Keeyask Generation Project

Aquatic Effects Monitoring Plan

Fish Community Monitoring Report

AEMP-2023-07

ᑮᔮᐢᐠ
KEEYASK

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

2022 - 2023

KEEYASK GENERATION PROJECT

AQUATIC EFFECTS MONITORING PLAN

REPORT #AEMP-2023-07

FISH COMMUNITY MONITORING IN THE NELSON RIVER FROM SPLIT LAKE TO STEPHENS LAKE, SUMMER 2022

Prepared for

Manitoba Hydro

By

B. Slongo and C.L. Hrenchuk

June 2023

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:

Slongo, B. and C.L. Hrenchuk. 2023. Fish community monitoring in the Nelson River from Split Lake to Stephens Lake, summer 2022. Keeyask Generation Project Aquatic Effects Monitoring Report #AEMP-2023-07. A report prepared for Manitoba Hydro by North/South Consultants Inc., June 2023. xvii + 97 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 and instream work was completed in 2020. The reservoir was impounded with water levels being raised to full supply level between August 31 and September 5, 2020. Commissioning of the powerhouse turbines was initiated after impoundment. They were brought into service one at a time with the final of seven turbines completed on March 9, 2022.

The monitoring of fish communities (in terms of species composition and abundance) is an important component of the overall plan to monitor the impacts of construction and operation of the Keeyask GS on fish. Fish communities upstream of the Keeyask GS, which include several species that are important sources of food to local people, may be affected by operation of the Keeyask GS and through reservoir flooding. Changes in water levels and flow will result in the changes or loss of existing habitats and the creation of new habitats. These habitat changes will also result in changes to the production of aquatic plants, invertebrates, and forage fish. Results from fish community monitoring will be used to describe existing fish populations and provide a way to see potential changes that may be associated with the construction and operation of the Keeyask GS.

This report presents the results of fish community monitoring conducted in the reach of the Nelson River from Split Lake to the Kettle GS. Sites in Split Lake were sampled to record the fish community in an area not directly affected by creation of the Keeyask reservoir and operation of the GS, to record how the fish community can vary from year to year. Sites in what is now the Keeyask reservoir were sampled as this environment has changed following flooding. Finally, the fish community in Stephens Lake could be affected by the loss of Gull Rapids, which was a spawning site for many of the fish species in Stephens Lake. Fish community data were collected in 2009, 2015, 2019, 2021, and 2022 for Split Lake; 2001, 2002, 2009, 2015, 2019, 2021, and 2022 for the Keeyask reservoir; and 2009, 2015, 2018, 2021, and 2022 for Stephens Lake North and South.

Why is the study being done?

The monitoring of fish communities is being done to answer several questions:

Will the abundance (i.e., catch-per-unit-effort) and species composition of the fish communities in the Keeyask reservoir and Stephens Lake change as a result of construction and operation of the Project?

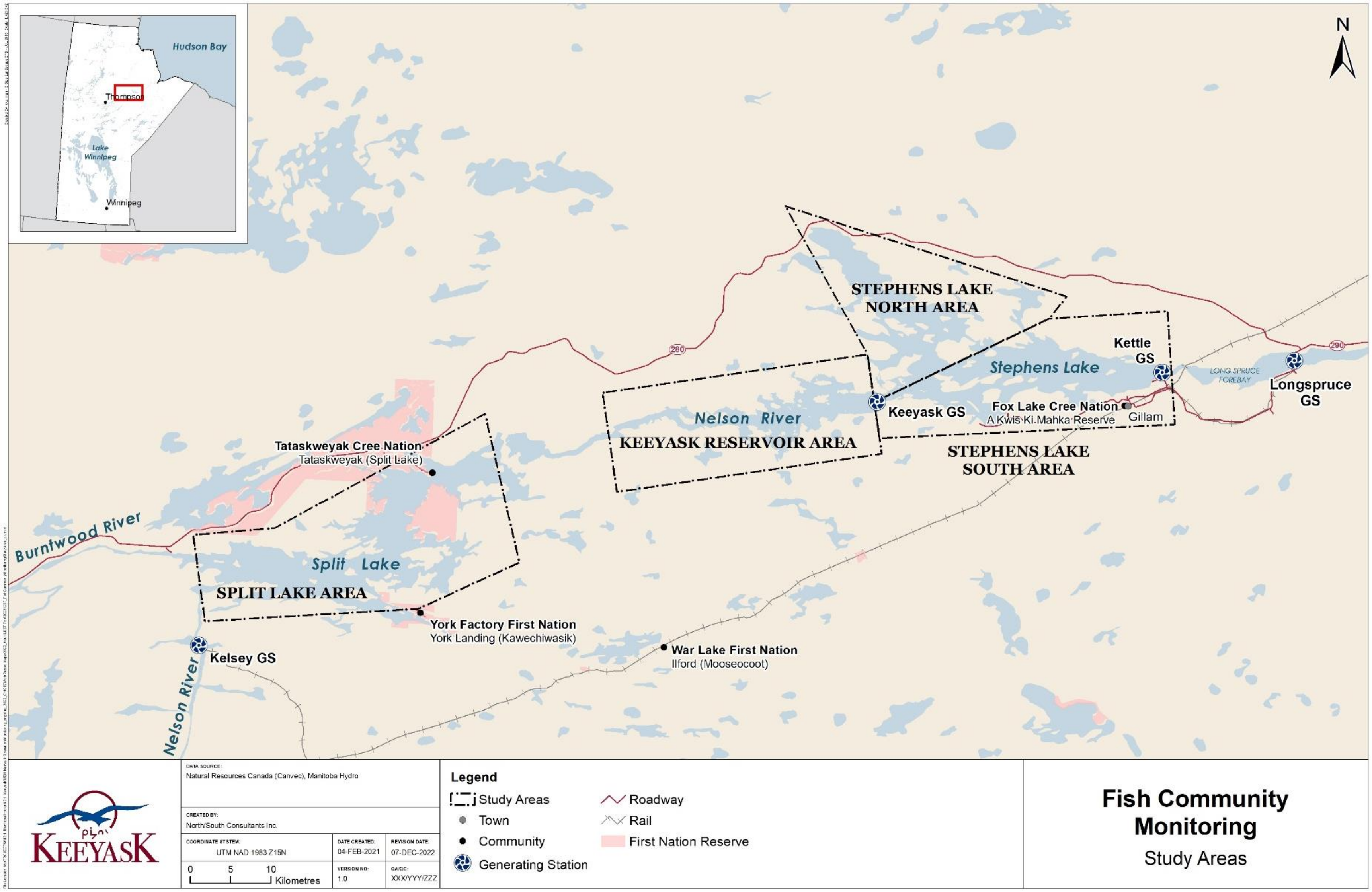
This question is important because habitat changes associated with the construction and operation of the Keeyask GS (for example, changes in water levels and flows) may result in changes in the abundance and species composition of resident fish communities. It is possible that certain fish species could move away from the newly created reservoir and be lost from the local populations, while other species could move into the reservoir and become more abundant.

Will there be a biologically meaningful change in condition factor or growth for Lake Whitefish, jackfish (Northern Pike), and pickerel (Walleye) in the Keeyask reservoir and/or Stephens Lake after the Keeyask GS is built?

This question is important because a change in body condition (if any of these species become fatter or skinnier than they used to be) might mean that something in their environment is changing.

Will the number of small-bodied fish (like minnows and the young of large fish) captured in small mesh index (SMI) gill nets set in the Keeyask reservoir and Stephens Lake change after the Keeyask GS is built?

This question is important because the small-bodied fish community is the major food source for many large fish species like jackfish and pickerel.



Map showing the four areas sampled during fish community monitoring: Split Lake, Keeyask reservoir, Stephens Lake North, and Stephens Lake South.

What was done?

Sampling was conducted in Split Lake, the Keeyask reservoir, and Stephens Lake (split into North and South parts for data analysis) in the summer of 2022 (see study area map). The same sites have been sampled off and on since 2001 and are called standard sites. Two types of gill nets were used: standard gang index (SGI) which catch large-bodied fish, and SMI which catch small-bodied fish (like minnows and the young of large fish). All fish captured in each waterbody were identified by species and counted. When a large-bodied fish was caught, it was measured and weighed. Ageing structures were taken from Lake Whitefish, jackfish, and pickerel. All Lake Sturgeon, Lake Whitefish, jackfish, pickerel, and White Sucker caught were checked for signs of any abnormal marks on the skin or growths. Data collected before Keeyask reservoir flooding (*i.e.,* 2019 and earlier; referred to as baseline data) were compared to those collected after flooding (*i.e.,* in 2021 and 2022).

Additional sites were sampled in the Keeyask reservoir in seven newly flooded areas including four bays formed at flooded streams, one lake that became connected to the reservoir after flooding (Little Gull Lake), and two sites upstream of the GS. These new sites were not used for comparisons to past years but will be used to see how fish use these newly flooded habitats as they change over time.

Assessing debris (left) in a gill net, setting a gill net (middle), and processing fish (right) for the fish community sampling program.

What was found?

A total of 2,401 fish representing 20 different species were captured in SGI and SMI gill nets set at standard sites in 2022 (Split Lake, the Keeyask reservoir, and Stephens Lake North and South). This included 12 large-bodied species and eight forage species. Most species caught in 2022 were also caught in previous study years. The relative abundance of White Sucker increased between sampling periods in all areas and the relative abundance of Shorthead Redhorse increased in the Keeyask reservoir. The biggest change in relative abundance observed between baseline (*i.e.*, 2019 and earlier) and the first two years after flooding (*i.e.*, 2021 and 2022) monitoring studies was in the number of Rainbow Smelt (a small, non-native forage fish that is food for larger fish) caught. Fewer Rainbow Smelt were captured in 2021 and 2022 than during previous studies in all locations. This is a trend that is seen throughout northern Manitoba.

Catch-per-unit-effort (CPUE) is a measure of how many fish were caught over a certain time in a certain length of net and is used to tell how abundant fish are in an area. The CPUE for fish caught in SGI gill nets were similar in all areas except for jackfish. The mean total CPUE of jackfish has decreased yearly since 2002 in the Keeyask reservoir and was lower in 2022 than in any previous year. However, the decrease in 2021 and 2022 may reflect where nets were set. Nets were set in the same places every year. Since flooding, these areas have become deeper and do not reflect habitat preferred by jackfish. Many jackfish were caught in the newly flooded areas.

The condition factor (a measure of how fat a fish is at a given size) and mean fork length for some fish was lower than seen in previous years and some were higher. These differences likely reflect a natural variation in size structure, as they were observed in both project-affected and reference sites. Further, any changes in condition and length due to reservoir impoundment would take more than two years to show.

CPUE in SMI gill nets was highly variable between study years and waterbodies but fell within the ranges seen in other years in the Keeyask reservoir and in Stephens Lake South. Lake Whitefish, jackfish, and pickerel spawned after flooding were caught in the Keeyask reservoir.

Lake Whitefish, jackfish, and pike were captured in the newly flooded areas in 2022. Jackfish were the most commonly captured species at all sites and were captured in the largest numbers in the backbays and in Little Gull Lake.

What does it mean?

The number and type of fish caught was generally similar between baseline and post-impoundment monitoring studies. The number of jackfish captured was lower in the Keeyask reservoir sites, but this may reflect the greater water depth after impoundment. They were the most commonly captured species caught in the new reservoir sites which are shallower and closer to shore which jackfish tend to prefer. The number of Rainbow Smelt in each location has decreased since studies began, a pattern that has been observed throughout northern Manitoba. Ongoing monitoring will continue to record changes in the fish community as it evolves in the Keeyask reservoir. This was the first year of monitoring in Stephens Lake after all turbines in the Keeyask GS were working. More monitoring in this area will show whether fish continue to spawn downstream of the Keeyask GS or if they find other spawning habitat.

What will be done next?

Each year, sampling will be conducted using the same capture methods, so that results can be compared between different years and trends can be seen.

ACKNOWLEDGEMENTS

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

Stewart Anderson and Ray Mayham of Fox Lake Cree Nation and Grant Connell, Kenneth Ouskun, Leslie Flett, and Terry Kitchekeesik of Tataskweyak Cree Nation are thanked for their local expertise and assistance in conducting the field work.

The collection of biological samples described in this report was authorized by Manitoba Natural Resources and Northern Development Fisheries Branch, under terms of the Scientific Collection Permits #41767128 (SCP 08-2022) and /41783559 (SCP 10-2022).

STUDY TEAM

Data Collection

Brock Kramble

Grant Connell

Jenelle Ehn

Jesse Bell

Ken Ambrose

Kenneth Ouskun

Leslie Flett

Natasha Fafard

Scott Morrison

Stewart Anderson

Data Analysis, Report Preparation, and Report Review

Brenden Slongo

Cam Barth

Chris Kullman

Claire Hrenchuk

Friederike Schneider-Vieira

Laura Henderson

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 on the lower Nelson River in northern Manitoba. The GS is approximately 725 kilometres (km) northeast of Winnipeg, 35 km upstream of the existing Kettle Generating Station, 60 km east of the community of Split Lake, 180 km east-northeast of Thompson and 30 km west of Gillam. Construction of the GS began in July 2014 and the seven generating units were all in-service in March 2022.

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 targeting species that had been identified as being of particular concern during the environmental assessment (referred to as Valued Ecosystem Components, or VECs). These species include Lake Whitefish, Northern Pike, and Walleye.

Fish community studies in the Keeyask study area were initially conducted between 2001 and 2004. Surveyed waterbodies included Split Lake (Dunmall et al. 2004; Holm and Remnant 2004), Clark Lake (Dunmall et al. 2004; Holm and Remnant 2004; Holm 2005), Assean Lake (off-system waterbody that flows into Clark Lake) (Dunmall et al. 2003; Holm et al. 2003), the reach of the Nelson River between Clark Lake and Gull Rapids (site of the Keeyask Generating Station) (Remnant et al. 2004b; Johnson and Parks 2005; Bretecher et al. 2007; Johnson 2005, 2007) and Stephens Lake (Pisiak et al. 2004; Pisiak 2005a, b; MacDonald 2007). In these studies, fish species composition and abundance were described, fish movements and biological variables were assessed, and spawning areas were identified. Concurrent fish studies were also conducted in several tributaries of the Nelson River between Clark Lake and Gull Rapids from 2001 to 2003 to determine fish usage and to assess the importance of each tributary to spawning fish (Barth et al. 2003; Remnant et al. 2004a; Richardson and Holm 2005; Kroeker and Jansen 2006). A similar fish spawning study was conducted in several tributaries of Stephens Lake in 2005 and 2006 (Cassin and Remnant 2008). Also, in Stephens Lake, Walleye (*Sander vitreus*) condition was evaluated in 2003 (Cooley and Johnson 2008) and the habitat preferences of fish in flooded areas were described in 2006 (Cooley and Dolce 2008).

In 2009, fish community data were collected in the reach of the Nelson River between Clark Lake and Gull Rapids (Holm 2010). From 2009–2022 fish community monitoring took place in Split and Assean lakes (annually), as part of the Coordinated Aquatic Monitoring Program (CAMP), a program conducted jointly by the province of Manitoba and Manitoba Hydro (CAMP 2014, CAMP unpublished data). Stephens Lake is sampled every third year (last in 2021) under CAMP.

Construction and operation of the Keeyask GS will affect fish populations within the reservoir due to alteration or loss of habitats (*e.g.*, tributaries, rapids, littoral) and the creation of new habitats. Impacts to the fish community may also occur due to changes to the production of aquatic plants, invertebrates, and forage fish. Downstream, construction and operation of the GS may also affect fish populations in Stephens Lake by changing fish habitat, primarily within the 3 km long reach of the Nelson River between the location of the powerhouse and Stephens Lake (KHLP 2012). In addition to changes in water levels, velocity, and sedimentation in this reach of river, spawning habitat in Gull Rapids will be lost.

The objective of the sampling conducted in 2022 was to collect information on species composition and abundance, as well as selected biological metrics, of the fish community in the Keeyask reservoir in the second year following impoundment. Sampling was also conducted in Stephens Lake, where the fish community may be experiencing change resulting from operation of the GS. Split Lake is upstream of the effects of the Keeyask GS and is being sampled as a reference site to monitor interannual variation in the fish community. Data collected in 2022 will be compared to previous years' data to determine if the fish community has changed over time and since impoundment of the Keeyask GS reservoir (fall 2020) and the final unit being brought into service in March 2022.

Additional gillnetting sites were sampled in flooded areas of the Keeyask reservoir from 2019 to 2022. These sampling sites are located in areas of new habitat and will continue to be sampled during future studies. Data from these sites were not used in comparisons to data collected in previous years.

2.0 STUDY SETTING

Fish community monitoring in 2022 was conducted at three locations: 1) Split Lake; 2) Keeyask reservoir (*i.e.,* the reach of the Nelson River between the outlet of Clark Lake and the Keeyask GS), and 3) Stephens Lake (Map 1).

Split Lake is located at the confluence of the Burntwood and Nelson rivers. Due to the large inflows from the Nelson and Burntwood rivers, the lake has detectable current in several locations. Split Lake has maximum and mean depths of 28.0 m and 3.9 m, respectively, at a water surface elevation of 167.0 m above sea level (ASL; Lawrence et al. 1999). The surface area of Split Lake was determined to be 26,100 ha (excluding islands), with a total shoreline length, including islands, of 940.0 km (Lawrence et al. 1999). The numerous islands in Split Lake represent 411.6 km of the total shoreline.

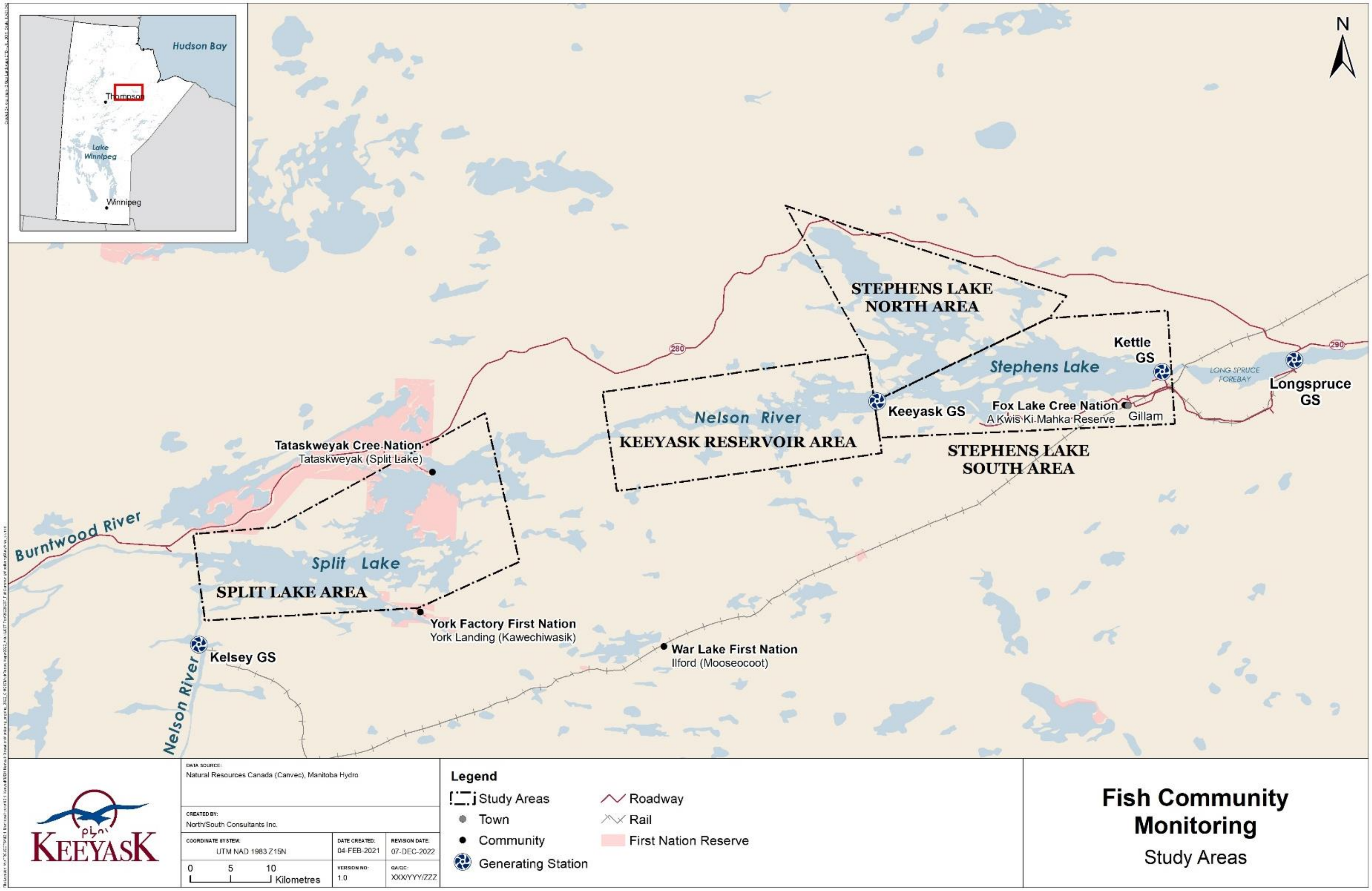
Clark Lake is located immediately downstream of Split Lake, and approximately 42 km upstream of the Keeyask GS. Current is restricted to the main section of the lake, with off-current bays outside the main channel. The Assean River is the only major tributary to Clark Lake and flows into the north side. Downstream from the outlet of Clark Lake, the Nelson River narrows and water velocity increases for a 3 km stretch, known as Long Rapids. For the next 7 km, the river widens, and water velocity decreases. The area between Clark Lake and Birthday Rapids is referred to herein as the upper Keeyask reservoir.

Birthday Rapids is located approximately 10 km downstream of Clark Lake and 30 km upstream of the Keeyask GS and marks the upstream end of major water level changes because of impoundment by the Keeyask GS. The drop in elevation from the upstream to downstream side of Birthday Rapids was approximately 2 m prior to impoundment but is now nearly level, albeit a fast-flowing section of river. The 14 km reach of the Nelson River between Birthday Rapids and Gull Lake was characterized as a large and somewhat uniform channel with medium to high water velocities and a few large bays. This area is now within the Keeyask reservoir, though flooding was limited to mainly shoreline areas, and is referred to herein as the middle Keeyask reservoir.

Prior to impoundment, Gull Lake was a widening of the Nelson River, with moderate to low water velocity beginning approximately 20 km upstream the Keeyask GS. Water levels on Gull Lake increased by several metres following impoundment and flooding along the shoreline and small tributaries entering this reach was extensive. Although this area is larger than prior to impoundment, the portion of the Keeyask reservoir is referred to herein as Gull Lake.

Just below the Keeyask GS, the Nelson River enters Stephens Lake. Stephens Lake was formed in 1971 by construction of the Kettle GS. Construction of the Keeyask GS has altered the flow distribution immediately downstream of the station.

