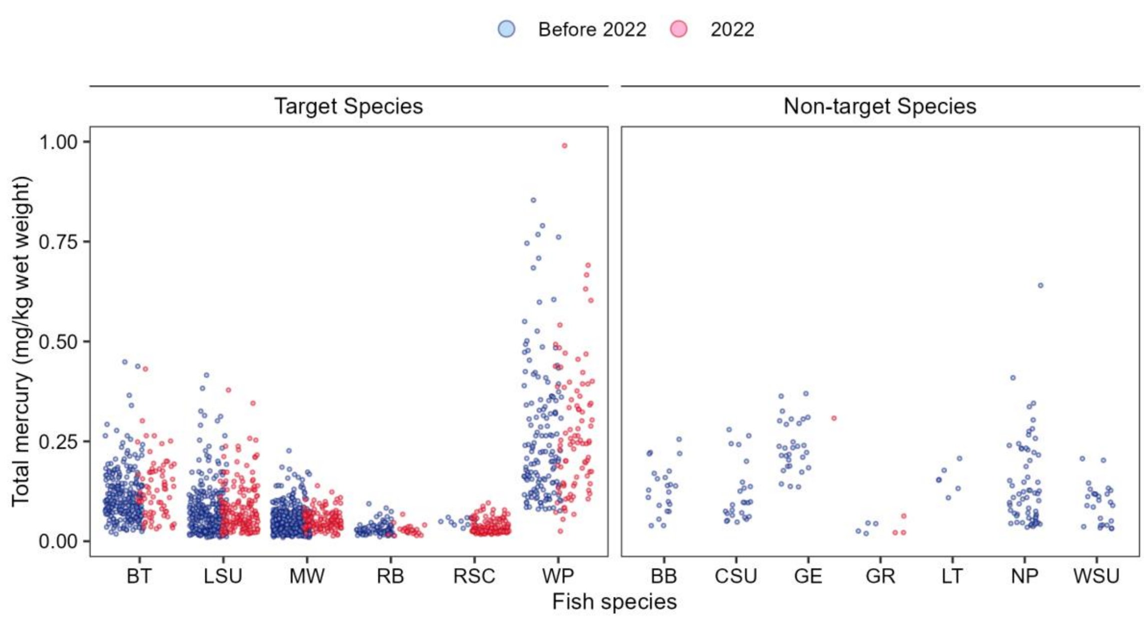
Table C1-4. Models used to characterize relationships between fish size and tissue mercury concentrations.

Model	Structure[1]	Note
Fit 1	THg ~ LC	Similar intercepts and similar slopes
Fit 2	THg ~ LC + Location + Period	Location:Period-specific intercepts and similar slopes
Fit 3	THg ~ LC * Location + Period	Period-specific intercepts and Location-specific slopes
Fit 4	THg ~ LC * Period + Location	Location-specific intercepts and Period-specific slopes

[1] LC in model structure is fish length centered to species-specific standard sizes.

Figure C1-1. Comparison of Peace River fish mercury concentrations (2008 – 2022) between river zone (Site C [Sections 1/3] vs downstream [Sections 5/7/9]; upper panels) and sampling periods (2022 vs earlier; lower panels.





C.2 BULL TROUT

Length-mercury relationships were modelled to characterize mercury concentrations in Bull Trout and determine possible changes across location and period. Key notes on the methods and results are provided below.

C.2.1 Data Overview

The coarse investigation identified three unique samples as outliers (listed in **Table C1-1**), which were removed from the data prior to formal analysis. Consistent with the MMP (BC Hydro 2022), locations were limited to Sections 1/3 and 5. All three time periods were included. The Bull Trout dataset is summarized in **Table C2-1** (sample numbers by location/period) and **Table C2-2** (sample numbers per size class by location/period). Key mercury-related data are shown in **Figure C2-1** and tabulated in **Table C2-3**. The length-mercury relationship is shown by location and time period in **Figure C2-2**.

C.2.2 Model fitting and Selection

Modeling was performed using log_{10}-transformed data of both mercury concentrations and fish length (centered to standard size of 550 mm fork length) according to transformation plots (**Figure C2-3**). There were only four Bull Trout samples available from Section 5 for the 2008-2011 period, which were excluded prior modeling length-mercury relationships (**Figure C2-2**). AICc ranked Fit 3 (THg ~ LC * Location + Period) as the best model, indicating that the slope of the length-mercury relationships was influenced by location (**Table C2-4**). Formal assessment of residuals from Fit 3 identified two more outliers (**Table C2-5**); removing these changed the AICc values slightly (not shown) but did not affect model ranking (see **Table C2-4**). Detailed results for the final model (Fit 3) are shown in **Table C2-6** (ANOVA table), **Table** C2-7 (coefficient estimates, confidence intervals and p-values) and **Figure C2-4** (model diagnostics). As expected, the model fits generally show strong positive relationships between length and mercury concentrations. Visual inspection of model diagnostics showed no issues with residuals or collinearity. The final model had an R^2 of 0.58, indicating that it explains much of the variability in the underlying data.

C.2.3 Estimates of Mercury Concentrations

Final model fits are shown relative to the underlying data in **Figure C2-5**. This model was used to estimate mercury concentrations and ±95% confidence intervals for three sizes (400, 550, and 700 mm) of Bull Trout at all location-period combinations supported by existing data (**Figure** C2-6).

Table C2-1. Bull Trout sample numbers by location and period.

Bull Trout – Sample Summary			
Period	Sections 1/3	Section 5	Total
2008-2011	43	4	**47**
2017-2021	77	105	**182**
2022	29	40	**69**
Total	**149**	**149**	**298**

Table C2-2. Bull Trout sample numbers by size class, location and period.

Bull Trout – Size Classes (fork length in mm)									
Location/Period	200-300	300-400	400-500	500-600	600-700	700-800	800-900	900-1000	Total
Sections 1/3									
2008-2011	3	13	9	7	6	4	1	-	**43**
2017-2021	14	25	25	8	2	1	2	-	**77**
2022	7	13	7	1	1	-	-	-	**29**
Section 5									
2008-2011	2	1	-	1	-	-	-	-	**4**
2017-2021	11	7	19	14	29	13	11	1	**105**
2022	5	3	10	9	5	8	-	-	**40**

Table C2-3. Summary of key mercury-related metrics for Bull Trout by location and period.

Bull Trout – Data Summary*					
Location/Period	Fork Length (mm)	Total Weight (g)	Total Hg (mg/kg ww)	Carbon SI Ratios (‰)	Nitrogen SI Ratios (‰)
Sections 1/3					
2008-2011	43, 488±149, 248–806	19, 1635±1941, 308–7160	43, 0.078±0.048, 0.031–0.34	19, -28.7±0.8, -30.3–-27.4	19, 10.2±0.5, 9–11
2017-2021	77, 413±127, 222–860	75, 828±781, 110–4195	77, 0.11±0.063, 0.03–0.45	47, -29.1±1.4, -33.2–-27	47, 10.7±0.8, 8.7–12.3
2022	29, 370±92, 273–656	29, 618±589, 190–2928	29, 0.086±0.043, 0.031–0.19	29, -29.4±0.9, -31.5–-28	29, 10.2±0.9, 8.1–11.7
Section 5					
2008-2011	4, 336±153, 211–544	NA	4, 0.073±0.054, 0.018–0.12	NA	NA
2017-2021	105, 578±178, 223–960	105, 2807±2252, 105–10064	105, 0.14±0.062, 0.023–0.37	92, -29.8±2, -34.9–-26.6	90, 11±0.6, 8.9–11.9
2022	40, 535±157, 252–790	40, 2071±1570, 146–5330	40, 0.17±0.075, 0.043–0.43	40, -29.7±1.6, -33.1–-25.3	40, 10.9±0.9, 9.1–12.4

* Statistics given include count, mean ± standard deviation, and minimum-maximum, respectively (if count > 1).

Table C2-4. Comparison of model fits for Bull Trout.

Bull Trout – Model Comparison				
Model	**Structure**[1]	**Note**	**AICc**	**Delta**
Fit 3	THg ~ LC * Location + Period	Period-specific intercepts and Location-specific slopes	-212.4	0.0
Fit 2	THg ~ LC + Location + Period	Location:Period-specific intercepts and similar slopes	-205.3	7.1
Fit 4	THg ~ LC * Period + Location	Location-specific intercepts and Period-specific slopes	-202.0	10.4
Fit 1	THg ~ LC	Similar intercepts and slopes	-161.3	51.1

[1] LC is fish length centered to standard size (i.e., 550 mm fork length).
Fish THg concentrations and centered lengths were $\log_{10}$ transformed.

Table C2-5. Outliers identified for Bull Trout based on the final model.

Bull Trout – Outliers						
Location	**Date**	**Fish ID**	**Species**	**StudRes**[1]	**CooksD**[1]	**Type**[2]
Section 5	2021-07-20	2216	Bull Trout	4.430	0.034	High Residual
Section 5	2022-08-29	1682	Bull Trout	4.135	0.078	High Residual

[1] StudRes = studentized residual; CooksD = Cook's distance

[2] Type: 'High Residual' = studentized residual ≥ 4, 'High Leverage' = Cook's distance ≥ 0.5, 'Both' = exceed both criteria.

Table C2-6. Final model ANOVA results for Bull Trout.

Bull Trout – ANOVA					
Predictor[1]	**df**	**Sum sq**	**Mean sq**	**F**	**P**
LC	1	8.19	8.19	335	<0.001
Location	1	0.371	0.371	15.2	<0.001
Period	2	1.08	0.540	22.1	<0.001
LC * Location	1	0.183	0.183	7.47	0.007
Residuals	286	7.00	0.024	-	-

[1] LC is fish length centered to standard size (i.e., 550 mm fork length). Fish THg concentrations and centered lengths were $\log_{10}$ transformed.

Fit 3: THg ~ LC * Location + Period (r^2 = 0.584)

Table C2-7. Final model summary results for Bull Trout.

Bull Trout – Model Summary			
Variable[1]	**Estimate**	**95% CI**[2]	**p-value**
Intercept	-1.059	-1.108, -1.010	<0.001
LC	1.324	1.116, 1.531	<0.001
Location			
Sections 1/3	—	—	
Section 5	-0.0223	-0.0730, 0.0285	0.4
Period			
2008-2011	—	—	
2017-2021	0.1907	0.1316, 0.2498	<0.001
2022	0.2342	0.1672, 0.3013	<0.001
LC * Location			
LC * Section 5	-0.3745	-0.6442, -0.1049	0.007

[1] LC is fish length centered to standard size (i.e., 550 mm fork length). Fish THg concentrations and centered lengths were $\log_{10}$ transformed.

Fit 3: THg ~ LC * Location + Period (r^2 = 0.584)

[2] CI = Confidence Interval

Figure C2-1. Key mercury-related data for Bull Trout.

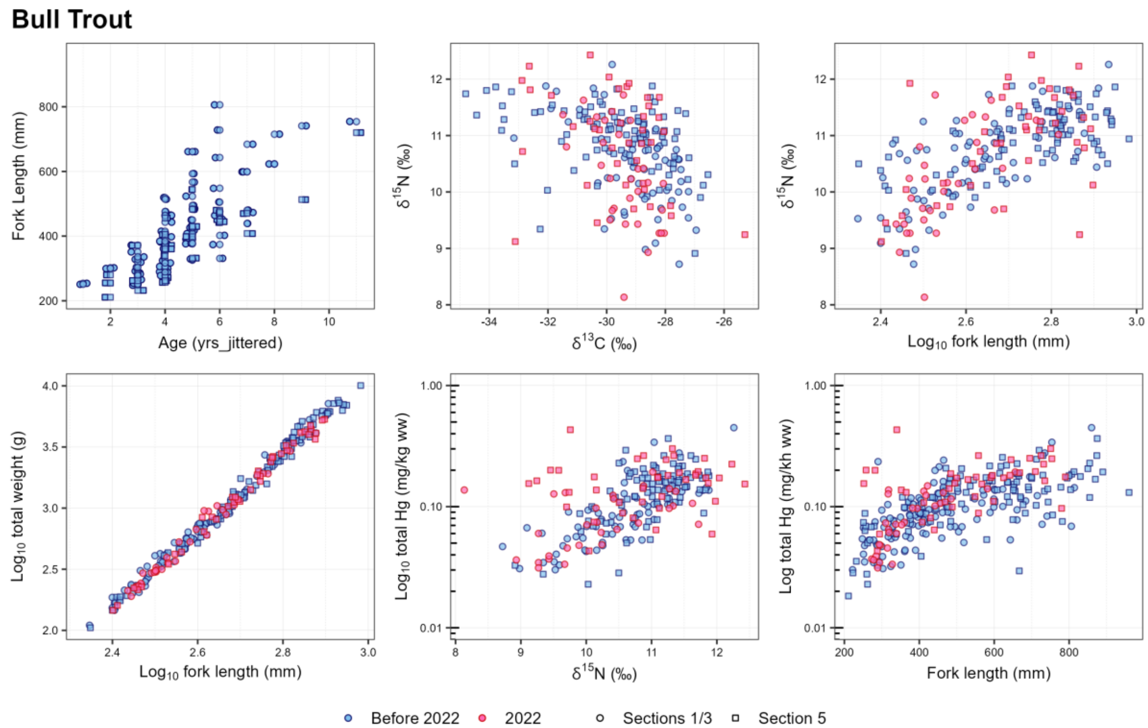


Figure C2-2. Length-mercury plots by location and period for Bull Trout.

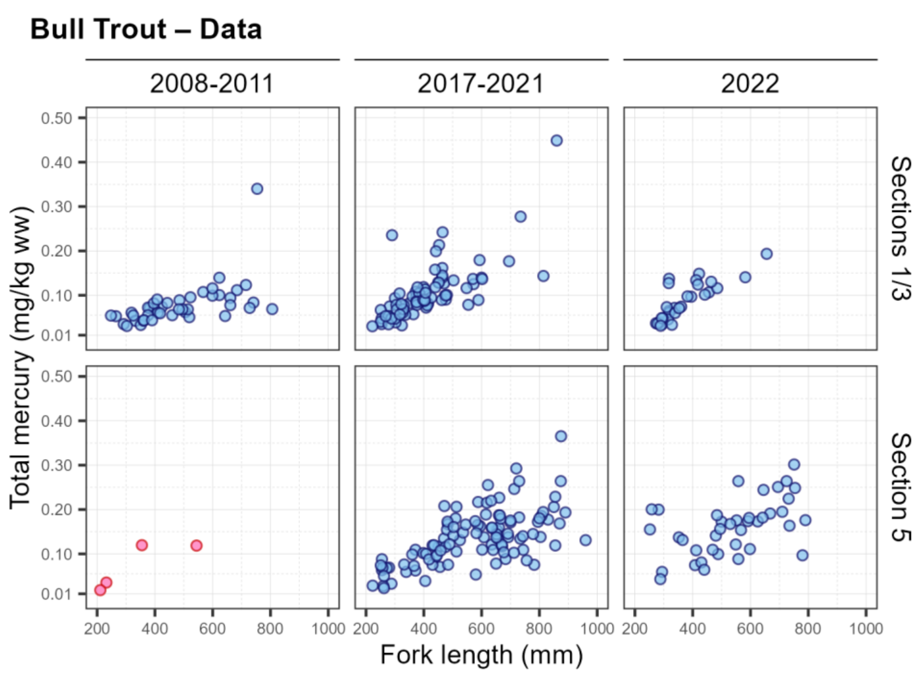


Figure C2-3. Length-mercury plots for Bull Trout showing transformation options.

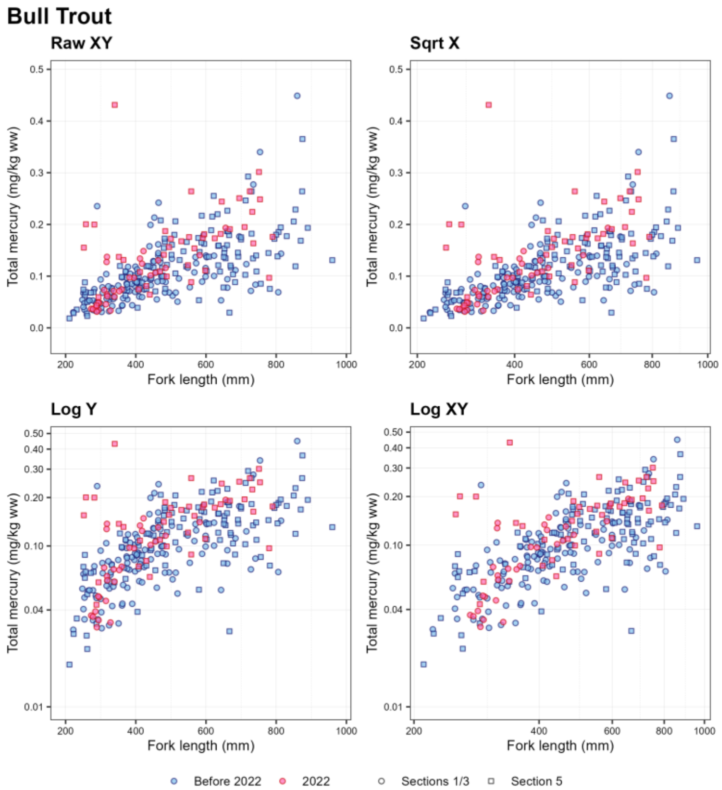


Figure C2-4. Diagnostics of final model for Bull Trout.

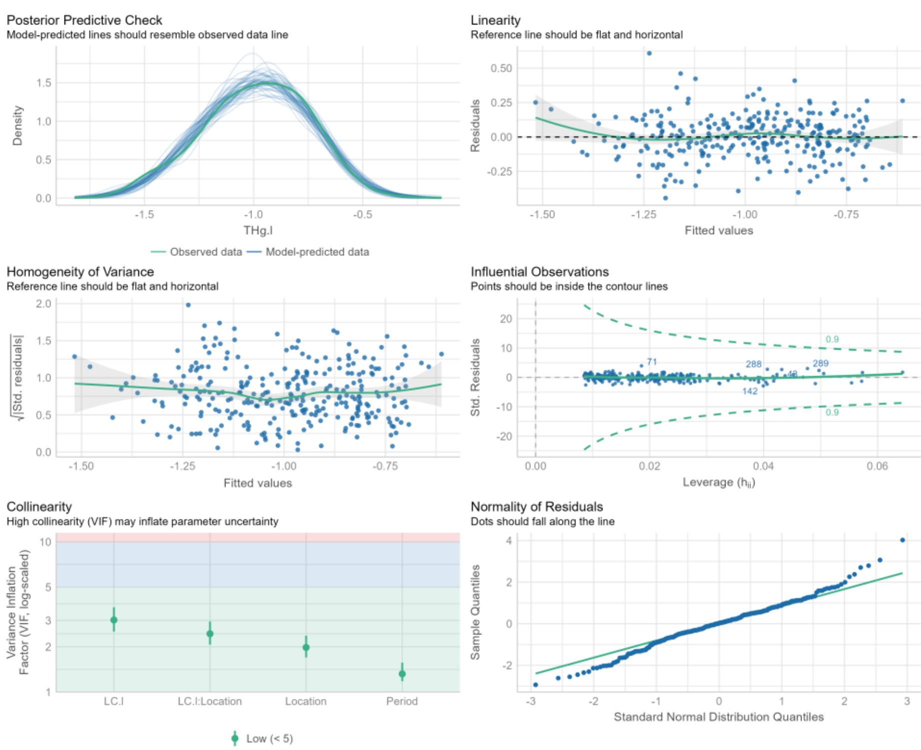


Figure C2-5. Length-mercury plots showing final model fits (and ±95% confidence intervals) for Bull Trout.

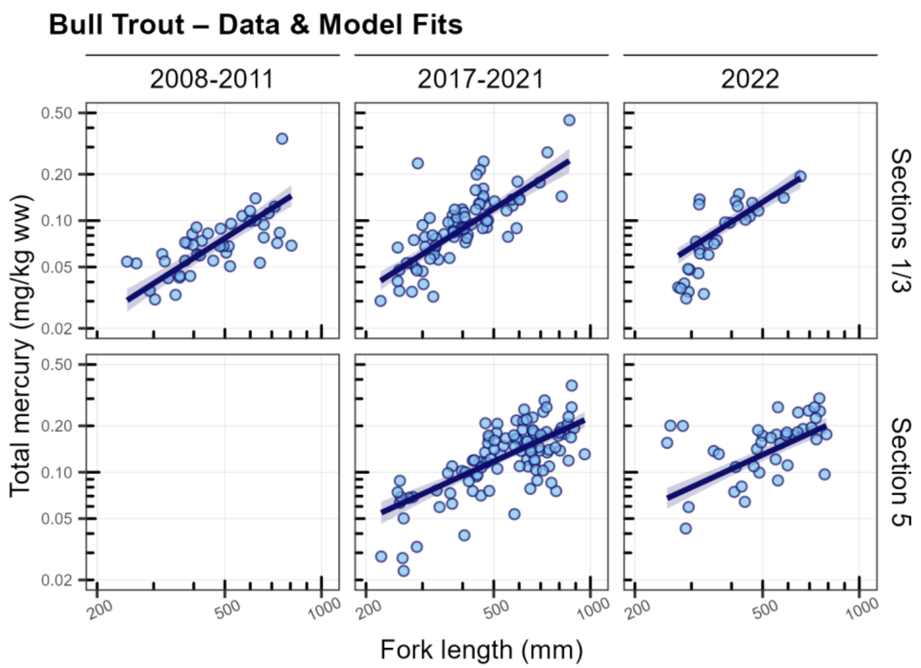
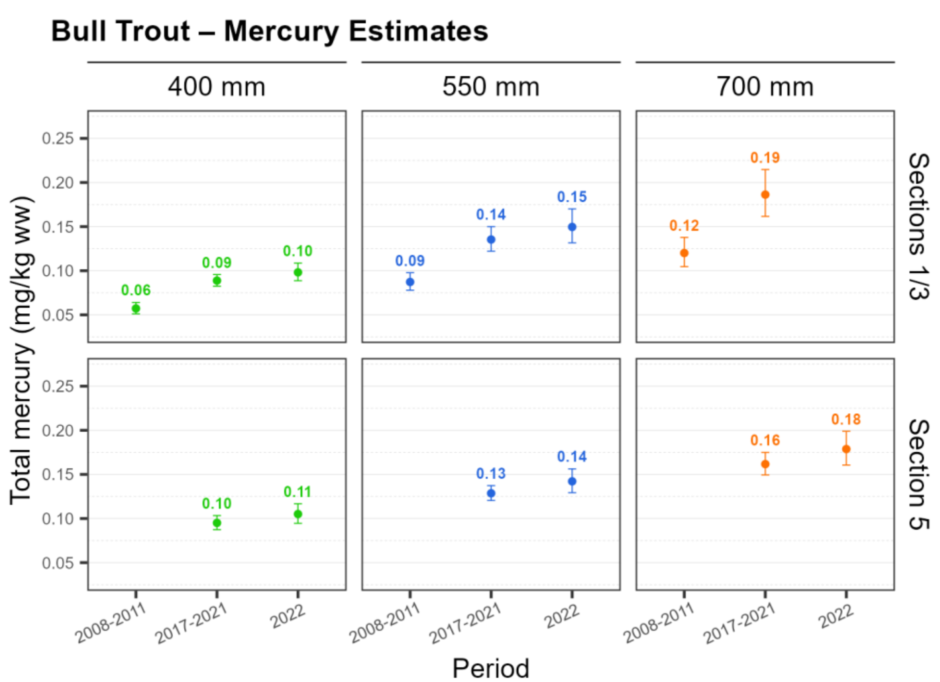


Figure C2-6. Estimates of mercury concentrations (±95% confidence intervals) in select sizes of Bull Trout using the best model.



C.3 MOUNTAIN WHITEFISH

Length-mercury relationships were modelled to characterize mercury concentrations in Mountain Whitefish and determine possible changes across location and period. Key notes on the methods and results are provided below.

C.3.1 Data Overview

The coarse investigation identified three unique samples as outliers (listed in **Table C1-1**), which were removed from the data prior to formal analysis. Consistent with the MMP (BC Hydro 2022), locations were limited to Sections 1/3, 5, 7, and 9. All three time periods were included. The Mountain Whitefish dataset is summarized in **Table C3-1** (sample numbers by location/period) and **Table C3-2** (sample numbers per size class by location/period). Key mercury-related data are shown in **Figure C3-1** and tabulated in **Table C3-3**. The length-mercury relationship is shown by location and time period in **Figure C3-2**.

C.3.2 Model fitting and Selection

Modeling was performed using log_{10}-transformed data of mercury concentrations and raw data of fish length (centered to standard size of 350 mm fork length) according to transformation plots (**Figure C3-3**). AICc ranked Fit 4 (THg ~ LC * Period + Location) as the best model, indicating that the slope of the length-mercury relationships was influenced by time (**Table C3-4**). Formal assessment of residuals from Fit 3 identified one more outlier (**Table C3-5**); Removing the outlier changed AICc values (not shown) but did not affect model ranking (see **Table C3-4**). Detailed results for the final model (Fit 4) are shown in **Table C3-6** (ANOVA table), **Table C3-7** (coefficient estimates, confidence intervals and p-values) and **Figure C3-4** (model diagnostics). As expected, the model fits generally show strong positive relationships between length and mercury concentrations. Visual inspection of model diagnostics showed no issues with residuals or collinearity. The final model had an R^2 of 0.67, indicating that it explains much of the variability in the underlying data.

C.3.3 Estimates of Mercury Concentrations

Final model fits are shown relative to the underlying data in **Figure C3-5**. This model was used to estimate mercury concentrations and ±95% confidence intervals for three sizes (275, 350, and 425 mm) of Mountain Whitefish at all location-period combinations supported by existing data (**Figure C3-6**).

Table C3-1. Mountain Whitefish sample numbers by location and period.

Mountain Whitefish – Sample Summary					
Period	Sections 1/3	Section 5	Section 7	Section 9	Total
2008-2011	72	34	10	-	**116**
2017-2021	111	57	40	79	**287**
2022	36	29	37	27	**129**
Total	**219**	**120**	**87**	**106**	**532**

Table C3-2. Mountain Whitefish sample numbers by size class, location and period.

Mountain Whitefish – Size Classes (fork length in mm)							
Location/Period	0-100	100-200	200-300	300-400	400-500	500-600	Total
Sections 1/3							
2008-2011	-	-	19	33	20	-	**72**
2017-2021	-	5	36	48	21	1	**111**
2022	-	-	9	16	11	-	**36**
Section 5							
2008-2011	-	-	10	10	13	1	**34**
2017-2021	3	1	15	24	14	-	**57**
2022	-	1	9	11	8	-	**29**
Section 7							
2008-2011	-	-	4	6	-	-	**10**
2017-2021	1	-	14	16	9	-	**40**
2022	-	-	8	21	8	-	**37**
Section 9							
2017-2021	-	15	22	35	7	-	**79**
2022	-	1	6	15	5	-	**27**

Table C3-3. Summary of key mercury-related metrics for Mountain Whitefish by location and period.

Mountain Whitefish – Data Summary*					
Location/Period	**Fork Length (mm)**	**Total Weight (g)**	**Total Hg (mg/kg ww)**	**Carbon SI Ratios (‰)**	**Nitrogen SI Ratios (‰)**
Sections 1/3					
2008-2011	72, 345±72, 209–480	39, 498±270, 108–1252	72, 0.037±0.023, 0.0093–0.17	39, -29.8±1.3, -33.1–-26.6	39, 8.4±1.3, 6.5–11.3
2017-2021	111, 332±75, 145–502	110, 443±289, 27–1346	111, 0.049±0.036, 0.013–0.19	98, -29.6±1.5, -35.9–-27.1	98, 8.7±1.2, 6.3–11.8
2022	36, 358±62, 277–476	36, 597±358, 234–1515	36, 0.053±0.023, 0.026–0.11	36, -29.9±1.4, -33.6–-27.9	36, 9.4±1.1, 7.4–11.8
Section 5					
2008-2011	34, 362±91, 202–512	NA	34, 0.045±0.02, 0.014–0.086	NA	NA
2017-2021	57, 327±97, 55–473	57, 433±319, 2–1248	57, 0.059±0.031, 0.012–0.16	50, -28.6±1.3, -33.2–-26.6	50, 8.4±0.9, 5.9–11.2
2022	29, 343±66, 150–450	28, 466±232, 35–971	29, 0.063±0.024, 0.018–0.14	29, -28.7±0.9, -31–-27	29, 8.8±1, 7.3–12.5
Section 7					
2008-2011	10, 319±45, 237–396	10, 366±141, 158–622	10, 0.037±0.016, 0.016–0.067	10, -27.9±0.7, -29.4–-26.9	10, 8.9±0.7, 8–10.1
2017-2021	40, 325±76, 91–470	40, 384±226, 9–926	40, 0.065±0.036, 0.013–0.15	35, -28.2±0.8, -29.8–-26.4	35, 8.8±0.7, 7.5–10.3
2022	37, 345±50, 251–444	37, 469±201, 168–915	37, 0.051±0.024, 0.016–0.12	36, -28.5±0.7, -29.8–-26.3	36, 9.2±1.3, 7.4–14.5
Section 9					
2017-2021	79, 298±86, 145–460	78, 315±219, 35–992	79, 0.049±0.04, 0.0097–0.23	56, -28.1±1.3, -32.3–-25.5	56, 8.4±0.6, 7.3–10.2
2022	28, 335±62, 154–425	28, 483±231, 36–948	27, 0.046±0.021, 0.013–0.11	27, -28±0.7, -29.1–-26.3	27, 8.5±0.8, 6.6–9.6

* Statistics given include count, mean ± standard deviation, and minimum-maximum, respectively (if count > 1).

Table C3-4. Comparison of model fits for Mountain Whitefish.

Mountain Whitefish – Model Comparison				
Model	Structure[1]	Note	AICc	Delta
Fit 4	THg ~ LC * Period + Location	Location-specific intercepts and Period-specific slopes	-478.1	0.0
Fit 3	THg ~ LC * Location + Period	Period-specific intercepts and Location-specific slopes	-477.6	0.5
Fit 2	THg ~ LC + Location + Period	Location:Period-specific intercepts and similar slopes	-466.7	11.4
Fit 1	THg ~ LC	Similar intercepts and slopes	-359.0	119.1

[1] LC is fish length centered to standard size (i.e., 350 mm fork length).
Fish THg concentrations were $\log_{10}$ transformed.

Table C3-5. Outliers identified for Mountain Whitefish based on the final model.

Mountain Whitefish – Outliers						
Location	Date	Fish ID	Species	StudRes[1]	CooksD[1]	Type[2]
Sections 1/3	2018-08-29	426	Mountain Whitefish	4.325	0.022	High Residual

[1] StudRes = studentized residual; CooksD = Cook's distance

[2] Type: 'High Residual' = studentized residual ≥ 4, 'High Leverage' = Cook's distance ≥ 0.5, 'Both' = exceed both criteria.

Table C3-6. Final model ANOVA results for Mountain Whitefish.

Mountain Whitefish – ANOVA					
Predictor[1]	df	Sum sq	Mean sq	F	P
LC	1	19.9	19.9	883	<0.001
Period	2	2.23	1.12	49.6	<0.001
Location	3	0.893	0.298	13.2	<0.001
LC * Period	2	0.392	0.196	8.70	<0.001
Residuals	522	11.8	0.023	-	-

[1] LC is fish length centered to standard size (i.e., 350 mm fork length). Fish THg concentrations were $\log_{10}$ transformed.

Fit 4: THg ~ LC * Period + Location (r^2 = 0.666)

Table C3-7. Final model summary results for Mountain Whitefish.

Mountain Whitefish – Model Summary			
Variable[1]	Estimate	95% CI[2]	p-value
Intercept	-1.489	-1.518, -1.459	<0.001
LC	0.0021	0.0017, 0.0024	<0.001
Period			
2008-2011	—	—	
2017-2021	0.1659	0.1315, 0.2003	<0.001
2022	0.1285	0.0889, 0.1680	<0.001
Location			
Sections 1/3	—	—	
Section 5	0.0976	0.0639, 0.1313	<0.001
Section 7	0.0855	0.0469, 0.1241	<0.001
Section 9	0.0359	-0.0011, 0.0728	0.057
LC * Period			
LC * 2017-2021	0.0008	0.0004, 0.0012	<0.001
LC * 2022	0.0001	-0.0004, 0.0007	0.6

[1] LC is fish length centered to standard size (i.e., 350 mm fork length). Fish THg concentrations were $\log_{10}$ transformed.

Fit 4: THg ~ LC * Period + Location (r^2 = 0.666)

[2] CI = Confidence Interval

Figure C3-1. Key mercury-related data for Mountain Whitefish.

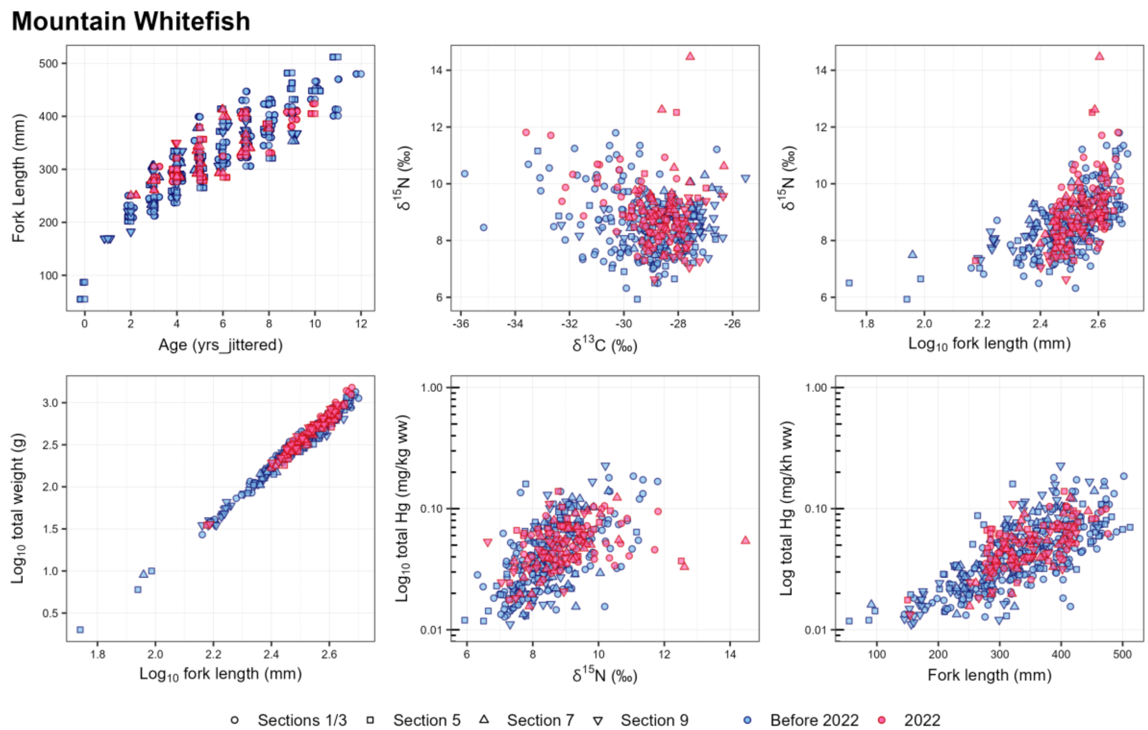


Figure C3-2. Length-mercury plots by location and period for Mountain Whitefish.

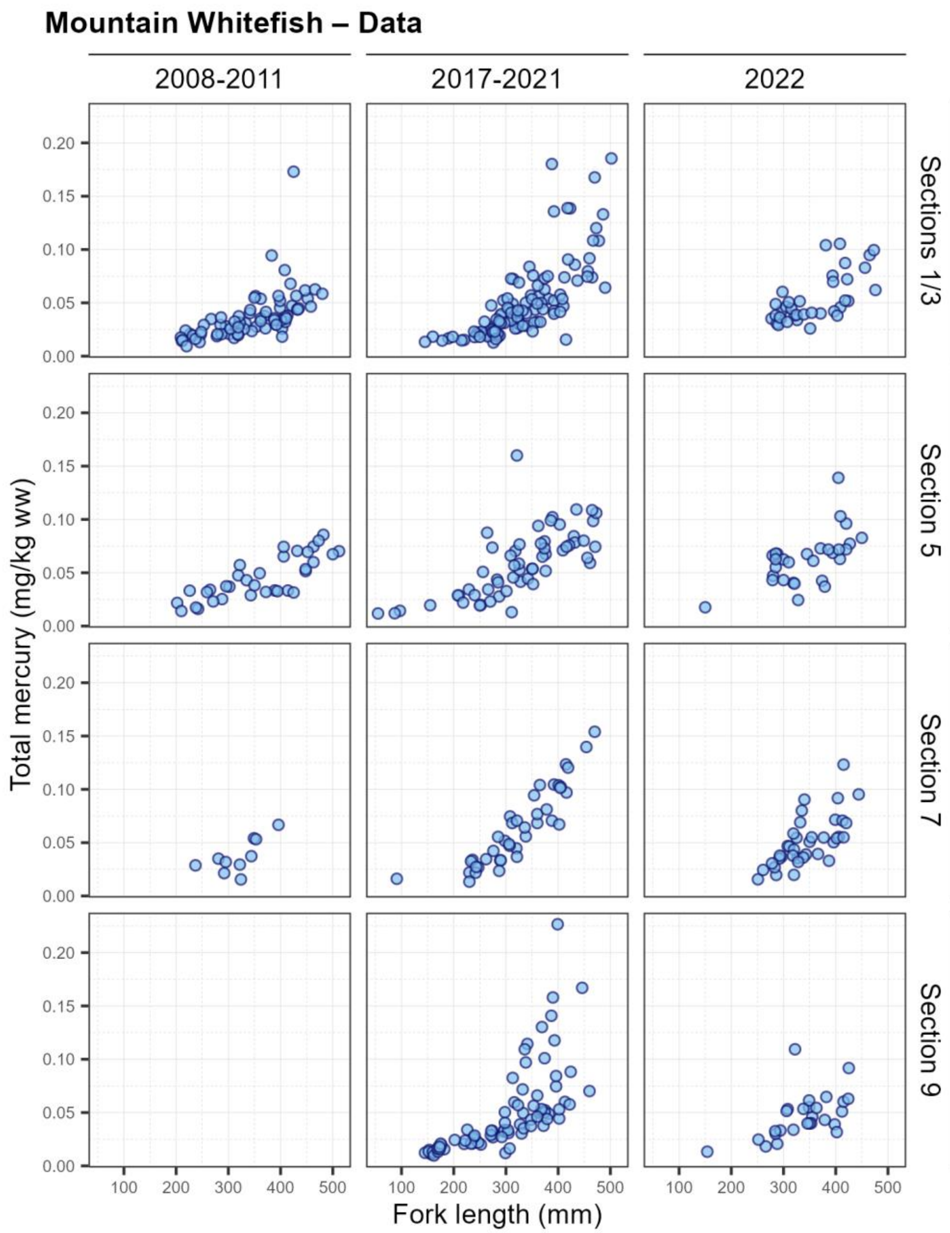


Figure C3-3. Length-mercury plots for Mountain Whitefish showing transformation options.

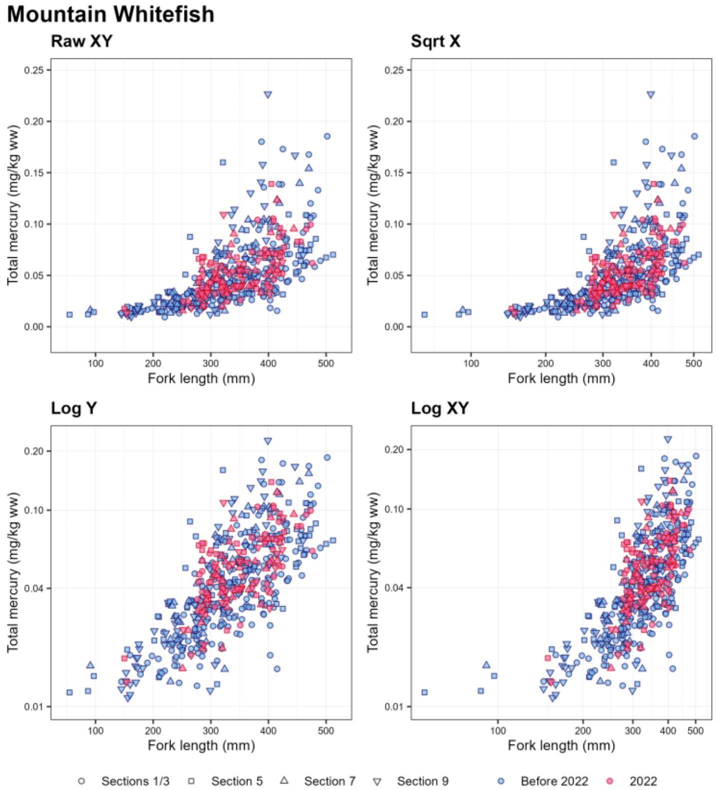


Figure C3-4. Diagnostics of final model for Mountain Whitefish.

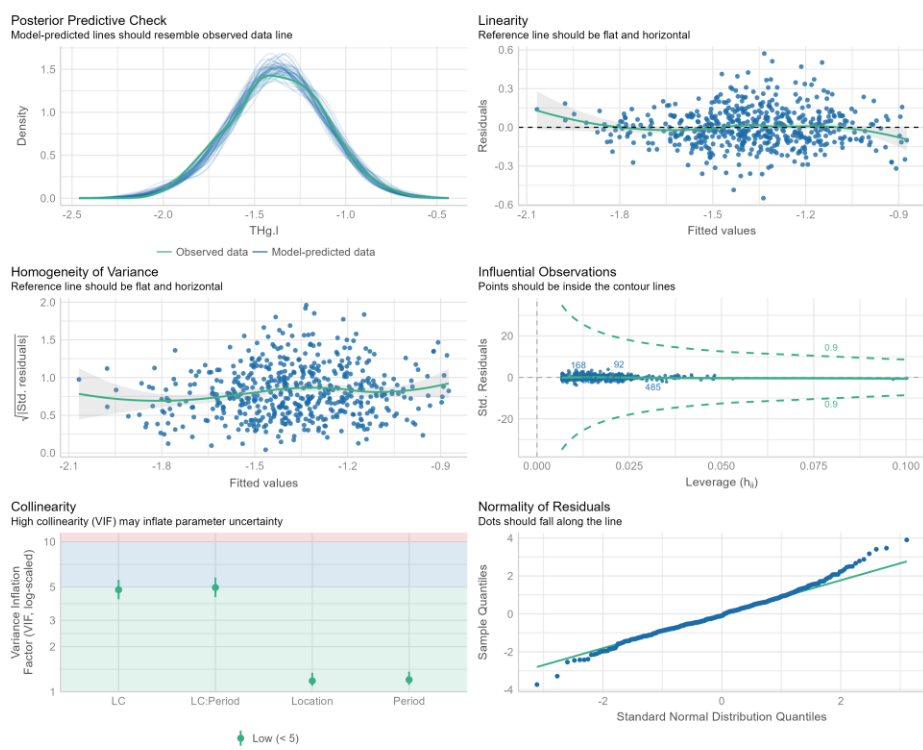


Figure C3-5. Length-mercury plots showing final model fits (and ±95% confidence intervals) for Mountain Whitefish.

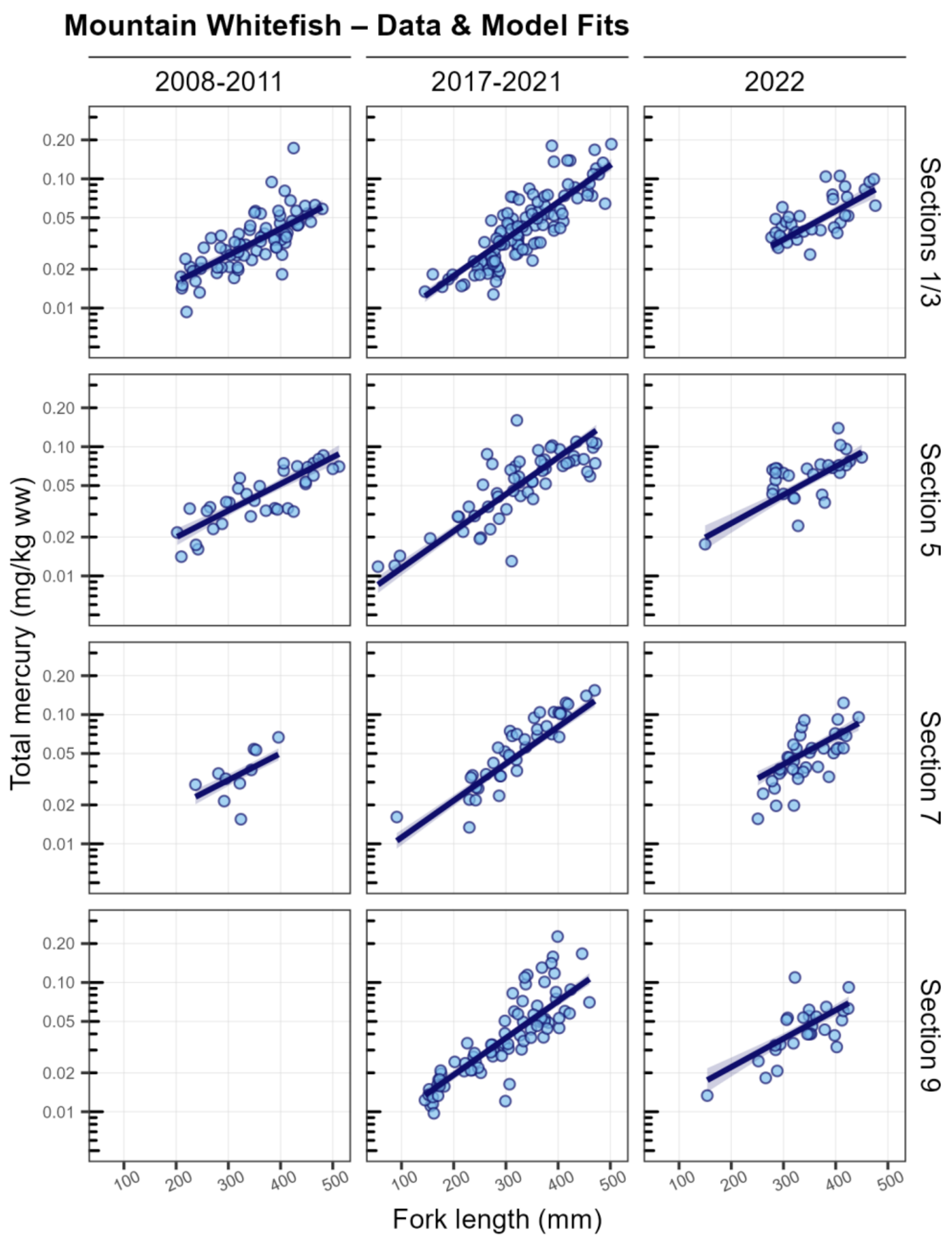
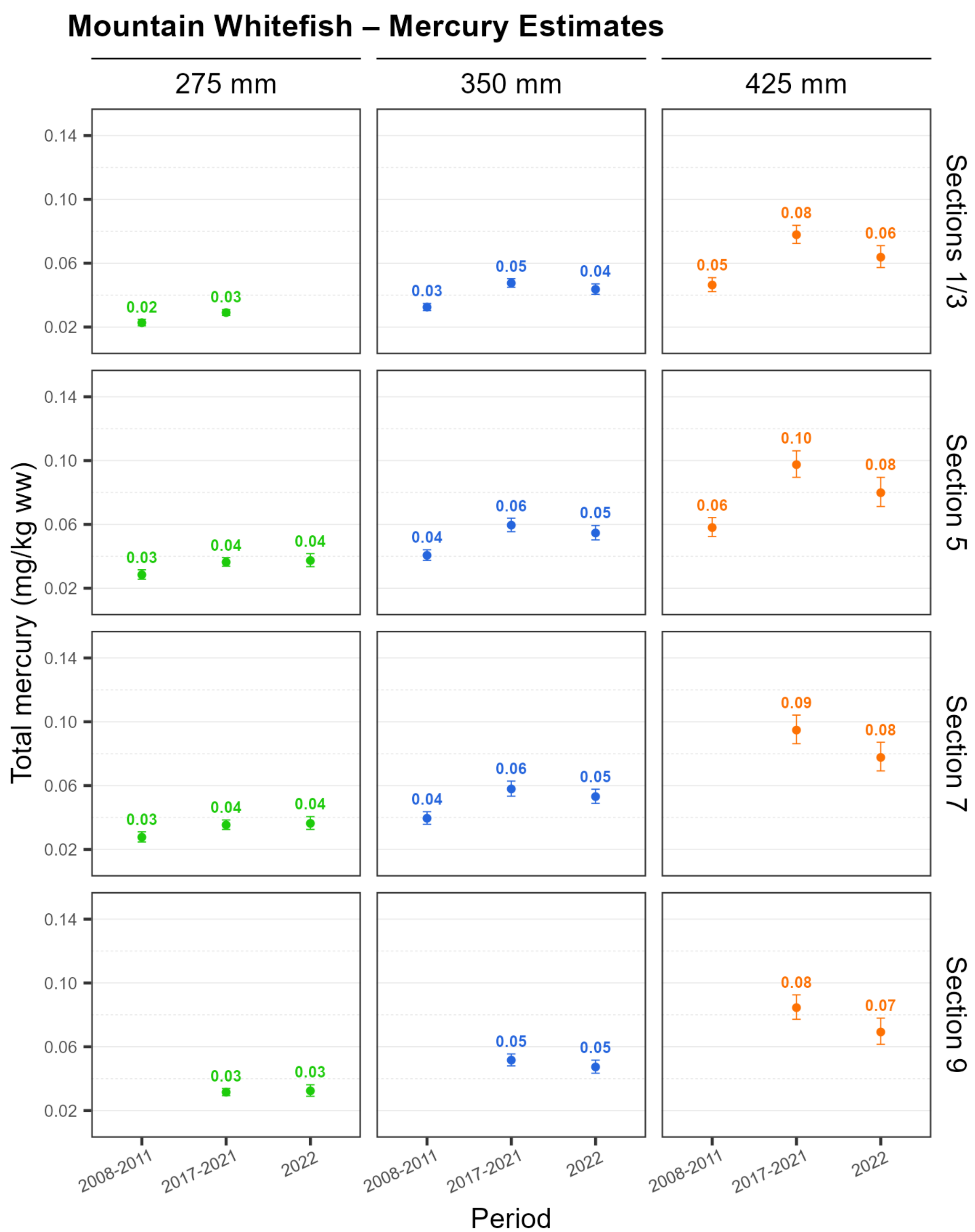


Figure C3-6. Estimates of mercury concentrations (±95% confidence intervals) in select sizes of Mountain Whitefish using the best model.



