



Keeyask Generation Project  
Aquatic Effects Monitoring Plan

Fish Winterkill Survey in Little Gull Lake Report

AEMP-2024-06



# KEYYASK GENERATION PROJECT

## AQUATIC EFFECTS MONITORING PLAN

REPORT #AEMP-2024-06

### FISH WINTERKILL SURVEY IN LITTLE GULL LAKE: YEAR 3 MONITORING

Prepared for

Manitoba Hydro

By

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June 2024



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# SUMMARY

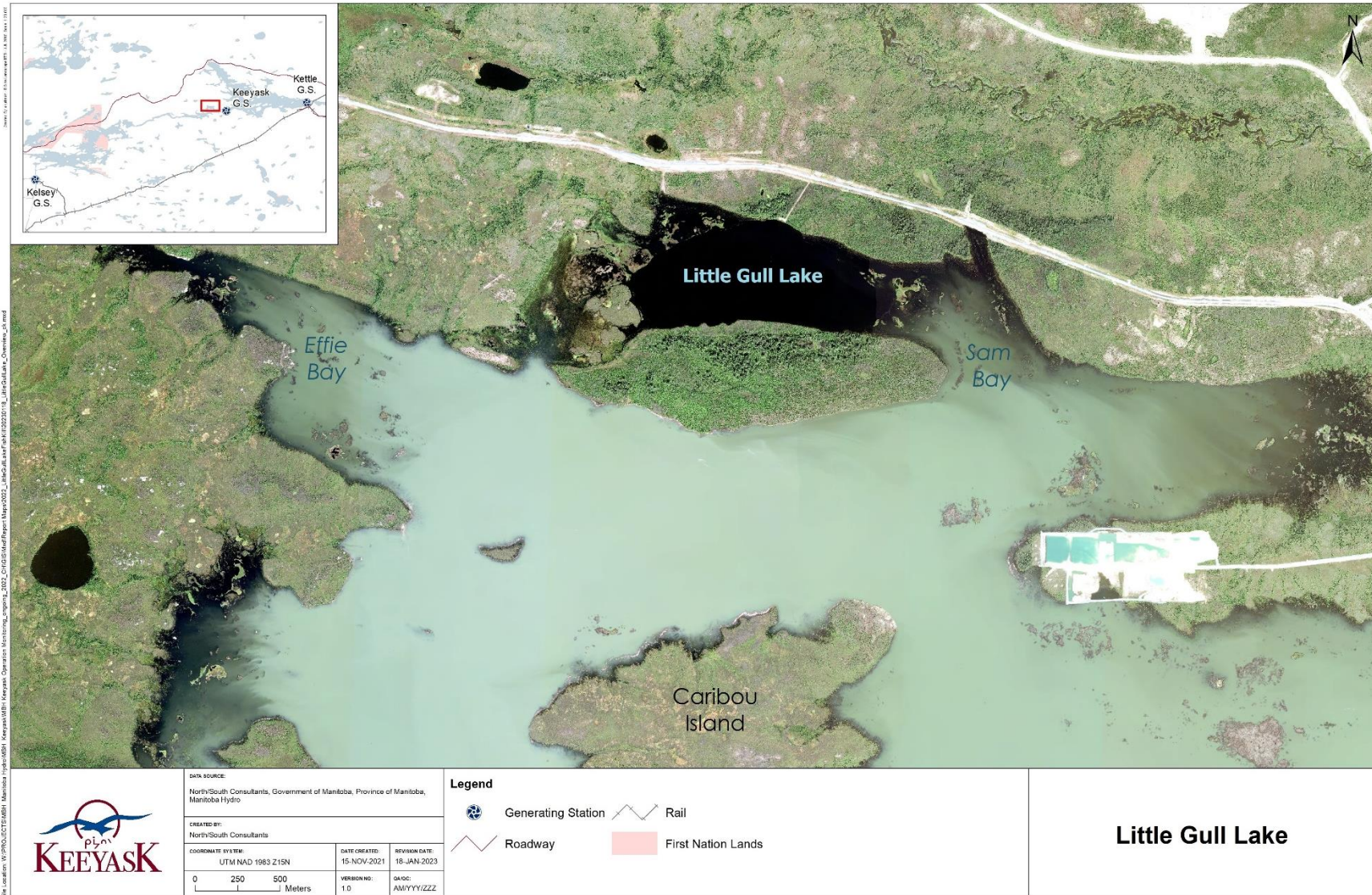
## Background

The Keeyask Hydropower Limited Partnership (KHLP) was required to prepare a plan to monitor the effects of construction and operation of the Keeyask Generating Station (GS) on the environment. Monitoring results provide information to assess the accuracy of predictions, information to determine the actual effects of construction and operation of the GS on the environment, and whether more needs to be done to reduce harmful effects.

Construction of the Keeyask GS began in mid-July 2014 and instream work was completed in 2020. The reservoir was impounded, and water levels were raised to full supply level between August 31 and September 5, 2020. Commissioning of the powerhouse turbines was initiated after impoundment. They were brought into service one at a time with the final of seven turbines completed on March 9, 2022.

Little Gull Lake was a small, shallow, isolated lake immediately to the north of Gull Lake. Before formation of the Keeyask reservoir, oxygen levels in Little Gull Lake dropped to critically low levels each winter and the only fish present were brook stickleback and fathead minnow, which can tolerate low concentrations of oxygen. After flooding of the Keeyask reservoir, Little Gull Lake became connected to the reservoir, but low oxygen levels were expected to continue to develop during winter because of its organic bottom and a lack of through flow from the rest of the reservoir. Fish can now enter from other parts of the Keeyask reservoir and during winter the connecting channels could freeze to the bottom, potentially trapping fish and resulting in a winterkill. To keep dissolved oxygen in the water at concentrations where fish could survive, an aeration system was installed prior to impoundment of the Keeyask reservoir.

This report presents results of a survey of Little Gull Lake following the third winter post-impoundment to determine if there was a fish kill in the area.



Location of Little Gull Lake in the Keyyask reservoir.