Construction of the Kettle GS flooded Moose Nose Lake (north arm) and several other small lakes that previously drained into the Nelson River, as well as the old channels of the Nelson River that now lie within the southern portion of the lake. Major tributaries of Stephens Lake include the North and South Moswakot rivers that enter the north arm of the lake. Looking Back Creek is a second order stream that drains into the north arm of Stephens Lake. Kettle GS is located approximately 40 km downstream of the Keeyask GS.



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

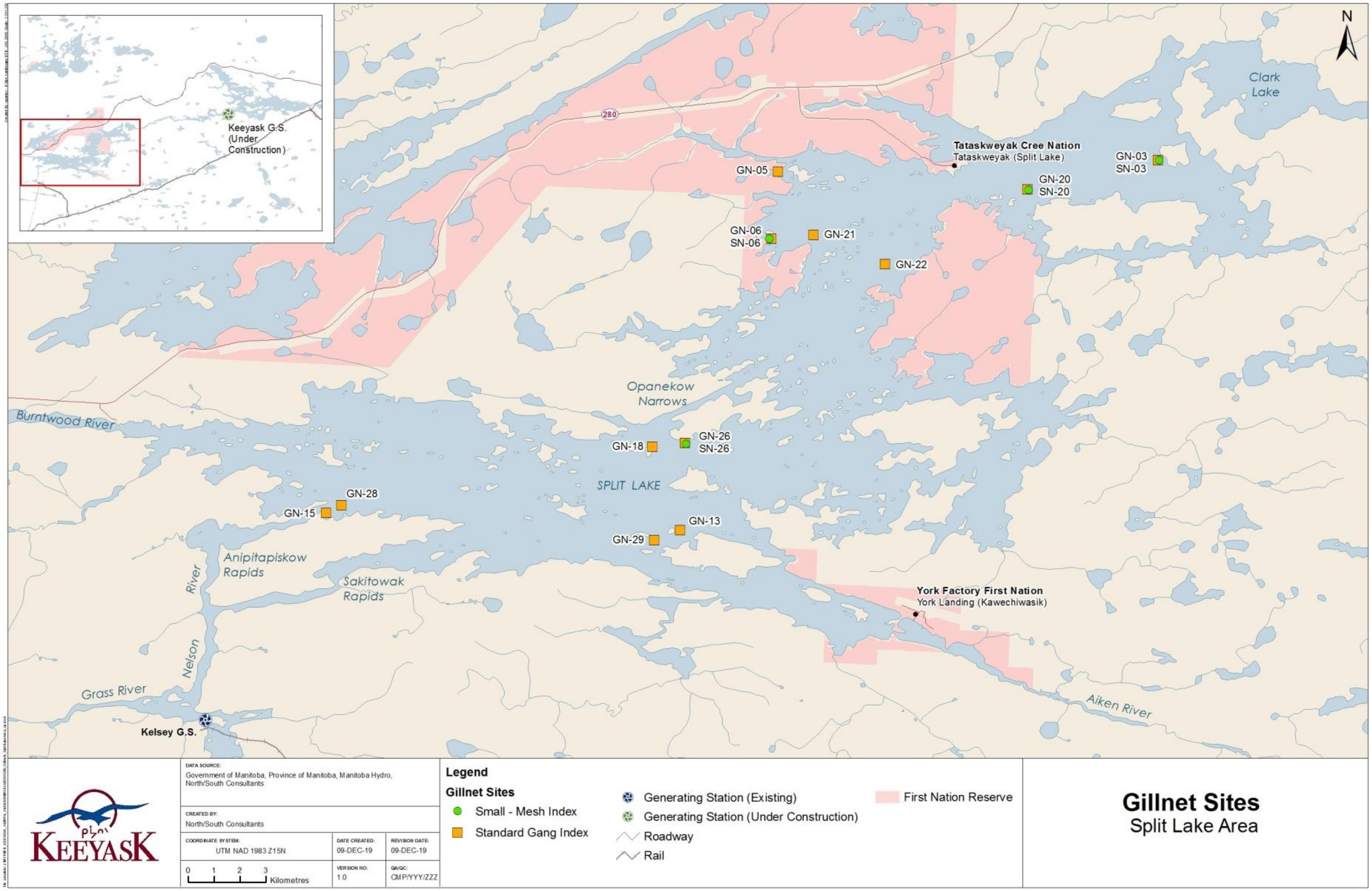
3.0 METHODS

Gillnetting was conducted at project-affected (the Nelson River between Clark Lake and the Keeyask GS referred to herein as the Keeyask reservoir; and Stephens Lake) and reference (Split Lake) waterbodies in 2022. Sampling was conducted in Split Lake from August 28 to September 1, 2022 (Map 2), and in Stephens Lake North and South from August 28 to September 1, 2022 and August 24 to 27, 2022, respectively (Map 3). The Keeyask reservoir was sampled from August 10 to 16, 2022 (Map 4).

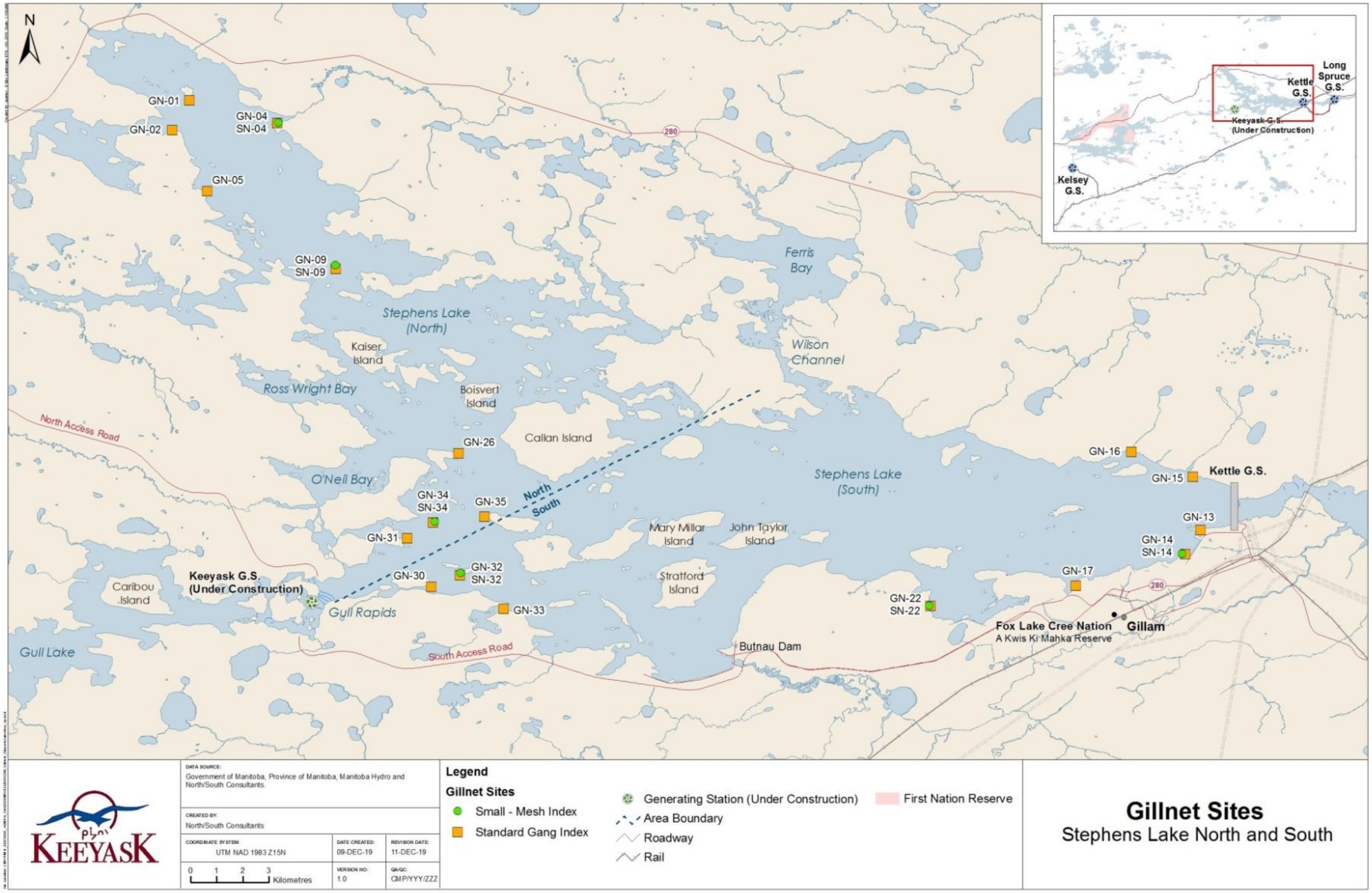
A total of 40 standard gang index (SGI) and 12 small mesh index (SMI) gill net sites were sampled in 2022. These included 12 SGI and four SMI sites on Split Lake, ten SGI and two SMI sites on the Keeyask reservoir, and nine SGI and three SMI sites on both Stephens Lake North and South. Sampling was conducted annually in Split Lake and every three years in Stephens Lake North and South since 2009 as well as in 2001 and 2002; however, different sites were sampled in each year. For this report, a subset of years was chosen in which the same sites were sampled to ensure comparability. These included 2009, 2015, 2019, 2021, and 2022 for Split Lake; 2001, 2002, 2009, 2015, 2019, 2021, and 2022 for the Keeyask reservoir; and 2009, 2015, 2018, 2021, and 2022 for Stephens Lake North and South. These data were compared between years to monitor potential changes occurring independent of GS operation.

An additional seven SGI and five SMI gill nets were set in newly-flooded areas in the Keeyask reservoir in 2022 including four backbays (GN-10, GN/SN-09, GN/SN-11, and GN/SN-15), one previously isolated lake now connected to the Keeyask reservoir via flooded terrestrial habitat (Little Gull Lake, GN/SN-14), and two sites near the newly built GS (GN/SN-16 and GN-17) Areas near these sites were sampled for the first time in 2019 but were not fully accessible pre-impoundment (*i.e.*, were not fully connected to the Nelson River, were not accessible by boat, or were situated too close to construction activities to sample) and therefore the results are not directly comparable to post-impoundment years (2021 and 2022).

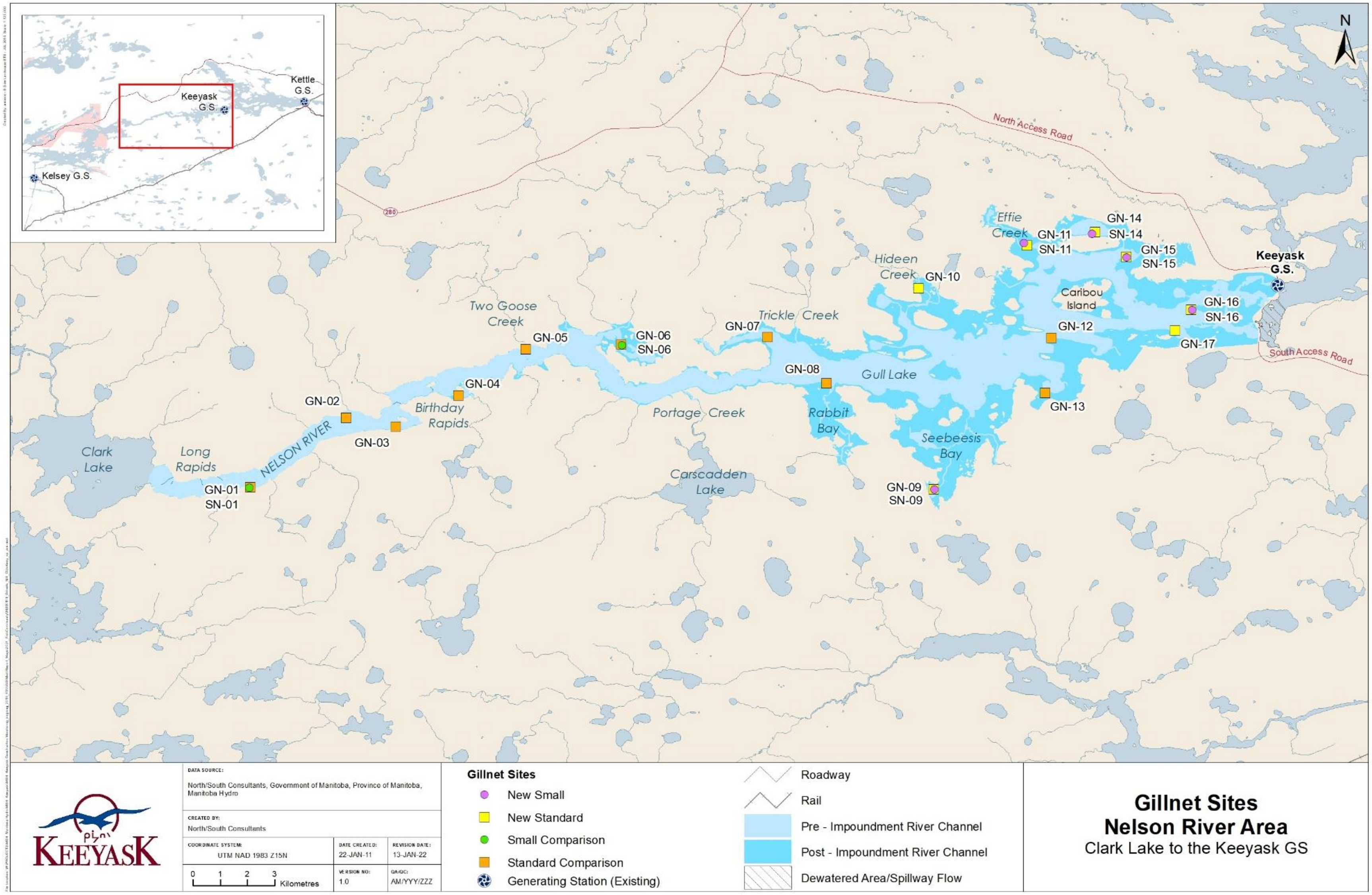
In this report, ten SGI and two SMI sites in the Keeyask reservoir (referred to herein as standard sites) that were fished in all study years were used for comparison. Data from the additional seven SGI and five SMI sites in the Keeyask reservoir not set in previous years (referred to herein as Keeyask reservoir additional sites) are presented separately (Section 4.2).



Map 2: Standard gang and small mesh index gillnetting sites in Split Lake, summer 2022.



Map 3: Standard gang and small-mess index gillnetting sites set in Stephens Lake North and South, summer 2022.



Map 4: Standard gang and small mesh index gillnetting sites set in the Keeyask reservoir, summer 2022.

3.1 GILLNETTING

SGI gill nets were composed of six 22.9-m (25-yd) long by 2.4-m (2.7-yd) deep gillnet panels made of twisted nylon mesh. Individual panels were joined together in a stretched mesh-size sequence of 38, 51, 76, 95, 108, and 127 mm (or 1½, 2, 3, 3¾, 4¼, and 5 inches). All SGI gill nets were set on the bottom for approximately 24 hours. A hand-held global positioning system (GPS) unit was used to record the location of each gillnetting site. Water depth was measured (in metres) at each end of the net using a portable depth sounder, and water temperature was measured (± 0.5°C) at least once daily using a hand-held thermometer.

SMI gill nets were attached to the 1½-inch end of four of the SGI gill nets at a subset of sites. SMI gill nets consisted of three 10-m (10.9-yd) long by 1.8-m (2.0-yd) deep gillnet panels made of twisted nylon mesh. Panels were tied together in a stretched mesh-size order of 16, 20, and 25 mm (or 0.63, 0.78, and 0.98 inches), with the 25-mm mesh size end attached to the 38-mm (1½ inch) end of the SGI gill net.

3.2 DEBRIS MONITORING IN GILL NETS

The type and quantity of debris in SGI and SMI gill nets were evaluated after each set by direct observation. Debris categories were based on the Manitoba Hydro Net Observation Program conducted in Playgreen Lake in 1984 (Horne 1994). Estimates of debris level and composition were based on the entire gill net gang. Each gang was assigned one of the following debris levels based on the area covered by debris:

- None (no debris in gang; nets were clean);
- Low (< 5% of gang area covered by debris);
- Moderate (5–15% of gang area covered by debris);
- High (16–25% of gang area covered by debris); and
- Very high (> 26% of gang area covered by debris).

Each type of debris observed in the gang was expressed as a percentage of the total debris present. Debris was categorized into the following types:

- terrestrial vegetation;
- terrestrial moss;
- sticks;
- algae;
- aquatic vegetation;
- aquatic moss; and

- silt/mud.

3.3 BIOLOGICAL SAMPLING

All fish captured in each waterbody were identified to species and enumerated. All fish captured in SGI gill nets and all large-bodied species captured in SMI gill nets were measured for fork length (FL; ± 1 mm) and round weight (± 25 g; mechanical pan scale). Burbot (*Lota lota*) were measured for total length and Lake Sturgeon (*Acipenser fulvescens*) were measured for both fork and total length. Forage fish species captured in SMI gill nets were bulk weighed.

Ageing structures were collected from a sub-sample of VEC species, across all sizes captured. Cleithra were collected from Northern Pike and otoliths were collected from both Lake Whitefish and Walleye. All structures were placed in individually labelled envelopes and air-dried prior to shipment to the North/South Consultants Inc. laboratory in Winnipeg.

For age determination, individual cleithra were first boiled to remove any tissue or oil residue that was left on the structure after removal from the fish. Cleithra were then typically read 'free-hand' (*i.e.*, without a microscope) against a dark background; a dissecting microscope (or a magnified ring light) was used when required. Dried otoliths were coated in epoxy and sectioned with a Struers Minitom™ low-speed sectioning saw. Sections were then fixed on glass slides with Cytoseal-60™ and examined under a microscope with transmitted light. Light intensity and magnification were adjusted during the viewing process.

Annuli from all 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.

Prior to 2015, dorsal fin spines were taken as ageing structures from Walleye. Since that time, it has been shown that otoliths not only provide more accuracy for ageing both younger and older fish (R. Remnant, pers comm.). Ages from Walleye collected in the Nelson River between Clark Lake and Gull Rapids prior to 2015 are presented herein but cannot be used for comparisons with more recent data (*e.g.*, comparison of age distribution prior to and after the onset of Keeyask GS construction). Cohort analysis was used to determine whether recruitment is occurring.

3.4 DEFORMITIES, EROSION, LESIONS, AND TUMOURS

All captured Lake Whitefish, Northern Pike, Walleye, White Sucker (*Catostomus commersonii*), Sauger and Lake Sturgeon were examined for external deformities, erosion, lesions, and tumours (collectively referred to as DELTs). Deformities could consist of a deformed fin or fin ray, head, spinal column or other body part, as well as scale disorientation, such as scale whorling or reversal. Erosion included erosion of fins, operculum, and tail, as well as fin rot. Lesions included open sores, exposed tissue, ulcerations, cysts, and eye abnormalities (*e.g.*, cataracts, exophthalmia). As per the US Environmental Protection Agency "fingernail test", solid growths were classified as tumours, whereas fluid-filled growths or nodules were considered lesions. Tumours may also include growths that are not true neoplaisia (*e.g.*, epidermal hyperplaisia, granulomatous growths), as histological confirmations were not performed. Physical injuries, such as injuries from predators or fishing gear, were not considered in the DELT classification. Where present, the frequency of DELTs was expressed as a percentage of the number of fish examined per species.

3.5 DATA ANALYSIS

Standard gang and small mesh index gill net catches were tabulated by species, sampling location, set type, and waterbody. For fish captured in SGI gill nets, catch-per-unit-effort (CPUE) was expressed as the number of fish captured in a 100-m net set for 24 hours. For fish captured in SMI index gill nets, CPUE was expressed as the number of fish captured in a 30-m net set for 24 hours. CPUE was calculated for the total catch and for each species by gear type and site. It was expressed as mean CPUE $\pm$ 1 standard deviation (StDev). Frequency of occurrence of a species was calculated as the percentage in relation to the total catch. Average CPUE of each VEC species captured in SGI nets was compared by year using a Kruskal-Wallis H test (significance level set at 0.05). If a significant difference was found, a Dunn's test was conducted to determine which sampling years differed. The test was only used if the sample size (*i.e.*, the number of fish captured) was greater than ten.

Mean length, weight, and condition factor (K) were calculated for all large-bodied VEC fish species captured in SGI and SMI gill nets. Condition factor was calculated (after Fulton 1911, in Ricker 1975) for individual fish using the following equation:

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

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

Length-frequency distributions were plotted in 50 mm length class intervals (*e.g.*, 300–349 mm). Ages were used to determine the year in which a fish was spawned, with each year representing a different cohort. Cohort-frequency distributions were plotted for each species for each location. The frequency of DELTs was expressed as a percentage of the total number of fish caught of each species.

Fork length frequency distributions were compared between years. If the sample size (*i.e.*, the number of fish captured) was greater than ten, a student's t-test was used to determine if mean fork lengths differed between sampling periods (significance level set at 0.05).

Analysis of co-variance (ANCOVA)/regression analysis was used to determine whether condition differed between years (for details see Schwarz 2015). This approach was taken as Fulton's condition factor is often positively correlated with fish length, making comparisons between years difficult when length distributions differ between years. To accomplish this, first a new variable was created called FL3, which was calculated by first rearranging the equation used to calculate Fulton's condition factor (K) and solving for weight as:

$$W = K \times FL3/100{,}000$$

where: W = weight (g);
K = Fulton's condition factor;
FL = fork length (mm); and
$FL3 = FL^3/100{,}000$.

This rearranged equation is essentially a linear regression between W and FL3 without an intercept (*i.e.*, α), while K equals the slope of the regression line (*i.e.*, β).

An ANCOVA/regression with the intercept forced to zero was then fitted between W (weight), and FL3 and an interaction term (FL3 × YEAR) which represents the differential condition (K) between years (Schwarz 2015). An interaction term with a p-value < 0.05 indicates a difference in condition between years.

4.0 RESULTS

Gill net survey information for 2022 in the Keeyask study area is presented in Appendix 1. Water temperature during sampling ranged from: 17.0–19.0˚C in Split Lake (August 27–31, 2022), 18.0–19.9°C in the Keeyask reservoir (August 10–16, 2022), 15.0–20.0°C in Stephens Lake North (August 28–31, 2022) and from 18.5–19.0°C in Stephens Lake South (August 24–27, 2022).

A total of 20 fish species were captured during fish community monitoring, including 12 large-bodied species and eight forage species (Table 1). The majority of species (n = 9) were captured in each of the waterbodies surveyed. Four species were captured in only one waterbody: Slimy Sculpin (*Cottus cognatus*) in the Keeyask reservoir, Logperch (*Percina caprodes*) in Stephens Lake South, and Freshwater Drum (*Aplodinotus grunniens*) and Lake Chub (*Couesius plumbeus*) in Split Lake.

