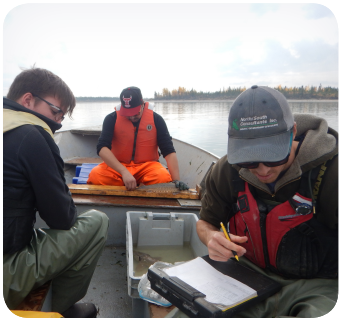
Keeyask Generation Project

Aquatic Effects Monitoring Plan

Mercury in Fish Flesh from Gull Lake 2019 Report

AEMP-2020-08



KEEYASK

Manitoba Conservation and Climate Client File 5550.00
Manitoba Environment Act Licence No. 3107

2019 -2020

KEEYASK GENERATION PROJECT

AQUATIC EFFECTS MONITORING PLAN

REPORT #AEMP-2020-08

MERCURY IN FISH FLESH FROM GULL LAKE, 2019

Prepared for

Manitoba Hydro

By

J. Holm

June 2020

North/South Consultants Inc.
Aquatic Environment Specialists

83 Scurfield Blvd.
Winnipeg, Manitoba, R3Y 1G4
Website: www.nscons.ca

Tel.: (204) 284-3366
Fax: (204) 477-4173
E-mail: nscons@nscons.ca

This report should be cited as follows:

Holm, J. 2020. Mercury in fish flesh from Gull Lake, 2019. Keeyask Generation Project Aquatic Effects Monitoring Plan Report #AEMP-2020-08. A report prepared for Manitoba Hydro by North/South Consultants Inc., June 2020, 56 pp.

SUMMARY

Background

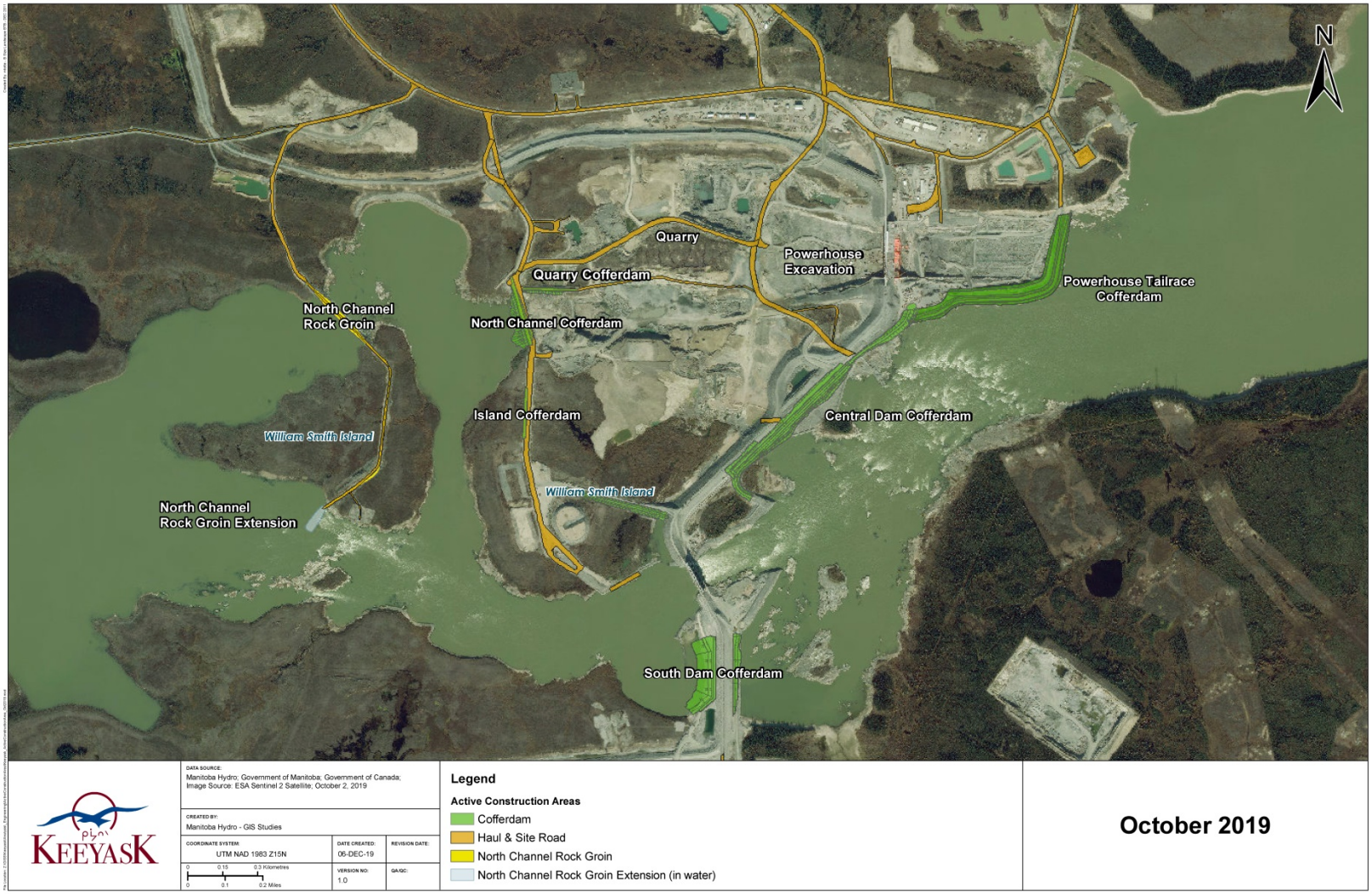
The Keeyask Hydropower Limited Partnership (KHLP) was required to prepare a plan to monitor the effects of construction and operation of the Keeyask Generating Station (GS) on the environment. Besides measuring the accuracy of the predictions made and actual effects of the GS on the environment, monitoring 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 with the construction of cofferdams that blocked flow in the north and central channels of Gull Rapids (see map below). During the winter of 2015/2016, the Spillway Cofferdam, which partially blocks the south channel, was constructed. Beginning late in 2016 and continuing in 2017, the Tailrace Cofferdam was constructed. Work was completed in fall 2017 with the exception of an opening that was left to allow fish movement into and out of the cofferdam over the 2017/18 winter. This opening was closed in spring 2018, and the area was dewatered. The spillway was commissioned in August 2018. The South Dam Cofferdam was completed in fall 2018, blocking the channel and forcing the entire flow of the river through the spillway. Almost all work in 2019 was in the dry. The construction activities included the excavation of the tailrace, construction of the tailrace spawning shoal, and completion of the dams and dykes.

Fish mercury is one of the key components for monitoring because it affects the suitability of fish for consumption by people. It is especially important to monitor at Keeyask, given the legacy of mercury uptake in fish in northern Manitoba as a result of historical hydroelectric development. Flooding to create the Keeyask reservoir is predicted to increase mercury levels in fish in Gull Lake and Stephens Lake, though the increase in Stephens Lake will be much less than when the lake was first created by construction of the Kettle GS in the early 1970s.

This report provides results of mercury concentrations measured in jackfish, pickerel and whitefish collected from Gull Lake in 2019. It also includes results for the same species sampled from Stephens Lake in 2018. These data are the last to be collected to measure mercury levels in fish prior to impounding the reservoir. Monitoring will continue annually on both lakes, starting in 2021, to measure the effect of impoundment on mercury in fish.

The data from mercury monitoring in fish are provided to the Mercury and Human Health Implementation Group (MMHIG), which is responsible for interpreting the fish mercury data in the context of human health. Consumption guidance is available for Gull and Stephens lakes from the MHHIG Members or from the partner First Nations' local mercury coordinator.



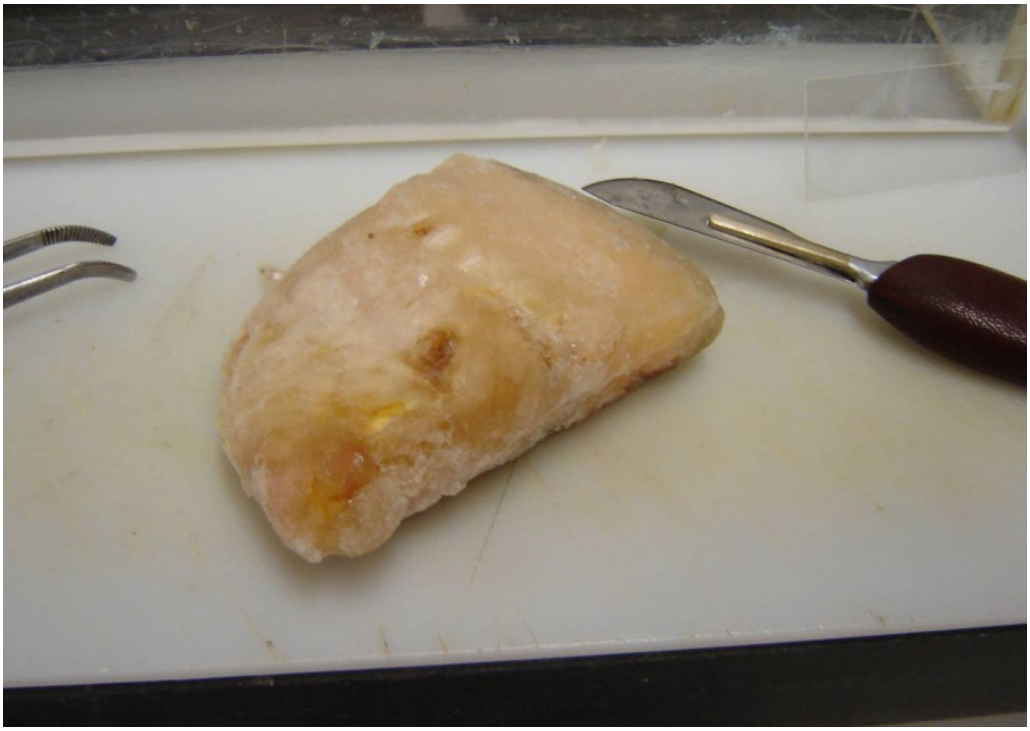
Satellite Imagery - October, 2019

Map of instream structures at the Keeyask Generating Station site, October 2019

Why is the study being done?

Monitoring in 2019 was done to answer the following questions:

- What are mercury concentrations in jackfish, pickerel, and whitefish in Gull Lake and Stephens Lake prior to final flooding in the Keeyask reservoir?
- Have mercury concentrations in jackfish, pickerel, and whitefish remained unchanged in Gull Lake in 2019 compared to previous study years?



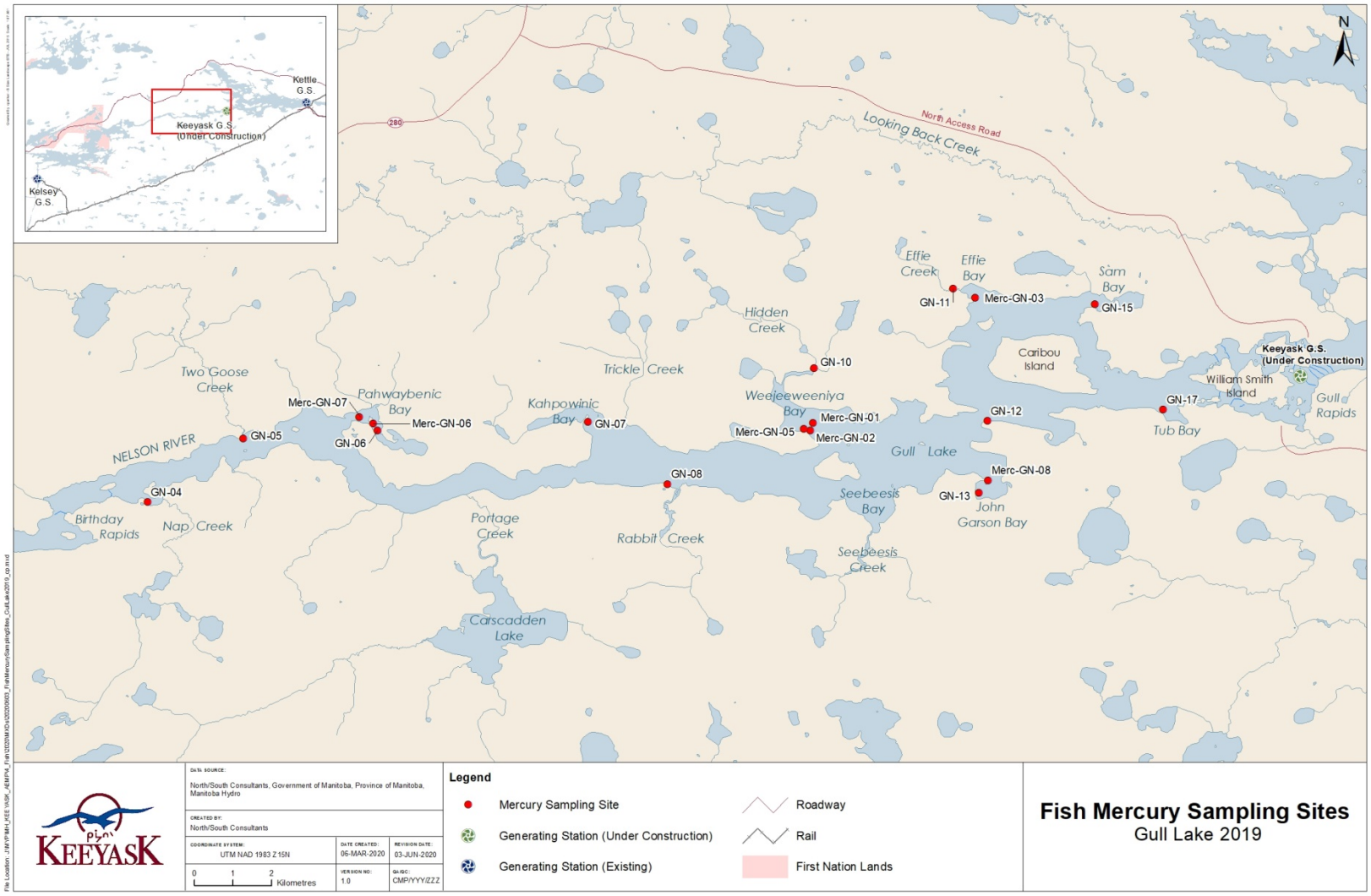
A frozen pickerel muscle sample being prepared for mercury analysis

What was done?

Thirty-six jackfish, 36 pickerel, and 33 whitefish were analyzed for mercury in Gull Lake in August 2019 (see map below). Mercury data from 36 jackfish, 36 pickerel, and 13 whitefish collected under the Coordinated Aquatic Monitoring Program (CAMP) from Stephens Lake in 2018, were reviewed and included in this report to provide the results to which post-impoundment monitoring results from Stephens Lake will be compared.

Fish collected from both lakes were measured for length and weight, and a structure to determine the fish's age was collected. 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, 400 mm for pickerel, and 350 mm for whitefish). 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.



Map of the Keeyask study area showing sampling sites for fish mercury in 2019.

What was found?

The standard mean mercury concentrations in fish collected from Gull Lake in 2019 were 0.61 ppm in a 550 mm long jackfish, 0.44 ppm in a 400 mm long pickerel, and 0.04 ppm in a 350 mm long whitefish.

A comparison of the results for 2019 with past results shows that:

- Standard mercury concentrations in whitefish from Gull Lake are low and have not changed much over time, including during construction; and
- Standard mercury concentrations in jackfish and pickerel caught in Gull Lake in 2019 were higher than they were in 2014 and 2016, during construction, and they continue to be higher than those measured during the environmental studies for the Project (1999, 2001, 2002, and 2006).

For fish from Stephens Lake:

- The standard mean mercury concentrations for fish caught in 2018 were 0.33 ppm in a 550 mm long jackfish, 0.38 ppm in a 400 mm long pickerel, and 0.06 ppm in a 350 mm long whitefish; and
- The mercury concentrations measured in fish from Stephens Lake since construction on Keeyask began in 2014 are within the range that has been measured since 1999, with the exception of an elevated value measured in Walleye in 2015.

Gillnetting on Gull Lake, August 2019.

What does it mean?

Mercury concentrations in jackfish and pickerel in Gull Lake in 2019 were higher than those measured in 2014 and 2016 and are higher than those measured during the baseline environmental studies. Concentrations of mercury in pickerel caught from Stephens Lake in 2018 were lower than what was found in 2015. The results from both lakes show the variability in mercury from year to year, which is a result of many interacting, environmental factors that affect the results. The means measured in Lake Whitefish continue to be low. Continued monitoring of mercury in fish flesh will indicate how concentrations in fish change in response to reservoir impoundment.

What will be done next?

Fish mercury concentrations will be monitored again in Gull and Stephens lakes during the summer of 2021 after impoundment of the Keeyask reservoir is complete, and annually after that to track the change.

ACKNOWLEDGEMENTS

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

Saul Mayham of Tataskweyak Cree Nation is thanked for his local expertise and assistance in conducting the field work.

The collection of biological samples described in this report was authorized by Manitoba Agriculture and Resource Development (previously Manitoba Sustainable Development), Fisheries Branch, under terms of the Scientific Collection Permit #18-19.

STUDY TEAM

Data Collection

Catherine Brandt

Claire Hrenchuk

Saul Mayham

Data Analysis, Report Preparation, and Report Review

Candace Parker

Friederike Schneider-Vieira

Cam Barth

Jodi Holm

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

LIST OF APPENDICES

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 Gull Lake, which will become part of the future Keeyask reservoir, Stephens Lake, Split Lake, and the Aiken 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 further 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 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 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 River, no measurable effects to average mercury concentrations of fish collected from these waterbodies are predicted. Sampling will be conducted to confirm these predictions.

The primary parameter of concern for the mercury monitoring program is the concentration of total mercury in fish skeletal muscle (*i.e.*, flesh) from the following species: Lake Whitefish (*Coregonus clupeaformis*), Northern Pike (*Esox lucius*), and Walleye (*Sander vitreus*). These species are sampled because they are important in domestic, commercial, and recreational fisheries and form the primary pathway by which humans ingest (methyl)mercury.