**Why is the study being done?**

The survey of Little Gull Lake was done to answer the following question:

*Is the aeration system installed in Little Gull Lake effective in preventing winterkill in this portion of the reservoir?*

This question is important because if the aeration system does not work, any fish trapped in Little Gull Lake during the winter may die due to a lack of oxygen. If this happened, an alternative method would be used to prevent the death of fish.

**What was done?**

A visual survey was conducted on May 20 by walking along shorelines and boating throughout the Lake to look for dead fish. A single gill net was also set overnight to determine if fish are present in Little Gull Lake in the spring.

**What was found?**

No dead fish were observed in Little Gull Lake in spring 2023.

A total of 46 fish were captured in the gill net. Most (43) of the fish caught were jackfish (Northern Pike), but single tullibee (Cisco), Shorthead Redhorse, and Yellow Perch were also captured. Twenty of the jackfish were in spawning condition including 14 females and 6 males. Both the Shorthead Redhorse and Yellow Perch were also pre-spawn males. The net was set after ice-off between Little Gull Lake and the Nelson River mainstem, so it is not clear if these fish were in Little Gull Lake over the winter or if they moved in during spring before the survey.

Dissolved oxygen (DO) was measured in Little Gull Lake by Manitoba Hydro during winter 2022/2023. Dissolved oxygen levels dropped over the fall and measured 0 mg/L (no oxygen) between January and May 2023. Ice formed over top of the area where the logger was installed. This was also observed during winter 2021/2022.





Image showing, bubbler head layout (blue circles), representative ice conditions, and approximate location of DO logger installation (red star). Image is from March 2022 looking north.

### What does it mean?

This means that a fish kill did not occur during winter 2022/2023 in Little Gull Lake.

Fish surveys show that fish use Little Gull Lake during the spring and summer for spawning and foraging. During summer 2021 and 2022 a net was set in Little Gull Lake during the fish community survey. Thirty-one jackfish were caught in 2021 and 24 Cisco, 46 jackfish, and one White Sucker were caught in 2022. Like the fish caught in spring 2023, it is not known if these fish remain in Little Gull Lake year-round or if they move out before winter.