Table 1: Fish species captured during standard gang and small mesh index gillnetting surveys conducted in the Keeyask study area during summer 2022.

Common Name	Scientific Name	Abbreviation	Split Lake	Keeyask reservoir	Stephens Lake	
					North	South
Burbot	*Lota lota*	*BURB*		X		X
Cisco	*Coregonus artedi*	*CISC*	X	X	X	
Emerald Shiner	*Notropis atherinoides*	*EMSH*	X		X	X
Freshwater Drum	*Aplodinotus grunniens*	*FRDR*	X			
Lake Chub	*Couesius plumbeus*	*LKCH*	X			
Lake Sturgeon	*Acipenser fluvescens*	*LKST*	X	X		X
Lake Whitefish	*Coregonus clupeaformis*	*LKWH*	X	X	X	X
Logperch	*Percina caprodes*	*LGPR*				X
Longnose Sucker	*Catostomus catostomus*	*LNSC*	X	X		X
Mooneye	*Hiodon tergisus*	*MOON*	X		X	X
Northern Pike	*Esox lucius*	*NRPK*	X	X	X	X
Rainbow Smelt	*Osmerus mordax*	*RNSM*	X	X	X	X
Sauger	*Sander canadensis*	*SAUG*	X	X	X	X
Shorthead Redhorse	*Moxostoma macrolepidotum*	*SHRD*	X	X	X	X
Slimy Sculpin	*Cottus cognatus*	*SLSC*		X		
Spottail Shiner	*Notropis hudsonius*	*SPSH*	X	X	X	X
Troutperch	*Percopsis omiscomaycus*	*TRPR*	X	X	X	X
Walleye	*Sander vitreus*	*WALL*	X	X	X	X
White Sucker	*Catostomus commersonii*	*WHSC*	X		X	X
Yellow Perch	*Perca flavescens*	*YLPR*	X	X	X	X

4.1 2001–2022 STANDARD SITE COMPARISONS

4.1.1 SPECIES COMPOSITION

4.1.1.1 SPLIT LAKE

A total of 514 fish representing 12 species were captured in SGI gill nets set at 12 standard sites in Split Lake in 2022 (Table 2). White Sucker were the most common species captured (39.5%; n = 203), followed by Walleye (27.4%; n = 141), and Sauger (14.4%; n = 74). An additional 636 fish representing 12 species were captured in four SMI gill nets. Spottail Shiner were the most common species captured (76.7%; n = 488).

The large-bodied species composition of SGI gill nets was generally similar between baseline (*i.e.*, 2009, 2015, and 2019) and post-impoundment (2021 and 2022) monitoring periods (Table 2). The largest decline in relative abundance by species was observed for Walleye which decreased from 27.0% of the catch during baseline study years to 20.1% of the catch in 2022. At the same time, the relative abundance of White Sucker increased from 27.9% to 35.4% of the catch.

Spottail Shiner was the most commonly captured species in SMI gill nets across all years, comprising 41.4% to 65.0% of the catch. The largest change observed in species relative abundance in SMI gill nets has been the decline of Rainbow Smelt, decreasing from 11.6% of the catch to 0.9%.

Table 2: Total number (n) and relative abundance (%) of fish, by species, captured in standard gang (SGI) and small mesh index (SMI) gill nets set in Split Lake during monitoring studies of the current year (2022), baseline years (2009, 2015, 2019) and post-impoundment years (2021 and 2022).

Common Name	2022				Baseline				Post-impoundment			
	SGI		SMI		SGI		SMI		SGI		SMI	
	n[1]	%	n	%	n	%	n	%	n	%	n	%
Burbot	-	-	-	-	14	0.9	-	-	4	0.4	-	-
Cisco	3	0.6	-	-	19	1.2	30	2.9	8	0.7	18	1.9
Common Carp	-	-	-	-	-	-	-	-	-	-	-	-
Emerald Shiner	-	-	23	3.6	-	-	196	18.9	-	-	117	12.1
Freshwater Drum	1	0.2	-	-	3	0.2	-	-	2	0.2	-	-
Logperch	-	-	-	-	-	-	1	0.1	-	-	2	0.2
Lake Chub	-	-	23	3.6	13	0.8	73	7.0	8	0.7	37	3.8
Lake Sturgeon	4	0.8	-	-	8	0.5	-	-	6	0.5	-	-
Lake Whitefish	25	4.9	1	0.2	52	3.3	-	-	50	4.5	1	0.1
Longnose Sucker	6	1.2	-	-	31	1.9	-	-	34	3.1	-	-
Mooneye	-	-	2	0.3	31	1.9	-	-	24	2.2	6	0.6
Northern Pike	28	5.4	5	0.8	167	10.5	15	1.4	83	7.5	8	0.8
Rainbow Smelt	8	1.6	6	0.9	28	1.8	121	11.6	8	0.7	9	0.9
Sauger	74	14.4	28	4.4	278	17.5	11	1.1	211	19.1	42	4.3
Shorthead Redhorse	13	2.5	-	-	47	3.0	-	-	35	3.2	-	-
Silver Redhorse	-	-	-	-	1	0.1	-	-	-	-	-	-
Slimy Sculpin	-	-	-	-	-	-	7	0.7	-	-	-	-
Spottail Shiner	-	-	488	76.7	-	-	430	41.4	-	-	629	65.0
Troutperch	-	-	12	1.9	2	0.1	119	11.5	-	-	33	3.4
Walleye	141	27.4	22	3.5	430	27.0	21	2.0	222	20.1	37	3.8
White Sucker	203	39.5	1	0.2	443	27.9	5	0.5	391	35.4	1	0.1
Yellow Perch	8	1.6	25	3.9	23	1.4	10	1.0	20	1.8	27	2.8
Total	**514**	**-**	**636**	**-**	**1590**	**-**	**1039**	**-**	**1106**	**-**	**967**	**-**

1 – Number of fish

4.1.1.2 KEEYASK RESERVOIR

In 2022, 257 fish representing 11 species were captured in SGI gill nets set at ten standard sites in the Keeyask reservoir. Walleye were the most common species captured (35.0%; n = 90), followed by Shorthead Redhorse (17.5%; n = 45), and White Sucker (14.4%, n = 37; Table 3). An additional 50 fish representing seven species were captured in two standard SMI gill nets. Spottail Shiner was the most common species captured (64.0%, n = 32; Table 3).

Large-bodied species composition in SGI gill nets were generally similar between baseline (*i.e.*, 2001, 2002, 2009, 2015, and 2019) and post-impoundment (*i.e.*, 2021 and 2022) periods (Table 3). The largest change in relative abundance was for Northern Pike which decreased from 44.1% of the catch during baseline to 11.1% post-impoundment. Mooneye were not captured post-impoundment but comprised 3.7% of the catch during baseline. Relative abundance of Sauger and Shorthead Redhorse also increased between baseline and post-impoundment, from 1.3–12.2% and 3.7–14.3%, respectively (Table 3).

Spottail Shiner was the most frequently captured species in SMI gill nets during both baseline and post-impoundment periods; relative abundance increased from 36.1% during baseline monitoring to 63.9% of the catch during post-impoundment monitoring (Table 3). The relative abundance of Emerald Shiner decreased from 30.9% during baseline to just 2.8% during the post-impoundment period. The relative abundance of Rainbow Smelt in SMI gill nets also decreased from 9.0% of the catch during baseline to being absent from the catch post-impoundment, although the species is known to be present in the Keeyask reservoir post-impoundment as several (n = 6) smelt were captured in SGI gill nets between 2021 and 2022.

Table 3: Total number (n) and relative abundance (%) of fish, by species, captured in all standard gang (SGI) and small mesh index (SMI) gill nets set in the Keeyask reservoir during monitoring studies of the current year (2022), baseline years (2009, 2015, 2019) and post-impoundment years (2021 and 2022).

Common Name	2022				Baseline				Post-impoundment			
	SGI		SMI		SGI		SMI		SGI		SMI	
	n[1]	%	n	%	n	%	n	%	n	%	n	%
Burbot	3	1.2	-	-	2	0.1	-	-	4	0.9	-	-
Cisco	-	-	2	4.0	7	0.5	40	3.0	3	0.7	5	2.8
Emerald Shiner	-	-	-	-	-	-	416	30.9	-	-	5	2.8
Logperch	-	-	-	-	-	-	1	0.1	-	-	-	-
Lake Chub	-	-	-	-	2	0.1	-	-	1	0.2	-	-
Lake Sturgeon	7	2.7	-	-	3	0.2	-	-	7	1.6	-	-
Lake Whitefish	9	3.5	-	-	94	6.9	2	0.1	16	3.6	1	0.6
Longnose Sucker	10	3.9	-	-	8	0.6	3	0.2	17	3.9	-	-
Mooneye	-	-	-	-	51	3.7	-	-	-	-	-	-
Northern Pike	20	7.8	2	4.0	601	44.1	22	1.6	49	11.1	4	2.2
Rainbow Smelt	2	0.8	-	-	35	2.6	121	9.0	6	1.4	-	-
Sauger	25	9.7	3	6.0	18	1.3	-	-	54	12.2	5	2.8
Shorthead Redhorse	45	17.5	1	2.0	51	3.7	-	-	63	14.3	1	0.6
Silver Redhorse	-	-	-	-	-	-	-	-	1	0.2	-	-
Slimy Sculpin	-	-	-	-	-	-	-	-	-	-	-	-
Spottail Shiner	-	-	32	64.0	-	-	486	36.1	1	0.2	115	63.9
Troutperch	-	-	2	4.0	1	0.1	78	5.8	-	-	12	6.7
Walleye	90	35.0	8	16.0	255	18.7	2	0.1	129	29.3	11	6.1
White Sucker	37	14.4	-	-	116	8.5	10	0.7	77	17.5	-	-
Yellow Perch	9	3.5	-	-	120	8.8	164	12.2	13	2.9	21	11.7
Total	**257**	**-**	**50**	**-**	**1364**	**-**	**1345**	**-**	**441**	**-**	**180**	**-**

1 – Number of fish

4.1.1.3 STEPHENS LAKE NORTH

A total of 337 fish representing ten species were captured in SGI gill nets set at nine standard sites in Stephens Lake North in 2022. Walleye were the most common species captured (36.5%; n = 123), followed by White Sucker (17.8%; n = 60), Northern Pike (14.5%; n = 49), and Cisco (13.9%, n = 47; Table 4). An additional 187 fish representing ten species were captured in three SMI gill nets; Spottail Shiner were the most common species captured (78.1%; n = 146).

Large-bodied species composition of SGI gill nets was generally similar between baseline (*i.e.*, 2009, 2015, and 2019) and post-impoundment (*i.e.*, 2021 and 2022) periods (Table 4). The largest change in relative abundance was for Northern Pike which decreased from 23.5% to 14.4% of the catch between monitoring periods, while Cisco and White Sucker increased from 2.9 to 12.1% and 6.6% to 15.5%, respectively.

Spottail Shiner was the most frequently captured species in SMI gill nets during both baseline and post-impoundment periods increasing from 47.1% to 58.4% of the catch (Table 4). The relative abundance of Rainbow Smelt caught in SMI gill nets decreased from 8.2% to 1.3% between monitoring periods.

Table 4: Total number (n) and relative abundance (%) for fish, by species, captured in all standard gang (SGI) and small mesh index (SMI) gill nets set in Stephens Lake North during monitoring studies of the current year (2022), baseline years (2009, 2015, 2019) and post-impoundment years (2021 and 2022).

	2022				Baseline				Post-impoundment			
	SGI		SMI		SGI		SMI		SGI		SMI	
Common Name	n[1]	%	n	%	n	%	n	%	n	%	n	%
Burbot	-	-	-	-	1	0.1	-	-	-	-	-	-
Cisco	47	13.9	3	1.6	23	2.9	8	0.9	77	12.1	12	1.3
Common Carp	-	-	-	-	1	0.1	-	-	-	-	-	-
Emerald Shiner	-	-	3	1.6	-	-	277	31.4	-	-	285	31.4
Goldeye	2	0.6	-	-	-	-	-	-	2	0.3	-	-
Logperch	-	-	-	-	-	-	-	-	-	-	-	-
Lake Chub	-	-	-	-	-	-	-	-	-	-	-	-
Lake Sturgeon	-	-	-	-	-	-	-	-	-	-	-	-
Lake Whitefish	14	4.2	-	-	49	6.1	3	0.3	28	4.4	-	-
Longnose Sucker	-	-	-	-	2	0.3	-	-	1	0.2	-	-
Mooneye	-	-	-	-	42	5.3	-	-	7	1.1	-	-
Northern Pike	49	14.5	3	1.6	188	23.5	19	2.2	92	14.4	6	0.7
Rainbow Smelt	14	4.2	5	2.7	22	2.8	72	8.2	16	2.5	12	1.3
Sauger	15	4.5	4	2.1	23	2.9	3	0.3	29	4.6	4	0.4
Shorthead Redhorse	8	2.4	-	-	3	0.4	-	-	15	2.4	-	-
Silver Redhorse	-	-	-	-	-	-	-	-	-	-	-	-
Slimy Sculpin	-	-	-	-	-	-	-	-	-	-	-	-
Spottail Shiner	-	-	146	78.1	-	-	416	47.1	-	-	531	58.4
Troutperch	-	-	11	5.9	-	-	43	4.9	-	-	20	2.2
Walleye	123	36.5	5	2.7	391	48.9	36	4.1	264	41.4	17	1.9
White Sucker	60	17.8	1	0.5	53	6.6	-	-	99	15.5	1	0.1
Yellow Perch	5	1.5	6	3.2	2	0.3	6	0.7	7	1.1	21	2.3
Total	**337**	**-**	**187**	**-**	**800**	**-**	**883**	**-**	**637**	**-**	**909**	**-**

1 – Number of fish

4.1.1.4 STEPHENS LAKE SOUTH

A total of 245 fish representing 11 species were captured in SGI gill nets set at nine standard sites in 2022 in Stephens Lake South. White Sucker was the most common species captured (46.9%; n = 115) followed by Walleye (24.1%; n = 59), and Sauger (15.5%, n = 38; Table 5). An additional 175 fish representing nine species were captured in three standard SMI gill nets. Spottail Shiner was the most common species captured (37.7%; n = 66) followed by Troutperch (27.4%; n = 48). Logperch were captured in Stephens Lake South for the first time in 2022, comprising 5.7% of the catch (n = 10).

The large-bodied species composition of SGI gill nets was generally similar between baseline (*i.e.*, 2009, 2015, and 2018) and post-impoundment (*i.e.*, 2021 and 2022) periods (Table 5). The largest observed change in relative abundance was for White Sucker which increased from 16.8% of the catch to 40.5%. The relative abundance of Walleye and Northern Pike decreased from 44.2% and 20.5% to 27.7% and 7.5%, respectively.

Spottail Shiner was the most frequently captured species in SMI gill nets set during both the baseline and post-impoundment periods accounting for 48.0% and 42.0% of the catch, respectively (Table 5). The relative abundance of Troutperch increased from 11.6% to 26.8%, while the relative abundance of Emerald Shiner decreased from 23.0% to 4.7%.

Table 5: Total number (n) and relative abundance (%) for fish, by species, captured in all standard gang (SGI) and small mesh index (SMI) gill nets set in Stephens Lake South during monitoring studies of the current year (2022), baseline years (2009, 2015, 2019) and post-impoundment years (2021 and 2022).

	2022				Baseline				Post-impoundment			
	SGI		SMI		SGI		SMI		SGI		SMI	
Common Name	n[1]	%	n	%	n	%	n	%	n	%	n	%
Burbot	1	0.4	-	-	2	0.2	-	-	3	0.5	-	-
Cisco	-	-	-	-	3	0.4	-	-	-	-	-	-
Common Carp	-	-	-	-	-	-	-	-	-	-	-	-
Emerald Shiner	-	-	3	1.7	-	-	188	23.0	-	-	15	4.7
Freshwater Drum	-	-	-	-	-	-	-	-	2	0.4	-	-
Logperch	-	-	10	5.7	-	-	-	-	-	-	10	3.2
Lake Chub	-	-	-	-	-	-	1	0.1	-	-	-	-
Lake Sturgeon	1	0.4	-	-	1	0.1	-	-	2	0.4	-	-
Lake Whitefish	3	1.2	-	-	16	2.0	19	2.3	7	1.2	-	-
Longnose Sucker	1	0.4	-	-	7	0.9	5	0.6	12	2.1	1	0.3
Mooneye	1	0.4	-	-	31	3.9	3	0.4	36	6.4	-	-
Northern Pike	15	6.1	-	-	165	20.5	5	0.6	42	7.5	-	-
Rainbow Smelt	-	-	5	2.9	28	3.5	54	6.6	-	-	6	1.9
Sauger	38	15.5	16	9.1	43	5.3	12	1.5	58	10.3	24	7.6
Shorthead Redhorse	6	2.4	-	-	7	0.9	-	-	12	2.1	-	-
Silver Redhorse	-	-	-	-	-	-	-	-	-	-	-	-
Slimy Sculpin	-	-	-	-	-	-	-	-	-	-	-	-
Spottail Shiner	-	-	66	37.7	-	-	393	48.0	-	-	133	42.0
Troutperch	-	-	48	27.4	2	0.2	95	11.6	-	-	85	26.8
Walleye	59	24.1	4	2.3	356	44.2	22	2.7	156	27.7	14	4.4
White Sucker	115	46.9	20	11.4	135	16.8	7	0.9	228	40.5	21	6.6
Yellow Perch	5	2.0	3	1.7	9	1.1	15	1.8	5	0.9	8	2.5
Total	**245**	**-**	**175**	**-**	**805**	**-**	**819**	**-**	**563**	**-**	**317**	**-**

1 – Number of fish

4.1.2 ABUNDANCE

4.1.2.1 SPLIT LAKE

Mean total CPUE for SGI gill nets set at 12 standard sites in Split Lake in 2022 was 30.9 fish/100 m of net/24 h (Table 6). In previous sampling years, mean total CPUE at the same sites ranged from 29.1 fish in 2019 to 35.3 fish in 2021. The mean total CPUE for all fish species captured in SGI gill nets did not differ significantly among years (H= 3.94, p = 0.41; Figure 1).

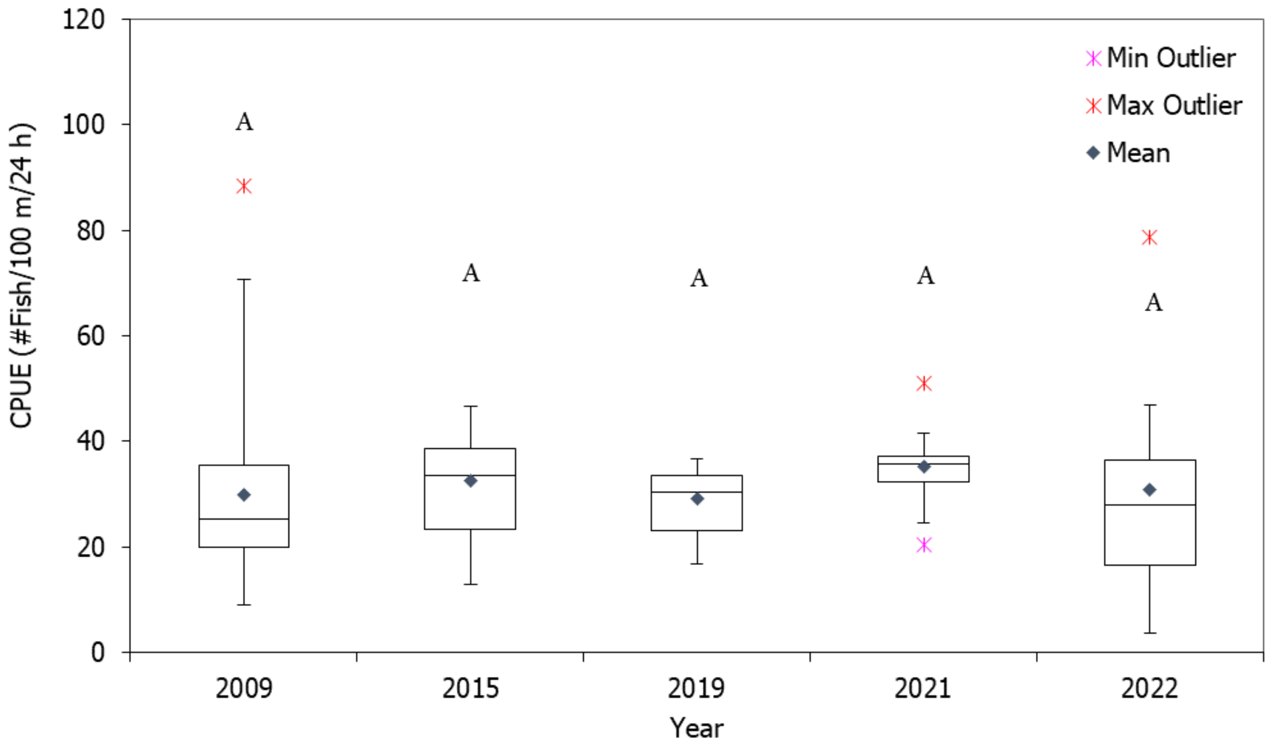


Figure 1: Mean total CPUE for all fish species captured in standard gang index gill nets set in Split Lake in 2009, 2015, 2019, 2021 and 2022. Letters denote significant differences in CPUE between study years.

Average CPUE for Lake Whitefish, Northern Pike, and Walleye captured in 2022 was 1.5, 1.7, and 8.5 fish/100 m of net/24 h, respectively (Table 6; Figure 2). Average CPUE of Lake Whitefish (H = 3.1, p = 0.54), Northern Pike (H = 2.21, p = 0.7), and Walleye (H = 3.62, p = 0.46) did not differ significantly among sampling years.