C.4 RAINBOW TROUT

Length-mercury relationships were modelled to characterize mercury concentrations in Rainbow Trout and determine possible changes across location and period. Key notes on the methods and results are provided below.

C.4.1 Data Overview

The coarse investigation identified three unique samples as outliers (listed in **Table C1-1**), which were removed from the data prior to formal analysis. Consistent with the MMP (BC Hydro 2022), locations were limited to Sections 1/3. All three time periods were included. The Rainbow Trout dataset is summarized in **Table C4-1** (sample numbers by location/period) and **Table C4-2** (sample numbers per size class by location/period). Key mercury-related data are shown in **Figure C4-1** and tabulated in **Table C4-3.** The length-mercury relationship is shown by location and time period in **Figure C4-2**.

C.4.2 Model fitting and Selection

Modeling was performed using log_{10}-transformed data of mercury concentrations and raw data of fish length (centered to standard size of 300 mm fork length) according to transformation plots (**Figure C4-3**). Given that the target sampling location of the MMP for Rainbow Trout is Section 1-3, the location term was dropped from models that investigated length-mercury relationships, focusing characterization of length-mercury relationships in Rainbow Trout on temporal changes. AICc ranked Fit 2 (THg ~ LC + Period) as the best model, indicating that the slope in length-mercury relationships was not influenced by period (**Table C4-4**). Formal assessment of residuals from Fit 2 identified no more outlier (**Table C4-5**). Detailed results for the final model (Fit 2) are shown in **Table C4-6** (ANOVA table), **Table C4-7** (coefficient estimates, confidence intervals and p-values) and **Figure C4-4** (model diagnostics). As expected, the model fits generally show strong positive relationships between length and mercury concentrations. Visual inspection of model diagnostics showed no issues with residuals or collinearity. The final model had an R^2 of 0.45, indicating that it explains much of the variability in the underlying data.

C.4.3 Estimates of Mercury Concentrations

Final model fits are shown relative to the underlying data in **Figure C4-5**. This model was used to estimate mercury concentrations and ±95% confidence intervals for three sizes (250, 325, and 400 mm) of Rainbow Trout at all location-period combinations supported by existing data (**Figure C4-6**).

Table C4-1. Rainbow Trout sample numbers by location and period.

Rainbow Trout – Sample Summary		
Period	**Sections 1/3**	**Total**
2008-2011	10	**10**
2017-2021	62	**62**
2022	23	**23**
Total	**95**	**95**

Table C4-2. Rainbow Trout sample numbers by size class, location and period.

Rainbow Trout – Size Classes (fork length in mm)					
Location/Period	**100-200**	**200-300**	**300-400**	**400-500**	**Total**
Sections 1/3					
2008-2011	-	3	4	3	**10**
2017-2021	1	27	29	5	**62**
2022	-	7	14	2	**23**

Table C4-3. Summary of key mercury-related metrics for Rainbow Trout by location and period.

Rainbow Trout – Data Summary*					
Location/Period	**Fork Length (mm)**	**Total Weight (g)**	**Total Hg (mg/kg ww)**	**Carbon SI Ratios (‰)**	**Nitrogen SI Ratios (‰)**
Sections 1/3					
2008-2011	10, 330±71, 215–440	10, 433±274, 128–984	10, 0.043±0.019, 0.022–0.083	10, -27.9±1.4, -29.8–-25.8	10, 9.2±0.6, 8.4–10.2
2017-2021	63, 309±61, 200–430	63, 367±207, 80–1039	62, 0.029±0.015, 0.011–0.094	49, -28.4±1.2, -32.2–-26.2	49, 8.3±1.1, 5.8–10.5
2022	23, 328±52, 250–414	23, 424±195, 158–787	23, 0.028±0.012, 0.014–0.068	23, -29.2±1, -32.2–-28.1	23, 8.8±0.9, 7–10.5

* Statistics given include count, mean ± standard deviation, and minimum-maximum, respectively (if count > 1).

Table C4-4. Comparison of model fits for Rainbow Trout.

Rainbow Trout – Model Comparison				
Model	**Structure**[1]	**Note**	**AICc**	**Delta**
Fit 2	THg ~ LC + Period	Period-specific intercepts and similar slopes	-98.7	0.0
Fit 3	THg ~ LC * Period	Period-specific intercepts and slopes	-95.5	3.2
Fit 1	THg ~ LC	Similar intercepts and slopes	-92.1	6.6

[1] LC is fish length centered to standard size (i.e., 300 mm fork length).
Fish THg concentrations were $\log_{10}$ transformed.

Table C4-5. Outliers identified for Rainbow Trout based on the final model.

Rainbow Trout – Outliers						
Location	**Date**	**Fish ID**	**Species**	**StudRes**	**CooksD**	**Type**

No outlier was identified.

Table C4-6. Final model ANOVA results for Rainbow Trout.

Rainbow Trout – ANOVA					
Predictor[1]	df	Sum sq	Mean sq	F	P
LC	1	1.22	1.22	62.9	<0.001
Period	2	0.216	0.108	5.58	0.005
Residuals	91	1.76	0.019	-	-

[1] LC is fish length centered to standard size (i.e., 300 mm fork length). Fish THg concentrations were log_{10} transformed.

Fit 2: THg ~ LC + Period (r^2 = 0.449)

Table C4-7. Final model summary results for Rainbow Trout.

Rainbow Trout – Model Summary			
Variable[1]	Estimate	95% CI[2]	p-value
Intercept	-1.460	-1.548, -1.371	<0.001
LC	0.0019	0.0014, 0.0023	<0.001
Period			
2008-2011	—	—	
2017-2021	-0.1318	-0.2265, -0.0371	0.007
2022	-0.1751	-0.2798, -0.0705	0.001

[1] LC is fish length centered to standard size (i.e., 300 mm fork length). Fish THg concentrations were log_{10} transformed.

Fit 2: THg ~ LC + Period (r^2 = 0.449)

[2] CI = Confidence Interval

Figure C4-1. Key mercury-related data for Rainbow Trout.

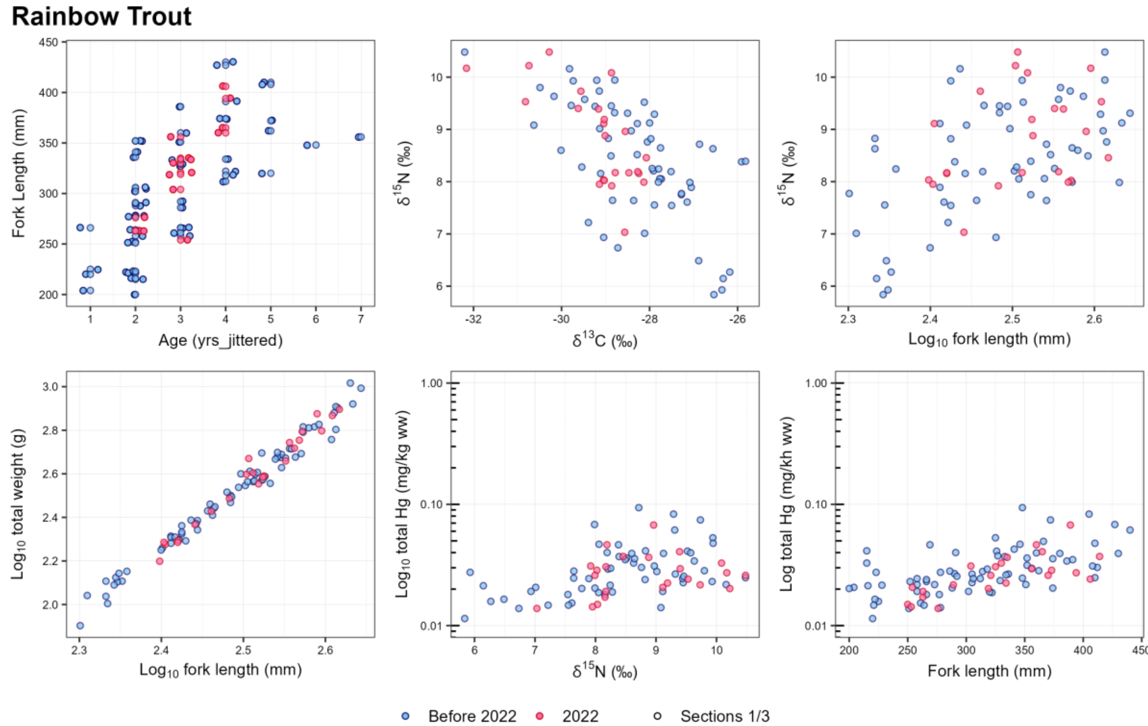


Figure C4-2. Length-mercury plots by location and period for Rainbow Trout.

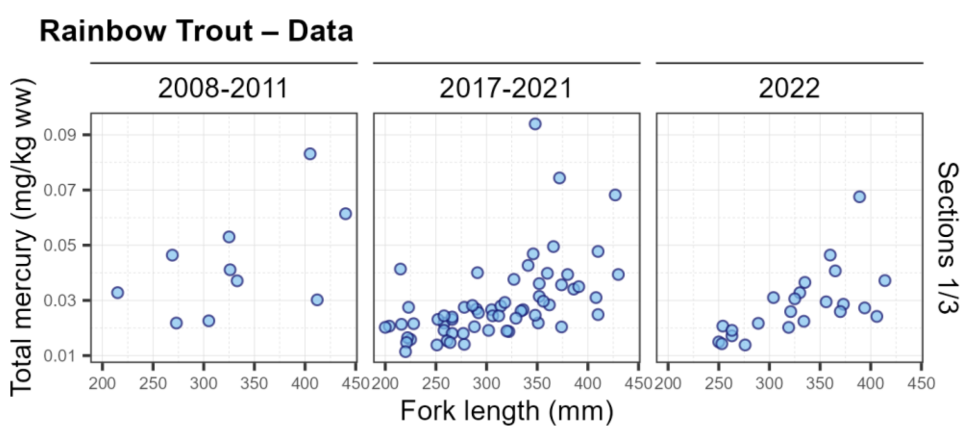


Figure C4-3. Length-mercury plots for Rainbow Trout showing transformation options.

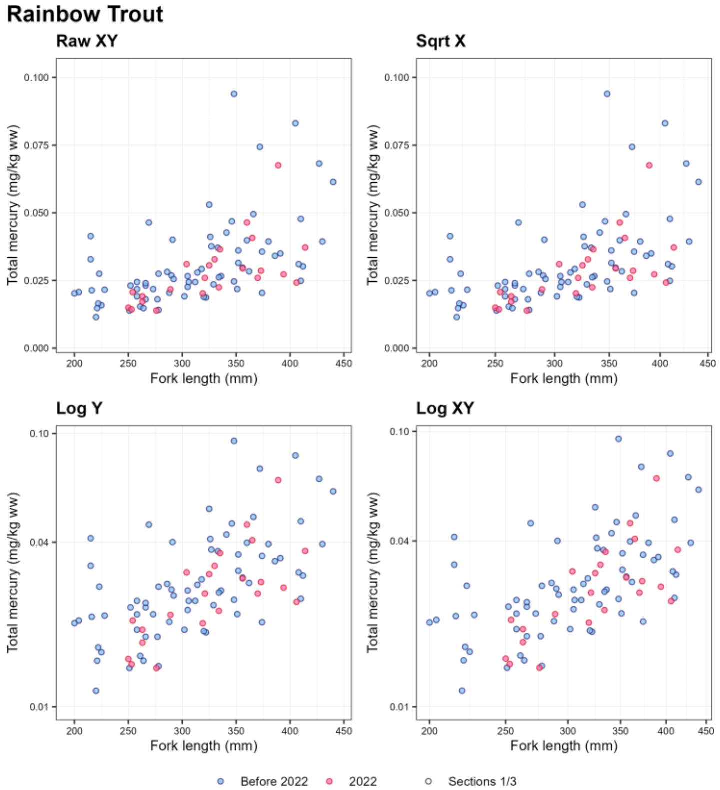


Figure C4-4. Diagnostics of final model for Rainbow Trout.

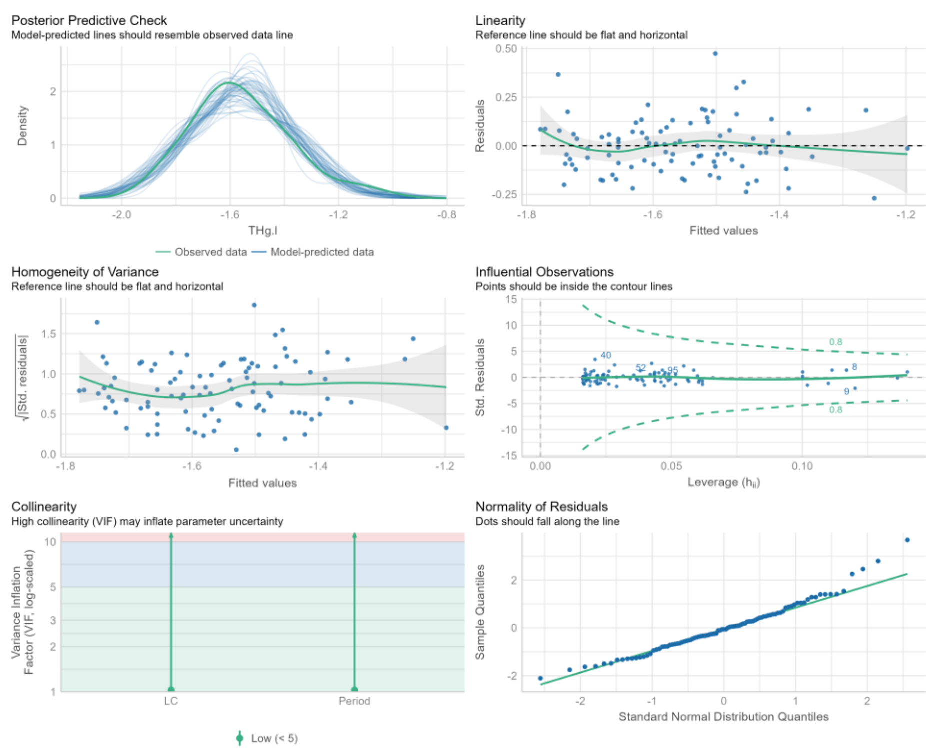


Figure C4-5. Length-mercury plots showing final model fits (and ±95% confidence intervals) for Rainbow Trout.

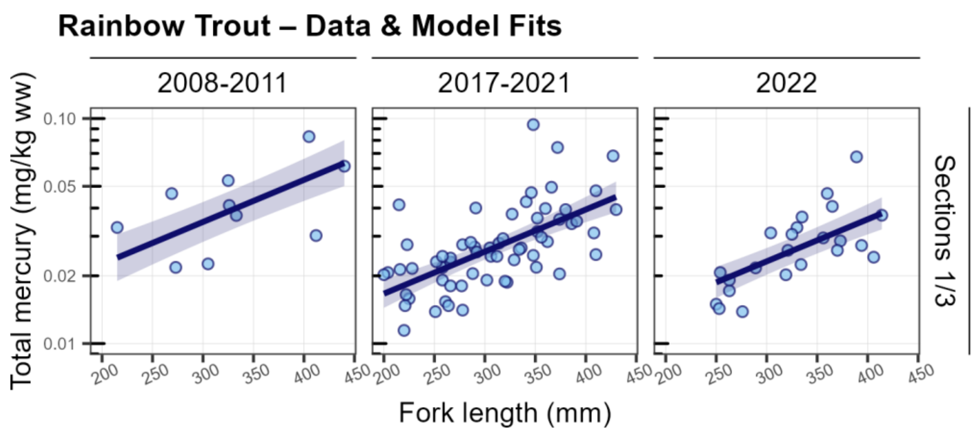
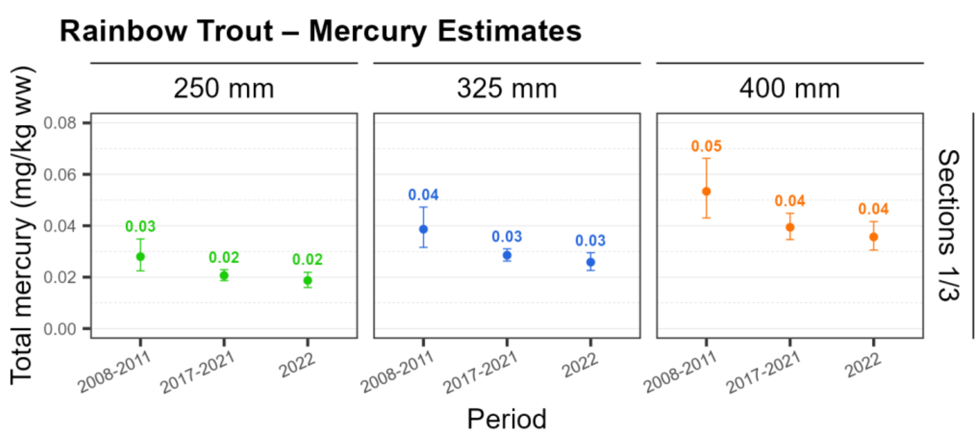


Figure C4-6. Estimates of mercury concentrations (±95% confidence intervals) in select sizes of Rainbow Trout using the best model.



C.5 LONGNOSE SUCKER

Length-mercury relationships were modelled to characterize mercury concentrations in Longnose Sucker and determine possible changes across location and period. Key notes on the methods and results are provided below.

C.5.1 Data Overview

The coarse investigation identified three unique samples as outliers (listed in **Table C1-1**), which were removed from the data prior to formal analysis. Consistent with the MMP (BC Hydro 2022), locations were limited to Sections 1/3, 5, 7, and 9. All three time periods were included. The Longnose Sucker dataset is summarized in

Table C5-1 (sample numbers by location/period) and **Table C5-2** (sample numbers per size class by section/period). Key mercury-related data are shown in **Figure C5-1** and tabulated in **Table C5-3**. The length-mercury relationship is shown by location and time in **Figure C5-2**.

C.5.2 Model fitting and Selection

Modeling was performed using log_{10}-transformed data of mercury concentrations and raw data of fish length (centered to standard size of 350 mm fork length) according to transformation plots (**Figure C5-3**). AICc ranked Fit 4 (THg ~ LC * Period + Location) as the best model (**Table** C5-4), which was heavily overloaded as indicated by high level of variation inflation factor (> 50). To avoid overfitting issues, therefore, the second-best model in the AICc ranking (Fit 2: THg ~ LC + Location + Period) was selected as the most plausible model in characterizing mercury concentrations in Longnose Sucker; the slope of the length-mercury relationships in Fit 2 was independent of both location and period (**Table C5-4**). Formal assessment of residuals from Fit 2 identified no more outlier (**Table C5-5**). Detailed results for the final model (Fit 2) are shown in **Table C5-6** (ANOVA table), **Table C5-7** (coefficient estimates, confidence intervals and p-values) and **Figure C5-4** (model diagnostics). As expected, the model fits generally show strong positive relationships between length and mercury concentrations. Visual inspection of model diagnostics showed no issues with residuals or collinearity. The final model had an R^2 of 0.56, indicating that it explains much of the variability in the underlying data

C.5.3 Estimates of Mercury Concentrations

Final model fits are shown relative to the underlying data in **Figure C5-5**. This model was used to estimate mercury concentrations and ±95% confidence intervals for three sizes (325, 375, and 425 mm) of Longnose Sucker at all location-period combinations supported by existing data (**Figure C5-6**).

Table C5-1. Longnose Sucker sample numbers by location and period.

Longnose Sucker – Sample Summary					
Period	**Sections 1/3**	**Section 5**	**Section 7**	**Section 9**	**Total**
2008-2011	31	-	10	-	**41**
2017-2021	74	48	44	84	**250**
2022	34	52	42	36	**164**
Total	**139**	**100**	**96**	**120**	**455**

Table C5-2. Longnose Sucker sample numbers by size class, location and period.

Longnose Sucker – Size Classes (fork length in mm)							
Location/Period	**0-100**	**100-200**	**200-300**	**300-400**	**400-500**	**500-600**	**Total**
Sections 1/3							
2008-2011	-	-	1	20	10	-	**31**
2017-2021	-	-	20	29	25	-	**74**
2022	-	-	8	15	11	-	**34**
Section 5							
2017-2021	-	1	12	16	19	-	**48**
2022	-	-	7	23	22	-	**52**
Section 7							
2008-2011	-	-	-	5	5	-	**10**
2017-2021	1	-	13	16	13	1	**44**
2022	-	-	8	19	15	-	**42**
Section 9							
2017-2021	-	10	24	26	24	-	**84**
2022	-	-	8	14	13	1	**36**

Table C5-3. Summary of key mercury-related metrics for Longnose Sucker by location and period.

Longnose Sucker – Data Summary*					
Location/Period	Fork Length (mm)	Total Weight (g)	Total Hg (mg/kg ww)	Carbon SI Ratios (‰)	Nitrogen SI Ratios (‰)
Sections 1/3					
2008-2011	31, 388±35, 295–442	31, 770±194, 362–1172	31, 0.053±0.042, 0.017–0.17	31, -29.2±1.1, -31.3–-26.3	31, 7.2±1, 5.7–9
2017-2021	75, 362±71, 221–486	75, 650±346, 138–1461	74, 0.071±0.061, 0.017–0.33	52, -28.2±0.9, -30.7–-26.7	52, 6.9±1.1, 5.6–10.3
2022	34, 364±69, 255–478	34, 661±337, 203–1361	34, 0.071±0.059, 0.02–0.21	34, -28.3±0.8, -30.2–-26.9	34, 6.6±0.6, 5.7–7.8
Section 5					
2017-2021	48, 365±86, 117–489	48, 674±382, 22–1435	48, 0.073±0.05, 0.014–0.21	36, -27.5±0.9, -29.6–-25.9	36, 6.7±0.6, 5.6–8.2
2022	52, 385±60, 256–483	52, 756±291, 211–1277	52, 0.087±0.051, 0.02–0.24	51, -27.9±0.8, -29.8–-26.4	51, 6.5±0.6, 5.3–8.4
Section 7					
2008-2011	10, 403±21, 373–442	10, 779±107, 654–990	10, 0.057±0.026, 0.019–0.1	10, -27.9±0.6, -28.7–-27.1	10, 7.9±0.7, 7.2–9.2
2017-2021	45, 346±92, 76–524	45, 594±397, 5–1675	44, 0.083±0.052, 0.011–0.21	37, -27.7±0.8, -29.4–-25.9	37, 7.8±1.4, 6.6–13.8
2022	42, 371±63, 267–477	42, 642±300, 225–1329	42, 0.089±0.072, 0.019–0.38	42, -28±1.1, -30.2–-25.2	42, 8.1±1.4, 6.3–13.3
Section 9					
2017-2021	85, 329±97, 130–495	85, 528±374, 22–1479	84, 0.086±0.086, 0.0096–0.42	63, -27.6±0.8, -29.4–-24.6	63, 7.2±0.7, 5.9–9.3
2022	36, 372±73, 251–537	36, 679±359, 172–1584	36, 0.088±0.071, 0.014–0.35	36, -27.8±0.9, -32.5–-26.9	36, 6.8±0.6, 5–7.7

* Statistics given include count, mean ± standard deviation, and minimum-maximum, respectively (if count > 1).

Table C5-4. Comparison of model fits for Longnose Sucker.

Longnose Sucker – Model Comparison				
Model	**Structure**[1]	**Note**	**AICc**	**Delta**
Fit 4	THg ~ LC * Period + Location	Location-specific intercepts and Period-specific slopes	-86.0	0.0
Fit 2	THg ~ LC + Location + Period	Location:Period-specific intercepts and similar slopes	-82.0	4.0
Fit 3	THg ~ LC * Location + Period	Period-specific intercepts and Location-specific slopes	-75.9	10.1
Fit 1	THg ~ LC	Similar intercepts and slopes	-29.9	56.1

[1] LC is fish length centered to standard size (i.e., 350 mm fork length).
Fish THg concentrations were $\log_{10}$ transformed.

Table C5-5. Outliers identified for Longnose Sucker based on the final model.

Longnose Sucker – Outliers						
Location	**Date**	**Fish ID**	**Species**	**StudRes**	**CooksD**	**Type**

No outlier was identified.

Table C5-6. Final model ANOVA results for Longnose Sucker.

Longnose Sucker – ANOVA					
Predictor[1]	df	Sum sq	Mean sq	F	P
LC	1	24.2	24.2	505	<0.001
Location	3	1.73	0.576	12.0	<0.001
Period	2	1.42	0.712	14.9	<0.001
Residuals	448	21.5	0.048	-	-

[1] LC is fish length centered to standard size (i.e., 350 mm fork length). Fish THg concentrations were log_{10} transformed.

Fit 2: THg ~ LC + Location + Period (r^2 = 0.56)

Table C5-7. Final model summary results for Longnose Sucker.

Longnose Sucker – Model Summary			
Variable[1]	Estimate	95% CI[2]	p-value
Intercept	-1.511	-1.580, -1.441	<0.001
LC	0.0031	0.0029, 0.0034	<0.001
Location			
Sections 1/3	—	—	
Section 5	0.0466	-0.0129, 0.1061	0.12
Section 7	0.1046	0.0465, 0.1628	<0.001
Section 9	0.1108	0.0544, 0.1672	<0.001
Period			
2008-2011	—	—	
2017-2021	0.2140	0.1368, 0.2912	<0.001
2022	0.1925	0.1124, 0.2726	<0.001

[1] LC is fish length centered to standard size (i.e., 350 mm fork length). Fish THg concentrations were log_{10} transformed.

Fit 2: THg ~ LC + Location + Period (r^2 = 0.56)

[2] CI = Confidence Interval

Figure C5-1. Key mercury-related data for Longnose Sucker.

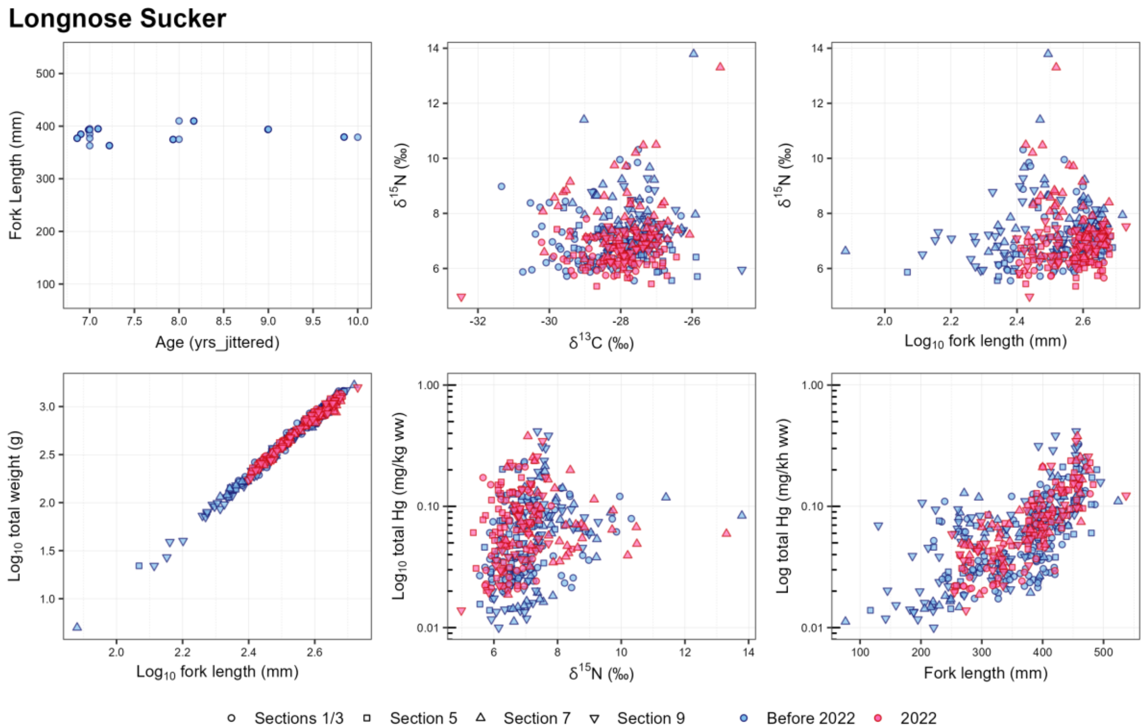


Figure C5-2. Length-mercury plots by location and period for Longnose Sucker.

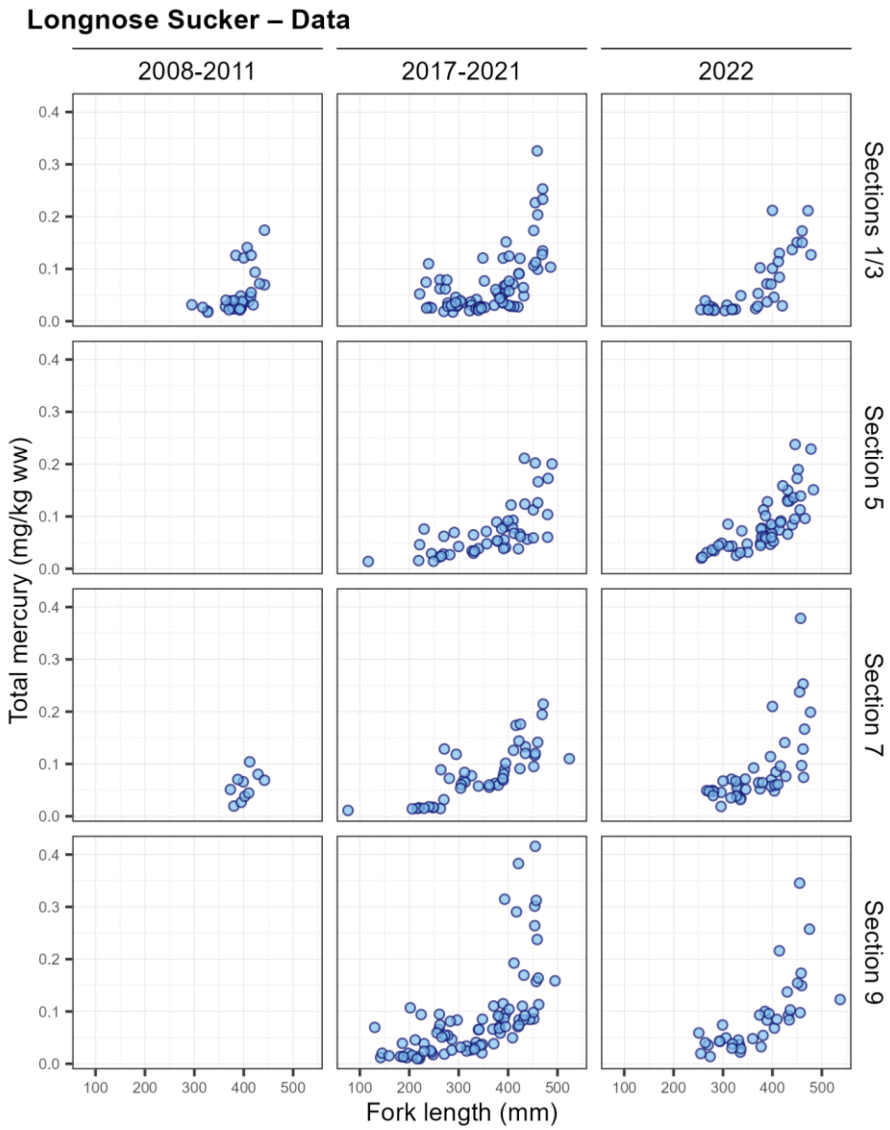


Figure C5-3. Length-mercury plots for Longnose Sucker showing transformation options.

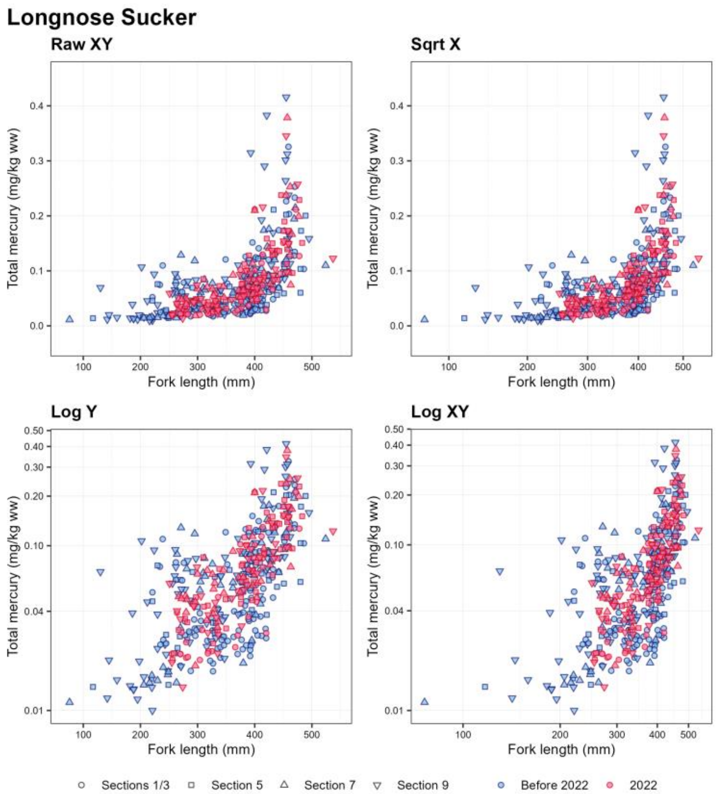


Figure C5-4. Diagnostics for final model for Longnose Sucker.

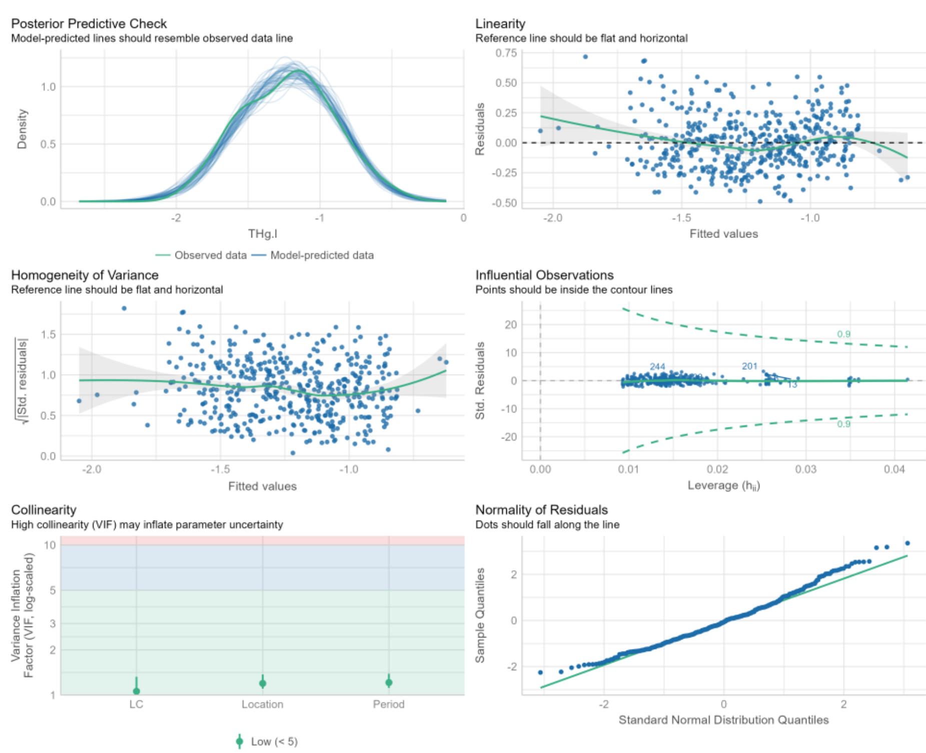


Figure C5-5. Length-mercury plots showing final model fits (and ±95% confidence intervals) for Longnose Sucker.

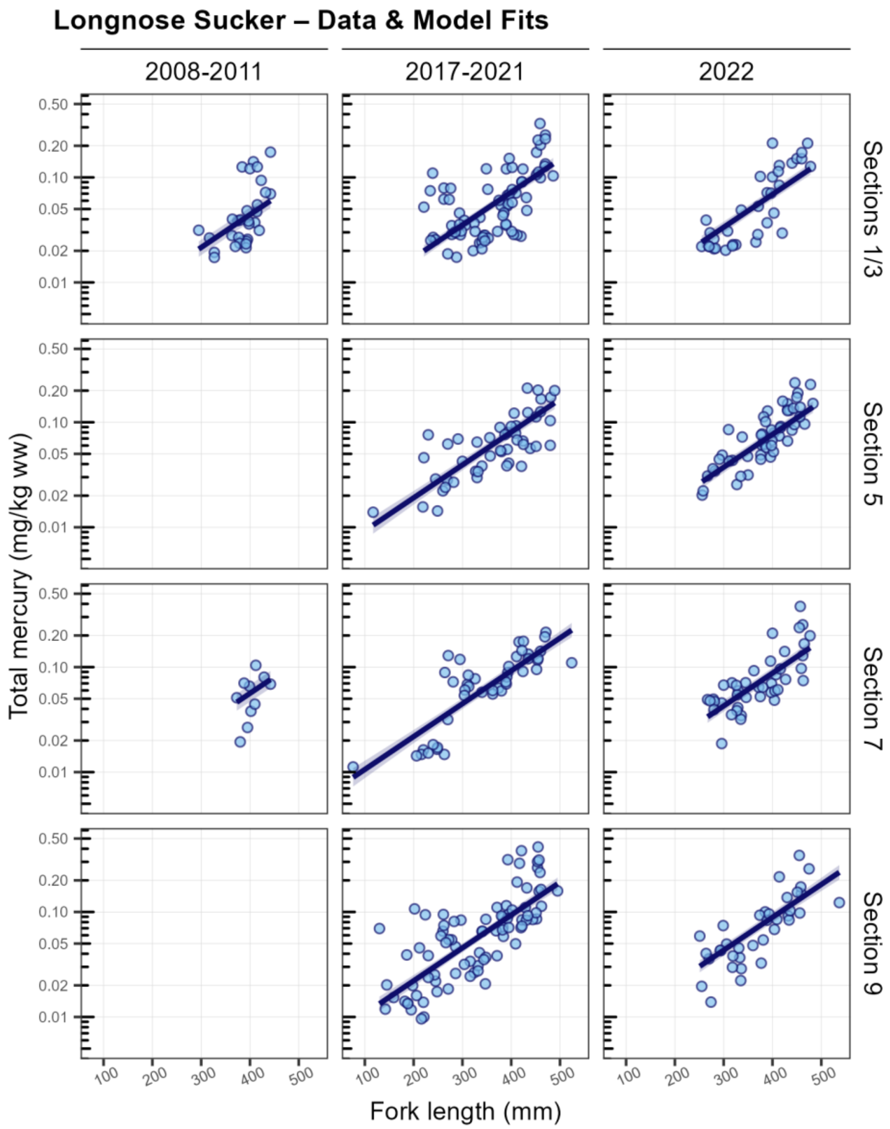
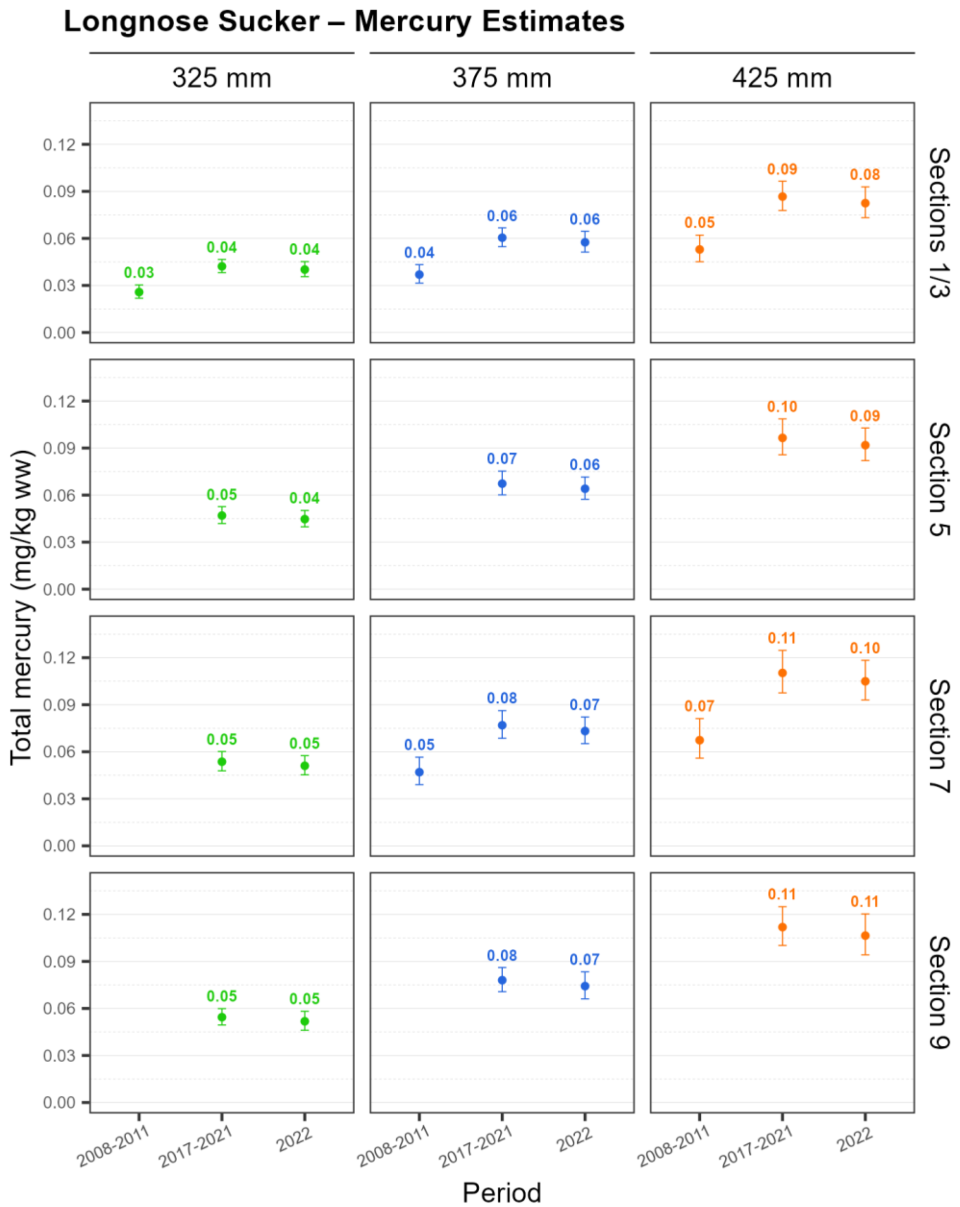


Figure C5-6. Estimates of mercury concentrations (±95% confidence intervals) in select sizes of Longnose Sucker using the best model.



C.6 WALLEYE

Length-mercury relationships were modelled to characterize mercury concentrations in Walleye and determine possible changes across location and period. Key notes on the methods and results are provided below.

C.6.1 Data Overview

The coarse investigation identified three unique samples as outliers (listed in **Table C1-1**), which were removed from the data prior to formal analysis. Although target sampling locations of the MMP (BC Hydro 2022) for Walleye were Sections 7 and 9, Section 5 was also included in the analyses due to sufficient data availability. Given the data availability, two time periods were included (2017-2021 and 2022). The Walleye dataset is summarized in **Table C6-1** (sample numbers by location/period) and **Table C6-2** (sample numbers per size class by location/period). Key mercury-related data shown in **Figure C6-1** and tabulated in **Table C6-3.** The length-mercury relationship is shown by location and time period in **Figure C6-2**.

C.6.2 Model fitting and Selection

Modeling was performed using $\log_{10}$-transformed data of both mercury concentrations and fish length (centered to standard size of 400 mm fork length) according to transformation plots (**Figure C6-3**). AICc ranked Fit 2 (THg ~ LC + Location + Period) as the best model, indicating the slope in length-mercury relationships was not influenced by location or period (**Table C6-4**). Formal assessment of residuals from Fit 2 identified no more outliers (**Table C6-5**). Detailed results for the final model (Fit 3) are shown in **Table C6-6** (ANOVA table), **Table C6-7** (coefficient estimates, confidence intervals and p-values) and **Figure C6-4** (model diagnostics). As expected, the model fits generally show strong positive relationships between length and mercury concentrations. Visual inspection of model diagnostics showed no issues with residuals or collinearity. The final model had an R^2 of 0.53, indicating that it explains much of the variability in the underlying data.

C.6.3 Estimates of Mercury Concentrations

Final model fits are shown relative to the underlying data in **Figure C6-5**. This model was used to estimate mercury concentrations and ±95% confidence intervals for three sizes (300, 400, and 500 mm) of Walleye at all location-period combinations supported by existing data (**Figure** C6-6).

Table C6-1. Walleye sample numbers by location and period.

Walleye – Sample Summary				
Period	Section 5	Section 7	Section 9	Total
2008-2011	-	6	-	**6**
2017-2021	38	40	60	**138**
2022	27	40	21	**88**
Total	**65**	**86**	**81**	**232**

Table C6-2. Walleye sample numbers by size class, location and period.

Walleye – Size Classes (fork length in mm)						
Location/Period	200-300	300-400	400-500	500-600	600-700	Total
Section 5						
2017-2021	1	12	18	5	2	**38**
2022	-	14	12	1	-	**27**
Section 7						
2008-2011	-	1	5	-	-	**6**
2017-2021	8	13	9	9	1	**40**
2022	4	18	16	-	2	**40**
Section 9						
2017-2021	9	31	20	-	-	**60**
2022	1	10	9	1	-	**21**

Table C6-3. Summary of key mercury-related metrics for Walleye by location and period.

Walleye – Data Summary*					
Location/Period	Fork Length (mm)	Total Weight (g)	Total Hg (mg/kg ww)	Carbon SI Ratios (‰)	Nitrogen SI Ratios (‰)
Section 5					
2017-2021	38, 434±78, 284–635	37, 1018±653, 263–3177	38, 0.28±0.19, 0.084–0.77	33, -26.3±0.6, -28.2–-25.3	33, 11.1±0.5, 9.7–12.3
2022	27, 402±56, 311–504	27, 762±314, 327–1361	27, 0.28±0.18, 0.055–0.69	24, -26.2±0.8, -27–-22.6	24, 10.8±0.4, 10–11.6
Section 7					
2008-2011	6, 425±20, 399–445	6, 904±191, 630–1114	6, 0.12±0.025, 0.085–0.15	6, -25.5±0.2, -25.7–-25.1	6, 10.7±0.2, 10.5–11.1
2017-2021	40, 402±102, 249–621	40, 903±699, 154–2772	40, 0.27±0.19, 0.076–0.85	28, -26.4±0.4, -27.2–-25.6	28, 11±0.8, 9–12
2022	40, 403±83, 261–656	40, 812±599, 186–3094	40, 0.27±0.19, 0.025–0.99	40, -26.5±0.5, -27.6–-25.7	40, 10.9±0.6, 9.5–12.3
Section 9					
2017-2021	60, 369±61, 222–499	60, 577±288, 134–1334	60, 0.26±0.14, 0.08–0.79	35, -25.8±0.6, -27.4–-24.1	35, 10.5±0.6, 9.1–11.6
2022	21, 398±63, 296–542	21, 750±382, 269–1804	21, 0.28±0.087, 0.11–0.44	21, -26.2±0.7, -27.7–-25.2	21, 10.9±0.4, 10–11.4

* Statistics given include count, mean ± standard deviation, and minimum-maximum, respectively (if count > 1).