Based on the results of DO monitoring between 2021 and 2023, it appears that the aeration system is not able to increase DO levels within little Gull Lake during the winter. However, fish kills have not happened in any of the winters since the reservoir was flooded. It is possible that the area between Little Gull Lake and the main part of the Keeyask reservoir does not freeze to the bottom during winter and fish are able to escape or that fish leave the lake before the onset of winter.

### What will be done next?

Sampling in 2023 represents the third and final year that fish winterkill surveys will be conducted in Little Gull Lake. No evidence of fish mortality has been observed over three years of monitoring.

# ACKNOWLEDGEMENTS

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

Grant Connell of Tataskweyak Cree Nation (TCN) is thanked for his local expertise and assistance in conducting the field work. We would also like to thank Douglas Kitchkeesik and Gordon Cook of TCN and Ray Mayham of Fox Lake Cree Nation for arranging logistic support and personnel needed to conduct the fieldwork.

The collection of biological samples described in this report was authorized by Manitoba Natural Resources and Northern Development, Fish and Wildlife Branch, under terms of the Scientific Collection Permit #57172605 (SCP 19-2023).



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# TABLE OF CONTENTS

1.0	INTRODUCTION .....	1
2.0	STUDY SETTING.....	3
3.0	METHODS.....	5
4.0	RESULTS AND DISCUSSION.....	6
5.0	CONCLUSIONS .....	13
6.0	LITERATURE CITED .....	14



# LIST OF TABLES

Table 1: Number and fork length (mm) of fish captured in a single gill net set in Little Gull Lake from May 20–21, 2023. .... 10

Table 2: Sex and maturity data for fish captured in a single gill net set in Little Gull Lake from May 20–21, 2023. .... 11



# LIST OF PHOTOS

Photo 1: Little Gull Lake on May 20, 2023, from the north shore facing east, showing no ice cover over its entire extent.....6

Photo 2: Little Gull Lake on May 20, 2023, from the north shore facing south. ....8

Photo 3: Little Gull Lake on May 20, 2023, from the eastern edge of the lake facing west. ....8

Photo 4: Little Gull Lake at the southeast corner showing the connection to the Nelson River, May 20, 2023.....9

Photo 5: Open water surrounding aerator and dissolved oxygen monitoring station, May 20, 2023. ....9

Photo 6: Little Gull Lake on May 20, 2023, on the south shore facing north, showing gill net set in open water. .... 10

Photo 7: Northern Pike captured in Little Gull Lake, May 21, 2023..... 11

# LIST OF MAPS

Map 1:	Map of the Keeyask reservoir showing the location of Little Gull Lake .....	4
Map 2:	Location of the gill net set in Little Gull Lake on May 20, 2023. ....	7

# LIST OF APPENDICES

Appendix 1: Biological and tag information for fish captured in Little Gull lake, spring 2023.....15



# 1.0 INTRODUCTION

The Keeyask Generation Project (the Project) is a 695-megawatt (MW) hydroelectric generating station (GS) at Gull Rapids on the lower Nelson River 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. 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 for the construction and operation phases of the Project.

Little Gull Lake was a small, shallow waterbody to the north of Gull Lake that was anticipated to winterkill in most years. A fish inventory of Little Gull Lake was conducted using seine nets in summer 2002 (Richardson and Holm 2005) and 2015 (Lavergne *et al.* 2016). Results indicated that the fish community consisted of two forage species, Fathead Minnow (*Pimephales promelas*) and Brook Stickleback (*Culaea inconstans*), species that are generally adapted to low dissolved oxygen (DO) conditions.

The EIS predicted that flooding associated with impoundment of the Keeyask reservoir would inundate Little Gull Lake, and that low oxygen levels may develop in this area during ice covered periods due to existing high concentrations of organic material in sediments, a lack of flow, long periods of ice cover, and long water residence times. Although low oxygen conditions were predicted to be characteristic of many areas of the reservoir during winter, this area is of particular concern due to predictions that shallow sections of flooded land on either end of Little Gull Lake will freeze to the bottom and potentially prevent fish from escaping when DO reaches critically low levels in winter, resulting in fish winterkill. To maintain sufficient DO to support fish, an aeration system was installed prior to impoundment of the Keeyask reservoir.

