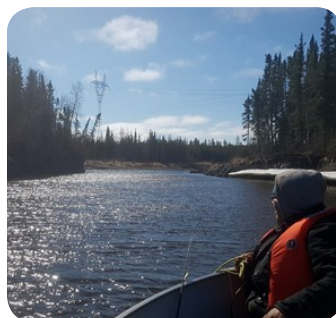




Keeyask Generation Project Aquatic Effects Monitoring Plan

Mercury in Fish Flesh from Aiken and Landing River Report

AEMP-2022-12



KEEYASK GENERATION PROJECT

AQUATIC EFFECTS MONITORING PLAN

REPORT #AEMP-2022-12

MERCURY IN FISH FLESH FROM THE AIKEN/LANDING RIVER IN 2021

Prepared for

Manitoba Hydro

By

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June 2022



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SUMMARY

Background

The Keeyask Hydropower Limited Partnership (KHLP) was required to prepare a plan to monitor the effects of construction and operation of the Keeyask Generating Station (GS) on the environment. Besides measuring the accuracy of the predictions made and actual effects of the GS on the environment, monitoring results will provide information on how construction and operation of the GS will affect the environment and if more needs to be done to reduce harmful effects.

Construction of the Keeyask GS began in mid-July 2014 and instream work was completed in 2020. The reservoir was impounded with water levels being raised to full supply level between August 31 and September 5, 2020. Commissioning of the powerhouse turbines was initiated after impoundment and five of seven units were in-service by fall 2021. During commissioning and as units came into service, substantial flows continued through the spillway until the summer of 2021, when more flow was going through the powerhouse than spillway. By mid-September the spillway was closed and barely used in the fall.

Fish mercury is one of the key components for monitoring because it affects the suitability of fish for consumption by people. Flooding to create the Keeyask reservoir is predicted to increase mercury levels in fish in the reservoir (formerly Gull Lake) and Stephens Lake, though the increase in fish from Stephens Lake is dependent on mercury produced in the reservoir and will be much lower than after Stephens Lake was flooded during construction of the Kettle GS in the early 1970s. The average concentration of mercury in fish in upstream waterbodies such as Split Lake and the Aiken/Landing River could be affected if a large proportion of the fish in these waterbodies also spend extended periods in the Keeyask reservoir. Given that fish moving out of the Keeyask reservoir are expected to form only a small proportion of the fish in Split Lake and the Aiken/Landing River, no measurable effects to average mercury concentrations of fish collected from these waterbodies are predicted. Sampling is being conducted to confirm this prediction.

This report provides mercury concentrations measured in jackfish and pickerel from the Aiken/Landing River near York Landing and Ilford in 2021. These data are the first to be collected to measure mercury levels in fish after operation of the reservoir.

Why is the study being done?

Monitoring in 2021 was done to answer the following questions:

- What are mercury concentrations in jackfish and pickerel, two domestically and commercially important species, at two locations on the Aiken/Landing River (York Landing and Ilford) during the construction/operation phase of the Keeyask Project?
- Have mercury concentrations in jackfish and pickerel at two locations on the Aiken/Landing River (York Landing and Ilford) in 2021 changed from previous study years?

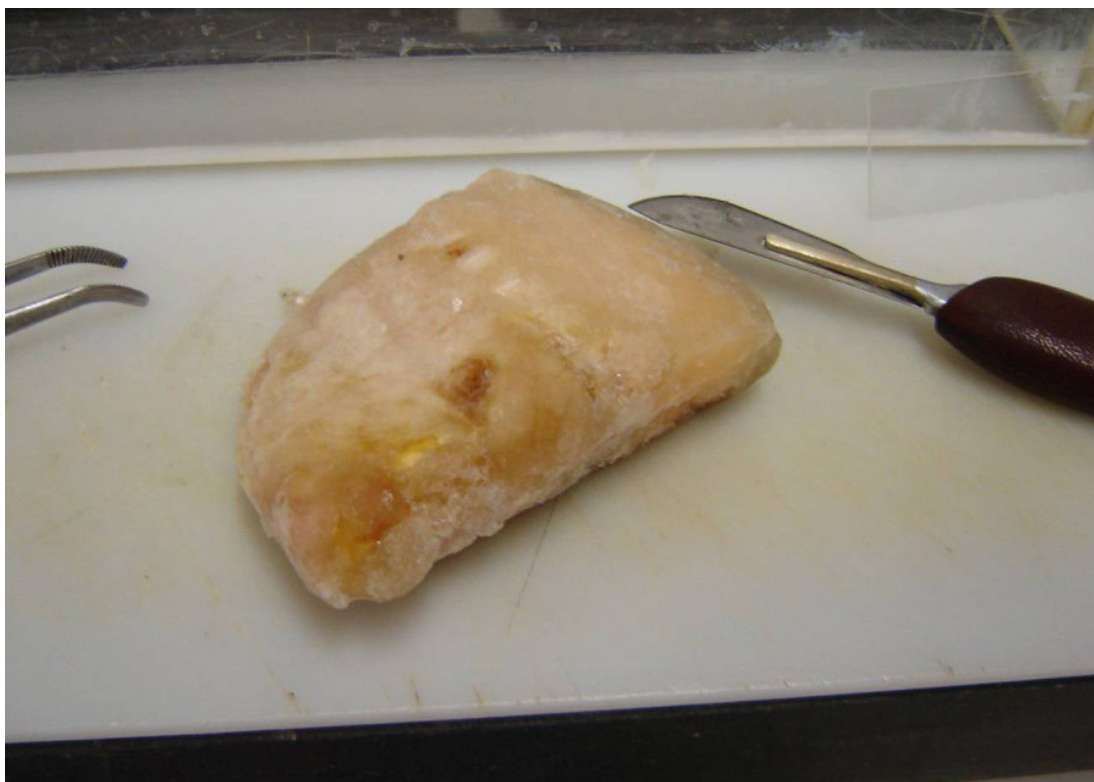


Freshly caught jackfish awaiting processing for muscle samples for mercury analysis.

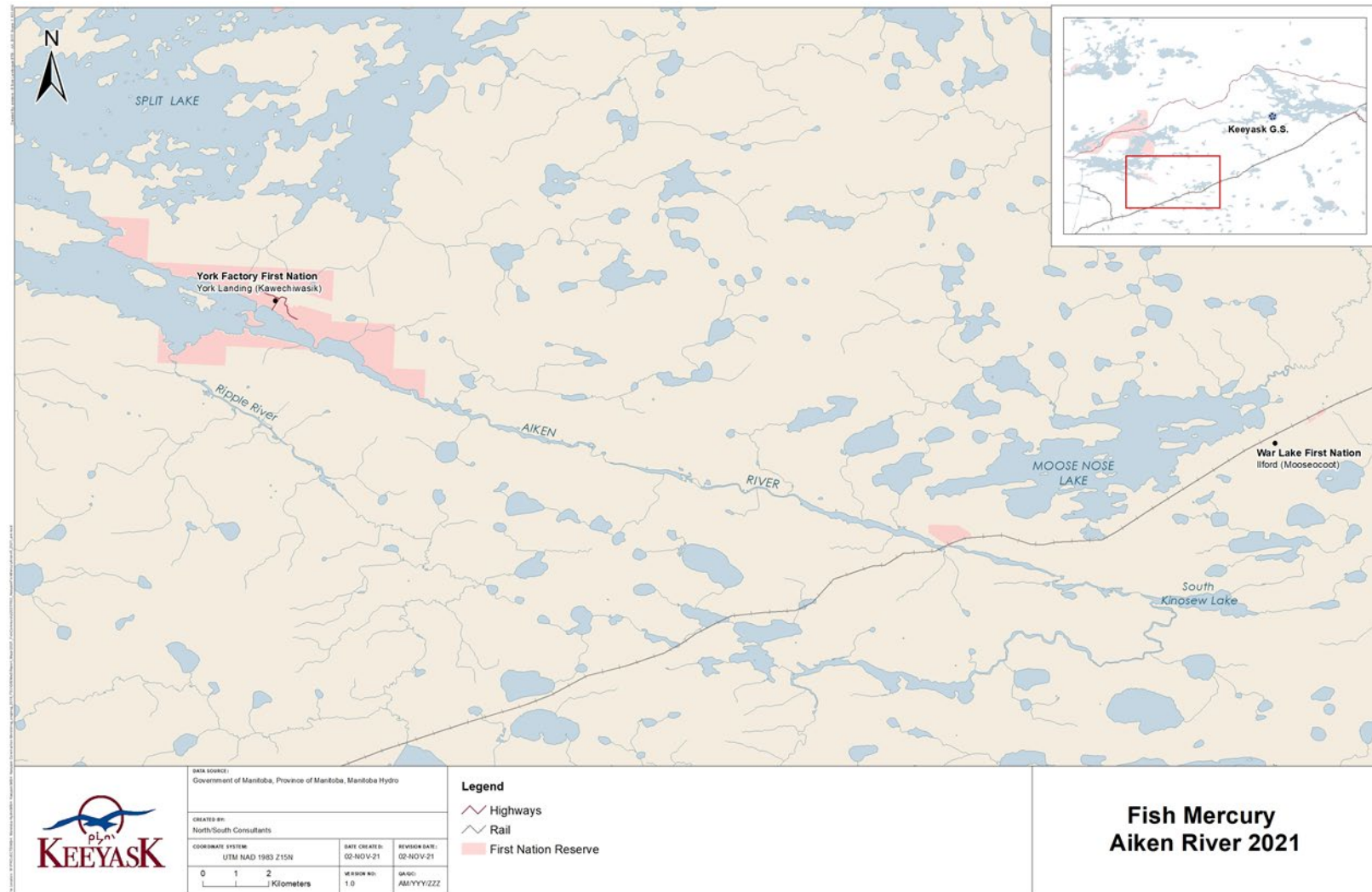
What was done?

Jackfish and pickerel were captured in the Aiken/Landing River near York Landing and Ilford in June 2021 (see map below). Thirty-two jackfish and 36 pickerel were analyzed for mercury from York Landing and only one jackfish and 12 pickerel were analyzed from Ilford due to access issues. Fish collected from both locations were measured for length and a piece of muscle was taken from each fish for mercury analysis. Mercury was measured at a certified laboratory in Winnipeg.

Using the mercury concentration measured in each fish, the average mercury concentration of all fish from each species was calculated. This concentration is referred to as the arithmetic mean. Because the concentration of mercury in fish typically increases with the length of the fish, a second value was calculated that adjusts the concentration to a standard fish length (550 mm for jackfish and 400 mm for pickerel). This value is called the standard mean. Comparison of mercury concentrations between years and waterbodies based on a standard mean is more meaningful than the arithmetic mean since the standard mean accounts for differences in the size of fish sampled each year. Standard means can only be calculated if the fish that were sampled show an increase in mercury concentration with fish length. Therefore, a standard mean is not always available.



Frozen pickerel muscle sample being prepared for mercury analysis.