This report provides results of mercury monitoring in Lake Whitefish, Northern Pike, and Walleye collected in summer 2019 from Gull Lake. Sampling at Gull Lake was conducted in 2019 to determine whether concentrations had changed since the previous sampling program in 2016 and to obtain a record of mercury concentrations before final impoundment, which will occur in fall 2020. Mercury concentrations in fish were measured in 2016 and 2014 to fulfill the requirement in the Project's *Environment Act* Licence to measure mercury levels in fish twice more before the Project was in operation. This report also includes results for the above three species sampled from Stephens Lake in 2018 to present the last year of measured mercury concentrations in Stephens Lake prior to impoundment. This sampling was done under the auspices of the Coordinated Aquatic Monitoring Program (CAMP).

The monitoring in 2019 was done to answer the following questions:

- What are mercury concentrations in Lake Whitefish, Northern Pike, and Walleye in Gull Lake prior to final impoundment of the Keeyask reservoir?
- Are mercury concentrations measured in these three species in 2019 unchanged from previous measurements?

Results from post-EIS fish mercury sampling in Gull Lake in 2014 and 2016 were reported in Jansen (2016a, 2018), respectively. Results reported herein add to the dataset of mercury concentrations in fish flesh from the Keeyask study area since 1999.

2.0 CONSTRUCTION SUMMARY

Construction of the Keeyask GS began in mid-July 2014 with the construction of cofferdams in the north and central channels of Gull Rapids (Map 2). These cofferdams resulted in the dewatering of the north and central channels and the diversion of all flow to the south channel. Construction of the Spillway Cofferdam (SWCD), which extends into the south channel of Gull Rapids, was completed in 2015. The rock placement for the inner and outer groins of the Tailrace Cofferdam (TRCD) started in late 2016 and the impervious fill placement was completed in fall 2017. An opening was created to allow fish to move freely over the winter of 2017–2018. The opening was closed in spring 2018 and dewatering of the TRCD occurred in July, at which time a fish salvage was completed. In preparation for commissioning of the spillway, the SWCD was watered-up on both sides of the structure in June 2018. Removal of the SWCD started in early July and continued into August. The spillway was commissioned between August 3 and 7, 2018. Closing the south channel with the upstream South Dam Cofferdam (SDCD) commenced at the beginning of August and river closure was achieved on August 16. This closure and the work that continued to seal the cofferdam forced the entire river flow through the spillway. The downstream SDCD was completed in September and the area between the two cofferdams was dewatered, allowing for fish salvage to be completed by late September 2018. Work continued on the upstream SDCD until it was complete in late fall 2018. Almost all work in 2019 was in the dry. The construction activities included the excavation of the tailrace, construction of the tailrace spawning shoal, and completion of the dams and dykes.

2.1 FLOWS AND WATER LEVELS

Due to high flows in the Nelson River and the construction of the North Channel Rock Groin, water levels in Gull Lake rose to between 155 m ASL and 156 m ASL during late summer 2014. This resulted in water levels above the existing environment 95th percentile water level for open-water (154.2 m ASL) until the following spring (Manitoba Hydro 2015). Open-water levels on Gull Lake in the existing environment were as high as 155 m and surpassed 156 m during winter on occasion. The amount of land inundated during the 2014-2015 period is not known, but based on estimates of flooded areas expected in the later stages of construction (as presented in the EIS), this area likely included the nearshore areas of much of Gull Lake and some localized areas in and around Gull Rapids, as well as low-lying areas that extended further inland.

Water levels during the open-water season of 2015 declined due to lower discharge in the Nelson River. Water levels on Gull Lake ranged from 154 m ASL to 155 m ASL in 2015, and inundated areas were likely confined to localized sections of low-lying areas around Gull Lake.

Split Lake outflows from late 2015 to the end of June 2016 were relatively high, generally ranging between 3,500–4,000 m^3/s. The 75th percentile flow for Split Lake outflow is approximately 3,500 m^3/s. Flow increased sharply in July 2016, reaching a peak of 4,700 m^3/s in August, before declining. Gull Lake water levels varied in relation to flow, and some winter staging due to ice

formation was apparent from December to May. Water levels rose to approximately 155.5 m ASL during winter 2015/16 and ranged from 154–155 m ASL for most of the open-water season of 2016.

From October 2016 to October 2017, Split Lake outflows ranged from about 3,200–6,600 m^3/s. Flow exceeded the historical annual median flow of approximately 3,300 m^3/s each month except for October 2017 when it dropped to about 3,200 m^3/s. From about October 2016 through mid-September 2017, the flow exceeded the historical 75th percentile flow of about 3,780 m^3/s, and from about May to mid-August 2017 the flow exceeded the 95th percentile flow of approximately 5,230 m^3/s. During the spring melt in May 2017, flow rose to about 6,590 m^3/s, which is near the historical maximum flow observed in August 2005. Water levels varied in conjunction with flow, ranging from about 154.9–156.6 m ASL on Gull Lake, with the highest level observed during the near historical maximum flow in May.

From October 2017 to October 2018, Split Lake outflow ranged from about 2,800–4,000 m^3/s. Flow typically fell in the range of about 3,000–3,500 m^3/s, which is near the historical annual median flow of approximately 3,300 m^3/s. Flow was generally higher during the 2017/2018 winter period, gradually declining from about 3,800 m^3/s at the end of February 2018 to about 2,800 m^3/s by the beginning of May. From early May 2018 to the beginning of July, flow gradually increased to about 3,500 m^3/s and remained at that level to the end of July. The flow subsequently declined to about 2,800 m^3/s by the end of September. Water levels varied in conjunction with the flows, ranging from about 153.4–155.2 m ASL on Gull Lake.

From October 2018 to October 2019, calculated Split Lake outflows ranged from about 2,600 to 3,700 m^3/s. However, over most of the period, outflows ranged from approximately 3,000 to 3,500 m^3/s and were near the historical annual median flow of approximately 3,300 m^3/s. Outflow increased from about 2,600 to 3,600 m^3/s from October to December 2018, and then was variable through the remainder of the winter period. Between June and September 2019, the flow generally ranged from 3,300 to 3,500 m^3/s. Flows dropped to about 2,900 m^3/s in early October 2019 before rising again to almost 3,700 m^3/s by the end of the month. Water levels varied in conjunction with flows, ranging from about 153.2–155.0 m ASL on Gull Lake.

3.0 METHODS

3.1 FIELD COLLECTIONS

The 2019 sampling program at Gull Lake was conducted using similar methodologies as those used during previous sampling programs conducted on Gull Lake between 1999 and 2006 and during monitoring conducted in 2014 and 2016. Methodologies and sampling locations for previous years can be found in the reports listed in Table 1. Fish were captured from Gull Lake in 2019 during the experimental gillnetting program conducted under the AEMP (Burnett and Hrenchuk 2020) and additional gillnetting was conducted specifically to capture the target number of 36 fish of each species for mercury analysis. Sampling locations and fish catches from the mercury-specific gillnetting are presented in Appendix 1.

Lake Whitefish, Walleye, and Northern Pike[1] were captured in 2019 using gill nets composed of six 22.9 m (25 yards [yd]) long and 2.5 m (2.7 yd) deep panels made of twisted nylon mesh. Individual panels were joined together and included a panel each of 38, 51, 76, 95, 108, and 127 mm (1½, 2, 3, 3¾, 4¼, and 5 inch) stretched mesh-size.

Lake Whitefish, Northern Pike, and Walleye were collected from 18 sites within Gull Lake from 8–15 August, 2019 (Map 3). Because of the difficulties obtaining the target numbers of fish from Gull Lake, 11 Lake Whitefish and five Walleye were captured at three tributary confluences in Nelson River upstream of Gull Lake (Map 3).

The CAMP sampling programs that included Stephens Lake in 2018 used similar methodologies to the Gull Lake program except that gill nets did not have a 38 mm (1½ inch) panel (CAMP, unpubl. data). Fish analysed for mercury from Stephens Lake were captured at eight sites in the south basin and three sites in the north basin from 30 August to 4 September, 2018 (Map 4).

To be consistent with the methodology described in earlier Manitoba fish mercury monitoring programs (Jansen and Strange 2007a), a broad size range of the large-bodied fish was collected. A tally of the fish captured within each consecutive 50 mm length interval (starting at 100 mm) was kept, aiming for an equal distribution of length classes within a target size of 36 fish per species. Upon capture, fish were measured for fork length (±1 mm) and round weight. Small fish that were less than approximately 100 g were weighed using a digital balance (±1 g), while heavier fish were weighed on a mechanical pan balance (±25 g). Bony structures were removed from fish for age analysis: cleithra were collected from Northern Pike, and otoliths were removed from Lake Whitefish and Walleye. A portion of axial muscle weighing between 10 and 40 g was removed from each fish, anterior to the caudal (tail) fin, for mercury analysis of the large-bodied species.

[1] 1-year old Yellow Perch were also collected from Gull Lake in 2019 and Stephens Lake in 2018 for mercury analysis, but insufficient numbers were collected to provide useful results, i.e., early indication of mercury mobilization in food web. Due to low abundance of perch, this component of the mercury program will not be continued.

The muscle, with the skin attached, was wrapped tightly with commercial “cling-wrap”, placed in mercury-free, internally and externally labelled Whirl-Pac bags or Zip-lock bags, and stored on ice until they could be frozen. Frozen tissue samples were shipped to the North/South Consultants Inc. in Winnipeg for further processing.

3.2 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 Gull Lake were analyzed for mercury between 17 January and 25 February, 2020 and those from Stephens Lake were analyzed between 16 November, 2018 and 28 January, 2019. 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 2. The results all fall within the control limits for the QC sample (ALS Data Quality Objective).

Dried ageing structures were prepared and analyzed using a variety of techniques. Northern Pike cleithra were boiled to remove any remaining tissue and typically examined without a microscope (i.e., free hand), although a dissecting microscope or magnified light ring was used when required. Lake Whitefish and Walleye otoliths were aged using the “crack and toast” method and then fixed on glass slides and examined under a microscope with reflected light. Annuli from all fish ageing structures were counted by a single reader without knowledge of length or weight of the fish. Quality assurance and quality control (QA/QC) procedures were conducted, which included re-ageing a random sample of at least 10% of all structures by an ageing technician not involved in the initial age determination.

3.3 DATA ANALYSIS

A condition factor (K) was calculated for each fish as:

$$K = W \times 10^5 / L^3$$

where: W = total weight (g); and
L = fork length (mm).

Fish obtained in different years from a group of lakes will invariably differ in mean size between years and lakes. Because fish accumulate mercury over their life time, 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 under earlier Manitoba fish mercury monitoring programs (Jansen and Strange 2007a) 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, Walleye, and Lake Whitefish were 550, 400, and 350, respectively.

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 using the following relationship:

$$Log_{10}[Hg] = a + b\ (Log_{10}\ L)$$

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 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 as 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 2019.4.2; Addinsoft 2020).

3.4 BENCHMARKS

The Keeyask AEMP identified three benchmarks for comparison with monitored fish mercury concentrations from Project area waterbodies. Two of the benchmarks were previously dropped as they were no longer appropriate (see Jansen 2016a, b). Since that time, it has been determined the 0.5 ppm total mercury Health Canada standard for commercial marketing of freshwater fish in Canada (Health Canada 2007a, b) is not an appropriate benchmark to apply to subsistence fishers and therefore, it will no longer be referenced in Keeyask monitoring reports.

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 use in that process.

4.0 RESULTS

4.1 SAMPLE DESCRIPTION AND BIOLOGICAL DATA

4.1.1 GULL LAKE

The target number of 36 Northern Pike and Walleye was captured for mercury analysis from Gull Lake in 2019, but only 33 Lake Whitefish were obtained for analysis (Tables 2 to 5). Lake Whitefish are not abundant in Gull Lake (KHLP 2012) and it has been difficult to catch the target number for mercury monitoring in previous years.

With a mean length of 491 mm, Lake Whitefish analyzed for mercury were on average 40% larger than the standard length for the species (350 mm) (Table 2). In contrast, the average lengths of Northern Pike (541 mm) and Walleye (378 mm) used for the analysis were within 5% of the respective species standard lengths of 550 and 400 mm (Tables 3 and 4).

The Walleye and Northern Pike analyzed for mercury showed a wide range of ages (2–18 and 2–16 years, respectively) and lengths (194–577 and 290–852 mm, respectively) (Figure 1). In contrast, the Lake Whitefish analyzed for mercury had a narrow range of lengths (355–585 mm), despite having a wide range of ages (3–20 years).

Biological data for individual fish of all species analyzed for mercury in 2019 are presented in Appendix 3 (Table A3-2). Box plots of lengths and ages of Lake Whitefish, Northern Pike, and Walleye captured for mercury analysis from 1999–2019 are presented in Appendix 4. Lake Whitefish captured from 2014–2019 have generally been longer and older than those captured from 1999–2002, while smaller and younger Northern Pike have been analyzed since 2006. There has been some variation in the size and age of Walleye analyzed in each year, but the mean and range has been more similar than the other species.

4.1.2 STEPHENS LAKE

Target numbers of Northern Pike and Walleye were captured for mercury analysis from Stephens Lake in 2018, but only 13 Lake Whitefish were obtained (Tables 2 to 5). Lake Whitefish have been difficult to catch in Stephens Lake in some previous sampling years. Differences in the ability to capture Lake Whitefish is likely related to the timing of sampling and locations fished (refer to the reports listed in Table 1 for information about sampling methodologies used in each year) as Lake Whitefish are known to make spawning migrations in Stephens Lake (KHLP 2012).

Lake Whitefish analysed for mercury in 2018 averaged 441 mm in length, which is 26% larger than the standard length for the species (350 mm) (Table 2). In contrast, the average lengths of

Northern Pike (540 mm) and Walleye (403 mm) were within 2% of the species standard lengths of 550 and 400 mm, respectively (Tables 3 and 4).

Walleye analyzed for mercury had a very wide range of ages (1–21) and lengths (158–671 mm) (Figure 2). Although Northern Pike showed a wide range of lengths (231–874 mm), they had a narrow range of ages (2–10 years). As observed in Gull Lake, no small Lake Whitefish were analyzed for mercury, with fish ranging from 251–541 mm. None of the Lake Whitefish were less than four years old and the oldest was 27 years.

Biological data for individual fish of all species analyzed in 2018 are presented in Appendix 3 (Table A3-3). The lengths and ages of Lake Whitefish, Northern Pike, and Walleye captured for mercury analysis from 1999–2018 are presented as box plots in Appendix 4. There has been a considerable amount of variation in the length and age of Lake Whitefish and Walleye analyzed for mercury in each year. There has been some variation in the size and age of Northern Pike analyzed in each year, but, with the exception of 1999, the mean and range has been more similar than the other species.

4.2 MERCURY CONCENTRATIONS

4.2.1 GULL LAKE

4.2.1.1 RESULTS FOR 2019

All three of the large-bodied species showed a significant, positive relationship between mercury concentration and fork length (Appendix 5), allowing for average concentrations to be standardized by fish length. The length standardized mean mercury concentrations of fish collected from Gull Lake in 2019 ranged from 0.04 ppm in the benthivorous Lake Whitefish to 0.44 and 0.61 ppm in the two piscivorous species, Walleye and Northern Pike, respectively (Tables 2 to 4).

4.2.1.2 COMPARISON TO PREVIOUS YEARS

Standard mean mercury concentrations measured for a 550 mm Northern Pike and a 400 mm Walleye in 2019 (0.61 ppm and 0.44 ppm, respectively) were higher than concentrations measured since environmental studies for the Keeyask GS began in 1999 (Figures 3 and 4). In particular, the standard mean of Northern Pike was almost twice the highest value from the previous years.

An increase in mercury over time has not been observed in Lake Whitefish from Gull Lake (Figure 5). In fact, the standard mean mercury concentration for a 350 mm Lake Whitefish appears lower in 2016 and 2019 (0.03 ppm and 0.04 ppm, respectively) compared to those measured in 1999–2002 (0.06–0.08 ppm).

4.2.2 STEPHENS LAKE

4.2.2.1 RESULTS FOR 2018

Although sample size was considerably below target numbers for Lake Whitefish, all three species showed a significant positive relationship between mercury concentration and fork length (Appendix 5), allowing for average concentrations to be standardized by fish length. Standard means were 0.06 ppm for Lake Whitefish, 0.33 ppm for Northern Pike, and 0.38 ppm for Walleye (Tables 2 to 4).

4.2.2.2 COMPARISONS TO PREVIOUS YEARS

Mercury concentrations in the three large-bodied species from Stephens Lake have fluctuated between 1999 and 2018 without showing a consistent increasing or decreasing trend (Figures 3 to 5). Length-standardized mean mercury concentrations measured in all three species since construction on the Project began in 2014 generally fell into the range of the standard means recorded during the pre-Project period (1999–2012). Since 1999, the standard mean of a 350 mm Lake Whitefish ranged from 0.03 ppm in 2005 to 0.11 ppm in 2002, and the standard mean of a 550 mm Northern Pike ranged from 0.18 ppm in 2005 to 0.43 ppm in 1999. The standard mean mercury concentration of a 400 mm Walleye was higher in 2015 (0.50 ppm) compared to the range of values observed in previous years (0.20 ppm in 2005 to 0.43 ppm in 1999), but in 2018 it was lower and within the previous range (0.38 ppm).

5.0 DISCUSSION

2019 and 2018 mark the final year of monitoring mercury concentrations in fish flesh of Northern Pike, Walleye, and Lake Whitefish from Gull and Stephens lakes, respectively, prior to final impoundment of the Keeyask reservoir. The results presented in this report show:

- The average length standardized Lake Whitefish mercury concentrations have remained consistently low in Gull and Stephens lakes since data collection for the EIS commenced in 1999.
- Concentrations in the piscivorous species have been more variable over the period:
    - Length-standardized mean mercury concentrations measured in Northern Pike and Walleye from Gull Lake in 2019 were higher than those collected in any year since 1999.
    - Mercury in Northern Pike measured in Stephens Lake in 2018 was similar to what was measured in previous years, both before and during construction, while measurements in Walleye in 2018 were lower than those measured in 2015.