DO was monitored throughout winter 2020/2021 by Manitoba Hydro, using both discrete measurements and continuous monitoring (Manitoba Hydro 2022). Discrete DO readings were collected monthly along transects approximately 5–10 m outside of the aeration field, at the limit of safe ice. Two HOBO DO loggers were deployed approximately 10 m outside of the aeration field for continuous monitoring. Data collected from the HOBO loggers were not useable as deployment methods meant that the loggers were positioned within the sediment and the moorings were damaged by ice. The system was also monitored via visual inspection of the aeration area (UAV photography). Continuous DO monitoring continued during winter 2021/2022

and 2022/2023 (Manitoba Hydro 2023, 2024). In both years, two HOBO DO loggers were deployed within the aeration field between the internal and external ring of aeration heads. Results suggest that the aeration system does not significantly raise DO levels within Little Gull Lake as currently designed and operated.

The perimeter of Little Gull Lake was surveyed immediately following ice-off in spring 2021 and 2022. No fish mortalities were observed. In spring 2023, air temperatures rose quickly, and Little Gull Lake became largely ice-free within a short timeframe (approximately three days). Therefore, the perimeter of the lake was surveyed three days after ice-off.

Fish winterkill monitoring in the vicinity of Little Gull Lake is being conducted to address the following key question, as described in the AEMP:

- Is the aeration system installed in Little Gull Lake effective in preventing winterkill in this portion of the reservoir?

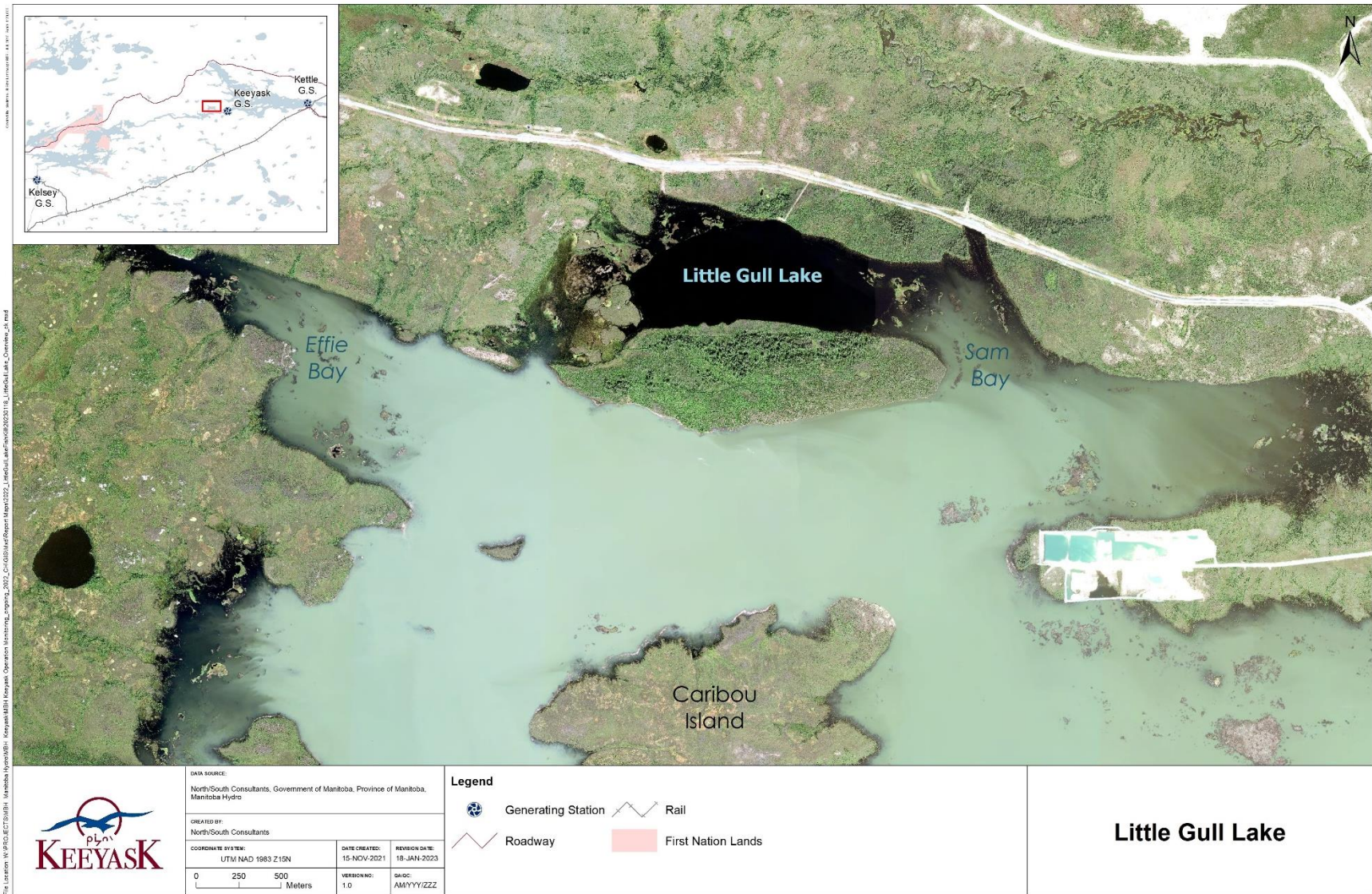
Surveys conducted in 2023 represent the third and final year of potential fish kill monitoring in Little Gull Lake. This report presents 2023 monitoring results.