Table C6-4. Comparison of model fits for Walleye.

Walleye – Model Comparison				
Model	Structure[1]	Note	AICc	Delta
Fit 2	THg ~ LC + Location + Period	Location:Period-specific intercepts and similar slopes	-120.0	0.0
Fit 3	THg ~ LC * Location + Period	Period-specific intercepts and Location-specific slopes	-118.9	1.1
Fit 4	THg ~ LC * Period + Location	Location-specific intercepts and Period-specific slopes	-117.1	2.9
Fit 1	THg ~ LC	Similar intercepts and slopes	-86.7	33.3

[1] LC is fish length centered to standard size (i.e., 400 mm fork length).
Fish THg concentrations and centered lengths were $\log_{10}$ transformed.

Table C6-5. Outliers identified for Walleye based on the final model.

Walleye – Outliers						
Location	Date	Fish ID	Species	StudRes	CooksD	Type

No outlier was identified.

Table C6-6. Final model ANOVA results for Walleye.

Walleye – ANOVA					
Predictor[1]	df	Sum sq	Mean sq	F	P
LC	1	7.03	7.03	209	<0.001
Location	2	0.800	0.400	11.9	<0.001
Period	2	0.699	0.349	10.4	<0.001
Residuals	226	7.61	0.034	-	-

[1] LC is fish length centered to standard size (i.e., 400 mm fork length). Fish THg concentrations and centered lengths were log_{10} transformed.

Fit 2: THg ~ LC + Location + Period (r^2 = 0.529)

Table C6-7. Final model summary results for Walleye.

Walleye – Model Summary			
Variable[1]	Estimate	95% CI[2]	p-value
Intercept	-1.031	-1.191, -0.8706	<0.001
LC	2.279	1.986, 2.572	<0.001
Location			
Section 5	—	—	
Section 7	0.0300	-0.0309, 0.0910	0.3
Section 9	0.1304	0.0681, 0.1928	<0.001
Period			
2008-2011	—	—	
2017-2021	0.3546	0.1992, 0.5101	<0.001
2022	0.3545	0.1991, 0.5099	<0.001

[1] LC is fish length centered to standard size (i.e., 400 mm fork length). Fish THg concentrations and centered lengths were log_{10} transformed.

Fit 2: THg ~ LC + Location + Period (r^2 = 0.529)

[2] CI = Confidence Interval

Figure C6-1. Key mercury-related data for Walleye.

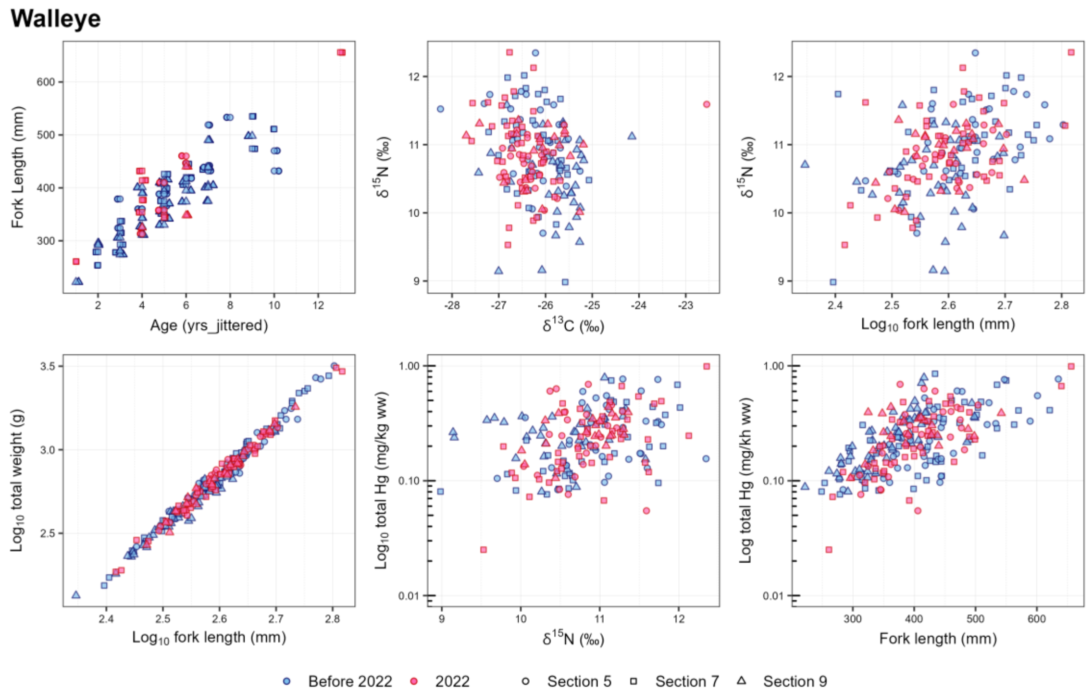


Figure C6-2. Length-mercury plots by location and period for Walleye.

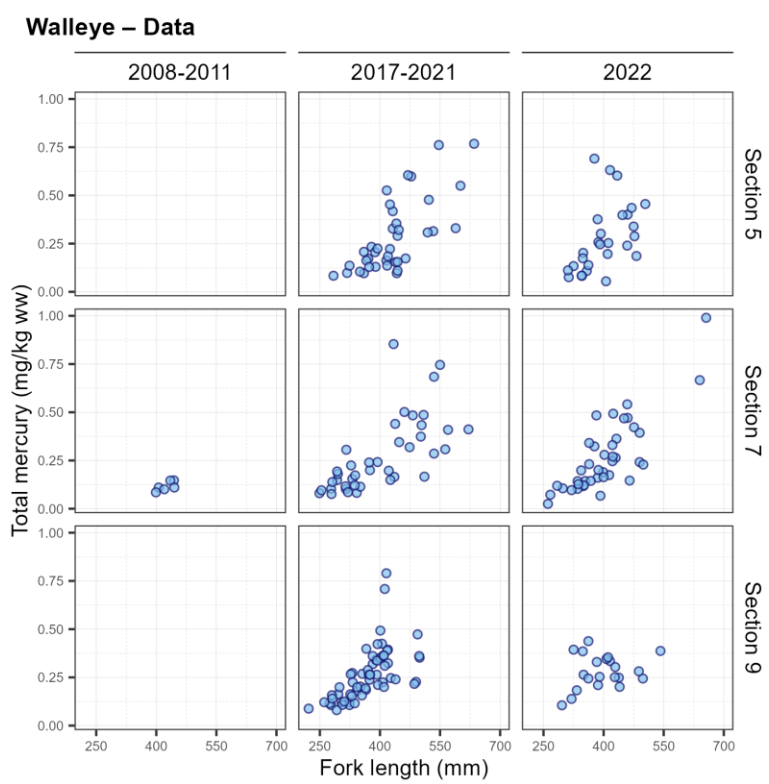


Figure C6-3. Length-mercury plots for Walleye showing transformation options.

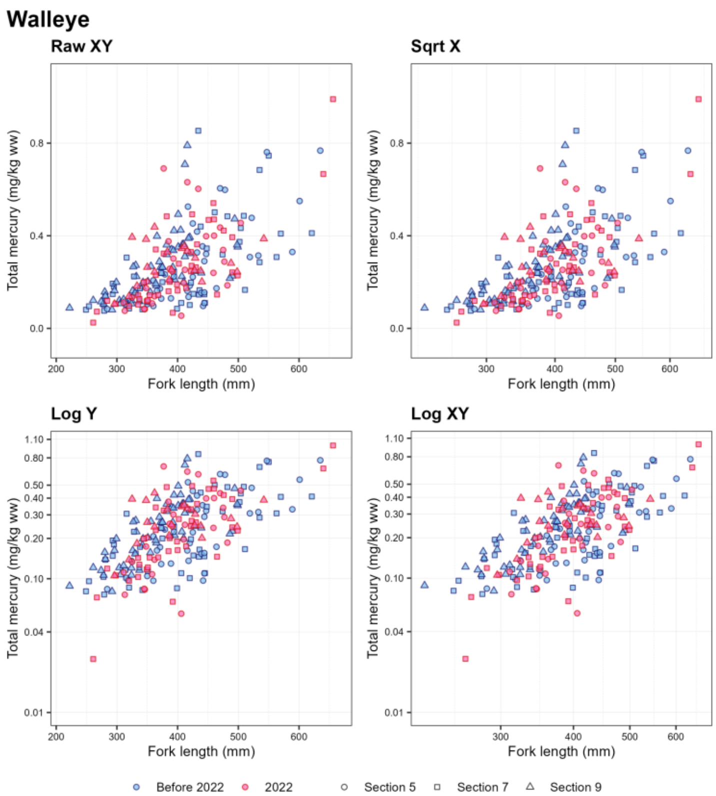


Figure C6-4. Diagnostics of final model for Walleye.

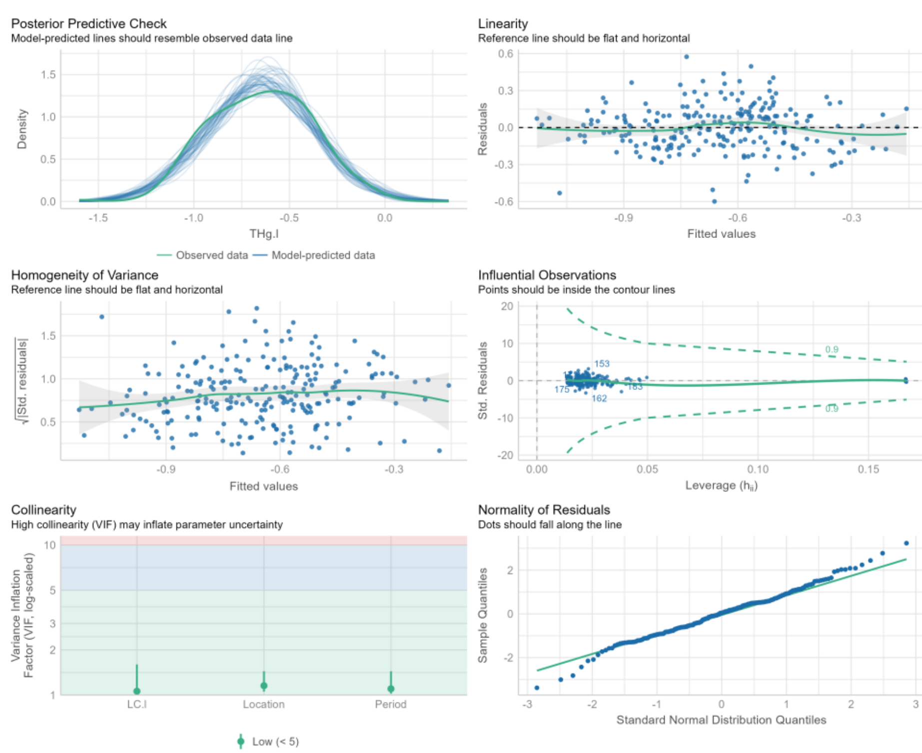


Figure C6-5. Length-mercury plots showing final model fits (and ±95% confidence intervals) for Walleye.

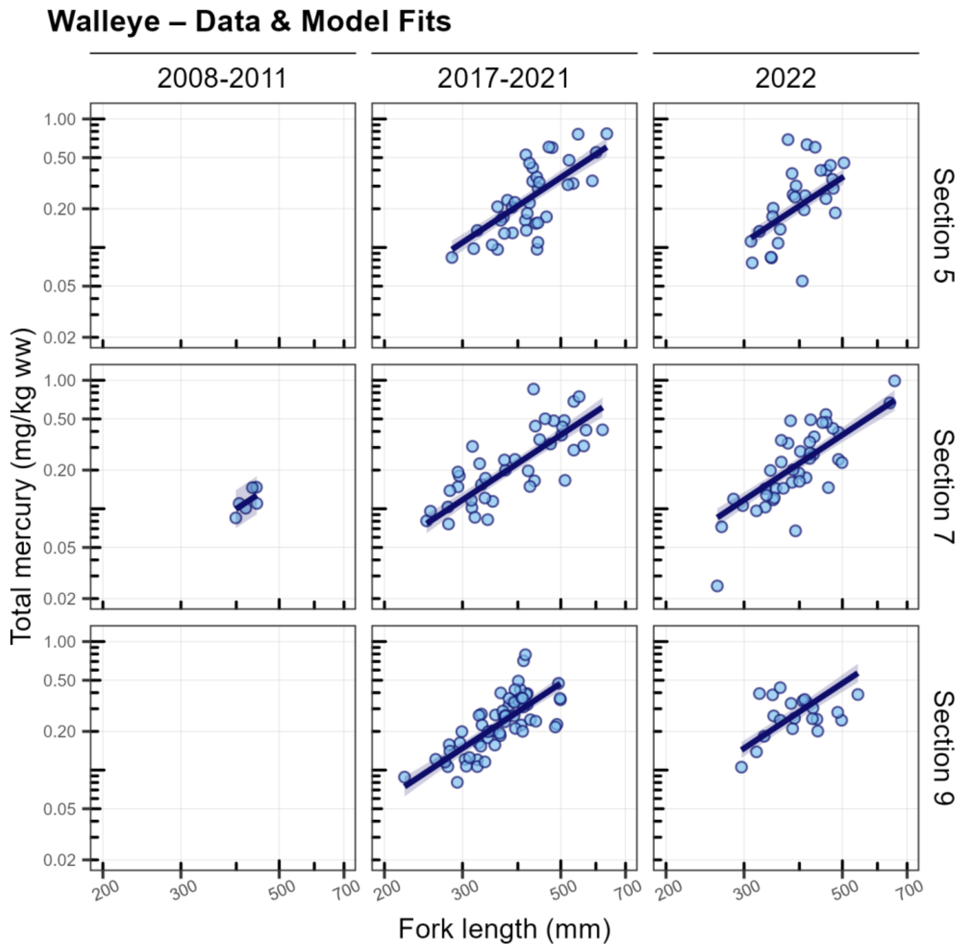
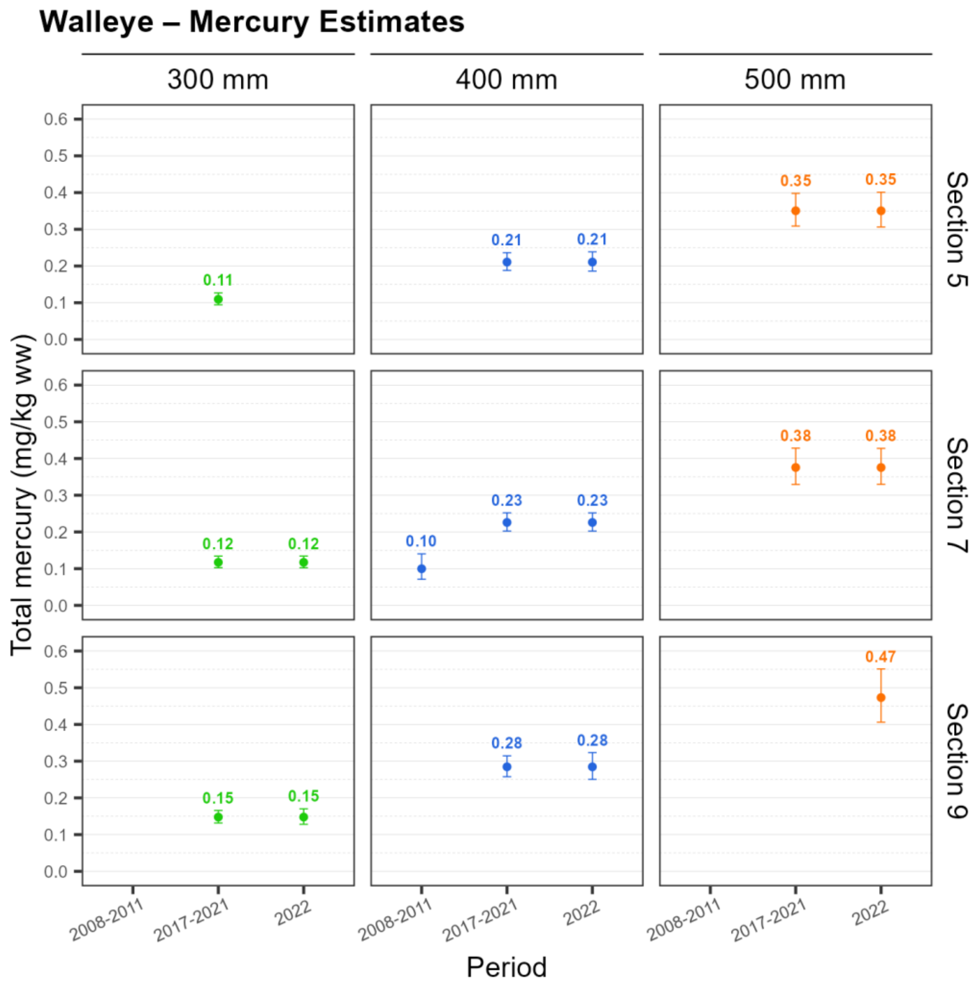


Figure C6-6. Estimates of mercury concentrations (±95% confidence intervals) in select sizes of Walleye using the best model.



C.7 REDSIDE SHINER

Length-mercury relationships were modelled to characterize mercury concentrations in Redside Shiner and determine possible changes across location and period. Key notes on the methods and results are provided below.

C.7.1 Data Overview

The coarse investigation identified three unique samples as outliers (listed in **Table C1-1**), which were removed from the data prior to formal analysis. Consistent with the MMP (BC Hydro 2022), locations were limited to Sections 1/3, 5, 7, and 9. Redside Shiner were available from all three time periods, although only 12 samples were available from 2010-2011 and 2017-2021. The Redside Shiner dataset is summarized in **Table C7-1** (sample numbers by location/period) and **Table C7-2** (sample numbers per size class by location/period). Key mercury-related data are shown in **Figure C7-1** and tabulated in **Table C7-3**. The length-mercury relationship is shown by location and time period and an overall visualization of fish length vs mercury concentrations is depicted in **Figure C7-2**.

C.7.2 Model fitting and Selection

Modeling was performed with $\log_{10}$-transformed data of both mercury concentrations and fish length (centered to standard size of 75 mm fork length) according to transformation plots (**Figure C7-3**). Due to insufficient data, especially considering fish length across sampling locations, analysis was performed using 2022 samples, focusing characterization of length-mercury relationships on spatial changes (but see **Section C.1.1** for temporal investigation). AICc ranked Fit 2 (THg ~ LC + Location) as the best model, indicating that the slope of the length-mercury relationships was not influenced by location (**Table C7-4**). Formal assessment of residuals from Fit 2 identified one more outlier (**Table C7-5**); removing the outlier changed the AICc values slightly (not shown) but did not affect model ranking (see **Table C7-4**). Detailed results for the final model (Fit 2) are shown in **Table C7-6** (ANOVA table), **Table C7-7** (coefficient estimates, confidence intervals and p-values) and **Figure C7-4** (model diagnostics). As expected, the model fits generally show strong positive relationships between length and mercury concentrations. Visual inspection of model diagnostics showed no issues with residuals or collinearity. The final model had an R^2 of 0.51, indicating that it explains much of the variability in the underlying data.

C.7.3 Estimates of Mercury Concentrations

Final model fits are shown relative to the underlying data in **Figure C7-5**. This model was used to estimate mercury concentrations and ±95% confidence intervals for three sizes (75, 85, and 95 mm) of Redside Shiner at all location-period combinations supported by existing data (**Figure** C7-6).

There were insufficient temporal data for total mercury to formally include time period in the characterization of length-mercury relationships for Redside Shiner. To gain some insights into temporal patterns, we combined total mercury and methylmercury data (**Figure** C7-7); the data looked comparable and there were samples available for each time period for Section 5. The data were trimmed to represent similar fish length range (85-119 mm fork length) across time periods. Mean tissue mercury concentrations (and standard deviations) are provided in **Figure C7-8**.

Table C7-1. Redside Shiner sample numbers by location and period.

Redside Shiner – Sample Summary					
Period	**Sections 1/3**	**Section 5**	**Section 7**	**Section 9**	**Total**
2008-2011	-	11	-	-	**11**
2017-2021	-	1	-	-	**1**
2022	36	38	34	36	**144**
Total	**36**	**50**	**34**	**36**	**156**

Table C7-2. Redside Shiner sample numbers by size class, location and period.

Redside Shiner – Size Classes (fork length in mm)			
Location/Period	**50-100**	**100-150**	**Total**
Sections 1/3			
2022	18	18	**36**
Section 5			
2008-2011	7	4	**11**
2017-2021	1	-	**1**
2022	28	10	**38**
Section 7			
2017-2021	-	-	**-**
2022	34	-	**34**
Section 9			
2022	35	1	**36**

Table C7-3. Summary of key mercury-related metrics for Redside Shiner by location and period.

Redside Shiner – Data Summary*					
Location/Period	Fork Length (mm)	Total Weight (g)	Total Hg (mg/kg ww)	Carbon SI Ratios (‰)	Nitrogen SI Ratios (‰)
Sections 1/3					
2022	36, 92±22, 55–140	36, 13±8, 1–35	36, 0.047±0.02, 0.018–0.088	34, -28±0.7, -29.1–-26.3	34, 8.1±0.5, 6.4–9.2
Section 5					
2008-2011	11, 99±12, 85–119	11, 14±7, 6–26	11, 0.049±0.0095, 0.032–0.06	11, -25.5±0.4, -26–-24.3	11, 8.1±0.3, 7.6–8.6
2017-2021	7, 78±22, 46–106	7, 6±5, 1–15	1, 0.048±NA	7, -27.5±0.7, -28.3–-26.1	7, 7.6±0.6, 6.9–8.6
2022	38, 85±17, 53–115	36, 9±4, 2–20	38, 0.035±0.013, 0.019–0.07	36, -27.4±0.7, -29.1–-25.4	36, 8±0.6, 7–9.5
Section 7					
2017-2021	4, 45±9, 33–53	2, 1±1, 0–1	NA	4, -27.5±0.7, -28.1–-26.8	4, 7.2±0.9, 6.6–8.5
2022	34, 72±15, 55–98	33, 5±4, 1–12	34, 0.028±0.014, 0.017–0.096	34, -26.3±0.4, -27.3–-25.4	34, 7.8±0.4, 6.9–8.8
Section 9					
2022	36, 85±10, 62–105	35, 8±3, 2–14	36, 0.029±0.01, 0.021–0.078	36, -25.9±0.5, -27.8–-25.1	36, 7.9±0.4, 7–9

* Statistics given include count, mean ± standard deviation, and minimum-maximum, respectively (if count > 1).

Table C7-4. Comparison of model fits for Redside Shiner.

Redside Shiner – Model Comparison				
Model	Structure[1]	Note	AICc	Delta
Fit 2	THg ~ LC + Location	Location-specific intercepts and similar slopes	-184.1	0.0
Fit 3	THg ~ LC * Location	Location-specific intercepts and slopes	-183.2	1.0
Fit 1	THg ~ LC	Similar intercepts and slopes	-164.8	19.4

[1] LC is fish length centered to standard size (i.e., 75 mm fork length).
Fish THg concentrations and centered lengths were $\log_{10}$ transformed.

Table C7-5. Outliers identified for Redside Shiner based on the final model.

Redside Shiner – Outliers						
Location	Date	Fish ID	Species	StudRes[1]	CooksD[1]	Type[2]
Section 9	2022-10-20	2127	Redside Shiner	4.043	0.085	High Residual

[1] StudRes = studentized residual; CooksD = Cook's distance

[2] Type: 'High Residual' = studentized residual ≥ 4, 'High Leverage' = Cook's distance ≥ 0.5, 'Both' = exceed both criteria.

Table C7-6. Final model ANOVA results for Redside Shiner.

Redside Shiner – ANOVA					
Predictor[1]	df	Sum sq	Mean sq	F	P
LC	1	1.79	1.79	128	<0.001
Location	3	0.488	0.163	11.7	<0.001
Residuals	138	1.92	0.014	-	-

[1] LC is fish length centered to standard size (i.e., 75 mm fork length).
Fish THg concentrations and centered lengths were $\log_{10}$ transformed.
Fit 2: THg ~ LC + Location (r^2 = 0.506)

Table C7-7. Final model summary results for Redside Shiner.

Redside Shiner – Model Summary			
Variable[1]	Estimate	95% CI[2]	p-value
Intercept	-1.455	-1.497, -1.412	<0.001
LC	1.081	0.8601, 1.303	<0.001
Location			
Sections 1/3	—	—	
Section 5	-0.0778	-0.1324, -0.0231	0.006
Section 7	-0.0984	-0.1587, -0.0380	0.002
Section 9	-0.1659	-0.2215, -0.1102	<0.001

[1] LC is fish length centered to standard size (i.e., 75 mm fork length).
Fish THg concentrations and centered lengths were $\log_{10}$ transformed.
Fit 2: THg ~ LC + Location (r^2 = 0.506)

[2] CI = Confidence Interval

Figure C7-1. Key mercury-related data for Redside Shiner.

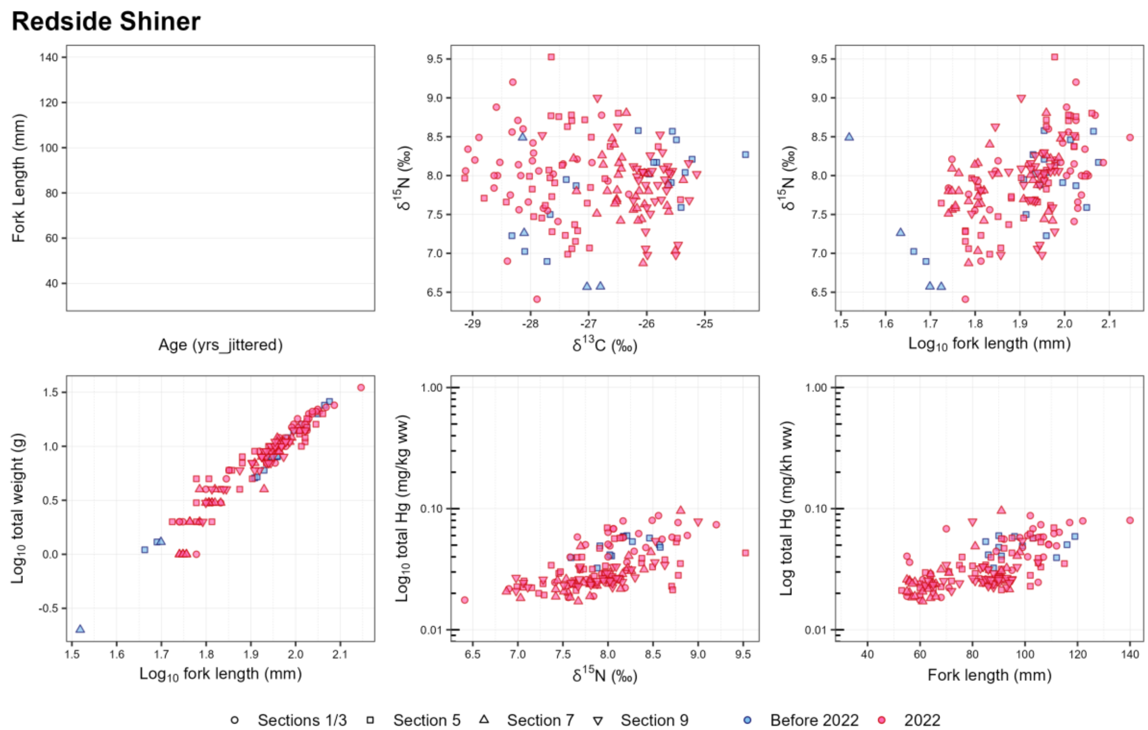


Figure C7-2. Length-mercury plots by location and period for Redside Shiner.

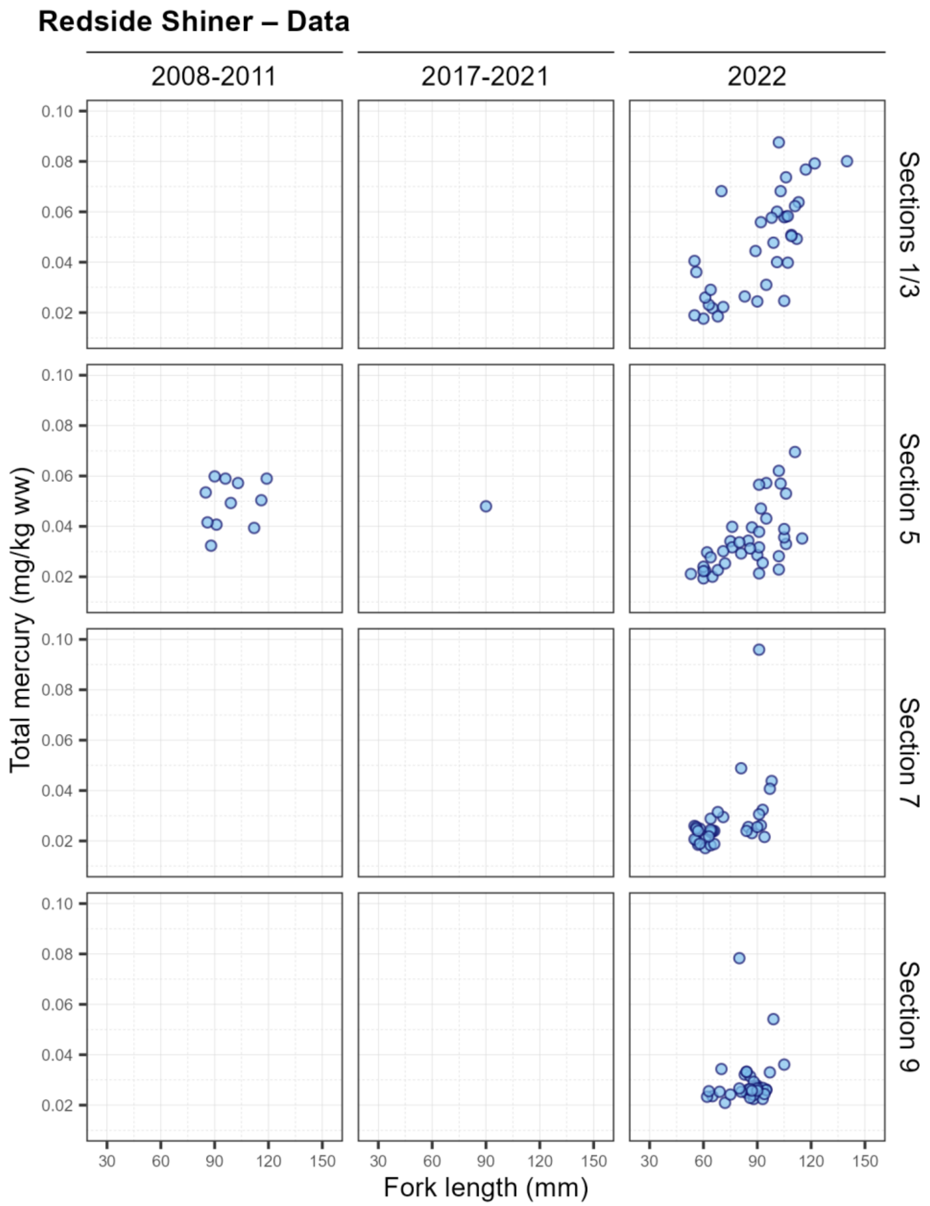


Figure C7-3. Length-mercury plots for Redside Shiner showing transformation options.

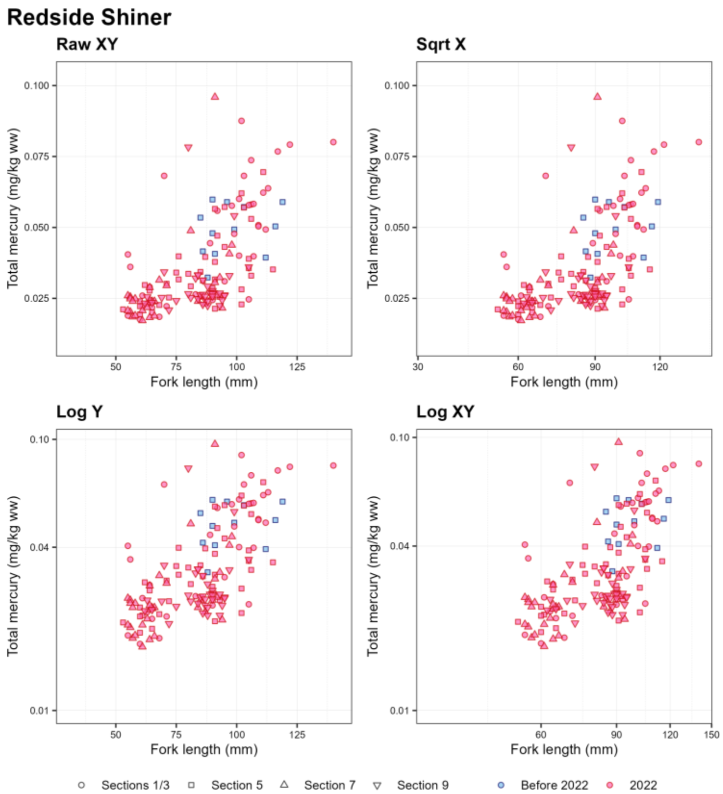


Figure C7-4. Diagnostics of final model for Redside Shiner.

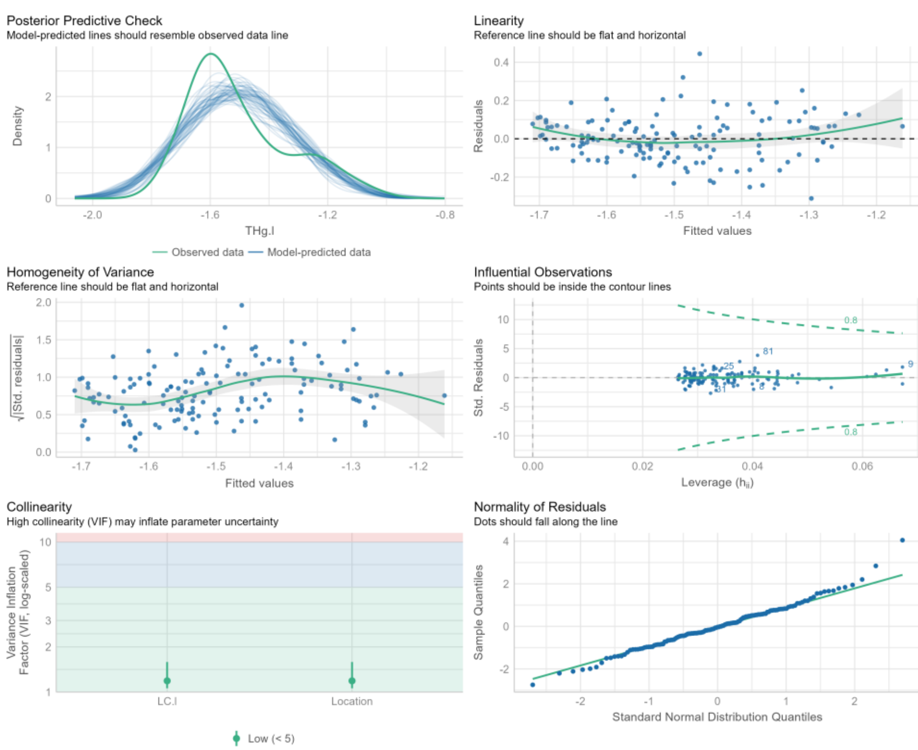


Figure C7-5. Length-mercury plots showing final model fits (and ±95% confidence intervals) for Redside Shiner.

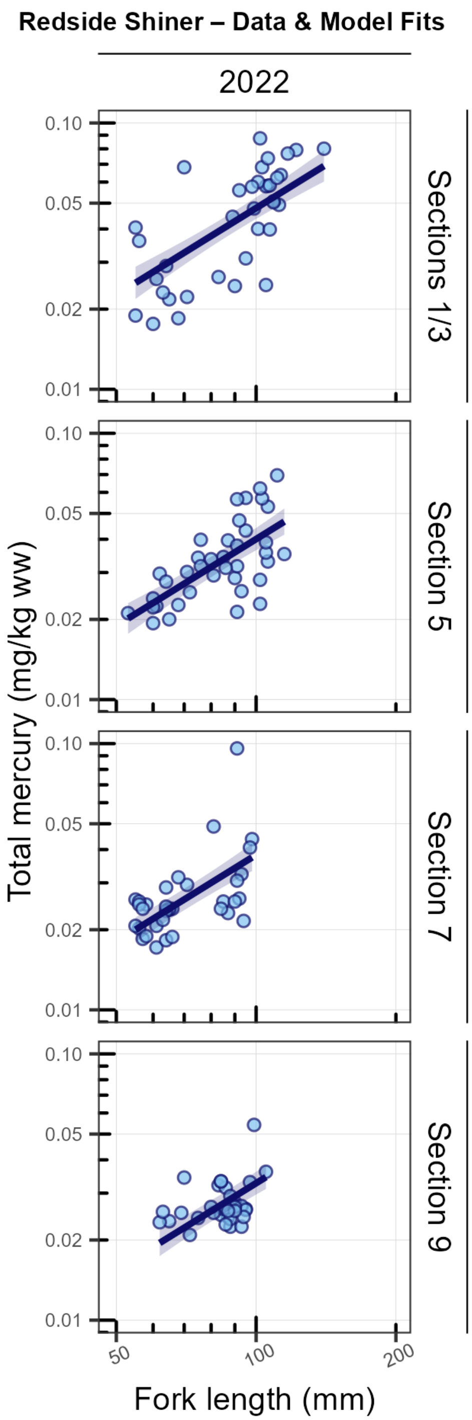


Figure C7-6. Estimates of mercury concentrations (±95% confidence intervals) in select sizes of Redside Shiner using the best model.

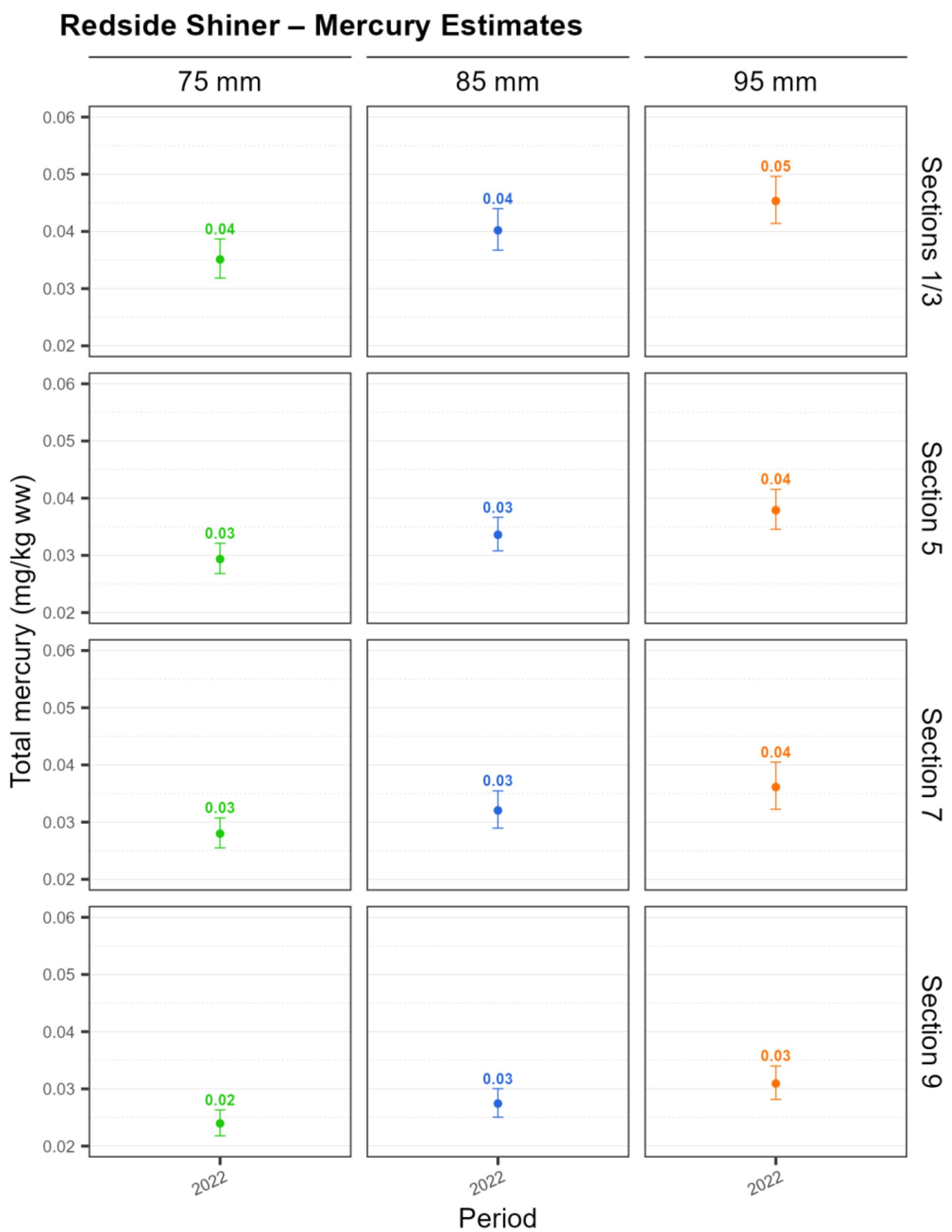


Figure C7-7. Length-mercury plots of raw data in Redside Shiner across location and period (blue circles represent total mercury concentrations and red circles represent methylmercury concentrations).

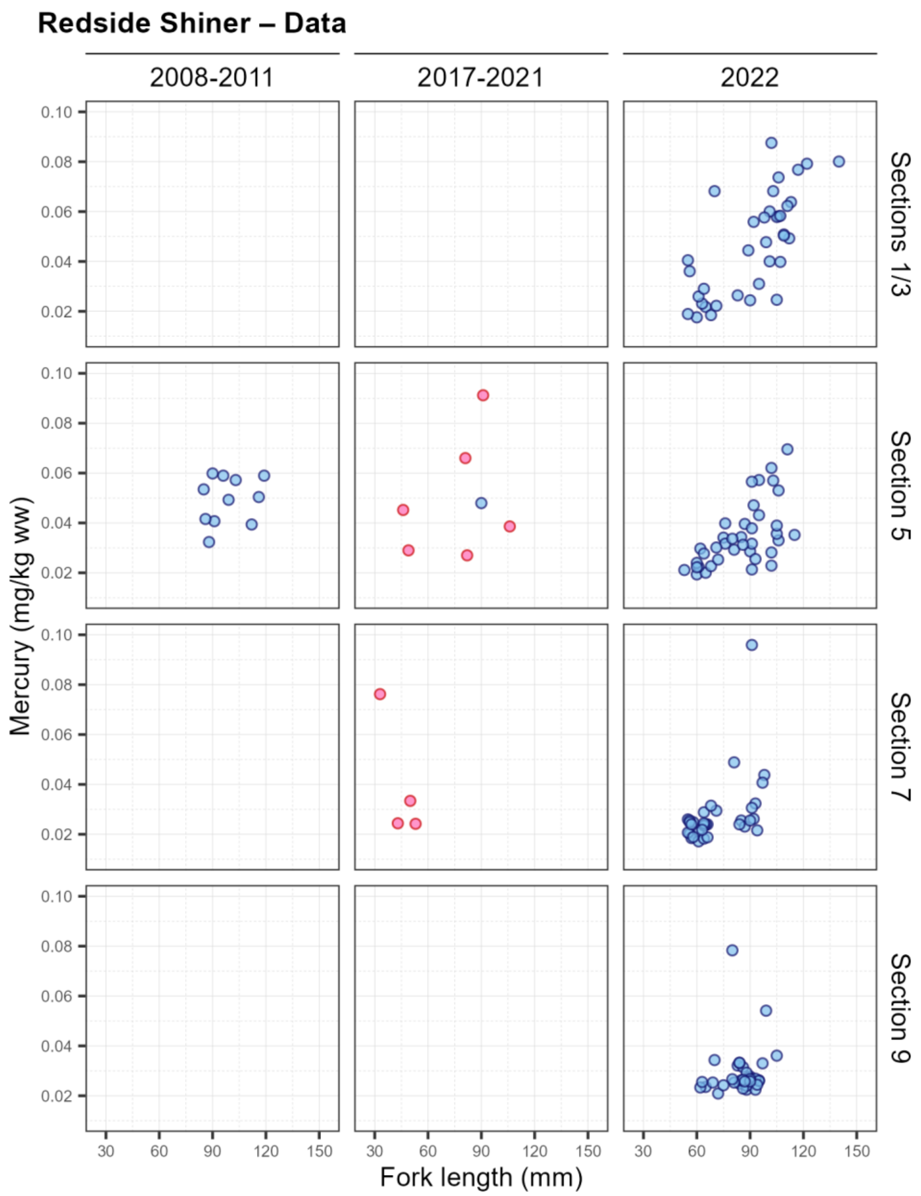
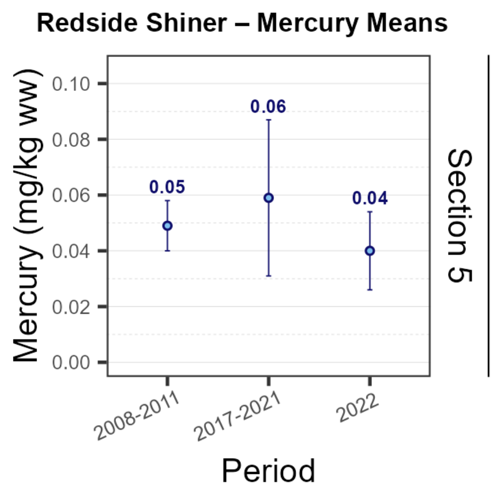


Figure C7-8. Averages (± standard deviations) of combined total mercury and methylmercury concentrations in Redside Shiner across period.



C.8 NON-TARGET SPECIES

Tissue mercury concentrations were analyzed for non-target species that were collected on an opportunistic basis across sampling sections and years from Peace River. The non-target species include Arctic Grayling, Burbot, Goldeye, Lake Trout, Largescale Sucker, Northern Pike, and White Sucker. Sample sizes of these non-target species were insufficient to perform detailed location- and period-specific modeling similar to that in target species. Data were thus combined across sampling locations and periods to characterize length-mercury relationships and provide size-specific estimates of mercury concentrations in non-target species. Depending on whether or not mercury concentrations were related to fish length, statistical analyses followed either generic modeling or mean estimates, which are outlined below:

Generic Modeling

Among non-target species, data from Bubot, Largescale Sucker, Northern Pike, and White Sucker generally showed positive relationships between mercury concentrations and fish length. Statistical analyses to characterize length-mercury relationships and provide mercury estimates thus followed a genetic modeling approach, as described below:

- *Data & Modeling* – Samples were combined across sampling locations and periods for each species. Length-mercury relationships were fit using a generic model (THg ~ LC), where THg was $\log_{10}$-transformed total mercury concentrations (mg/kg wet weight) and LC was centered fork length.
- *Mercury Estimates* – The generic models were used to provide estimates (± 95% confidence intervals) of total mercury concentrations at multiple species-specific standard sizes (small, medium, and large). Given that data from all sampling locations and periods were combined to fit the generic models, mercury estimates are not location- and/or period-specific.

Mean Estimates

Data from the remaining target species (Arctic Grayling, Goldeye, and Lake Trout) generally showed no relationships between mercury concentrations and fish length. Estimates of mercury concentrations in these non-target species were thus simply arithmetic means (± standard deviations), which were calculated using data combined across sampling locations and periods.

Detailed species-specific results regarding generic modeling or mean estimates of mercury concentrations are presented in the following sub-sections.

C.8.1 Burbot

For Burbot, data were available from locations 1-3, 5, 7, and 9, and period 2017-2021. Location- and period-specific counts of samples and descriptive statistics of data are given in **Table C8-1**. An overall visualization of key mercury-related data, including length-mercury relationship, is depicted in **Figure C8-1**.

Results of the generic length-mercury modeling using fish length centered to standard size of 450 mm fork length and log_{10}-transformed total mercury concentrations are provided in **Table C8-2**. The mode fit relative to the underlying data (combined across sampling locations and periods) as well as the generic (i.e., not location- and/or period-specific) estimates of mercury concentrations at three sizes (325, 450, and 575 mm) of Burbot are shown in **Figure C8-2**. Overall, the length-mercury model showed a positive relationship between fish length and mercury concentrations, with fish length explaining 38% of variability of mercury concentrations in the combined data.

Table C8-1. Sample sizes and descriptive data for Burbot.