A temporal comparison of mercury concentrations indicates that there were several differences among years that could be due to a combination of factors:

- The calculation of a standard mean may not be accurate when only part of the length range is represented in the data. For example, only large Lake Whitefish have been sampled from Gull Lake in recent years. Therefore, the concentration of mercury in smaller fish is not known and could contribute to a lower estimate of standard mean. The size of Lake Whitefish captured in Gull Lake in 2019 is reflective of the size of the catch during the index gillnetting program (range 355–545, mean 463; Burnett and Hrenchuk 2020) and not an artifact of additional netting to obtain target numbers or sub-sampling for mercury analysis.
- There is a large range in the mercury concentrations of individual fish of similar lengths, particularly the piscivores, Walleye and Northern Pike, which have higher concentrations of mercury compared to Lake Whitefish. Variation in the amount of mercury accumulated in individuals is the result of a number of interacting environmental and physiological factors such as diet, growth, gender, metabolism, and use of habitat in the lake. Some difference in the average mercury concentrations calculated each year will result from sampling variation. For example, in some years the target number of each species sampled will contain a larger proportion of fish with higher concentrations and in other years, a larger proportion of individuals with lower concentrations.
- It is also possible that the temporal difference seen among years may reflect actual changes in mercury concentrations. A wide range of variables such as weather and water level changes may affect mercury concentrations. Given the increase observed in Northern Pike and Walleye in 2019 in Gull Lake, and as discussed in the EIS, mercury in

fish may have begun to increase as a result of water level increases during the construction period. However, given the many confounding factors that are also at play, measuring the actual change caused by construction, if any, is not possible. As described in the EIS, the effects of Keeyask on mercury in fish will become evident a few years after impoundment.

6.0 KEY QUESTIONS

The key questions to be answered about mercury in fish in relation to monitoring completed in 2019 are:

What are the concentrations of mercury in Northern Pike, Walleye, and Lake Whitefish caught in Gull Lake prior to final impoundment of the Keeyask reservoir?

The standard means of fish caught in Gull Lake in 2019 were: 0.04 ppm for a 350 mm Lake Whitefish, 0.61 ppm for a 550 mm Northern Pike, and 0.44 ppm for a 400 mm Walleye.

Are mercury concentrations measured in these four species in 2019 unchanged from previous measurements?

The standard means of Northern Pike and Walleye from Gull Lake in 2019 were higher than those measured since construction of the Project began in 2014 and 2016, which, in turn were higher than standard means measured during baseline EIS studies (1999–2006). In contrast, the standard mean of Lake Whitefish from Gull Lake in 2019 was similar to that measured in 2014, but was lower than the standard means measured during EIS studies.

7.0 CONCLUSION AND NEXT STEPS

Mercury concentrations in Walleye and Northern Pike from Gull Lake measured in 2019 are generally higher than concentrations obtained since data collection for the EIS commenced in 1999. Those measured in piscivorous fish from Stephens Lake in 2018 were within the range that has been measured since 1999. Lake Whitefish mercury concentrations remain consistently low in Gull and Stephens lakes over this period.

The AEMP requires mercury concentrations in fish in the Keeyask reservoir and Stephens Lake to be monitored annually for several years after final impoundment of the reservoir until maximum concentrations (predicted to be just above 1.0 ppm in Northern Pike and Walleye) have been reached.

8.0 LITERATURE CITED

Addinsoft (2020). XLSTAT statistical and data analysis solution. New York, USA.

Bretecher, R.L. and MacDonell, D.S. 2000. Lower Nelson River forebay monitoring program 1999. A report prepared for Manitoba Hydro by North/South Consultants Inc. 104 pp.

Burnett, D.C. and Hrenchuk, C.L. 2020. Fish community monitoring in the Nelson River from Split Lake to Stephens Lake, summer 2019. Keeyask Generation Project Aquatic Effects Monitoring Plan Report # AEMP-2020-09. Report prepared for Manitoba Hydro by North/South Consultants Inc., June 2020. 79 pp.

CAMP (Coordinated Aquatic Monitoring Program). 2017. Six year summary report (2008–2013). Report prepared for Manitoba/Manitoba Hydro MOU Working Group by North/South Consultants Inc., Winnipeg, MB.

CAMP (Coordinated Aquatic Monitoring Program). 2014. Three year summary report (2008–2010). Report prepared for the Manitoba/Manitoba Hydro MOU Working Group by North/South Consultants Inc., Winnipeg, MB.

Evans, M.S, Lockhart, W.L., Doetzel, L., Low, G., Muir, D., Kidd, K., Stephens, G., and Delaronde, J. 2005. Elevated mercury concentrations in fish in lakes in the Mackenzie River basin: The role of physical, chemical, and biological factors. Science of the Total Environment 351-352: 479–500.

Green, D.J. 1986. Summary of fish mercury data collected from lakes on the Rat Burntwood and Nelson River systems, 1983–1985. Manitoba Natural Resources, Fisheries Branch MS Report No. 86-06, 359 pp.

Health Canada. 2007a. Human health risk assessment of mercury in fish and health benefits of fish consumption. Health Canada: Bureau of Chemical Safety, Food Directorate, Health Products and Food Branch, Ottawa, ON. 70 pp.

Health Canada. 2007b. Updating the existing risk management strategy for mercury in fish. Health Canada: Bureau of Chemical Safety, Food Directorate, Health Products and Food Branch, Ottawa, ON. 45 pp.

Jansen, W. 2018. Mercury in fish flesh from Gull Lake, 2016. Keeyask Generation Project Aquatic Effects Monitoring Plan Report #AEMP-2018-08. Report prepared for Manitoba Hydro by North/South Consultants Inc., June 2018. 63 pp.

Jansen, W. 2016a. Mercury in fish flesh from Gull Lake in 2014. Keeyask Generation Project Aquatic Effects Monitoring Report #AEMP-2016-11. Report prepared for Manitoba Hydro by North/South Consultants Inc., June 2016. 29 pp.

Jansen, W. 2016b. Mercury in fish flesh from the Aiken River in 2015. Keeyask Generation Project Aquatic Effects Monitoring Report #AEMP-2016-10. A report prepared for Manitoba Hydro by North/South Consultants Inc., June 2016. 33 pp.

Jansen, W. 2010. Fish mercury concentrations in the Keeyask study area, 2009. Keeyask Project Environmental Studies Program Report # 09-05. A report prepared for Manitoba Hydro by North/South Consultants Inc. 32 pp.

Jansen, W. and Strange, N. 2009. Fish mercury concentrations from the Keeyask Project study area for 2006. Keeyask Project Environmental Studies Program Report #06-11. Report prepared for Manitoba Hydro by North/South Consultants Inc. 55 pp.

Jansen, W. and Strange, N. 2007a. Mercury in fish from northern Manitoba reservoirs: Results from 1999–2005 sampling and a summary of all monitoring data for 1970 2005. Report prepared for Manitoba Hydro by North/South Consultants Inc. 102 pp.

Jansen, W. and Strange, N. 2007b. Fish mercury concentrations from the Keeyask Project study area, 1999–2005. Keeyask Project Environmental Studies Program Report #05-04. Report prepared for Manitoba Hydro by North/South Consultants Inc. 152 pp.

Johnson, M.W. and Parks, C.R. 2005. Results of fish community investigations conducted in the reach of the Nelson River between Clark Lake and Gull Rapids, 2002. Keeyask Project Environmental Studies Program Report #02-20. Report prepared for Manitoba Hydro by North/South Consultants Inc. 198 pp.

KHLP (Keeyask Hydropower Limited Partnership). 2012. Keeyask Generation Project: Environmental Impact Statement. Supporting volume - Aquatic Environment. Keeyask Hydropower Limited Partnership, Winnipeg, MB.

Manitoba Hydro. 2019. 2018–2019 physical environment monitoring report: Year 5 construction. Keeyask Generation Project Physical Environment Monitoring Plan Report # PEMP-2019-01. June 2019.

Pisiak, D.J. Kroeker, T., and Remnant, R.A. 2004. Results of summer index gillnetting studies in Stephens Lake, Manitoba, and seasonal investigations of adult and larval fish communities in the reach of the Nelson River between Gull Rapids and Stephens Lake, 2001. Year 1. Gull (Keeyask) Project Environmental Studies Program Report #01-10. Report prepared for Manitoba Hydro by North/South Consultants Inc. 94 pp.

Pisiak, D.J. 2005a. Results of summer index gillnetting studies in Stephens Lake, Manitoba, and seasonal investigations of adult and larval fish communities in the reach of the Nelson River between Gull Rapids and Stephens Lake, 2002. Year 2. Gull (Keeyask) Project Environmental Studies Program Report #02-16. Report prepared for Manitoba Hydro by North/South Consultants Inc. 159 pp.

Pisiak, D.J. 2005b. Results of summer index gillnetting studies in Stephens Lake, Manitoba, and seasonal investigations of fish communities in the reach of the Nelson River between Gull Rapids and Stephens Lake, 2003. Year 3. Keeyask Project Environmental Studies Program Report #03-14. Report prepared for Manitoba Hydro by North/South Consultants Inc. 289 pp.

Remnant, R.A. and Barth, C.C. 2003. Results of experimental gillnetting on the Nelson River between Birthday and Gull rapids, Manitoba, fall 1999. Gull (Keeyask) Project Environmental Studies Program Report #99-01. Report prepared for Manitoba Hydro by North/South Consultants Inc. 59 pp.

Remnant, R.A., Parks, C.R, and MacDonald, J.E. 2004. Results of fisheries investigations conducted in the reach of the Nelson River between Clark Lake and Gull Rapids (including Gull Lake), 2001. Gull (Keeyask) Project Environmental Studies Program Report #01-13. Report prepared for Manitoba Hydro by North/South Consultants Inc. 132 pp.

TABLES

Table 1: Summary of sampling conducted for fish mercury monitoring in Gull Lake and Stephens Lake from 1999–2019.

Waterbody	Year	Sampling Dates	# Sites	Sample Source
Gull Lake	1999	6–10 Oct	12	Remnant and Barth 2003
	2001	15–25 Aug	14	Remnant et al. 2004
	2002	6–14 Aug	17	Johnson and Parks 2005
	2003	29 Jul–19 Aug	4	Jansen and Strange 2007b
	2006	31 May–30 Jun, 18–27 Aug	21	Jansen and Strange 2009
	2014	1–16 Sep	33	Jansen 2016a
	2016	14–24 Sep	16	Jansen 2018
	2019	8–15 Aug	21	This report
Stephens Lake	1999	13–19 Aug	6	Bretecher and MacDonell 2000
	2001	31 Aug, 1–29 Sep	11	Pisiak et al. 2004
	2002	24 Jul–8 Aug	16	Pisiak 2005a
	2003	23 Jul–5 Aug	42	Pisiak 2005b
	2005	25–27 Aug, 29 Sep, 4–11 Oct	12	Jansen and Strange 2007a
	2007	19 Sep–2 Oct	21	Jansen 2010a
	2009	4–17 Sep	8	CAMP 2014
	2012	4–9 Sep	10	CAMP 2017
	2015	7–9 Sep	11	CAMP, unpubl. Data
	2018	30 Aug–4 Sep	14	CAMP, unpubl. Data

Table 2: Size and age (mean ± SE) and mercury concentration ([Hg], arithmetic mean ± SE and standardized mean ± 95% confidence interval, CI) of Lake Whitefish sampled for mercury analysis from Gull Lake and Stephens Lake from 1999–2019.

Waterbody/ Year	N	Fork Length (mm)	n	Weight (g)	n	Age (y)	n	Arithmetic [Hg] ppm)	Standardized [Hg] (ppm)	95% CI
Gull Lake										
1999	22	356 ± 22	21	1018 ± 152	22	5.8 ± 0.7	22	0.098 ± 0.016	0.075	0.055-0.103
2001	21	415 ± 23	21	1585 ± 256	21	7.7 ± 1.1	21	0.088 ± 0.010	0.062	0.053-0.073
2002	26	367 ±30	25	1406 ± 235	26	7.8 ± 1.2	26	0.102 ± 0.014	0.082	0.070-0.097
2014	4	498 ± 17	4	2300 ± 334	4	11.8 ± 1.9	4	0.225 ± 0.052	not significant	-
2016	19	500 ± 9	19	2372 ± 129	19	10.6 ± 0.9	19	0.182 ± 0.020	0.034	0.014-0.085
2019	33	491 ± 9	33	2209 ± 118	33	11.1 ± 0.8	33	0.218 ± 0.020	0.038	0.024-0.058
Stephens Lake										
1999	6	365 ± 33	0	-	6	4.8 ± 0.9	6	0.091 ± 0.019	0.077	0.050-0.119
2001	15	489 ± 9	15	2180 ± 119	9	13.2 ± 1.3	15	0.153 ± 0.014	not significant	-
2002	25	403 ± 23	25	1364 ± 185	25	8.1 ± 0.9	25	0.134 ± 0.013	0.112	0.096-0.131
2003	78	394 ± 15	65	1797 ± 132	75	9.6 ± 0.7	78	0.125 ± 0.008	0.104	0.096-0.113
2005	25	488 ± 9	25	2234 ± 136	25	12.2 ± 0.7	25	0.108 ± 0.009	0.029	0.020-0.042
2007	33	463 ± 10	32	1931 ± 123	32	10.1 ± 0.7	33	0.138 ± 0.009	0.069	0.056-0.085
2009	7	483 ± 26	7	2410 ± 397	6	12.7 ± 1.9	7	0.159 ± 0.027	0.046	0.025-0.084
2012	5	526 ± 20	5	2718 ± 307	5	16.0 ± 2.3	5	0.168 ± 0.018	0.053	0.024-0.115
2015	11	302 ± 61	11	1138 ± 361	11	7.2 ± 2.6	11	0.110 ± 0.036	0.107	0.081-0.141
2018	13	441 ± 22	13	1626 ± 226	13	10.8 ± 1.6	13	0.116 ± 0.018	0.059	0.045-0.078

Table 3: Size and age (mean ± SE) and mercury concentration ([Hg], arithmetic mean ± SE and standardized mean ± 95% confidence interval, CI) of Northern Pike sampled for mercury analysis from Gull Lake and Stephens Lake from 1999–2019.

Waterbody/ Year	N	Fork Length (mm)	n	Weight (g)	n	Age (y)	n	Arithmetic [Hg] ppm)	Standardized [Hg] (ppm)	95% CI
Gull Lake										
1999	40	694 ± 27	40	3440 ± 407	39	8.0 ± 0.5	40	0.572 ± 0.048	0.314	0.278–0.355
2001	33	688 ± 30	33	2967 ± 375	31	7.5 ± 0.5	33	0.447 ± 0.059	0.220	0.181–0.268
2002	35	700 ± 29	35	3299 ± 406	35	9.2 ± 0.6	35	0.466 ± 0.049	0.226	0.196–0.261
2006	66	552 ± 22	66	1590 ± 164	44	5.3 ± 0.5	66	0.231 ± 0.018	0.208	0.187–0.230
2014	31	707 ± 17	31	2774 ± 227	29	7.1 ± 0.4	31	0.572 ± 0.039	0.338	0.274–0.417
2016	36	554 ± 33	36	1729 ± 294	36	5.5 ± 0.5	36	0.378 ± 0.041	0.342	0.313–0.373
2019	36	541 ± 26	36	1441 ± 196	35	6.4 ± 0.5	36	0.630 ± 0.050	0.611	0.557–0.670
Stephens Lake										
1999	14	501 ± 17	14	1620 ± 120	14	4.6 ± 0.4	14	0.369 ± 0.067	0.432	0.316–0.591
2001	27	641 ± 35	27	2377 ± 399	26	6.5 ± 0.5	27	0.573 ± 0.097	0.316	0.276–0.361
2002	35	700 ± 30	35	2955 ± 352	33	9.3 ± 0.7	35	0.663 ± 0.082	0.332	0.280–0.395
2003	76	632 ± 18	76	2277 ± 202	73	9.4 ± 0.5	76	0.448 ± 0.038	0.272	0.246–0.301
2005	52	583 ± 20	52	1743 ± 205	52	6.7 ± 0.4	52	0.250 ± 0.030	0.180	0.165–0.196
2007	40	669 ± 29	20	1828 ± 364	40	8.2 ± 0.6	40	0.521 ± 0.052	0.339	0.302–0.381
2009	36	526 ± 32	36	1501 ± 224	28	6.8 ± 0.7	36	0.295 ± 0.042	0.261	0.230–0.297
2012	42	511 ± 22	42	1206 ± 143	42	6.0 ± 0.5	42	0.266 ± 0.022	0.275	0.249–0.304
2015	36	532 ± 27	36	1424 ± 220	34	5.9 ± 0.4	36	0.372 ± 0.051	0.333	0.284–0.390
2018	36	540 ± 23	36	1327 ± 180	36	5.0 ± 0.3	36	0.372 ± 0.049	0.329	0.289–0.375

Table 4: Size and age (mean ± SE) and mercury concentration ([Hg], arithmetic mean ± SE and standardized mean ± 95% confidence interval, CI) of Walleye sampled for mercury analysis from Gull Lake and Stephens Lake from 1999–2019.