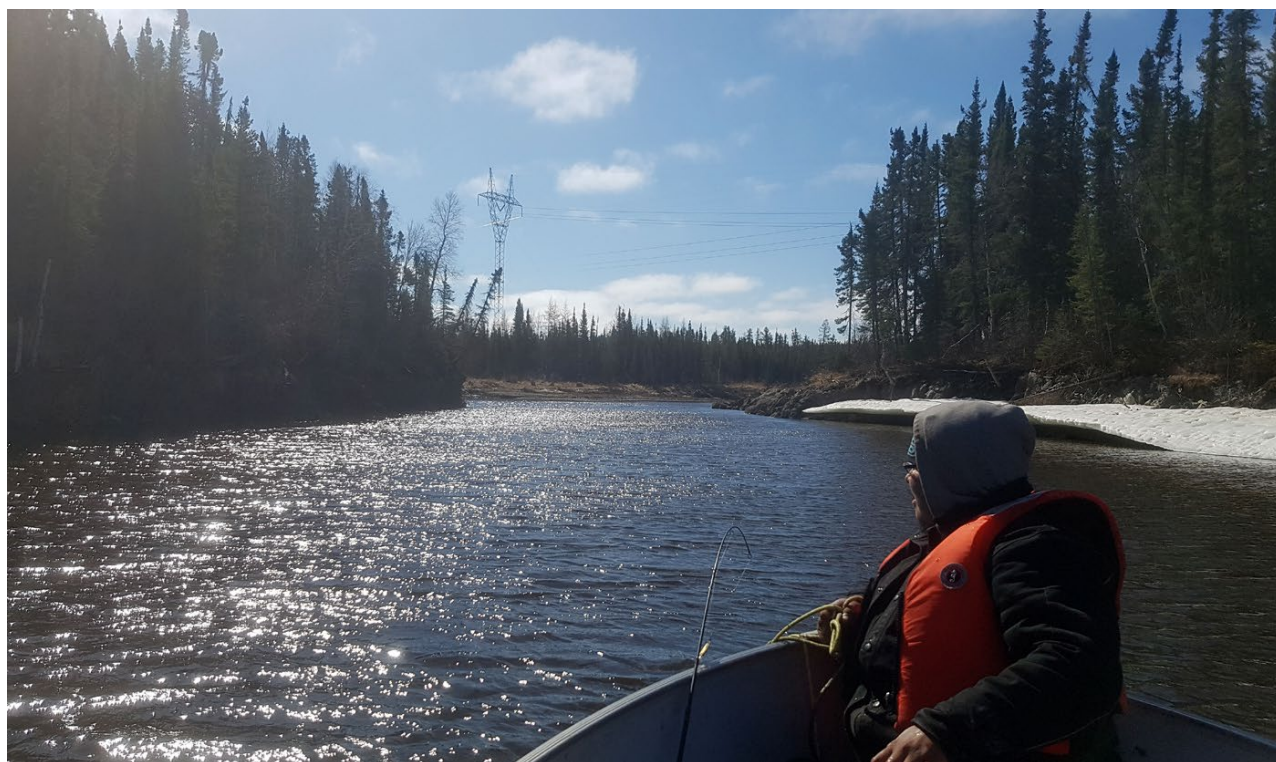
Map of the Aiken/Landing River area.

What was found?

The standard mean mercury concentrations in fish collected from the Aiken/Landing River in 2021 were 0.30 ppm in a 550 mm long jackfish from York Landing, 0.39 ppm in a 400 mm long pickerel from York Landing, and 0.43 ppm in a pickerel from Ilford.

A comparison of the results for 2021 with past results shows that:

- Standard mercury concentrations in jackfish from the York Landing area of the Aiken/Landing River in 2021 is within the range observed since 2006. A comparison of mercury concentrations in the Ilford area was not possible since only one jackfish was collected; and
- Standard mercury concentrations in pickerel from both locations on the Aiken/Landing River in 2021 continued to be higher than they were since 2002 (Ilford) and 2006 (York Landing).



Fishing on the Aiken/Landing River.

What does it mean?

This is the first year that mercury concentrations have been measured in jackfish and pickerel from the Aiken/Landing River since the final impoundment of the Keeyask reservoir in fall 2020. It was predicted the Keeyask project would not affect mercury concentrations of fish from the Aiken/Landing River since few fish were expected to move upstream out of the Keeyask reservoir. Currently, there is no indication of any effect of Keeyask GS construction on fish mercury levels in the Aiken/Landing River.

What will be done next?

Fish mercury concentrations from the Aiken/Landing River at York Landing and Ilford will be monitored again in 2024 according to the schedule in the Keeyask AEMP.

ACKNOWLEDGEMENTS

We would like to thank Manitoba Hydro for the opportunity and resources to conduct this study.

Chief and Council and members of War Lake First Nation and York Factory First Nation are thanked for coordinating and conducting the field sampling for this study.

The collection of biological samples described in this report was authorized by Manitoba Conservation and Water Stewardship, Fisheries Branch, under terms of the Scientific Collection Permit #08-21.

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1.0 INTRODUCTION

The Keeyask Generation Project (the Project) is a 695-megawatt (MW) hydroelectric generating station currently under construction in northern Manitoba. The Project is approximately 725 kilometres (km) northeast of Winnipeg, 35 km upstream of the existing Kettle Generating Station, where Gull Lake flows into Stephens Lake, 60 km east of the community of Split Lake, 180 km east-northeast of Thompson and 30 km west of Gillam (Map 1). Construction of the Project began in July 2014.

The *Keeyask Generation Project: Response to EIS Guidelines*, completed in June 2012, provides a summary of predicted effects and planned mitigation for the Project. Technical supporting information for the aquatic environment, including a description of the environmental setting, effects and mitigation, and a summary of proposed monitoring and follow-up programs is provided in the *Keeyask Generation Project Environmental Impact Statement: Aquatic Environment Supporting Volume* (AE SV). As part of the licensing process for the Project, an *Aquatic Effects Monitoring Plan* (AEMP) was developed detailing the monitoring activities of various components of the aquatic environment. This includes monitoring mercury concentrations in fish flesh of four species during the construction and operation phases of the Project.

The waterbodies included in the fish mercury component of the AEMP are the Keeyask reservoir, which was formerly Gull Lake, Stephens Lake, Split Lake, and the Aiken/Landing River, a tributary of Split Lake. In the event that the mercury concentration in fish from Stephens Lake should exceed predicted maximum concentrations by more than 10%, the fish mercury monitoring program will be extended farther downstream on the Nelson River by sampling within the Long Spruce Forebay.

Fish mercury is one of the key components for monitoring because it affects the suitability of fish for consumption by people. Flooding of the Keeyask reservoir is predicted to increase mercury levels in fish in Gull (now part of the Keeyask reservoir) and Stephens lakes, though the increase in Stephens Lake is predicted to be much less than when the lake was first created by construction of the Kettle GS in the early 1970s. The average concentration of mercury in fish in upstream waterbodies such as Split Lake and the Aiken/Landing River could be affected if a large proportion of the fish in these waterbodies also spend extended periods in the Keeyask reservoir. Given that fish moving out of the Keeyask reservoir are expected to form only a small proportion of the fish in Split Lake and the Aiken/Landing River, no measurable effects to average mercury concentrations of fish collected from these waterbodies are predicted.

This report provides results of mercury monitoring in Northern Pike and Walleye collected in spring 2021 from the Aiken/Landing River. Mercury data from these two piscivorous species in the Aiken/Landing River were first collected during environmental studies for the Project in 2002 and 2003. In response to War Lake First Nation (WLFN) and York Factory First Nation (YFFN) members' concerns with respect to mercury in fish flesh, a study was initiated in 2006 to monitor mercury concentrations in Northern Pike and Walleye on a three-year cycle until such time as there was (or was not) an indication of change.

The monitoring in 2021 was done to answer the following questions:

- What are mercury concentrations in Northern Pike and Walleye at two locations on the Aiken/Landing River (York Landing and Ilford) during the construction/operation phase of the Keeyask Project?
- Have mercury concentrations measured in these two species in 2021 changed from previous measurements?

Results from post-EIS fish mercury sampling in 2009, 2012, 2015, and 2018 have been reported in Jansen (2010), Jansen (2012), Jansen (2016a), Jansen (2019), respectively. The current report builds upon the 2002 to 2018 timeline of fish mercury concentrations, adding results from the 2021 sampling.

2.0 METHODS

2.1 FIELD COLLECTIONS

Due to complications associated with the COVID-19 pandemic, the consultant was unable to access the remote communities to conduct their field work. Instead, York Factory First Nation (YFFN) and War Lake First Nation (WLFN) undertook the 2021 field work. As in previous sampling programs conducted between 2006 and 2018, Northern Pike and Walleye were collected from two locations in the Aiken/Landing River near the communities of York Landing and Ilford (in the following referred to as “from” or “at” York Landing/Ilford). YFFN collected fish from 1 to 8 June 2021 at York Landing and WLFN collected fish on 1 June 2021 at Ilford (Map 2). At both locations, Northern Pike and Walleye were first captured by gillnetting, but the fishing crews switched to angling to reduce the number of fish mortalities of non-target species.

The target sample size was 36 fish of each species. Fish were measured for fork length using a fish tape (cm or inches and converted to mm) and a portion of axial muscle was removed from each fish for mercury analysis. The muscle with skin attached was wrapped in plastic cling wrap and placed in an externally labelled Whirl-Pac bag and frozen tissue samples were shipped to the North/South office in Winnipeg.

2.2 LABORATORY DETERMINATIONS

Muscle samples were weighed and shipped frozen to ALS Laboratories in Winnipeg for analysis of total mercury, ensuring the holding time requirement between catching the fish and its analysis was less than one year. Fish muscle samples from the Aiken/Landing River were analyzed for mercury between 12 and 14 October, 2021. The skin and a thin surface layer of the exposed muscle tissue on the opposite side were sliced away before the remaining sample was homogenized (see below). This procedure helped to ensure that the percentage of water in the muscle sample was representative of the original sample taken from the fish.

Mercury analysis was conducted by cold-vapor atomic absorption spectrometry (CVAAS) applying a modification of EPA Method 200.3/1631E and using a Teledyne Leeman M-7600 mercury analyzer (Teledyne Leeman Labs, Hudson, NH). Quality control results are presented in Appendix 1. The results all fall within the control limits for the QC sample (ALS Data Quality Objective).

2.3 DATA ANALYSIS

The mean size of fish obtained in different years from a group of waterbodies will invariably differ between years and waterbodies. Because fish accumulate mercury over their lifetime, older and, normally, larger individuals have higher levels than younger, smaller fish (Green 1986; Evans *et al.* 2005). In addition to calculating arithmetic mean mercury concentrations (also referred to as arithmetic means), mean mercury concentrations have been standardized to a common fish length that was determined under earlier Manitoba fish mercury monitoring programs (Jansen and Strange 2007) and CAMP (CAMP 2017) to facilitate comparisons for the same species of fish over time or between waterbodies. The standard lengths used for Northern Pike is 550 mm and Walleye is 400 mm.