## 2.0 STUDY SETTING

Prior to impoundment of the Keeyask reservoir in fall 2020, Little Gull Lake was a shallow, 68 ha isolated lake approximately 900 m north of the Nelson River in Gull Lake ([Map 1](#)). Submerged vegetation was abundant, and the substrate consisted mainly of fines with organic material. Little Gull Lake was fed by bogs and fens and drains into the Nelson River by way of a short, unnamed creek.

In fall 2020, Gull Lake was impounded by the Keeyask GS and became part of the Keeyask reservoir. The Keeyask reservoir is comprised of the mainstem of the original Nelson River from the outlet of Clark Lake as far as the Keeyask GS, plus 45 km<sup>2</sup> of adjacent, flooded terrestrial area. Reservoir impoundment formed relatively shallow bays due to flooding of terrestrial areas, which generally have low water velocities and limited mixing with the mainstem flow. Reservoir impoundment resulted in the connection of Little Gull Lake to the Keeyask reservoir, via flooded terrestrial habitat.





**Map 1: Map of the Keeyask reservoir showing the location of Little Gull Lake**

### 3.0 METHODS

On May 20, 2023, visual surveys were conducted by walking along shorelines and boating throughout the lake. A single gill net was set to determine whether fish may overwinter in Little Gull Lake. The gill net was composed of five panels of 2, 3, 3 ¾, 4 ¼, and 5" twisted nylon stretched mesh (51, 76, 95, 108, and 127 mm). Each panel was 25 yards (yd) (22.9 m) long and 2.7 yd (2.5 m) deep. The location of the gill net was recorded using a Garmin Marine GPS navigator (Garmin International Inc., Olathe, Kansas). Water depth at each end of the net was measured using a Hawkeye Depthtrax 1H handheld depth finder. The gill net was set for approximately 24 hours. Each captured fish was identified to species, enumerated, measured for fork length (FL; ±1 mm), and weighed (±5 g using a digital scale, or nearest 25 g for fish greater than 4,000 g). Sex and maturity were determined for individual fish by applying pressure to the ventral surface of the fish to express gametes. If no gametes were expressed, sex and maturity codes were not assigned. The following codes were used:

#### Female (F)

2 – maturing to spawn (pre-spawn)

3 – ripe (spawning)

4 – spent (post-spawn)

#### Male (M)

7 – maturing to spawn (pre-spawn)

8 – ripe (spawning)

9 – spent (post-spawn)

All captured Lake Whitefish, Northern Pike, and Walleye in good condition were marked with an individually numbered external Floy FD-94 T-bar anchor tag (Floy tag & Mfg. Inc., Seattle, Washington).