Burbot – Sample Summary					
Period	**Sections 1/3**	**Section 5**	**Section 7**	**Section 9**	**Total**
2008-2011	-	-	-	-	**0**
2017-2021	1	4	5	12	**22**
2022	-	-	-	-	**0**
Total	**1**	**4**	**5**	**12**	**22**

Burbot – Data Summary*					
Location/Period	**Fork Length (mm)**	**Total Weight (g)**	**Total Hg (mg/kg ww)**	**Carbon SI Ratios (‰)**	**Nitrogen SI Ratios (‰)**
Sections 1/3					
2017-2021	1, 420±NA	1, 367±NA	1, 0.17±NA	1, -28.1±NA	1, 10.4±NA
Section 5					
2017-2021	4, 384±53, 326–454	4, 351±144, 186–485	4, 0.076±0.026, 0.039–0.099	2, -27.1±0.3, -27.4–-26.9	2, 8.7±0.8, 8.1–9.2
Section 7					
2017-2021	5, 423±78, 341–550	5, 466±307, 216–1000	5, 0.13±0.032, 0.075–0.16	5, -27.1±1.8, -29.6–-24.6	5, 10.3±1, 8.7–11.2
Section 9					
2017-2021	12, 448±100, 302–635	12, 512±302, 170–1223	12, 0.15±0.07, 0.039–0.26	11, -26.2±0.3, -26.7–-25.8	11, 10.3±0.6, 8.8–11.2

* Statistics given include count, mean ± standard deviation, and minimum-maximum, respectively (if count > 1).

Table C8-2. Results of generic size-mercury modeling for Burbot.

Burbot – ANOVA					
Predictor[1]	**df**	**Sum sq**	**Mean sq**	**F**	**P**
LC	1	0.455	0.455	13.8	0.001
Residuals	20	0.658	0.033	-	-

[1] LC is fish length centered to standard size (i.e., 450 mm fork length). Fish THg concentrations were log_{10} transformed.

Generic model: THg ~ LC (r^2 = 0.379)

Burbot – Model Summary			
Variable[1]	**Estimate**	**95% CI**[2]	**p-value**
Intercept	-0.8932	-0.9762, -0.8102	<0.001
LC	0.0017	0.0008, 0.0027	0.001

[1] LC is fish length centered to standard size (i.e., 450 mm fork length). Fish THg concentrations were log_{10} transformed.

Generic model: THg ~ LC (r^2 = 0.379)

[2] CI = Confidence Interval

Figure C8-1. Key mercury-related data for Burbot.

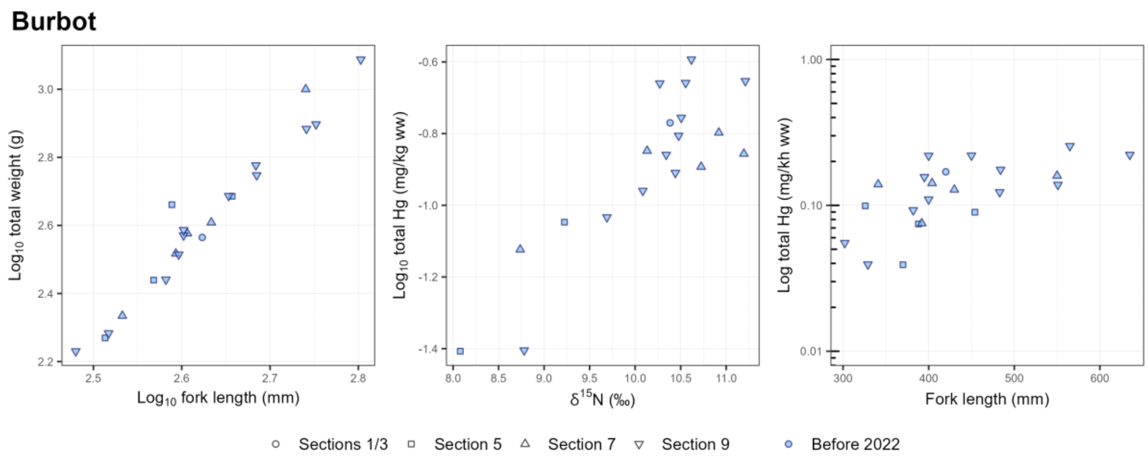
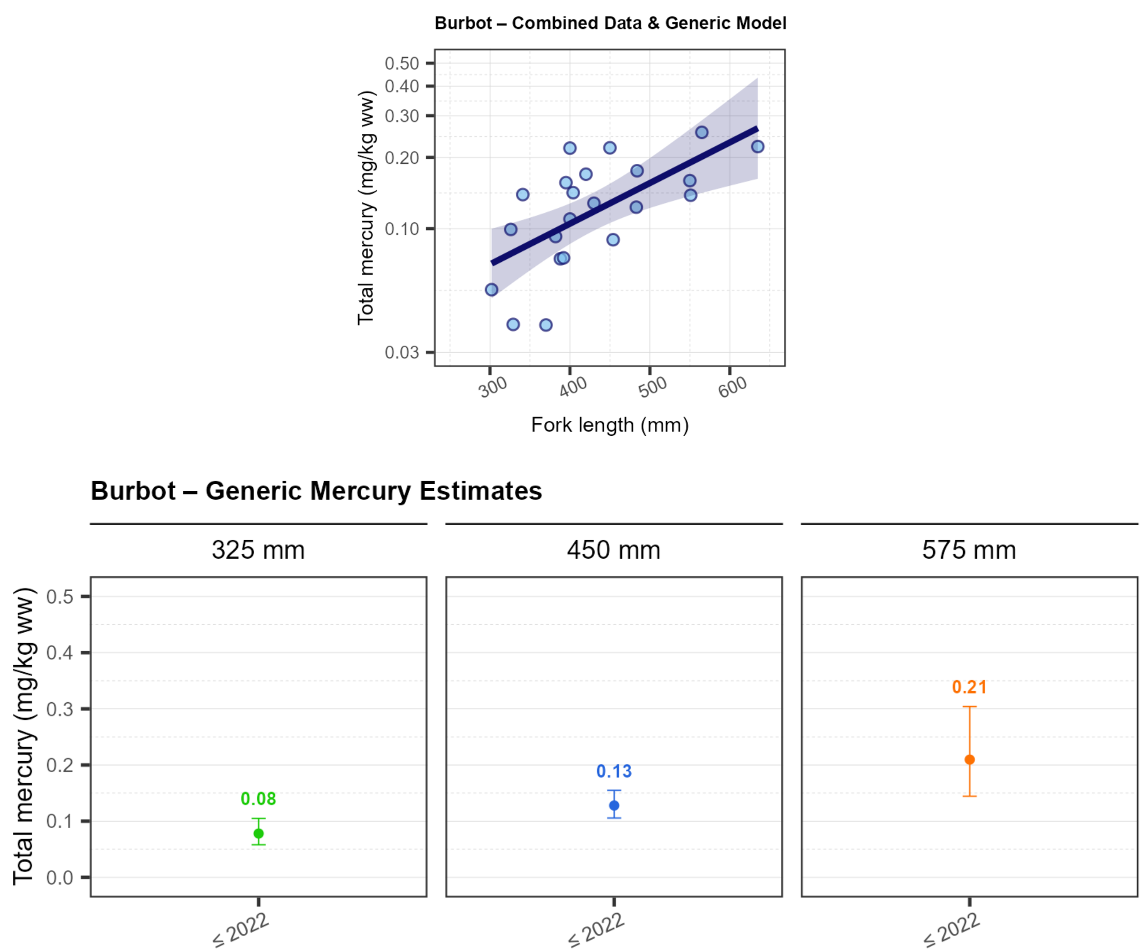


Figure C8-2. Model fit and underlying data along with generic mercury estimates for Burbot.



C.8.2 Largescale Sucker

For Largescale Sucker, data were available from locations 1-3, 5, 7, and 9, and period 2017-2021. Location- and period-specific counts of samples and descriptive statistics of data are given in **Table C8-3**. An overall visualization of key mercury-related data, including length-mercury relationship, is depicted in **Figure C8-3**.

Results of the generic length-mercury modeling using fish length centered to standard size of 450 mm fork length and $\log_{10}$-transformed total mercury concentrations are provided in **Table C8-4**. The mode fit relative to the underlying data (combined across sampling locations and periods) as well as the generic (i.e., not location- and/or period-specific) estimates of mercury concentrations at three sizes (375, 420, and 550 mm) of Largescale Sucker are shown in **Figure C8-4**. Overall, the length-mercury model showed a positive relationship between fish length and mercury concentrations, with fish length explaining 59% of variability of mercury concentrations in the combined data.

Table C8-3. Sample sizes and descriptive data for Largescale Sucker.

Largescale Sucker – Sample Summary					
Period	Sections 1/3	Section 5	Section 7	Section 9	Total
2008-2011	-	-	-	-	**0**
2017-2021	11	5	5	4	**25**
2022	-	-	-	-	**0**
Total	**11**	**5**	**5**	**4**	**25**

Largescale Sucker – Data Summary*					
Location/Period	Fork Length (mm)	Total Weight (g)	Total Hg (mg/kg ww)	Carbon SI Ratios (‰)	Nitrogen SI Ratios (‰)
Sections 1/3					
2017-2021	11, 448±53, 380–573	11, 1093±360, 655–1986	11, 0.13±0.082, 0.055–0.26	11, -28±0.5, -28.9–-27.3	11, 7.5±0.4, 7–8.1
Section 5					
2017-2021	5, 479±65, 391–551	5, 1350±483, 695–1832	5, 0.15±0.089, 0.052–0.28	5, -27.6±0.6, -28.5–-27.1	5, 7.3±0.6, 6.8–8.4
Section 7					
2017-2021	5, 470±16, 452–494	5, 1291±121, 1093–1409	5, 0.1±0.027, 0.07–0.14	5, -27.8±0.3, -28.2–-27.4	5, 7.7±0.2, 7.3–7.9
Section 9					
2017-2021	4, 394±29, 363–430	4, 753±136, 595–881	4, 0.06±0.013, 0.048–0.075	4, -27.1±0.6, -27.8–-26.4	4, 7.4±0.1, 7.3–7.6

* Statistics given include count, mean ± standard deviation, and minimum-maximum, respectively (if count > 1).

Table C8-4. Results of generic size-mercury modeling for Largescale Sucker.

Largescale Sucker – ANOVA					
Predictor[1]	df	Sum sq	Mean sq	F	P
LC	1	0.836	0.836	35.2	<0.001
Residuals	23	0.546	0.024	-	-

[1] LC is fish length centered to standard size (i.e., 450 mm fork length). Fish THg concentrations were $\log_{10}$ transformed.
Generic model: THg ~ LC (r^2 = 0.588)

Largescale Sucker – Model Summary			
Variable[1]	Estimate	95% CI[2]	p-value
Intercept	-0.9971	-1.061, -0.9334	<0.001
LC	0.0035	0.0023, 0.0048	<0.001

[1] LC is fish length centered to standard size (i.e., 450 mm fork length). Fish THg concentrations were $\log_{10}$ transformed.
Generic model: THg ~ LC (r^2 = 0.588)
[2] CI = Confidence Interval

Figure C8-3. Key mercury-related data for Largescale Sucker.

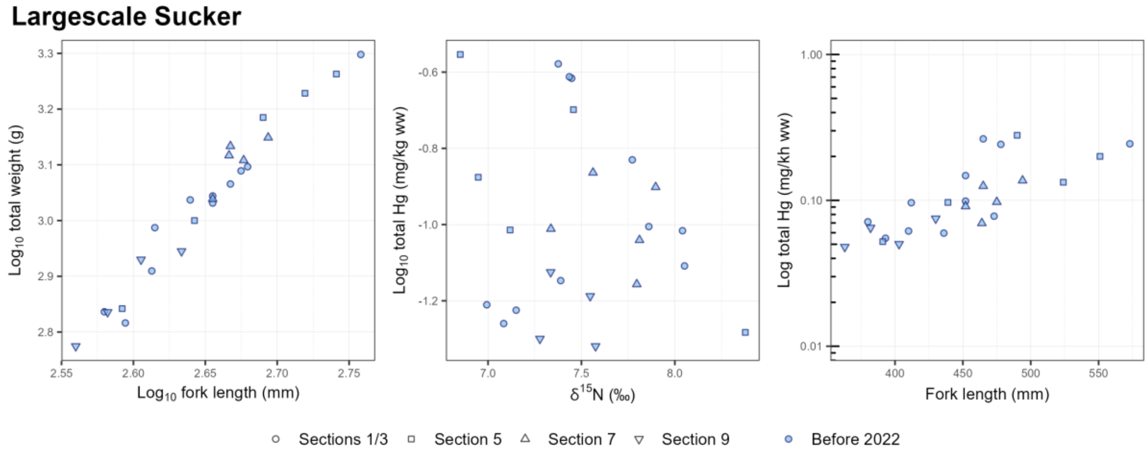
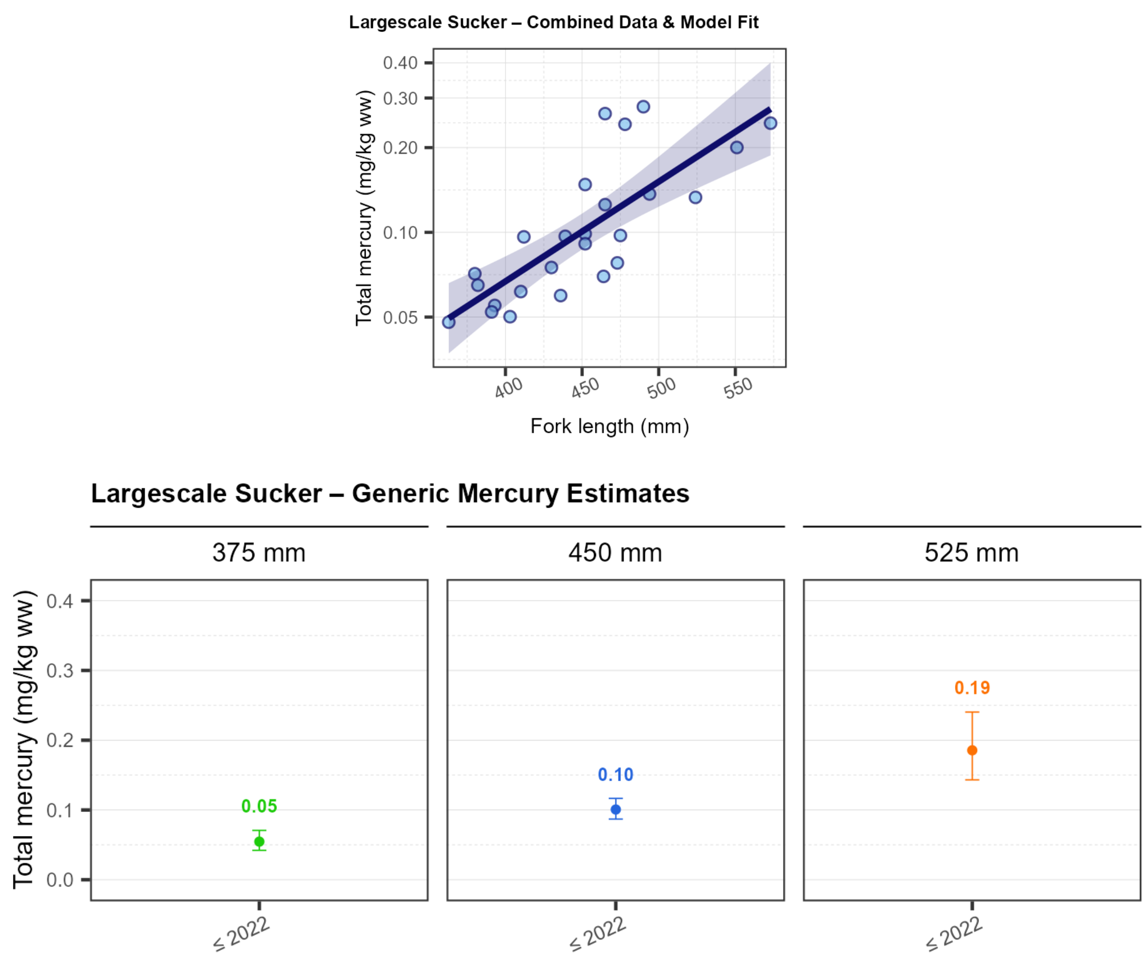


Figure C8-4. Model fit and underlying data along with generic mercury estimates for Largescale Sucker.



C.8.3 Northern Pike

For Northern Pike, data were available from locations 1-3, 5, 7, and 9, and period 2017-2021. Location- and period-specific counts of samples and descriptive statistics of data are given in **Table C8-5**. An overall visualization of key mercury-related data, including length-mercury relationship, is depicted in **Figure C8-5**.

Results of the generic length-mercury model using fish length centered to standard size of 550 mm fork length and log_{10}-transformed total mercury concentrations are provided in **Table C8-6**. The mode fit relative to the underlying data (combined across sampling locations and periods) as well as the generic (i.e., not location- and/or period-specific) estimates of mercury concentrations at three sizes (400, 550, and 700 mm) of Northern Pike are shown in **Figure C8-6**. Overall, the length-mercury model showed a positive relationship between fish length and mercury concentrations, with fish length explaining 85% of variability of mercury concentrations in the combined data.

Table C8-5. Sample sizes and descriptive data for Northern Pike.

Northern Pike – Sample Summary					
Period	Sections 1/3	Section 5	Section 7	Section 9	Total
2008-2011	-	-	-	-	**0**
2017-2021	6	33	17	6	**62**
2022	-	-	-	-	**0**
Total	**6**	**33**	**17**	**6**	**62**

Northern Pike – Data Summary*					
Location/Period	Fork Length (mm)	Total Weight (g)	Total Hg (mg/kg ww)	Carbon SI Ratios (‰)	Nitrogen SI Ratios (‰)
Sections 1/3					
2017-2021	6, 539±153, 348–684	5, 1642±1137, 345–2737	6, 0.14±0.11, 0.035–0.34	6, -28.1±2.2, -31.5–-25.9	6, 9.1±1.3, 7.3–10.6
Section 5					
2017-2021	33, 512±134, 284–800	33, 1228±992, 159–4139	33, 0.12±0.066, 0.04–0.27	32, -27.3±0.6, -28.7–-26.3	32, 9.3±0.9, 7.3–11.2
Section 7					
2017-2021	17, 619±183, 351–896	16, 2226±1745, 305–5470	17, 0.22±0.16, 0.037–0.64	16, -26.9±0.5, -27.9–-26.3	16, 10.2±0.9, 8.4–11.4
Section 9					
2017-2021	6, 501±167, 310–696	6, 1217±1071, 221–2595	6, 0.11±0.076, 0.042–0.24	4, -26.4±0.3, -26.6–-26.1	4, 9.7±1, 8.3–10.6

* Statistics given include count, mean ± standard deviation, and minimum-maximum, respectively (if count > 1).

Table C8-6. Results of generic size-mercury modeling for Northern Pike.

Northern Pike – ANOVA					
Predictor[1]	df	Sum sq	Mean sq	F	P
LC	1	5.00	5.00	333	<0.001
Residuals	60	0.902	0.015	-	-

[1] LC is fish length centered to standard size (i.e., 550 mm fork length). Fish THg concentrations were $\log_{10}$ transformed.

Generic model: THg ~ LC (r^2 = 0.845)

Northern Pike – Model Summary			
Variable[1]	Estimate	95% CI[2]	p-value
Intercept	-0.9363	-0.9675, -0.9051	<0.001
LC	0.0018	0.0016, 0.0020	<0.001

[1] LC is fish length centered to standard size (i.e., 550 mm fork length). Fish THg concentrations were $\log_{10}$ transformed.

Generic model: THg ~ LC (r^2 = 0.845)

[2] CI = Confidence Interval

Figure C8-5. Key mercury-related data for Northern Pike.

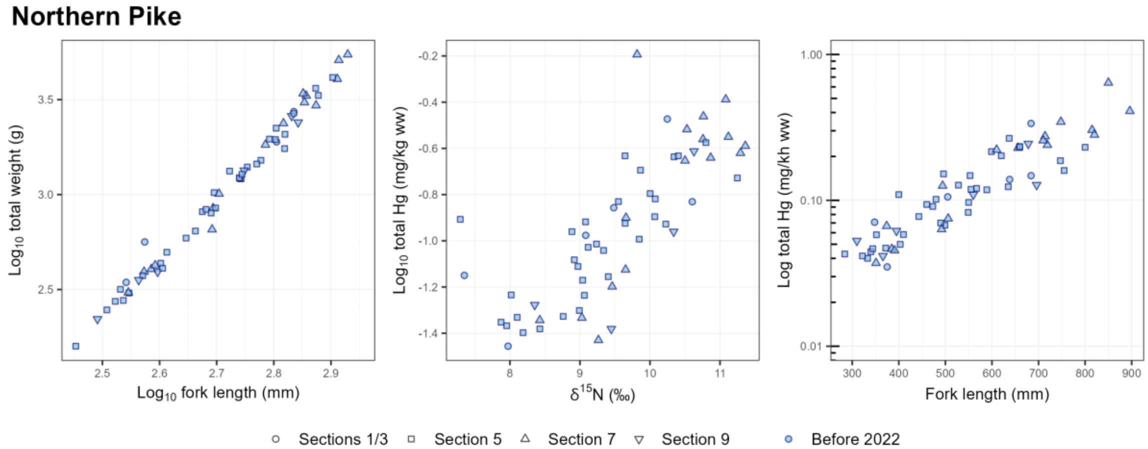
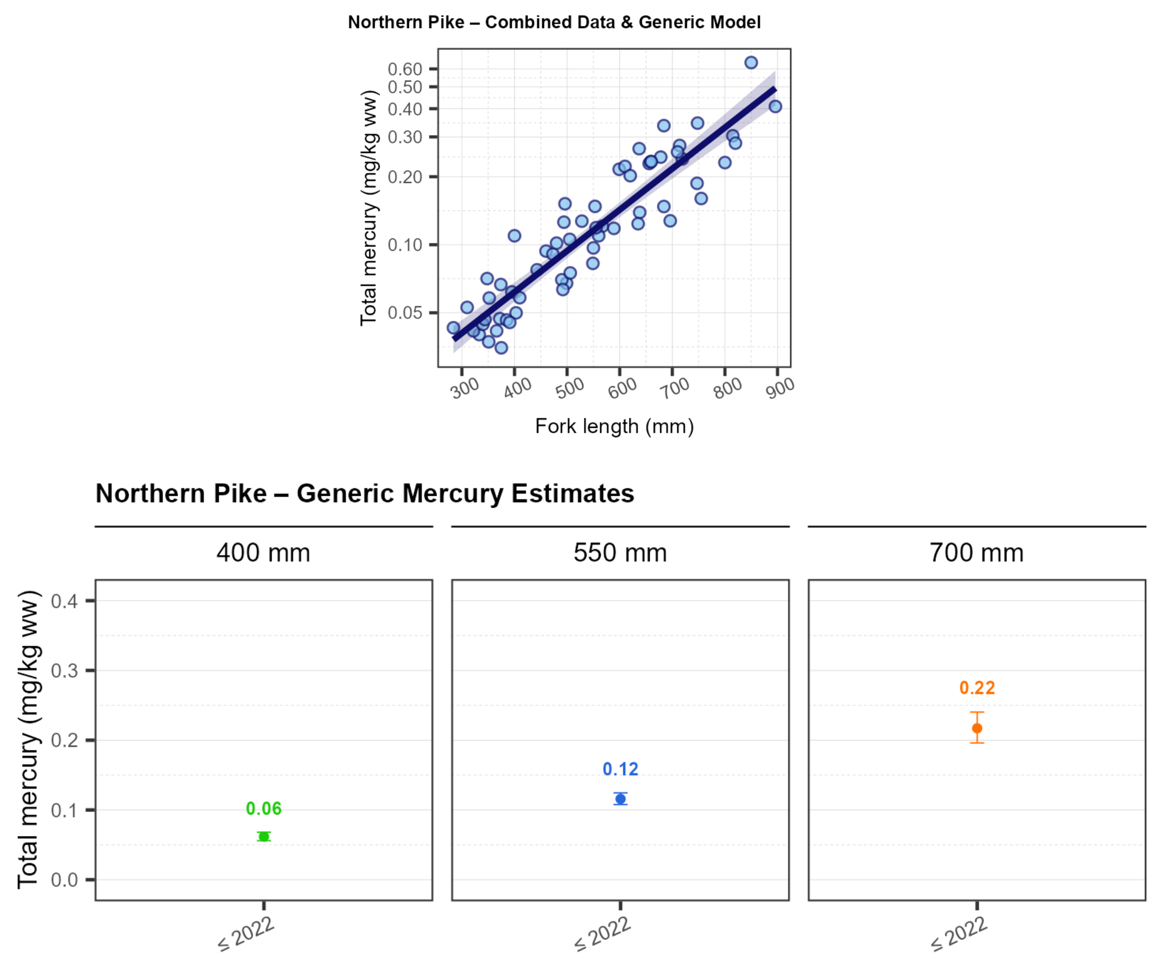


Figure C8-6. Model fit and underlying data along with generic mercury estimates for Northern Pike.



C.8.4 White Sucker

For White Sucker, data were available from locations 1-3, 5, 7, and 9, and period 2017-2021. Location- and period-specific counts of samples and descriptive statistics of data are given in **Table C8-7**. An overall visualization of key mercury-related data, including length-mercury relationship, is depicted in **Figure C8-7**.

Results of the generic length-mercury model using fish length centered to standard size of 350 mm fork length and log_{10}-transformed total mercury concentrations are provided in **Table C8-8**. The mode fit relative to the underlying data (combined across sampling locations and periods) as well as the generic (i.e., not location- and/or period-specific) estimates of mercury concentrations at three sizes (325, 375, and 425 mm) of White Sucker are shown in **Figure C8-8**. Overall, the length-mercury model showed a positive relationship between fish length and mercury concentrations, with fish length explaining 60% of variability of mercury concentrations in the combined data.

Table C8-7. Sample sizes and descriptive data for White Sucker.

White Sucker – Sample Summary					
Period	**Sections 1/3**	**Section 5**	**Section 7**	**Section 9**	**Total**
2008-2011	-	-	-	-	**0**
2017-2021	7	5	7	7	**26**
2022	-	-	-	-	**0**
Total	**7**	**5**	**7**	**7**	**26**

White Sucker – Data Summary*					
Location/Period	**Fork Length (mm)**	**Total Weight (g)**	**Total Hg (mg/kg ww)**	**Carbon SI Ratios (‰)**	**Nitrogen SI Ratios (‰)**
Sections 1/3					
2017-2021	7, 419±33, 361–464	7, 1032±276, 636–1479	7, 0.12±0.041, 0.086–0.21	7, -27.2±1.2, -28.7–-25.4	7, 7.3±0.6, 6.2–7.9
Section 5					
2017-2021	5, 372±20, 351–397	5, 639±69, 534–714	5, 0.098±0.029, 0.051–0.12	5, -27.4±0.6, -28–-26.8	5, 7.8±0.8, 7–9
Section 7					
2017-2021	7, 324±48, 272–390	7, 461±222, 243–752	7, 0.07±0.044, 0.032–0.13	7, -25.8±1.6, -28–-23.9	7, 7.7±0.5, 7–8.5
Section 9					
2017-2021	7, 334±53, 277–414	7, 541±264, 281–949	7, 0.088±0.064, 0.033–0.2	7, -27.1±0.6, -28–-26.2	7, 7.6±0.6, 7–8.5

* Statistics given include count, mean ± standard deviation, and minimum-maximum, respectively (if count > 1).

Table C8-8. Results of generic size-mercury modeling for White Sucker.

White Sucker – ANOVA					
Predictor[1]	**df**	**Sum sq**	**Mean sq**	**F**	**P**
LC	1	0.991	0.991	38.1	<0.001
Residuals	24	0.624	0.026	-	-

[1] LC is fish length centered to standard size (i.e., 350 mm fork length).
Fish THg concentrations were $\log_{10}$ transformed.
Generic model: THg ~ LC (r^2 = 0.597)

White Sucker – Model Summary			
Variable[1]	**Estimate**	**95% CI**[2]	**p-value**
Intercept	-1.129	-1.196, -1.062	<0.001
LC	0.0036	0.0024, 0.0048	<0.001

[1] LC is fish length centered to standard size (i.e., 350 mm fork length).
Fish THg concentrations were $\log_{10}$ transformed.
Generic model: THg ~ LC (r^2 = 0.597)

[2] CI = Confidence Interval

Figure C8-7. Key mercury-related data for White Sucker.

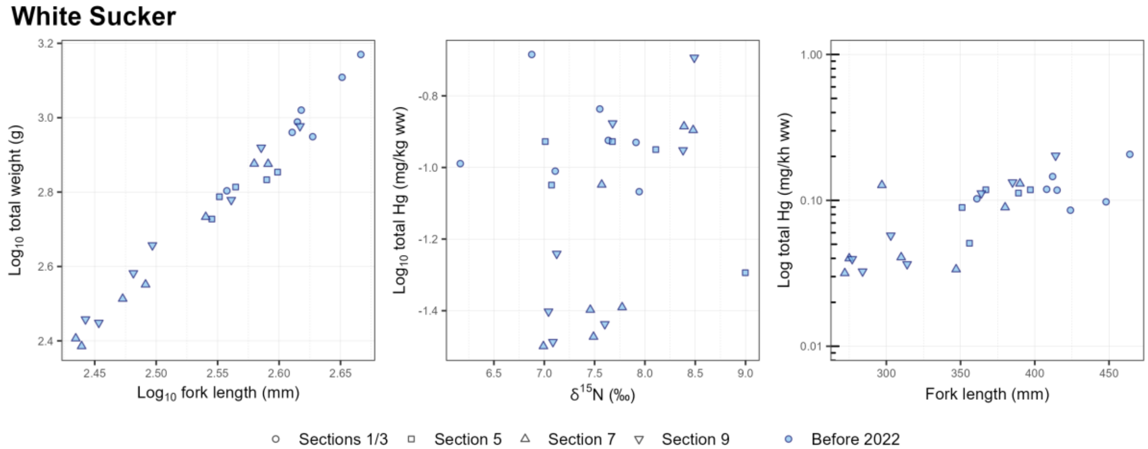
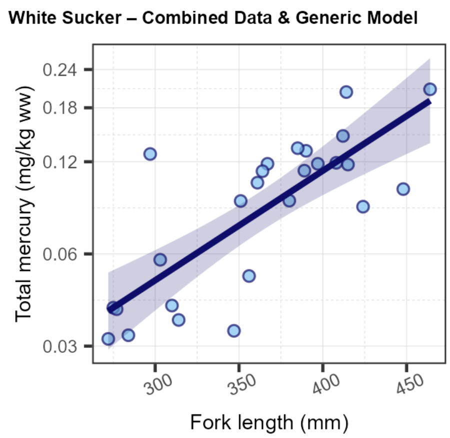
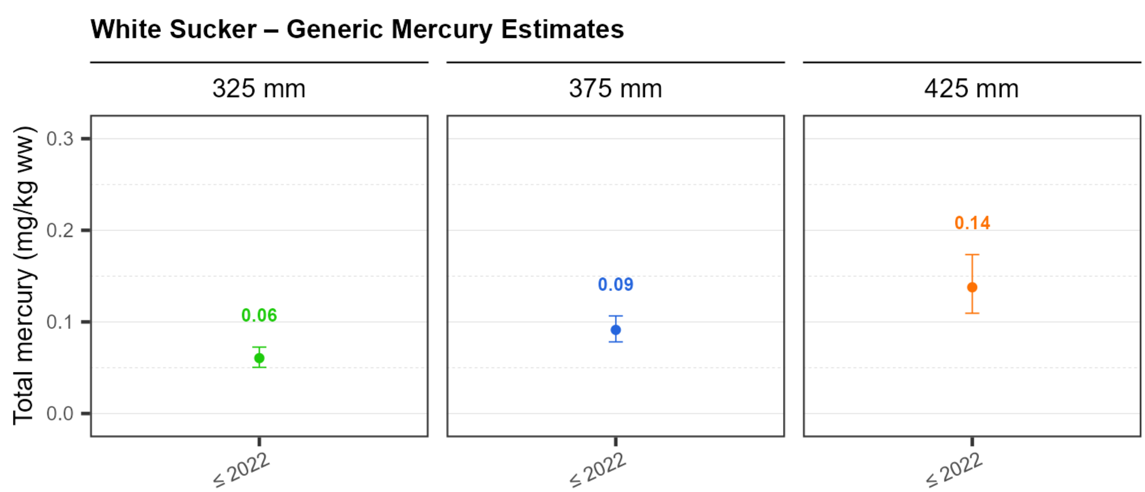


Figure C8-8. Model fit and underlying data along with generic mercury estimates for White Sucker.





C.8.5 Arctic Grayling

For White Sucker, data were available from locations 1-3, 5, and 7, and periods 2017-2021 and 2022. Location- and period-specific counts of samples and descriptive statistics of data are given in **Table C8-9**.

An overall visualization of key mercury-related data (including length-mercury relationship), along with results of mean estimates for fork length and mercury concentrations relative to the underlying data (combined across sampling locations and periods), in Arctic Grayling are shown in **Figure** C8-9.

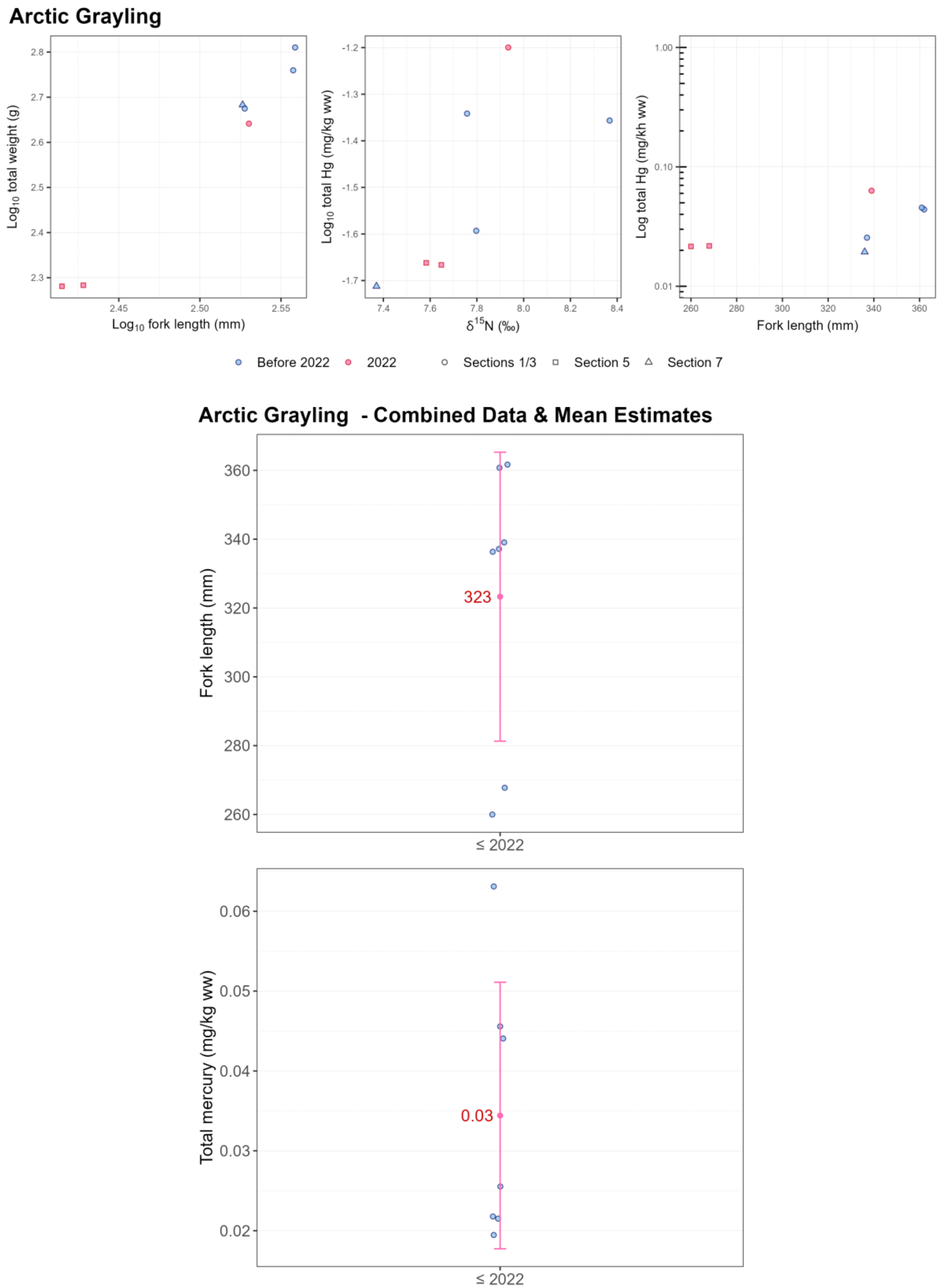
Table C8-9. Sample sizes and descriptive data for Arctic Grayling.

Arctic Grayling – Sample Summary					
Period	**Sections 1/3**	**Section 5**	**Section 7**	**Section 9**	**Total**
2008-2011	-	-	-	-	**0**
2017-2021	3	-	1	-	**4**
2022	1	2	-	-	**3**
Total	**4**	**2**	**1**	**0**	**7**

Arctic Grayling – Data Summary*					
Location/Period	**Fork Length (mm)**	**Total Weight (g)**	**Total Hg (mg/kg ww)**	**Carbon SI Ratios (‰)**	**Nitrogen SI Ratios (‰)**
Sections 1/3					
2017-2021	3, 353±14, 337–362	3, 565±87, 473–646	3, 0.038±0.011, 0.026–0.046	3, -27.9±0.3, -28.1–-27.6	3, 8±0.3, 7.8–8.4
2022	1, 339±NA	1, 438±NA	1, 0.063±NA	1, -28.3±NA	1, 7.9±NA
Section 5					
2022	2, 264±6, 260–268	2, 192±1, 191–192	2, 0.022±0.00016, 0.022–0.022	2, -27.2±0.3, -27.4–-27	2, 7.6±0, 7.6–7.7
Section 7					
2017-2021	1, 336±NA	1, 482±NA	1, 0.019±NA	1, -26.5±NA	1, 7.4±NA

* Statistics given include count, mean ± standard deviation, and minimum-maximum, respectively (if count > 1).

Figure C8-9. Key mercury-related data along with mean estimates of fork length and mercury concentrations for Arctic Grayling.



C.8.6 Goldeye

For White Sucker, data were available from locations 7 and 9, and periods 2010-2011, 2017-2021, and 2022. Location- and period-specific counts of samples and descriptive statistics of data are given in **Table C8-10**.

An overall visualization of key mercury-related data (including length-mercury relationship), along with results of mean estimates for fork length and mercury concentrations relative to the underlying data (combined across sampling locations and periods), in Goldeye are shown in **Figure** C8-10.

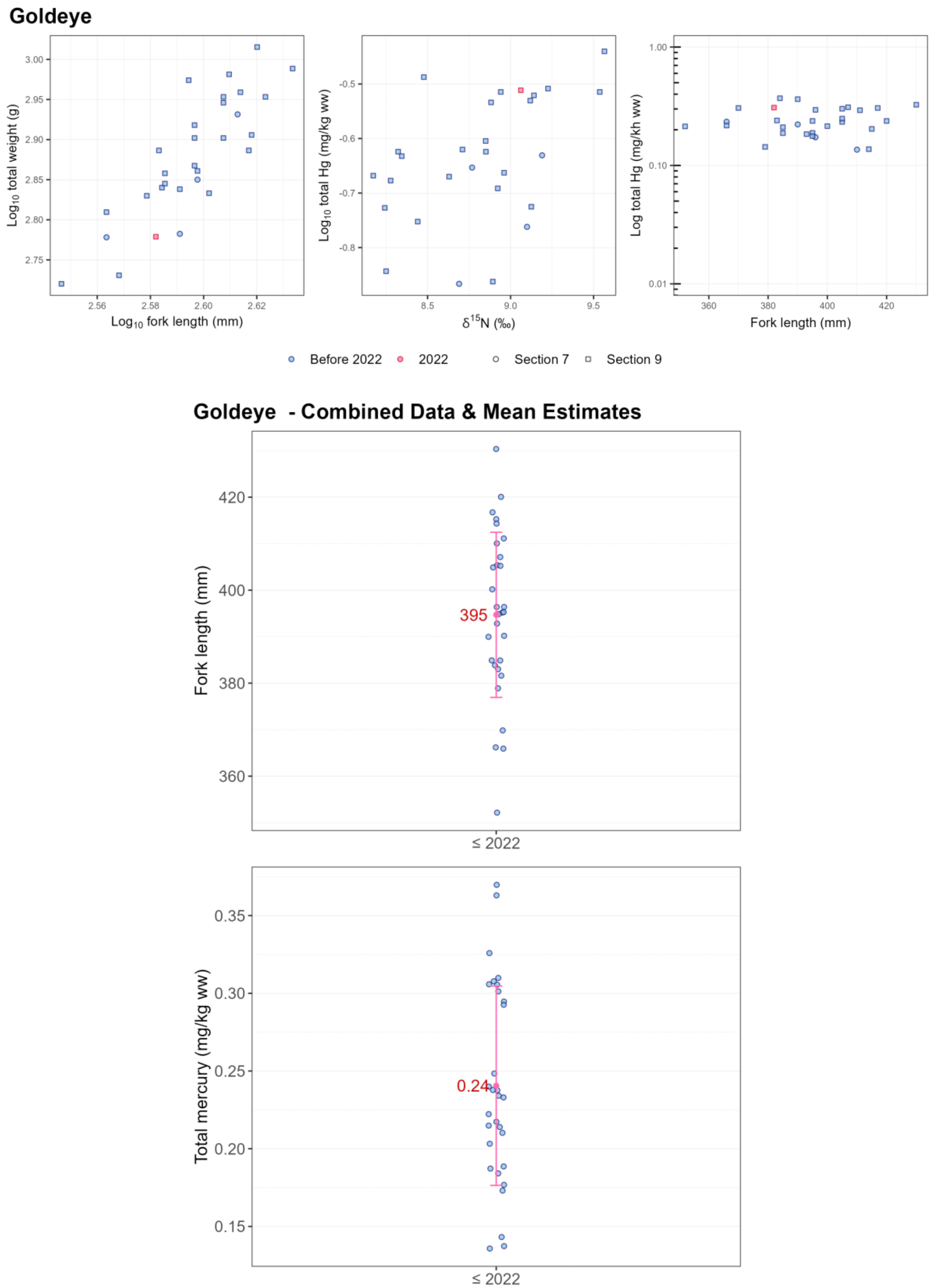
Table C8-10. Sample sizes and descriptive data for Goldeye.

Goldeye – Sample Summary					
Period	Sections 1/3	Section 5	Section 7	Section 9	Total
2008-2011	-	-	3	-	**3**
2017-2021	-	-	1	25	**26**
2022	-	-	-	1	**1**
Total	**0**	**0**	**4**	**26**	**30**

Goldeye – Data Summary*					
Location/Period	Fork Length (mm)	Total Weight (g)	Total Hg (mg/kg ww)	Carbon SI Ratios (‰)	Nitrogen SI Ratios (‰)
Section 7					
2008-2011	3, 391±22, 366–410	3, 721±127, 600–854	3, 0.18±0.049, 0.14–0.23	3, -26.3±0.5, -26.6–-25.8	3, 9±0.3, 8.7–9.2
2017-2021	1, 390±NA	1, 606±NA	1, 0.22±NA	1, -26.1±NA	1, 8.8±NA
Section 9					
2017-2021	25, 396±18, 352–430	25, 784±131, 525–1036	25, 0.25±0.064, 0.14–0.37	23, -26.1±0.6, -27.3–-25.2	23, 8.8±0.4, 8.2–9.6
2022	1, 382±NA	1, 601±NA	1, 0.31±NA	1, -26.6±NA	1, 9.1±NA

* Statistics given include count, mean ± standard deviation, and minimum-maximum, respectively (if count > 1).

Figure C8-10. Key mercury-related data along with mean estimates of fork length and mercury concentrations for Goldeye.



C.8.7 Lake Trout

For White Sucker, data were available from locations 1-3, 5, and 7, and period 2017-2021. Location- and period-specific counts of samples and descriptive statistics of data are given in **Table C8-11**.

An overall visualization of key mercury-related data (including length-mercury relationship), along with results of mean estimates for fork length and mercury concentrations relative to the underlying data (combined across sampling locations and periods), in Lake Trout are shown in **Figure** C8-11.

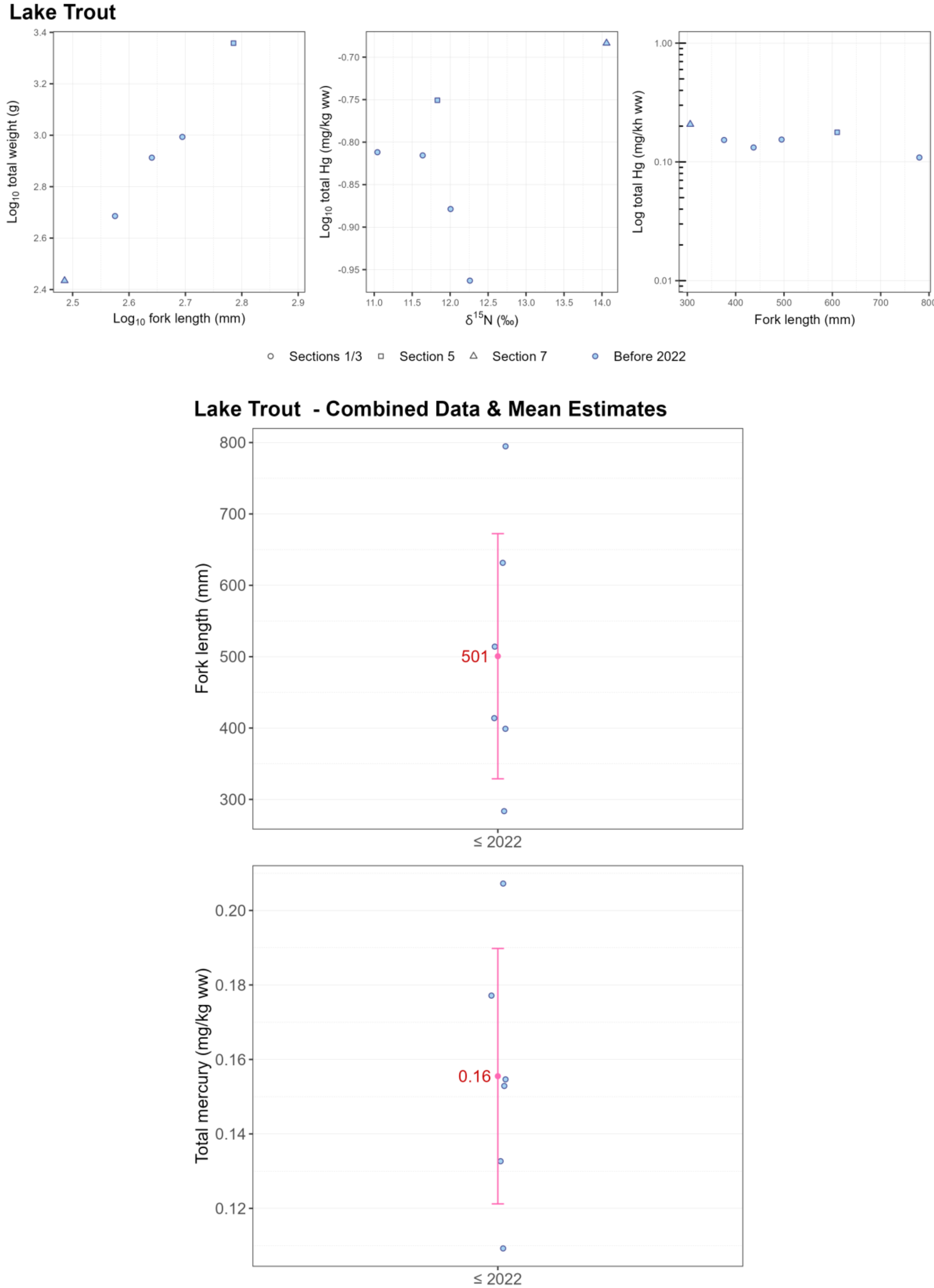
Table C8-11. Sample sizes and descriptive data for Lake Trout.