Length standardized mean mercury concentrations (also referred to as standard means) were calculated from unique regression equations, by species and location, based on the analysis of logarithmic transformations of muscle mercury concentration and fork lengths (mm) using the following relationship:

$$\text{Log}_{10}[\text{Hg}] = a + b (\text{Log}_{10} L)$$

where: [Hg] = muscle mercury concentration (ppm);

L = fork length (mm);

a = Y-intercept (constant); and

b = slope of the regression line (coefficient).

Standard means could not be calculated when the relationship between mercury concentration and fish length was not statistically significant. To present data in more familiar units, all standard means and their measures of variance presented in the tables and figures have been retransformed to arithmetic values (*i.e.*, inverse log). All fish mercury concentrations were expressed in parts per million (ppm), which is the equivalent of mg/kg or µg/g wet weight muscle tissue.

Statistical analysis was completed using XLSTAT (Version 2021.2.2; Addinsoft 2021).

2.4 BENCHMARKS

The benchmarks included in the Keeyask AEMP have been dropped as they are no longer relevant and not appropriate to apply to subsistence fishers (discussed in Jansen 2016a, b).

The key reason for measuring mercury in fish is to determine the risk of it to consumers. For this reason, the mercury data collected under the AEMP is shared with the *Keeyask Mercury and Human Health Implementation Group* for their purposes.

3.0 RESULTS

3.1 SAMPLE DESCRIPTION AND BIOLOGICAL DATA

Mercury concentrations were obtained from 33 Northern Pike and 48 Walleye caught in the Aiken/Landing River in 2021. Thirty-six Walleye and 32 Northern Pike were collected from the York Landing area in 2021 (Tables 1 and 2). Low water levels and the presence of a large beaver dam on the Aiken/Landing River between York Landing and Ilford may have been a barrier to fish passage and made it difficult to obtain the target number of fish from the Ilford area in 2021; only one Northern Pike and 12 Walleye were collected for mercury analysis at this location.

The average length of Northern Pike (539 mm) from York Landing used for the analysis were within 2% of the 550 mm standard length (Table 1). With mean lengths of 363 and 354 mm, Walleye analyzed for mercury from York Landing and Ilford, respectively, were 9 to 11% smaller than the 400 mm standard length (Table 2).

Biological data for individual fish of all species analyzed for mercury in 2021 are presented in Appendix 2. Box plots of lengths of Northern Pike and Walleye captured for mercury analysis between 2002 and 2021 are presented in Appendix 3.

Northern Pike captured at York Landing have generally been longer than those captured at Ilford, with the maximum annual mean of fish from Ilford (521 mm) being less than the minimum annual mean of fish from York Landing (526 mm). Only 10% of the fish analyzed for mercury at Ilford were >600 mm while 38% of the catch at York Landing was >600 mm. Likewise, Walleye from York Landing were longer each year than those captured near Ilford, although the range of annual means was more similar between areas (354–417 mm at Ilford and 363–423 mm at York Landing). As was observed in Northern Pike, the largest size class of Walleye (>475 mm) were less commonly collected from Ilford (<3%) than York Landing (11%).

3.2 MERCURY CONCENTRATIONS

3.2.1.1 RESULTS FOR 2021

Walleye from both locations on the Aiken/Landing River and Northern Pike from York Landing showed a significant, positive relationship between mercury concentration and fork length (Appendix 4), allowing for average concentrations to be standardized by fish length. The length standardized mean mercury concentration of a 550 mm Northern Pike from the York Landing area of the Aiken/Landing River in 2021 was 0.30 ppm (Table 1). Because only a single Northern Pike was collected from the Ilford area in 2021, a length standardized mean could not be calculated for Northern Pike near Ilford. This Northern Pike had a concentration of 0.125 ppm. The length standardized mean mercury concentrations of a 400 mm Walleye from the Aiken/Landing River

in 2021 ranged from 0.39 ppm in the York Landing reach to 0.43 ppm farther upstream near Ilford (Table 2).

3.2.1.2 COMPARISON TO PREVIOUS YEARS

A standard mean could be calculated for Northern Pike in all years in which monitoring has been carried out, except for 2002 (York Landing) and 2021 (Ilford) (Table 1). In 2021, the standard mean mercury concentration for a 550 mm Northern Pike from the York Landing area was 0.30 ppm, which is within the range of standard means that has been observed since the first year of monitoring in 2006 (0.26 ppm to 0.36 ppm) (Figure 2). Likewise, the standard mean concentration of a 550 mm Northern Pike from the Ilford area has varied over the 2002 to 2018 period with values ranging from 0.25 ppm in 2006 to 0.40 ppm in 2009 (Figure 2). Annual standard mean concentrations were generally similar between locations (Figure 2). The only exception was 2009, when Northern Pike from Ilford had a higher standard mean than those from York Landing; this may be attributable to the small number of fish analyzed from Ilford that year ($n = 7$) compared to other years ($n \geq 16$), which may have decreased the certainty in the prediction of the standard mean.

A standard mean concentration could be calculated for Walleye in all years except for 2003 (Ilford) and 2015 (York Landing) (Table 2). Standard mean mercury concentrations have generally shown an increasing trend over the 2002–2021 period at both locations (Figure 3). The only exception was the standard mean in 2015 of fish from the Ilford was lower than the previous two years. The standard mean mercury concentration for a 400 mm Walleye from the York Landing area in 2021 was 0.39 ppm, which was higher than the range of values in previous years (0.19 ppm to 0.33 ppm). Likewise, Walleye from Ilford had a higher length-standardized mean in 2021 (0.43 ppm) compared to the range in previous years (0.22–0.37 mm). A relatively small number of Walleye were sampled from the Ilford area in 2021 ($n = 12$) due to a large beaver dam and low water levels.

4.0 DISCUSSION

2021 marks the first year of monitoring mercury concentrations in Northern Pike and Walleye from the Aiken/Landing River after final impoundment of the Keeyask reservoir in fall 2020. It was predicted there would be no measurable effects to average mercury concentrations of fish collected from the Aiken/Landing River since few fish are expected to move upstream out of the Keeyask reservoir, where mercury concentrations are expected to increase. The results presented in this report show:

- The average length-standardized mercury concentration in Northern Pike from York Landing and Ilford areas of the Aiken/Landing River have fluctuated since data collection commenced in 2002. The mean concentration of a 550 mm Northern Pike from York Landing in 2021 is within the range observed in previous years.
- In years where Northern Pike were collected from both locations, concentrations were typically comparable at both locations. The exception was in 2009, but this difference was likely influenced by the small sample size. The Northern Pike collected from the York Landing area of the Aiken/Landing River in 2021 (0.30 ppm) had a lower length-standardized mean mercury concentration than those from Split Lake in 2021 (0.42 ppm) (Holm and Aiken 2022).
- The average length-standardized mercury concentration in Walleye from the Aiken/Landing River have generally shown an increasing trend at both locations since 2002. The mean concentration of a 400 mm Walleye from York Landing and Ilford in 2021 is higher than the range observed since 2002. The increasing trend in the Aiken River has been occurring prior to the initiation of Keeyask Project. Likewise, the length standardized mercury concentrations of Walleye from Split Lake in 2021 was comparable to but slightly higher than the range measured in previous years (Holm and Aiken 2022). In years where Walleye were collected from both locations, concentrations were slightly lower in fish from York Landing compared to those from Ilford. The length standardized concentration of Walleye from Split Lake in 2021 (0.45 ppm) was higher than fish from York Landing (Holm and Aiken 2022).
- There is no indication of any effect of Keeyask GS construction on fish mercury levels in the Aiken/Landing River.

5.0 KEY QUESTIONS

The key questions to be answered about mercury in fish in relation to monitoring completed in 2021 are:

What are mercury concentrations in Northern Pike and Walleye at two locations on the Aiken/Landing River (York Landing and Ilford) during the construction/operation phase of the Keeyask Project?

The standard means of fish caught in the Aiken/Landing River in 2021 were: 0.30 ppm for a 550 mm Northern Pike from York Landing, 0.39 ppm for a 400 mm Walleye from York Landing, and 0.43 ppm for a 400 mm Walleye from Ilford.

Have mercury concentrations measured in these two species in 2021 changed from previous measurements?

The standard mean mercury concentrationa of Northern Pike from the Aiken/Landing River in 2021 was within the range of values measured at York Landing since 2006. The standard means of Walleye have shown an increasing trend over time at both York Landing and Ilford since monitoring began in 2002 (12 years before the start of Keeyask GS construction).

6.0 CONCLUSION AND NEXT STEPS

Mercury concentrations in Northern Pike from the Aiken/Landing River at York Landing measured in 2021 were within the range that has been measured since 2006. Those measured in Walleye from both the York Landing and Ilford areas in 2021 were higher than in previous years and have shown an increase over time. This trend appears to be unrelated to Keeyask GS construction, as it has been observed since sampling began in 2002. Mercury concentrations at both locations on the Aiken/Landing River were lower than those observed in Split Lake in 2021.

There is no indication of any effect of the Keeyask GS on fish mercury levels in the Aiken/Landing River during the first year following reservoir impoundment.

Mercury concentrations in Northern Pike and Walleye will be sampled again in the Aiken/Landing River at York Landing and Ilford in 2024.

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TABLES

Table 1: Size and age (mean \pm SE) and mercury concentration ([Hg], arithmetic mean \pm SE and standardized mean \pm 95% confidence interval, CI) of Northern Pike sampled for mercury analysis from the Aiken/Landing River from 2002–2021.

Waterbody/ Year	n	Fork Length (mm)	n	Weight (g)	n	Age (y)	n	Arithmetic [Hg] ppm	Standardized [Hg] (ppm)	95% CI
York Landing										
2002	1	985	1	7600	0		1	0.446	-	-
2006	33	589 \pm 12	33	1520 \pm 100	30	7.2 \pm 0.3	33	0.298 \pm 0.017	0.259	0.228–0.293
2009	38	546 \pm 22	38	1535 \pm 197	30	8.3 \pm 0.4	38	0.355 \pm 0.027	0.338	0.309–0.369
2012	35	571 \pm 21	35	1578 \pm 160	0		35	0.424 \pm 0.034	0.356	0.311–0.408
2015	36	567 \pm 15	36	1285 \pm 85	35	5.5 \pm 0.2	36	0.431 \pm 0.032	0.364	0.324–0.409
2018	36	526 \pm 19	36	981 \pm 97	36	4.8 \pm 0.2	36	0.360 \pm 0.036	0.343	0.295–0.399
2021	32	539 \pm 15	0		0		32	0.329 \pm 0.035	0.299	0.250–0.358
Ilford										
2002	16	502 \pm 20	16	1052 \pm 109	15	5.1 \pm 0.4	16	0.233 \pm 0.025	0.274	0.219–0.342
2003	18	493 \pm 21	14	959 \pm 101	18	6.2 \pm 0.5	18	0.268 \pm 0.037	0.327	0.252–0.424
2006	50	496 \pm 8	50	949 \pm 44	50	6.3 \pm 0.2	50	0.225 \pm 0.012	0.252	0.222–0.285
2009	7	489 \pm 36	7	961 \pm 184	4	10.5 \pm 1.5	7	0.312 \pm 0.063	0.400	0.283–0.566
2012	28	512 \pm 18	28	1092 \pm 127	17	6.2 \pm 0.5	28	0.307 \pm 0.033	0.329	0.273–0.397
2015	36	521 \pm 10	36	1011 \pm 58	36	5.3 \pm 0.1	36	0.351 \pm 0.033	0.349	0.286–0.425
2018	36	467 \pm 10	36	676 \pm 37	36	4.3 \pm 0.2	36	0.228 \pm 0.024	0.334	0.255–0.437
2021	1	381	0		0		1	0.125	-	-

Table 2: Size and age (mean \pm SE) and mercury concentration ([Hg], arithmetic mean \pm SE and standardized mean \pm 95% confidence interval, CI) of Walleye sampled for mercury analysis from the Aiken/Landing River from 2002–2021.