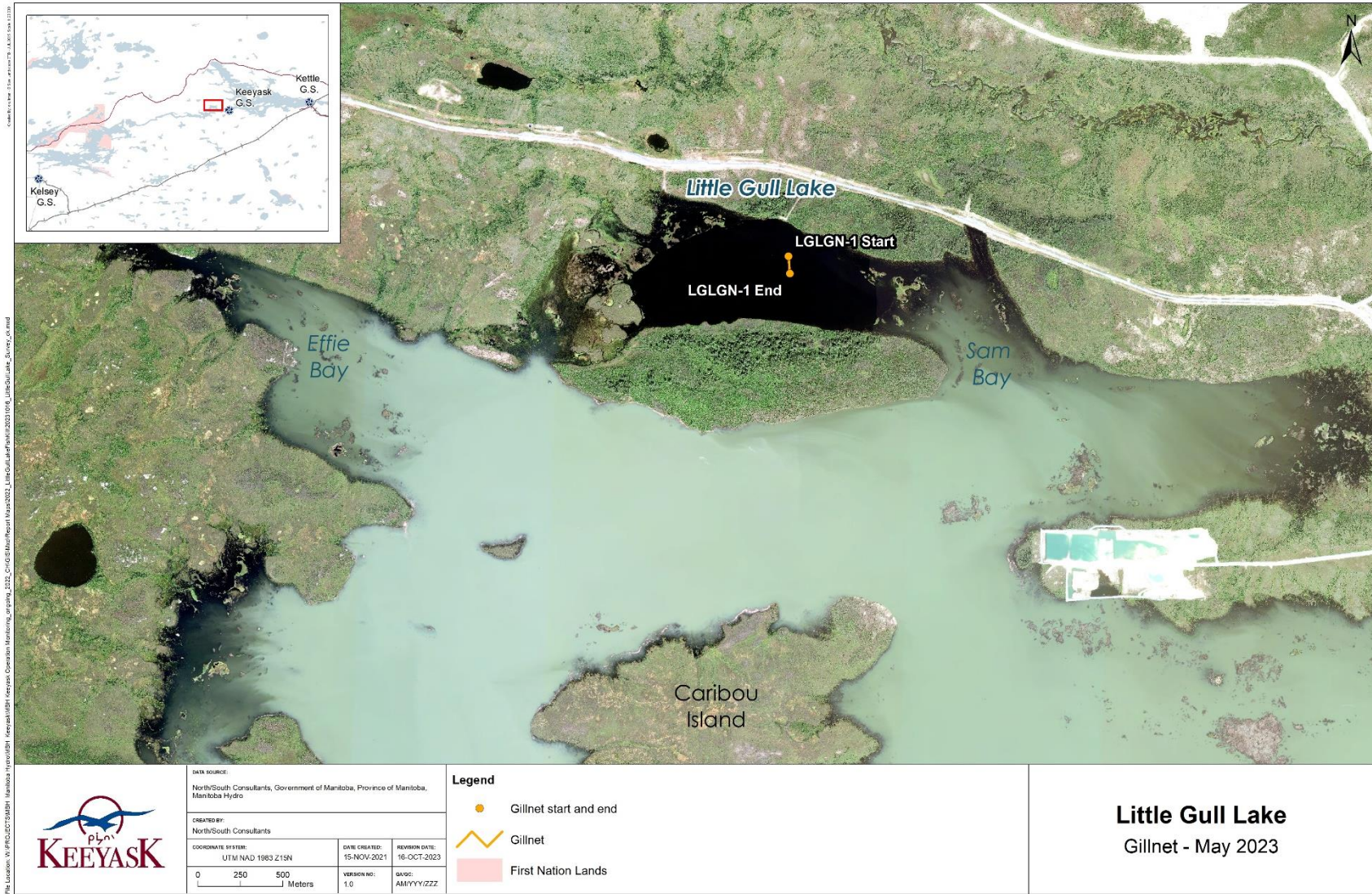
## 4.0 RESULTS AND DISCUSSION

On May 20, 2023, Little Gull Lake was largely ice-free over its entire extent. To search for fish mortalities, a survey was conducted by walking along the north shore of the lake (Photos [1](#), [2](#), and [3](#)), and an aluminum Jon boat was driven around the perimeter ([Map 2](#); Photos [4](#) and [5](#)). No fish mortalities were observed during either survey. Based on survey results, it does not appear that a fish kill occurred in Little Gull Lake during winter 2022/2023.