Waterbody/ Year	N	Fork Length (mm)	n	Weight (g)	n	Age (y)	n	Arithmetic [Hg] ppm)	Standardized [Hg] (ppm)	95% CI
Gull Lake										
1999	22	445 ± 13	22	1350 ± 128	22	8.5 ± 0.8	22	0.414 ± 0.041	0.293	0.244–0.353
2001	26	422 ± 20	26	1181 ± 162	24	7.0 ± 1.0	26	0.273 ± 0.045	0.190	0.167–0.217
2002	32	423 ± 23	32	1340 ± 198	32	9.1 ± 1.1	32	0.371 ± 0.050	0.263	0.227–0.304
2006	44	478 ± 16	44	1521 ± 125	34	9.9 ± 0.9	44	0.432 ± 0.044	0.212	0.170–0.253
2014	38	391 ± 18	38	904 ± 128	38	8.6 ± 1.2	38	0.364 ± 0.045	0.325	0.294–0.358
2016	36	394 ± 17	35	862 ± 114	36	9.1 ± 1.5	36	0.369 ±0.057	0.302	0.254–0.358
2019	36	378 ± 15	36	761 ± 138	36	6.8 ± 0.5	36	0.437 ± 0.038	0.438	0.387–0.497
Stephens Lake										
1999	24	380 ± 20	17	1504 ± 250	23	7.8 ± 0.8	24	0.444 ± 0.057	0.425	0.356–0.508
2001	29	419 ± 20	29	1217 ± 171	27	8.7 ± 1.0	29	0.373 ± 0.049	0.277	0.243–0.316
2002	34	438 ± 21	33	1342 ± 173	33	10.4 ± 0.9	34	0.469 ± 0.035	0.405	0.378–0.434
2003	70	433 ± 12	69	1240 ± 94	67	10.2 ± 0.6	70	0.418 ± 0.027	0.329	0.298–0.364
2005	69	401 ± 13	69	1141 ± 95	69	10.1 ± 0.7	69	0.249 ± 0.022	0.204	0.183–0.227
2007	18	522 ± 17	15	2113 ± 171	18	14.4 ± 1.0	18	0.685 ± 0.058	0.394	0.282–0.551
2009	36	419 ± 18	36	1241 ± 141	33	11.5 ± 1.2	36	0.315 ± 0.030	0.262	0.236–0.291
2012	41	462 ± 15	41	1425 ± 120	41	9.2 ± 0.9	41	0.431 ± 0.045	0.283	0.248–0.322
2015	36	416 ± 18	36	961 ± 95	36	12.0 ± 1.2	36	0.592 ± 0.050	0.498	0.427–0.582
2018	36	403 ± 19	36	862 ± 106	35	8.7 ± 0.9	36	0.447 ± 0.051	0.380	0.336–0.431

FIGURES

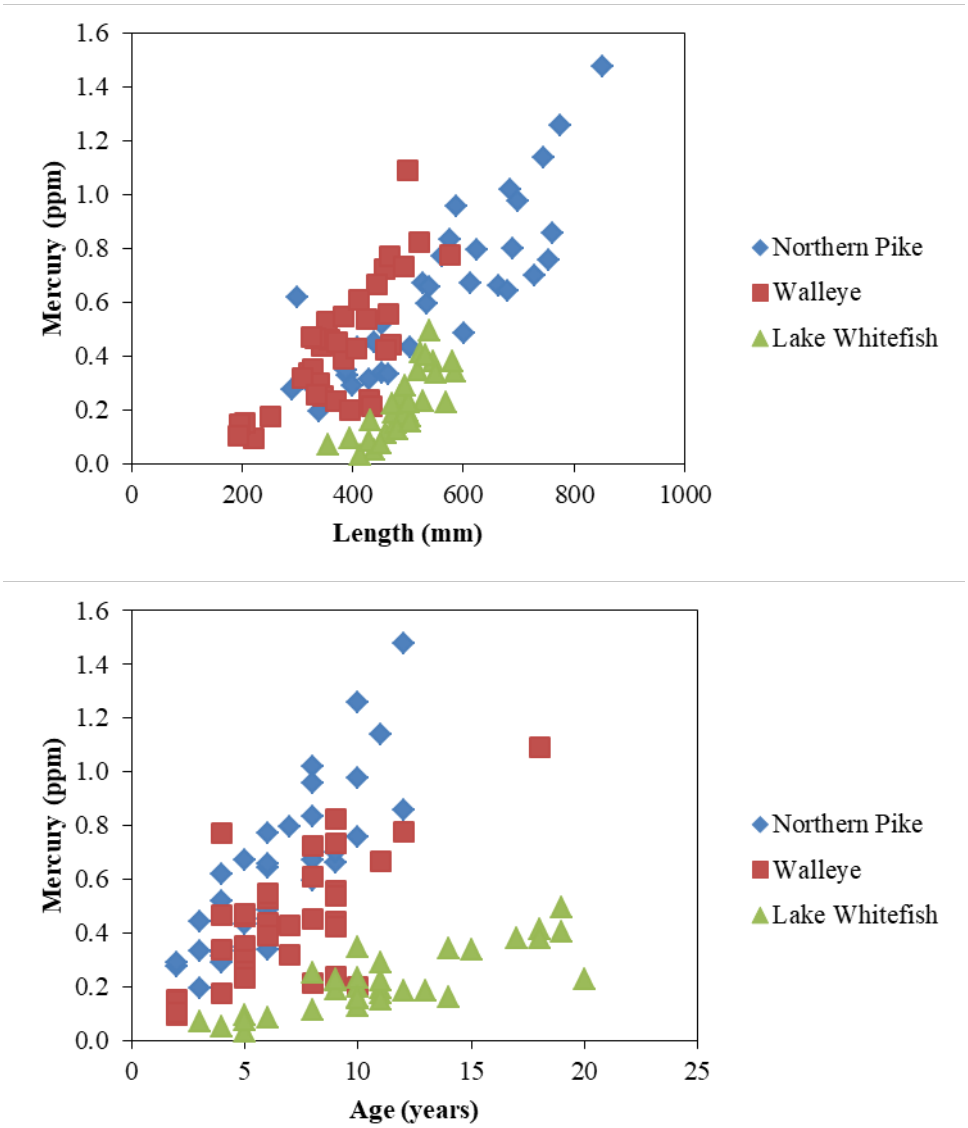


Figure 1: **Mercury concentration versus fork length (top) and age (bottom) for Northern Pike, Walleye, and Lake Whitefish captured from Gull Lake in 2019.**

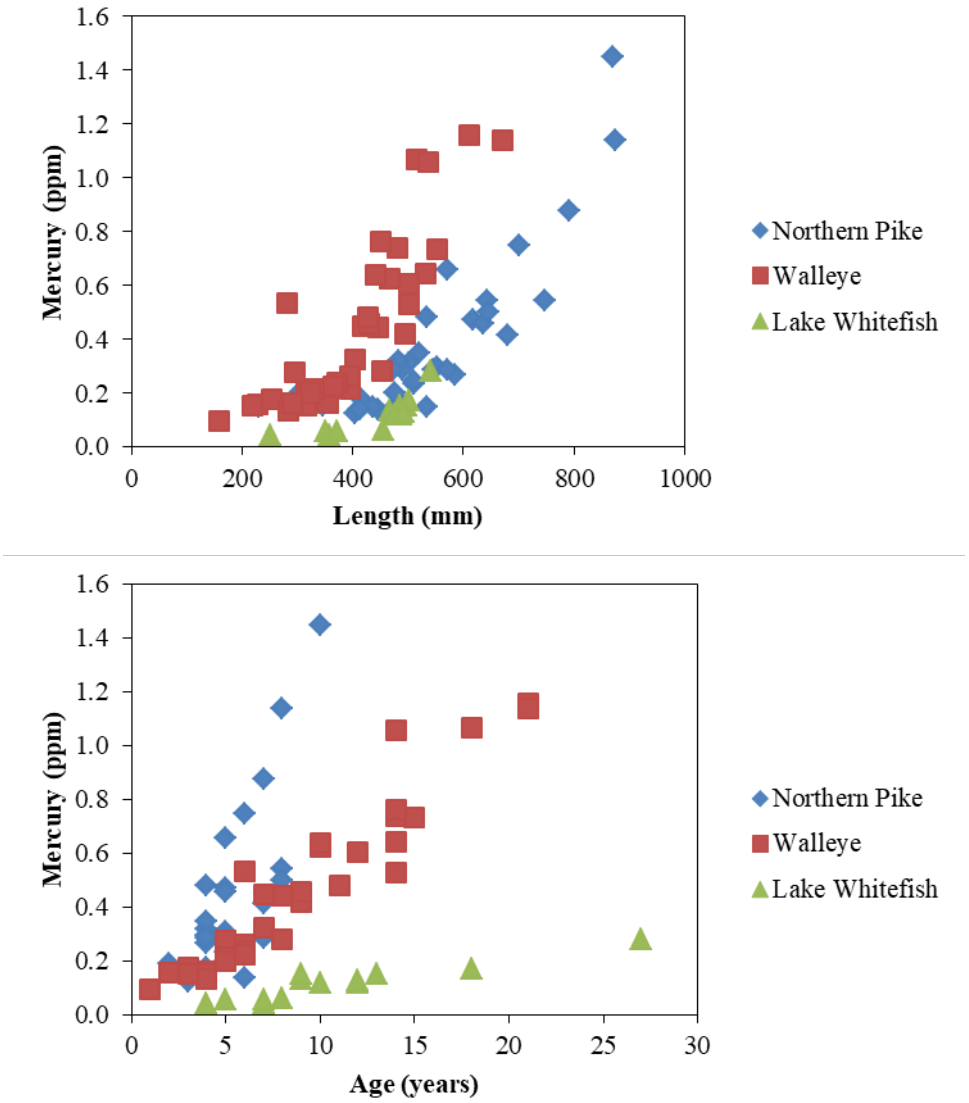


Figure 2: **Mercury concentration versus fork length (top) and age (bottom) for Northern Pike, Walleye, and Lake Whitefish captured from Stephens Lake in 2018.**

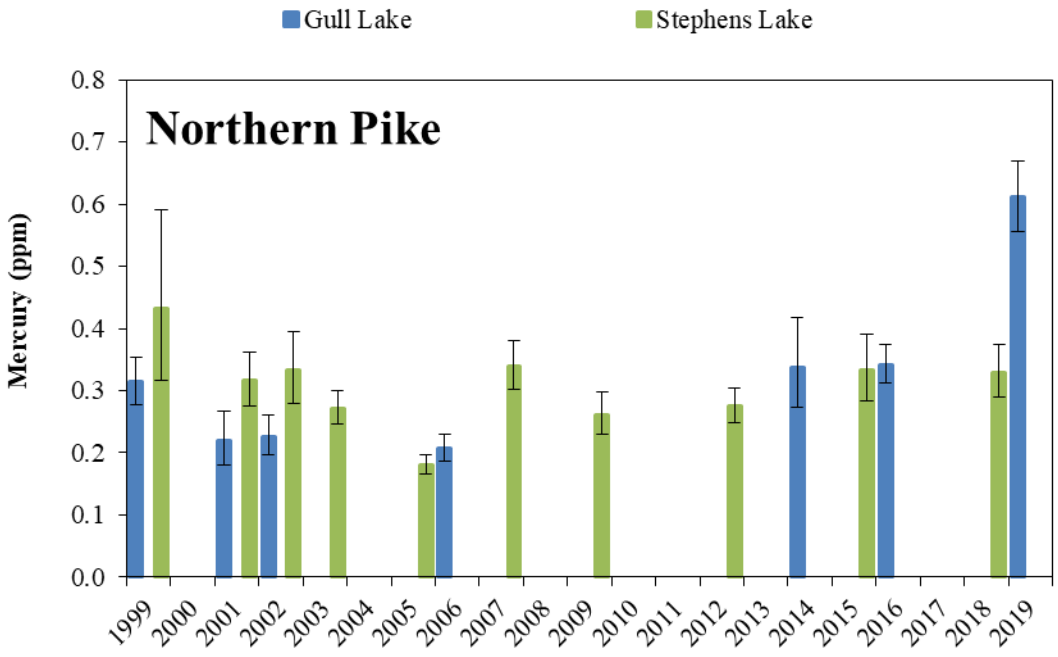


Figure 3: **Length standardized mean (±95% confidence limits, CL) muscle mercury concentrations of a 550 mm Northern Pike from Gull Lake and Stephens Lake for years 1999–2019.**

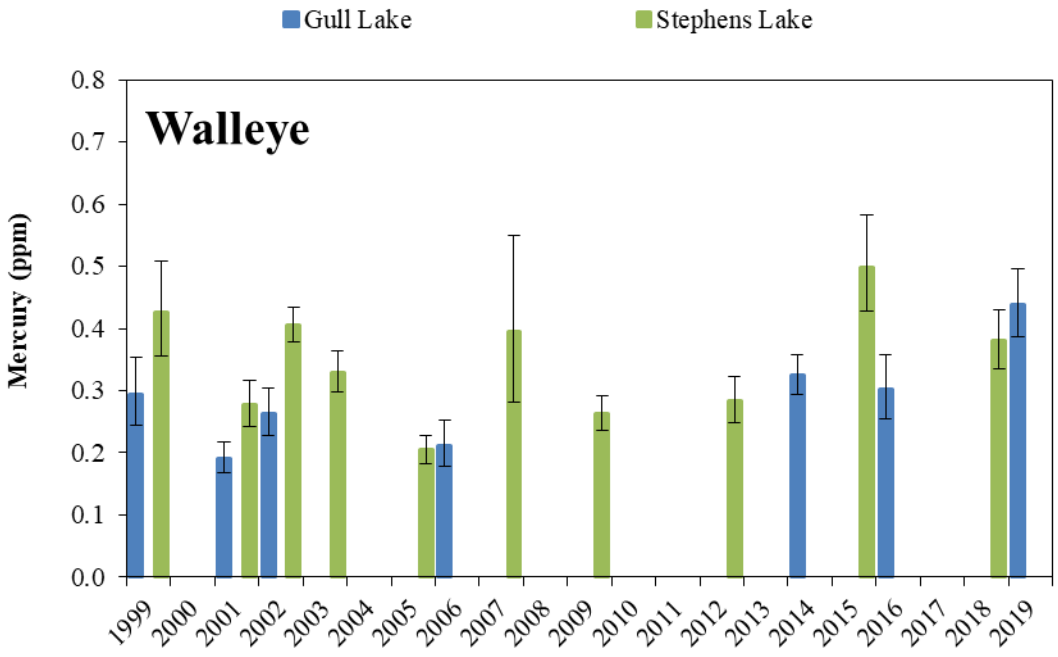


Figure 4: **Length standardized mean (±95% confidence limits, CL) muscle mercury concentrations of a 400 mm Walleye from Gull Lake and Stephens Lake for years 1999–2019.**