Waterbody/ Year	n	Fork Length (mm)	n	Weight (g)	n	Age (y)	n	Arithmetic [Hg] ppm)	Standardized [Hg] (ppm)	95% CI
York Landing										
2002	0		0		0		0		-	-
2006	51	387 \pm 6	51	723 \pm 36	51	6.5 \pm 0.2	51	0.187 \pm 0.007	0.190	0.179–0.202
2009	37	423 \pm 10	37	972 \pm 67	37	6.5 \pm 0.2	37	0.297 \pm 0.013	0.272	0.252–0.295
2012	50	409 \pm 11	50	944 \pm 98	50	6.4 \pm 0.5	50	0.312 \pm 0.019	0.284	0.264–0.305
2015	36	416 \pm 8	36	781 \pm 43	36	6.2 \pm 0.2	36	0.280 \pm 0.016	not significant	
2018	36	405 \pm 7	36	619 \pm 27	36	6.2 \pm 0.2	36	0.361 \pm 0.027	0.332	0.297–0.370
2021	36	363 \pm 7	0		0		36	0.322 \pm 0.023	0.385	0.339–0.438
Ilford										
2002	41	387 \pm 6	39	715 \pm 39	38	6.7 \pm 0.3	41	0.224 \pm 0.014	0.221	0.197–0.248
2003	16	397 \pm 10	11	682 \pm 68	13	8.1 \pm 0.5	16	0.208 \pm 0.019	not significant	
2006	49	397 \pm 5	49	737 \pm 34	49	7.6 \pm 0.2	49	0.249 \pm 0.010	0.244	0.228–0.261
2009	38	417 \pm 8	38	863 \pm 51	38	7.4 \pm 0.3	38	0.323 \pm 0.012	0.304	0.286–0.323
2012	50	387 \pm 6	50	688 \pm 40	50	6.4 \pm 0.3	50	0.341 \pm 0.017	0.351	0.325–0.378
2015	37	400 \pm 6	37	708 \pm 35	37	6.4 \pm 0.1	37	0.308 \pm 0.014	0.300	0.279–0.322
2018	36	368 \pm 5	36	556 \pm 22	36	6.1 \pm 0.2	36	0.336 \pm 0.013	0.373	0.334–0.416
2021	12	354 \pm 12	0		0		12	0.324 \pm 0.033	0.432	0.365–0.510

FIGURES

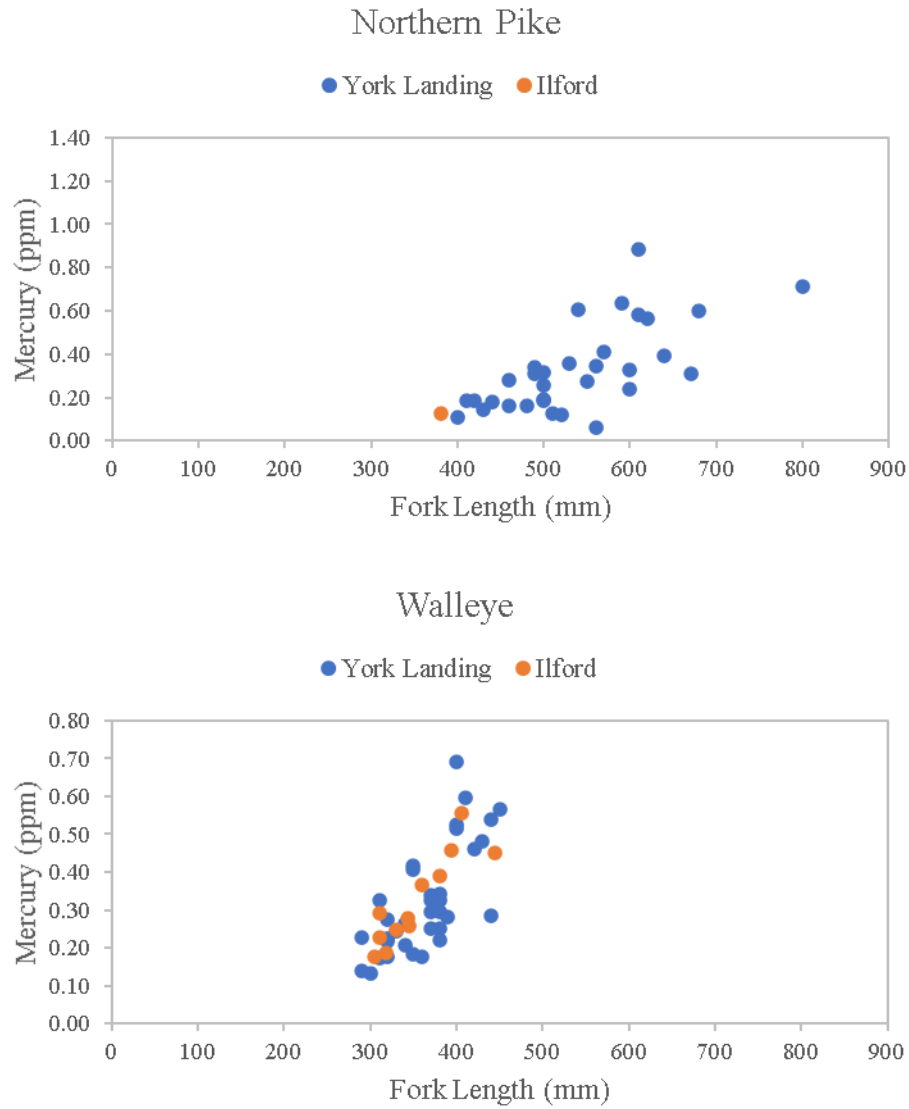


Figure 1: Mercury concentration versus fork length for Northern Pike (top) and Walleye (bottom) captured from the Aiken/Landing River in 2021.

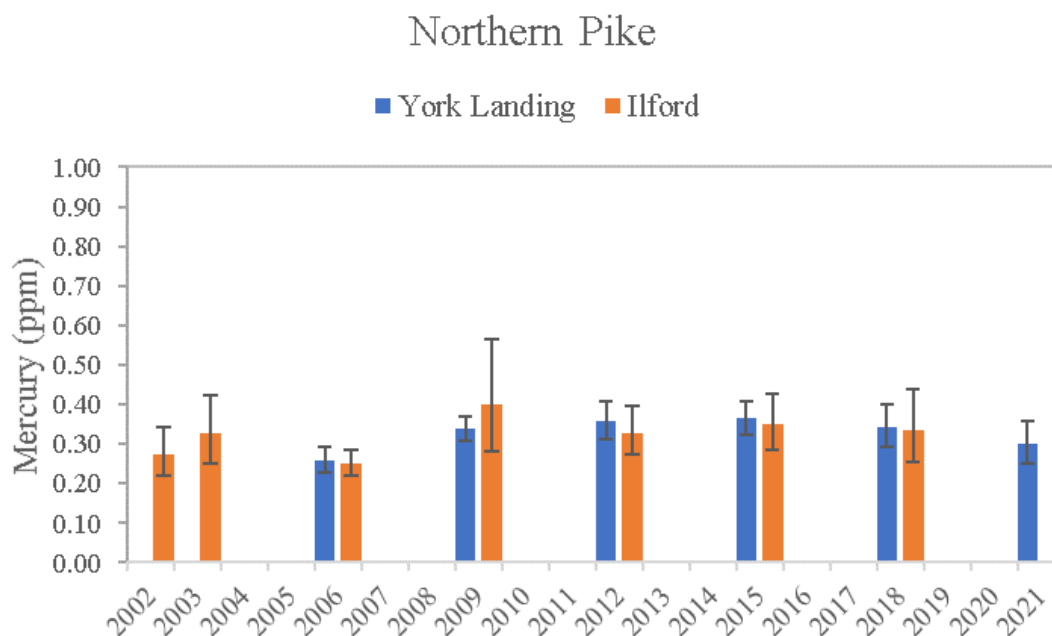


Figure 2: Length standardized mean ($\pm 95\%$ confidence limits, CL) muscle mercury concentration of a 550 mm Northern Pike from the Aiken/Landing River for years 2002–2021.