**Photo 1:** Little Gull Lake on May 20, 2023, from the north shore facing east, showing no ice cover over its entire extent.





**Map 2: Location of the gill net set in Little Gull Lake on May 20, 2023.**



**Photo 2: Little Gull Lake on May 20, 2023, from the north shore facing south.**



**Photo 3: Little Gull Lake on May 20, 2023, from the eastern edge of the lake facing west.**





**Photo 4: Little Gull Lake at the southeast corner showing the connection to the Nelson River, May 20, 2023.**



**Photo 5: Open water surrounding aerator and dissolved oxygen monitoring station, May 20, 2023.**



A single gill net was set in Little Gull Lake on May 20, 2023, for 23.7 hours ([Photo 6](#)). In total, 46 fish were captured representing four species including Cisco, Northern Pike, Shorthead Redhorse, and Yellow Perch ([Table 1](#); [Table A1-1](#)). Northern Pike made up the majority (93%) of the catch ([Photo 7](#)).



**Photo 6:** Little Gull Lake on May 20, 2023, on the south shore facing north, showing gill net set in open water.

**Table 1:** Number and fork length (mm) of fish captured in a single gill net set in Little Gull Lake from May 20–21, 2023.

Species	Scientific Name	n	Fork Length (mm)		
			Average	Min	Max
Cisco	<i>Coregonus artedi</i>	1	177	-	-
Northern Pike	<i>Esox lucius</i>	43	530	305	695
Shorthead Redhorse	<i>Maxostoma macrolepidotum</i>	1	460	-	-
Yellow Perch	<i>Perca flavescens</i>	1	166	-	-



**Photo 7: Northern Pike captured in Little Gull Lake, May 21, 2023.**

Sex and maturity were determined for 22 of the 46 captured fish ([Table 2](#)). Both the single Shorthead Redhorse and Yellow Perch captured were pre-spawn males. Sex and maturity were determined for 20 Northern Pike, including five pre-spawn females, nine ripe females, three pre-spawn males, and three ripe males. This indicates that Northern Pike spawn in Little Gull Lake. Although only single Shorthead Redhorse and Yellow Perch males preparing to spawn were captured, it is likely that both species also spawn in this area.

**Table 2: Sex and maturity data for fish captured in a single gill net set in Little Gull Lake from May 20–21, 2023.**

Species	Sex and Maturity						# of Spawners	Unknown Maturity
	Female			Male				
	2	3	4	7	8	9		
Cisco	-	-	-	-	-	-	0	1
Northern Pike	5	9	-	3	3	-	20	23
Shorthead Redhorse	-	-	-	1	-	-	1	0
Yellow Perch	-	-	-	1	-	-	1	0

By the time the gill net was set in 2023, the connection between Little Gull Lake and the mainstem of the Nelson River was largely ice-free and passable to fish. Previously, gill nets had been set within Little Gull Lake in August 2021 and 2022. A total of 31 Northern Pike were captured in 2021 (Loeppky and Hrenchuk 2022). In 2022, three species were captured including 24 Cisco, 46 Northern Pike, and one White Sucker (Slongo and Hrenchuk 2023). It is not clear

whether fish captured in Little Gull Lake are resident year-round, whether fish are able to move freely between Little Gull Lake and the mainstem during winter, or whether the fish moved into Gull Lake after it became ice-free.

Monitoring of over-winter DO within Little Gull Lake has been conducted by Manitoba Hydro since reservoir impoundment in September 2020. Monitoring of DO within Little Gull Lake during winter 2020/2021 suggested that the system was elevating DO above background levels, however, increases to DO were limited outside of the immediate area of the aeration field (Manitoba Hydro 2022). DO levels were lower in both winter 2021/2022 and 2022/2023, dropping over the fall and measuring 0 mg/L by January (Manitoba Hydro 2023, 2024). Stable ice cover formed over the area where the loggers were installed in both 2021/2022 and 2022/2023. After three years of monitoring, it is clear that the aeration system does not significantly raise DO levels within Little Gull Lake as currently designed and operated. Despite this, there has been no evidence of a winter fish kill in any of the three sampling years following reservoir impoundment.