Lake Trout – Sample Summary					
Period	Sections 1/3	Section 5	Section 7	Section 9	Total
2008-2011	-	-	-	-	**0**
2017-2021	4	1	1	-	**6**
2022	-	-	-	-	**0**
Total	**4**	**1**	**1**	**0**	**6**

Lake Trout – Data Summary*					
Location/Period	Fork Length (mm)	Total Weight (g)	Total Hg (mg/kg ww)	Carbon SI Ratios (‰)	Nitrogen SI Ratios (‰)
Sections 1/3					
2017-2021	4, 522±179, 376–780	3, 763±255, 485–985	4, 0.14±0.021, 0.11–0.15	4, -29.9±3.8, -34.9–-26.9	4, 11.7±0.5, 11–12.3
Section 5					
2017-2021	1, 610±NA	1, 2281±NA	1, 0.18±NA	1, -29.7±NA	1, 11.8±NA
Section 7					
2017-2021	1, 306±NA	1, 272±NA	1, 0.21±NA	1, -31.8±NA	1, 14.1±NA

* Statistics given include count, mean ± standard deviation, and minimum-maximum, respectively (if count > 1).

Figure C8-11. Key mercury-related data along with mean estimates of fork length and mercury concentrations for Lake Trout.



C.9 REFERENCES

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APPENDIX D: METHYLMERCURY VERSUS TOTAL MERCURY IN SITE C FISH

Table of Contents

TABLES

FIGURES

D.1 INTRODUCTION

This appendix provides detailed methods and results for the 2022 study examining total mercury (THg) and methylmercury (MeHg) concentrations in fish to document baseline conditions prior to reservoir filling (summarized in **Section 4.4 of the Main Report**). In addition to looking at the THg-MeHg relationships for each species sampled, we looked at a number of factors to help explain the results including fish size, trophic level (indicated by nitrogen stable isotope ratios; $\delta^{15}N$), and carbon source (indicated by carbon stable isotope ratios; $\delta^{13}C$).

D.2 MATERIALS AND METHODS

D.2.1 Fish Tissue Laboratory Analyses

D.2.1.1 Total Mercury and Methylmercury

Fish tissue samples were sent to ALS Environmental, Vancouver, BC for analysis of total mercury and methylmercury. Total mercury was analyzed using cold vapour atomic adsorption spectrophotometry (CVAAS) following US EPA methods (EPA 1631). Methylmercury was analyzed using gas chromatograph atomic fluorescence spectroscopy (GCAFS) following US EPA methods (EPA 1630). Results for both analyses were reported on a wet-weight and/or dry-weight basis; dry-weight results were converted to wet weight assuming a 78.8% moisture content.

D.2.1.2 Stable Isotope Analysis

Fish tissue samples for carbon and nitrogen stable isotope analysis (SIA) were sent to the University of New Brunswick Stable Isotopes in Nature Laboratory (SINLAB). Further details on SINLAB's SIA methods is provided in **Appendix A1**.

D.2.1.3 Data Quality Assessment

Data quality is assessed in **Appendix A** of the main document.

D.2.2 Data Analysis

All statistical analyses and plotting were conducting using R 4.3.1 (R Core Team 2023). The data analysis steps of paired wet-weight tissue mercury concentrations (total mercury and methylmercury) were as follows:

- Tabulation of %MeHg (methylmercury concentrations ÷ total mercury concentrations × 100) results for all species sampled.
- Plotting and linear model fitting of relationships between total mercury and methylmercury concentrations for CORE MMP target species (Bull Trout, Longnose Sucker, Mountain Whitefish, Rainbow Trout, Redside Shiner, and Walleye).
- Plotting and linear model fitting of fish length-%MeHg, $\delta^{15}N$-%MeHg, and $\delta^{13}C$-%MeHg relationships for CORE MMP target species.

D.3 RESULTS AND DISCUSSION

A total of 156 paired total mercury and methylmercury analyses were completed. A summary of the %MeHg results for all species sampled is presented in **Table D3-1**. While sampling focused on the six CORE MMP target species, approximately a quarter of the samples were from six non-target species. Species-specific mean %MeHg ranged from 77% (Arctic Grayling and Rainbow Trout) to over 100% (Lake Trout and White Sucker). Results of %MeHg for individual fish were highly variable, ranging from 32% for one Bull Trout sample to nearly 114% for one Lake Trout sample.

While %MeHg should not exceed 100% in theory, studies have documented greater results (Lescord et al., 2018; Aqdam et al., 2023). These observations can in part be related to underlying laboratory analyses. Because methylmercury is harder to measure, it can have higher laboratory variability compared to total mercury. Indeed, comparing of Quality Control field and laboratory duplicate samples from the 2022 MMP (**Appendix A**) highlights higher variability (relative percent differences [RPDs] were 2-3 times higher) in methylmercury measurements relative to total mercury measurements (**Figure D3-1**).

There was a significant positive relationship between concentrations of total mercury and methylmercury in each and across all target species (**Figure D3-2**). While total mercury concentrations, and by proxy methylmercury concentrations, generally increase as fish get bigger for all target species (see examples in 'Key mercury-related data' plots for target species in **Appendix C**), there was no evidence that %MeHg increased with fish size (**Figure D3-3**). Interestingly, Redside Shiner actually showed a decrease in %MeHg with increasing fork length, although this relationship was not statistically significant.

Similar results were seen for comparisons of %MeHg and staple isotope ratios of nitrogen (**Figure D3-4**) and carbon (**Figure D3-5**). Isotopic ratios of nitrogen ($\delta^{15}N$) reflect trophic position (i.e., how high up the food web a fish is feeding) and of carbon ($\delta^{13}C$) reflect energy pathway (i.e., benthic or pelagic). Similar to fish size, total mercury concentrations (and by proxy [methylmercury concentrations) in fish muscle tissue have been shown to generally increase with higher nitrogen $\delta^{15}N$ values (see results for **Appendix C**). However, %MeHg does not appear to be related to trophic position in the analyzed samples.

Lescord et al (2018) found weak evidence that fish with more pelagic diets (negative $\delta^{13}C$ values) had higher %MeHg, but noted that they would have expected bigger differences in %MeHg between species with clearly divergent dietary patterns like Walleye (primarily piscivorous) and shiners/suckers (primarily invertivores) if dietary shifts were responsible for the observed patterns. In our study, only Mountain Whitefish showed a near-statistically significant pattern in %MeHg relative to energy pathway ($p=0.059$), with higher %MeHg at lower (indicating more pelagic) $\delta^{13}C$ values. However, as pointed out by Lescord et al (2018), we would expect to see bigger differences in %MeHg across species with notably different feeding ecology if trophic positions and/or energy pathways were important drivers, which was not the case (**Figure D3-4** and **Figure D3-5**). Average %MeHg appeared to be slightly higher in fish with littoral carbon signature (higher) than in fish with pelagic carbon signature (lower values) (**Figure D3-6**), although average values can be hard to interpret as they do not consider potential changes in feeding ecology throughout fish lifetime.

Overall, while data from samples that were analyzed for both total mercury and methylmercury concentrations indicated no relationships between %MeHg and fish size, $\delta^{15}N$, or $\delta^{13}C$, they did indicate a significant and positive relationship between total mercury concentrations and methylmercury concentrations in fish muscle tissues, meaning that concentrations of methylmercury increased as concentrations of total mercury increased. It is possible that any relationship between %MeHg and these other factors could have been obscured due to the higher variability observed in methylmercury measurements (i.e., low signal relative to noise).

Table D3-1. Species-specific descriptive statistics of %MeHg in muscle tissue samples.

Descriptive Statistics of %MeHg						
Name	count	minimum	maximum	median	mean	std.dev.
Arctic Grayling	9	61.18	102.16	68.99	76.73	16.96
Bull Trout	14	31.60	112.47	82.72	78.61	19.45
Burbot	6	67.74	119.41	74.80	87.32	25.04
Lake Trout	6	113.86	128.97	121.46	121.39	6.60
Lake Whitefish	4	93.47	97.31	95.29	95.34	2.08
Longnose Sucker	16	56.75	133.09	80.48	82.92	21.34
Mountain Whitefish	48	40.53	112.36	77.65	79.01	17.54
Northern Pike	12	81.72	106.34	92.62	93.86	7.90
Rainbow Trout	6	52.56	118.46	63.84	76.87	27.11
Redside Shiner	22	47.84	130.66	90.92	85.59	25.48
Walleye	11	37.14	119.26	81.09	81.30	25.01
White Sucker	2	101.92	102.14	102.03	102.03	0.16

Figure D3-1. Variability of total mercury and methylmercury concentrations in laboratory and field duplicate samples.

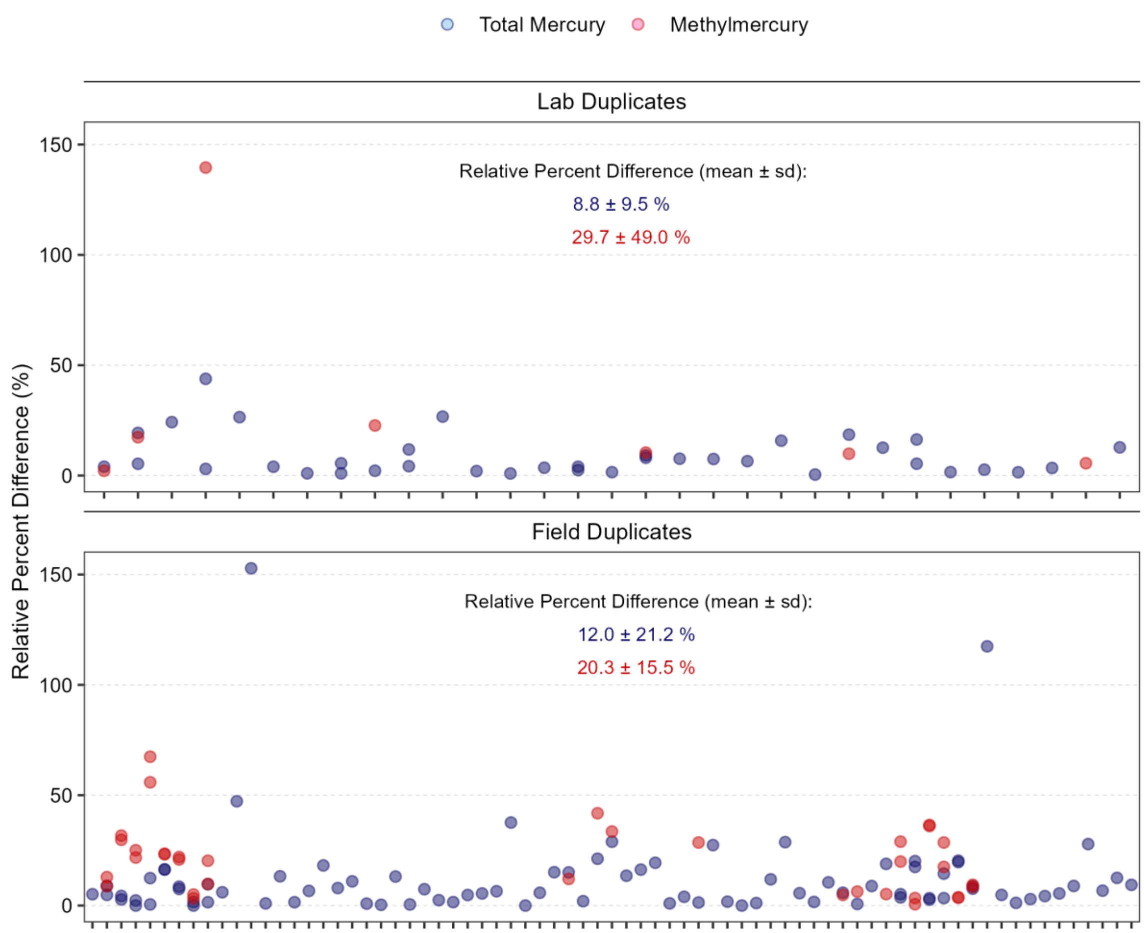


Figure D3-2. Relationships between total mercury and methylmercury concentrations in target species.

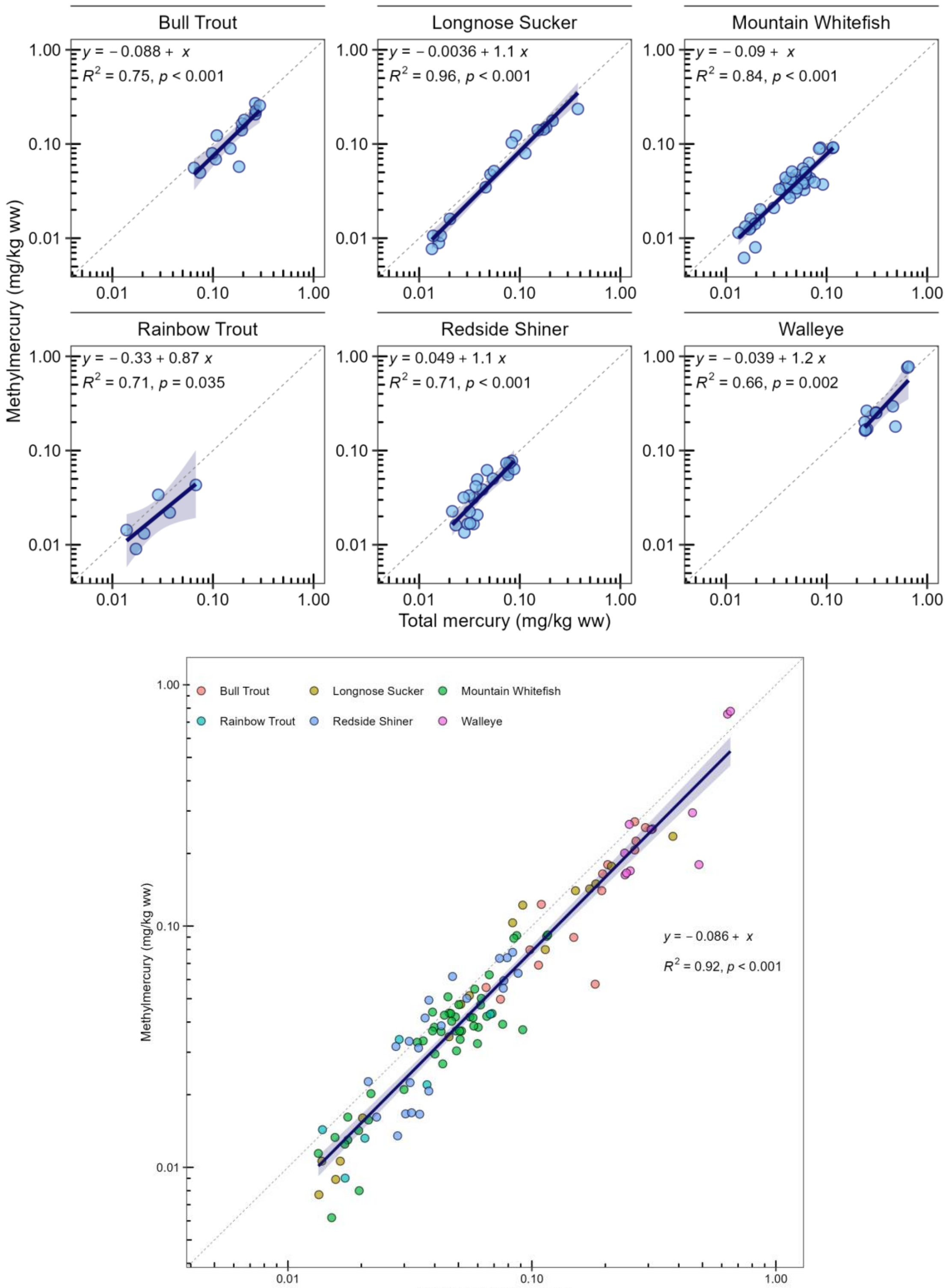
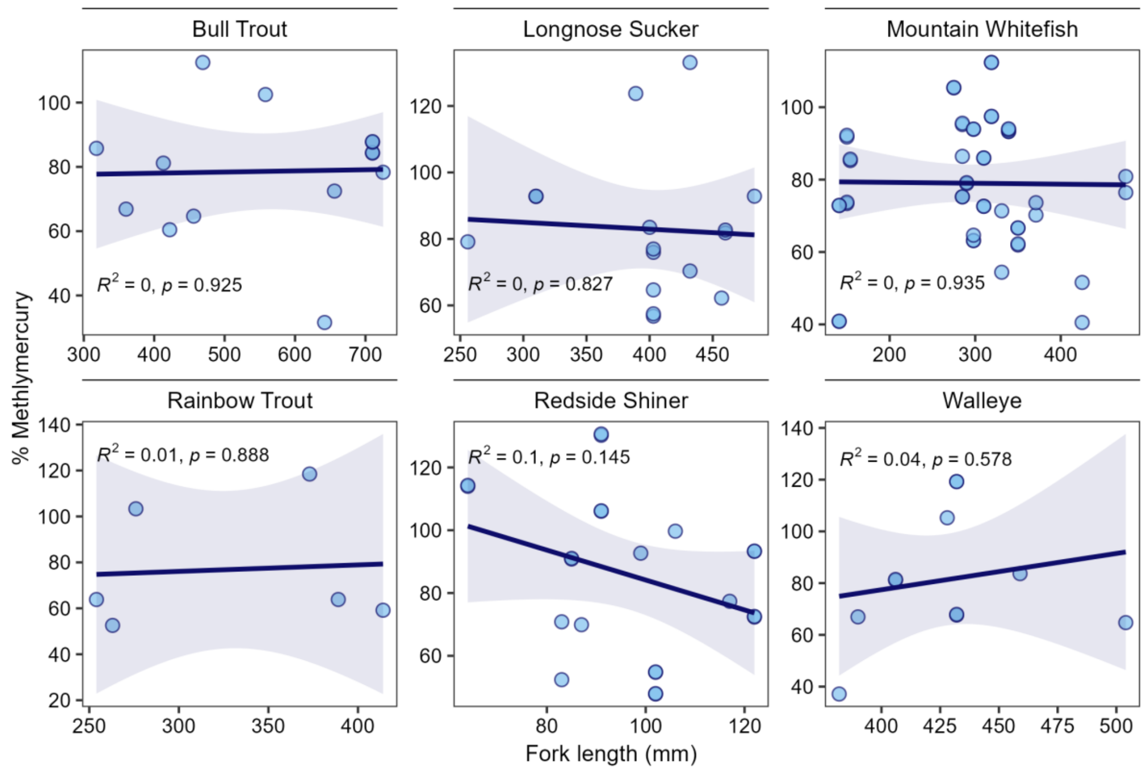


Figure D3-3. Relationships between %MeHg and size in target species.



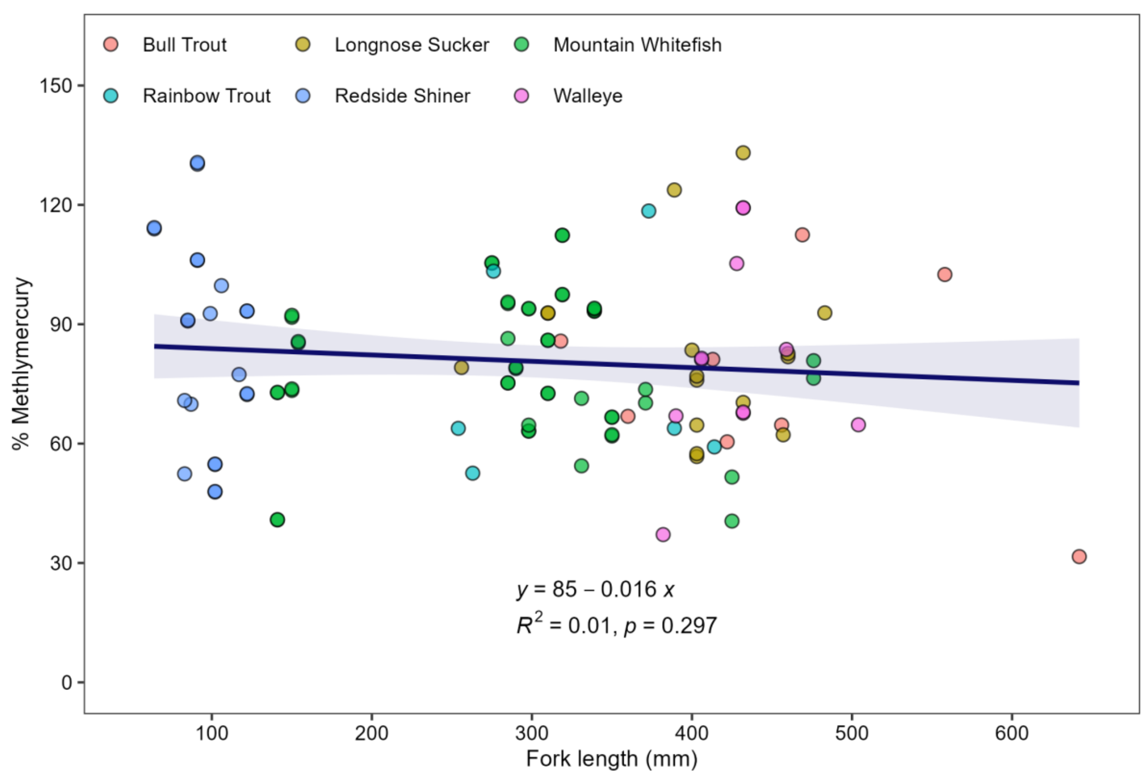
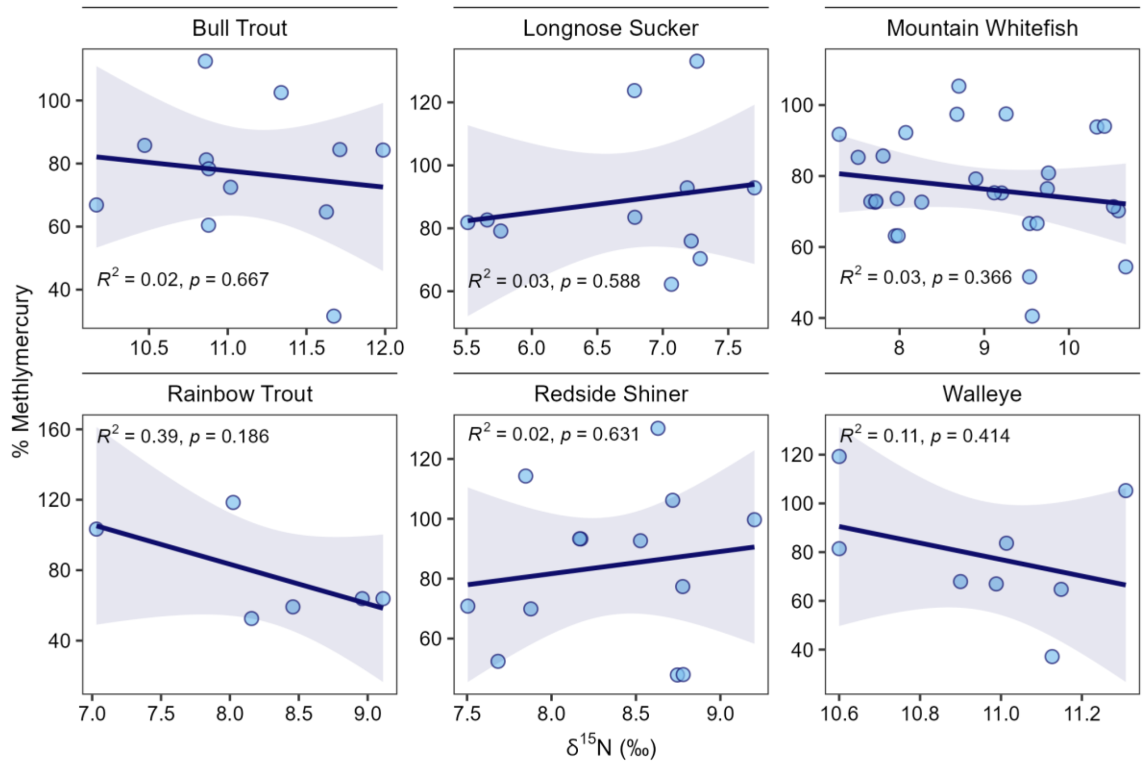


Figure D3-4. Relationships between %MeHg and nitrogen stable isotope ratios in target species.



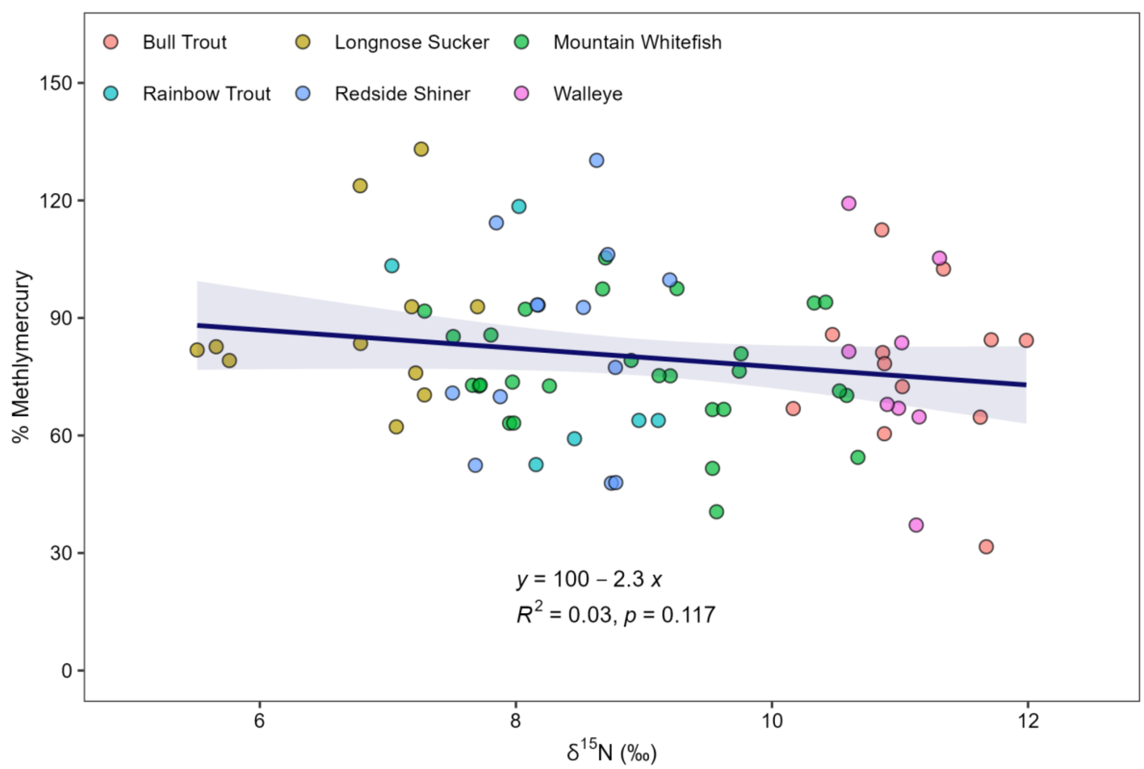


Figure D3-5. Relationships between %MeHg and carbon stable isotope ratios in target species.

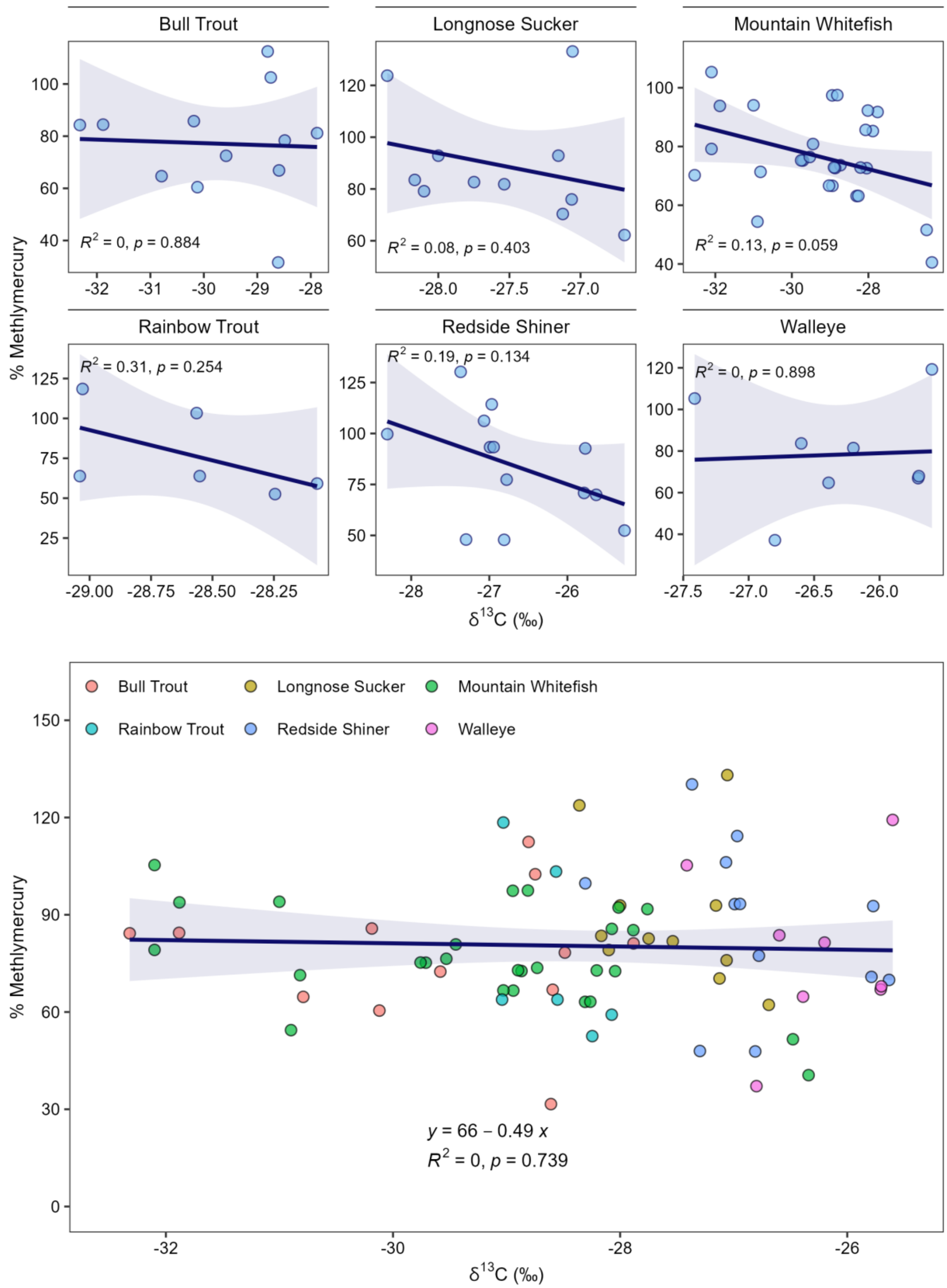
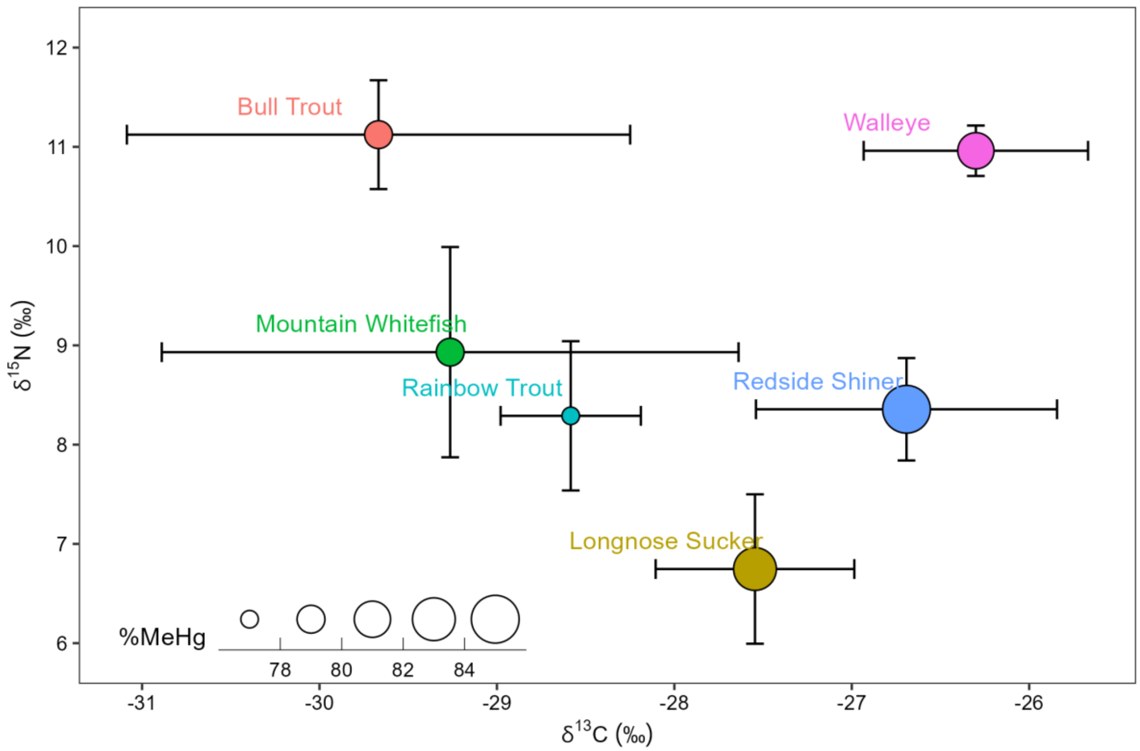


Figure D3-6. Average stable isotope ratios (± standard deviations) and %MeHg in target species.



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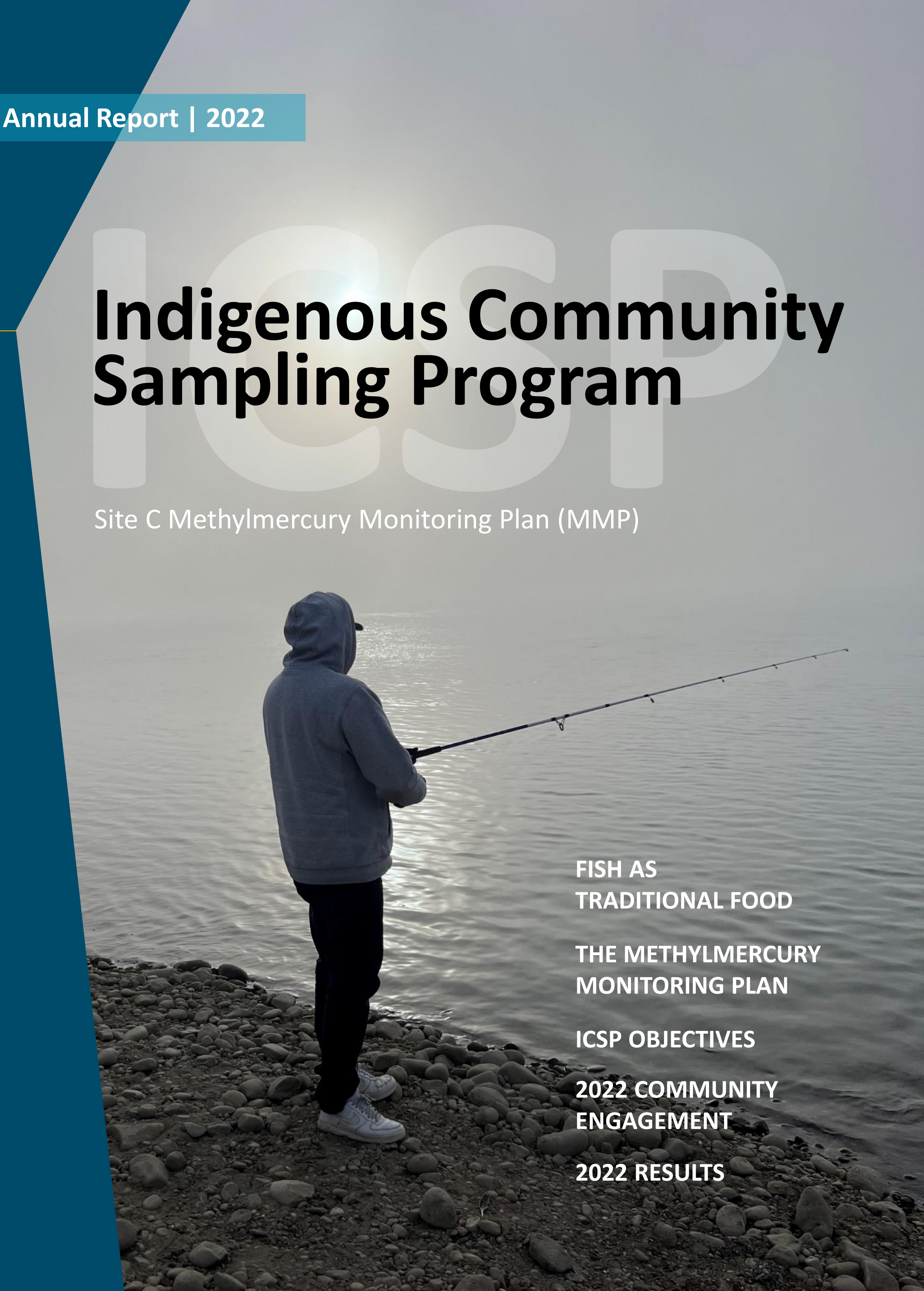
APPENDIX E: INDIGENOUS COMMUNITY SAMPLING PROGRAM – ANNUAL REPORT 2022

ICSP

Annual Report | 2022

Indigenous Community Sampling Program

Site C Methylmercury Monitoring Plan (MMP)



FISH AS TRADITIONAL FOOD

THE METHYLMERCURY MONITORING PLAN

ICSP OBJECTIVES

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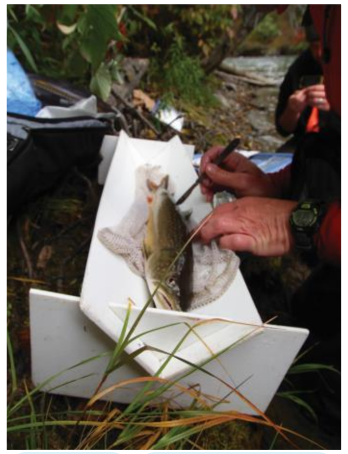


ICSP

Indigenous Community Sampling Program

Cover: Photo 1 by Brendan Bushy

AZIMUTH

FISH IS GOOD FOR YOU

HEALTH BENEFITS OF EATING FISH

Eating fish can provide numerous health benefits due to fish's rich nutritional profile.

- Studies have shown that traditional diets are healthier than non-traditional diets.
- Compared to other types of meat, fish have higher levels of good fats (omega-3 fats) and lower levels of bad fats (saturated fats).
- Fish are high in beneficial vitamins and minerals, like vitamin D and the essential elements selenium, and iron.
- Replacing store-bought processed foods with fish can help achieve a more balanced diet.

Photo 2 by Deborah Prince

Photo 3,4,5

FISH AS TRADITIONAL FOOD

In 2009 the First Nations Food, Nutrition and Environment Study concluded work in BC with the following findings:

- Fish is a culturally, spiritually, economically, and nutritionally important traditional food for many Indigenous Peoples in Canada.
- About half of Indigenous people in Canada face food insecurity.
- The current diet of many Indigenous people in Canada is nutritionally inadequate.
- Increased access to fish that is safe to eat can help address these issues.

Photo 6

FISH METHYLMERCURY
in NATURAL HABITATS

Mercury is a naturally occurring element that is found in low levels everywhere – in air, water, soil, plants, animals, and humans.

BIOMAGNIFICATION UP THE FOOD CHAIN

Bacteria in the bottom of lakes and rivers transform naturally occurring mercury into methylmercury (MeHg; see figure).

Methylmercury levels naturally increase up the food chain. Predatory fish have higher levels of methylmercury than fish lower down the food chain. That's why Lake Trout, Bull Trout and Walleye have more methylmercury than Kokanee, Mountain Whitefish or Rainbow Trout.

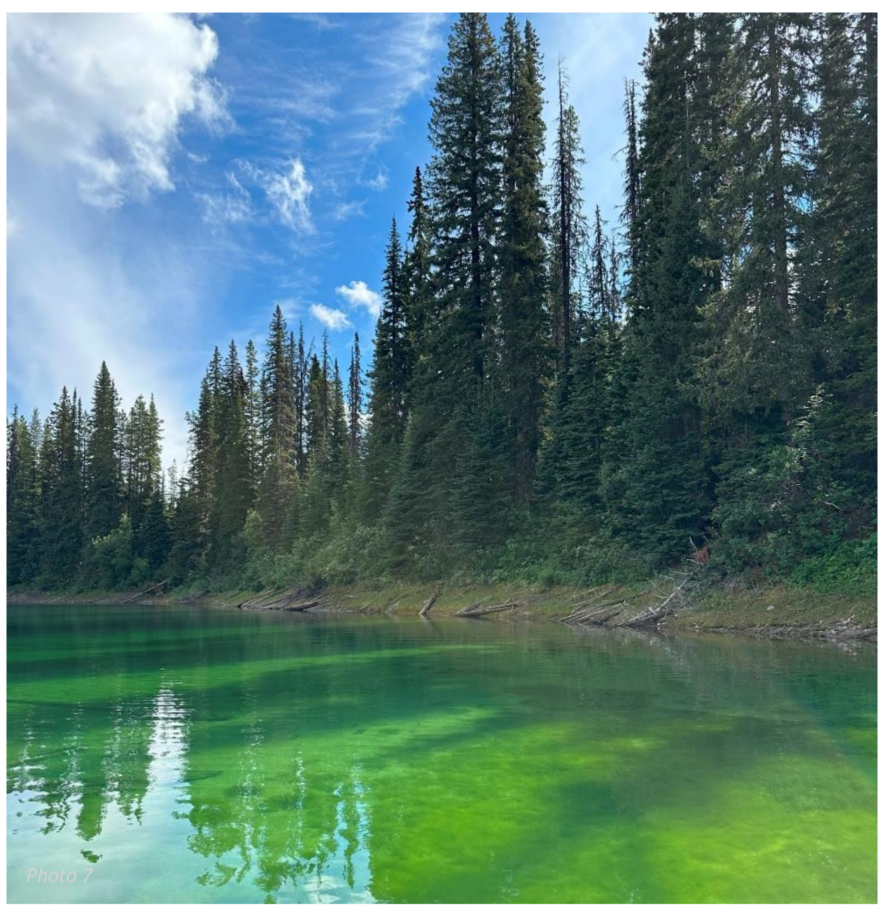
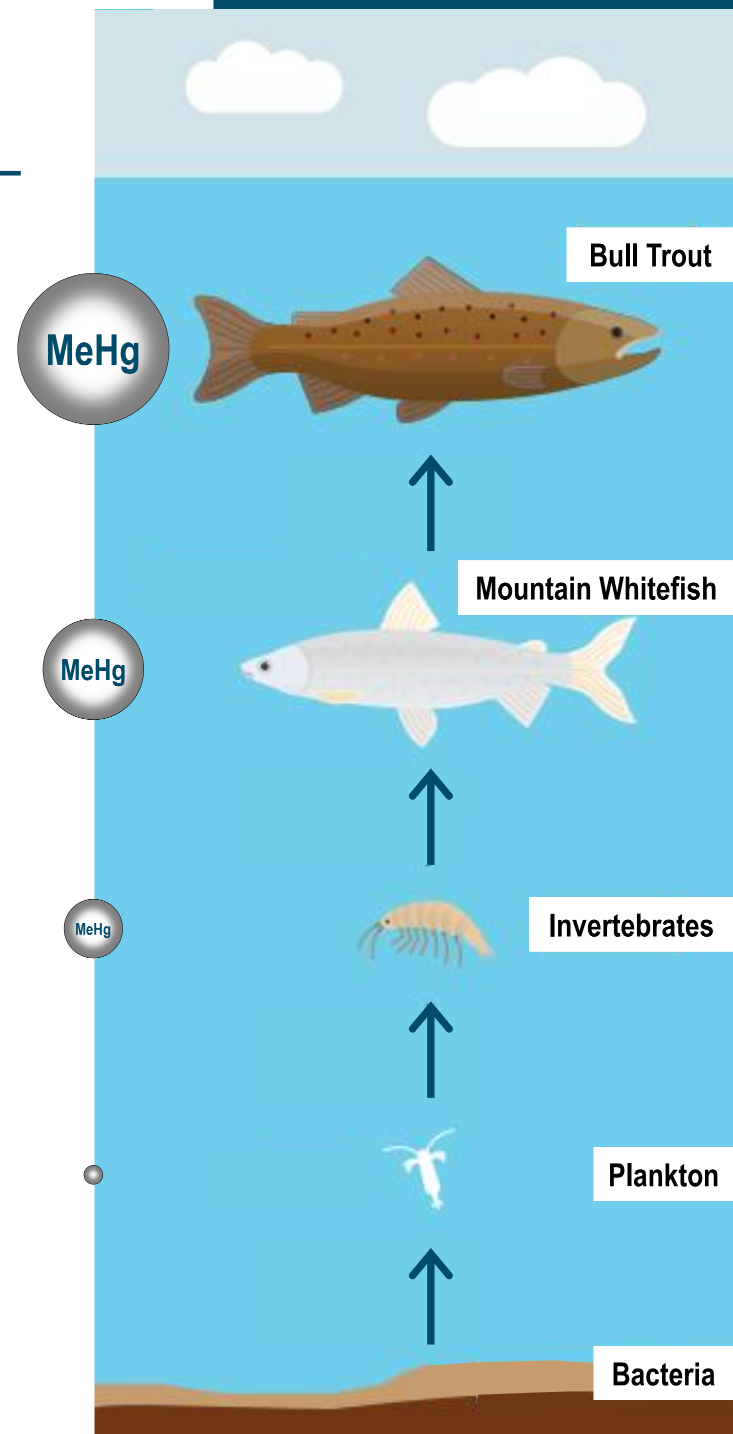
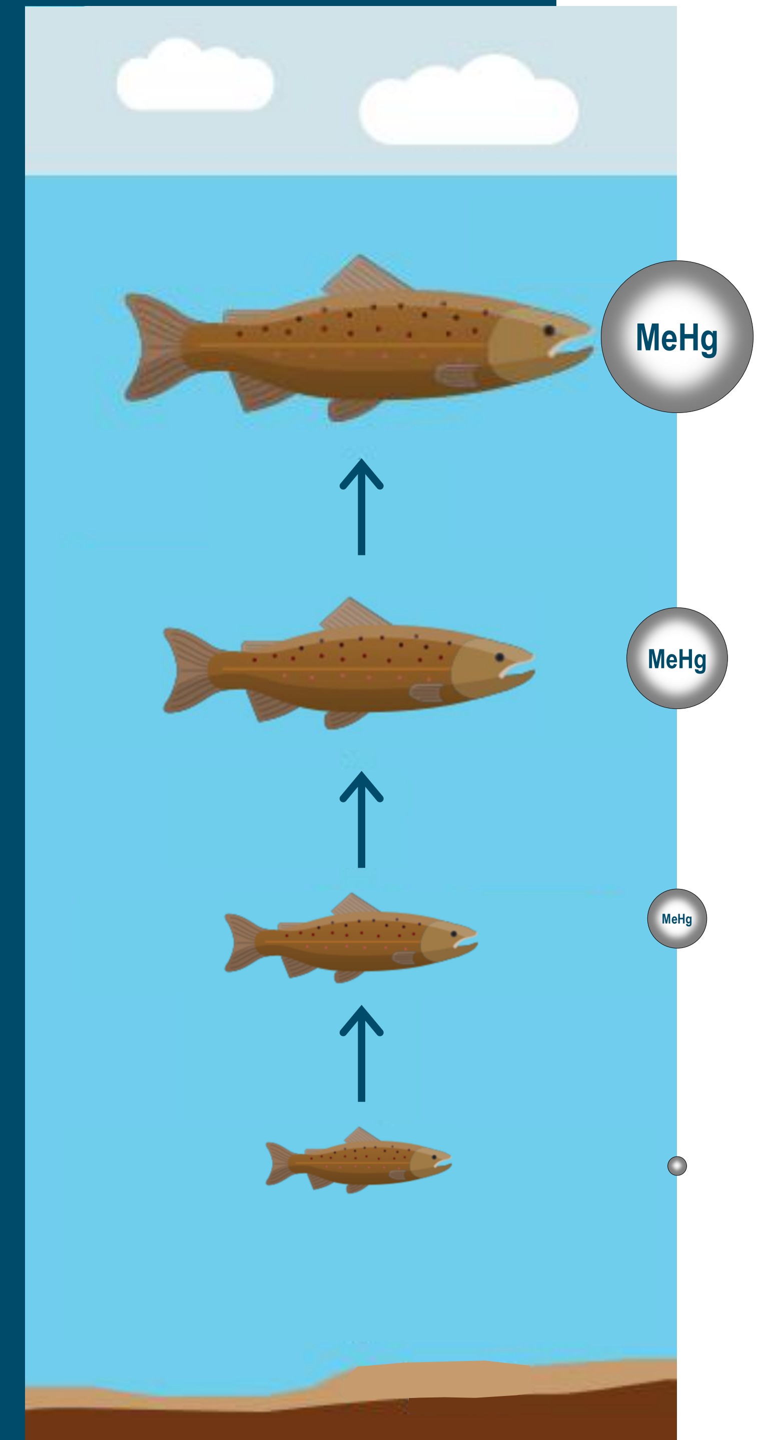
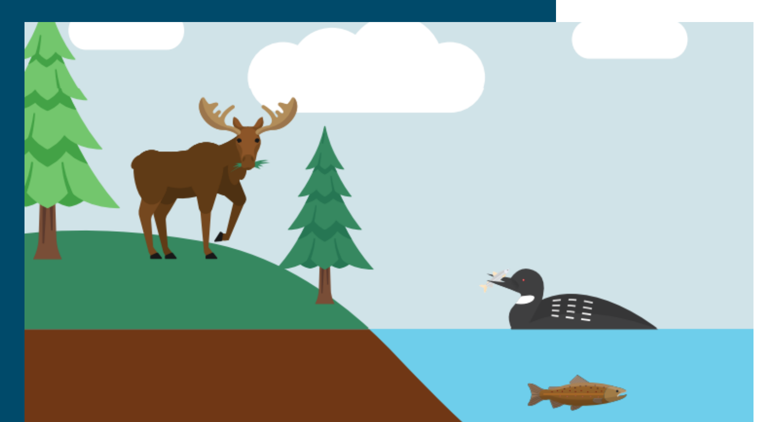


Photo 7







BIOACCUMULATION IN OLDER FISH

Larger, older fish of all species accumulate higher concentrations of methylmercury in their tissue compared to younger smaller fish (MeHg; see figure).