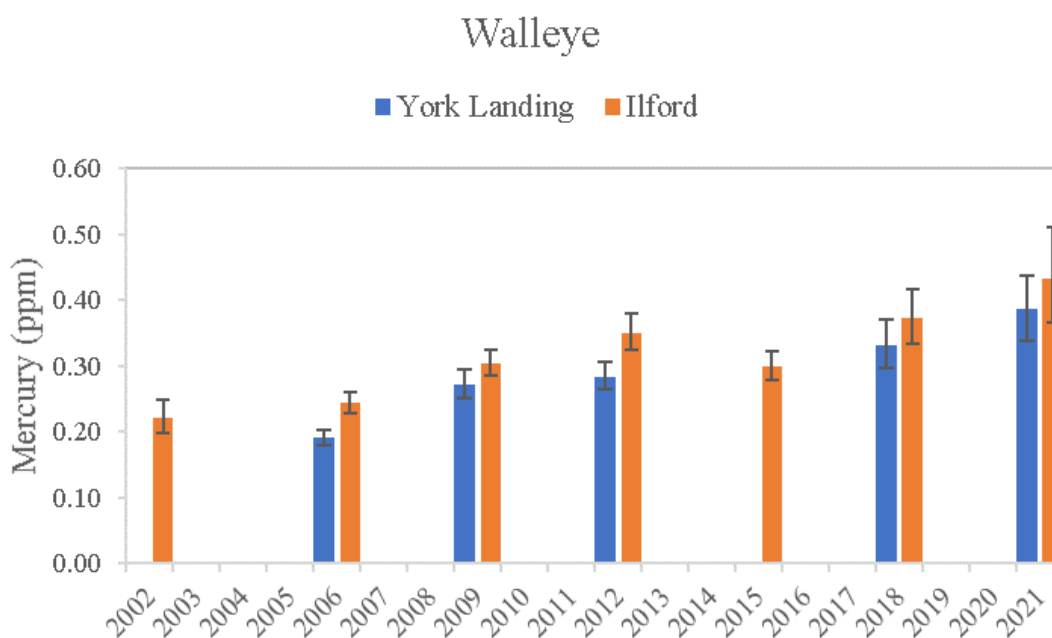
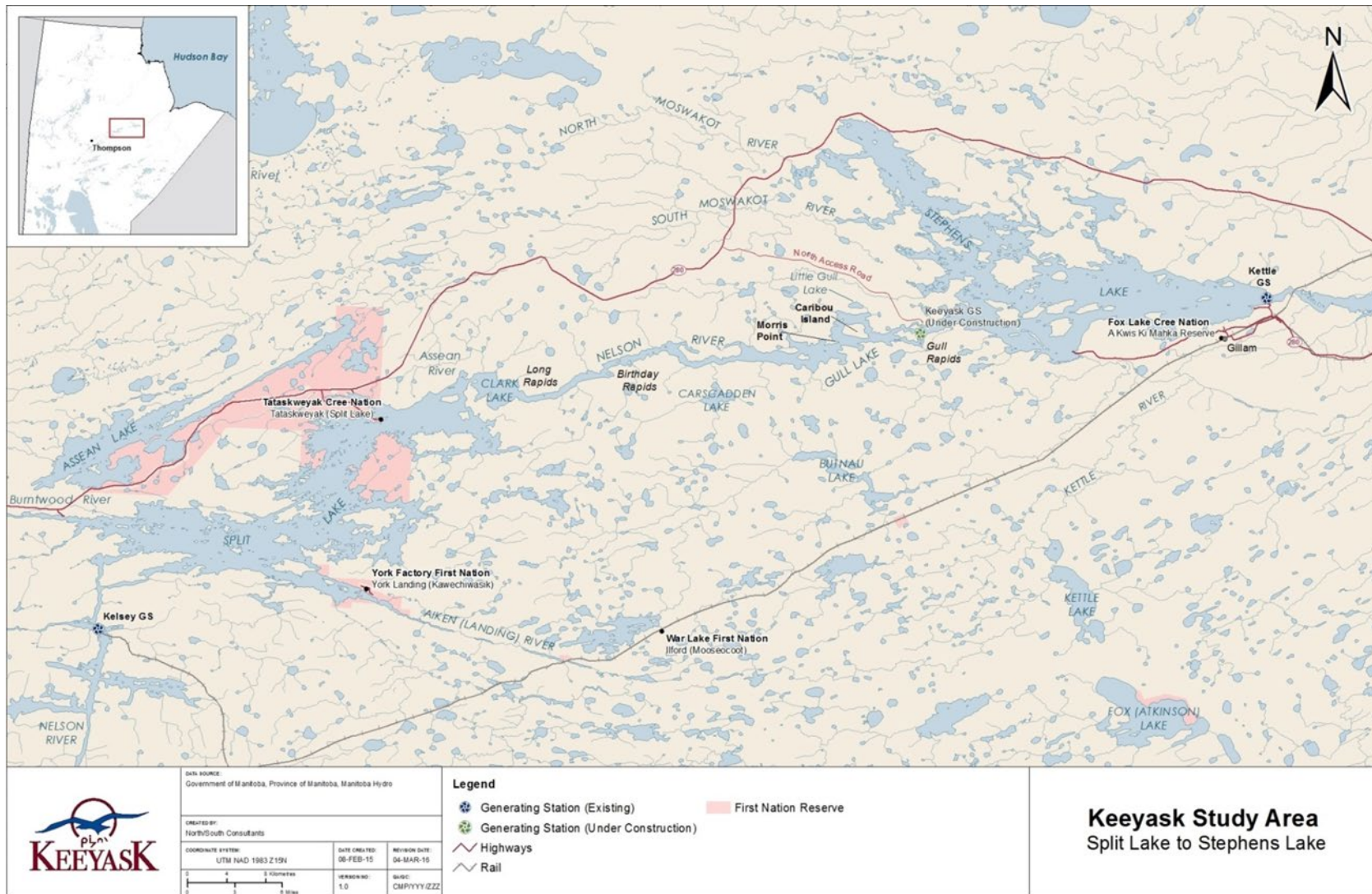
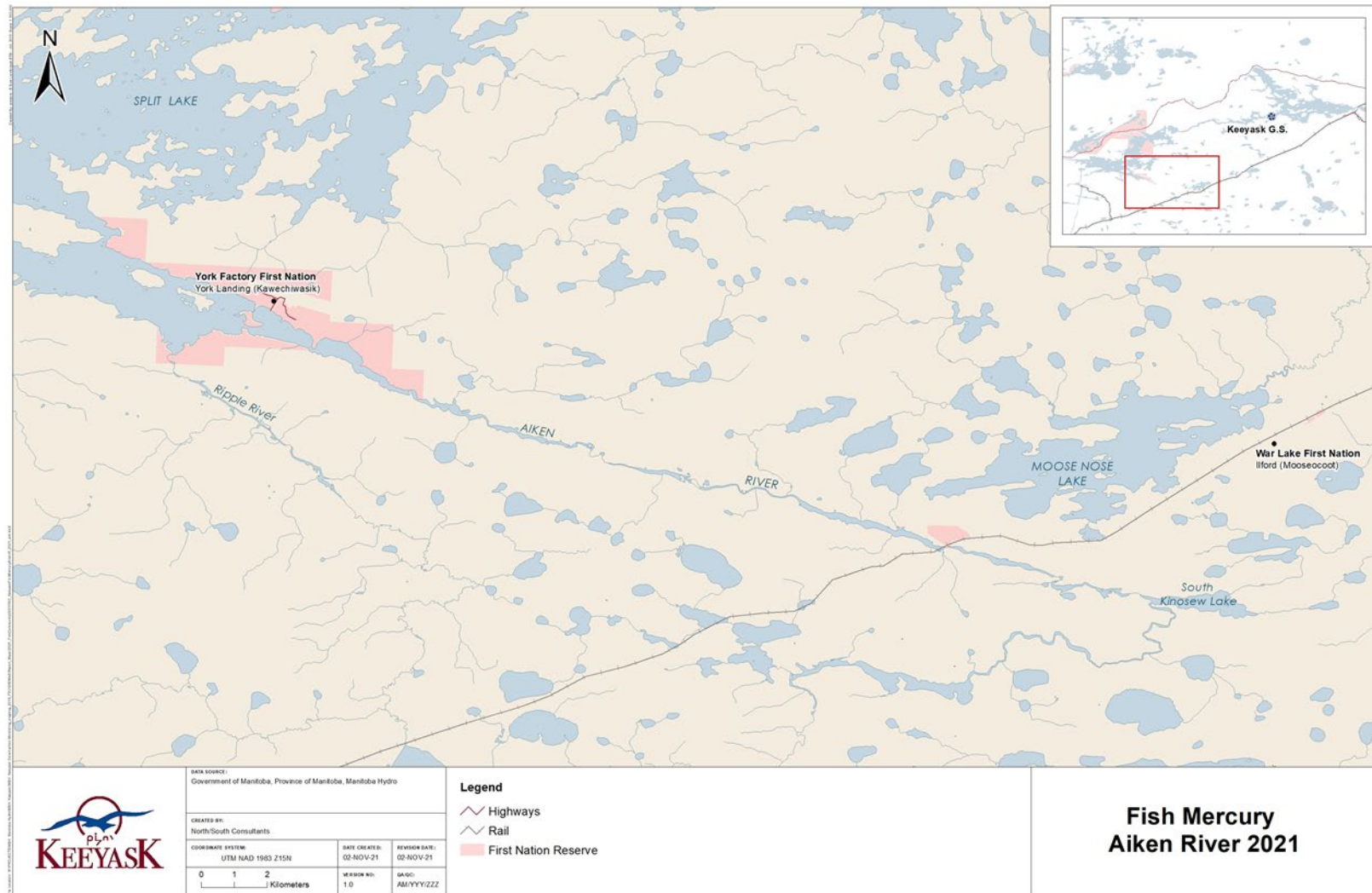


Figure 3: Length standardized mean ($\pm 95\%$ confidence limits, CL) muscle mercury concentrations of a 400 mm Walleye from the Aiken/Landing River for years 2002–2021.

MAPS



Map 1: Map of the Nelson River showing the site of Keeyask Generating Station and the fish mercury study setting.



Map 2: Map of the Aiken/Landing River – sampling occurred in reaches upstream of York Landing and the rail bridge.

APPENDICES

APPENDIX 1:

ALS LABORATORY REPORT



North/South Consultants
ATTN: Jodi Holm
83 Scurfield Blvd
Winnipeg MB R3Y 1G4

Date Received: 13-AUG-21
Report Date: 10-DEC-21 12:19 (MT)
Version: FINAL REV. 2

Client Phone: 204-487-5646

Certificate of Analysis

Lab Work Order #: L2626744
Project P.O. #: NOT SUBMITTED
Job Reference: KEEYASK FISH
C of C Numbers:
Legal Site Desc:

Comments:

10-DEC-2021 revised report -70 and 78 amended.

Hua Wo
Chemistry Laboratory Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 1329 Niakwa Road East, Unit 12, Winnipeg, MB R2J 3T4 Canada | Phone: +1 204 255 9720 | Fax: +1 204 255 9721
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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2626744-1 13 Sampled By: CLIENT on 02-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.598		0.010	mg/kg ww	16-SEP-21	12-OCT-21	R5616778
L2626744-2 16 Sampled By: CLIENT on 02-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.125		0.0020	mg/kg ww	16-SEP-21	12-OCT-21	R5616778
L2626744-3 19 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.712		0.010	mg/kg ww	16-SEP-21	12-OCT-21	R5616778
L2626744-4 20 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.564		0.010	mg/kg ww	16-SEP-21	12-OCT-21	R5616778
L2626744-5 23 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.356		0.0020	mg/kg ww	16-SEP-21	12-OCT-21	R5616778
L2626744-6 24 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.159		0.0020	mg/kg ww	16-SEP-21	12-OCT-21	R5616778
L2626744-7 26 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.316		0.0020	mg/kg ww	16-SEP-21	12-OCT-21	R5616778
L2626744-8 29 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.193		0.0020	mg/kg ww	16-SEP-21	12-OCT-21	R5616778
L2626744-9 30 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.277		0.0020	mg/kg ww	16-SEP-21	12-OCT-21	R5616778
L2626744-10 32 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.409		0.0020	mg/kg ww	16-SEP-21	12-OCT-21	R5616778

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2626744-11 35 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.635		0.010	mg/kg ww	16-SEP-21	12-OCT-21	R5616778
L2626744-12 39 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.326		0.0020	mg/kg ww	16-SEP-21	12-OCT-21	R5616778
L2626744-13 41 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.188		0.0020	mg/kg ww	16-SEP-21	12-OCT-21	R5616778
L2626744-14 42 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.254		0.0020	mg/kg ww	16-SEP-21	12-OCT-21	R5616778
L2626744-15 43 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.162		0.0020	mg/kg ww	16-SEP-21	12-OCT-21	R5616778
L2626744-16 45 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.310		0.0020	mg/kg ww	16-SEP-21	12-OCT-21	R5616778
L2626744-17 46 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.142		0.0020	mg/kg ww	16-SEP-21	12-OCT-21	R5616778
L2626744-18 48 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.344		0.0020	mg/kg ww	16-SEP-21	12-OCT-21	R5616778
L2626744-19 50 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.604		0.010	mg/kg ww	16-SEP-21	12-OCT-21	R5616778
L2626744-20 52 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.183		0.0020	mg/kg ww	16-SEP-21	12-OCT-21	R5616778