## 5.0 CONCLUSIONS

Sampling conducted in 2023 represents the third and final year that fish winterkill surveys were conducted in Little Gull Lake. No evidence of fish mortality has been observed over three years of monitoring (*i.e.*, following winter 2020/2021, 2021/2022, or 2022/2023). Capture data suggest that several species of fish use Little Gull Lake during open water for spawning and foraging, however, it remains unclear whether fish leave before winter. After three years of monitoring, it is clear that the aeration system does not significantly raise DO levels within Little Gull Lake as currently designed and operated. As there has been no evidence of fish mortality, it is likely that either Little Gull Lake maintains sufficient connectivity with the Nelson River mainstem to allow fish to move between the two areas year-round or that fish leave Little Gull Lake before winter. Despite the uncertainties, there is no evidence to suggest that a fish winterkill has occurred in Little Gull Lake in any year following reservoir impoundment in fall 2020.

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# **APPENDIX 1: BIOLOGICAL AND TAG INFORMATION FOR FISH CAPTURED IN LITTLE GULL LAKE, SPRING 2023.**

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Table A1-1: Biological and tagging information for fish captured in Little Gull Lake, spring 2023..... 16



**Table A1-1: Biological and tagging information for fish captured in Little Gull Lake, spring 2023.**

Location	Site	Date	Species	Floy Tag Prefix	Floy tag	Fork Length (mm)	Weight (g)	Sex	Maturity
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	122368	592	1600	F	3
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	122367	673	2100	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	122366	615	1875	F	2
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	122365	666	2400	F	3
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	122364	680	2650	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	122363	625	2000	F	2
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	122362	695	2900	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	122361	535	1175	M	8
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	122360	503	1050	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	122359	620	1800	F	2
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	122358	576	1650	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	122357	613	1700	F	2
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	122356	551	1300	M	8
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	122355	521	1100	F	3
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	122354	488	1000	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	122353	600	1600	M	7
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	122352	425	600	M	7
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	122351	530	1125	M	7
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	123647	575	1300	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	123646	431	700	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	123645	428	550	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	122644	548	1300	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	-	-	450	675	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	-	-	564	1350	-	-

**Table A1-1: Biological and tagging information for fish captured in Little Gull Lake, spring 2023 (continued).**

Location	Site	Date	Species	Floy Tag Prefix	Floy tag	Fork Length (mm)	Weight (g)	Sex	Maturity
Little Gull Lake	LGLGN-1	21-May-23	NRPK	-	-	618	1900	F	3
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	123643	466	800	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	123642	455	650	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	123641	413	575	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	123640	408	625	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	123639	403	525	-	-
Little Gull Lake	LGLGN-1	21-May-23	CISC	-	-	177	100	-	-
Little Gull Lake	LGLGN-1	21-May-23	YLPR	-	-	166	25	M	7
Little Gull Lake	LGLGN-1	21-May-23	SHRD	-	-	460	1100	M	7
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	123638	410	550	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	123637	448	800	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	123636	415	550	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	123635	525	1175	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	123634	448	750	F	3
Little Gull Lake	LGLGN-1	21-May-23	NRPK	NSC	123633	470	750	M	8
Little Gull Lake	LGLGN-1	21-May-23	NRPK	-	-	485	850	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	-	-	305	200	-	-
Little Gull Lake	LGLGN-1	21-May-23	NRPK	-	-	651	2350	F	3
Little Gull Lake	LGLGN-1	21-May-23	NRPK	-	-	556	1300	F	3
Little Gull Lake	LGLGN-1	21-May-23	NRPK	-	-	642	2200	F	3
Little Gull Lake	LGLGN-1	21-May-23	NRPK	-	-	603	1700	F	3
Little Gull Lake	LGLGN-1	21-May-23	NRPK	-	-	559	1325	F	2