Photo 8

METHYLMERCURY IN ANIMALS

The amount of methylmercury in an animal depends on the amount and type of fish it eats. Non-fish-eating animals like moose have low levels, while fish-eating wildlife like loons can have higher methylmercury levels.

Humans consume small amounts of methylmercury when we eat fish.

For more information, scan below.

SCAN ME

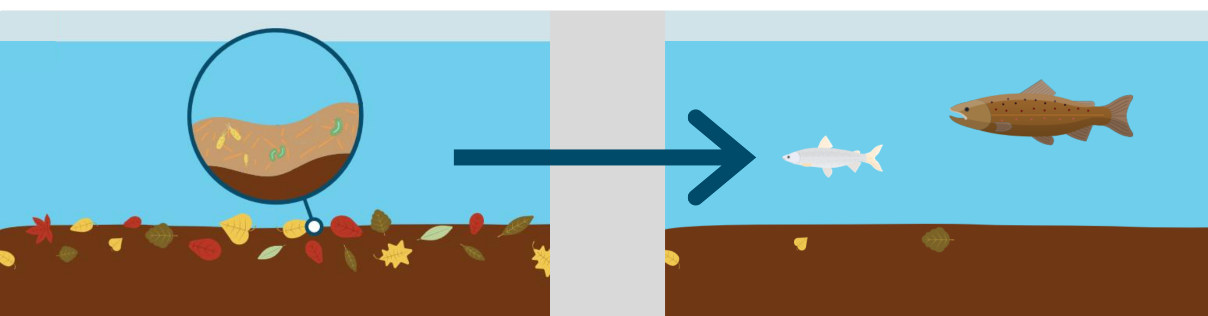
SITE C and changes in FISH METHYLMERCURY

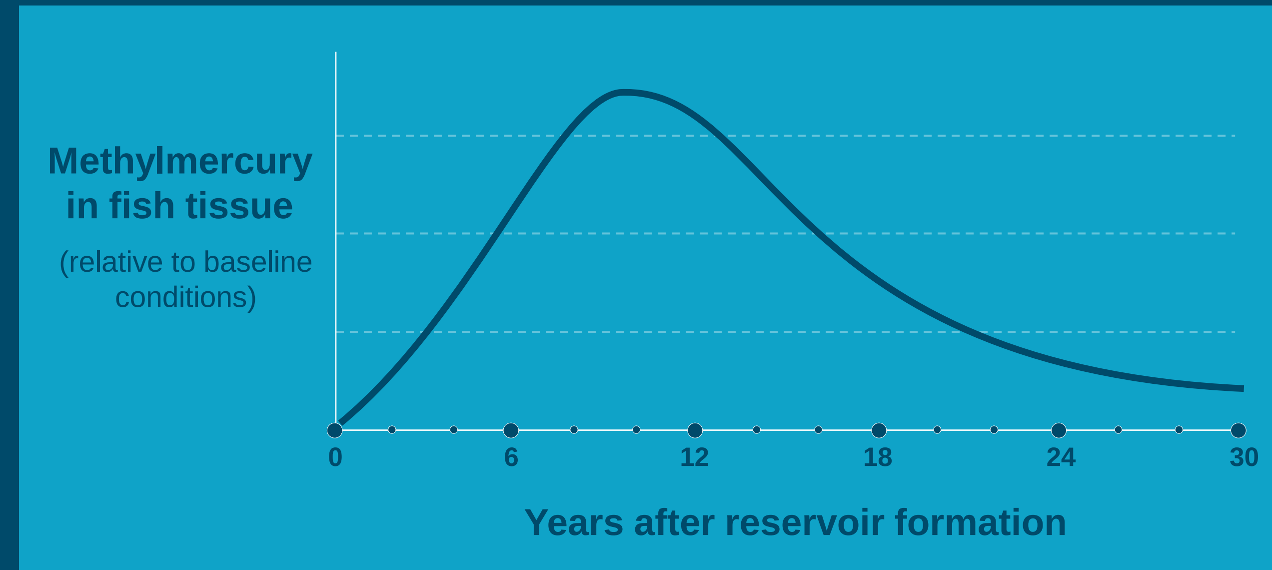
RESERVOIR EFFECT

Currently, Peace River fish have low methylmercury levels, similar to other B.C. water bodies.

The creation of the Site C reservoir will lead to an initial increase in methylmercury as bacteria decompose organic material, converting inorganic mercury to methylmercury.

Over the years, as organic matter diminishes, methylmercury production will slow, causing levels to drop across the food chain.





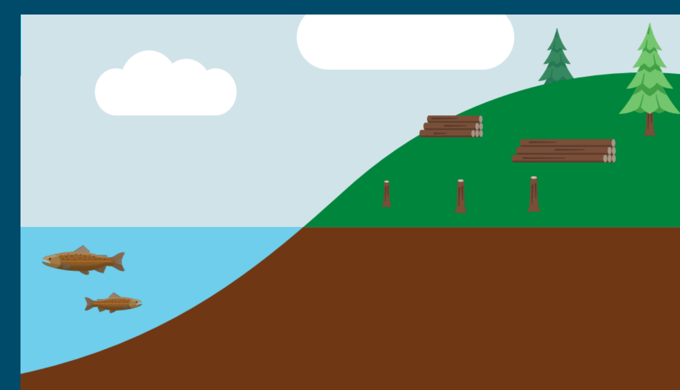
MONITORING

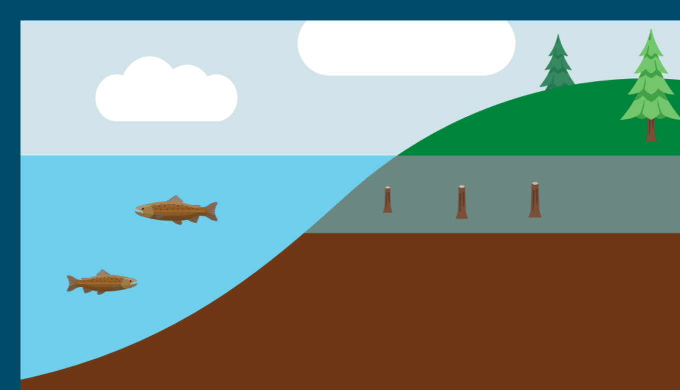
To verify the predicted affects that the Site C project will have on fish methylmercury levels, BC Hydro is working with Indigenous groups, communities and health authorities to implement a Methylmercury Monitoring Plan (MMP).

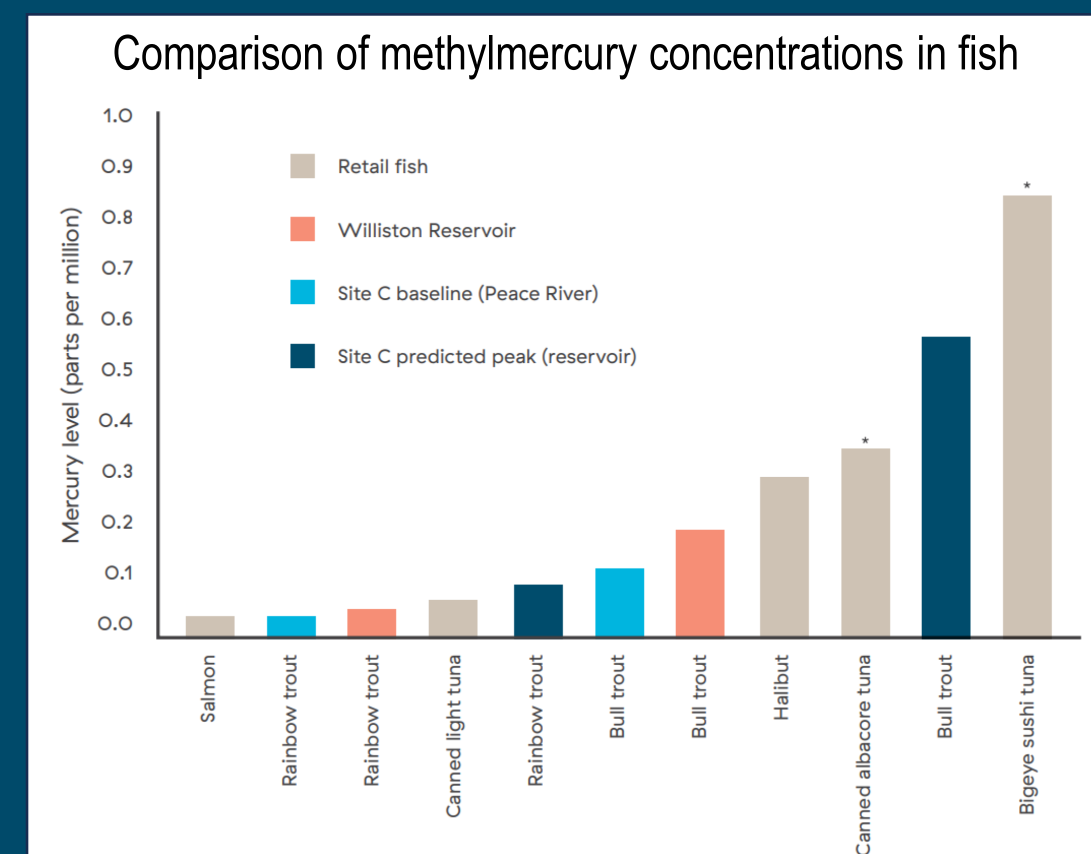
METHYLMERCURY INCREASES

When the Site C reservoir is created, levels of methylmercury in fish will increase for approximately 10 years. Tissue methylmercury concentrations of fish in the reservoir are predicted to increase by 3-4 times current levels, while concentrations in downstream fish are only expected to peak at 2x baseline (downstream of Many Islands, AB no increases are expected). This is followed by a decrease over the next 20-30 years to levels that are similar to natural lakes and rivers in the area.

The bar chart below compares baseline methylmercury concentrations to predicted peak concentrations, as well as concentrations in the Williston Reservoir and common retail fish.







Refer to Health Canada for consumption guidelines for canned albacore tuna and fresh tuna: https://www.canada.ca/en/health-canada/services/food-nutrition/food-safety/chemical-contaminants/environmental-contaminants/mercury/mercury-fish-questions-answers.html#ca2

THE
MMP
Methylmercury Monitoring Plan

WHAT IS THE MMP?

The Methylmercury Monitoring Plan (MMP) was developed to measure changes to levels of methylmercury in fish after the creation of the Site C Reservoir and provide information on how much fish is safe for people to eat.

The three components (figure right): the Core MMP, the Fish Consumption Program, and the Indigenous Community Sampling Program (ICSP).

The Core MMP targets six species of fish (see below) for mercury analysis, using non-lethal sampling.


Photo 9

TARGET FISH FOR THE CORE MMP:


Bull Trout

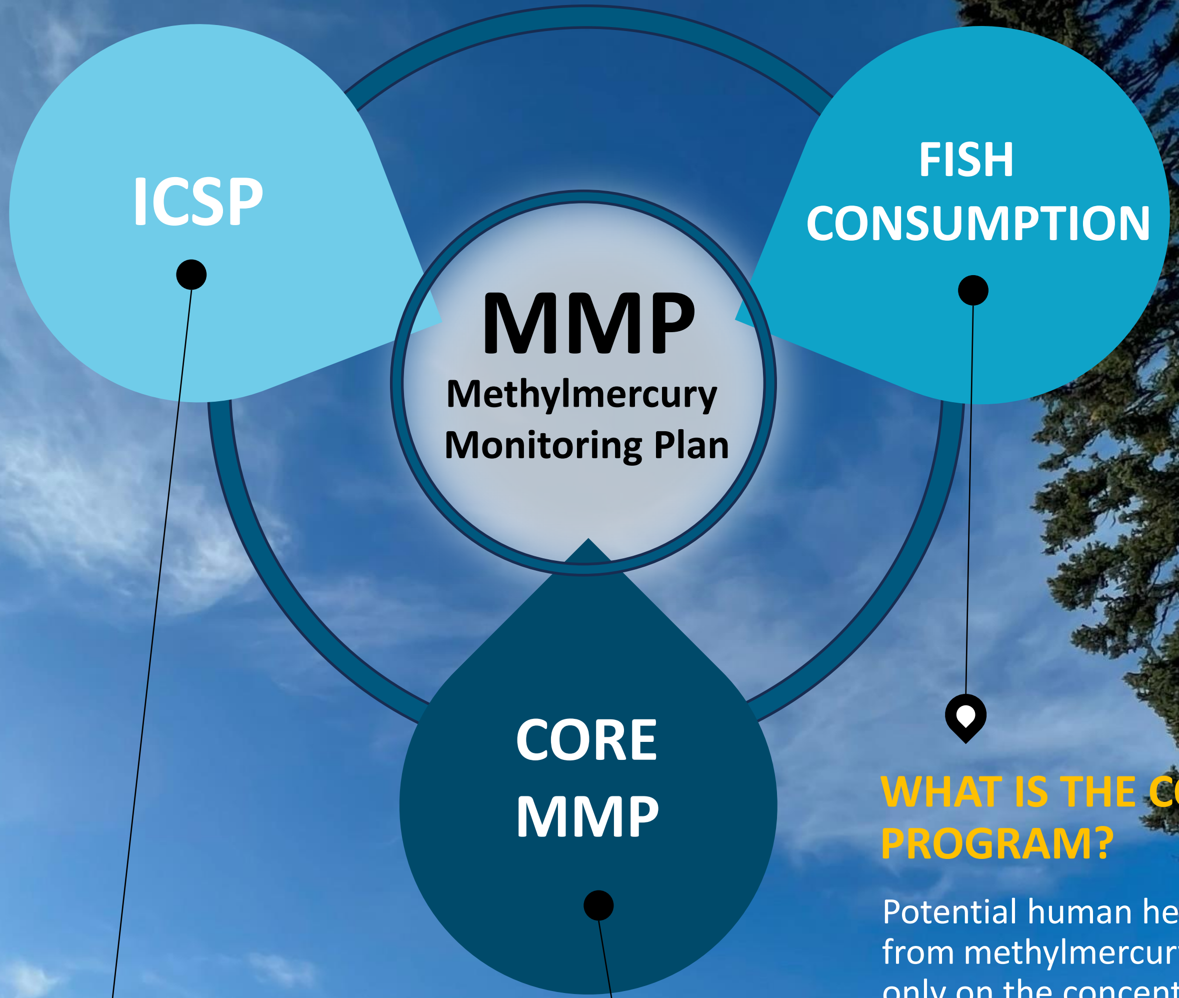

Walleye


Rainbow Trout


Mountain Whitefish


Longnose Sucker


Redside Shiner



WHAT IS THE CONSUMPTION PROGRAM?

Potential human health risks from methylmercury depend not only on the concentration in fish, but also the amount of fish that people eat. This program aims to quantify fish consumption and establish guidance for how much fish is safe to eat.

WHAT IS THE ICSP?

The ICSP is an Indigenous community methylmercury monitoring program targeting fish commonly consumed by people, but distinct from the sampling locations and species covered under the Core MMP.

WHAT IS THE CORE MMP?

It is the primary MMP sampling program, monitoring methylmercury in fish in the Peace River at the site of the future Site C reservoir and downstream to Many Islands, AB. The program also monitors mercury in water, sediment, porewater, and bugs.

SCAN ME

Photo 10

THE

ICSP

Indigenous Community Sampling Program

An Indigenous community methylmercury monitoring program that samples fish people eat, but is distinct from the sampling locations and species covered under the Core MMP.

ICSP OBJECTIVES

There are three main objectives of the ICSP Program:

- Test the levels of methylmercury in fish that people eat, but which are not monitored in the Core MMP.
- Provide opportunities for Indigenous communities to participate in monitoring changes to the environment from the Site C Project.
- Improve food security and food sovereignty for Indigenous communities by building skills and knowledge related to methylmercury in fish.

Photo 11 by Brendan Bushy

Photo 13 by Brendan Bushy

Photo 12 by Ben Jackson

COMMUNITY CHAMPIONS are trained to collect fish tissue samples and are the link between BC Hydro and Indigenous communities.

THE ICSP

Indigenous Community Sampling Program

2022 COMMUNITY ENGAGEMENT

In 2022, the ICSP was fully implemented, providing baseline data on fish methylmercury levels before reservoir filling.

Three training events were conducted at Northern Lights College on May 26, June 9, and October 13, 2022. The sessions covered methylmercury in reservoirs, an MMP overview, and hands-on training in fish tissue sampling.

CHAMPIONS TRAINED IN 2022

4 Blueberry River First Nation

2 Dene Tha' First Nation

4 Doig River First Nation

2 Duncan's First Nation

2 Fort Nelson First Nation

3 Halfway River

2 Horse Lake First Nation

4 Kelly Lake Cree Nation

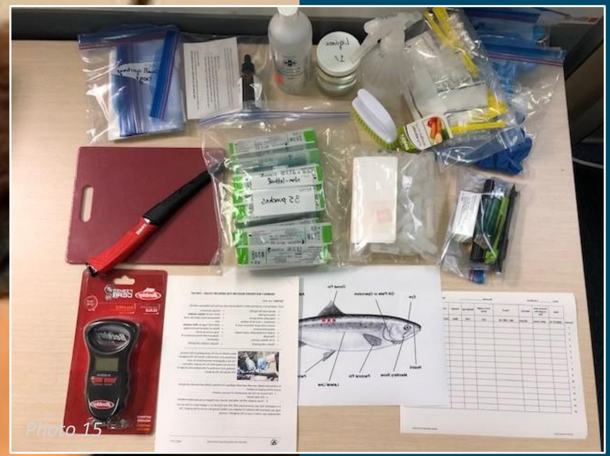
4 McLeod Lake Indian Band

1 Metis Nation of BC

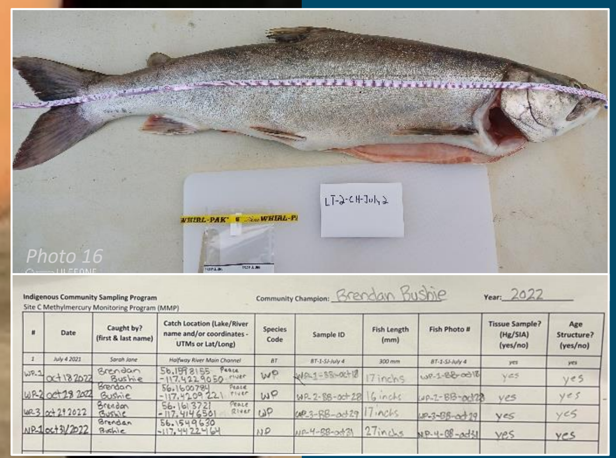
1 Prophet River First Nation

1 Saulteau First Nation

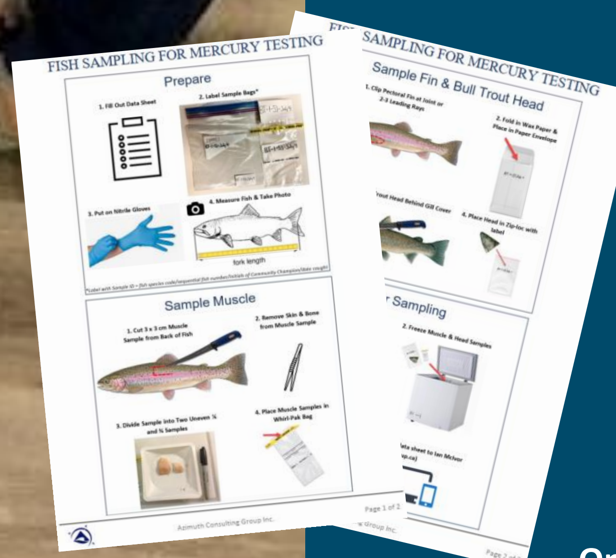
1 West Moberly First Nation



Each Community Champion received a "Fish Kit" for sampling.



Trained Community Champions sampled fish throughout summer, reporting data and submitting tissue samples for mercury analysis.



In 2022 and 2023, Azimuth created a "Quick Start Guide" and an online training video as reference guides. A Peace River Fish ID Key is also available.

Online Training Video

SCAN ME

Fish ID Guide

SCAN ME

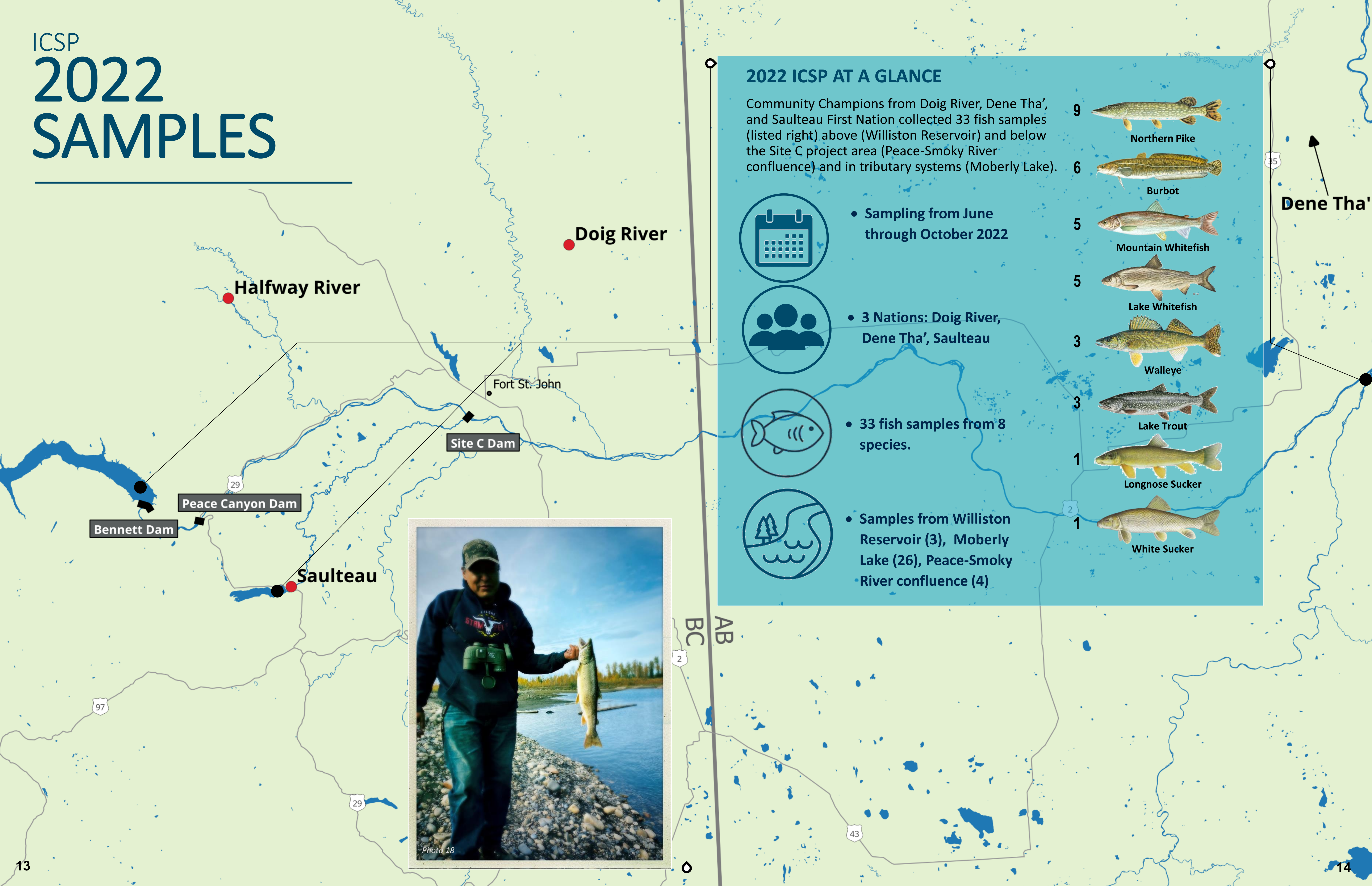
ICSP
2022 SAMPLES

2022 ICSP AT A GLANCE

Community Champions from Doig River, Dene Tha', and Saulteau First Nation collected 33 fish samples (listed right) above (Williston Reservoir) and below the Site C project area (Peace-Smoky River confluence) and in tributary systems (Moberly Lake).

- Sampling from June through October 2022
- 3 Nations: Doig River, Dene Tha', Saulteau
- 33 fish samples from 8 species.
- Samples from Williston Reservoir (3), Moberly Lake (26), Peace-Smoky River confluence (4)

9 Northern Pike
6 Burbot
5 Mountain Whitefish
5 Lake Whitefish
3 Walleye
3 Lake Trout
1 Longnose Sucker
1 White Sucker



ICSP

2022 RESULTS

DATA ANALYSIS

When the ICSP fish methylmercury data were analyzed, the following variables were included:

- Mercury – total mercury concentrations in fish tissues.*
- Fork Length – fish length (nose to tail fork) was used as an indicator of fish size and age.

In the following pages, mercury data are presented for each species sampled in the ICSP program from 2022 and 2021 compared to results from the Core program. Note that the graphs all use the same scale to help visualize mercury content across species.

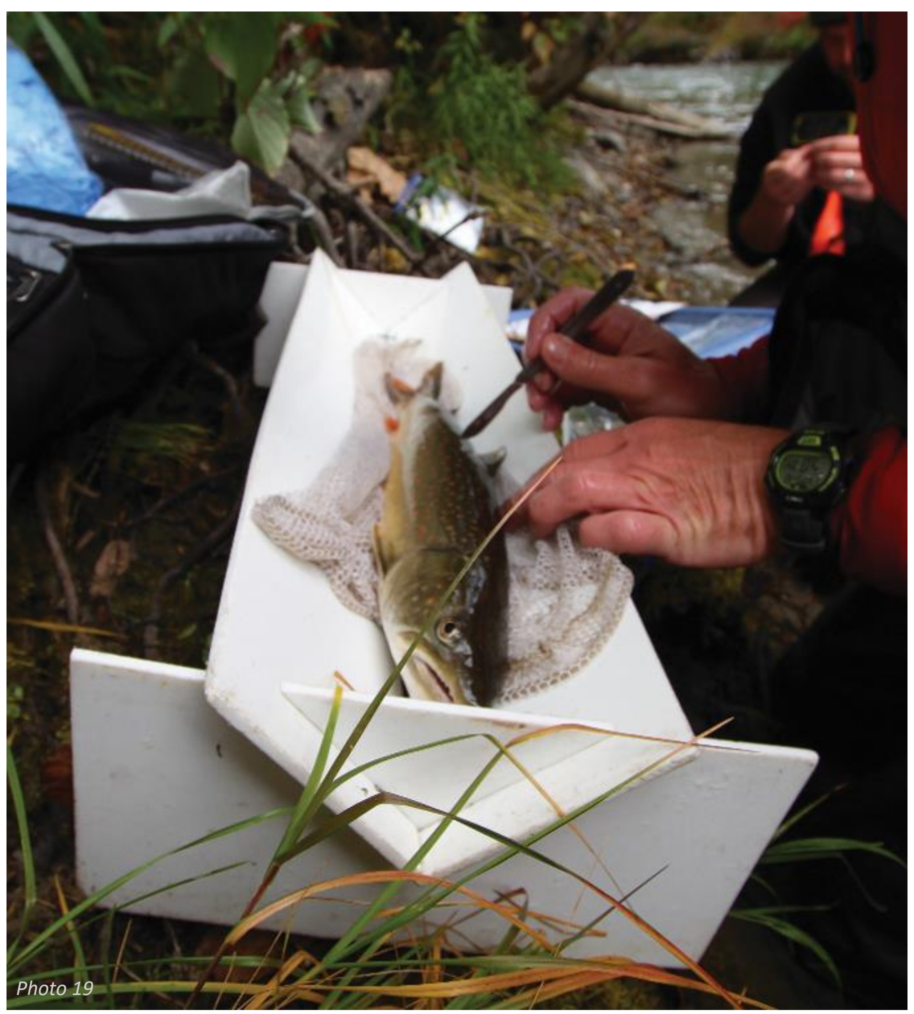


Photo 19

*Note that it is assumed that all mercury in fish tissues is present as methylmercury.

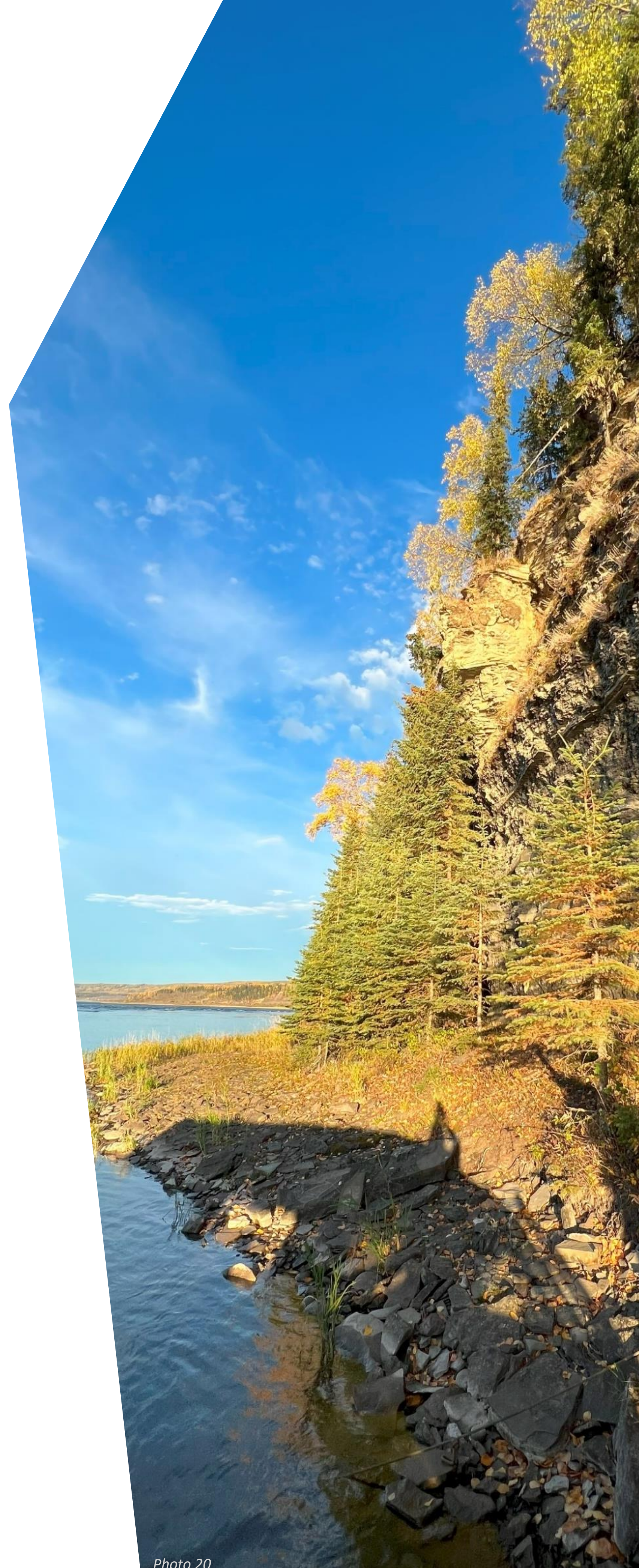


Photo 20

FISH MERCURY CONCENTRATIONS

Average mercury concentrations in muscle tissue for key fish species collected in the Core MMP (2017-2022) and ICSP (2021-2022) programs are summarized below in descending order. Bug-eating species such as Rainbow Trout and Mountain Whitefish tend to have lower mercury levels, while fish-eating species higher in the food web, such as Walleye, Burbot, and Northern Pike, have higher mercury concentrations.

These results are meant to provide a rough idea of the amount of mercury in these fish. Actual mercury concentrations will vary from place to place and over time, particularly once the reservoir is created. See the annual MMP reports for specific concentrations for targeted locations and species.

Fish Species	Mercury (mg/kg ww)
Walleye	0.27
Burbot	0.17
Northern Pike	0.16
Lake Trout	0.15
Bull Trout	0.13
Lake Whitefish	0.12
White Sucker	0.10
Longnose Sucker	0.08
Mountain Whitefish	0.05
Rainbow Trout	0.03

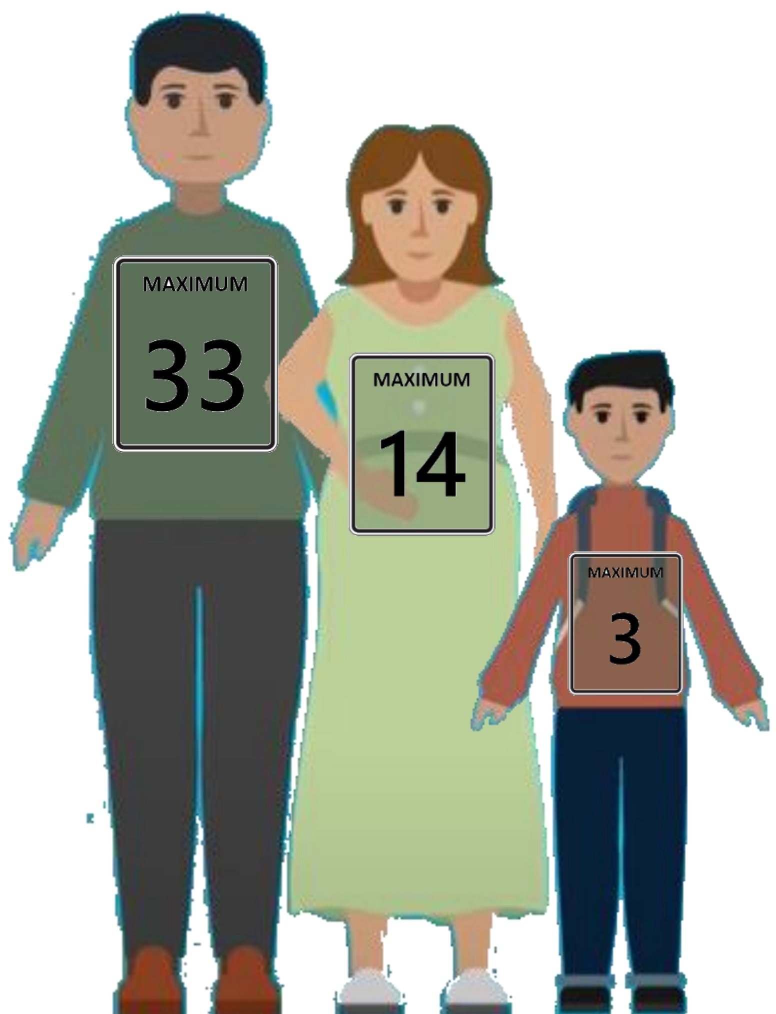
How Much Fish Can I Eat?

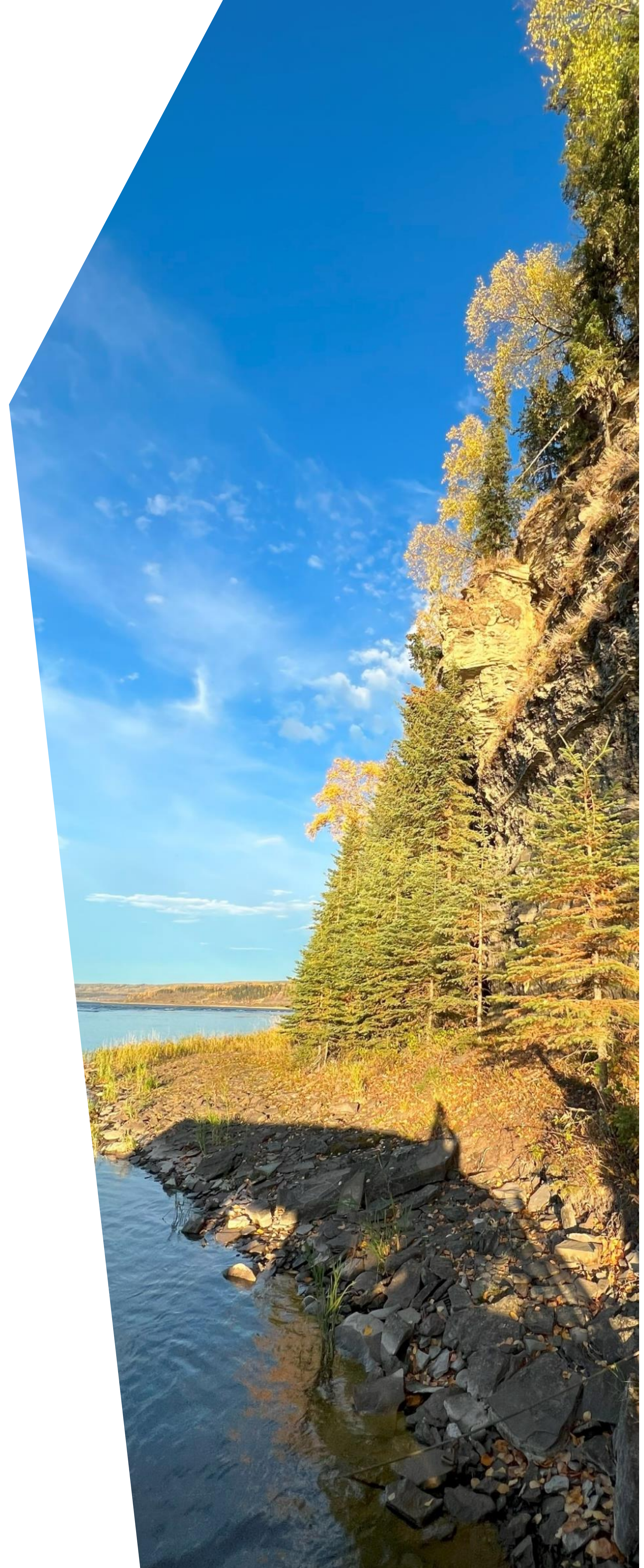
Health Canada guidance on safe levels of exposure

Methylmercury occurs naturally in fish and people are exposed to small amounts of methylmercury when they eat fish. People can safely tolerate exposure to some methylmercury, but exposure to too much methylmercury can be harmful to the brain and nerves.

Health Canada provides guidance on how much methylmercury people can be exposed to without risk of harm. These amounts vary, depending on a person's age and if they are, or could be pregnant.

Health Canada's guidance on methylmercury exposure are like speed limits – people won't necessarily be harmed if they exceed them, but it is best to keep exposure below them.





This brochure provides information on how much fish a person can safely eat

Information on the amount of methylmercury in fish was used to calculate how many servings of fish people can eat every month without going over Health Canada's safe levels of exposure for methylmercury. An example for Northern Pike is shown below.

Guidance is provided for different lengths of fish, measured in millimeters or inches

Guidance is provided for children less than 12 years old (C), people who are or could be pregnant (P), and others (O)

Northern Pike

Size mm|in | Mercury ppm	C	P	O
400|16 | 0.06	24	43	101
550|22 | 0.12	12	21	50
700|28 | 0.22	6	11	27

People who regularly eat more than one type of fish should see the detailed guidance in Figure 6-1 in the MMP report

Safe to Eat

- Once Every Day
- Once Every Other Day
- Twice a Week
- Once a Week
- Twice a Month
- Once a Month

The number of servings of fish a person can safely eat every month.

The squares are coloured according to the legend to the left.

HOW BIG IS A SERVING OF FISH?

100 g (0.2 lbs) serving size for children.

163 g (0.4 lbs) serving size for adult.

Walleye

OVERVIEW

- Walleye, a top predator in the Peace River, primarily eats other fish. It's high position in the food chain means that Walleye have higher levels of mercury. They are predominately found downstream of the Site C Dam.
- In 2022, there were three Walleye caught at the Peace-Smoky River confluence (lower plot; blue points) with lengths comparable to fish captured in the Core MMP (grey points).

Mercury vs Length - Walleye

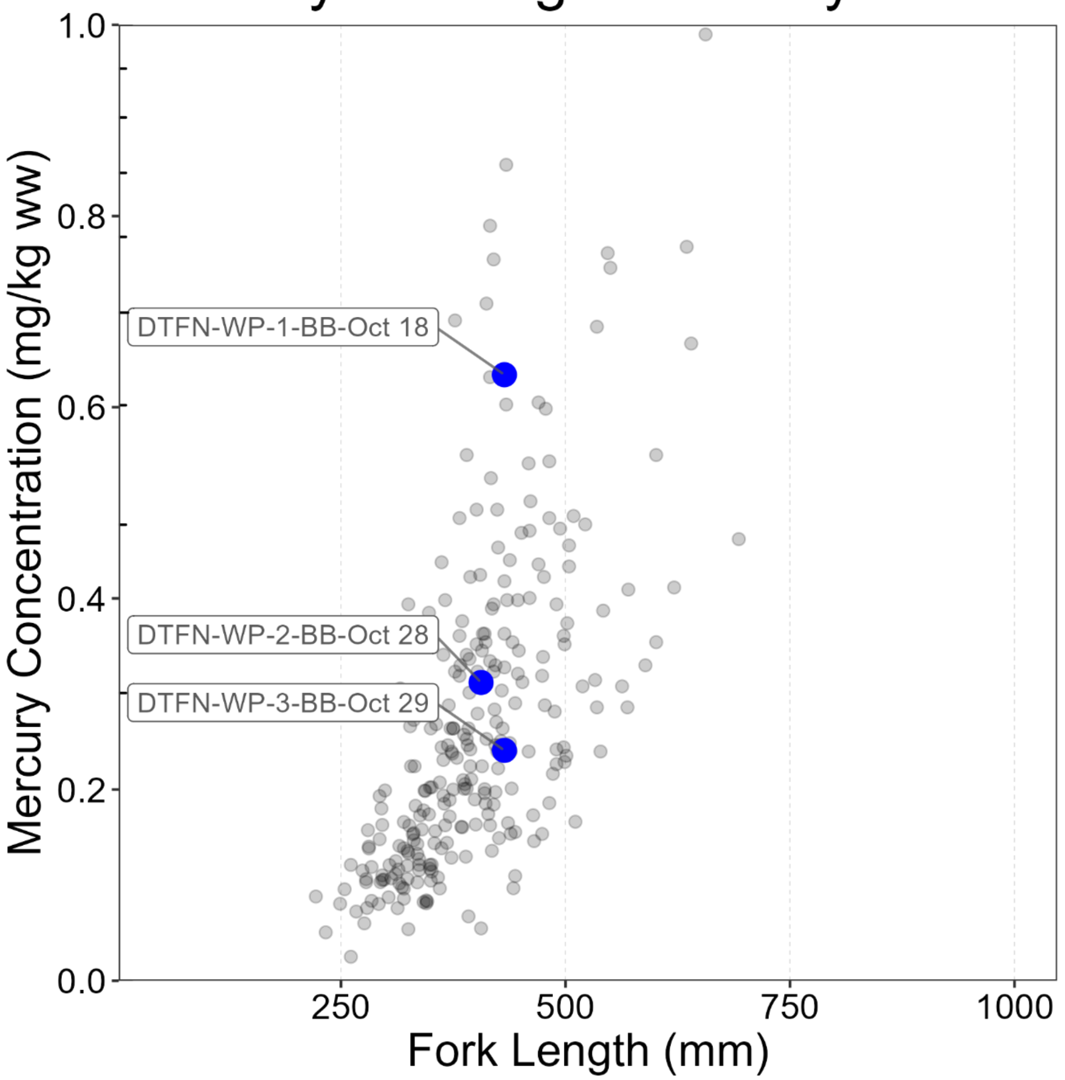


Photo 21

FISH MERCURY RESULTS

- Results show a positive relationship between mercury concentration and fish length, meaning larger/older fish have higher concentrations than smaller/younger fish.
- 2022 ICSP results are consistent with the Core MMP data.

FISH CONSUMPTION GUIDANCE

- Walleye (up to 20") can fall into serving categories of just twice a month for children
- For Walleye (up to 20") caught in the Peace River between Dinosaur Reservoir and Many Islands, follow consumption guidance based on the Core MMP (table below):

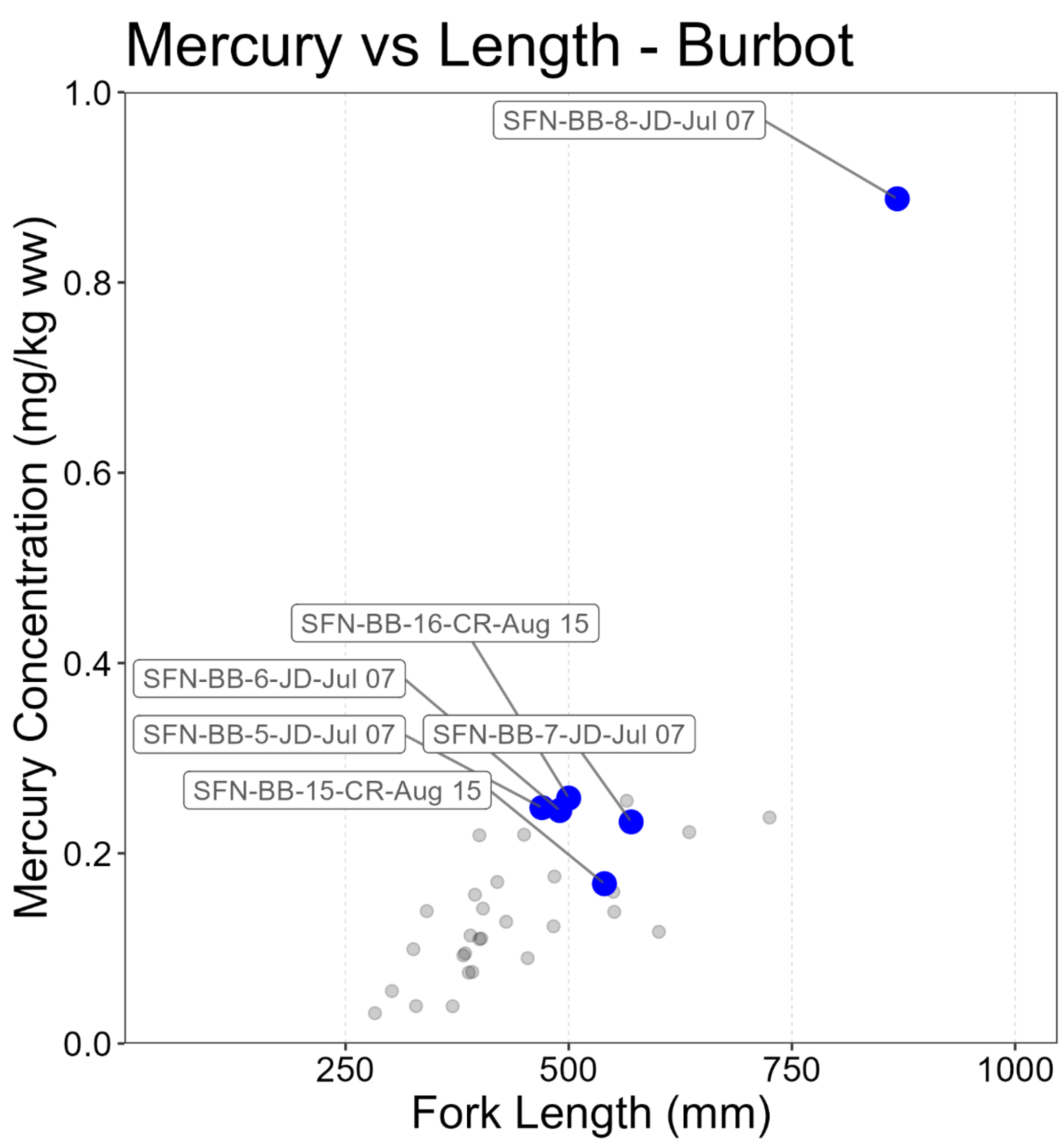
Walleye			
Size$^{mm\|in}$ | Mercury^{ppm}	C	P	O
300|12 | 0.15	9	17	40
400|16 | 0.28	5	9	21
500|20 | 0.47	3	5	13

Mercury estimates from the CORE MMP in the Peace River; see 2022 Annual Report (Appendix F) for details.