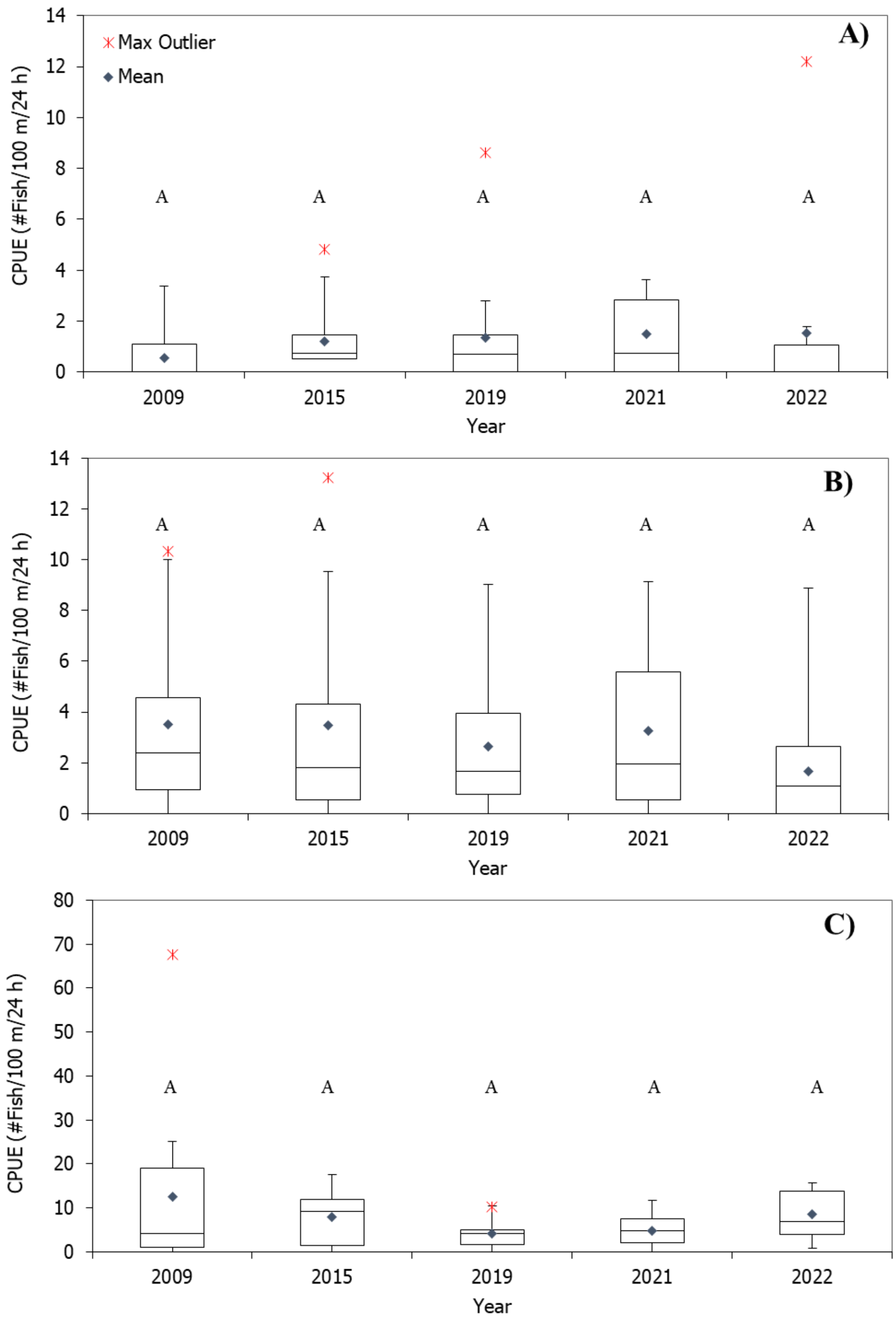


Figure 2: Mean total CPUE for A) Lake Whitefish, B) Northern Pike and C) Walleye captured in standard gang index gill nets set in Split Lake in 2009, 2015, 2019, 2021 and 2022. Letters denote significant differences in CPUE between study years.

Mean total CPUE for the SMI gillnet catch in 2022 was 158.6 fish/30 m of net/24 h (Table 7). In previous sampling years, mean total CPUE ranged from 90.2 fish in 2009 to 134.8 fish in 2019 (Table 7; Figure 3). Mean CPUE could not be compared statistically among years as too few sites were sampled.

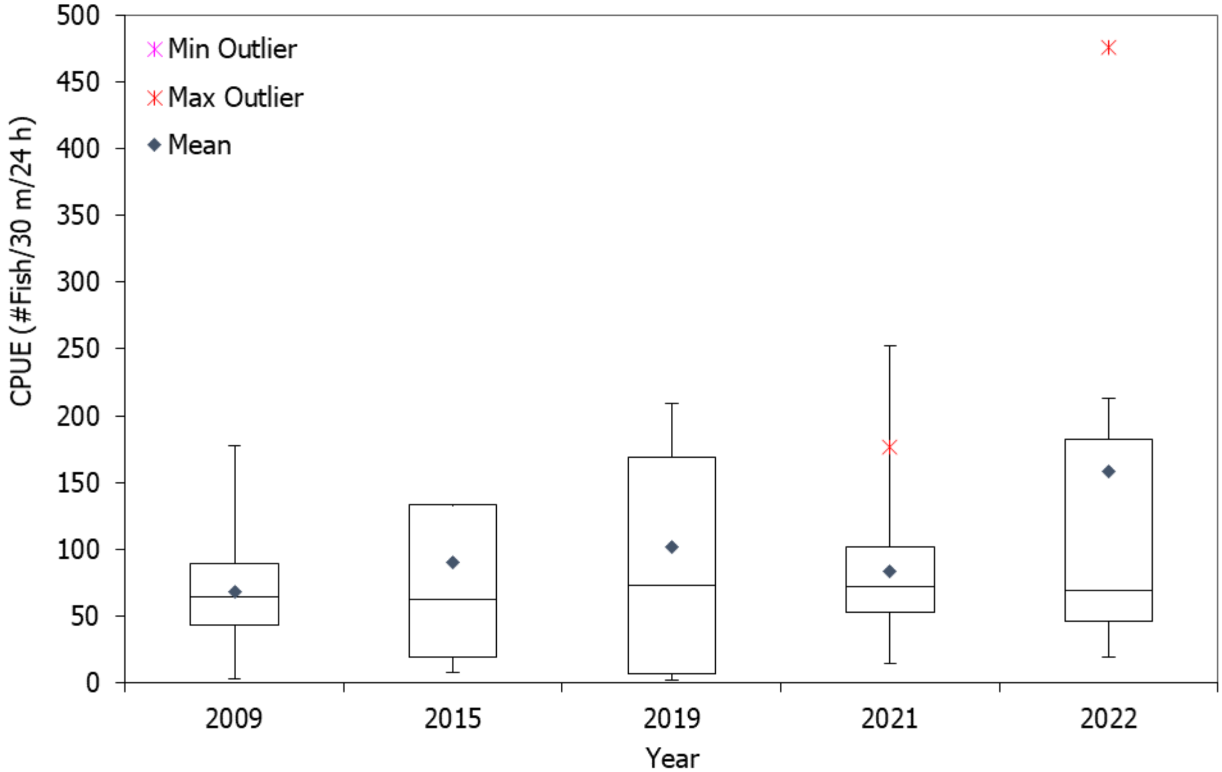


Figure 3: Mean total CPUE for all fish species captured in small mesh index gill nets set in Split Lake in 2009, 2015, 2019, 2021 and 2022.

Table 6: Mean catch-per-unit-effort (CPUE; fish/100 m of net/24 h) by species and study year for fish captured in standard gang index gill nets set in Split Lake, summer 2009, 2015, 2019, 2021 and 2022.

Common Name	2009			2015			2019			2021			2022		
	n[1]	CPUE	Std[2]	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std
Burbot	10	0.5	1.1	-	-	-	4	0.3	0.5	4	0.3	0.8	-	-	-
Cisco	2	0.1	0.3	4	0.2	0.7	13	0.9	1.7	5	0.3	0.6	3	0.2	0.5
Common Carp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Emerald Shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Freshwater Drum	-	-	-	3	0.1	0.4	-	-	-	1	0.1	0.2	1	0.1	0.2
Logperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake chub	3	0.2	0.3	5	0.3	1	5.0	0	0.6	8	0.5	1	-	-	-
Lake Sturgeon	-	-	-	8	0.4	1.1	-	-	-	2	0.1	0.3	4	0.3	0.7
Lake Whitefish	10	0.5	0.7	22	1.2	1.4	20	1.3	2.4	25	1.5	1.8	25	1.5	3.5
Longnose Sucker	10	0.5	0.9	9	0.5	0.9	12	0.8	1.4	28	1.7	3.1	6	0.4	0.7
Mooneye	9	0.5	1.2	13	0.6	1.5	9	0.5	1.1	24	1.4	2.6	-	-	-
Northern Pike	64	3.5	3.7	60	3.5	4.4	43	2.7	2.4	55	3.3	3.5	28	1.7	2.0
Rainbow Smelt	27	1.5	1.9	1	0.0	0.2	-	-	-	-	-	-	8	0.5	1.3
Sauger	74	4.3	6.0	112	6.2	3.7	92	5.7	6.0	137	8.2	7.4	74	4.5	3.8
Shorthead Redhorse	3	0.2	0.4	18	1.0	2.7	26	1.5	3.1	22	1.3	1.4	13	0.8	1.5
Silver Redhorse	-	-	-	-	-	-	1.0	0	0.2	-	-	-	-	-	-
Spottail Shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trout-perch	2	0.1	0.3	-	-	-	-	-	-	-	-	-	-	-	-
Walleye	220	12.5	19.4	138	7.9	6.3	72	4.2	3.4	81	4.9	3.7	141	8.5	6.3
White Sucker	100	5.8	4.4	178	10.2	9.0	165	10.3	5.0	188	11.1	5.1	203	12.1	12.8
Yellow Perch	4	0.2	0.4	9	0.5	0.8	10	0.6	0.8	12	0.7	0.9	8	0.5	0.6
Total	**538**	**30.5**	**41.0**	**580**	**32.6**	**33.6**	**472**	**29.1**	**28.5**	**592**	**35.3**	**32.4**	**514**	**30.9**	**33.8**

1 – Number of fish

2 – Standard deviation

Table 7: Mean catch-per-unit-effort (CPUE; fish/30 m of net/24 h) by species and study year for fish captured in small mesh index gill nets set in Split Lake, summer 2009, 2015, 2019, 2021 and 2022.

Common Name	2009			2015			2019			2021			2022		
	n[1]	CPUE	Std[2]	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std
Burbot	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cisco	-	-	-	1	0.3	0.6	29	10.1	12.3	18	6.1	6.0	-	-	-
Common Carp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Emerald Shiner	29	8.3	14.4	45	15.2	14.9	122	43.4	37.6	94	30.8	33.9	23	5.7	10.9
Freshwater Drum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Logperch	-	-	-	-	-	-	1	0.3	0.6	2	0.7	1.3	-	-	-
Lake chub	14	4.3	7.5	35	11.9	16.4	24	8.3	14.3	14	3.9	3.9	23	5.8	5.7
Lake Sturgeon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Whitefish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Longnose Sucker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mooneye	-	-	-	-	-	-	-	-	-	4	1.4	1.2	2	0.5	1.0
Northern Pike	6	1.8	1.8	6	2.0	2.7	3	1.1	1.0	3	1.0	1.7	5	1.2	2.4
Rainbow Smelt	105	31.3	6.6	9	3.0	2.7	7	2.6	4.5	3	1.0	0.1	6	1.4	1.6
Sauger	1	0.3	0.5	5	1.3	1.1	5	1.7	2.1	14	2.6	3.6	28	7.1	8.1
Shorthead Redhorse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver Redhorse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Slimy Sculpin	7	2.3	3.1	-	-	-	-	-	-	-	-	-	-	-	-
Spottail Shiner	86	26.3	36.1	172	58.3	59.9	172	60.2	67.5	141	46.3	38.5	488	121.9	194.2
Trout-perch	42	12.9	7.5	65	19.8	16.6	12	3.5	0.5	21	7.2	8.4	12	3.0	2.4
Walleye	5	1.6	1.5	7	2.4	2.1	9	3.2	2.9	15	5.1	1.5	22	5.4	2.5
White Sucker	2	0.6	1.1	3	1.0	1.0	-	-	-	-	-	-	1	0.2	0.5
Yellow Perch	2	0.6	1.1	7	2.0	3.5	1	0.3	0.6	2	0.7	0.6	25	6.3	12.5
Total	**299**	**90.2**	**81.1**	**355**	**117.3**	**121.5**	**385**	**134.8**	**143.9**	**331**	**114.0**	**75.9**	**635**	**158.6**	**241.6**

1 – Number of fish

2 – Standard deviation

4.1.2.2 KEEYASK RESERVOIR

Mean total CPUE for SGI gill nets set at ten standard sites in the Keeyask reservoir in 2022 was 20.7 fish/100 m of net/24 h (Table 8). In previous sampling years, mean total CPUE at the same sites ranged from 12.2 fish in 2019 to 30.0 fish in 2001 (Table 8). The mean total CPUE was significantly lower in 2019 and 2021 compared to 2002, but no significant differences between other years was found (Figure 4).

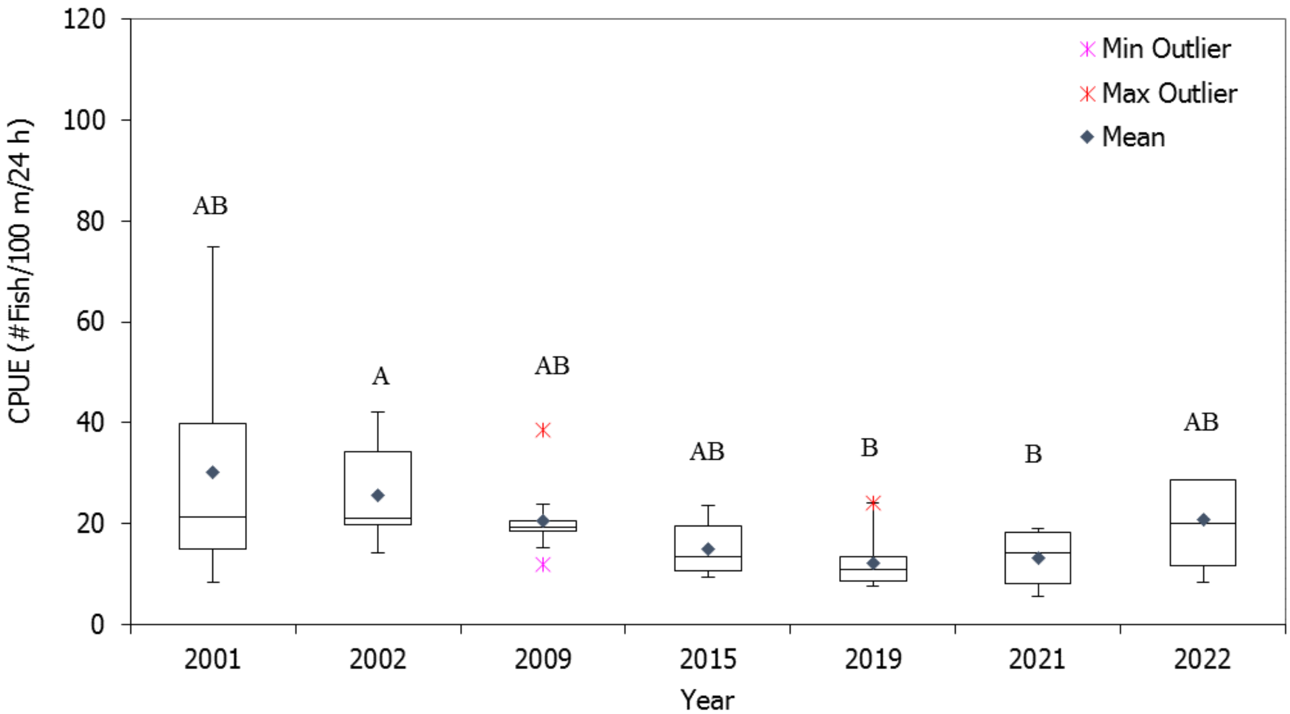


Figure 4: Mean total CPUE for all fish species captured in standard gang index gill nets set in the Keeyask reservoir in 2001, 2002, 2009, 2015, 2019, 2021 and 2022. Letters denote significant differences in CPUE between study years.

Average CPUE for Lake Whitefish, Northern Pike, and Walleye captured in 2022 were 0.7, 1.7, and 7.1 fish/100 m of net/24 h, respectively (Table 8; Figure 5). Average CPUE of Lake Whitefish (H = 3.98, p = 0.68) and Walleye (H = 10.86, p = 0.09) did not differ significantly among sampling years (Figure 5). Average CPUE of Northern Pike was lower in 2022 than in any previous sampling year and was significantly lower in 2022 than in 2001, 2002, and 2009 (Figure 5). It did not differ significantly from 2015, 2019, or 2021.

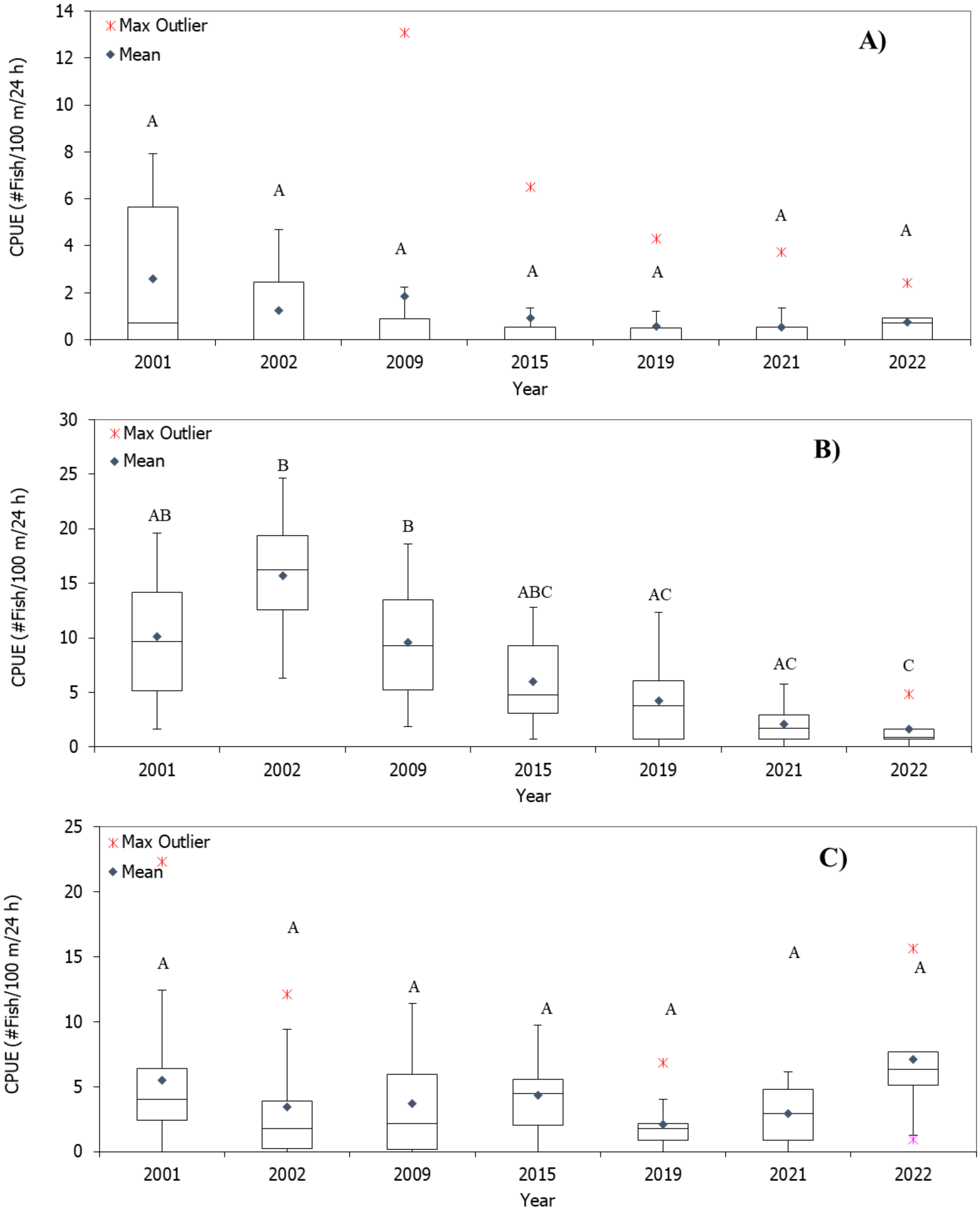


Figure 5: **Mean total CPUE for A) Lake Whitefish, B) Northern Pike and C) Walleye captured in standard gang index gill nets set in the Keeyask reservoir in 2001, 2002, 2009, 2015, 2019, 2021 and 2022. Letters denote significant differences in CPUE between study years.**

Mean total CPUE for the SMI gillnet catch in 2022 was 27.6 fish/30 m of net/24 h (Table 9). Mean total CPUE in SMI nets has been variable, ranging from 11.5 fish in 2002 to 316.3 fish in 2015 (Table 9; Figure 6). Because only two sites were sampled, mean CPUE could not be compared statistically among years.

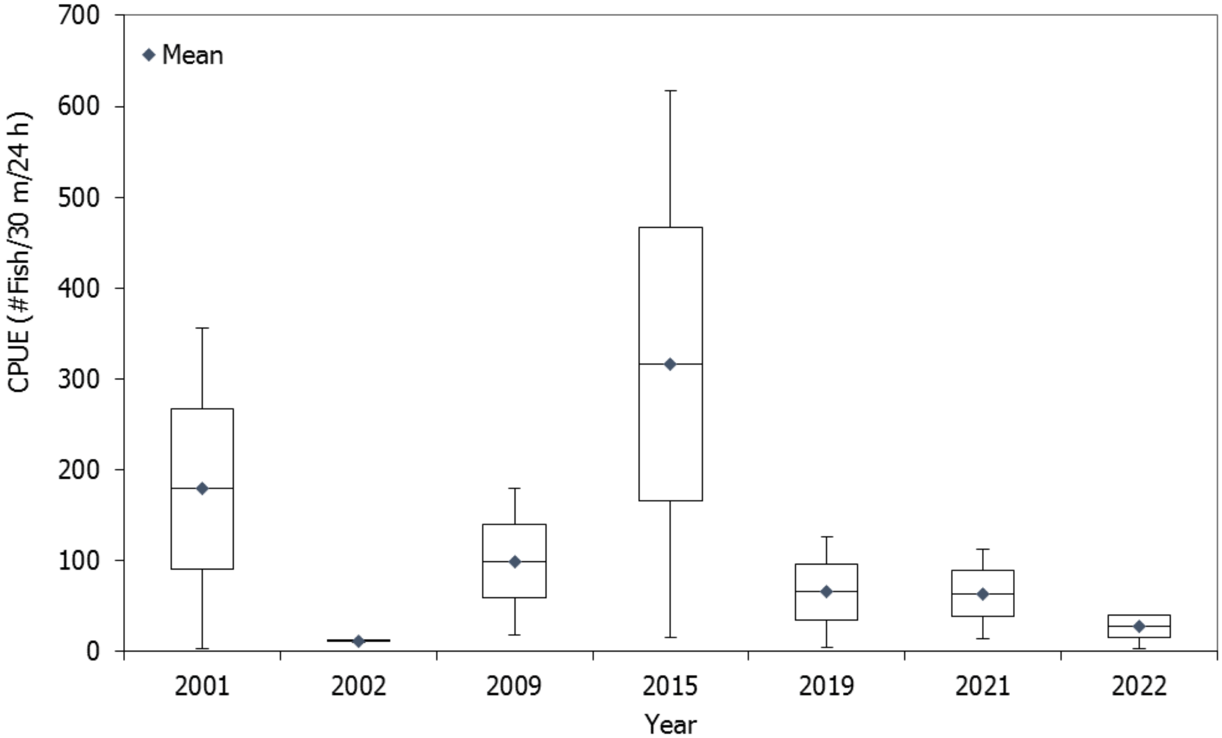


Figure 6: Mean total CPUE for all fish species captured in small mesh index gill nets set in the Keeyask reservoir in 2001, 2002, 2009, 2015, 2019, 2021 and 2022.