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2626744-21 56 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.187		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-22 59 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.884		0.010	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-23 63 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.122		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-24 64 Sampled By: CLIENT on 08-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.241		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-25 65 Sampled By: CLIENT on 08-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.340		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-26 66 Sampled By: CLIENT on 08-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.107		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-27 67 Sampled By: CLIENT on 08-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.391		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-28 68 Sampled By: CLIENT on 08-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.307		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-29 69 Sampled By: CLIENT on 08-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.180		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-30 70 Sampled By: CLIENT on 08-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.0597		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2626744-31 71 Sampled By: CLIENT on 08-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.580		0.010	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-32 72 Sampled By: CLIENT on 08-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.278		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-33 1 Sampled By: CLIENT on 02-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.597		0.010	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-34 2 Sampled By: CLIENT on 02-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.132		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-35 3 Sampled By: CLIENT on 02-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.296		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-36 4 Sampled By: CLIENT on 02-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.461		0.010	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-37 5 Sampled By: CLIENT on 02-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.340		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-38 6 Sampled By: CLIENT on 02-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.295		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-39 7 Sampled By: CLIENT on 02-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.228		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-40 8 Sampled By: CLIENT on 02-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.219		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2626744-41 9 Sampled By: CLIENT on 02-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.342		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-42 10 Sampled By: CLIENT on 02-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.284		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-43 11 Sampled By: CLIENT on 02-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.539		0.010	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-44 14 Sampled By: CLIENT on 02-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.225		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-45 15 Sampled By: CLIENT on 02-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.251		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-46 17 Sampled By: CLIENT on 02-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.182		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-47 18 Sampled By: CLIENT on 02-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.141		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-48 21 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.324		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-49 22 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.216		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-50 25 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.691		0.010	mg/kg ww	17-SEP-21	13-OCT-21	R5618525

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2626744-51 27 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.482		0.010	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-52 28 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.250		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-53 33 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.178		0.0010	mg/kg ww	17-SEP-21	14-OCT-21	R5619920
L2626744-54 36 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.207		0.0020	mg/kg ww	17-SEP-21	14-OCT-21	R5619920
L2626744-55 37 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.245		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-56 38 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.416		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-57 40 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.524		0.010	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-58 47 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.326		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-59 49 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.567		0.010	mg/kg ww	17-SEP-21	13-OCT-21	R5618525
L2626744-60 51 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.282		0.0020	mg/kg ww	17-SEP-21	13-OCT-21	R5618525

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2626744-61 53 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.224		0.0020	mg/kg ww	24-SEP-21	14-OCT-21	R5619920
L2626744-62 54 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.276		0.0020	mg/kg ww	24-SEP-21	14-OCT-21	R5619920
L2626744-63 55 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.265		0.0020	mg/kg ww	24-SEP-21	14-OCT-21	R5619920
L2626744-64 57 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.407		0.0020	mg/kg ww	24-SEP-21	14-OCT-21	R5619920
L2626744-65 58 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.325		0.0020	mg/kg ww	24-SEP-21	14-OCT-21	R5619920
L2626744-66 60 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.173		0.0020	mg/kg ww	24-SEP-21	14-OCT-21	R5619920
L2626744-67 61 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.514		0.0020	mg/kg ww	24-SEP-21	14-OCT-21	R5619920
L2626744-68 62 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.178		0.0020	mg/kg ww	24-SEP-21	14-OCT-21	R5619920
L2626744-69 81 Sampled By: CLIENT on 01-JUN-21 Matrix: NORTHERN PIKE Miscellaneous Parameters Mercury (Hg)	0.125		0.0020	mg/kg ww	24-SEP-21	14-OCT-21	R5619920
L2626744-70 73 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.557		0.010	mg/kg ww	30-NOV-21	09-DEC-21	R5674529

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2626744-71 74 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.187		0.0020	mg/kg ww	24-SEP-21	14-OCT-21	R5619920
L2626744-72 75 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.367		0.0020	mg/kg ww	24-SEP-21	14-OCT-21	R5619920
L2626744-73 76 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.391		0.0020	mg/kg ww	24-SEP-21	14-OCT-21	R5619920
L2626744-74 77 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.178		0.0020	mg/kg ww	24-SEP-21	14-OCT-21	R5619920
L2626744-75 78 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.291		0.0020	mg/kg ww	24-SEP-21	14-OCT-21	R5619920
L2626744-76 79 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.249		0.0020	mg/kg ww	24-SEP-21	14-OCT-21	R5619920
L2626744-77 80 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.257		0.0020	mg/kg ww	24-SEP-21	14-OCT-21	R5619920
L2626744-78 82 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.459		0.010	mg/kg ww	30-NOV-21	09-DEC-21	R5674529
L2626744-79 83 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.450		0.0020	mg/kg ww	24-SEP-21	14-OCT-21	R5619920
L2626744-80 84 Sampled By: CLIENT on 01-JUN-21 Matrix: WALLEYE Miscellaneous Parameters Mercury (Hg)	0.228		0.0020	mg/kg ww	24-SEP-21	14-OCT-21	R5619920

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
HG-WET-CVAA-WP	Tissue	Mercury in Tissue	EPA 200.3/1631E (mod)
Tissue samples undergo hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide, followed by cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analysis by CVAAS.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

mg/kg - milligrams per kilogram based on dry weight of sample

mg/kg ww - milligrams per kilogram based on wet weight of sample

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight

mg/L - unit of concentration based on volume, parts per million.

< - Less than.

D.L. - The reporting limit.

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L2626744

Report Date: 10-DEC-21

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Client: North/South Consultants
83 Scurfield Blvd
Winnipeg MB R3Y 1G4
Contact: Jodi Holm

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-WET-CVAA-WP		Tissue						
Batch	R5616778							
WG3619474-3	CRM	DORM-4N						
Mercury (Hg)			102.5		%		70-130	12-OCT-21
WG3619474-4	DUP	L2626744-1						
Mercury (Hg)		0.598	0.583		mg/kg ww	2.6	40	12-OCT-21
WG3619474-2	LCS							
Mercury (Hg)			95.9		%		80-120	12-OCT-21
WG3619474-1	MB							
Mercury (Hg)			<0.0010		mg/kg ww		0.001	12-OCT-21
Batch	R5618525							
WG3619729-3	CRM	DORM-4N						
Mercury (Hg)			101.4		%		70-130	13-OCT-21
WG3619729-7	CRM	DORM-4N						
Mercury (Hg)			99.4		%		70-130	13-OCT-21
WG3619729-4	DUP	L2626744-21						
Mercury (Hg)		0.187	0.191		mg/kg ww	2.6	40	13-OCT-21
WG3619729-8	DUP	L2626744-41						
Mercury (Hg)		0.342	0.360		mg/kg ww	5.1	40	13-OCT-21
WG3619729-2	LCS							
Mercury (Hg)			96.1		%		80-120	13-OCT-21
WG3619729-6	LCS							
Mercury (Hg)			94.2		%		80-120	13-OCT-21
WG3619729-1	MB							
Mercury (Hg)			<0.0010		mg/kg ww		0.001	13-OCT-21
WG3619729-5	MB							
Mercury (Hg)			<0.0010		mg/kg ww		0.001	13-OCT-21
Batch	R5619920							
WG3625800-3	CRM	DORM-4N						
Mercury (Hg)			109.9		%		70-130	14-OCT-21
WG3625800-7	CRM	DORM-4N						
Mercury (Hg)			113.0		%		70-130	14-OCT-21
WG3625800-4	DUP	L2626744-61						
Mercury (Hg)		0.224	0.203		mg/kg ww	10	40	14-OCT-21
WG3625800-8	DUP	L2626744-81						
Mercury (Hg)		0.279	0.268		mg/kg ww	4.1	40	14-OCT-21
WG3625800-2	LCS							
Mercury (Hg)			107.8		%		80-120	14-OCT-21
WG3625800-6	LCS							
Mercury (Hg)			108.0		%		80-120	14-OCT-21
WG3625800-1	MB							

Quality Control Report

Workorder: L2626744

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Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-WET-CVAA-WP		Tissue						
Batch	R5619920							
WG3625800-1 MB								
Mercury (Hg)			<0.0010		mg/kg wwt		0.001	14-OCT-21
WG3625800-5 MB								
Mercury (Hg)			<0.0010		mg/kg wwt		0.001	14-OCT-21
Batch	R5674529							
WG3673086-3 CRM		DORM-4N						
Mercury (Hg)			111.5		%		70-130	09-DEC-21
WG3673086-4 DUP		L2626744-70						
Mercury (Hg)		0.557	0.603		mg/kg wwt	7.9	40	09-DEC-21
WG3673086-2 LCS								
Mercury (Hg)			119.3		%		80-120	09-DEC-21
WG3673086-1 MB								
Mercury (Hg)			<0.0010		mg/kg wwt		0.001	09-DEC-21

Quality Control Report

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Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.



L2626744-COFC -..

Request Form
668 9878

COC # Keevask GS

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[illegible]

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - REPORT COPY, PINK - FILE COPY, YELLOW - CLIENT COPY

GENE 18.00 Front

Aiken River Spring 2021 Hg Samples



L2626744-COFC

	Location	Fish #	Species	Sample Date
1	York Landing	13	Northern Pike	02-Jun-21
2	York Landing	16	Northern Pike	02-Jun-21
3	York Landing	19	Northern Pike	01-Jun-21
4	York Landing	20	Northern Pike	01-Jun-21
5	York Landing	23	Northern Pike	01-Jun-21
6	York Landing	24	Northern Pike	01-Jun-21
7	York Landing	26	Northern Pike	01-Jun-21
8	York Landing	29	Northern Pike	01-Jun-21
9	York Landing	30	Northern Pike	01-Jun-21
10	York Landing	32	Northern Pike	01-Jun-21
11	York Landing	35	Northern Pike	01-Jun-21
12	York Landing	39	Northern Pike	01-Jun-21
13	York Landing	41	Northern Pike	01-Jun-21
14	York Landing	42	Northern Pike	01-Jun-21
15	York Landing	43	Northern Pike	01-Jun-21
16	York Landing	45	Northern Pike	01-Jun-21
17	York Landing	46	Northern Pike	01-Jun-21
18	York Landing	48	Northern Pike	01-Jun-21
19	York Landing	50	Northern Pike	01-Jun-21
20	York Landing	52	Northern Pike	01-Jun-21
21	York Landing	56	Northern Pike	01-Jun-21
22	York Landing	59	Northern Pike	01-Jun-21
23	York Landing	63	Northern Pike	01-Jun-21
24	York Landing	64	Northern Pike	08-Jun-21
25	York Landing	65	Northern Pike	08-Jun-21
26	York Landing	66	Northern Pike	08-Jun-21
27	York Landing	67	Northern Pike	08-Jun-21
28	York Landing	68	Northern Pike	08-Jun-21
29	York Landing	69	Northern Pike	08-Jun-21
30	York Landing	70	Northern Pike	08-Jun-21
31	York Landing	71	Northern Pike	08-Jun-21
32	York Landing	72	Northern Pike	08-Jun-21
33	York Landing	1	Walleye	02-Jun-21
34	York Landing	2	Walleye	02-Jun-21
35	York Landing	3	Walleye	02-Jun-21
36	York Landing	4	Walleye	02-Jun-21
37	York Landing	5	Walleye	02-Jun-21
38	York Landing	6	Walleye	02-Jun-21
39	York Landing	7	Walleye	02-Jun-21
40	York Landing	8	Walleye	02-Jun-21
41	York Landing	9	Walleye	02-Jun-21
42	York Landing	10	Walleye	02-Jun-21
43	York Landing	11	Walleye	02-Jun-21