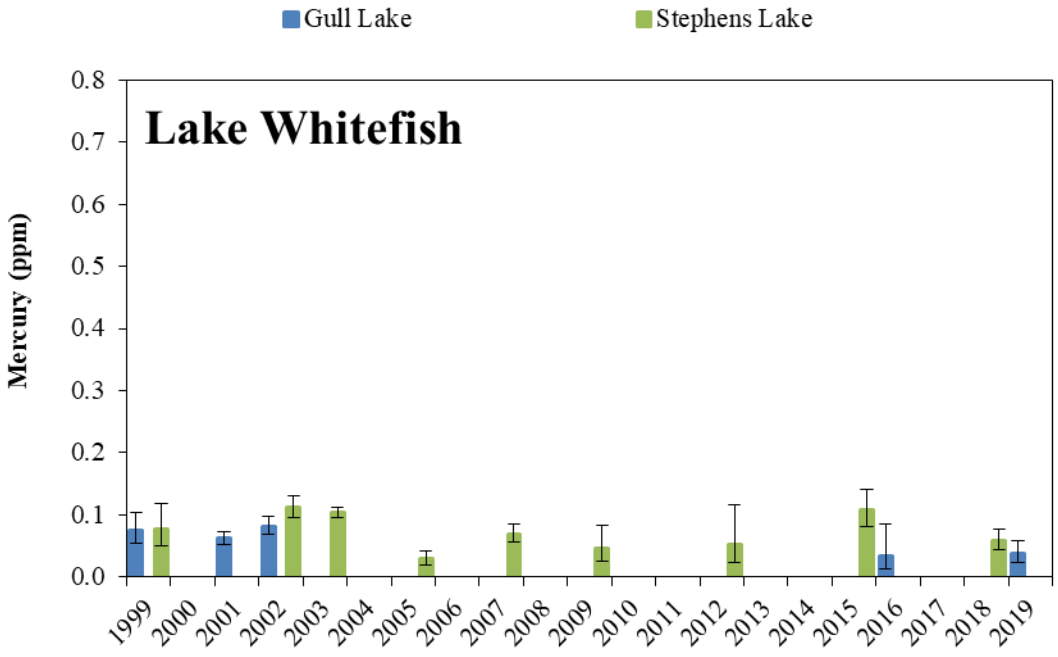
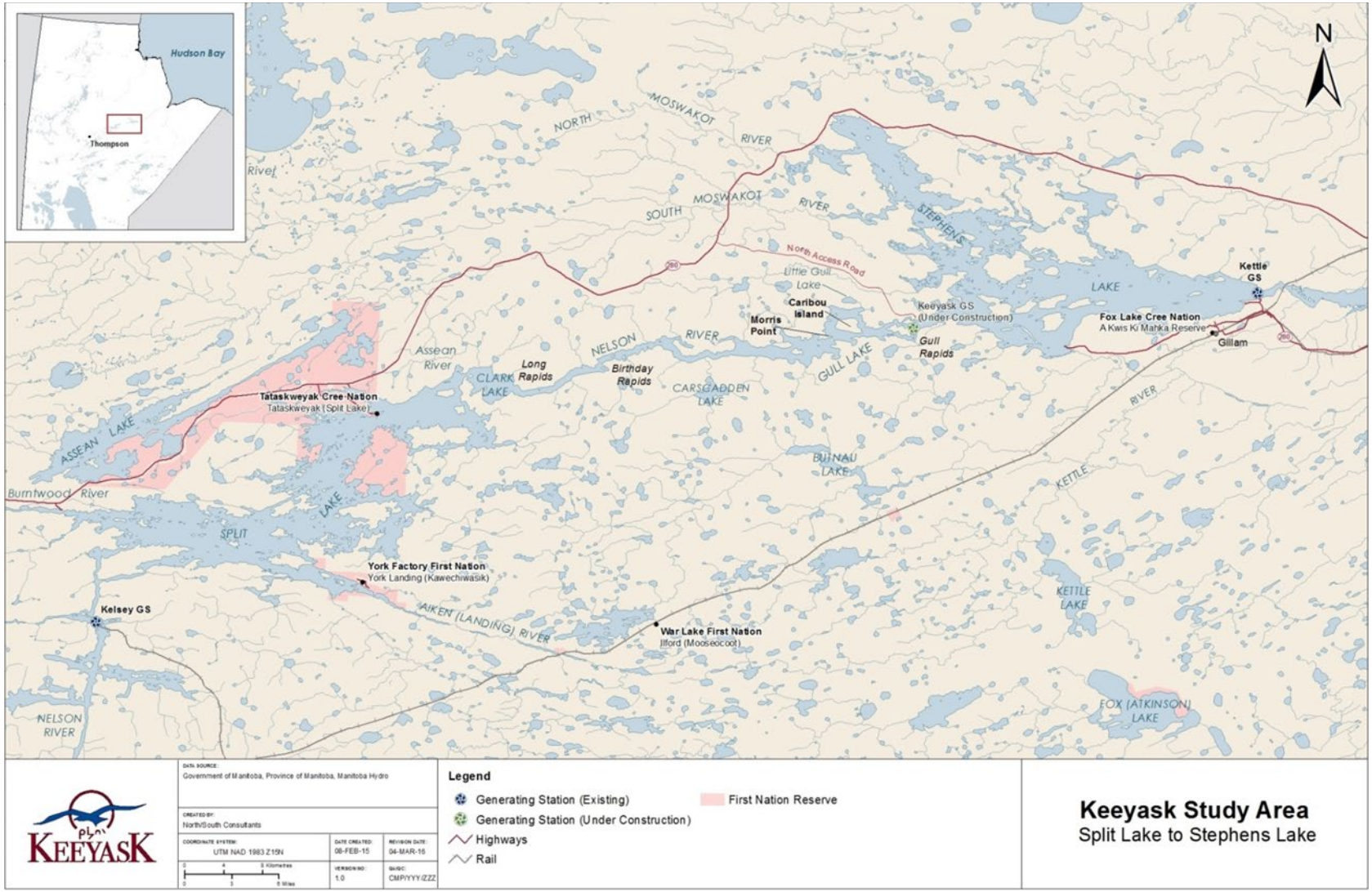
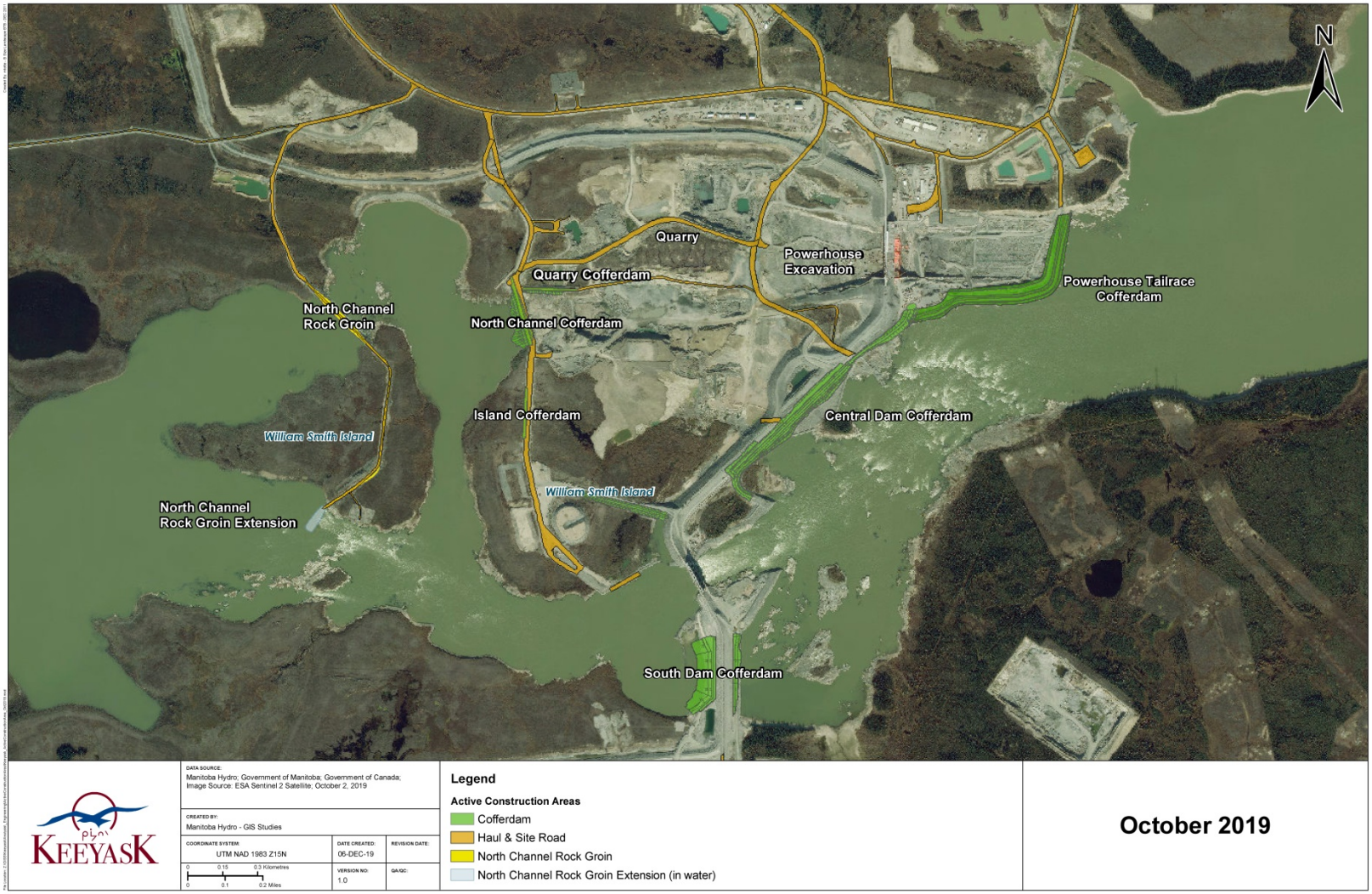


Figure 5: **Length standardized mean (±95% confidence limits, CL) muscle mercury concentrations of a 350 mm Lake Whitefish from Gull Lake and Stephens Lake for years 1999–2019.**

MAPS

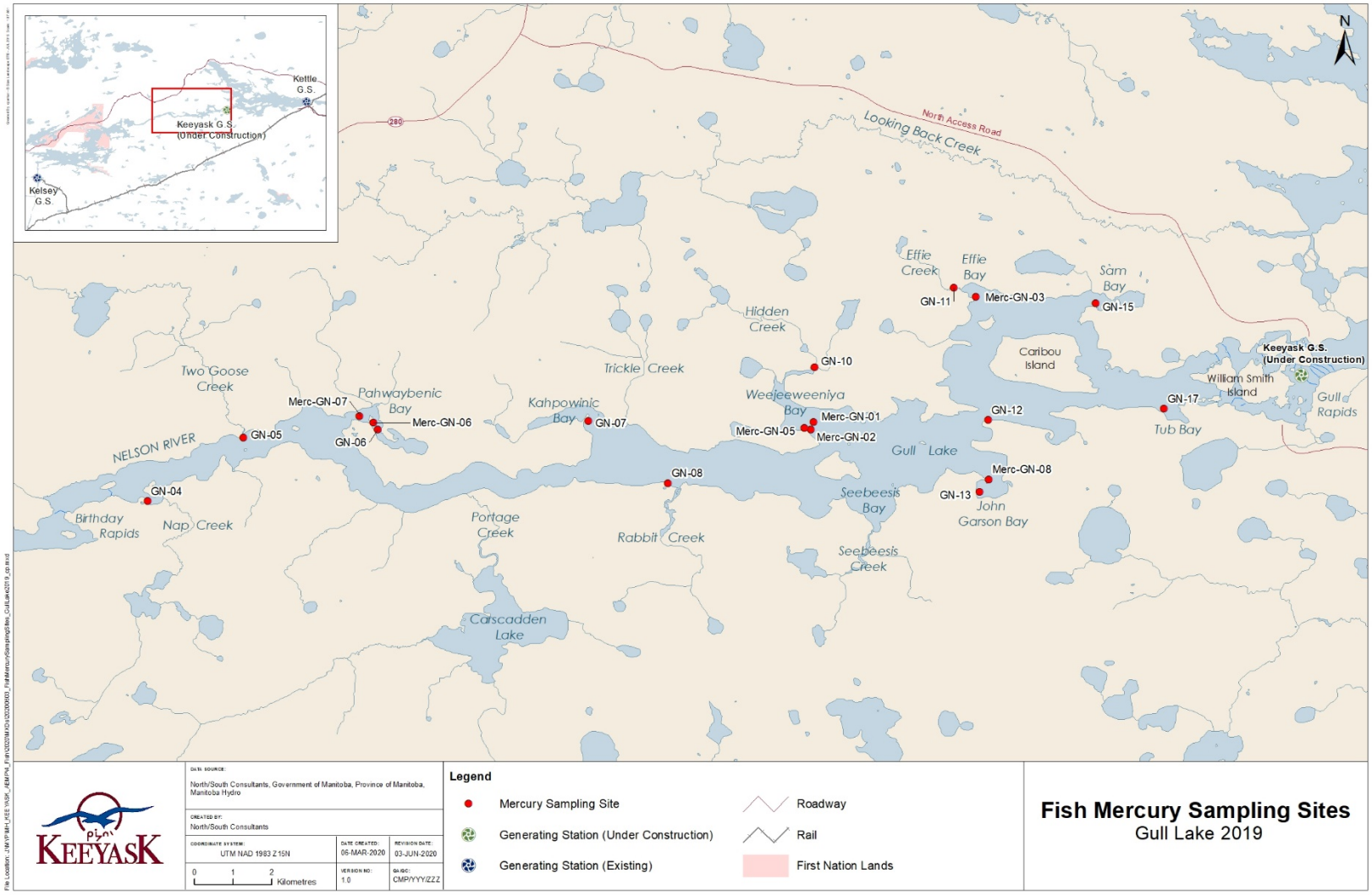


Map 1: Map of the Nelson River showing the site of Keeyask Generating Station and the fish mercury study setting.

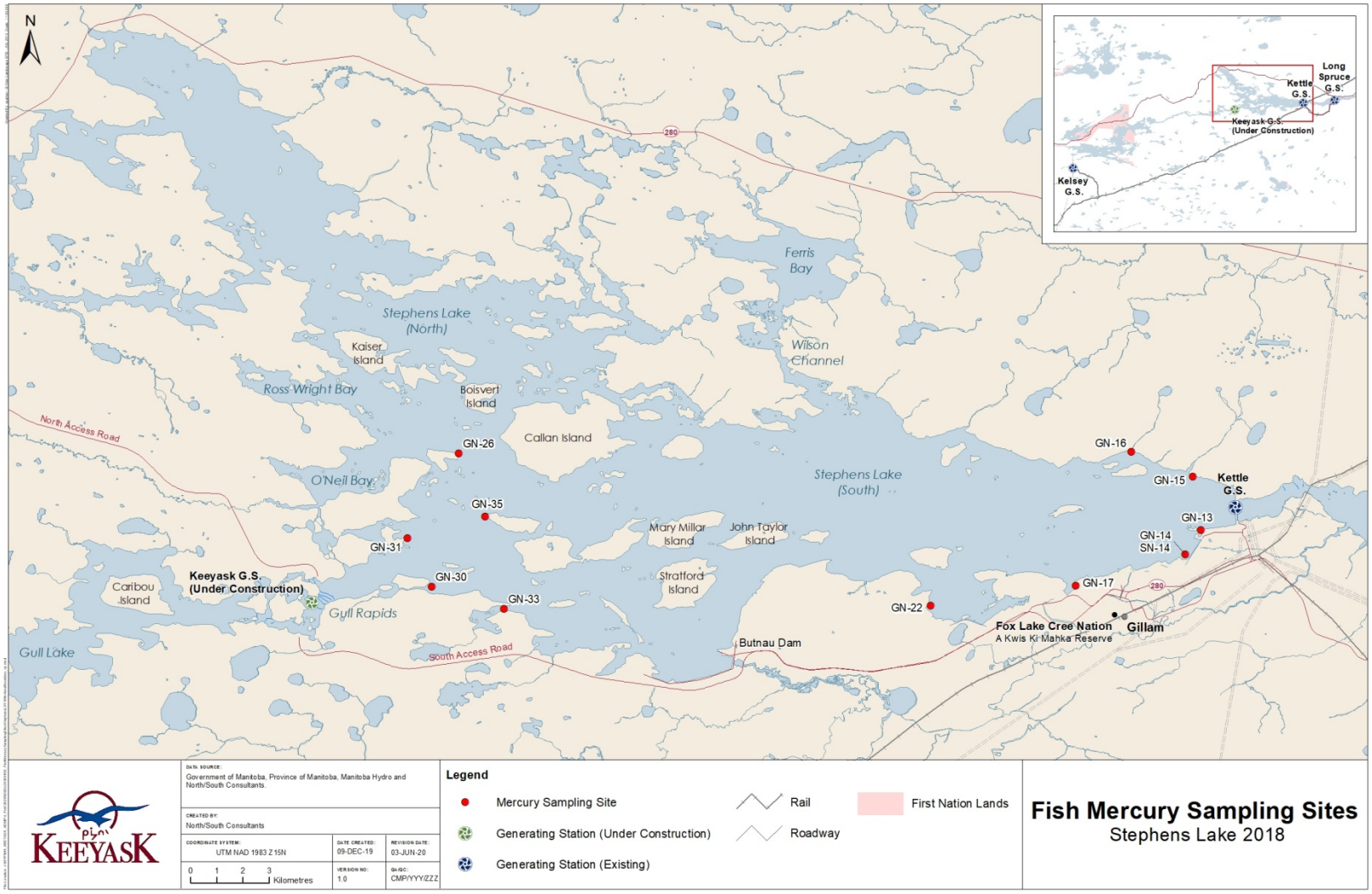


Satellite Imagery - October, 2019

Map 2: Map of instream structures at the Keeyask Generating Station site, October, 2019.



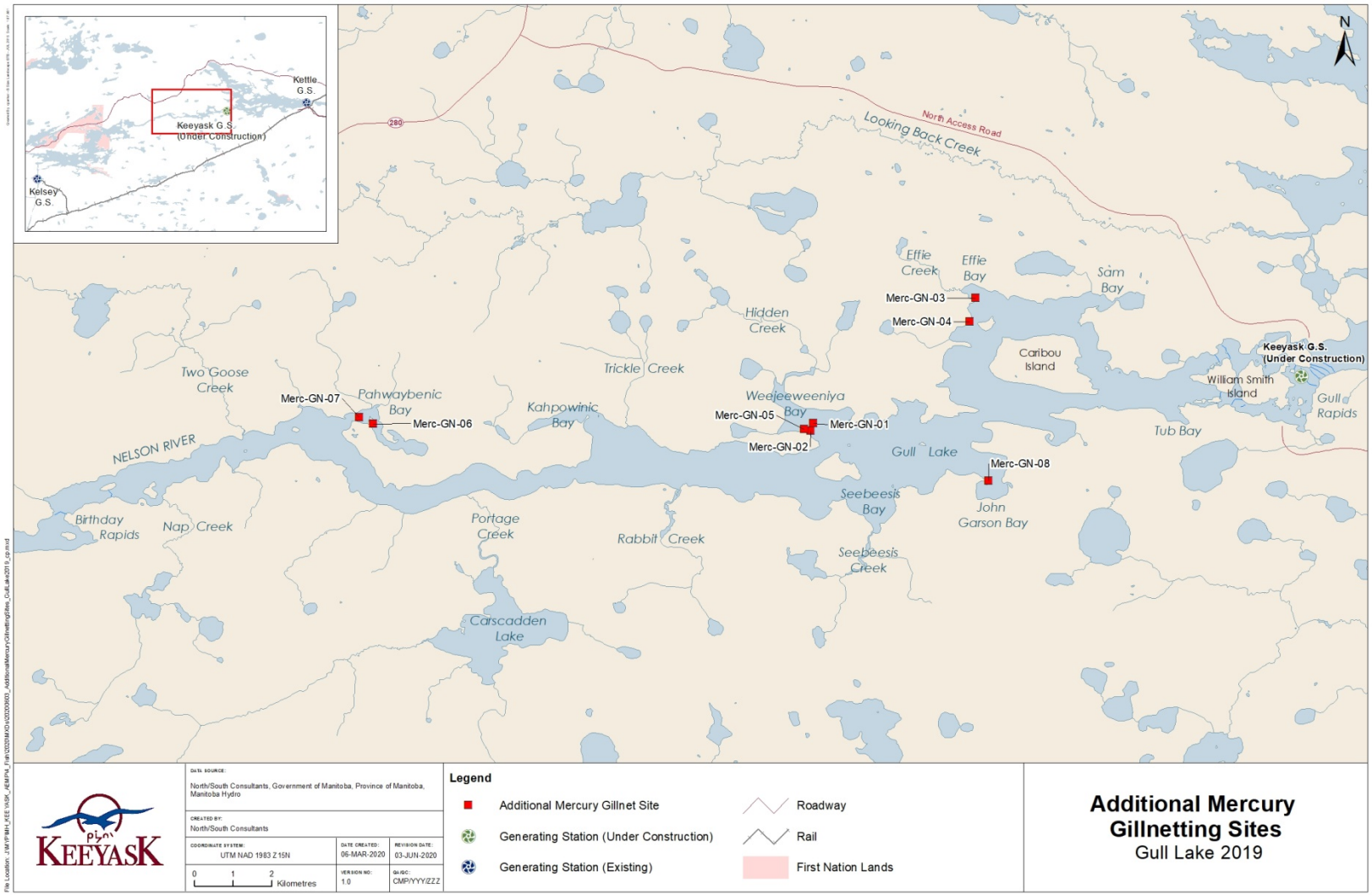
Map 3: Map of Gull Lake showing sites where fish were captured for mercury analysis in 2019.



Map 4: Map of Stephens Lake showing sampling sites where fish were captured for mercury analysis in 2018.