Table 8: Mean catch-per-unit-effort (CPUE; fish/100 m of net/24 h) by species and study year for fish captured in standard gang index gill nets set in the Keeyask reservoir, summer 2001, 2002, 2009, 2015, 2019, 2021 and 2022.

Common Name	2001			2002			2009			2015			2019			2021			2022		
	n[1]	CPUE	Std[2]	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std
Burbot	-	-	-	1	0.1	0.3	-	-	-	-	-	-	1	0.1	0.2	1	0.1	0.2	3	0.2	0.4
Cisco	4	0.4	0.9	1	0.1	0.3	-	-	-	1	0.1	0.3	1	0.1	0.2	3	0.2	0.4	-	-	-
Emerald Shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Logperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake chub	-	-	-	1	0.1	0.3	-	-	-	-	-	-	1	0.1	0.3	1	0.1	0.2	-	-	-
Lake Sturgeon	-	-	-	-	-	-	1	0.1	0.2	1	0.1	0.2	1	0.1	0.2	-	-	-	7	0.6	1.1
Lake Whitefish	30	2.6	3.2	15	1.2	1.7	27	1.8	4.2	14	0.9	2.1	8	0.6	1.3	7	0.5	1.2	9	0.7	0.8
Longnose Sucker	3	0.3	0.6	-	-	-	1	0.1	0.2	1	0.1	0.2	3	0.2	0.5	7	0.5	0.6	10	0.8	0.9
Mooneye	31	2.8	6.3	12	1.0	2.9	6	0.4	1.1	1	0.1	0.2	1	0.1	0.2	-	-	-	-	-	-
Northern Pike	122	10.1	6.5	190	15.7	5.9	144	9.5	5.4	84	6.0	4.1	61	4.2	4.2	29	2.1	1.9	20	1.7	1.7
Rainbow Smelt	6	0.5	0.8	12	1.0	1.9	13	0.9	1.0	-	-	-	4	0.3	0.7	4	0.3	0.4	2	0.2	0.5
Sauger	1	0.1	0.2	-	-	-	-	-	-	2	0.1	0.3	15	1.1	1.4	29	2.2	2.0	25	2.2	3.0
Shorthead Redhorse	2	0.2	0.3	2	0.2	0.6	32	2.1	3.8	5	0.3	0.7	10	0.7	1.6	18	1.3	0.9	45	3.4	5.1
Silver Redhorse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.1	0.3	-	-	-
Spottail Shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trout-perch	-	-	-	-	-	-	1	0.1	0.2	-	-	-	-	-	-	-	-	-	-	-	-
Walleye	66	5.5	6.4	41	3.4	4.4	57	3.7	4.1	61	4.3	3.1	30	2.1	1.9	39	2.9	2.2	90	7.1	4.3
White Sucker	28	2.3	2.4	17	1.5	2.2	15	1.0	0.9	22	1.5	1.7	34	2.4	3.4	40	2.9	2.1	37	3.0	2.5
Yellow Perch	62	5.4	10.7	17	1.4	2.9	15	1.0	1.6	21	1.4	1.7	5	0.3	0.7	4	0.3	0.5	9	0.8	1.3
Total	**355**	**30.0**	**27.7**	**309**	**25.6**	**9.7**	**312**	**20.6**	**7.4**	**213**	**15.0**	**5.5**	**175**	**12.2**	**5.0**	**183**	**13.5**	**5.6**	**257**	**20.7**	**9.9**

1 – Number of fish

2 – Standard deviation

Table 9: Mean catch-per-unit-effort (CPUE; fish/30 m of net/24 h) by species and study year for fish captured in small mesh index gill nets set in the Keeyask reservoir, summer 2001, 2002, 2009, 2015, 2019, 2021 and 2022.

Common Name	2001			2002			2009			2015			2019			2021			2022		
	n[1]	CPUE	Std[2]	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std
Burbot	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cisco	-	-	-	-	-	-	1	0.4	0.6	17	8.1	11.4	22	10.8	15.3	3	1.5	2.1	2	1.1	1.6
Emerald Shiner	-	-	-	1	0.6	0.8	-	-	-	413	195.9	260.3	2	1.0	1.4	5	2.5	3.5	-	-	-
Logperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Sturgeon	2	1.2	1.7	-	-	-	-	-	-	-	-	-	-	-	-	1	0.5	0.7	-	-	-
Lake Whitefish	-	-	-	-	-	-	-	-	-	-	-	-	1	0.5	0.7	-	-	-	-	-	-
Longnose Sucker	-	-	-	1	0.6	0.8	-	-	-	-	-	-	2	1.0	1.4	-	-	-	-	-	-
Mooneye	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern Pike	2	1.2	1.7	2	1.1	1.6	6	2.7	3.8	5	2.4	3.3	7	3.4	4.9	2	1.0	1.4	2	1.0	0.1
Rainbow Smelt	98	58.4	82.7	-	-	-	21	9.3	9.6	2	0.9	1.3	-	-	-	-	-	-	-	-	-
Sauger	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1.0	0.1	3	1.7	2.4
Shorthead Redhorse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.5	0.7
Silver Redhorse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spottail Shiner	146	87.1	123.1	2	1.1	1.6	33	14.7	20.8	214	101.4	142.0	91	44.7	63.2	83	41.1	58.1	32	17.8	25.2
Trout-perch	18	10.6	12.0	7	4.2	5.9	39	16.9	1.3	9	4.3	1.9	5	2.5	2.1	10	4.7	2.4	2	1.1	1.6
Walleye	2	1.2	1.7	-	-	-	-	-	-	-	-	-	-	-	-	3	1.5	2.1	8	4.4	4.8
White Sucker	3	1.7	1.0	-	-	-	1	0.4	0.6	4	1.9	2.7	2	1.0	1.4	-	-	-	-	-	-
Yellow Perch	30	17.9	25.3	7	3.9	5.5	123	54.8	77.5	3	1.4	2.0	1	0.5	0.7	21	10.1	5.3	-	-	-
Total	**301**	**179.3**	**249.2**	**20**	**11.5**	**1.1**	**224**	**99.3**	**114.3**	**667**	**316.3**	**425.0**	**133**	**65.4**	**87.9**	**130**	**63.8**	**70.8**	**50**	**27.6**	**34.9**

1 – Number of fish

2 – Standard deviation

4.1.2.3 STEPHENS LAKE NORTH

Mean total CPUE for SGI gill nets set at nine standard sites in 2022 was 28.9 fish/100 m of net/24 h (Table 10). In previous sampling years, mean total CPUE at the same sites ranged from 19.0 fish in 2009 to 34.6 fish in 2015. Mean total CPUE did not differ significantly among sampling years (H = 2.44, p = 0.64; Figure 7).

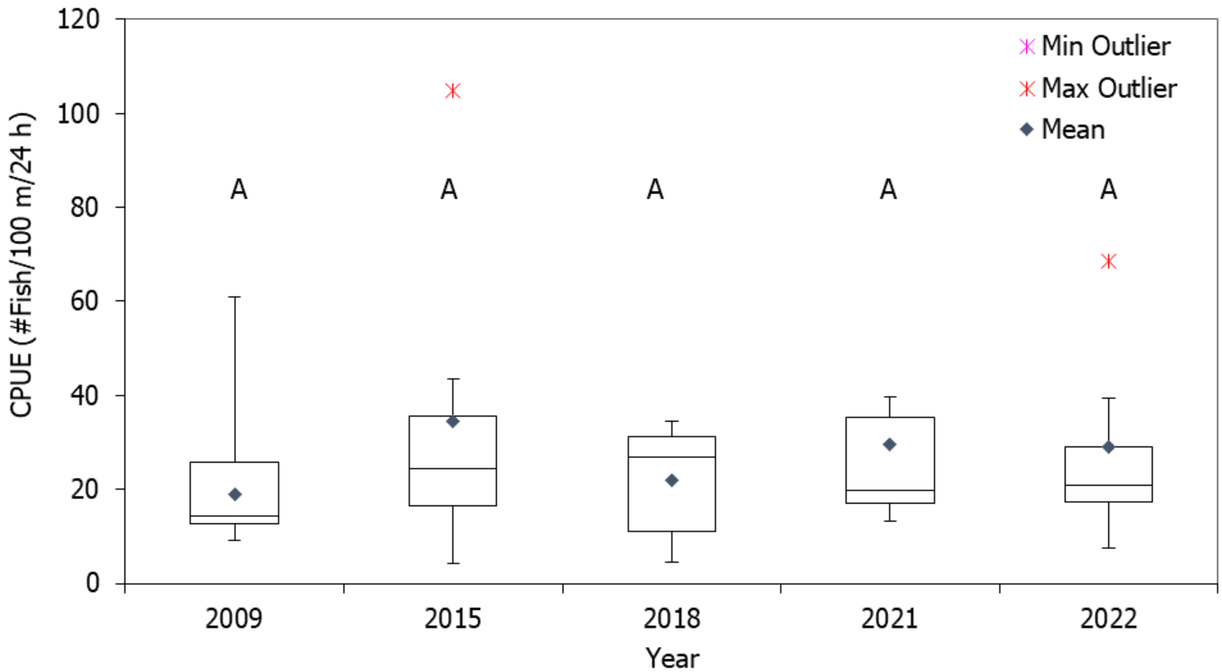


Figure 7: Mean total CPUE for all fish species captured in standard gang index gill nets set in Stephens Lake North in 2009, 2015, 2018, 2021 and 2022. Letters denote significant differences in CPUE between study years.

Average CPUE for Lake Whitefish, Northern Pike, and Walleye captured in 2022 was 1.2, 4.2, and 10.6 fish/100 m of net/24 h, respectively (Table 9). Average CPUE of Lake Whitefish (H = 3.46, p = 0.48), Northern Pike (H = 9.2, p = 0.057), and Walleye (H = 0.95, p = 0.92) did not differ significantly among sampling years (Figure 8).

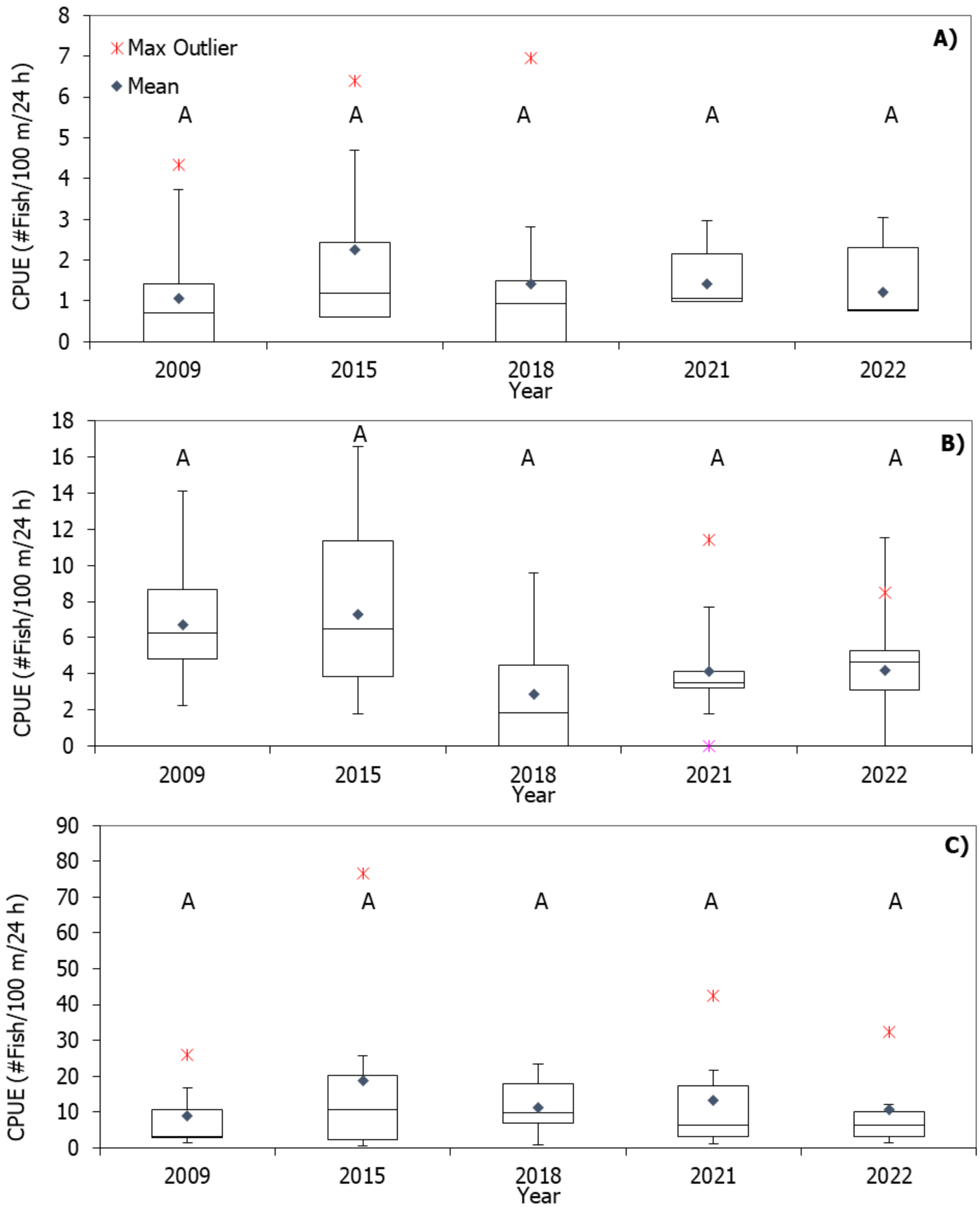


Figure 8: **Mean total CPUE for A) Lake Whitefish, B) Northern Pike and C) Walleye captured in standard gang index gill nets set in Stephens Lake North in 2009, 2015, 2018, 2021 and 2022. Letters denote significant differences in CPUE between study years.**

Mean total CPUE for the SMI gillnet catch in 2022 was 66.3 fish/30 m of net/24 h (Table 11). In previous sampling years, it ranged from 66.7 fish in 2009 to 289.2 fish in 2021 (Table 11; Figure 9). Mean CPUE could not be compared statistically among years as too few sites were sampled each year.

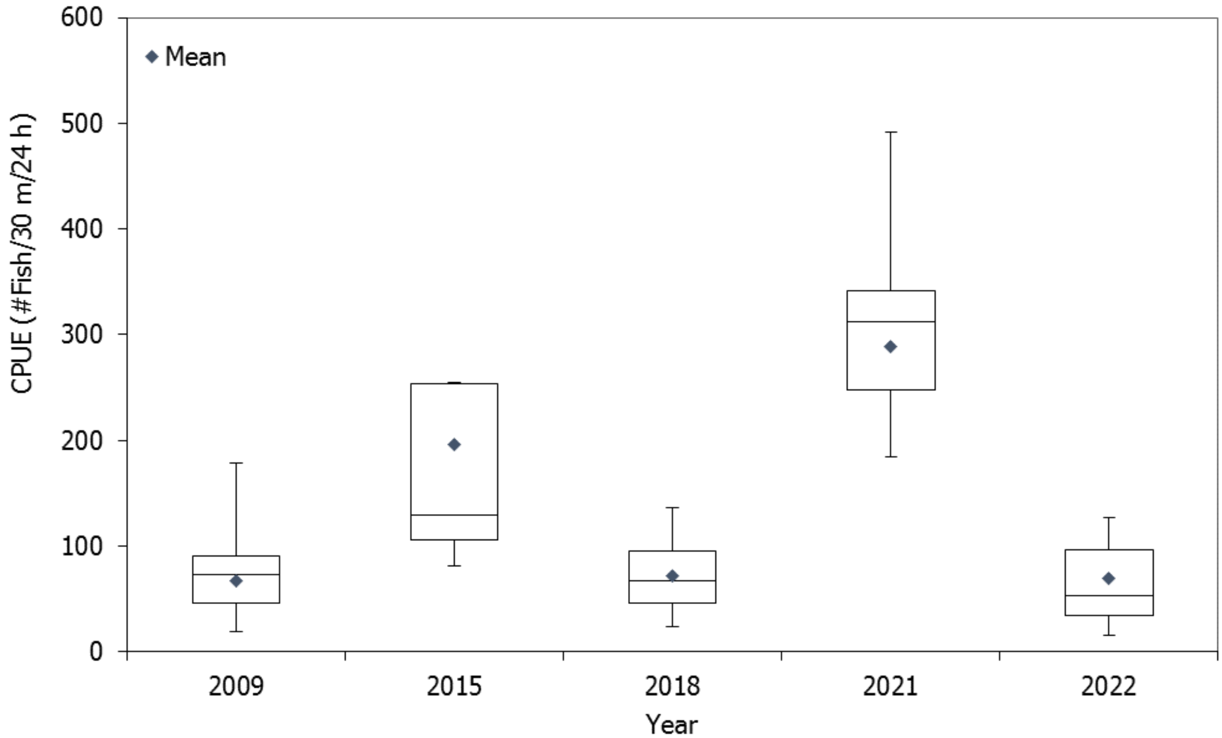


Figure 9: Mean total CPUE for all fish species captured in small mesh index gill nets set in Stephens Lake North in 2009, 2015, 2018, 2021 and 2022.

Table 10: Mean catch-per-unit-effort (CPUE; fish/100 m of net/24 h) by species and study year for fish captured in standard gang index gill nets set in Stephens Lake North, summer 2009, 2015, 2018, 2021 and 2022.

Common Name	2009			2015			2018			2021			2022		
	n[1]	CPUE	Std[2]	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std
Burbot	-	-	-	1	0.1	0.3	-	-	-	-	-	-	-	-	-
Cisco	7	0.5	1.4	7	1.0	2.2	9	0.9	1.1	30	2.7	4.6	47	4.0	5.9
Common Carp	1	0.1	0.2	-	-	-	-	-	-	-	-	-	-	-	-
Emerald Shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Logperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Sturgeon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Whitefish	13	1.1	1.5	21	2.2	2.4	15	1.4	2.2	14	1.4	0.9	14	1.2	1.0
Longnose Sucker	-	-	-	2	0.2	0.4	-	-	-	1	0.1	0.3	-	-	-
Mooneye	-	-	-	42	2.8	8.4	-	-	-	7	0.8	1.4	2	1.5	-
Northern Pike	85	6.7	3.2	74	7.3	4.9	29	2.9	3.0	43	4.1	3.1	49	4.2	2.6
Rainbow Smelt	16	1.3	1.0	6	0.8	1.7	-	-	-	2	0.2	0.4	14	1.2	2.8
Sauger	-	-	-	-	-	-	23	2.3	3.9	14	1.6	2.9	15	1.3	1.1
Shorthead Redhorse	-	-	-	-	-	-	3	0.3	0.9	7	0.8	1.4	8	0.7	1.3
Silver Redhorse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spottail Shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trout-perch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Walleye	107	8.8	9.6	168	18.8	24.1	116	11.1	7.4	141	13.2	14.9	123	10.6	11.9
White Sucker	6	0.5	0.6	15	1.2	1.4	32	3.1	3.1	39	4.3	3.9	60	5.1	1.2
Yellow Perch	-	-	-	2	0.3	0.5	-	-	-	2	0.2	0.4	5	0.4	0.8
Total	**235**	**19.0**	**10.1**	**338**	**34.6**	**31.9**	**227**	**21.9**	**11.3**	**300**	**29.5**	**34.1**	**337**	**28.9**	**20.7**

1 – Number of fish

2 – Standard deviation

Table 11: Mean catch-per-unit-effort (CPUE; fish/30 m of net/24 h) by species and study year for fish captured in small mesh index gill nets set in Stephens Lake North, summer 2009, 2015, 2018, 2021 and 2022.

Common Name	2009			2015			2018			2021			2022		
	n[1]	CPUE	Std[2]	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std
Burbot	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cisco	-	-	-	-	-	-	8	3.3	3.4	9	3.3	5.7	3	1.1	1.9
Common Carp	34	11.6	20.0	180	84.6	114.4	63	26.7	34.7	282	118.2	87.4	-	-	-
Emerald Shiner	1	0.3	0.5	-	-	-	2	0.9	1.6	-	-	-	3	1.1	1.1
Logperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Sturgeon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Whitefish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Longnose Sucker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mooneye	3	1.0	0.1	13	6.2	8.7	3	1.1	1.0	3	1.2	2.1	-	-	-
Northern Pike	66	21.3	14.4	5	1.3	2.2	1	0.3	0.6	7	2.8	4.8	3	1.1	1.1
Rainbow Smelt	-	-	-	-	-	-	3	1.3	1.3	-	-	-	5	1.8	3.1
Sauger	-	-	-	-	-	-	-	-	-	-	-	-	4	1.4	2.4
Shorthead Redhorse	87	27.6	19.7	283	98.4	38.7	46	18.6	13.6	385	149.6	162.2	-	-	-
Silver Redhorse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spottail Shiner	1	0.3	0.6	10	2.7	2.9	32	11.6	11.1	9	3.7	0.6	146	51.7	54.8
Trout-perch	12	4.0	3.8	8	2.9	1.7	16	6.5	2.5	12	4.7	2.9	11	3.9	3.4
Walleye	-	-	-	-	-	-	-	-	-	-	-	-	5	1.8	3.1
White Sucker	2	0.6	1.1	1	0.5	0.9	3	1.3	1.3	15	5.7	4.9	1	0.4	0.6
Yellow Perch	-	-	-	-	-	-	-	-	-	-	-	-	6	2.1	2.9
Total	**206**	**66.7**	**44.3**	**500**	**196.5**	**159.5**	**177**	**71.7**	**50.0**	**722**	**289.2**	**95.2**	**187**	**66.3**	**68.3**

1 – Number of fish

2 – Standard deviation

4.1.2.4 STEPHENS LAKE SOUTH

Mean total CPUE for SGI gill nets set at nine standard sites in 2022 was 20.2 fish/100 m of net/24 h (Table 12). In previous sampling years, mean total CPUE at the same sites ranged from 18.4 fish in 2015 to 35.8 fish in 2021 but did not differ significantly among sampling years ($H_{1,4}$ = 4.71, p = 0.32; Figure 10).