Burbot

OVERVIEW

- Burbot are bottom dwellers, more common in the lower reaches of the Peace study area. They are long-lived and eat other fish, meaning they generally contain higher levels of mercury.
- Six Burbot were caught in Moberly Lake in 2022 (lower plot; blue points), one which was noticeably larger than any fish captured in the Core MMP (grey points).



FISH MERCURY RESULTS

- Results show a strong positive relationship between mercury concentration and fish length, meaning larger/older fish have higher concentrations than smaller/younger fish.
- 2022 ICSP results are consistent with the Core MMP data. The large Burbot (868 mm) is bigger than any Core MMP fish, but we would expect larger Burbot to have higher mercury levels.

FISH CONSUMPTION GUIDANCE

- All ICSP Burbot samples to date have been collected from Moberly Lake. Consumption guidance for Burbot in Moberly Lake will be provided separately by Azimuth in 2024.
- For Burbot (up to 23”) caught in the Peace River between Dinosaur Reservoir and Many Islands, follow consumption guidance based on the Core MMP (table below):

Burbot

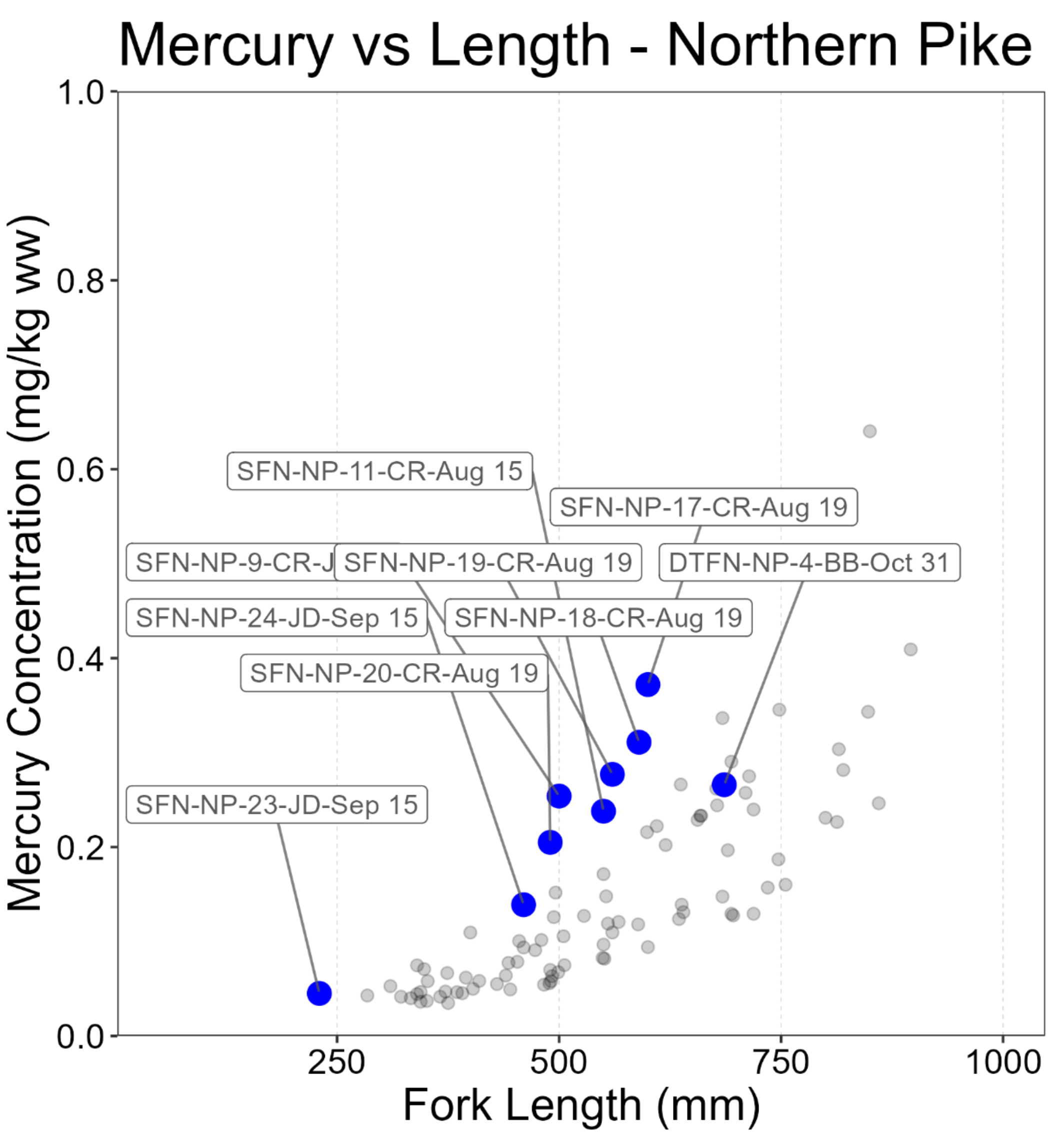
Size$^{mm\|in}$ | Mercury^{ppm}	C	P	O
325|13 | 0.08	18	32	76
450|18 | 0.13	11	20	47
575|23 | 0.21	7	12	29

Mercury estimates from the CORE MMP in the Peace River; see 2022 Annual Report (Appendix F) for details.

Northern Pike

OVERVIEW

- Northern Pike prefer side channel and confluence habitat along the Peace River. As opportunistic ambush predators, they occupy a high position in the food chain and have higher levels of mercury.
- 2022 Northern Pike ICSP results are shown in the plot below as blue points compared to Core MMP fish (grey points). Of the nine ICSP pike, eight were caught in Moberly Lake, and one was caught at the Peace-Smoky River confluence (DTFN-NP-4-BB-Oct31).



FISH MERCURY RESULTS

- Results show a positive relationship between mercury concentration and fish length.
- Only the Northern Pike Caught at the Peace-Smoky River confluence appears to be consistent with the Core MMP data.
- Results from Moberly Lake are not consistent with Core MMP and have a higher mercury concentrations for a given fish length.

FISH CONSUMPTION GUIDANCE

- For Pike caught in Moberly Lake, Azimuth will provide separate consumption advice in 2024.
- For Pike (up to 28”) caught in the Peace River between Dinosaur Reservoir and Many Islands, follow consumption guidance based on the Core MMP (table below):

Northern Pike

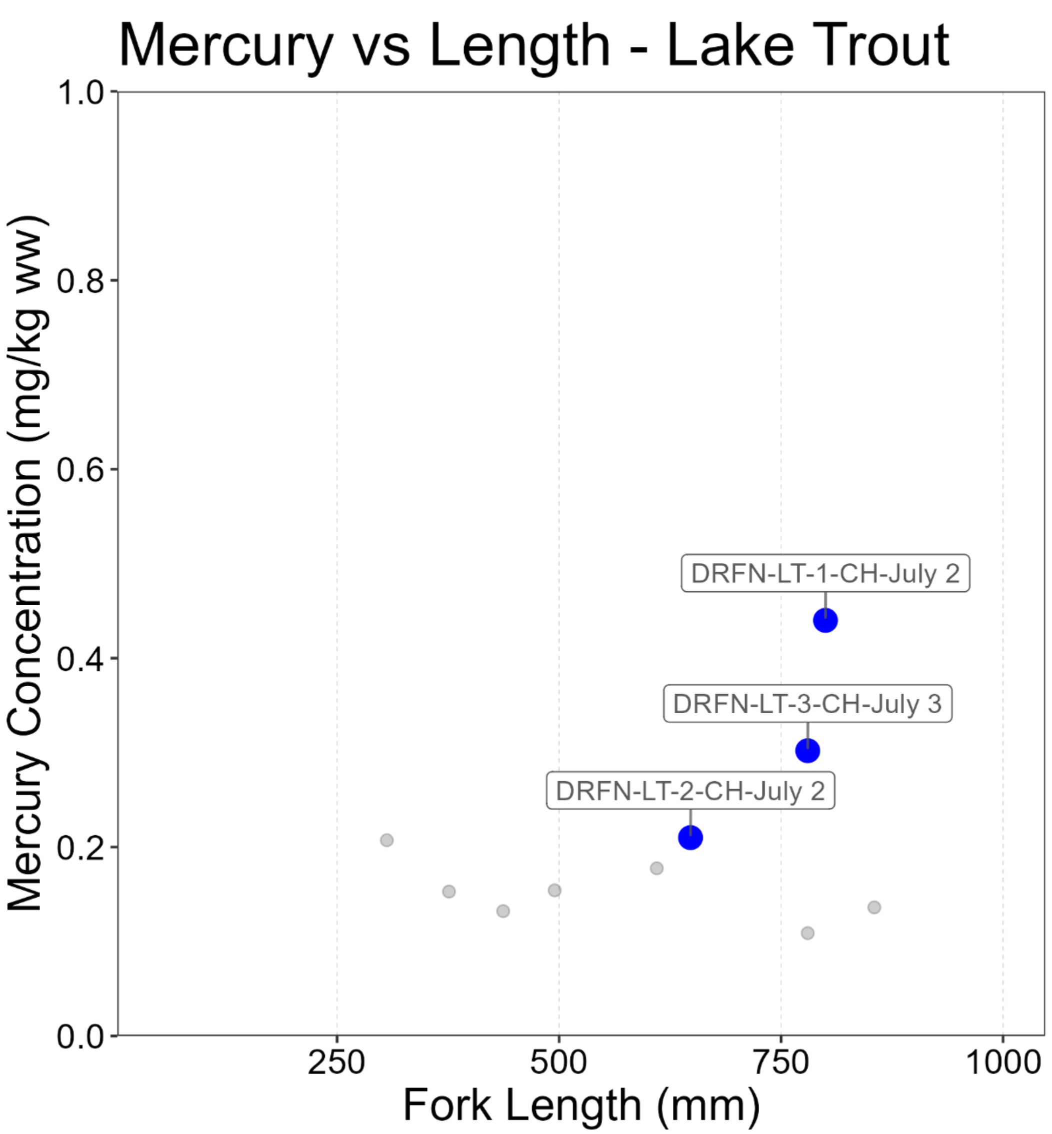
Size mm|in | Mercury ppm	C	P	O
400|16 | 0.06	24	43	101
550|22 | 0.12	12	21	50
700|28 | 0.22	6	11	27

Mercury estimates from the CORE MMP in the Peace River; see 2022 Annual Report (Appendix F) for details.

Lake Trout

OVERVIEW

- Lake Trout are rare in the Peace River, but common in the upstream reservoirs. Young trout eat invertebrates, shifting to preying on other fish as they mature.
- Three ICSP Lake Trout were caught in the Williston Reservoir in 2022 (lower plot; blue points) with lengths comparable to fish captured in the Core MMP (grey points).



FISH MERCURY RESULTS

- ICSP results appear to show a positive relationship between mercury and fish length.
- Core MMP results do not demonstrate a positive length-mercury relationship.
- 2022 ICSP results are not directly comparable to the Core MMP results, since the ICSP fish were collected in Williston Reservoir.

FISH CONSUMPTION GUIDANCE

- Based on FWCP findings reported in 2019, the following consumption guidance applies to Lake Trout from Williston Reservoir:

Lake Trout

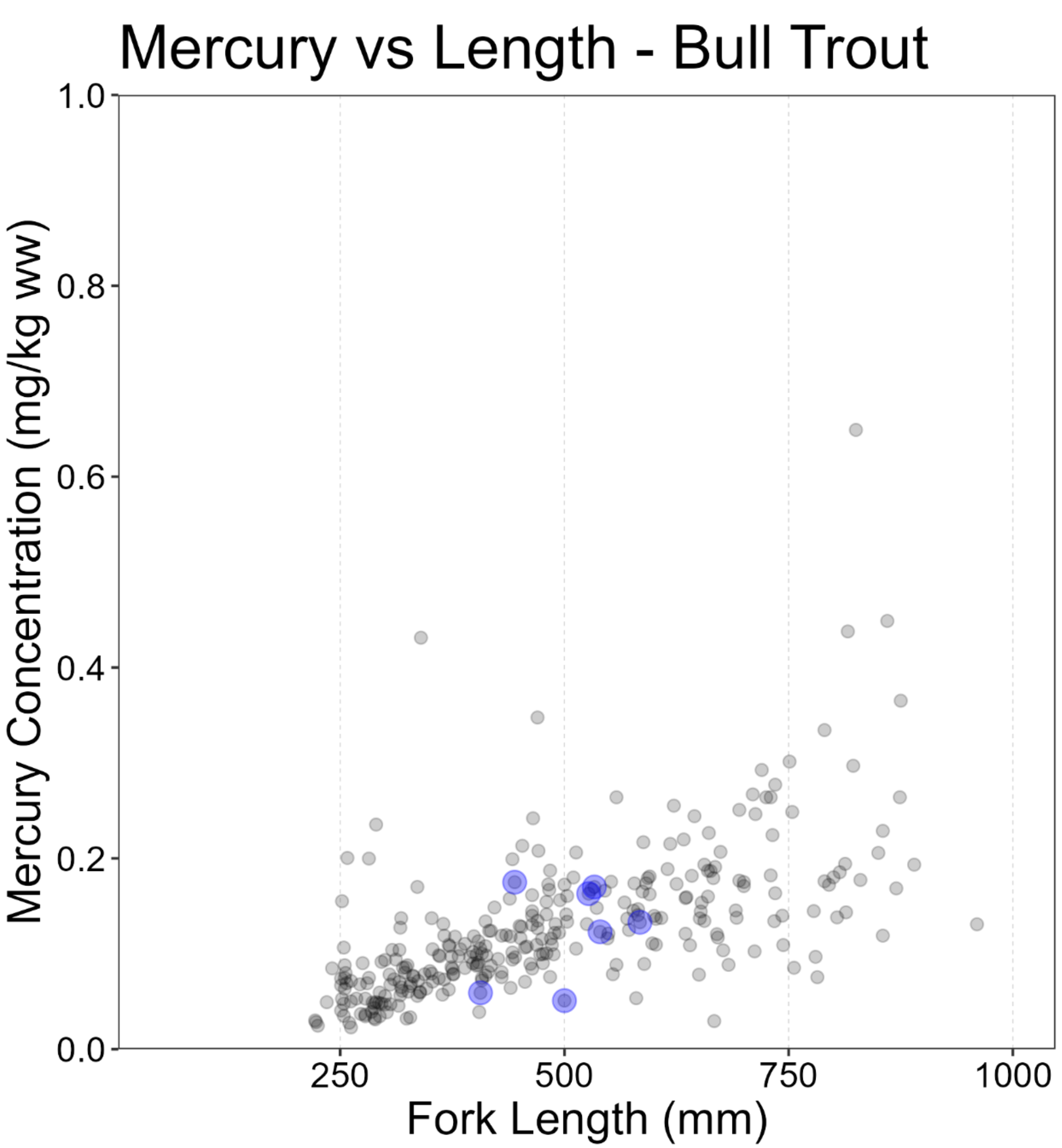
Size$^{mm\|in}$ | Mercury^{ppm}	C	P	O
400|16 | 0.19	7	13	32
550|22 | 0.22	6	11	27
700|28 | 0.31	4	8	19
850|33 | 0.57	2	4	10

Mercury estimates from the FWCP in Peace Region; see 2022 Annual Report (Appendix F) for details.

Bull Trout
Sa-pa*

OVERVIEW

- Bull Trout are most abundant upstream of the Peace-Beaton confluence, utilizing specific spawning habitat on the Halfway River. As opportunistic predators, they feed on invertebrates and fish, altering their diet depending on prey availability.
- No Bull Trout were caught in the 2022 ICSP program. Results from 2021 are shown in the lower plot as faded blue points.



FISH MERCURY RESULTS

- Results show a positive relationship between mercury concentration and fish length, meaning larger/older fish have higher concentrations than smaller/younger fish.
- 2021 ICSP results are consistent with the Core MMP data.

FISH CONSUMPTION GUIDANCE

- For Bull Trout (up to 28”) caught in the Peace (between Dinosaur Reservoir and Many Islands) and Halfway Rivers, follow consumption guidance based on the Core MMP (table below):

Bull Trout			
Size$^{mm\|in}$ | Mercury^{ppm}	C	P	O
400|16 | 0.11	13	23	55
550|22 | 0.15	9	17	40
700|28 | 0.18	8	14	33

Mercury estimates from the CORE MMP in the Peace River; see 2022 Annual Report (Appendix F) for details.

Indigenous name translated into English from the Beaver language. Names provided to BC Hydro by the Halfway River First Nation.

Lake Whitefish
Ihuwe-dak'ale*

OVERVIEW

- Lake Whitefish are more common in the lakes of the Peace River watershed. They are bottom dwelling, feeding primarily on benthic invertebrates.
- ICSP results from 2022 are shown as blue points in the plot below. Five Lake Whitefish were caught in Moberly Lake. No data are available for Lake Whitefish from the Core MMP.

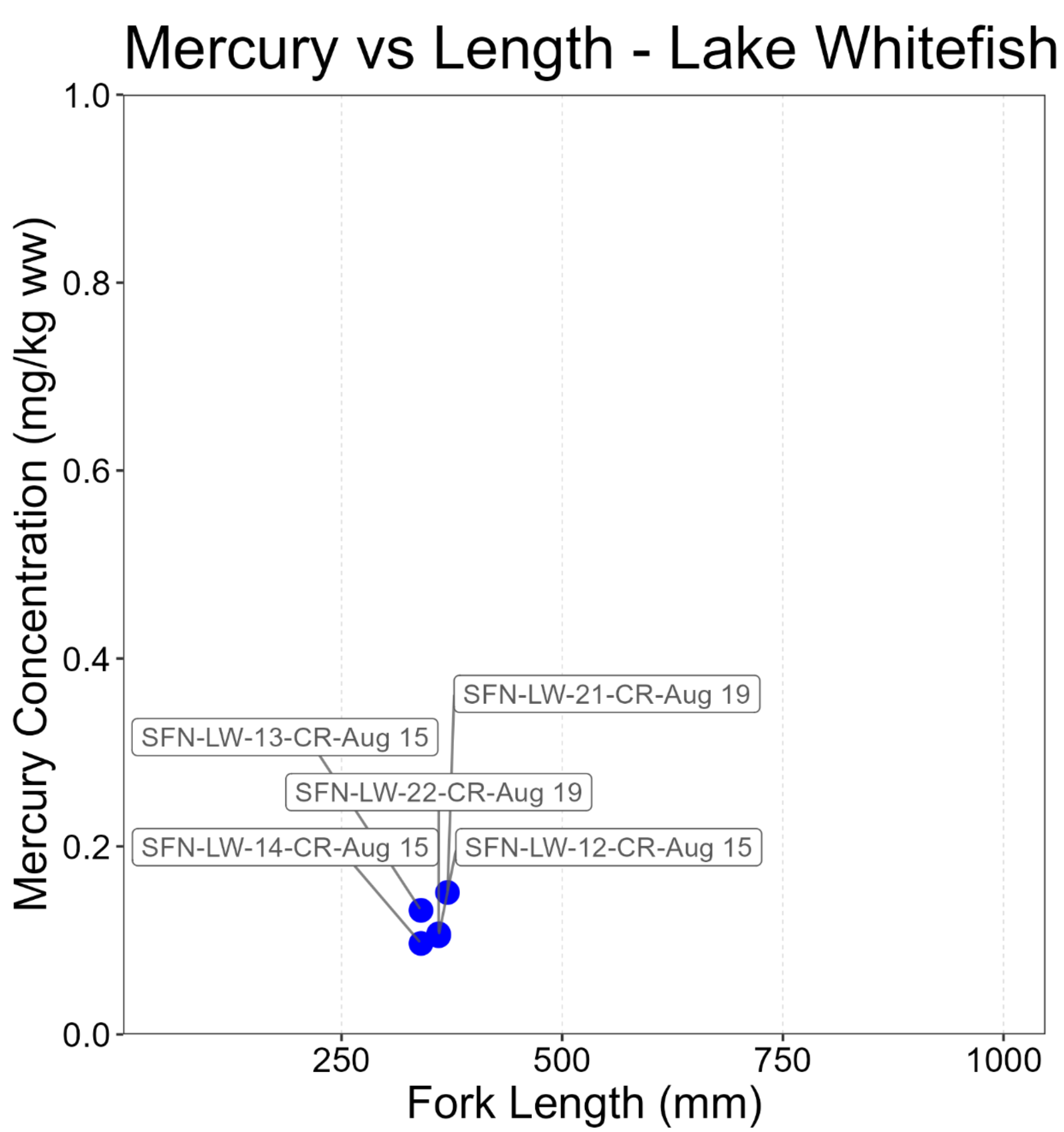


Photo 26

FISH MERCURY RESULTS

- Too few samples are available to make conclusions on length-mercury relationships for Lake Whitefish within Moberly Lake, However, the tissue concentrations found in 2022 are similar to regional reference lakes.

FISH CONSUMPTION GUIDANCE

- Based on FWCP findings reported in 2019, the following consumption guidance applies to Lake Whitefish (up to 12") and is applicable for Moberly Lake:

Lake Whitefish			
Size$^{mm\|in}$ | Mercury^{ppm}	C	P	O
300|12 | 0.15	9	17	40

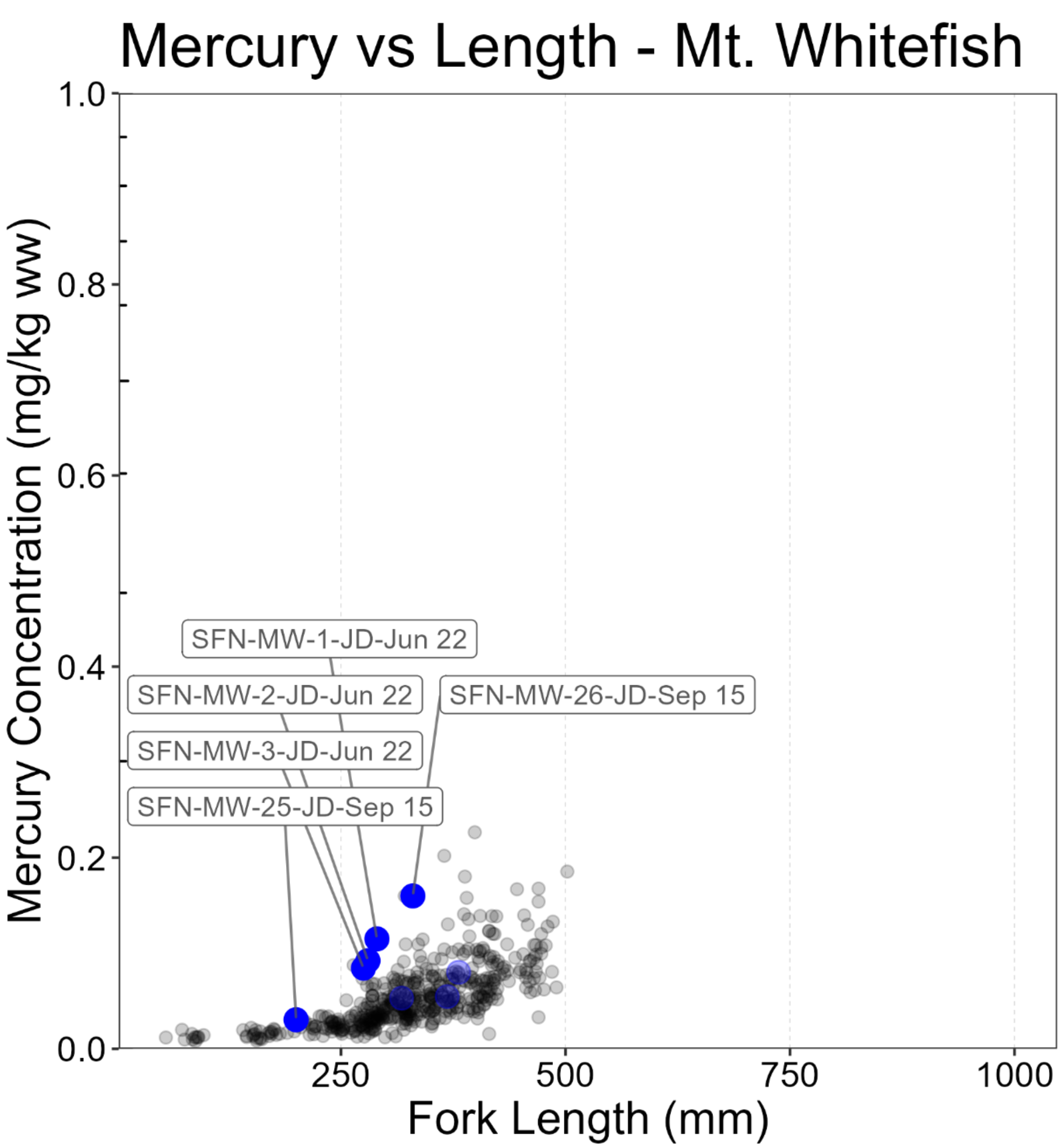
Mercury estimates from the FWCP in Peace Region; see 2022 Annual Report (Appendix F) for details.

Indigenous name translated into English from the Beaver language. Names provided to BC Hydro by the Halfway River First Nation.

Mountain Whitefish

OVERVIEW

- On the Peace River, Mountain Whitefish are most common above the Beatton River confluence, but also occur in lakes throughout the region. They are bottom dwelling, feeding primarily on benthic invertebrates.
- Mountain Whitefish ICSP results from 2022 (labelled blue points) and 2021 (faded blue points) are shown with Core MMP data (grey points) in the plot below. Five fish were caught in 2022 in Moberly Lake, while three fish were caught in 2021 in the Halfway River watershed.



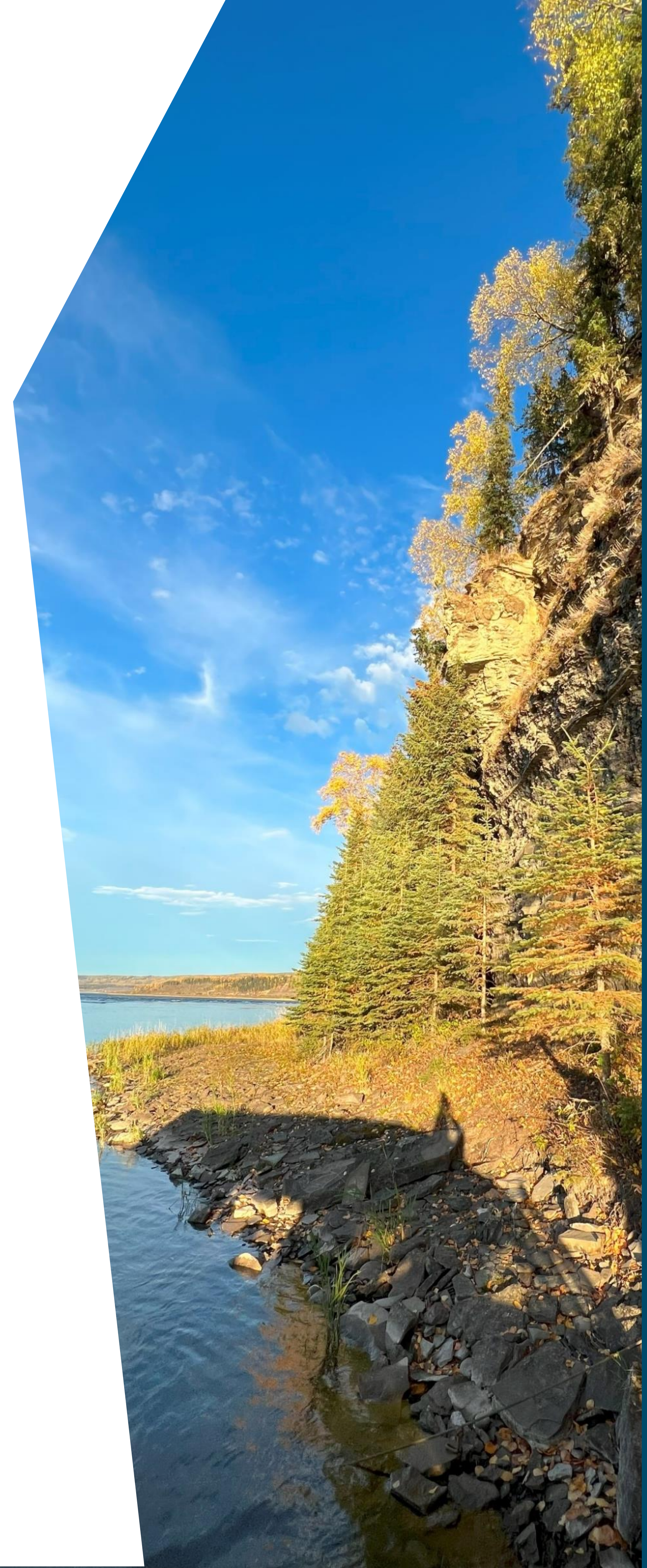


Photo 27

FISH MERCURY RESULTS

- Results show a positive relationship between mercury concentration and fish length.
- 2021 ICSP results from the Halfway River are consistent with the Core MMP data.
- 2022 ICSP results from Moberly Lake are not consistent with Core MMP data and have higher mercury for a given fish length.

FISH CONSUMPTION GUIDANCE

- For Mountain Whitefish caught in Moberly Lake, Azimuth will provide separate consumption advice in 2024.
- For Mountain Whitefish (up to 17”) caught in the Peace River between Dinosaur Reservoir and Many Islands, follow consumption guidance based on the Core MMP (table below):

Mountain Whitefish

Size$^{mm\|in}$ | Mercury^{ppm}	C	P	O
275|11 | 0.04	37	65	152
350|14 | 0.05	29	52	122
425|17 | 0.08	18	32	76

Mercury estimates from the CORE MMP in the Peace River; see 2022 Annual Report (Appendix F) for details.

White Sucker

OVERVIEW

- White Sucker are more common below the Site C Dam, but spawn on tributaries throughout the Peace River. They are also common in lakes across the region. Suckers feed in the bottom substrate, eating worms, clams, and insect larva.
- In 2022 a single ICSP White Sucker was caught in Moberly Lake (lower plot; blue point) of comparable size to those captured in the Core MMP (grey points).

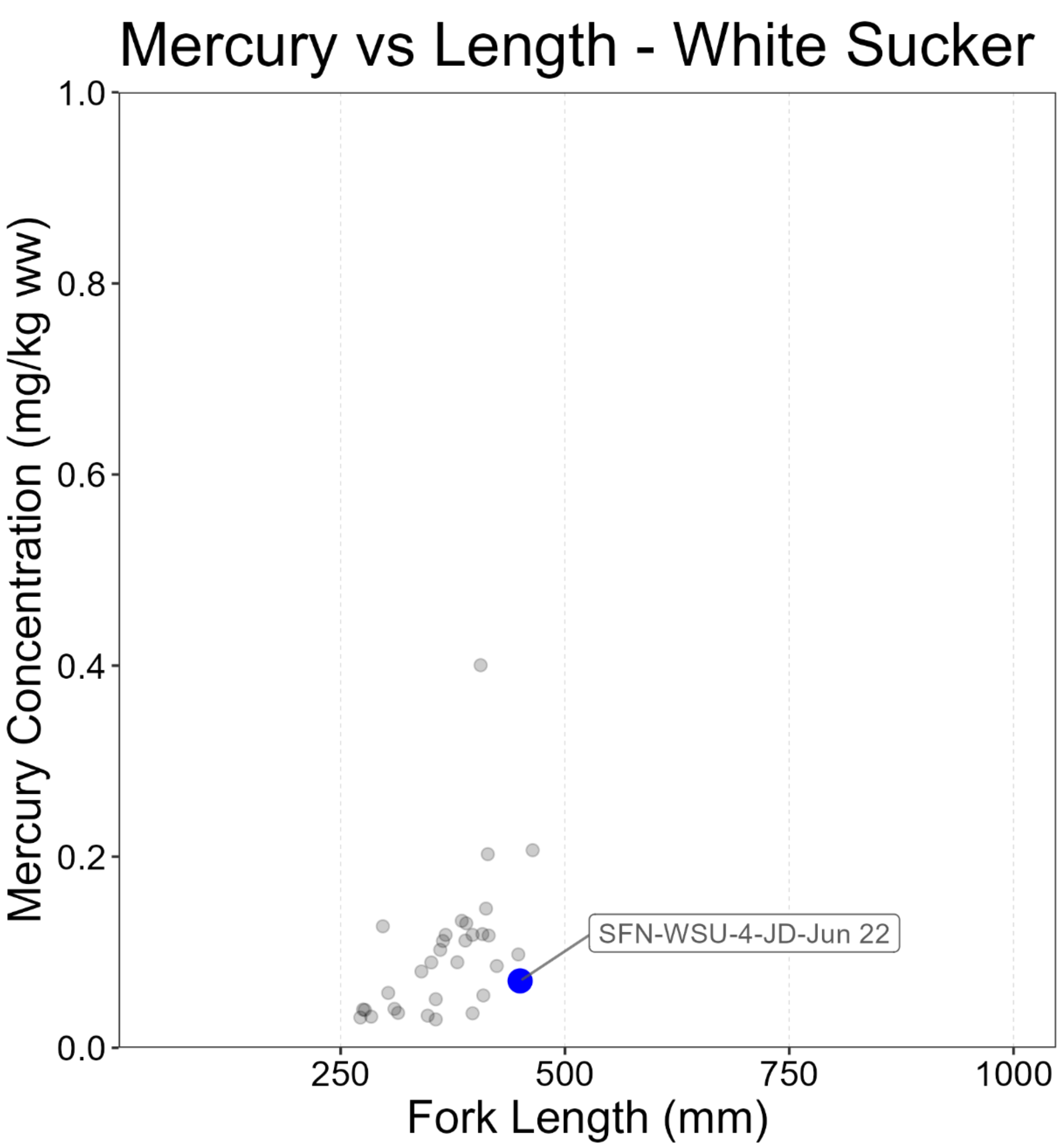


Photo 28

FISH MERCURY RESULTS

- Core MMP data show a positive length-mercury relationship. Larger/older fish have higher concentrations than smaller/younger fish.
- 2022 ICSP results are consistent with the Core MMP data.

FISH CONSUMPTION GUIDANCE

- For White Sucker (up to 17") caught in the Peace River (between Dinosaur Reservoir and Many Islands) and Moberly Lake, follow consumption guidance based on the Core MMP (table below):

White Sucker

Size mm|in | Mercury ppm	C	P	O
325|13 | 0.06	24	43	101
375|15 | 0.09	16	28	67
425|17 | 0.14	10	18	43

Mercury estimates from the CORE MMP in the Peace River; see 2022 Annual Report (Appendix F) for details.

Longnose Sucker

OVERVIEW

- Longnose Suckers are more common on the Peace River downstream of the Halfway River confluence. They are also common in the lakes of the region. Suckers feed in the bottom substrate, eating worms, clams, and insect larva.
- ICSP results from 2022 are shown as blue points in the length-mercury plot (below). In 2022 a single Longnose Sucker was caught in Moberly Lake of comparable size to those captured in the Core MMP (grey points).

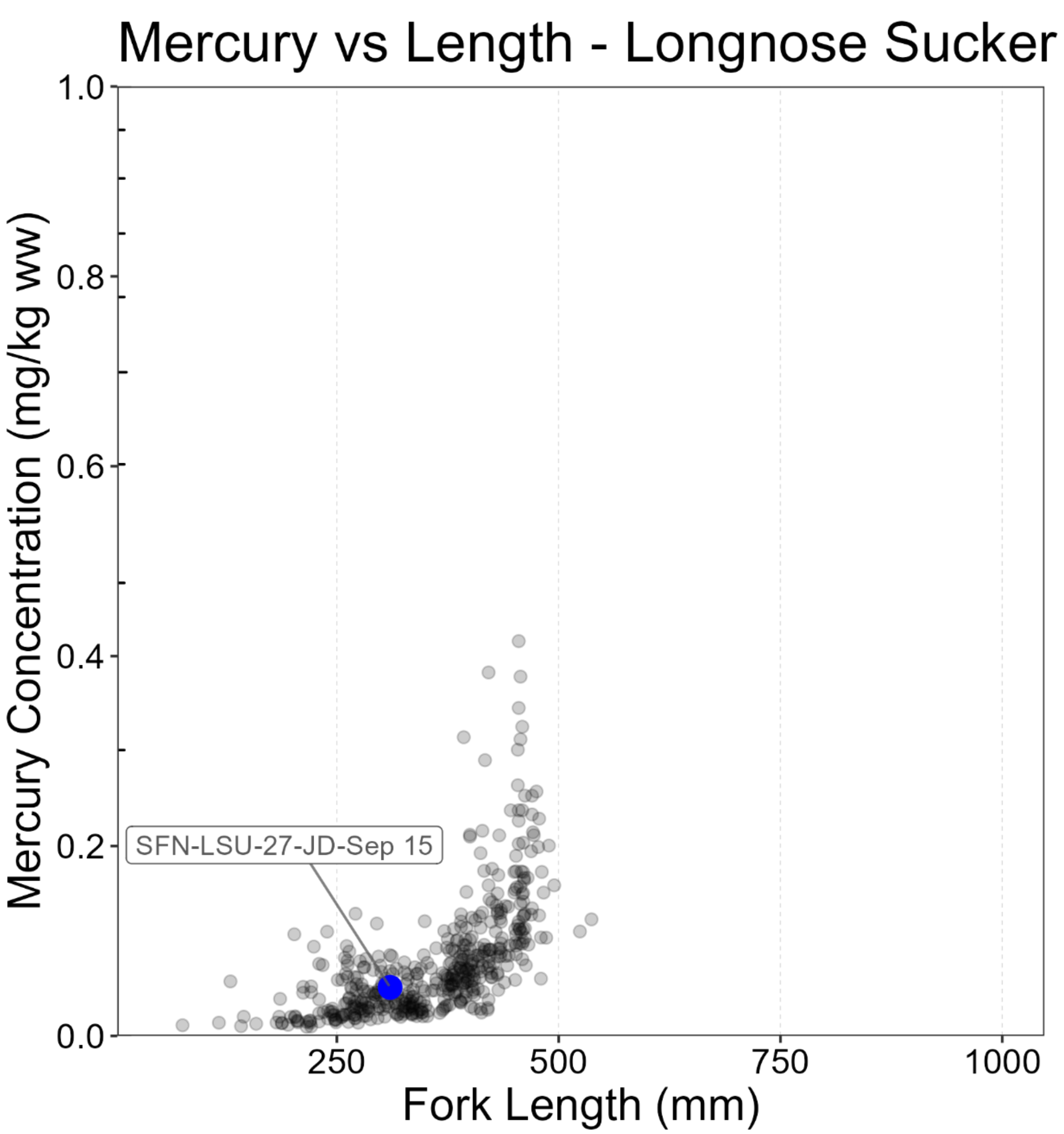


Photo 29

FISH MERCURY RESULTS

- Core MMP data show a positive length-mercury relationship. Larger/older fish have higher concentrations than smaller/younger fish.
- 2022 ICSP results are consistent with the Core MMP data.

FISH CONSUMPTION GUIDANCE

- For Longnose Sucker (up to 17”) caught in the Peace River (between Dinosaur Reservoir and Many Islands) and Moberly Lake, follow consumption guidance based on the Core MMP (table below):

Longnose Sucker

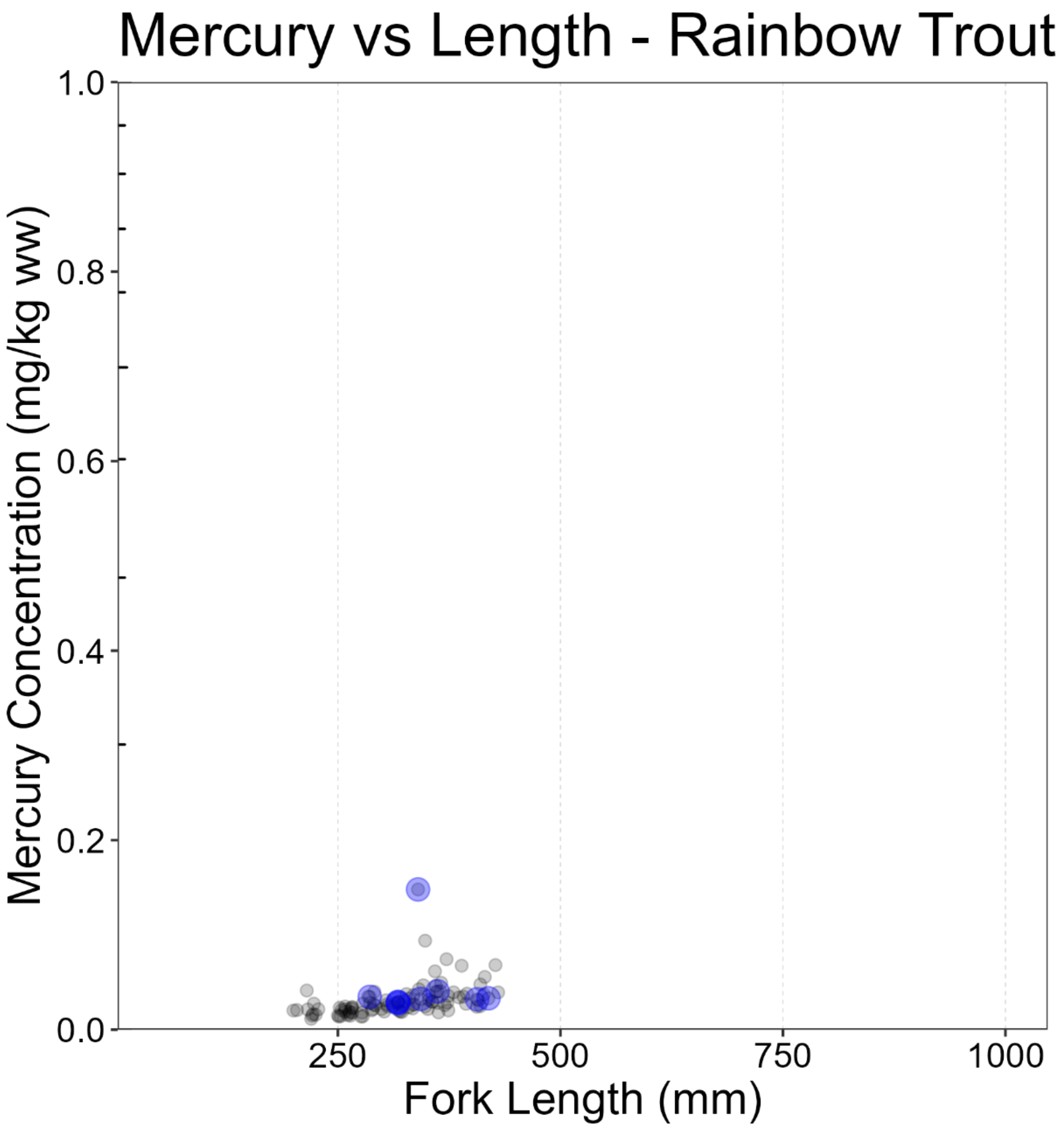
Size mm|in | Mercury ppm	C	P	O
325|13 | 0.05	29	52	122
375|15 | 0.07	21	37	87
425|17 | 0.11	13	23	55

Mercury estimates from the CORE MMP in the Peace River; see 2022 Annual Report (Appendix F) for details.

Rainbow Trout

OVERVIEW

- Rainbow Trout are most common upstream of the Site C Dam They primarily eat insects like caddisflies, mayflies, and midges. Feeding lower on the food chain means that Rainbow Trout have lower levels of mercury.
- No Rainbow Trout were caught in the 2022 ICSP. Results for nine fish from 2021 are shown in the plot as faded blue points. Lengths were comparable to fish captured in the Core MMP (grey points).



FISH MERCURY RESULTS

- Core MMP data show a slight positive length-mercury relationship. Larger/older fish have higher concentrations than smaller/younger fish.
- Mercury concentrations for this species are generally low.
- One trout in 2021 had unusually high mercury for its size class. This sample is considered an outlier.

FISH CONSUMPTION GUIDANCE

- For Rainbow Trout caught in the Peace River between Dinosaur Reservoir and Many Islands, follow consumption guidance based on the Core MMP (table below):

Rainbow Trout

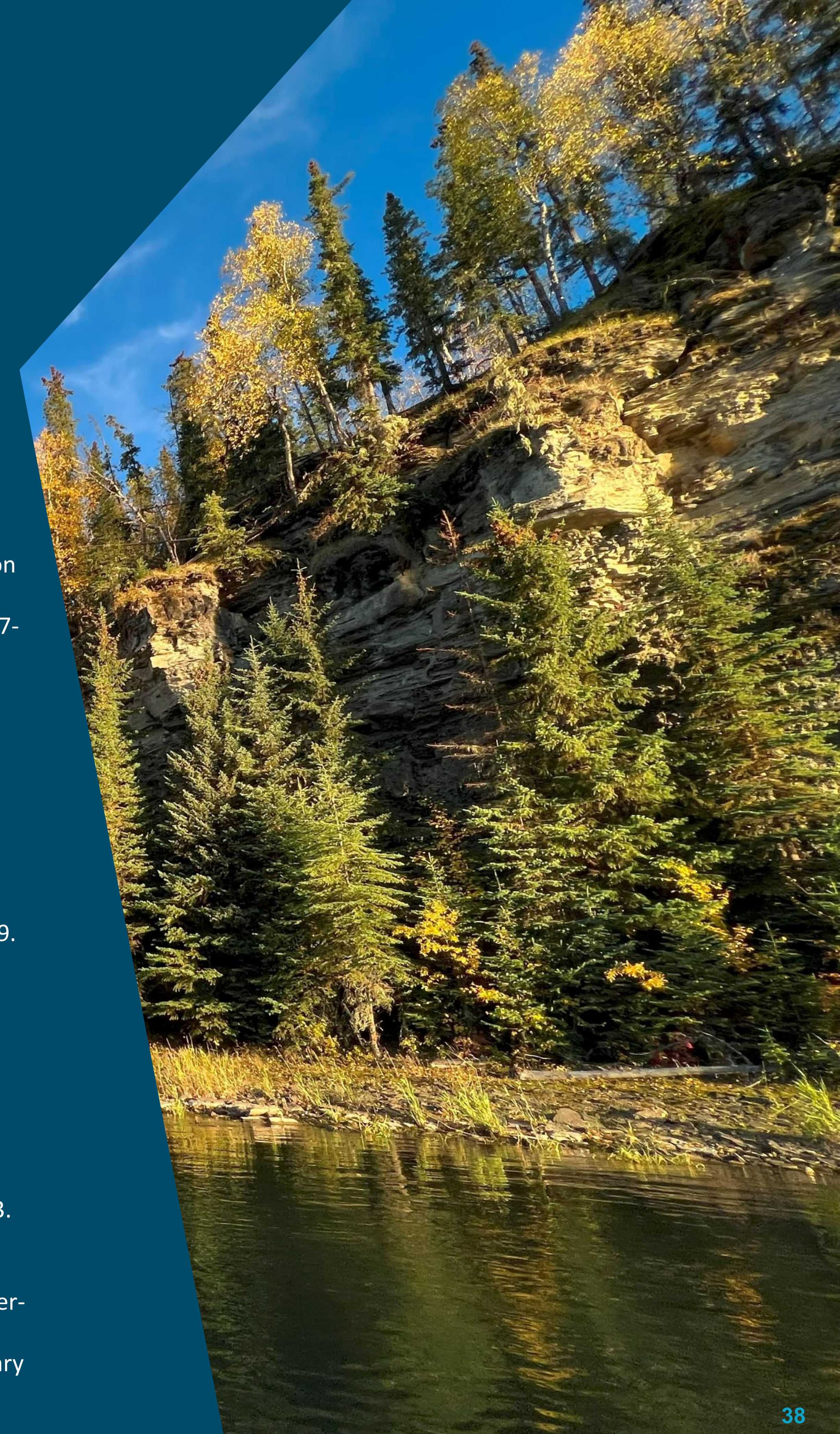
Size$^{mm\|in}$ | Mercury^{ppm}	C	P	O
250|10 | 0.02	74	130	305
325|13 | 0.03	49	86	203
400|16 | 0.04	37	65	152

Mercury estimates from the CORE MMP in the Peace River; see 2022 Annual Report (Appendix F) for details.