Aiken River Spring 2021 Hg Samples



L2626744-COFC

	Location	Fish #	Species	Sample Date
44	York Landing	14	Walleye	02-Jun-21
45	York Landing	15	Walleye	02-Jun-21
46	York Landing	17	Walleye	02-Jun-21
47	York Landing	18	Walleye	02-Jun-21
48	York Landing	21	Walleye	01-Jun-21
49	York Landing	22	Walleye	01-Jun-21
50	York Landing	25	Walleye	01-Jun-21
51	York Landing	27	Walleye	01-Jun-21
52	York Landing	28	Walleye	01-Jun-21
53	York Landing	33	Walleye	01-Jun-21
54	York Landing	36	Walleye	01-Jun-21
55	York Landing	37	Walleye	01-Jun-21
56	York Landing	38	Walleye	01-Jun-21
57	York Landing	40	Walleye	01-Jun-21
58	York Landing	47	Walleye	01-Jun-21
59	York Landing	49	Walleye	01-Jun-21
60	York Landing	51	Walleye	01-Jun-21
61	York Landing	53	Walleye	01-Jun-21
62	York Landing	54	Walleye	01-Jun-21
63	York Landing	55	Walleye	01-Jun-21
64	York Landing	57	Walleye	01-Jun-21
65	York Landing	58	Walleye	01-Jun-21
66	York Landing	60	Walleye	01-Jun-21
67	York Landing	61	Walleye	01-Jun-21
68	York Landing	62	Walleye	01-Jun-21
69	Ilford	81	Northern Pike	01-Jun-21
70	Ilford	73	Walleye	01-Jun-21
71	Ilford	74	Walleye	01-Jun-21
72	Ilford	75	Walleye	01-Jun-21
73	Ilford	76	Walleye	01-Jun-21
74	Ilford	77	Walleye	01-Jun-21
75	Ilford	78	Walleye	01-Jun-21
76	Ilford	79	Walleye	01-Jun-21
77	Ilford	80	Walleye	01-Jun-21
78	Ilford	82	Walleye	01-Jun-21
79	Ilford	83	Walleye	01-Jun-21
80	Ilford	84	Walleye	01-Jun-21
81	Ilford	85	Walleye	01-Jun-21

APPENDIX 2: MUSCLE MERCURY CONCENTRATIONS AND BIOLOGICAL DATA FOR INDIVIDUAL FISH FROM THE AIKEN/LANDING RIVER IN 2021

Table A2-1: Muscle mercury concentrations (Hg) and biological data for Northern Pike and Walleye from the Aiken/Landing River in 2021.....	25
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Table A2-1: Muscle mercury concentrations (Hg) and biological data for Northern Pike and Walleye from the Aiken/Landing River in 2021.

Fish #	Location	Date	Species	Fork Length (mm)	Sex	Hg (ppm)
1	York Landing	2-Jun-21	Walleye	410	-	0.597
2	York Landing	2-Jun-21	Walleye	300	-	0.132
3	York Landing	2-Jun-21	Walleye	380	-	0.296
4	York Landing	2-Jun-21	Walleye	420	-	0.461
5	York Landing	2-Jun-21	Walleye	370	-	0.340
6	York Landing	2-Jun-21	Walleye	370	-	0.295
7	York Landing	2-Jun-21	Walleye	290	-	0.228
8	York Landing	2-Jun-21	Walleye	380	-	0.219
9	York Landing	2-Jun-21	Walleye	380	-	0.342
10	York Landing	2-Jun-21	Walleye	440	-	0.284
11	York Landing	2-Jun-21	Walleye	440	-	0.539
13	York Landing	2-Jun-21	Northern Pike	680	-	0.598
14	York Landing	2-Jun-21	Walleye	320	-	0.225
15	York Landing	2-Jun-21	Walleye	370	-	0.251
16	York Landing	2-Jun-21	Northern Pike	510	-	0.125
17	York Landing	2-Jun-21	Walleye	350	-	0.182
18	York Landing	2-Jun-21	Walleye	290	-	0.141
19	York Landing	1-Jun-21	Northern Pike	800	-	0.712
20	York Landing	1-Jun-21	Northern Pike	620	-	0.564
21	York Landing	1-Jun-21	Walleye	380	-	0.324
22	York Landing	1-Jun-21	Walleye	320	-	0.216
23	York Landing	1-Jun-21	Northern Pike	530	Female	0.356
24	York Landing	1-Jun-21	Northern Pike	480	-	0.159
25	York Landing	1-Jun-21	Walleye	400	-	0.691
26	York Landing	1-Jun-21	Northern Pike	500	-	0.316
27	York Landing	1-Jun-21	Walleye	430	-	0.482
28	York Landing	1-Jun-21	Walleye	380	-	0.250
29	York Landing	1-Jun-21	Northern Pike	500	-	0.193
30	York Landing	1-Jun-21	Northern Pike	550	-	0.277
32	York Landing	1-Jun-21	Northern Pike	570	-	0.409
33	York Landing	1-Jun-21	Walleye	360	-	0.178
35	York Landing	1-Jun-21	Northern Pike	590	-	0.635
36	York Landing	1-Jun-21	Walleye	340	Male	0.207
37	York Landing	1-Jun-21	Walleye	330	-	0.245
38	York Landing	1-Jun-21	Walleye	350	-	0.416
39	York Landing	1-Jun-21	Northern Pike	600	-	0.326

Table A2-1: Muscle mercury concentrations (Hg) and biological data for Lake Whitefish, Northern Pike, and Walleye from the Aiken/Landing River in 2021 (continued).

Fish #	Location	Date	Species	Fork Length (mm)	Sex	Hg (ppm)
40	York Landing	1-Jun-21	Walleye	400	-	0.524
41	York Landing	1-Jun-21	Northern Pike	410	-	0.188
42	York Landing	1-Jun-21	Northern Pike	500	-	0.254
43	York Landing	1-Jun-21	Northern Pike	460	-	0.162
45	York Landing	1-Jun-21	Northern Pike	670	Male	0.310
46	York Landing	1-Jun-21	Northern Pike	430	-	0.142
47	York Landing	1-Jun-21	Walleye	310	-	0.326
48	York Landing	1-Jun-21	Northern Pike	560	-	0.344
49	York Landing	1-Jun-21	Walleye	450	-	0.567
50	York Landing	1-Jun-21	Northern Pike	540	Female	0.604
51	York Landing	1-Jun-21	Walleye	390	-	0.282
52	York Landing	1-Jun-21	Northern Pike	420	-	0.183
53	York Landing	1-Jun-21	Walleye	320	-	0.224
54	York Landing	1-Jun-21	Walleye	320	-	0.276
55	York Landing	1-Jun-21	Walleye	340	-	0.265
56	York Landing	1-Jun-21	Northern Pike	500	-	0.187
57	York Landing	1-Jun-21	Walleye	350	-	0.407
58	York Landing	1-Jun-21	Walleye	370	-	0.325
59	York Landing	1-Jun-21	Northern Pike	610	-	0.884
60	York Landing	1-Jun-21	Walleye	310	-	0.173
61	York Landing	1-Jun-21	Walleye	400	-	0.514
62	York Landing	1-Jun-21	Walleye	320	-	0.178
63	York Landing	1-Jun-21	Northern Pike	520	Female	0.122
64	York Landing	8-Jun-21	Northern Pike	600	-	0.241
65	York Landing	8-Jun-21	Northern Pike	490	-	0.340
66	York Landing	8-Jun-21	Northern Pike	400	-	0.107
67	York Landing	8-Jun-21	Northern Pike	640	-	0.391
68	York Landing	8-Jun-21	Northern Pike	490	-	0.307
69	York Landing	8-Jun-21	Northern Pike	440	Female	0.180
70	York Landing	8-Jun-21	Northern Pike	560	Female	0.0597
71	York Landing	8-Jun-21	Northern Pike	610	-	0.580
72	York Landing	8-Jun-21	Northern Pike	460	-	0.278
73	Ilford	1-Jun-21	Walleye	406	Male	0.557
74	Ilford	1-Jun-21	Walleye	318	Male	0.187
75	Ilford	1-Jun-21	Walleye	360	Male	0.367
76	Ilford	1-Jun-21	Walleye	381	Male	0.391

Table A2-1: Muscle mercury concentrations (Hg) and biological data for Northern Pike and Walleye from the Aiken/Landing River in 2021 (continued).

Fish #	Location	Date	Species	Fork Length (mm)	Sex	Hg (ppm)
77	Ilford	1-Jun-21	Walleye	305	Male	0.178
78	Ilford	1-Jun-21	Walleye	310	Male	0.291
79	Ilford	1-Jun-21	Walleye	330	Male	0.249
80	Ilford	1-Jun-21	Walleye	345	Male	0.257
81	Ilford	1-Jun-21	Northern Pike	381	Male	0.125
82	Ilford	1-Jun-21	Walleye	394	Male	0.459
83	Ilford	1-Jun-21	Walleye	445	Male	0.450
84	Ilford	1-Jun-21	Walleye	310	Male	0.228
85	Ilford	1-Jun-21	Walleye	343	Male	0.279

APPENDIX 3:

SIZE AND MERCURY CONCENTRATION OF FISH SAMPLED FOR MERCURY 2002–2021

Figure A3-1:	Box plots of fork length (top) and mercury concentration (bottom) of Northern Pike captured from the Aiken/Landing River from 2002–2021.....	29
Figure A3-2:	Box plots of fork length (top) and mercury concentration (bottom) of Walleye captured from the Aiken/Landing River from 2002–2021.....	30