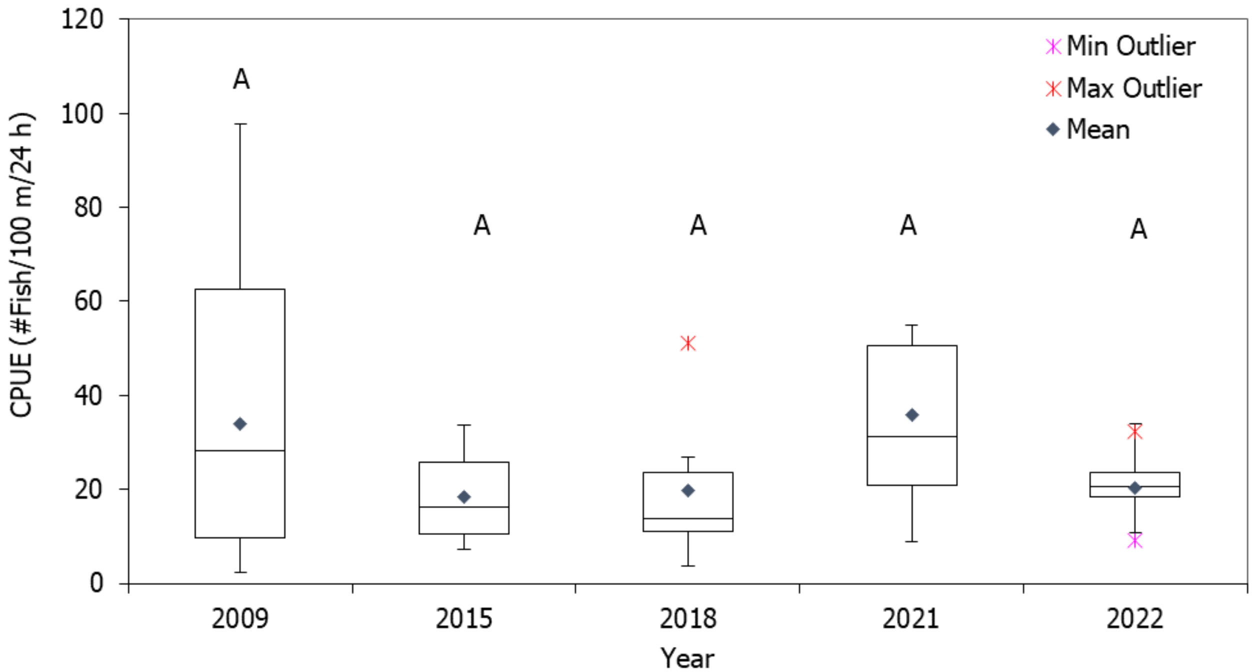


Figure 10: Mean total CPUE for all fish species captured in standard gang index gill nets set in Stephens Lake South in 2009, 2015, 2018, 2021 and 2022. Letters denote significant differences in CPUE between study years.

Average CPUE for Lake Whitefish, Northern Pike, and Walleye captured in 2022 was 0.3, 1.2, and 4.9 fish/100 m of net/24 h, respectively (Table 12). Average CPUE of Lake Whitefish (H = 2.9, p = 0.57), Northern Pike (H = 6.19, p = 0.19), and Walleye (H = 2.46, p = 0.65) did not differ significantly among sampling years (Figure 11).

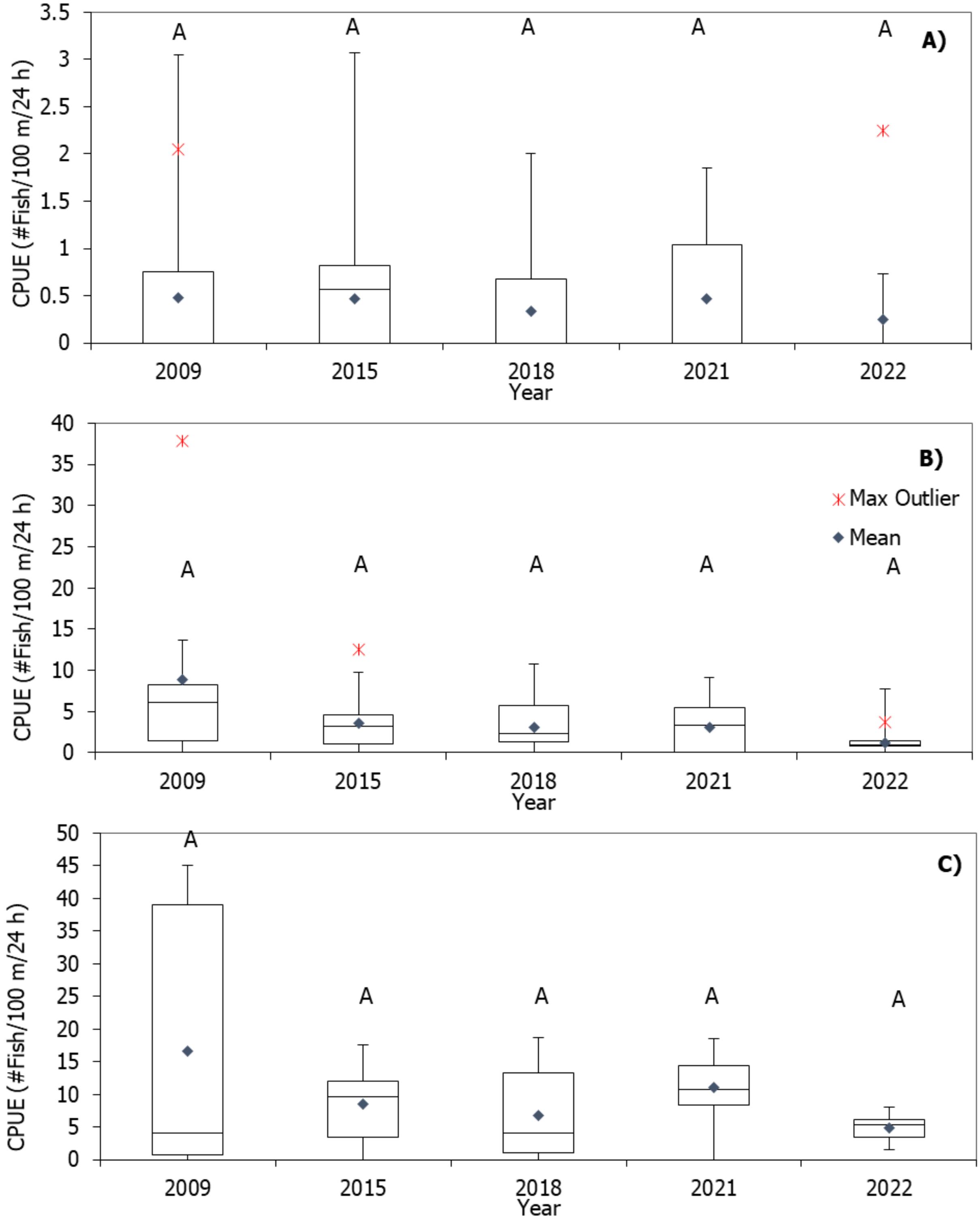


Figure 11: Mean total CPUE for A) Lake Whitefish, B) Northern Pike and C) Walleye captured in standard gang index gill nets set in Stephens Lake South in 2009, 2015, 2018, 2021 and 2022. Letters denote significant differences in CPUE between study years.

Mean total CPUE for the SMI gillnet catch in 2022 was 59.2 fish/30 m of net/24 h (Table 13). In previous sampling years, mean total CPUE ranged from 43.6 fish in 2009 to 134.5 fish in 2015 (Table 13; Figure 12). Mean CPUE could not be compared statistically among years as too few sites were sampled each year.

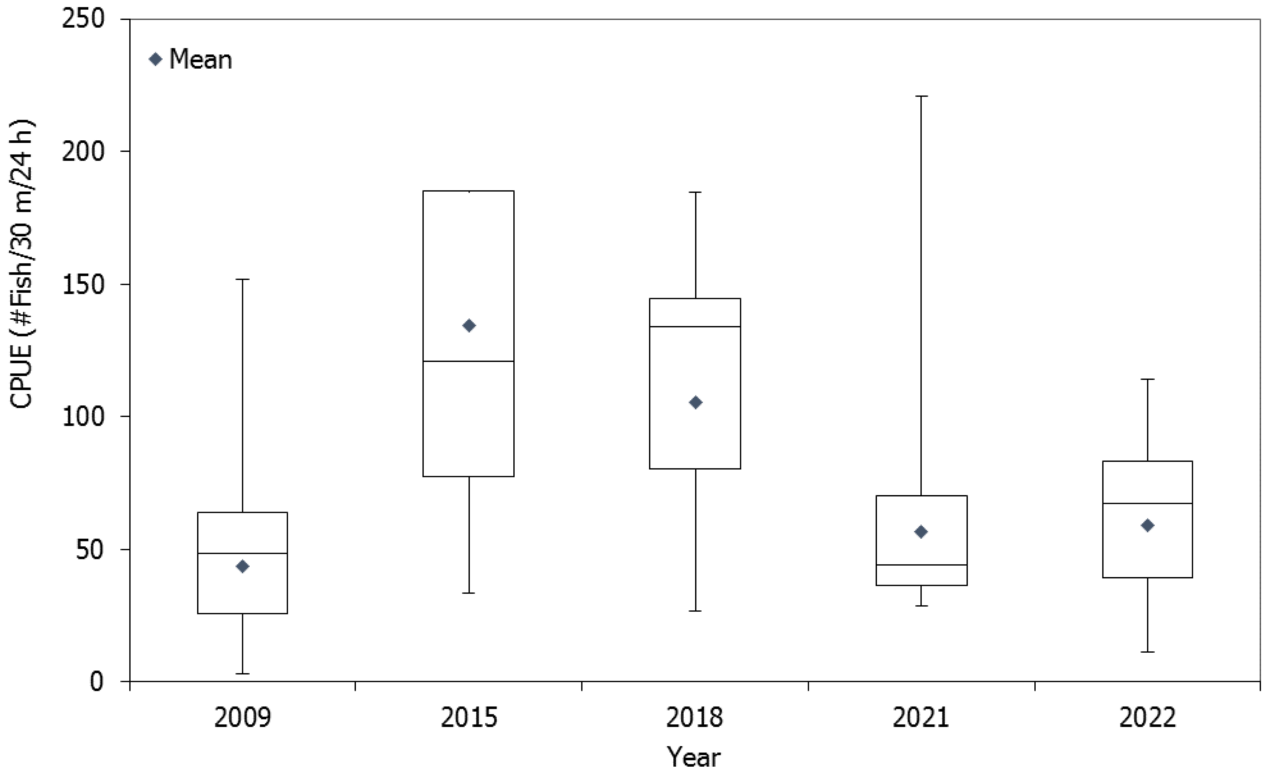


Figure 12: Mean total CPUE for all fish species captured in small mesh index gill nets set in Stephens Lake South in 2009, 2015, 2018, 2021 and 2022.

Table 12: Mean catch-per-unit-effort (CPUE; fish/100 m of net/24 h) by species and study year for fish captured in standard gang index gill nets set in Stephens Lake South, summer 2009, 2015, 2018, 2021 and 2022.

Common Name	2009			2015			2018			2021			2022		
	n[1]	CPUE	Std[2]	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std
Burbot	-	-	-	-	-	-	2	0.2	0.5	2	0.2	0.5	1	0.1	0.3
Cisco	1	0.1	0.2	2	0.1	0.4	-	-	-	-	-	-	-	-	-
Common Carp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Emerald Shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Freshwater Drum	-	-	-	-	-	-	-	-	-	2	0.2	0.5	-	-	-
Logperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Sturgeon	-	-	-	1	0.1	0.3	-	-	-	1	0.1	0.3	1	0.1	0.3
Lake Whitefish	6	0.5	0.7	6	0.5	0.5	4	0.3	0.5	4	0.5	0.6	3	0.3	0.8
Longnose Sucker	-	-	-	4	0.4	1.3	3	0.4	0.7	11	1.2	2.7	1	0.1	0.2
Mooneye	12	1.0	3.0	-	-	-	19	1.6	2.8	35	3.2	9.2	1	0.1	0.2
Northern Pike	88	8.9	11.7	45	3.6	3.8	32	3.1	2.4	27	3.0	2.8	15	1.2	1.1
Rainbow Smelt	28	2.5	2.8	-	-	-	-	-	-	-	-	-	-	-	-
Sauger	33	2.8	7.3	5	0.3	0.4	5	0.6	0.7	20	2.2	3.8	38	3.2	3.9
Shorthead Redhorse	-	-	-	-	-	-	7	0.7	1.6	6	0.7	1.4	6	0.5	1.2
Silver Redhorse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spottail Shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trout-perch	1	0.1	0.3	-	-	-	1	0.1	0.4	-	-	-	-	-	-
Walleye	183	16.6	21.4	101	8.4	5.6	72	6.7	6.7	97	11.0	7.8	59	4.9	2.1
White Sucker	15	1.3	1.7	57	4.5	2.7	63	5.8	6.8	113	13.4	14.7	115	9.5	5.2
Yellow Perch	1	0.1	0.4	5	0.4	0.7	3	0.2	0.5	-	-	-	5	0.4	0.5
Total	**368**	**33.9**	**29.4**	**226**	**18.4**	**8.7**	**211**	**19.8**	**16.5**	**318**	**35.8**	**21.1**	**245**	**20.2**	**7.2**

1 – Number of fish

2 – Standard deviation

Table 13: Mean catch-per-unit-effort (CPUE; fish/30 m of net/24 h) by species and study year for fish captured in small mesh index gill nets set in Stephens Lake South, summer 2009, 2015, 2018, 2021 and 2022.

Common Name	2009			2015			2018			2021			2022		
	n[1]	CPUE	Std[2]	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std
Burbot	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cisco	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Common Carp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Emerald Shiner	-	-	-	53	17.3	17.1	135	48.0	41.6	12	4.7	5.9	3	1.0	1.0
Freshwater Drum	-	-	-	6	2.2	3.1	13	4.0	6.9	-	-	-	-	-	-
Logperch	-	-	-	-	-	-	-	-	-	-	-	-	10	3.3	3.4
Lake chub	-	-	-	5	1.3	2.3	-	-	-	1	0.3	0.5	-	-	-
Lake Sturgeon	-	-	-	-	-	-	3	0.9	1.6	-	-	-	-	-	-
Lake Whitefish	-	-	-	5	2.1	1.8	-	-	-	-	-	-	-	-	-
Longnose Sucker	45	15.4	13.4	9	2.5	3.3	-	-	-	1	0.4	0.7	-	-	-
Mooneye	5	1.6	2.8	2	0.9	1.6	5	2.5	2.5	8	3.8	3.3	-	-	-
Northern Pike	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rainbow Smelt	31	10.3	10.0	277	92.9	95.0	85	29.5	26.1	67	25.7	29.3	5	1.7	3.0
Sauger	41	13.6	12.7	31	12.5	10.0	23	10.9	9.6	37	15.4	6.6	16	5.5	5.2
Shorthead Redhorse	1	0.4	0.6	3	0.9	0.8	18	6.5	5.8	10	3.6	3.2	-	-	-
Silver Redhorse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spottail Shiner	4	1.3	2.2	1	0.3	0.5	2	0.6	1.1	1	0.6	1.0	66	22.3	20.0
Trout-perch	3	1.1	1.1	5	1.3	2.3	7	2.3	2.9	5	2.0	2.7	48	16.3	15.6
Walleye	-	-	-	1	0.4	0.7	-	-	-	-	-	-	4	1.3	2.3
White Sucker	-	-	-	-	-	-	-	-	-	-	-	-	20	6.7	5.9
Yellow Perch	-	-	-	-	-	-	-	-	-	-	-	-	3	1.0	2
Total	**130**	**43.6**	**38.2**	**398**	**134.5**	**108.3**	**291**	**105.3**	**68.6**	**142**	**56.5**	**35.5**	**175**	**59.2**	**44.4**

1 – Number of fish

2 – Standard deviation

4.1.3 SIZE

4.1.3.1 SPLIT LAKE

A total of 675 VEC fish were measured for FL during baseline and 401 during the post-impoundment period (Table 14). Length frequency distributions are provided in Figure 13. Lake Whitefish in the 400–449 mm FL interval were captured most frequently during both baseline (31.4%) and post-impoundment (43.1%) periods. Northern Pike measuring between 450 and 499 mm FL were captured most frequently during both periods (21.0% and 22.0%). Walleye measuring between 200 and 249 mm FL were most frequently captured (23.9%) post-impoundment, while fish between 400 and 449 mm FL were most frequently captured (23.4%) during the baseline period.

Mean FL for Lake Whitefish ($t = 1.3$, $p = 0.2$) and Northern Pike ($t = 1.67$, $p = 0.1$) did not differ significantly between baseline and post-impoundment periods. Mean FL for Walleye was significantly lower during post-impoundment compared to the baseline period ($t = 8.24$, $p < 0.001$).

Table 14: Mean Fork length (FL), weight and condition factor (K) for Lake Whitefish, Northern Pike and Walleye captured in the Keeyask Area during baseline (*i.e.*, 2001–2019; white) and post-impoundment (2021 and 2022; grey) studies.

Location	Year	Lake Whitefish				Northern Pike				Walleye			
		n[1]	FL (mm)	Weight (g)	K	n	FL (mm)	Weight (g)	K	n	FL (mm)	Weight (g)	K
Split Lake	2009	10	498	2435	1.93	64	513	1294	0.77	222	369	741	1.29
	2015	22	404	1159	1.65	66	495	1032	0.68	145	342	530	1.09
	2019	19	434	1453	1.75	46	487	833	0.66	81	292	363	1.07
	2021	25	446	1,489	1.61	58	488	1,121	0.73	96	326	452	1.10
	2022	26	385	1006	1.48	33	439	760	0.66	163	290	352	1.14
Keeyask reservoir[2,3]	2001	31	416	1674	1.73	124	483	1201	0.77	68	420	1206	1.30
	2002	15	406	1659	1.69	190	561	1669	0.77	41	470	1643	1.37
	2009	27	455	1894	1.76	150	539	1487	0.76	57	433	1268	1.30
	2015	13	419	1357	1.60	89	564	1503	0.68	61	402	942	1.13
	2019	8	463	1960	1.88	68	534	1524	0.71	30	379	706	1.10
	2021	8	287	842	1.39	31	446	1314	0.71	42	333	530	1.07
	2022	9	431	1883	1.65	22	483	1492	0.71	98	327	470	1.08
Stephens Lake North	2009	14	388	1581	1.91	88	547	1416	0.74	119	428	1284	1.40
	2015	21	361	1044	1.45	87	571	1533	0.66	176	382	771	1.15
	2018	17	383	991	1.52	31	498	958	0.72	130	387	692	1.13
	2021	14	366	976	1.51	46	517	1322	1.04	153	362	625	1.14
	2022	14	351	815	1.31	52	480	879	0.65	128	398	753	1.10
Stephens Lake South	2009	6	486	2528	2.04	88	529	1449	0.75	184	442	1345	1.40
	2015	12	284	1043	1.42	50	520	1268	0.69	104	413	984	1.15
	2018	4	500	1952	1.92	32	517	1173	0.71	78	409	823	1.09
	2021	4	411	1223	1.80	27	501	1325	0.69	107	347	573	1.15
	2022	3	377	697	1.26	15	453	639	0.67	63	337	497	1.14

1 – Number of fish.

2 – Area of the Nelson River between Clark Lake and Gull Rapids/the Keeyask GS.

3 – Standard sites

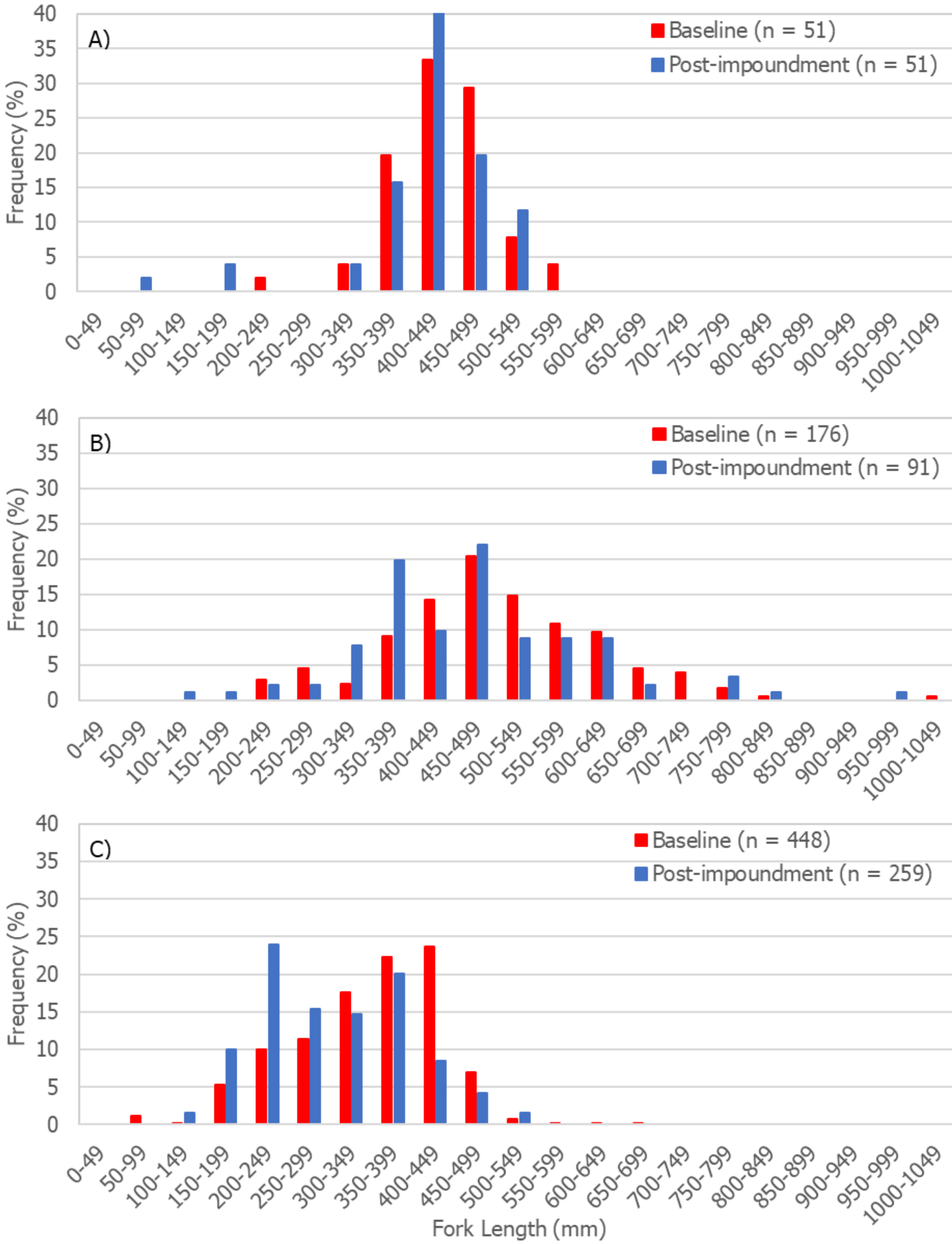


Figure 13: Fork length frequency distribution of A) Lake Whitefish B) Northern Pike and C) Walleye captured in standard gang index gill nets in Split Lake, during baseline (2009, 2015, 2019) and post-impoundment (2021 and 2022) monitoring.