APPENDICES

APPENDIX 1:
SITE AND CATCH INFORMATION FOR GILLNETTING CONDUCTED IN GULL LAKE IN 2019 TO CAPTURE FISH FOR MERCURY ANALYSIS



Map A1-1. Gillnetting sites targeting fish for mercury analysis in Gull Lake, 2019.

Table A1-1. Mercury gillnetting survey information and catches in Gull Lake, 2019.

Site	Replicate	UTM Coordinates			Pull Date	Duration (h)	Depth (m)		Catch (n)		
		Zone	Easting	Northing			At Start	At End	LKWH	WALL	YLPR
Merc-GN-01	1	15	351018	6245195	11-Aug-19	23.50	1.8	2.0	3	16	-
Merc-GN-02	1	15	350945	6244997	12-Aug-19	23.83	2.0	2.5	3	-	-
Merc-GN-03	1	15	355231	6248444	13-Aug-19	23.50	2.8	2.7	1	-	-
Merc-GN-04	1	15	355078	6247835	14-Aug-19	25.67	2.8	2.4	-	-	-
Merc-GN-05	1	15	350777	6245050	15-Aug-19	24.92	1.9	1.7	6	-	-
Merc-GN-06	1	15	339590	6245191	15-Aug-19	21.50	1.6	1.6	5	-	-
Merc-GN-06	2	15	339590	6245191	16-Aug-19	23.67	1.6	1.6	-	-	-
Merc-GN-07	1	15	339231	6245345	15-Aug-19	21.75	1.1	1.5	4	-	-
Merc-GN-07	2	15	339231	6245345	16-Aug-19	23.67	1.1	1.5	-	-	-
Merc-GN-08	1	15	355566	6243708	15-Aug-19	21.33	1.4	2.4	7	-	-

APPENDIX 2:
ALS LABORATORY REPORT

North/South Consultants
ATTN: JODI HOLM
83 Scurfield Blvd
Winnipeg MB R3Y 1G4

Date Received: 18-OCT-19
Report Date: 03-MAR-20 07:47 (MT)
Version: FINAL REV. 2

Client Phone: 204-487-5638

Certificate of Analysis

Lab Work Order #: L2387968
Project P.O. #: NOT SUBMITTED
Job Reference: KEEYASK FISH - GULL LAKE
C of C Numbers:
Legal Site Desc:

Comments:
3-MAR-2020 Revised report - ID correction on sample 21 and 30

Hua Wo
Chemistry Laboratory Manager

ADDRESS: 1329 Niakwa Road East, Unit 12, Winnipeg, MB R2J 3T4 Canada | Phone: +1 204 255 9720 | Fax: +1 204 255 9721
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

KEEYASK FISH - GULL LAKE

L2387968 CONTD....
PAGE 2 of 14
Version: FINAL REV.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2387968-1 6 Sampled By: CLIENT on 08-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.223		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-2 58 Sampled By: CLIENT on 10-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.195		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-3 89 Sampled By: CLIENT on 11-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.175		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-4 102 Sampled By: CLIENT on 11-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.413		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-5 103 Sampled By: CLIENT on 11-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.347		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-6 127 Sampled By: CLIENT on 11-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.380		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-7 159 Sampled By: CLIENT on 12-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.200		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-8 160 Sampled By: CLIENT on 12-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.406		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-9 161 Sampled By: CLIENT on 12-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.235		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-10 162 Sampled By: CLIENT on 12-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.0529		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699

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

KEEYASK FISH - GULL LAKE

L2387968 CONTD....
PAGE 3 of 14
Version: FINAL REV.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2387968-11 163 Sampled By: CLIENT on 12-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.112		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-12 164 Sampled By: CLIENT on 12-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.0310		0.0010	mg/kg wwt	07-FEB-20	25-FEB-20	R5007811
L2387968-13 166 Sampled By: CLIENT on 12-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.0696		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-14 167 Sampled By: CLIENT on 12-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.186		0.0020	mg/kg wwt	31-JAN-20	21-FEB-20	R5002555
L2387968-15 200 Sampled By: CLIENT on 13-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.344		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-16 266 Sampled By: CLIENT on 15-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.253		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-17 267 Sampled By: CLIENT on 15-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.162		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-18 268 Sampled By: CLIENT on 15-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.153		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-19 269 Sampled By: CLIENT on 15-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.0945		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-20 270 Sampled By: CLIENT on 15-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.189		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699

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

KEEYASK FISH - GULL LAKE

L2387968 CONTD....
PAGE 4 of 14
Version: FINAL REV.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2387968-21 271 Sampled By: CLIENT on 15-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.186		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-22 273 Sampled By: CLIENT on 15-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.0844		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-23 274 Sampled By: CLIENT on 15-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.0753		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-24 275 Sampled By: CLIENT on 15-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.221		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-25 276 Sampled By: CLIENT on 15-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.129		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-26 280 Sampled By: CLIENT on 15-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.157		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-27 281 Sampled By: CLIENT on 15-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.160		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-28 282 Sampled By: CLIENT on 15-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.493		0.0050	mg/kg wwt	31-JAN-20	21-FEB-20	R5002555
L2387968-29 283 Sampled By: CLIENT on 15-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.227		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-30 284 Sampled By: CLIENT on 15-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.382		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699

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

KEEYASK FISH - GULL LAKE

L2387968 CONTD....
PAGE 5 of 14
Version: FINAL REV.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2387968-31 285 Sampled By: CLIENT on 15-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.292		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-32 286 Sampled By: CLIENT on 15-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.340		0.0020	mg/kg wwt	31-JAN-20	20-FEB-20	R4999699
L2387968-33 287 Sampled By: CLIENT on 15-AUG-19 Matrix: LAKE WHITEFISH **Miscellaneous Parameters** Mercury (Hg)	0.229		0.0020	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-34 4 Sampled By: CLIENT on 08-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	1.02		0.020	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-35 5 Sampled By: CLIENT on 08-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.664		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-36 8 Sampled By: CLIENT on 08-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.757		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-37 9 Sampled By: CLIENT on 08-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.670		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-38 10 Sampled By: CLIENT on 08-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	1.26		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-39 12 Sampled By: CLIENT on 08-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.859		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-40 13 Sampled By: CLIENT on 08-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.278		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555

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

KEEYASK FISH - GULL LAKE

L2387968 CONTD....
PAGE 6 of 14
Version: FINAL REV.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2387968-41 14 Sampled By: CLIENT on 08-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.330		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-42 18 Sampled By: CLIENT on 08-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.435		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-43 19 Sampled By: CLIENT on 08-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.617		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-44 20 Sampled By: CLIENT on 08-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.337		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-45 22 Sampled By: CLIENT on 08-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.331		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-46 23 Sampled By: CLIENT on 08-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.194		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-47 26 Sampled By: CLIENT on 09-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.486		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-48 27 Sampled By: CLIENT on 09-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.596		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-49 31 Sampled By: CLIENT on 09-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.290		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-50 39 Sampled By: CLIENT on 10-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	1.48		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555

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

KEEYASK FISH - GULL LAKE

L2387968 CONTD....
PAGE 7 of 14
Version: FINAL REV.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2387968-51 40 Sampled By: CLIENT on 10-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.671		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-52 43 Sampled By: CLIENT on 10-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.836		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-53 44 Sampled By: CLIENT on 10-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.978		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-54 45 Sampled By: CLIENT on 10-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.451		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-55 46 Sampled By: CLIENT on 10-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.432		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-56 47 Sampled By: CLIENT on 10-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.312		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-57 48 Sampled By: CLIENT on 10-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.348		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-58 51 Sampled By: CLIENT on 10-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	1.14		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-59 52 Sampled By: CLIENT on 10-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.444		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-60 53 Sampled By: CLIENT on 10-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.334		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555

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

KEEYASK FISH - GULL LAKE

L2387968 CONTD....
PAGE 8 of 14
Version: FINAL REV.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2387968-61 56 Sampled By: CLIENT on 10-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.701		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-62 57 Sampled By: CLIENT on 10-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.642		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-63 61 Sampled By: CLIENT on 10-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.800		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-64 64 Sampled By: CLIENT on 10-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.291		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-65 65 Sampled By: CLIENT on 10-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.519		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-66 68 Sampled By: CLIENT on 10-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.797		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-67 69 Sampled By: CLIENT on 10-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.774		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-68 70 Sampled By: CLIENT on 10-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.659		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-69 71 Sampled By: CLIENT on 10-AUG-19 Matrix: NORTHERN PIKE **Miscellaneous Parameters** Mercury (Hg)	0.958		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-70 2 Sampled By: CLIENT on 08-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.775		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555

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

KEEYASK FISH - GULL LAKE

L2387968 CONTD....
PAGE 9 of 14
Version: FINAL REV.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2387968-71 28 Sampled By: CLIENT on 09-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.527		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-72 55 Sampled By: CLIENT on 10-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.826		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-73 80 Sampled By: CLIENT on 10-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.339		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-74 105 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.441		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-75 106 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.436		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-76 107 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.462		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-77 108 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.466		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-78 109 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.724		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-79 110 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.238		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-80 111 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.548		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555

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

KEEYASK FISH - GULL LAKE

L2387968 CONTD....
PAGE 10 of 14
Version: FINAL REV.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2387968-81 112 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.390		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-82 114 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.450		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-83 115 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.354		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-84 116 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.300		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-85 117 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.177		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-86 118 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.095		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-87 119 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.471		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-88 120 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.150		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-89 122 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.254		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-90 124 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.557		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555

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

KEEYASK FISH - GULL LAKE

L2387968 CONTD....
PAGE 11 of 14
Version: FINAL REV.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2387968-91 128 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.427		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-92 136 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.320		0.010	mg/kg wwt	04-FEB-20	21-FEB-20	R5002555
L2387968-93 137 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.259		0.0020	mg/kg wwt	05-FEB-20	20-FEB-20	R4999699
L2387968-94 139 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.234		0.0020	mg/kg wwt	05-FEB-20	20-FEB-20	R4999699
L2387968-95 150 Sampled By: CLIENT on 11-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.198		0.0020	mg/kg wwt	05-FEB-20	20-FEB-20	R4999699
L2387968-96 152 Sampled By: CLIENT on 12-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	1.09		0.010	mg/kg wwt	05-FEB-20	21-FEB-20	R5002555
L2387968-97 154 Sampled By: CLIENT on 12-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.734		0.010	mg/kg wwt	05-FEB-20	21-FEB-20	R5002555
L2387968-98 169 Sampled By: CLIENT on 12-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.536		0.0050	mg/kg wwt	05-FEB-20	21-FEB-20	R5002555
L2387968-99 197 Sampled By: CLIENT on 13-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.214		0.0020	mg/kg wwt	05-FEB-20	20-FEB-20	R4999699
L2387968-100 198 Sampled By: CLIENT on 13-AUG-19 Matrix: WALLEYE **Miscellaneous Parameters** Mercury (Hg)	0.668		0.0050	mg/kg wwt	05-FEB-20	21-FEB-20	R5002555

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

KEEYASK FISH - GULL LAKE

L2387968 CONTD....
PAGE 12 of 14
Version: FINAL REV.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2387968-101 201							
Sampled By: CLIENT on 13-AUG-19							
Matrix: WALLEYE							
Miscellaneous Parameters							
Mercury (Hg)	0.145		0.0020	mg/kg wwt	05-FEB-20	20-FEB-20	R4999699
L2387968-102 202							
Sampled By: CLIENT on 13-AUG-19							
Matrix: WALLEYE							
Miscellaneous Parameters							
Mercury (Hg)	0.105		0.0020	mg/kg wwt	05-FEB-20	20-FEB-20	R4999699
L2387968-103 203							
Sampled By: CLIENT on 13-AUG-19							
Matrix: WALLEYE							
Miscellaneous Parameters							
Mercury (Hg)	0.772		0.0050	mg/kg wwt	05-FEB-20	21-FEB-20	R5002555
L2387968-104 204							
Sampled By: CLIENT on 13-AUG-19							
Matrix: WALLEYE							
Miscellaneous Parameters							
Mercury (Hg)	0.611		0.0050	mg/kg wwt	05-FEB-20	21-FEB-20	R5002555
L2387968-105 205							
Sampled By: CLIENT on 13-AUG-19							
Matrix: WALLEYE							
Miscellaneous Parameters							
Mercury (Hg)	0.422		0.0020	mg/kg wwt	05-FEB-20	20-FEB-20	R4999699
L2387968-106 30							
Sampled By: CLIENT on 09-AUG-19							
Matrix: YELLOW PERCH							
Miscellaneous Parameters							
Mercury (Hg)	0.0792		0.0010	mg/kg wwt	05-FEB-20	20-FEB-20	R4999699
Sample Weight	22.40		0.01	g		17-JAN-20	R4972281
L2387968-107 179							
Sampled By: CLIENT on 12-AUG-19							
Matrix: YELLOW PERCH							
Miscellaneous Parameters							
Mercury (Hg)	0.0657		0.0010	mg/kg wwt	05-FEB-20	20-FEB-20	R4999699
Sample Weight	22.20		0.01	g		17-JAN-20	R4972281
L2387968-108 180							
Sampled By: CLIENT on 12-AUG-19							
Matrix: YELLOW PERCH							
Miscellaneous Parameters							
Mercury (Hg)	0.0452		0.0010	mg/kg wwt	05-FEB-20	20-FEB-20	R4999699
Sample Weight	20.30		0.01	g		17-JAN-20	R4972281
L2387968-109 181							
Sampled By: CLIENT on 12-AUG-19							
Matrix: YELLOW PERCH							
Miscellaneous Parameters							
Mercury (Hg)	0.0187		0.0010	mg/kg wwt	05-FEB-20	20-FEB-20	R4999699
Sample Weight	3.40		0.01	g		17-JAN-20	R4972281

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

KEEYASK FISH - GULL LAKE

L2387968 CONTD....
PAGE 13 of 14
Version: FINAL REV.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2387968-110 1000							
Sampled By: CLIENT on 08-AUG-19							
Matrix: YELLOW PERCH							
Miscellaneous Parameters							
Mercury (Hg)	0.144		0.0010	mg/kg wwt	05-FEB-20	20-FEB-20	R4999699
Sample Weight	25.70		0.01	g		17-JAN-20	R4972281
L2387968-111 1001							
Sampled By: CLIENT on 08-AUG-19							
Matrix: YELLOW PERCH							
Miscellaneous Parameters							
Mercury (Hg)	0.0429		0.0010	mg/kg wwt	05-FEB-20	20-FEB-20	R4999699
Sample Weight	33.80		0.01	g		17-JAN-20	R4972281
L2387968-112 1002							
Sampled By: CLIENT on 13-AUG-19							
Matrix: YELLOW PERCH							
Miscellaneous Parameters							
Mercury (Hg)	0.0354		0.0010	mg/kg wwt	05-FEB-20	20-FEB-20	R4999699
Sample Weight	19.70		0.01	g		17-JAN-20	R4972281
L2387968-113 1003							
Sampled By: CLIENT on 14-AUG-19							
Matrix: YELLOW PERCH							
Miscellaneous Parameters							
Mercury (Hg)	0.0346		0.0010	mg/kg wwt	05-FEB-20	20-FEB-20	R4999699
Sample Weight	3.30		0.01	g		17-JAN-20	R4972281
L2387968-114 1004							
Sampled By: CLIENT on 15-AUG-19							
Matrix: YELLOW PERCH							
Miscellaneous Parameters							
Mercury (Hg)	0.0365		0.0010	mg/kg wwt	05-FEB-20	20-FEB-20	R4999699
Sample Weight	5.10		0.01	g		17-JAN-20	R4972281
L2387968-115 1005							
Sampled By: CLIENT on 15-AUG-19							
Matrix: YELLOW PERCH							
Miscellaneous Parameters							
Mercury (Hg)	0.0666		0.0010	mg/kg wwt	05-FEB-20	20-FEB-20	R4999699
Sample Weight	4.60		0.01	g		17-JAN-20	R4972281

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

KEEYASK FISH - GULL LAKE

L2387968 CONTD....
PAGE 14 of 14
Version: FINAL REV

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 additons of hydrogen peroxide, followed by cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analysis by CVAAS.			
WEIGHT-WP	Tissue	Weight of sample	WEIGHT

** 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 wwt - 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.

APPENDIX 3:
MUSCLE MERCURY CONCENTRATIONS AND BIOLOGICAL DATA FOR INDIVIDUAL FISH FROM GULL LAKE IN 2019

Table A3-1: Definitions of codes used in Appendix 3 tables.

Term	Code	Definition
Species	LKWH	Lake Whitefish
	NRPK	Northern Pike
	WALL	Walleye
Sex	F	Female
	M	Male
Maturity	IMM	Immature
	MAT	Mature
K		Condition factor

Table A3-2: Muscle mercury concentrations (Hg) and biological data for Lake Whitefish, Northern Pike, and Walleye from Gull Lake in 2019.