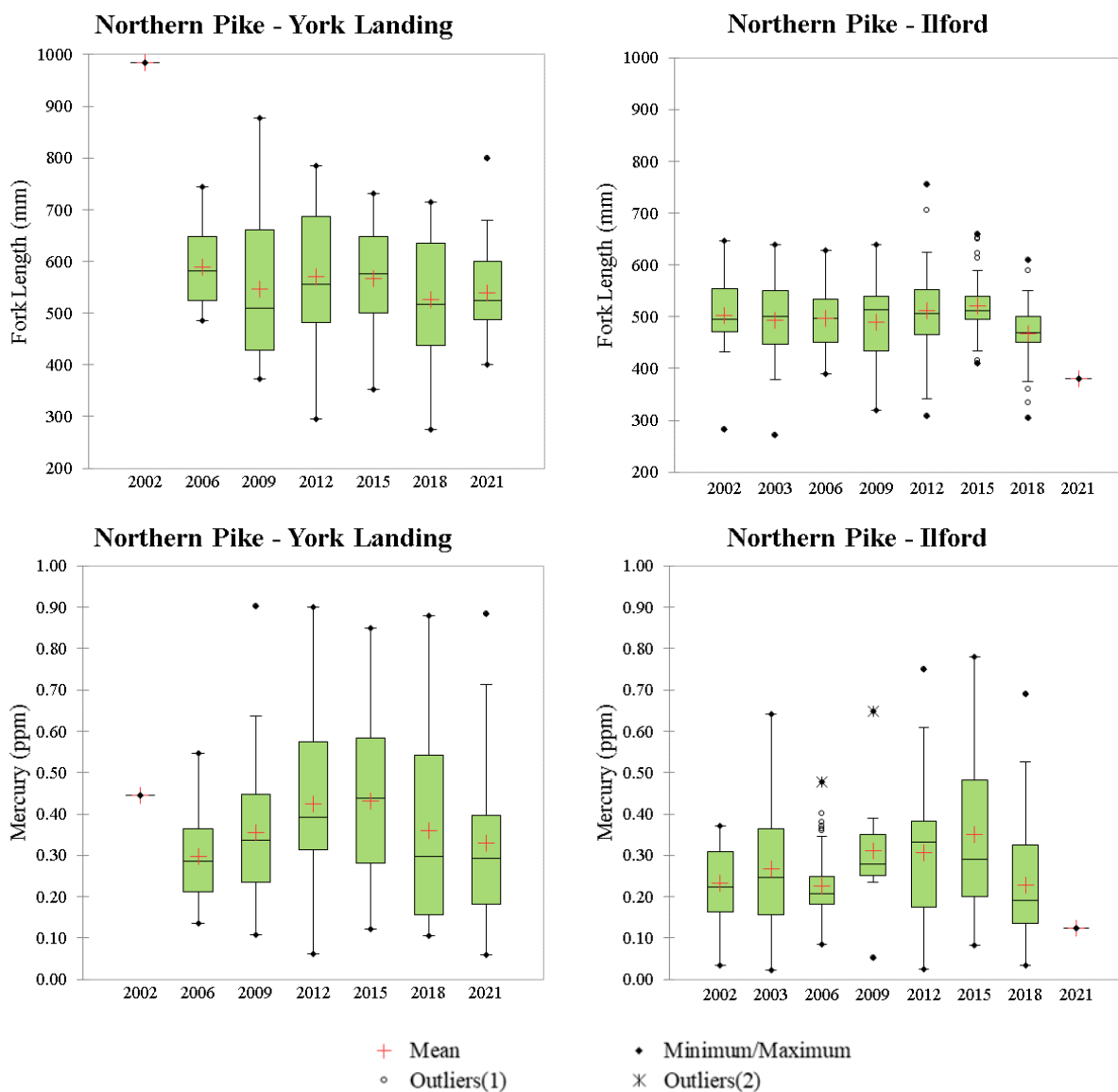


Figure A3-1: Box plots of fork length (top) and mercury concentration (bottom) of Northern Pike captured from the Aiken/Landing River from 2002–2021.

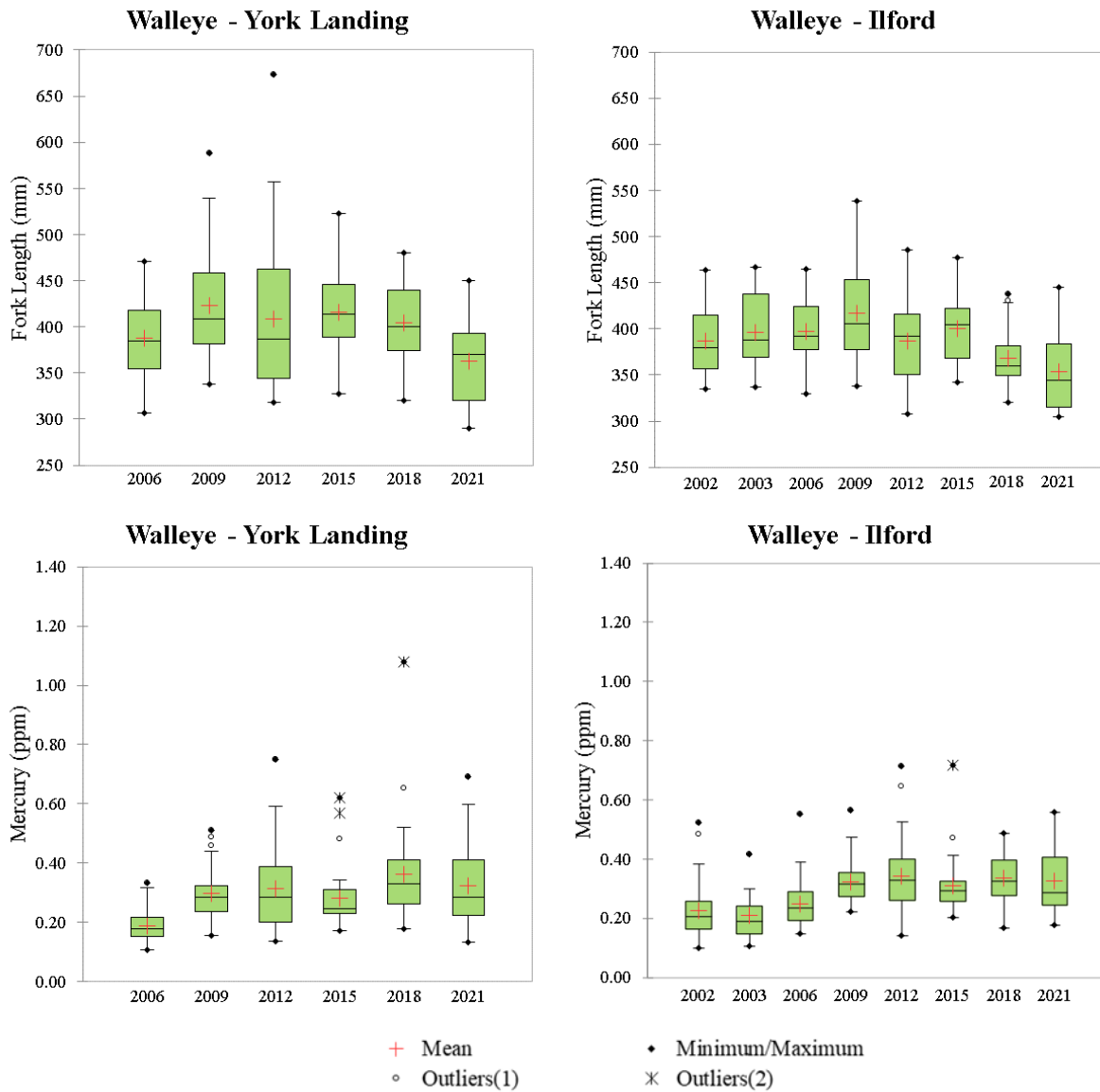


Figure A3-2: Box plots of fork length (top) and mercury concentration (bottom) of Walleye captured from the Aiken/Landing River from 2002–2021.

APPENDIX 4:

RESULTS OF LINEAR REGRESSION ANALYSIS

Figure A4-1: Plot of Log10 fork length (mm) and Log10 total mercury (ppm) in Northern Pike captured from the Aiken/Landing River in 2021.....	32
Figure A4-2: Plot of Log10 fork length (mm) and Log10 total mercury (ppm) in Walleye captured from the Aiken/Landing River in 2021.....	32

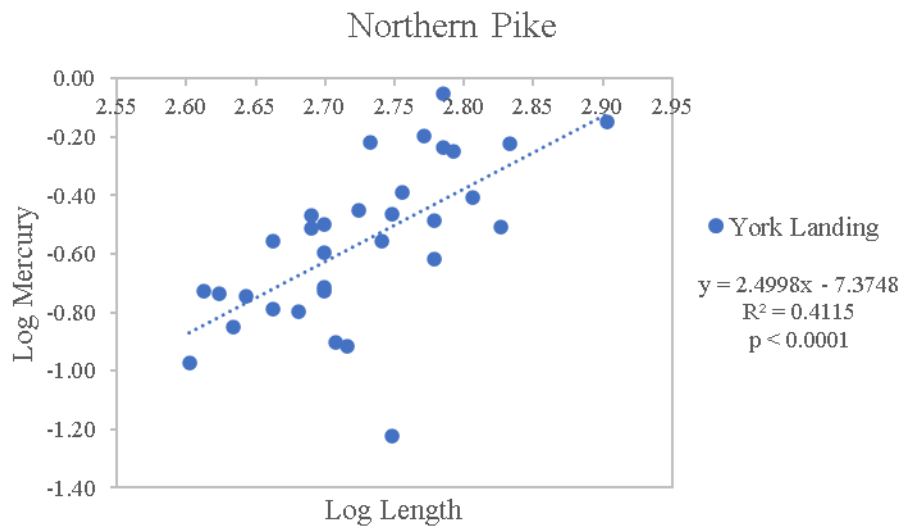


Figure A4-1: Plot of Log10 fork length (mm) and Log10 total mercury (ppm) in Northern Pike captured from the Aiken/Landing River in 2021.

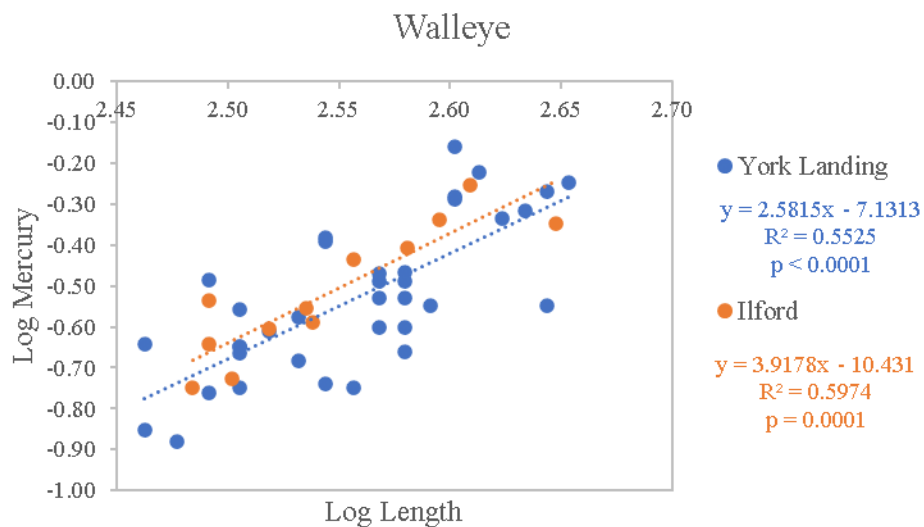


Figure A4-2: Plot of Log10 fork length (mm) and Log10 total mercury (ppm) in Walleye captured from the Aiken/Landing River in 2021.