4.1.3.2 KEEYASK RESERVOIR

A total of 972 VEC fish were measured for FL during baseline and 210 during post-impoundment (Table 14). Length frequency distributions are provided in Figure 14. Lake Whitefish in the 200–249 mm FL interval were most frequently captured post-impoundment (23.5%), but only represented 4.3% of the catch during the baseline period. More small Northern Pike were also captured post-impoundment with fish measuring 200–299 mm FL making up 32.1% of the catch compared to 6.3% during baseline studies. Walleye measuring between 400 and 499 mm FL were captured most frequently during both baseline (36.2%) and post-impoundment (30.0%) periods. However, as with other species, more small Walleye were captured post-impoundment with those measuring between 200 and 299 mm FL making up 30.0% of the catch compared with 9.7% of the catch during baseline.

Mean FL of Lake Whitefish ($t = 2.03$ $p = 0.044$), Northern Pike ($t = 3.3$, $p = 0.001$), and Walleye (= 8.24, $p < 0.001$) was significantly lower during post-impoundment compared to baseline.

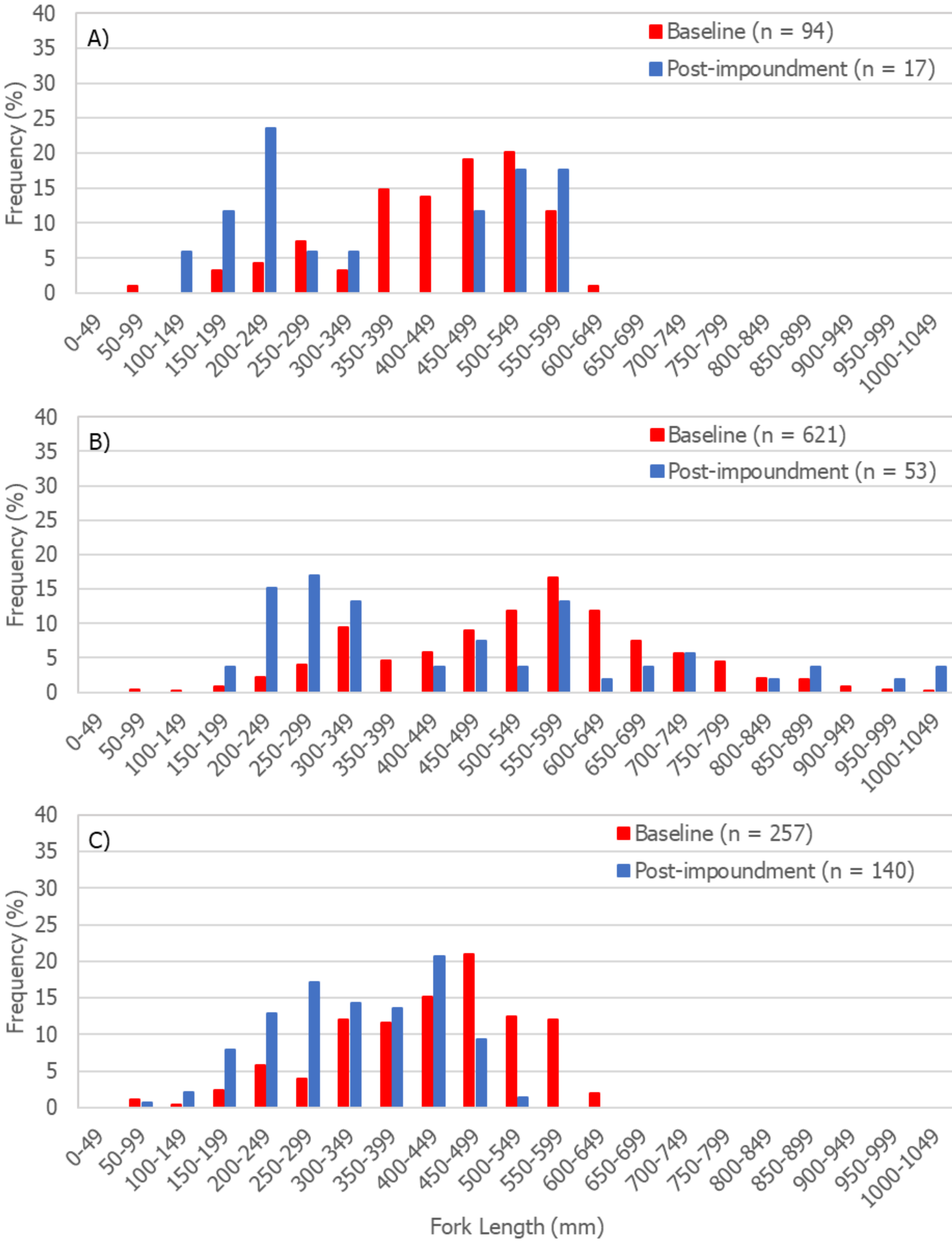


Figure 14: Fork length frequency distribution of A) Lake Whitefish B) Northern Pike and C) Walleye captured in standard gang index gill nets in the Keeyask reservoir, during baseline (2001, 2002, 2009, 2015, 2019) and post-impoundment (2021 and 2022) monitoring.

4.1.3.3 STEPHENS LAKE NORTH

A total of 683 VEC fish were measured for FL during baseline and 407 during post-impoundment (Table 14). Length frequency distributions are provided in Figure 15. Lake Whitefish in the 400–449 mm FL interval were most commonly captured post-impoundment (21.4%), while those in the 500–549 mm FL interval were most commonly captured during baseline (19.9%). Northern Pike in the 450–499 mm FL interval were captured most frequently post-impoundment (20.4%) while those in the 500–549 mm FL interval were most commonly captured during baseline (19.9%). Walleye measuring between 350 and 449 mm FL were captured most frequently during both baseline (39.5%) and post-impoundment (54.4%) periods.

Mean FL for Lake Whitefish ($t = 0.58$, $p = 0.57$) did not differ significantly between baseline and post-impoundment. The mean FL for both Northern Pike ($t = 2.94$, $p = 0.004$) and Walleye ($t = 2.72$, $p = 0.007$) was significantly lower during the post-impoundment period.

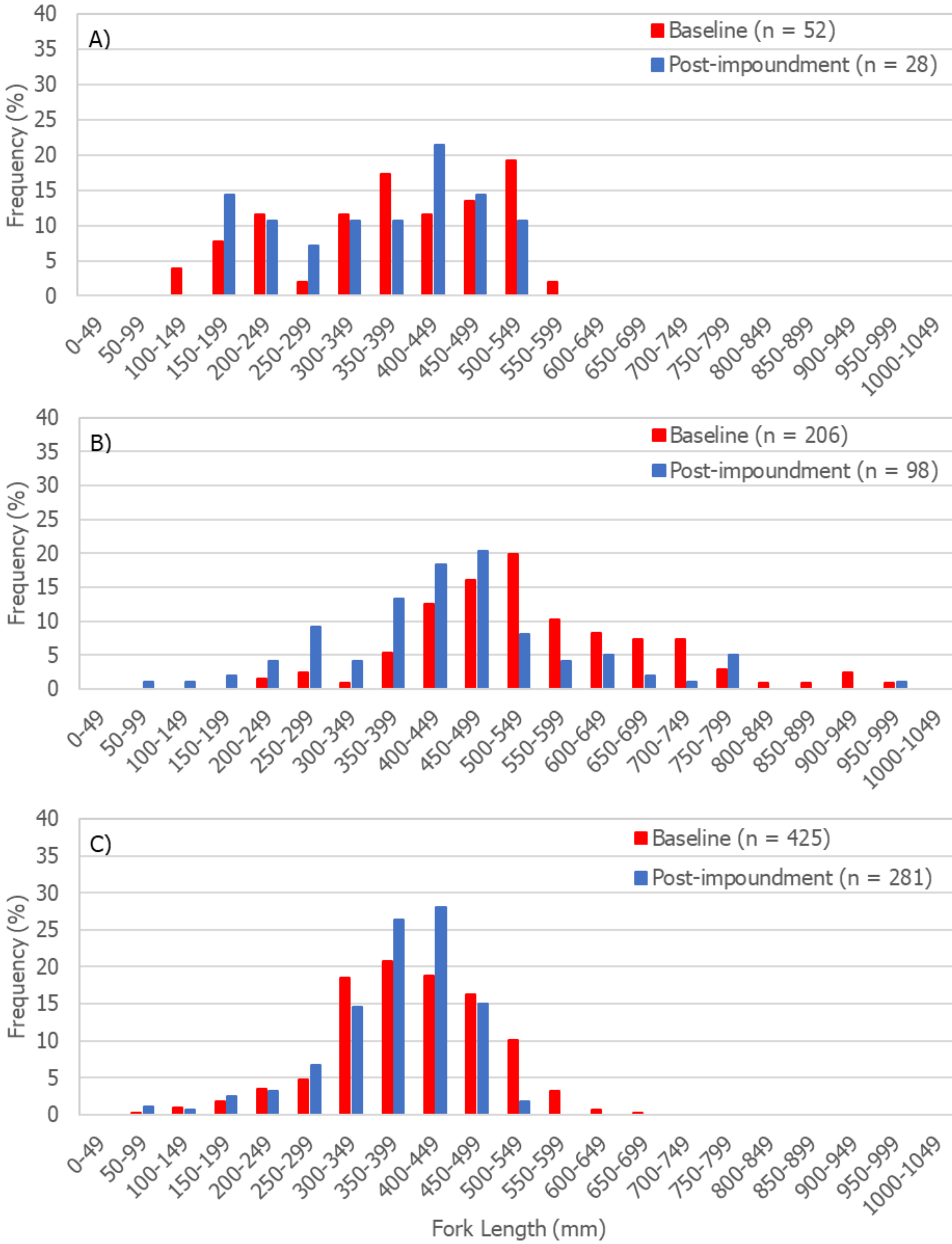


Figure 15: Fork length frequency distribution of A) Lake Whitefish B) Northern Pike and C) Walleye captured in standard gang index gill nets in Stephens Lake North, during baseline (2009, 2015, 2018) and post-impoundment (2021 and 2022) monitoring.

4.1.3.4 STEPHENS LAKE SOUTH

A total of 558 VEC fish were measured for FL during baseline and 219 during post-impoundment (Table 14). Length frequency distributions are provided in Figure 16. Too few Lake Whitefish were captured during both baseline and post-impoundment periods to define length-frequency modes. Northern Pike measuring between 400 and 499 mm FL made up the majority of captured fish during both baseline (29.9%) and post-impoundment (45.2%) periods. A larger number of small Walleye were captured post-impoundment with fish in the 300–349 mm FL interval captured most frequently (19.4%). During baseline, Walleye in the 400–449 mm FL interval were captured most frequently (25.7%).

Mean FL of Lake Whitefish (t = -0.24, p = 0.81) and Northern Pike (t = 1.51, p = 0.13) did not differ significantly between baseline to post-impoundment sampling periods. Mean FL of Walleye was significantly lower post-impoundment than during baseline (t = 9.36, p < 0.001).

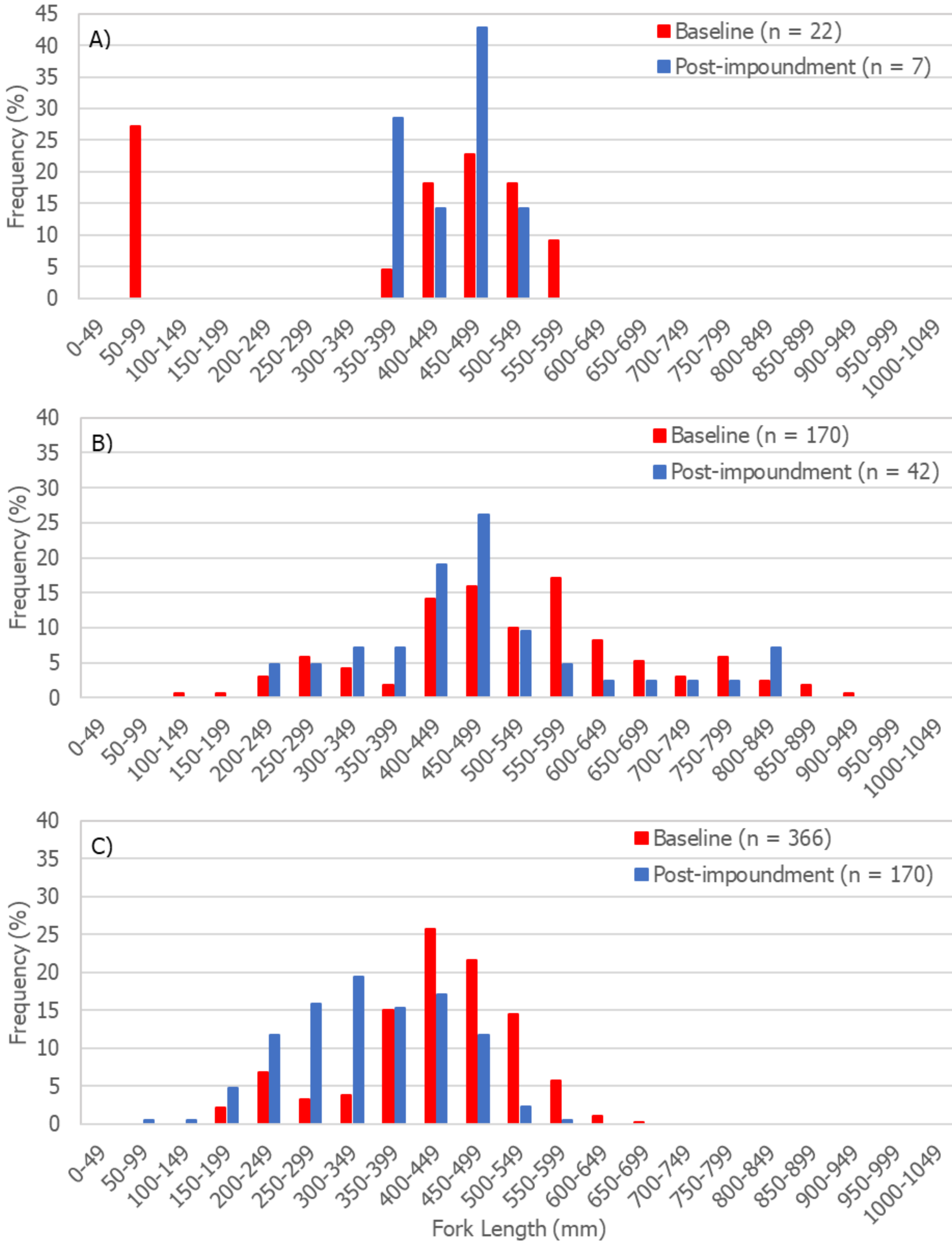


Figure 16: Fork length frequency distribution of A) Lake Whitefish B) Northern Pike and C) Walleye captured in standard gang index gill nets in Stephens Lake South, during baseline (2009, 2015, 2018) and post-impoundment (2021 and 2022) monitoring.

4.1.4 CONDITION

4.1.4.1 SPLIT LAKE

Mean condition factor of VEC fish captured in Split Lake during 2022 was 1.48 for Lake Whitefish (n = 26), 0.66 for Northern Pike (n = 33), and 1.14 for Walleye (n = 163; Table 14). The condition of Lake Whitefish and Walleye was significantly higher during baseline than post impoundment (ANCOVA, p = 0.02 and <0.0001, respectively) (Figure 17). The condition factor of Northern Pike was significantly higher post-impoundment (ANCOVA, *p*<0.0001) (Figure 17).

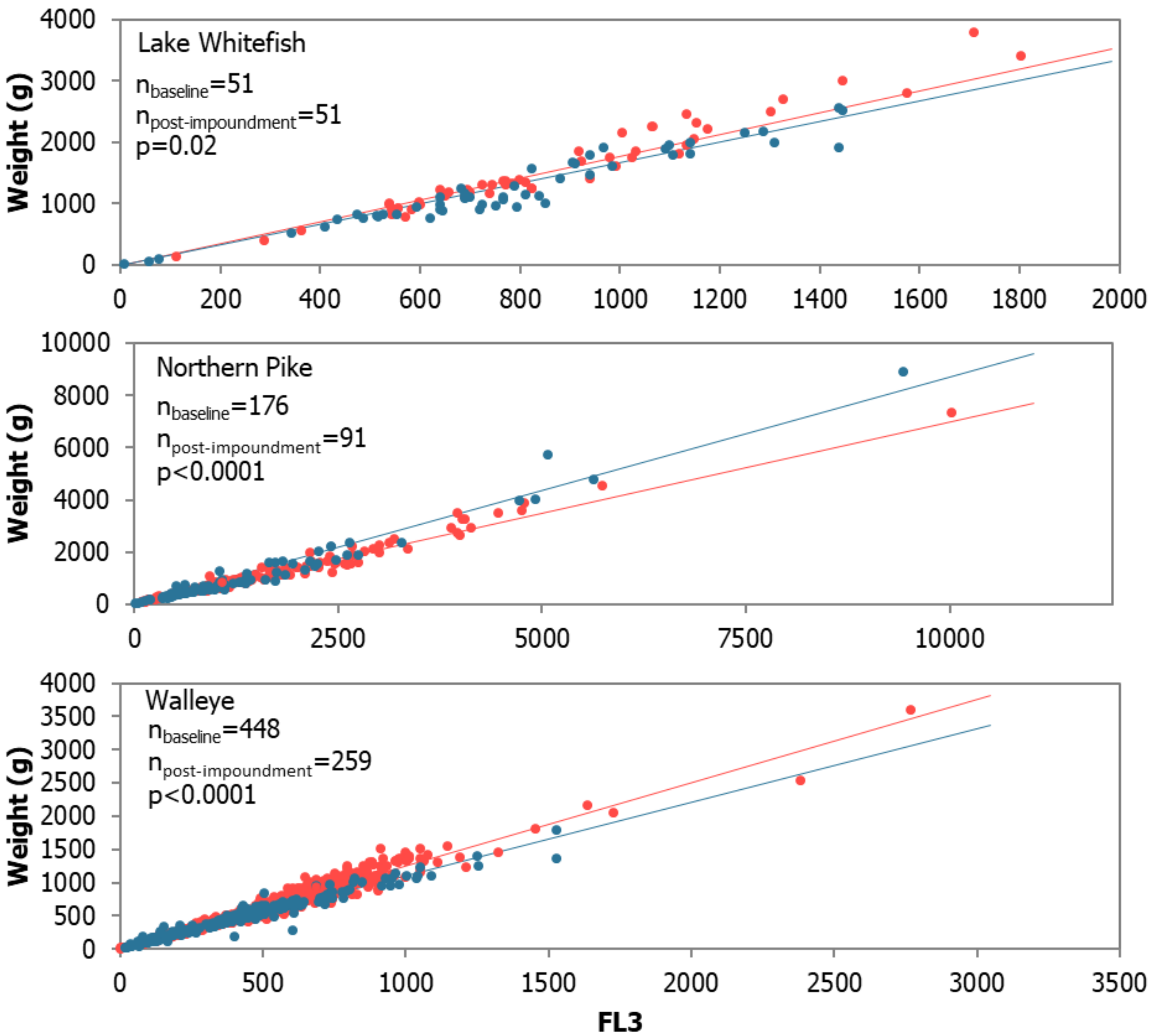


Figure 17: Bivariate plots of weight (Wt; g) versus FL3 (fork length [mm]³/100,000) for VEC species captured in standard gang and small mesh index gill nets set in Split Lake during baseline (2009, 2015, 2019; red) and post-impoundment (2021 and 2022; blue) studies. Note that the slope of the lines is equivalent to the estimate of condition, and the x- and y-axes differ between plots.

4.1.4.2 KEEYASK RESERVOIR

Mean condition factor of VEC fish captured at standard sites in the Keeyask reservoir in 2022 was 1.65 for Lake Whitefish (n = 9), 0.71 for Northern Pike (n = 22), and 1.08 for Walleye (n = 98; Table 14). The condition of Lake Whitefish did not differ significantly between baseline and post impoundment periods (ANCOVA, p = 0.70) (Figure 18). Northern Pike captured post-impoundment had a significantly higher condition (ANCOVA, p = 0.001) while Walleye captured post-impoundment had a lower condition (ANCOVA p<0.0001) than those captured during baseline (Figure 18).