Fish #	Site	Sampling Date	Species	Fork Length (mm)	Weight (g)	K	Sex	Maturity	Age (y)	Hg (ppm)
6	GN-15	08-Aug-19	LKWH	493	2260	1.89	M	MAT	9	0.223
58	GN-11	10-Aug-19	LKWH	500	2050	1.64	F	MAT	11	0.195
89	GN-13	11-Aug-19	LKWH	504	2000	1.56	M	MAT	11	0.175
102	Merc-GN-01	11-Aug-19	LKWH	523	2470	1.73	F	MAT	18	0.413
103	Merc-GN-01	11-Aug-19	LKWH	518	2770	1.99	F	MAT	10	0.347
127	GN-07	11-Aug-19	LKWH	545	3420	2.11	F	MAT	18	0.380
159	Merc-GN-02	12-Aug-19	LKWH	487	2000	1.73	M	MAT	10	0.200
160	Merc-GN-02	12-Aug-19	LKWH	533	2640	1.74	M	MAT	19	0.406
161	Merc-GN-02	12-Aug-19	LKWH	528	2620	1.78	F	MAT	10	0.235
162	GN-06	12-Aug-19	LKWH	440	1420	1.67	M	MAT	4	0.0529
163	GN-06	12-Aug-19	LKWH	460	1900	1.95	F	MAT	8	0.112
164	GN-06	12-Aug-19	LKWH	414	1200	1.69	M	MAT	5	0.0310
166	GN-06	12-Aug-19	LKWH	355	910	2.03	M	IMM	3	0.0696
167	GN-06	12-Aug-19	LKWH	486	2390	2.08	F	MAT	12	0.186
200	Merc-GN-03	13-Aug-19	LKWH	585	3560	1.78	F	MAT	14	0.344
266	Merc-GN-08	15-Aug-19	LKWH	485	1990	1.74	F	MAT	8	0.253
267	Merc-GN-08	15-Aug-19	LKWH	499	2210	1.78	F	MAT	10	0.162
268	Merc-GN-08	15-Aug-19	LKWH	478	1660	1.52	M	MAT	11	0.153
269	Merc-GN-08	15-Aug-19	LKWH	395	940	1.53	F	MAT	5	0.0945
270	Merc-GN-08	15-Aug-19	LKWH	475	2060	1.92	M	MAT	9	0.189
271	Merc-GN-08	15-Aug-19	LKWH	492	2100	1.76	M	MAT	13	0.186
273	Merc-GN-06	15-Aug-19	LKWH	430	1440	1.81	M	IMM	6	0.0844
274	Merc-GN-06	15-Aug-19	LKWH	450	1800	1.98	F	MAT	5	0.0753
275	Merc-GN-06	15-Aug-19	LKWH	471	2130	2.04	M	MAT	11	0.221
276	Merc-GN-06	15-Aug-19	LKWH	480	2340	2.12	M	MAT	10	0.129

Table A3-2: Muscle mercury concentrations (Hg) and biological data for Lake Whitefish, Northern Pike, and Walleye from Gull Lake in 2019 (continued).

Fish #	Site	Sampling Date	Species	Fork Length (mm)	Weight (g)	K	Sex	Maturity	Age (y)	Hg (ppm)
280	Merc-GN-07	15-Aug-19	LKWH	505	2590	2.01	F	MAT	10	0.157
281	Merc-GN-07	15-Aug-19	LKWH	433	1060	1.31	F	MAT	14	0.160
282	Merc-GN-05	15-Aug-19	LKWH	540	2860	1.82	M	MAT	19	0.493
283	Merc-GN-05	15-Aug-19	LKWH	502	2170	1.72	M	MAT	9	0.227
284	Merc-GN-05	15-Aug-19	LKWH	580	2840	1.46	M	MAT	17	0.382
285	Merc-GN-05	15-Aug-19	LKWH	495	2460	2.03	F	MAT	11	0.292
286	Merc-GN-05	15-Aug-19	LKWH	550	3530	2.12	M	MAT	15	0.340
287	Merc-GN-05	15-Aug-19	LKWH	570	3110	1.68	M	MAT	20	0.229
4	GN-15	08-Aug-19	NRPK	684	1820	0.57	F	MAT	8	1.02
5	GN-15	08-Aug-19	NRPK	665	2470	0.84	F	MAT	9	0.664
8	GN-15	08-Aug-19	NRPK	755	3940	0.92	F	MAT	10	0.757
9	GN-15	08-Aug-19	NRPK	614	1680	0.73	F	MAT	8	0.670
10	GN-15	08-Aug-19	NRPK	776	3360	0.72	F	MAT	10	1.26
12	GN-15	08-Aug-19	NRPK	761	3050	0.69	F	MAT	12	0.859
13	GN-15	08-Aug-19	NRPK	290	160	0.66	F	IMM	2	0.278
14	GN-15	08-Aug-19	NRPK	390	390	0.66	F	IMM	4	0.330
18	GN-12	08-Aug-19	NRPK	505	910	0.71	F	MAT	6	0.435
19	GN-12	08-Aug-19	NRPK	301	190	0.70	F	IMM	4	0.617
20	GN-12	08-Aug-19	NRPK	452	690	0.75	M	MAT	6	0.337
22	GN-12	08-Aug-19	NRPK	464	660	0.66	F	MAT	5	0.331
23	GN-12	08-Aug-19	NRPK	339	270	0.69	F	IMM	3	0.194
26	GN-17	09-Aug-19	NRPK	602	1560	0.72	F	MAT	6	0.486
27	GN-17	09-Aug-19	NRPK	535	1090	0.71	M	MAT	8	0.596
31	GN-17	09-Aug-19	NRPK	325	205	0.60	F	IMM	2	0.290
39	GN-10	10-Aug-19	NRPK	852	4989.52	0.81	F	MAT	12	1.48

Table A3-2: Muscle mercury concentrations (Hg) and biological data for Lake Whitefish, Northern Pike, and Walleye from Gull Lake in 2019 (continued).

Fish #	Site	Sampling Date	Species	Fork Length (mm)	Weight (g)	K	Sex	Maturity	Age (y)	Hg (ppm)
40	GN-10	10-Aug-19	NRPK	527	1060	0.72	M	MAT	5	0.671
43	GN-10	10-Aug-19	NRPK	576	1420	0.74	F	MAT	8	0.836
44	GN-10	10-Aug-19	NRPK	699	2500	0.73	F	MAT	10	0.978
45	GN-10	10-Aug-19	NRPK	439	640	0.76	M	MAT	6	0.451
46	GN-10	10-Aug-19	NRPK	408	480	0.71	M	MAT	5	0.432
47	GN-10	10-Aug-19	NRPK	430	610	0.77	F	MAT	4	0.312
48	GN-10	10-Aug-19	NRPK	389	480	0.82	M	MAT	5	0.348
51	GN-10	10-Aug-19	NRPK	744	2730	0.66	F	MAT	11	1.14
52	GN-10	10-Aug-19	NRPK	365	340	0.70	F	IMM	3	0.444
53	GN-10	10-Aug-19	NRPK	313	200	0.65	F	IMM	3	0.334
56	GN-11	10-Aug-19	NRPK	730	2340	0.60	F	MAT	9	0.701
57	GN-11	10-Aug-19	NRPK	680	2482	0.79	F	MAT	6	0.642
61	GN-11	10-Aug-19	NRPK	690	2810	0.86	F	MAT	-	0.800
64	GN-11	10-Aug-19	NRPK	400	470	0.73	M	MAT	4	0.291
65	GN-11	10-Aug-19	NRPK	452	690	0.75	F	MAT	4	0.519
68	GN-11	10-Aug-19	NRPK	625	1620	0.66	F	MAT	7	0.797
69	GN-11	10-Aug-19	NRPK	563	1140	0.64	F	MAT	6	0.774
70	GN-11	10-Aug-19	NRPK	539	1060	0.68	F	MAT	6	0.659
71	GN-11	10-Aug-19	NRPK	588	1380	0.68	F	MAT	8	0.958
2	GN-15	08-Aug-19	WALL	577	5200	2.71	F	MAT	12	0.775
28	GN-17	09-Aug-19	WALL	354	510	1.15	F	MAT	6	0.527
55	GN-11	10-Aug-19	WALL	520	1360	0.97	F	MAT	9	0.826
80	GN-11	10-Aug-19	WALL	321	400	1.21	F	MAT	4	0.339
105	Merc-GN-01	11-Aug-19	WALL	470	1060	1.02	F	MAT	9	0.441
106	Merc-GN-01	11-Aug-19	WALL	344	440	1.08	F	IMM	6	0.436

Table A3-2: Muscle mercury concentrations (Hg) and biological data for Lake Whitefish, Northern Pike, and Walleye from Gull Lake in 2019 (continued).

Fish #	Site	Sampling Date	Species	Fork Length (mm)	Weight (g)	K	Sex	Maturity	Age (y)	Hg (ppm)
107	Merc-GN-01	11-Aug-19	WALL	358	490	1.07	F	IMM	5	0.462
108	Merc-GN-01	11-Aug-19	WALL	332	420	1.15	F	MAT	4	0.466
109	Merc-GN-01	11-Aug-19	WALL	458	1010	1.05	F	MAT	8	0.724
110	Merc-GN-01	11-Aug-19	WALL	431	760	0.95	F	MAT	9	0.238
111	Merc-GN-01	11-Aug-19	WALL	384	570	1.01	F	MAT	6	0.548
112	Merc-GN-01	11-Aug-19	WALL	383	590	1.05	F	MAT	6	0.390
114	Merc-GN-01	11-Aug-19	WALL	372	500	0.97	F	MAT	8	0.450
115	Merc-GN-01	11-Aug-19	WALL	328	380	1.08	F	MAT	5	0.354
116	Merc-GN-01	11-Aug-19	WALL	339	420	1.08	F	MAT	5	0.300
117	Merc-GN-01	11-Aug-19	WALL	252	140	0.87	-	IMM	4	0.177
118	Merc-GN-01	11-Aug-19	WALL	221	120	1.11	F	IMM	2	0.095
119	Merc-GN-01	11-Aug-19	WALL	325	410	1.19	F	MAT	5	0.471
120	Merc-GN-01	11-Aug-19	WALL	204	77.8	0.92	F	IMM	2	0.150
122	GN-07	11-Aug-19	WALL	347	500	1.20	M	MAT	5	0.254
124	GN-07	11-Aug-19	WALL	464	1050	1.05	F	MAT	9	0.557
128	GN-07	11-Aug-19	WALL	406	700	1.05	M	MAT	7	0.427
136	GN-07	11-Aug-19	WALL	310	320	1.07	-	IMM	7	0.320
137	GN-07	11-Aug-19	WALL	334	420	1.13	F	MAT	5	0.259
139	GN-07	11-Aug-19	WALL	370	660	1.30	F	MAT	5	0.234
150	GN-07	11-Aug-19	WALL	396	630	1.01	F	MAT	10	0.198
169	GN-06	12-Aug-19	WALL	425	870	1.13	F	MAT	9	0.536
197	GN-04	13-Aug-19	WALL	435	860	1.04	F	MAT	8	0.214
198	GN-04	13-Aug-19	WALL	444	970	1.11	F	MAT	11	0.668
201	GN-08	13-Aug-19	WALL	196	70.6	0.94	-	IMM	2	0.145
202	GN-08	13-Aug-19	WALL	194	73.7	1.01	-	IMM	2	0.105

Table A3-2: Muscle mercury concentrations (Hg) and other biological data for Lake Whitefish, Northern Pike, and Walleye from Gull Lake in 2019 (continued).

Fish #	Site	Sampling Date	Species	Fork Length (mm)	Weight (g)	K	Sex	Maturity	Age (y)	Hg (ppm)
203	GN-08	13-Aug-19	WALL	466	1140	1.13	F	MAT	4	0.772
204	GN-08	13-Aug-19	WALL	412	720	1.03	F	MAT	8	0.611
205	GN-08	13-Aug-19	WALL	461	1110	1.13	F	MAT	9	0.422
152	GN-05	12-Aug-19	WALL	499	1120	0.90	F	MAT	18	1.09
154	GN-05	12-Aug-19	WALL	492	1320	1.11	F	MAT	9	0.734

Table A3-3: Muscle mercury concentrations (Hg) and biological data for Lake Whitefish, Northern Pike, and Walleye from Stephens Lake in 2018.

Fish #	Site	Sampling Date	Species	Fork Length (mm)	Weight (g)	K	Sex	Maturity	Age (y)	Hg (ppm)
362	GN-26	04-Sep-18	LKWH	251	196	1.24	M	IMM	4	0.0400
376	GN-26	04-Sep-18	LKWH	357	730	1.60	M	IMM	7	0.0404
377	GN-26	04-Sep-18	LKWH	351	630	1.46	F	IMM	7	0.0580
383	GN-26	04-Sep-18	LKWH	485	1150	1.01	M	MAT	13	0.152
384	GN-26	04-Sep-18	LKWH	467	1970	1.93	F	MAT	9	0.133
385	GN-26	04-Sep-18	LKWH	456	1540	1.62	M	MAT	8	0.0620
389	GN-26	04-Sep-18	LKWH	496	2100	1.72	F	MAT	9	0.152
390	GN-26	04-Sep-18	LKWH	502	2230	1.76	M	MAT	18	0.171
394	GN-31	04-Sep-18	LKWH	371	900	1.76	F	IMM	5	0.0564
53	GN-14	30-Aug-18	LKWH	541	3200	2.02	F	MAT	27	0.279
136	GN-17	31-Aug-18	LKWH	489	2190	1.87	F	MAT	10	0.117
137	GN-17	31-Aug-18	LKWH	477	2120	1.95	F	MAT	12	0.117
145	GN-22	31-Aug-18	LKWH	492	2180	1.83	F	MAT	12	0.130
400	GN-31	04-Sep-18	NRPK	747	3150	0.76	M	MAT	-	0.541
403	GN-31	04-Sep-18	NRPK	874	3970	0.59	F	MAT	8	1.14
422	GN-35	04-Sep-18	NRPK	642	1910	0.72	M	MAT	8	0.541
423	GN-35	04-Sep-18	NRPK	502	830	0.66	F	MAT	5	0.309
424	GN-35	04-Sep-18	NRPK	546	980	0.60	F	MAT	5	0.286
425	GN-35	04-Sep-18	NRPK	511	990	0.74	M	MAT	5	0.231
11	GN-13	30-Aug-18	NRPK	535	1100	0.72	M	MAT	4	0.149
17	GN-13	30-Aug-18	NRPK	491	990	0.84	M	MAT	5	0.284
18	GN-13	30-Aug-18	NRPK	535	960	0.63	F	MAT	4	0.480
19	GN-13	30-Aug-18	NRPK	472	750	0.71	F	MAT	6	0.138
20	GN-13	30-Aug-18	NRPK	446	610	0.69	F	IMM	4	0.137
30	GN-13	30-Aug-18	NRPK	701	2660	0.77	M	MAT	6	0.750

Table A3-3: Muscle mercury concentrations (Hg) and biological data for Lake Whitefish, Northern Pike, and Walleye from Stephens Lake in 2018 (continued).

Fish #	Site	Sampling Date	Species	Fork Length (mm)	Weight (g)	K	Sex	Maturity	Age (y)	Hg (ppm)
55	GN-14	30-Aug-18	NRPK	492	780	0.65	M	MAT	4	0.152
58	GN-14	30-Aug-18	NRPK	484	1470	1.30	M	MAT	4	0.317
60	GN-14	30-Aug-18	NRPK	553	1030	0.61	M	MAT	4	0.297
61	GN-14	30-Aug-18	NRPK	436	610	0.74	M	MAT	3	0.148
1	GN-15	30-Aug-18	NRPK	301	173	0.63	M	IMM	2	0.190
71	GN-16	31-Aug-18	NRPK	404	410	0.62	F	IMM	3	0.122
72	GN-16	31-Aug-18	NRPK	477	700	0.64	M	MAT	5	0.198
74	GN-16	31-Aug-18	NRPK	416	470	0.65	F	MAT	4	0.176
79	GN-16	31-Aug-18	NRPK	681	2260	0.72	F	MAT	7	0.415
99	GN-17	31-Aug-18	NRPK	585	1080	0.54	F	MAT	4	0.264
100	GN-17	31-Aug-18	NRPK	411	500	0.72	M	MAT	4	0.138
101	GN-17	31-Aug-18	NRPK	346	280	0.68	M	IMM	3	0.152
108	GN-17	31-Aug-18	NRPK	618	1600	0.68	F	MAT	5	0.470
109	GN-17	31-Aug-18	NRPK	571	1160	0.62	F	MAT	5	0.658
111	GN-17	31-Aug-18	NRPK	414	500	0.70	F	IMM	3	0.136
112	GN-17	31-Aug-18	NRPK	521	830	0.59	M	IMM	4	0.347
123	GN-17	31-Aug-18	NRPK	636	1650	0.64	F	MAT	5	0.458
146	GN-22	31-Aug-18	NRPK	474	700	0.66	F	MAT	4	0.283
172	GN-30	01-Sep-18	NRPK	645	2080	0.78	F	MAT	8	0.499
173	GN-33	01-Sep-18	NRPK	871	4020	0.61	M	MAT	10	1.45
177	GN-33	01-Sep-18	NRPK	571	1200	0.64	F	MAT	7	0.283
182	GN-33	01-Sep-18	NRPK	511	820	0.61	F	MAT	6	0.242
185	GN-33	01-Sep-18	NRPK	791	4460	0.90	F	MAT	7	0.875
189	GN-33	01-Sep-18	NRPK	231	80	0.65	F	IMM	-	0.147
427	GN-35	04-Sep-18	WALL	553	2210	1.31	F	MAT	15	0.736

Table A3-3: Muscle mercury concentrations (Hg) and biological data for Lake Whitefish, Northern Pike, and Walleye from Stephens Lake in 2018 (continued).

Fish #	Site	Sampling Date	Species	Fork Length (mm)	Weight (g)	K	Sex	Maturity	Age (y)	Hg (ppm)
9	GN-13	30-Aug-18	WALL	158	41	1.04	F	IMM	1	0.0933
12	GN-13	30-Aug-18	WALL	355	530	1.18	M	MAT	4	0.162
13	GN-13	30-Aug-18	WALL	295	300	1.17	F	IMM	5	0.276
21	GN-13	30-Aug-18	WALL	316	380	1.20	F	IMM	4	0.152
22	GN-13	30-Aug-18	WALL	394	680	1.11	F	MAT	5	0.213
23	GN-13	30-Aug-18	WALL	331	360	0.99	F	IMM	5	0.212
24	GN-13	30-Aug-18	WALL	404	920	1.40	F	MAT	7	0.324
31	GN-13	30-Aug-18	WALL	516	1230	0.90	F	MAT	18	1.07
34	GN-13	30-Aug-18	WALL	481	1120	1.01	F	MAT	14	0.737
35	GN-13	30-Aug-18	WALL	494	1490	1.24	F	MAT	9	0.417
62	GN-14	30-Aug-18	WALL	228	115	0.97	M	IMM	2	0.156
3	GN-15	30-Aug-18	WALL	281	250	1.13	F	IMM	6	0.534
73	GN-16	31-Aug-18	WALL	454	1040	1.11	F	MAT	8	0.282
75	GN-16	31-Aug-18	WALL	317	310	0.97	M	IMM	5	0.198
86	GN-16	31-Aug-18	WALL	611	2700	1.18	F	MAT	21	1.16
91	GN-16	31-Aug-18	WALL	531	1700	1.14	M	MAT	14	0.641
166	GN-16	31-Aug-18	WALL	446	880	0.99	F	MAT	8	0.443
167	GN-16	31-Aug-18	WALL	418	620	0.85	M	MAT	7	0.448
93	GN-17	31-Aug-18	WALL	254	168	1.03	M	IMM	3	0.176
96	GN-17	31-Aug-18	WALL	451	1050	1.14	M	MAT	14	0.764
97	GN-17	31-Aug-18	WALL	671	2280	0.75	F	MAT	21	1.14
102	GN-17	31-Aug-18	WALL	285	251	1.08	M	IMM	4	0.132
103	GN-17	31-Aug-18	WALL	323	360	1.07	F	IMM	5	0.201
104	GN-17	31-Aug-18	WALL	219	120	1.14	F	IMM	3	0.152
105	GN-17	31-Aug-18	WALL	292	300	1.20	F	IMM	-	0.162

Table A3-3: Muscle mercury concentrations (Hg) and biological data for Lake Whitefish, Northern Pike, and Walleye from Stephens Lake in 2018 (continued).