Image Reference List

In order of appearance:

1. Photo by Brendan Bushy, 2023 ICSP sampling at the Peace-Smoky River confluence, provided by SMS on 29-Nov-2023.
2. Photo provided by Deborah Prince, 2023 ICSP sampling near McLeod Lake, provided by email on 27-Jul-2023.
3. A) rawpixel.com / U.S. Department of Interior (Source), Percussion Images, https://www.rawpixel.com/search/percussion?page=9&path=_topics&sort=curated
4. B) Flickr (Bezaire D, Havens-Bezaire S), Salmon filets hanging on a rack by a river in Alaska, https://www.flickr.com/photos/75988799@N00/3697623415
5. C) Vector Portal, Stock Silhouette Of A Runner 2 Vector Icon, https://vectorportal.com/vector/vector-silhouette-of-a-runner-2/12673
6. Flickr (USDA Photo by Preston Keres), A local catches a trout in at Georgetown Lake in the Pintler Ranger District of Beaverhead-Deerlodge National Forest Montana, https://www.flickr.com/photos/usdagov/48762226763/
7. Azimuth (photo by Ian McIvor), 2023 water sampling at Bralorne-Takla, taken on 1-Aug-2024.
8. US Fish and Wildlife Service (Ryan Hagerty), Comparison of Rainbow trout sizes including a 3 inch, 5 inch, and 10 inch fish, https://www.fws.gov/media/rainbow-trout-sizesjpg
9. Fish and Wildlife Compensation Program (FWCP), Online information video: Methylmercury and fish consumption information in the Peace River system, https://fwcp.ca/mercury/
10. Azimuth (photo by Gary Mann), 2022 MMP supporting media sampling near the Peace-Halfway River confluence, taken on 27-Sep-2022.
11. Photo by Brendan Bushy, 2023 ICSP sampling at the Peace-Smoky River confluence, provided by SMS on 29-Nov-2023.
12. Photo provided by Deborah Prince, 2023 ICSP sampling near McLeod Lake, provided by email on 27-Jul-2023.
13. Photo by Brendan Bushy, 2023 ICSP sampling at the Peace-Smoky River confluence, provided by SMS on 29-Nov-2023.
14. Azimuth (photo by Laura Bekar), 2021 ICSP pilot program training session, taken on 28-Jul-2024.
15. Azimuth (photo by Laura Bekar), 2021 ‘Fish Kit’ contents, taken on 27-Jul-2024.
16. Photo provided by Deborah Prince, Fish LT-2-CH-July2, provided by email on 27-Jul-2023.
17. Azimuth (photo by Ian McIvor), Photo from the ‘How To Video’, 24-Apr-2023.
18. Photo provided by Amanda Metecheah, Danny Apsassin fishing on the Halfway River, provided by email on 24-Sep-2021.
19. Photo by Mike Tilson (Tsay Keh Dene First Nation), 2019 Site C MMP Internal Technical Forum Presentation, 7 November 2019.
20. Azimuth (photo by Gary Mann), 2022 MMP supporting media sampling near Hudson Hope, taken on 26-Sep-2022.
21. Flickr (Sam Stukel, USFWS), Walleye (Sander vitreus), https://www.flickr.com/photos/usfwsmtnprairie/51745624627
22. Flickr, Trüsche, Quappe, https://www.flickr.com/photos/w-tommerdich/39974665553
23. Przemek Pietrak, Esox Lucius at Bydgoszcz Zoo, https://globalquiz.org/ru/иллюстрация-викторины/щука-1/
24. Flickr (Tom Hart), Lake Trout – BWCA – Seagull Lake, https://www.flickr.com/photos/thart2009/51218219333/in/faves-48599217@N08/
25. BC Hydro, Site C Project – Fish and methylmercury in the reservoir, https://www.sitecproject.com/sites/default/files/SiteC-methylmercury-info-sheet-updates.pdf
26. Modified from a photo provided by Jessica Eastman, 2023 ICSP sampling on Moberly Lake, provided by email on 27-Sep-2023.
27. Modified from a photo provided by Patricia Apannah, 2021 ICSP Pilot sampling on the Halfway River, sent in autumn 2021.
28. Flickr (Sam Stukel, USFWS), White Sucker, https://www.flickr.com/photos/usfwsmtnprairie/47383259832
29. BC Hydro, Peace River Fish Identification Key (Draft 2022-01-31), https://www.sitecproject.com/sites/default/files/Peace-River-Fish-Identification-Key.pdf
30. Wikipedia (Liquid Art), Rainbow trout (Oncorhynchus mykiss), swimming underwater of river Vrelo in Perucac, Serbia. Tributary of river Drina., https://en.m.wikipedia.org/wiki/File:Rainbow_Trout_(Oncorhynchus_mykiss)_(cropped).jpg



APPENDIX F: DETAILED FISH CONSUMPTION GUIDANCE FOR 2022

TABLE OF CONTENTS

TABLES

FIGURES

1 INTRODUCTION

This appendix reports the methods and results for providing fish consumption guidance for the 2022 MMP report.

2 METHODS

The methods used to calculate fish consumption guidance were based on the approach presented in Appendix B of the MMP (BC Hydro 2021). The formula and input variables are described below.

2.1 Formula and Input Variables

The maximum number of servings a month of a particular type of fish (i.e., species, size, location) that can be eaten in a month without exceeding Health Canada's (2007) provisional tolerable daily intakes (pTDI) for methylmercury was calculated by **Equation 1**.

Equation 1

$$SV = \frac{(pTDI \times BW \times \delta)}{(C \times S)}$$

Where:

SV = Number of servings of fish that can be consumed per month without exceeding the pTDI

pTDI = provisional tolerable daily intake for methylmercury (µg/kg/day)

BW = Body weight (kg)

δ = Unit conversion constant (days/month)

C = Average concentration of methylmercury in fish (mg/kg wet weight)

S = Average serving size of fish (g wet weight)

Values for the input variables are discussed below and summarized in **Table F-1**.

2.1.1 Tolerable Daily Intakes

Health Canada (1996) defines the amount of oral exposure to methylmercury that a person can be exposed to on a daily basis for their lifetime without unacceptable risk of harm. These values are known as provisional tolerable daily intakes (pTDI) and they are explained in more detail in Appendix B of the MMP (BC Hydro 2021). The pTDI for methylmercury for the general population is 0.47 µg methylmercury/kg body weight/day (µg/kg/d) and the pTDI for methylmercury for people who are, or could be, pregnant and children less than 12 years of age is 0.2 µg/kg/d (Health Canada 2007).

2.1.2 Body Weights and Fish Serving Sizes

Input values for average fish serving sizes and average body weights are described in more detail in Appendix B of the MMP (BC Hydro 2021). Briefly:

- Default average body weights for Canadians recommended by Health Canada (2021) were used as input values for body weight;
- Default average fish servings sizes for Canadian children recommended by Health Canada (2007) were used as input values for average fish serving sizes for children; and,
- Average fish servings sizes for Indigenous adults from the British Columbia regional First Nations Food, Nutrition, and Environment Study (Chan et al. 2011) were used as input values for average fish servings sizes for adults.

2.1.3 Days per Month

The unit conversion constant of 30 days per month was used to calculate fish consumption guidance for the 2022 MMP report. This is a slight deviation from the methods described in Appendix B of the MMP (BC Hydro 2021), which defined this input value as 30.44 days per month. We changed the input value to 30 days per month to ensure consistency when back-calculating a maximum concentration of methylmercury in fish from a nominal consumption frequency expressed as a number of servings per month, when the number of servings is expressed as a whole number. See **Section 2.4.3** for information on categories of nominal consumption frequencies.

2.1.4 Guidance for Children Less than 12 Years Old

As discussed in Appendix B of the MMP (BC Hydro 2021), there is often no practical difference, after rounding, between the maximum number of servings calculated for a toddler (children 6 months to 4 years old) and a child 5 to 11 years old.

The maximum number of servings of fish a month for all receptor age groups across a gradient of concentrations of methylmercury in fish is illustrated in **Figure F-1**. The differences in fish consumption guidance between toddlers, the most sensitive age group, and child 5 to 11 years old and children less than 12 years old are relatively small, and become progressively smaller as concentrations of methylmercury in fish increase.

The difference between servings per month for toddlers and children under 12 years old is illustrated in **Figure F-2**. The relative difference is constant, with the servings per month for children under 12 years old about 10% greater than the servings per month for toddlers. When expressed in absolute terms, the difference falls below 1 serving per month when concentrations of methylmercury in fish exceed 0.162 ppm. The difference exceeds 4 servings per month when concentrations of methylmercury in fish fall below 0.04 ppm, but at these low concentrations of methylmercury in fish the consumption frequency for toddlers already exceeds 30 servings per month.

Figure F-1. Servings per month for toddlers, children 5 to 11 years old, children under 12 years old, people who could be pregnant, and others across a gradient of concentrations of methylmercury in fish

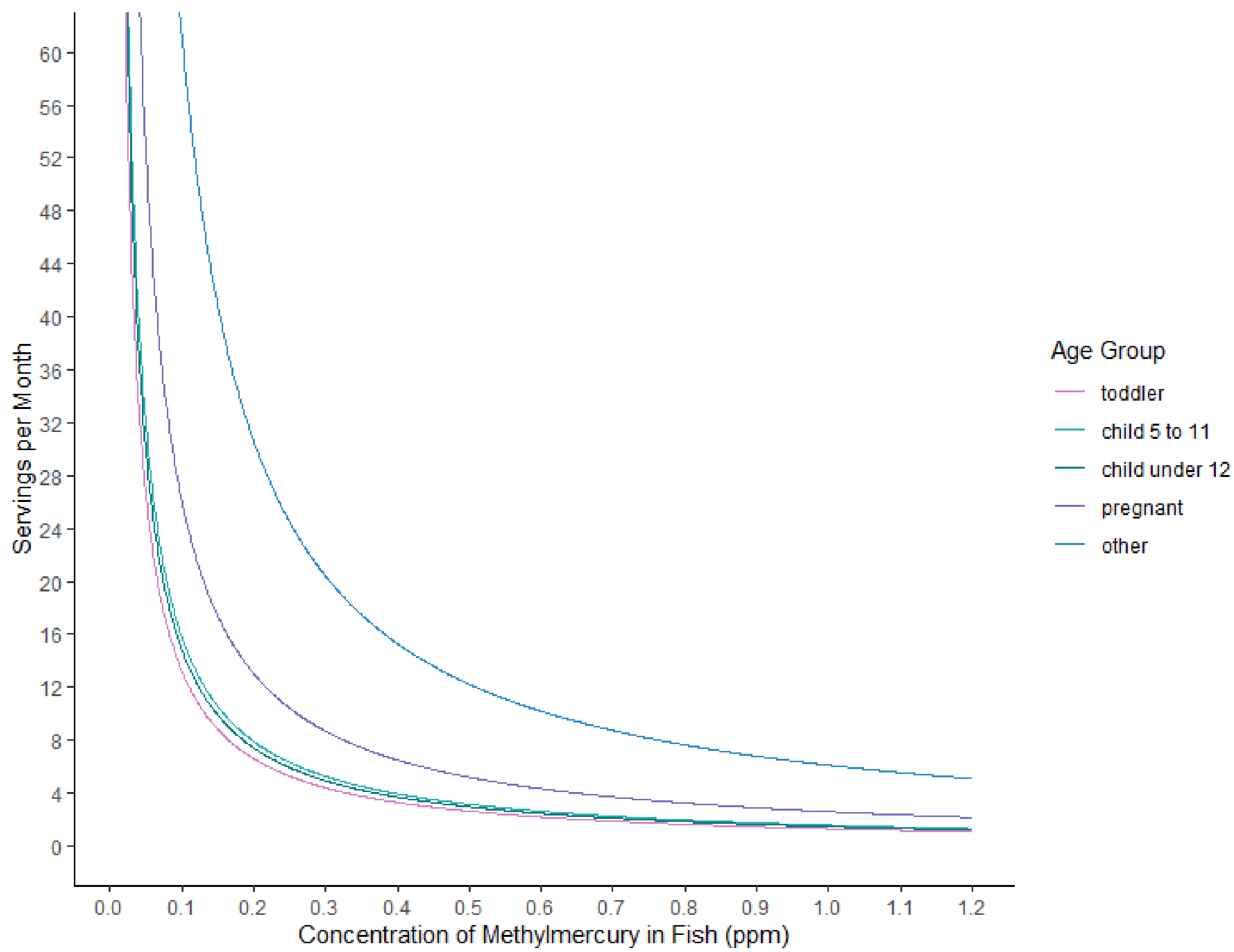
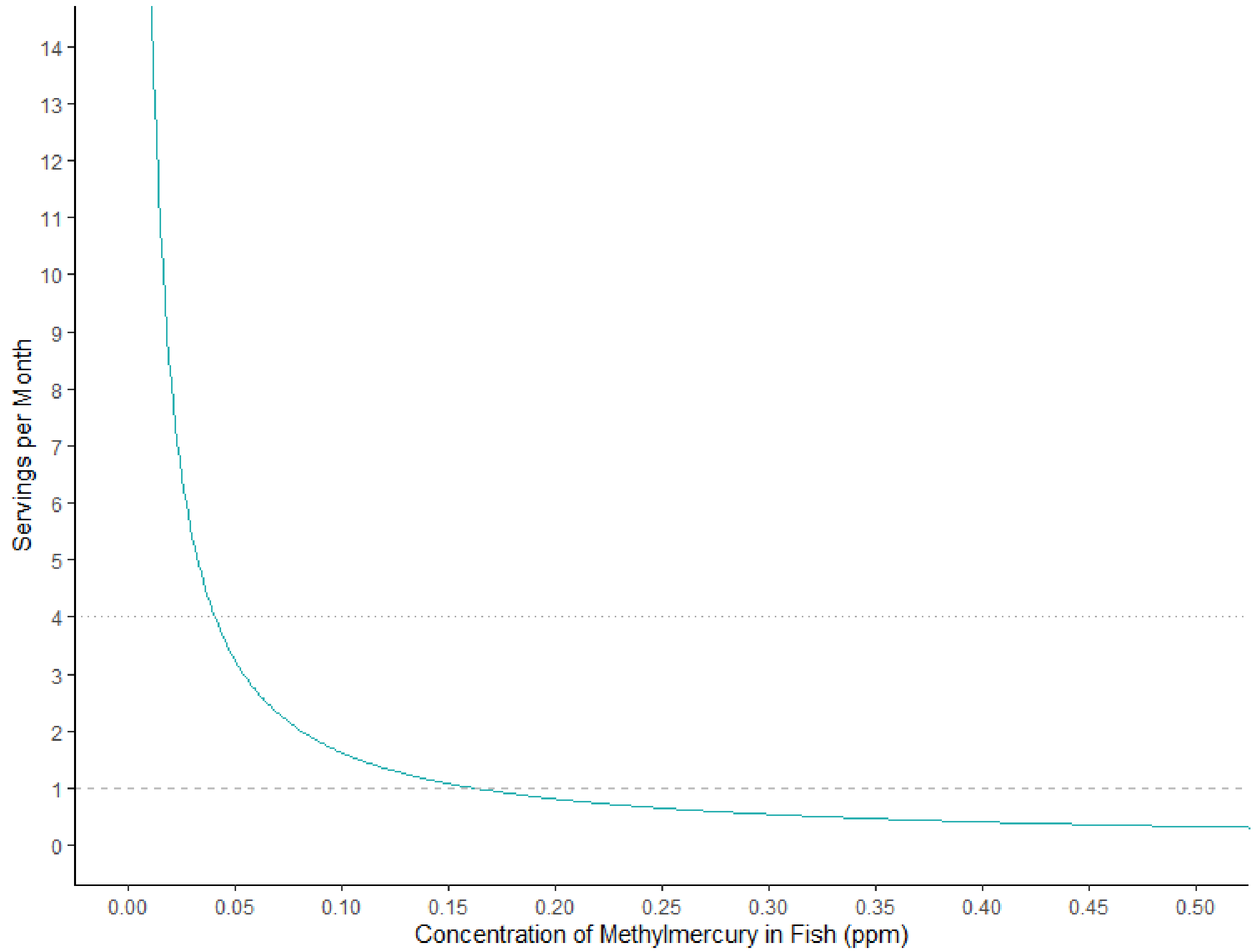


Figure F-2. The difference in servings per month for toddlers and children under 12 years old across a gradient of concentrations of methylmercury in fish



In our judgment, the benefits of simplifying the consumption guidance from four to three age groups outweighed the relatively small loss of precision in consumption guidance for toddlers. Therefore, rather than presenting separate consumption guidance for toddlers and children 5 to 11 years old, we calculated and presented consumption guidance for children less than 12 years old based on the following input parameters:

- Body weight: 24.6 kg
- Average fish serving size: 100 g
- Provisional tolerable daily intake for methylmercury: 0.2 µg/kg/d

The input parameters for body weight and average fish servings size for children less than 12 years old were calculated as the arithmetic mean of the input parameters for toddlers and children 5 to 11 years old.

Table F-1. Summary of input values to calculate fish consumption guidance

Receptor	pTDI (µg/kg/d)	Body Weight (kg)	Fish Serving Size (g)
Toddlers	0.2	16.5	75
Children 5 to 11 yrs old	0.2	32.9	125
Children less than 12 yrs old	0.2	24.7	100
Pregnant	0.2	70.7	163
Others	0.47	70.7	163

2.1.5 Concentration of Methylmercury in Fish

Fish consumption guidance was calculated for MMP target fish species (except Redside Shiner), MMP non-target fish species, ICSP fish, and a selection of retail fish (i.e., fish bought in stores and restaurants). Methods used to derive estimates of the concentration of methylmercury in these types of fish are described in the following sections.

It was assumed that the concentration of total mercury in fish are also representative of the concentration of methylmercury in fish. The input value for the concentration methylmercury in fish is intended to be representative of the average concentration of methylmercury in fish that people eat over a period of 90 days or more (i.e., chronic exposure). The more fish that a person eats, the closer the average concentration of methylmercury in the fish that they are eating will become to the average concentration of methylmercury among the underlying population of fish that they are selecting fish to eat from.

2.1.5.1 MMP Target Fish Species

Fish consumption guidance was calculated for all MMP target fish species except Redside Shiner (i.e., Rainbow Trout, Longnose Sucker, Mountain Whitefish, Bull Trout, and Walleye). Fish consumption guidance was not calculated for Redside Shinner because it was assumed people do not regularly eat Redside Shinner.

Input values for the concentrations of methylmercury in MMP target fish species used to calculate fish consumption guidance are provided in **Table F-3**. These values were the outputs from detailed modelling of location and species-specific length-mercury relationships based on 2022 MMP data. The output of the modelling was estimates of the average concentrations of methylmercury in (often several) standard lengths of fish. Readers are referred to **Section 4.3 of the Main Report** and **Appendix C** for more details.

2.1.5.2 MMP Non-Target Fish Species

Fish consumption guidance was also calculated for fish that were not MMP target fish, but were opportunistically sampled. Input values for the concentrations of methylmercury in non-target fish species used to calculate fish consumption guidance are provided in **Table F-3**. The estimates of concentrations of methylmercury in non-target fish were based on pooled data from multiple sampling years and locations, (both varied by fish species; see **Table F-3**). The estimates of concentrations of methylmercury in non-target fish were derived either from:

- "Generic" models of length-mercury relationships based on pooled data (i.e., all years and locations); or
- Arithmetic means of the concentration of mercury in all samples for a species (i.e., all years, locations, and lengths).

Arithmetic means were used in cases where relationships between length and mercury could not be modelled due to lack of such relationships or insufficient data.

2.1.5.3 Indigenous Community Sampling Program

Fish consumption guidance was calculated for fish that were sampled by the Indigenous Community Sampling Program (ISCP). Information on the sources of data and methods used to generate estimates of the concentrations of methylmercury in ICSP fish is provided below. Input values for the concentrations of methylmercury in ICSP fish are provided in **Table F-4**.

2.1.5.3.1 ICSP Fish Species that Were MMP Target Species

The ICSP included sample data from the following fish species that were also MMP target species: Walleye, Bull Trout, Mountain Whitefish, Longnose Sucker, and Rainbow Trout. The concentrations of mercury in the 2022 ICSP samples for these species were, based on visual inspection of length-mercury plots, similar to the concentrations of mercury in the 2022 core MMP samples for these species. Therefore, the 2022 core MMP data were considered sufficiently representative of the ICSP fish and the estimates of concentrations of methylmercury in 2022 ICSP fish were based on the *maximum* location and length-specific estimates derived from detailed modelling of length-mercury relationships from the 2022 core MMP data.

2.1.5.3.2 Other ICSP Fish Species

Burbot. The concentrations of mercury in the 2022 ICSP samples for Burbot were, based on visual inspection of length-mercury plots, similar to the concentrations of mercury in the core MMP non-target species samples for Burbot. Therefore, the core MMP non-target species data were considered sufficiently representative of the ICSP fish and the estimates of concentrations of methylmercury in 2022 ICSP Burbot were based on estimates derived from generic modelling of length-mercury relationships from the 2017-2021 core MMP data for Burbot.

Northern Pike. The concentrations of mercury in the 2022 ICSP samples for Northern Pike were, based on visual inspection of length-mercury plots, similar to the concentrations of mercury in the core MMP non-target species samples for Northern Pike. Therefore, the core MMP non-target species data were considered sufficiently representative of the ICSP fish and the estimates of concentrations of methylmercury in 2022 ICSP Northern Pike were based on estimates derived from generic modelling of length-mercury relationships from the 2017-2021 core MMP data for Northern Pike.

Lake Trout. The Lake Trout samples in the 2022 ICSP were all from Williston Reservoir (reach unknown). The most recent representative data on concentrations of methylmercury in Lake Trout from Williston Reservoir that we were aware of are from the 2016-2018 Fish and Wildlife Compensation Program (FWCCP) Peace Region study of mercury in fish from the Williston and Dinosaur reservoir watersheds (Azimuth, 2019). The estimates of concentrations of methylmercury in Lake Trout sampled by the 2022 ICSP were based on arithmetic averages of estimates of the concentrations of methylmercury in standardized size classes of Lake Trout from the Finlay, Parsnip, and Peace reaches of the Williston Reservoir from the 2016-2018 Fish and Wildlife Compensation Program (FWCCP) Peace Region fish mercury study (Azimuth, 2019).

Lake Whitefish. The most recent representative data on concentrations of methylmercury in Lake Whitefish from the Peace Region that we were aware of are from the 2016-2018 Fish and Wildlife Compensation Program (FWCCP) Peace Region study of mercury in fish from the Williston and Dinosaur reservoir watersheds (Azimuth, 2019). The estimates of concentrations of methylmercury in Lake Whitefish sampled by the 2022 ICSP were based on the arithmetic average of estimates of the concentrations of methylmercury in standardized 300 mm Lake Whitefish from the Finlay, Parsnip, and Peace reaches of the Williston Reservoir from the 2016-2018 Fish and Wildlife Compensation Program (FWCCP) Peace Region fish mercury study (Azimuth, 2019).

White Sucker. The concentrations of mercury in the 2022 ICSP samples for White Sucker were, based on visual inspection of length-mercury plots, similar to the concentrations of mercury in the core MMP non-target species samples for White Sucker. Therefore, the core MMP non-target species data were considered sufficiently representative of the ICSP fish and the estimates of concentrations of methylmercury in 2022 ICSP White Sucker were based on estimates derived from generic modelling of length-mercury relationships from the 2017-2021 core MMP data for White Sucker.

2.1.5.4 Retail Fish

Fish consumption guidance was calculated for select species of fish sold in stores and restaurants (retail fish). Fish consumption guidance for retail fish was provided to help put the guidance for wild-caught fish from the Peace Region into context. The fish consumption guidance for retail fish helps emphasize the following key messages:

- All fish contain some methylmercury;
- The concentrations of methylmercury in wild-caught fish from the Peace Region are within the range of the concentrations of methylmercury in fish sold in stores and restaurants; and
- Many types of wild-caught fish from the Peace Region and fish sold in stores and restaurants can safely be eaten very frequently.

Input values for the concentrations of methylmercury in retail fish are provided in **Table F-5**. The source of these estimates of the average concentrations of methylmercury in retail fish was the database of mercury concentrations in market fish published by Karimi et al. (2016). This database of mercury concentrations in market fish was based on approximately 300 sources of data from government monitoring programs and published scientific literature. The database includes grand means of the concentrations of mercury in specific types of fish. The grand means were based on reported means from individual studies, weighted by sample size. Sample-size weighted means are an appropriate method for estimating the average concentration of mercury in fish because mercury concentrations in fish are typically skewed to the left (e.g., log-normally distributed) and studies with smaller sample sizes are less likely to include data from the upper end of the distribution. The database of mercury concentrations in retail fish published by Karimi et al. (2016) was intended to characterize the concentrations of mercury in fish sold in the U.S. We, however, considered it a reasonable proxy for the concentrations of mercury in fish sold in British Columbia and Alberta because 43% of the sources included in the Karimi et al. (2016) were international, including data from Canada, and there is a high degree of overlap between Canadian and U.S. commercial food suppliers. Additionally, for some species the Karimi et al. (2016) database provides grand mean concentrations of mercury in fish on a regional basis (e.g., Pacific).

2.1.5.5 Confidence

The level of precision, accuracy, and confidence in estimates of the average concentration of methylmercury in a particular type of fish (i.e., species, length, and location) varies depending on the source as well as quantity and quality of the data. We were most confident in the estimates of the average concentrations of methylmercury in MMP target fish species because these estimates were based on sufficient data to support detailed year and location-specific models of length-mercury relationships. Our confidence in the estimates of the average concentrations of methylmercury in other types of fish varied, but was not as great as our confidence in the estimates of the average concentrations of methylmercury in MMP target fish. Therefore, fish consumption guidance for fish other than MMP target fish species was identified as less certain.

2.2 Rounding and Precision

The following methods for rounding and precision were used to ensure consistency, conservatism, minimize bias introduced by rounding, and provide an appropriate magnitude of precision in calculating fish consumption guidance.

Input values for the concentration of methylmercury in fish were rounded to the nearest one hundredth of a ppm (i.e., two decimal places) using the rounding half-up method[1]. For example, the estimated concentration of methylmercury in a 250 mm Rainbow Trout from Sections 1-3 of the Peace River from detailed length-mercury modelling was 0.0186964684362232 ppm. This value was rounded to 0.02 ppm for use as an input value for calculating fish consumption guidance for 250 mm Rainbow Trout from Sections 1-3 of the Peace River.

Calculated servings of fish per month were rounded down to the nearest whole number. For example, the estimated concentration of methylmercury in a 250 mm Rainbow Trout from Sections 1-3 of the Peace River was 0.02 ppm. The calculated and rounded number of servings per month for a 250 mm Rainbow Trout from Sections 1-3 of the Peace River were:

- Children under 12 years old: (0.20 * 24.7 * 30) / (0.02 * 100) = 74.1 = 74 servings per month
- People who are, or could be, pregnant: (0.20 * 70.7 * 30) / (0.02 * 163) = 130.1227 = 130 servings per month
- Others: (0.47 * 70.7 * 30) / (0.02 * 163) = 305.7883 = 305 servings per month

[1] When a number is halfway between two others, it is rounded up. For example, 0.125 rounds to 0.13; 0.135 rounds to 0.14.

Calculated servings per month input were rounded *down* to the nearest whole number as a measure of conservatism (i.e., reflect a preference for under-estimating the maximum recommended fish consumption frequency rather than over-estimating the maximum recommended fish consumption frequency).

2.3 Quality Assurance

All calculated servings per month values were independently verified.

2.4 Reporting and Presentation

The following sections provide information on the methods used for reporting and presentation of the results.

2.4.1 Locations

Consumption guidance was provided for MMP target fish species for the following locations on the Peace River: reservoir (Sections 1-3), Section 5, Section 7, and Section 9. Separate guidance was provided for these locations, even in cases where the guidance was the same or similar, because:

- People who fish regularly tend to do so within a relatively small geographical area and it will be logical to have guidance tables separately for each of the MMP monitoring locations on the Peace River.
- We expect to see differences in fish mercury concentrations between these locations during the time when fish mercury concentrations are influenced by the reservoir effect. The concentrations of methylmercury in fish from the reservoir are expected to be different from the concentrations of methylmercury in fish from the Peace River downstream of the reservoir. And, the concentrations of methylmercury in fish from the downstream sections closer the dam are expected to be different from the concentrations of methylmercury in fish from the downstream sections further away from the dam.

2.4.2 Results Ordered by Concentration of Methylmercury in Fish

Guidance on the maximum number of servings per month of a particular type of fish (i.e., species, size, location) that can be eaten without exceeding the pTDI for methylmercury was reported in tables, with the results ordered from lowest to highest concentrations of methylmercury in fish. Therefore, a reader can eat a particular type of fish, *or any fish listed above it*, at the indicated frequency (servings per month). While this approach provides some degree of guidance for people that eat more than one type of fish, it may unnecessarily restrict the number of a type of fish a person can safely eat) and care must be taken so that people do not misinterpret the guidance and eat the indicated number of servings a month for a particular type of fish *and* the indicated number of servings a month for another type of fish.

2.4.3 Categories of Nominal Consumption Frequency

In order to further simplify the fish consumption guidance, the maximum number of servings per month were also expressed as categorical "nominal" consumption frequencies. The maximum concentrations of methylmercury in fish for categories of nominal consumption frequency were calculated by rearranging and solving for the average concentration of methylmercury in fish. The maximum concentrations of methylmercury in fish for categories of nominal consumption frequency are presented in **Table F-2**

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The maximum number of servings per month of a particular type of fish (i.e., species, size, location) that can be eaten without exceeding the provisional tolerable daily intakes (pTDI) for methylmercury recommended by Health Canada (1997) are reported in **Table F-6**.

Table F-2. Maximum concentrations of methylmercury in fish for categories of nominal consumption frequency

		Maximum Methylmercury Concentrations (ppm)[1]		
Nominal Frequency	**Servings per Month**	**Child Under 12**	**Pregnant**	**Other**
once per day	30	0.04940	0.086748	0.20386
every second day	15	0.09880	0.173497	0.40772
twice per week	8	0.18525	0.325307	0.76447
once per week	4	0.37050	0.650613	1.52894
twice per month	2	0.74100	1.301227	3.05788
once per month	1	1.48200	2.602454	6.11577

[1] Reported with high precision becuase these are calculated, not measured, vlaues

Table F-3. Input values for the concentrations of methylmercury in fish from the Peace River

Fish Species	Year	Sections	Size	Count	Mercury	Fish Species	Year	Sections	Size	Count	Mercury
Bull Trout	2022	1/3	400	29	0.10 (0.09-0.11)	Redside Shiner	2022	7	75	34	0.03 (0.03-0.03)
Bull Trout	2022	5	400	40	0.11 (0.09-0.12)	Redside Shiner	2022	9	75	36	0.02 (0.02-0.03)
Bull Trout	2022	1/3	550	29	0.15 (0.13-0.17)	Redside Shiner	2022	1/3	85	36	0.04 (0.04-0.04)
Bull Trout	2022	5	550	40	0.14 (0.13-0.16)	Redside Shiner	2022	5	85	38	0.03 (0.03-0.04)
Bull Trout	2022	5	700	40	0.18 (0.16-0.20)	Redside Shiner	2022	7	85	34	0.03 (0.03-0.04)
Longnose Sucker	2022	1/3	325	34	0.04 (0.04-0.05)	Redside Shiner	2022	9	85	36	0.03 (0.03-0.03)
Longnose Sucker	2022	5	325	52	0.04 (0.04-0.05)	Redside Shiner	2022	1/3	95	36	0.05 (0.04-0.05)
Longnose Sucker	2022	7	325	42	0.05 (0.05-0.06)	Redside Shiner	2022	5	95	38	0.04 (0.03-0.04)
Longnose Sucker	2022	9	325	36	0.05 (0.05-0.06)	Redside Shiner	2022	7	95	34	0.04 (0.03-0.04)
Longnose Sucker	2022	1/3	375	34	0.06 (0.05-0.06)	Redside Shiner	2022	9	95	36	0.03 (0.03-0.03)
Longnose Sucker	2022	5	375	52	0.06 (0.06-0.07)	Walleye	2022	7	300	40	0.12 (0.10-0.13)
Longnose Sucker	2022	7	375	42	0.07 (0.07-0.08)	Walleye	2022	9	300	21	0.15 (0.13-0.17)
Longnose Sucker	2022	9	375	36	0.07 (0.07-0.08)	Walleye	2022	5	400	27	0.21 (0.19-0.24)
Longnose Sucker	2022	1/3	425	34	0.08 (0.07-0.09)	Walleye	2022	7	400	40	0.23 (0.20-0.25)
Longnose Sucker	2022	5	425	52	0.09 (0.08-0.10)	Walleye	2022	9	400	21	0.28 (0.25-0.32)
Longnose Sucker	2022	7	425	42	0.10 (0.09-0.12)	Walleye	2022	5	500	27	0.35 (0.31-0.40)
Longnose Sucker	2022	9	425	36	0.11 (0.09-0.12)	Walleye	2022	7	500	40	0.38 (0.33-0.43)
Mountain Whitefish	2022	5	275	29	0.04 (0.03-0.04)	Walleye	2022	9	500	21	0.47 (0.41-0.55)
Mountain Whitefish	2022	7	275	37	0.04 (0.03-0.04)	Burbot*	2017-2021	1/3, 5, 7, 9	325	22	0.08 (0.06-0.11)
Mountain Whitefish	2022	9	275	27	0.03 (0.03-0.04)	Burbot*	2017-2021	1/3, 5, 7, 9	450	22	0.13 (0.11-0.15)
Mountain Whitefish	2022	1/3	350	36	0.04 (0.04-0.05)	Burbot*	2017-2021	1/3, 5, 7, 9	575	22	0.21 (0.14-0.30)
Mountain Whitefish	2022	5	350	29	0.05 (0.05-0.06)	Largescale Sucker*	2017-2021	1/3, 5, 7, 9	375	25	0.05 (0.04-0.07)
Mountain Whitefish	2022	7	350	37	0.05 (0.05-0.06)	Largescale Sucker*	2017-2021	1/3, 5, 7, 9	450	25	0.10 (0.09-0.12)
Mountain Whitefish	2022	9	350	27	0.05 (0.04-0.05)	Largescale Sucker*	2017-2021	1/3, 5, 7, 9	525	25	0.19 (0.14-0.24)
Mountain Whitefish	2022	1/3	425	36	0.06 (0.06-0.07)	Northern Pike*	2017-2021	1/3, 5, 7, 9	400	62	0.06 (0.06-0.07)
Mountain Whitefish	2022	5	425	29	0.08 (0.07-0.09)	Northern Pike*	2017-2021	1/3, 5, 7, 9	550	62	0.12 (0.11-0.12)
Mountain Whitefish	2022	7	425	37	0.08 (0.07-0.09)	Northern Pike*	2017-2021	1/3, 5, 7, 9	700	62	0.22 (0.20-0.24)
Mountain Whitefish	2022	9	425	27	0.07 (0.06-0.08)	White Sucker*	2017-2021	1/3, 5, 7, 9	325	26	0.06 (0.05-0.07)
Rainbow Trout	2022	1/3	250	23	0.02 (0.02-0.02)	White Sucker*	2017-2021	1/3, 5, 7, 9	375	26	0.09 (0.08-0.11)
Rainbow Trout	2022	1/3	325	23	0.03 (0.02-0.03)	White Sucker*	2017-2021	1/3, 5, 7, 9	425	26	0.14 (0.11-0.17)
Rainbow Trout	2022	1/3	400	23	0.04 (0.03-0.04)	Arctic Grayling†	2017-2021, 2022	1/3, 5, 7	323	7	0.03 (0.02)
Redside Shiner	2022	1/3	75	36	0.04 (0.03-0.04)	Goldeye†	2010-2011, 2017-2021, 2022	1/3, 7	395	30	0.24 (0.06)
Redside Shiner	2022	5	75	38	0.03 (0.03-0.03)	Lake Trout†	2017-2021	1/3, 5, 7	501	6	0.16 (0.03)

Notes:
1. Year is fish sampling year(s) and Section is fish sampling section(s) in Peace River.
2. Size is fish fork length [mm], Count is sample size [n], and Mercury is concentrations of total mercury in fish muscle tissues [mg/kg wet weight].
3. [*] or [†] in fish species column indicates CORE MMP non-target fish species, where data are combined across sampling sections and years to estimate/calculate mercury concentrations due to small section- and year-specific sample sizes.
4. Mercury concentrations are given for CORE MMP (see Appendix C for full details):
- target species as:
  model estimates (lower - upper 95% confidence intervals) of section-specific relationships between size and mercury using 2022 data, and for
- non-target species as either:
  [*] model estimates (lower - upper 95% confidence intervals) of size-mercury relationships using pooled data across sampling sections and years, or
  [†] arithmetic means (standard deviations) of pooled data across sampling sections and years (i.e., not modeling size-mercury relationships).

Table F-4. Input values for the concentrations of methylmercury in fish sampled in the 2022 ICSP.

Fish Species	Location	Year	Size	Mercury
Bull Trout*	Peace River - section(s): 5	2022	400	0.11 (0.09-0.12)
Bull Trout*	Peace River - section(s): 1/3	2022	550	0.15 (0.13-0.17)
Bull Trout*	Peace River - section(s): 5	2022	700	0.18 (0.16-0.20)
Longnose Sucker*	Peace River - section(s): 9	2022	325	0.05 (0.05-0.06)
Longnose Sucker*	Peace River - section(s): 9	2022	375	0.07 (0.07-0.08)
Longnose Sucker*	Peace River - section(s): 9	2022	425	0.11 (0.09-0.12)
Mountain Whitefish*	Peace River - section(s): 5	2022	275	0.04 (0.03-0.04)
Mountain Whitefish*	Peace River - section(s): 5	2022	350	0.05 (0.05-0.06)
Mountain Whitefish*	Peace River - section(s): 5	2022	425	0.08 (0.07-0.09)
Rainbow Trout*	Peace River - section(s): 1/3	2022	250	0.02 (0.02-0.02)
Rainbow Trout*	Peace River - section(s): 1/3	2022	325	0.03 (0.02-0.03)
Rainbow Trout*	Peace River - section(s): 1/3	2022	400	0.04 (0.03-0.04)
Walleye*	Peace River - section(s): 9	2022	300	0.15 (0.13-0.17)
Walleye*	Peace River - section(s): 9	2022	400	0.28 (0.25-0.32)
Walleye*	Peace River - section(s): 9	2022	500	0.47 (0.41-0.55)
Burbot†	Peace River - section(s): 1/3, 5, 7, 9	2017-2021	325	0.08 (0.06-0.11)
Burbot†	Peace River - section(s): 1/3, 5, 7, 9	2017-2021	450	0.13 (0.11-0.15)
Burbot†	Peace River - section(s): 1/3, 5, 7, 9	2017-2021	575	0.21 (0.14-0.30)
Northern Pike†	Peace River - section(s): 1/3, 5, 7, 9	2017-2021	400	0.06 (0.06-0.07)
Northern Pike†	Peace River - section(s): 1/3, 5, 7, 9	2017-2021	550	0.12 (0.11-0.12)
Northern Pike†	Peace River - section(s): 1/3, 5, 7, 9	2017-2021	700	0.22 (0.20-0.24)
White Sucker†	Peace River - section(s): 1/3, 5, 7, 9	2017-2021	325	0.06 (0.05-0.07)
White Sucker†	Peace River - section(s): 1/3, 5, 7, 9	2017-2021	375	0.09 (0.08-0.11)
White Sucker†	Peace River - section(s): 1/3, 5, 7, 9	2017-2021	425	0.14 (0.11-0.17)
Lake Trout‡	Williston Reservoir - reaches: Finlay, Parsnip, Peace	2010-2011, 2016-2018	400	0.19 (0.15-0.24)
Lake Trout‡	Williston Reservoir - reaches: Finlay, Parsnip, Peace	2010-2011, 2016-2018	550	0.22 (0.19-0.26)
Lake Trout‡	Williston Reservoir - reaches: Finlay, Parsnip, Peace	2010-2011, 2016-2018	700	0.31 (0.27-0.36)
Lake Trout‡	Williston Reservoir - reaches: Finlay, Parsnip, Peace	2010-2011, 2016-2018	850	0.57 (0.48-0.68)
Lake Whitefish‡	Williston Reservoir - reaches: Finlay, Parsnip, Peace	2016-2018	300	0.15 (0.12-0.18)

Notes:
1. Year is fish sampling year(s), Location is fish sampling locations(s), Size is fish fork length in mm, and Mercury is estimates (lower - upper 95% confidence intervals) of total mercury concentrations in fish muscle tissues in mg/kg wet weight.
2. Species-specific mercury values are based on:
[*] The maximum length-specific estimates derived from detailed modeling of length-mercury relationships using 2022 CORE MMP data from Peace River; see Appendix C.
[†] The estimates derived from generic modeling of length-mercury relationships using combined CORE MMP data from Peace River (all sampling locations and years); see Appendix C.
[‡] The arithmetic averages of size-specific estimates derived from length-mercury relationships modeled using data from Finlay, Parsnip, and Peace reaches of Williston Reservoir in Peace Region by the Fish and Wildlife Compensation Program (FWCP); see Azimuth, 2019.

Table F-5. Input values for the concentrations of methylmercury in retail fish.

	Total mercury concentrations (mg/kg wet weight)					
Fish Species	**Count**	**Min**	**Max**	**Mean**	**SD**	**SE**
Halibut	3111	0.16	0.45	0.26	1.17	0.05
Salmon	2818	0.01	0.19	0.05	0.14	0.02
Light Tuna (canned/packed)	972	0.05	0.40	0.12	0.30	0.04
Ahi Tuna (fresh/frozen)	1183	0.03	0.65	0.27	0.80	0.13
Ahi Tuna (canned)	298	0.03	0.24	0.14	0.69	0.10
Albacore Tuna (fresh/frozen)	296	0.03	0.50	0.32	0.48	0.10
Albacore Tuna (canned)	1362	0.16	0.59	0.33	0.96	0.11
Bigeye Tuna	376	0.11	1.15	0.58	1.11	0.22
Bluefin Tuna	514	0.06	2.41	0.80	2.41	0.54
Cod	431	0.02	0.18	0.14	0.26	0.04

Notes:
1. Data sourced from Table S1 (supplemental material) of Karimi et al 2016 (https://doi.org/10.1289/ehp.1205122), using the following criteria:
  - Halibut was based on 'Halibut, Pacific'.
  - Salmon was based on 'Salmon (All)'.
  - Ahi Tuna (fresh/frozen) was based on 'Tuna, Yellowfin'.
  - Ahi Tuna (canned) was based on 'Tuna, Yellowfin (canned)'.
  - Bluefin Tuna was based on 'Tuna, Bluefin (wild)'.
  - Cod was based on 'Cod, Pacific'.
2. SD and SE are weighted (adjusted to sample size) standard deviation and standard error, respectively; visit the cited paper for full details.

Table F-6. 2022 MMP fish consumption guidance

Peace River

Sections 1/3 (Future Site C Reservoir)						
Species*	Size (mm)	Size (in)	Mercury (ppm)	C	P	O
Rainbow Trout	250	10	0.02	74	130	305
Rainbow Trout	325	13	0.03	49	86	203
Arctic Grayling*	323	13	0.03	49	86	203
Longnose Sucker	325	13	0.04	37	65	152
Mountain Whitefish	350	14	0.04	37	65	152
Rainbow Trout	400	16	0.04	37	65	152
Largescale Sucker*	375	15	0.05	29	52	122
Longnose Sucker	375	15	0.06	24	43	101
Mountain Whitefish	425	17	0.06	24	43	101
Northern Pike*	400	16	0.06	24	43	101
White Sucker*	325	13	0.06	24	43	101
Longnose Sucker	425	17	0.08	18	32	76
Burbot*	325	13	0.08	18	32	76
White Sucker*	375	15	0.09	16	28	67
Bull Trout	400	16	0.10	14	26	61
Largescale Sucker*	450	18	0.10	14	26	61
Northern Pike*	550	22	0.12	12	21	50
Burbot*	450	18	0.13	11	20	47
White Sucker*	425	17	0.14	10	18	43
Bull Trout	550	22	0.15	9	17	40
Lake Trout*	501	20	0.16	9	16	38
Largescale Sucker*	525	21	0.19	7	13	32
Burbot*	575	23	0.21	7	12	29
Northern Pike*	700	28	0.22	6	11	27
Goldeye*	395	16	0.24	6	10	25

Section 5 (Site C Dam to Talyor)						
Species*	Size (mm)	Size (in)	Mercury (ppm)	C	P	O
Arctic Grayling*	323	13	0.03	49	86	203
Longnose Sucker	325	13	0.04	37	65	152
Mountain Whitefish	275	11	0.04	37	65	152
Largescale Sucker*	375	15	0.05	29	52	122
Mountain Whitefish	350	14	0.05	29	52	122
Northern Pike*	400	16	0.06	24	43	101
White Sucker*	325	13	0.06	24	43	101
Longnose Sucker	375	15	0.06	24	43	101
Burbot*	325	13	0.08	18	32	76
Mountain Whitefish	425	17	0.08	18	32	76
White Sucker*	375	15	0.09	16	28	67
Longnose Sucker	425	17	0.09	16	28	67
Largescale Sucker*	450	18	0.10	14	26	61
Bull Trout	400	16	0.11	13	23	55
Northern Pike*	550	22	0.12	12	21	50
Burbot*	450	18	0.13	11	20	47
White Sucker*	425	17	0.14	10	18	43
Bull Trout	550	22	0.14	10	18	43
Lake Trout*	501	20	0.16	9	16	38
Bull Trout	700	28	0.18	8	14	33
Largescale Sucker*	525	21	0.19	7	13	32
Burbot*	575	23	0.21	7	12	29
Walleye	400	16	0.21	7	12	29
Northern Pike*	700	28	0.22	6	11	27
Walleye	500	20	0.35	4	7	17

Section 7 (Confluence with Kiskatinaw River)						
Species*	Size (mm)	Size (in)	Mercury (ppm)	C	P	O
Arctic Grayling*	323	13	0.03	49	86	203
Mountain Whitefish	275	11	0.04	37	65	152
Largescale Sucker*	375	15	0.05	29	52	122
Longnose Sucker	325	13	0.05	29	52	122
Mountain Whitefish	350	14	0.05	29	52	122
Northern Pike*	400	16	0.06	24	43	101
White Sucker*	325	13	0.06	24	43	101
Longnose Sucker	375	15	0.07	21	37	87
Burbot*	325	13	0.08	18	32	76
Mountain Whitefish	425	17	0.08	18	32	76
White Sucker*	375	15	0.09	16	28	67
Largescale Sucker*	450	18	0.10	14	26	61
Longnose Sucker	425	17	0.10	14	26	61
Northern Pike*	550	22	0.12	12	21	50
Walleye	300	12	0.12	12	21	50
Burbot*	450	18	0.13	11	20	47
White Sucker*	425	17	0.14	10	18	43
Lake Trout*	501	20	0.16	9	16	38
Largescale Sucker*	525	21	0.19	7	13	32
Burbot*	575	23	0.21	7	12	29
Northern Pike*	700	28	0.22	6	11	27
Walleye	400	16	0.23	6	11	26
Goldeye*	395	16	0.24	6	10	25
Walleye	500	20	0.38	3	6	16

Section 9 (Many Islands)						
Species*	Size (mm)	Size (in)	Mercury (ppm)	C	P	O
Mountain Whitefish	275	11	0.03	49	86	203
Largescale Sucker*	375	15	0.05	29	52	122
Longnose Sucker	325	13	0.05	29	52	122
Mountain Whitefish	350	14	0.05	29	52	122
Northern Pike*	400	16	0.06	24	43	101
White Sucker*	325	13	0.06	24	43	101
Longnose Sucker	375	15	0.07	21	37	87
Mountain Whitefish	425	17	0.07	21	37	87
Burbot*	325	13	0.08	18	32	76
White Sucker*	375	15	0.09	16	28	67
Largescale Sucker*	450	18	0.10	14	26	61
Longnose Sucker	425	17	0.11	13	23	55
Northern Pike*	550	22	0.12	12	21	50
Burbot*	450	18	0.13	11	20	47
White Sucker*	425	17	0.14	10	18	43
Walleye	300	12	0.15	9	17	40
Largescale Sucker*	525	21	0.19	7	13	32
Burbot*	575	23	0.21	7	12	29
Northern Pike*	700	28	0.22	6	11	27
Walleye	400	16	0.28	5	9	21
Walleye	500	20	0.47	3	5	13

Fish from Stores & Restaurants				
Species*	Mercury (ppm)	C	P	O
Salmon*	0.05	29	52	122
Light Tuna*	0.12	12	21	50
Cod*	0.14	10	18	43
Ahi Tuna*	0.21	7	12	29
Halibut*	0.26	5	10	23
Albacore Tuna*	0.32	4	8	19
Bigeye Tuna*	0.58	2	4	10
Bluefin Tuna*	0.80	1	3	7

Notes:
Star [*] indicates MMP non-target fish species (uncertainty in mercury estimates) and retail fish species (mercury levels from literature).
Servings per month (SPM) are given for children under 12 years old [C], people who are, or could be, pregnant [P], and others [O].
Color codes for SPM: Once Every Day [SPM ≥ 30] Once Every Other Day [15 ≤ SPM < 30] Twice a Week [8 ≤ SPM < 15] Once a Week [4 ≤ SPM < 8] Twice a Month [2 ≤ SPM < 4] Once a Month [SPM < 2].

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