Fish #	Site	Sampling Date	Species	Fork Length (mm)	Weight (g)	K	Sex	Maturity	Age (y)	Hg (ppm)
114	GN-17	31-Aug-18	WALL	466	900	0.89	M	MAT	10	0.623
116	GN-17	31-Aug-18	WALL	431	880	1.10	M	MAT	9	0.458
117	GN-17	31-Aug-18	WALL	396	730	1.18	M	MAT	6	0.262
124	GN-17	31-Aug-18	WALL	502	1380	1.09	F	MAT	12	0.604
141	GN-22	31-Aug-18	WALL	373	620	1.19	M	MAT	6	0.239
142	GN-22	31-Aug-18	WALL	366	500	1.02	F	IMM	6	0.222
178	GN-33	01-Sep-18	WALL	501	1520	1.21	M	MAT	14	0.528
67	SN-14	30-Aug-18	WALL	441	980	1.14	M	MAT	10	0.639
68	SN-14	30-Aug-18	WALL	536	1300	0.84	M	MAT	14	1.06
69	SN-14	30-Aug-18	WALL	427	830	1.07	F	MAT	11	0.481

APPENDIX 4:
SIZE AND AGE OF FISH SAMPLED FOR MERCURY 1999–2019

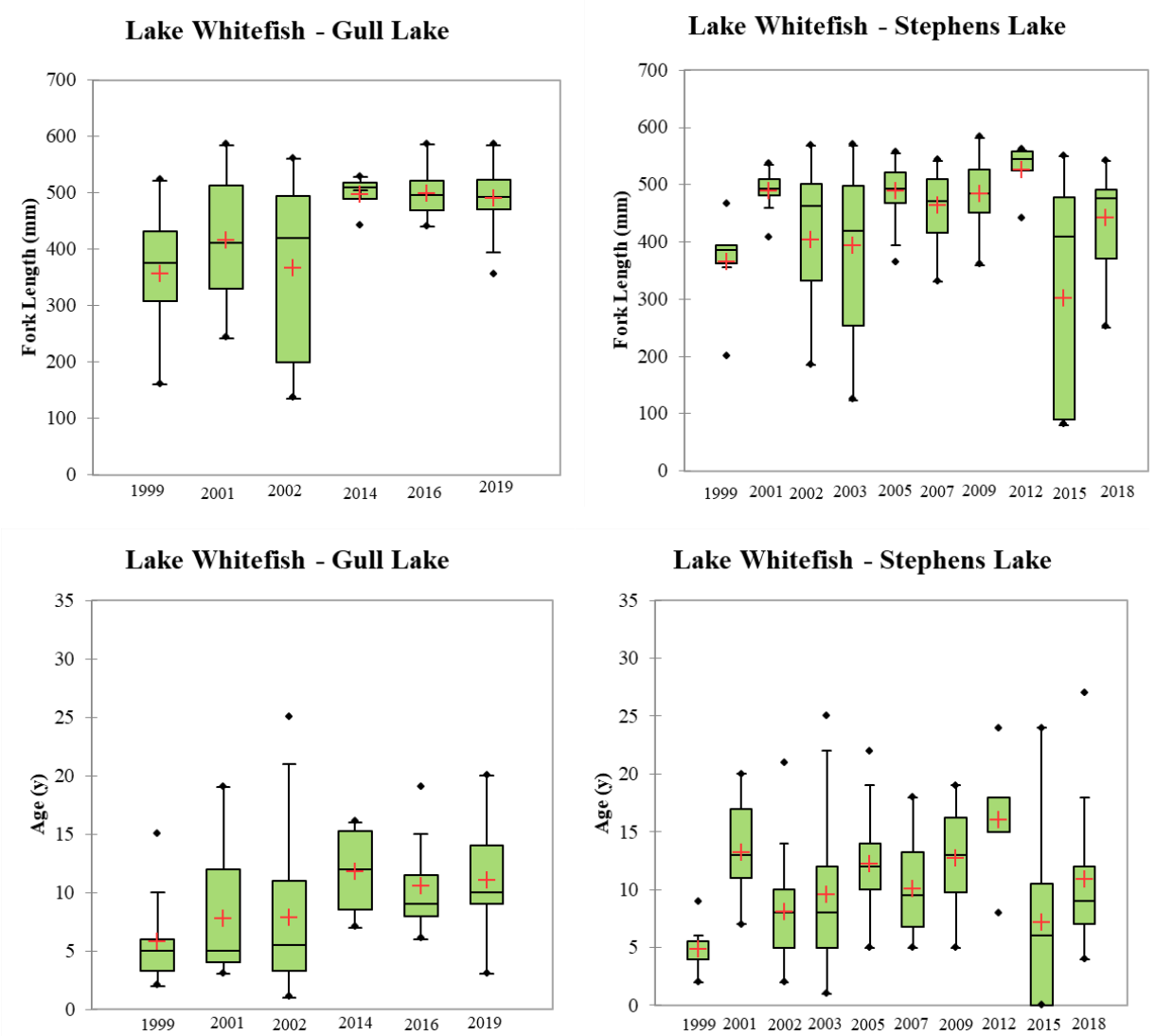


Figure A4-1: Box plots of fork length (top) and age (bottom) of Lake Whitefish captured from Gull Lake and Stephens Lake from 1999–2019.

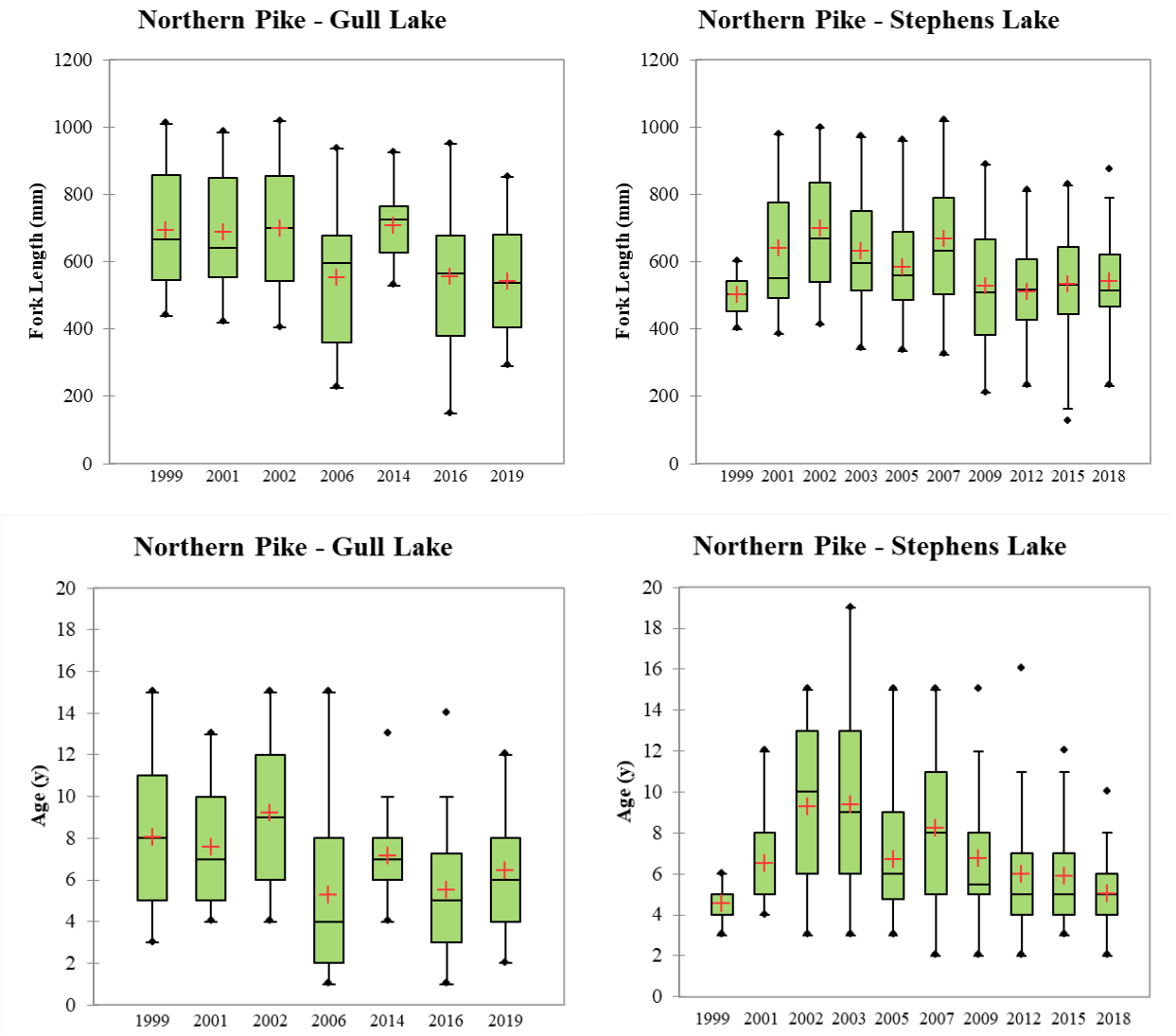


Figure A4-2: Box plots of fork length (top) and age (bottom) of Northern Pike captured from Gull Lake and Stephens Lake from 1999–2019.

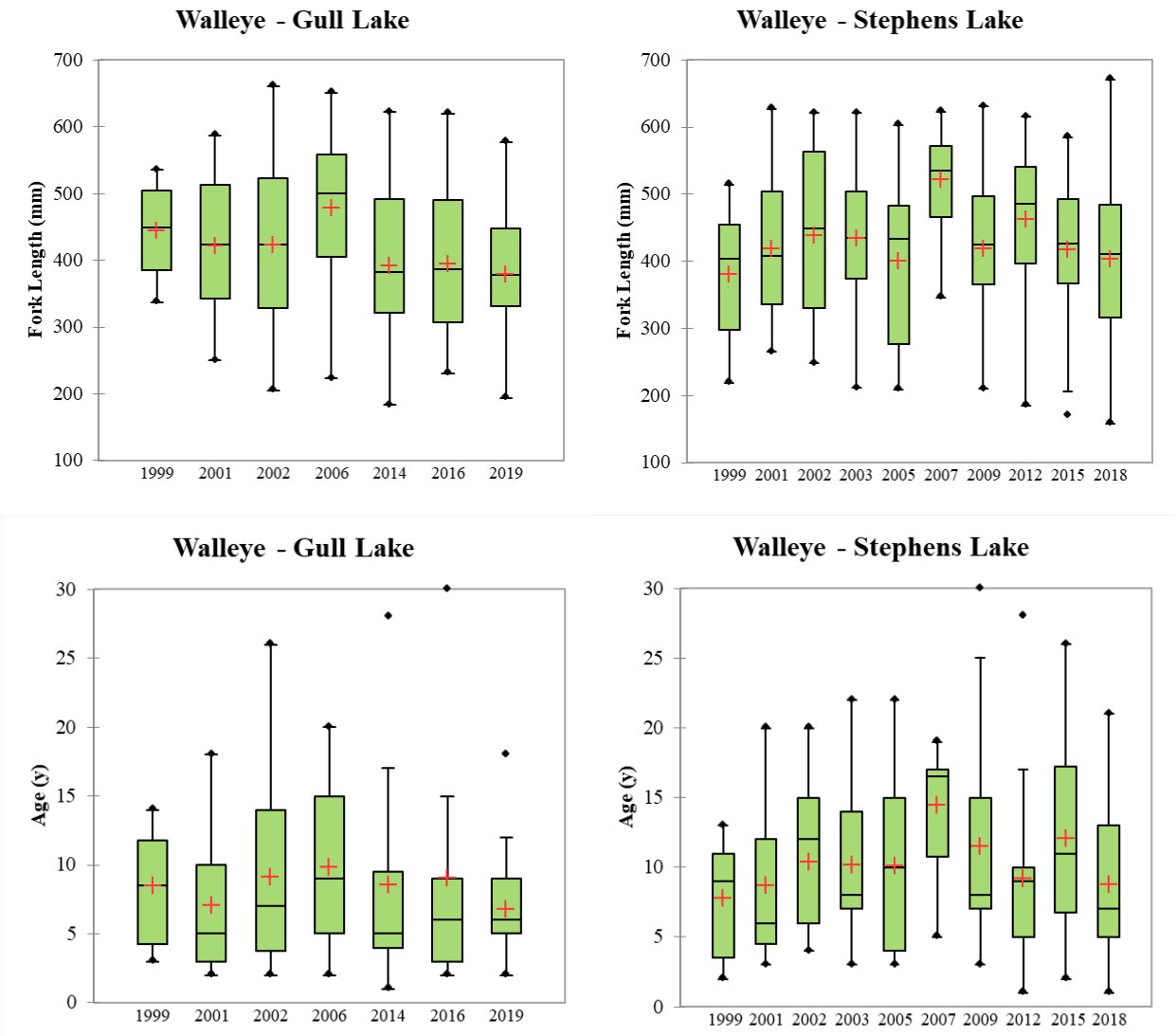


Figure A4-3: Box plots of fork length (top) and age (bottom) of Walleye captured from Gull Lake and Stephens Lake from 1999–2019.

APPENDIX 5:
RESULTS OF LINEAR REGRESSION ANALYSIS

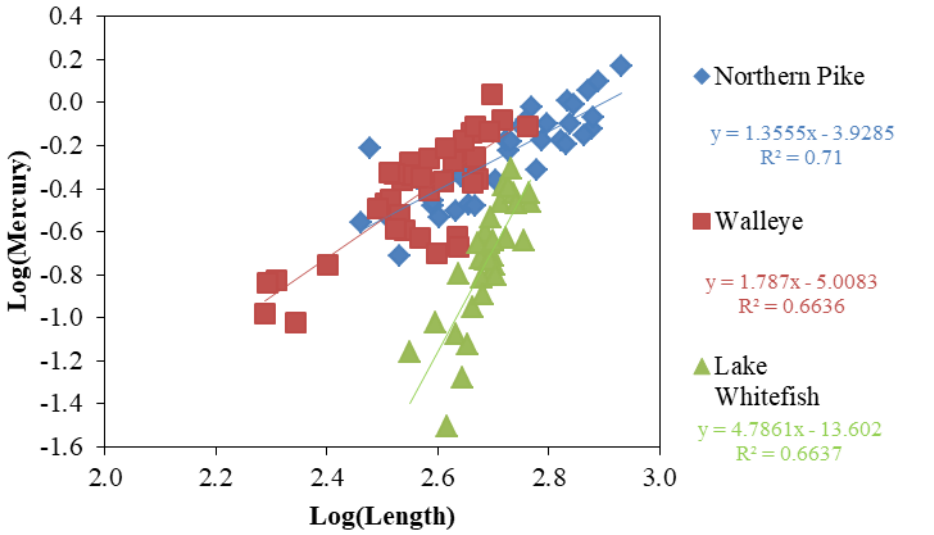


Figure A5-1: Plot of Log_{10} fork length (mm) and Log_{10} total mercury (ppm) in Northern Pike Walleye, and Lake Whitefish captured from Gull Lake in 2019.

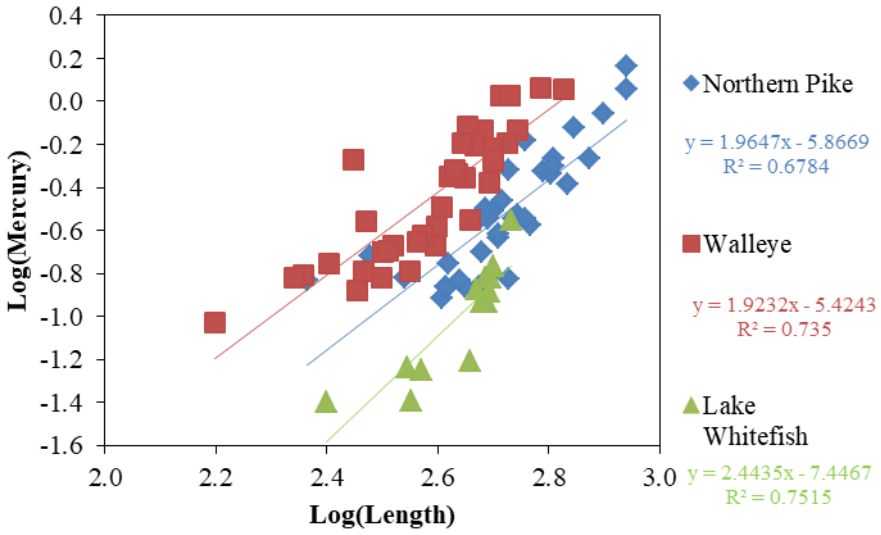


Figure A5-2: Plot of Log_{10} fork length (mm) and Log_{10} total mercury (ppm) in Northern Pike Walleye, and Lake Whitefish captured from Stephens Lake in 2018.