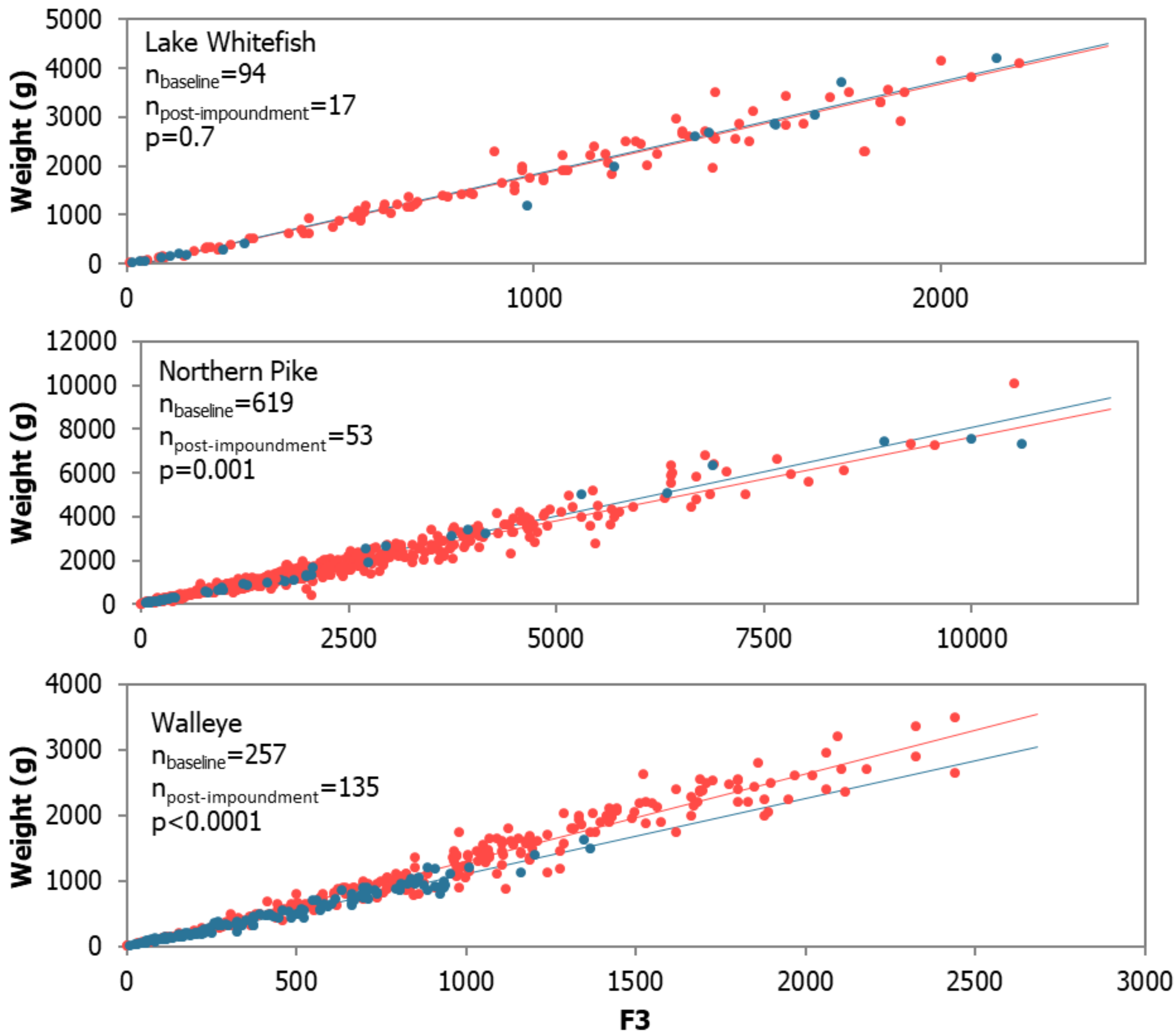


Figure 18: Bivariate plots of weight (Wt; g) versus F3 (fork length [mm]^3/100,000) for VEC species captured in standard gang and small mesh index gill nets set in the Keeyask reservoir during baseline (2001, 2002, 2009, 2015, 2019; red) and post-impoundment (2021 and 2022; blue) studies. Note that the slope of the lines is equivalent to the estimate of condition, and the x- and y-axes differ between plots.

4.1.4.3 STEPHENS LAKE NORTH

Mean condition factor of VEC fish captured in Stephens Lake North in 2022 was 1.31 for Lake Whitefish (n = 14), 0.65 for Northern Pike (n = 52), and 1.10 for Walleye (n = 128; Table 14). The condition of Northern Pike did not differ between baseline and post-impoundment sampling periods (ANCOVA, p = 0.21) (Figure 19). The condition of Lake Whitefish and Walleye was significantly higher during baseline than post impoundment (ANCOVA, p = 0.02 and <0.0001, respectively).

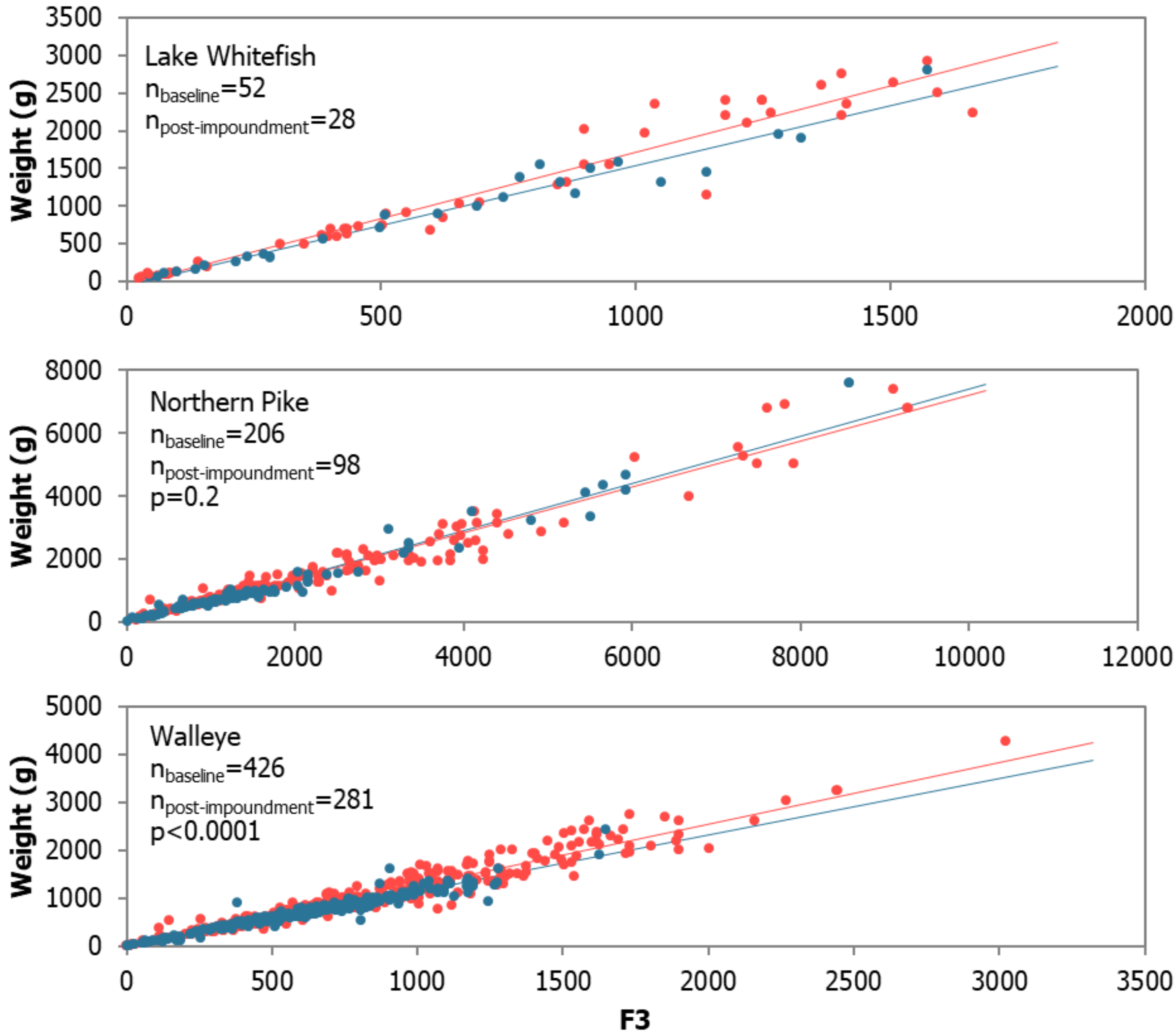


Figure 19: Bivariate plots of weight (Wt; g) versus F3 (fork length [mm]^3/100,000) for VEC species captured in standard gang and small mesh index gill nets set in Stephens Lake North during baseline (2009, 2015, 2018; red) and post-impoundment (2021 and 2022; blue) studies. Note that the slope of the lines is equivalent to the estimate of condition, and the x- and y-axes differ between plots.

4.1.4.4 STEPHENS LAKE SOUTH

Mean condition factor of VEC fish captured in Stephens Lake South in 2022 was 1.26 for Lake Whitefish (n = 3), 0.67 for Northern Pike (n = 15), and 1.14 for Walleye (n = 63; Table 14). Too few Lake Whitefish were captured to make statistical comparisons between the two monitoring periods. Northern Pike captured post-impoundment had a significantly higher condition (ANCOVA, p = 0.03) while Walleye captured post-impoundment had a lower condition (ANCOVA p<0.0001) than those captured during baseline studies (Figure 20).

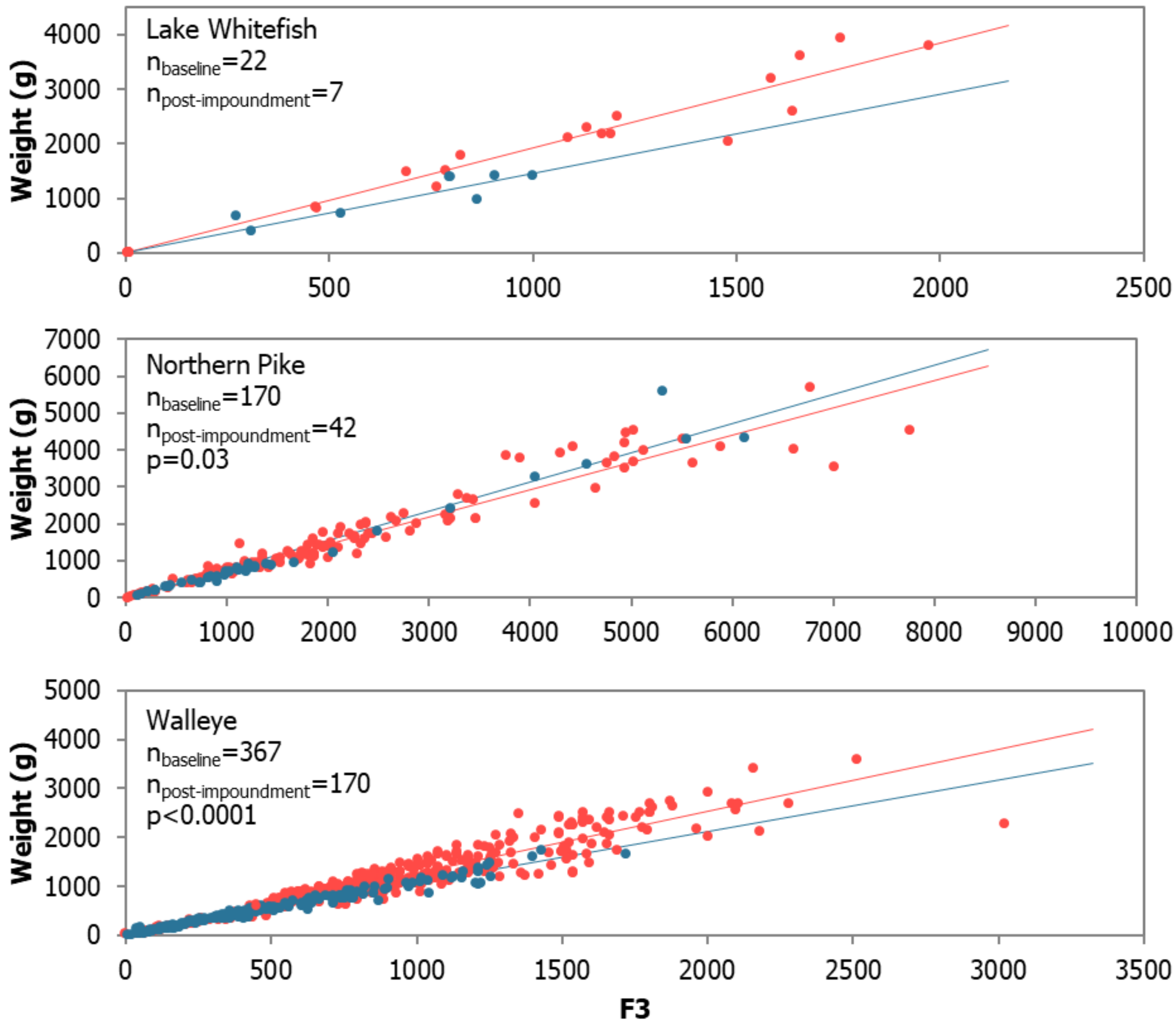


Figure 20: Bivariate plots of weight (Wt; g) versus F3 (fork length [mm]^3/100,000) for VEC species captured in standard gang and small mesh index gill nets set in Stephens Lake South during baseline (2009, 2015, 2018; red) and post-impoundment (2021 and 2022; blue) studies. Note that the slope of the lines is equivalent to the estimate of condition, and the x- and y-axes differ between plots.

4.1.5 AGE

4.1.5.1 SPLIT LAKE

Ageing structures were collected from 219 VEC fish captured in Split Lake in 2022. Aged Lake Whitefish (n = 25) ranged from 2–17 years with fish spawned in fall 2007 (14 years old) captured most frequently (24% of aged fish). Northern Pike (n = 33) ranged from 0 (young-of-the-year) to 11 years, with 3-year-old fish (*i.e.*, 2019 cohort) captured most frequently (39% of aged fish). Aged Walleye (n = 161) ranged from 2–18 years, with four-year-old fish (*i.e.*, 2018 cohort) captured most frequently (19% of aged fish).

Cohort frequency distributions for VEC species (n = 1,018) captured in 2009, 2015, 2019, 2021, and 2022 are provided in Figure 21. Lake Whitefish from the 2007–2008 cohorts were most commonly captured. Few young (*i.e.*, 2015–2021 cohorts) Lake Whitefish were captured. Northern Pike from every cohort between 1997 and 2020 were captured, with fish from the 2016 cohort accounting for 11% (n = 28) of the catch. For Walleye (excluding the 1998 cohort), all cohorts between 1991 and 2020 were represented in the catch, with the 2012 cohort accounting for 10% (n = 69) of the catch.

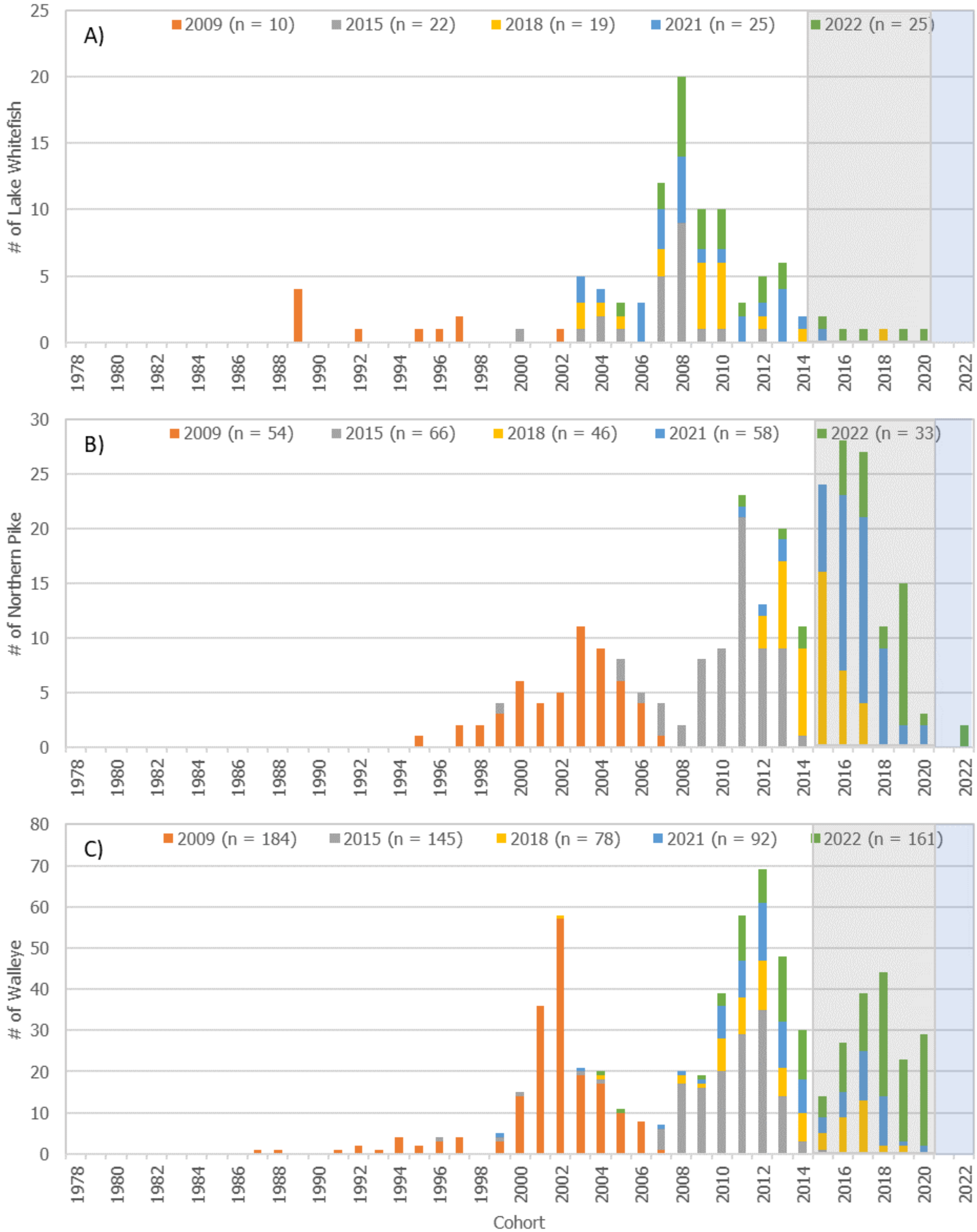


Figure 21: **Cohort frequency distributions for A) Lake Whitefish B) Northern Pike and C) Walleye captured in standard gang and small mesh index gill nets set in Split Lake in 2009, 2015, 2019, 2021, and 2022. Grey shading indicates fish spawned during Keeyask GS construction. Blue indicates fish spawned post-impoundment.**

4.1.5.2 KEEYASK RESERVOIR

Ageing structures were collected from 249 VEC fish captured at all sites (both standard and new) in the Keeyask reservoir in 2022. Aged Lake Whitefish (n = 16) ranged from 1–20 years, Northern Pike (n = 121) from 0–12 years, and Walleye (n = 112) from 1–17 years.

Cohort frequency distributions for VEC species (n = 868) captured in SGI and SMI gill nets sampled in 2001, 2002, 2015, 2019, 2021, and 2022 are provided in Figure 22 (fish sampled in 2009 were not aged). Lake Whitefish spawned in each construction year (2014–2019) and one year post-impoundment (spawned in fall 2020) were present in the catch. Northern Pike spawned in every construction (2015–2020) and post-impoundment (2021–2022) year were present in the catch. Walleye spawned in each construction year (2015–2020) and one post-impoundment year (2021) were present in the catch.

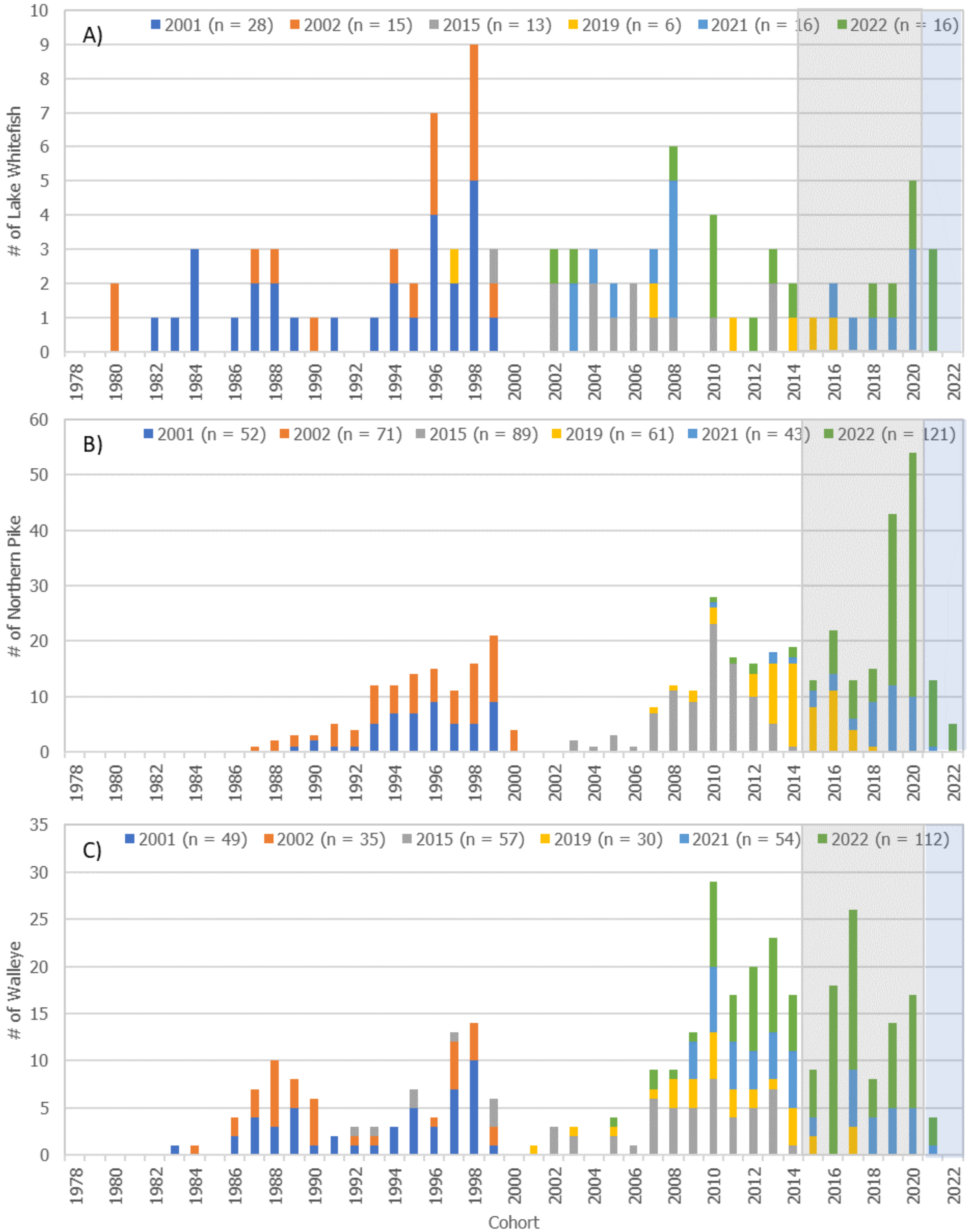


Figure 22: Cohort breakdown of A) Lake Whitefish B) Northern Pike and C) Walleye caught in standard gang and small mesh index gill nets set in the Keeyask reservoir in 2001, 2002, 2015, 2019, 2021, and 2022. Grey shading indicates fish spawned during Keeyask GS construction. Blue indicates fish spawned post-impoundment.

4.1.5.3 STEPHENS LAKE NORTH

Ageing structures were collected from 191 VEC fish captured in Stephens Lake North in 2022. Aged Lake Whitefish (n = 15) ranged from 2–20 years, aged Northern Pike (n = 50) ranged from 0 (young-of-the-year) to 11 years, and aged Walleye (n = 126) ranged from two to 19 years.

Cohort frequency distributions for VEC species (n = 939) captured in SGI and SMI gill nets sampled in 2009, 2015, 2018, 2021, and 2022 are provided in Figure 23. Lake Whitefish from every cohort between 2009 and 2019 were captured, as well as small numbers of cohorts dating back to 1984. Northern Pike from every cohort between 1997 and 2020 were captured, with individuals from the 2011 and 2017 cohorts captured most frequently. Walleye from every cohort between 1993 and 2020 (other than 2018) were captured, with the 2010 cohort accounting for 18% (n = 104) of the total catch.

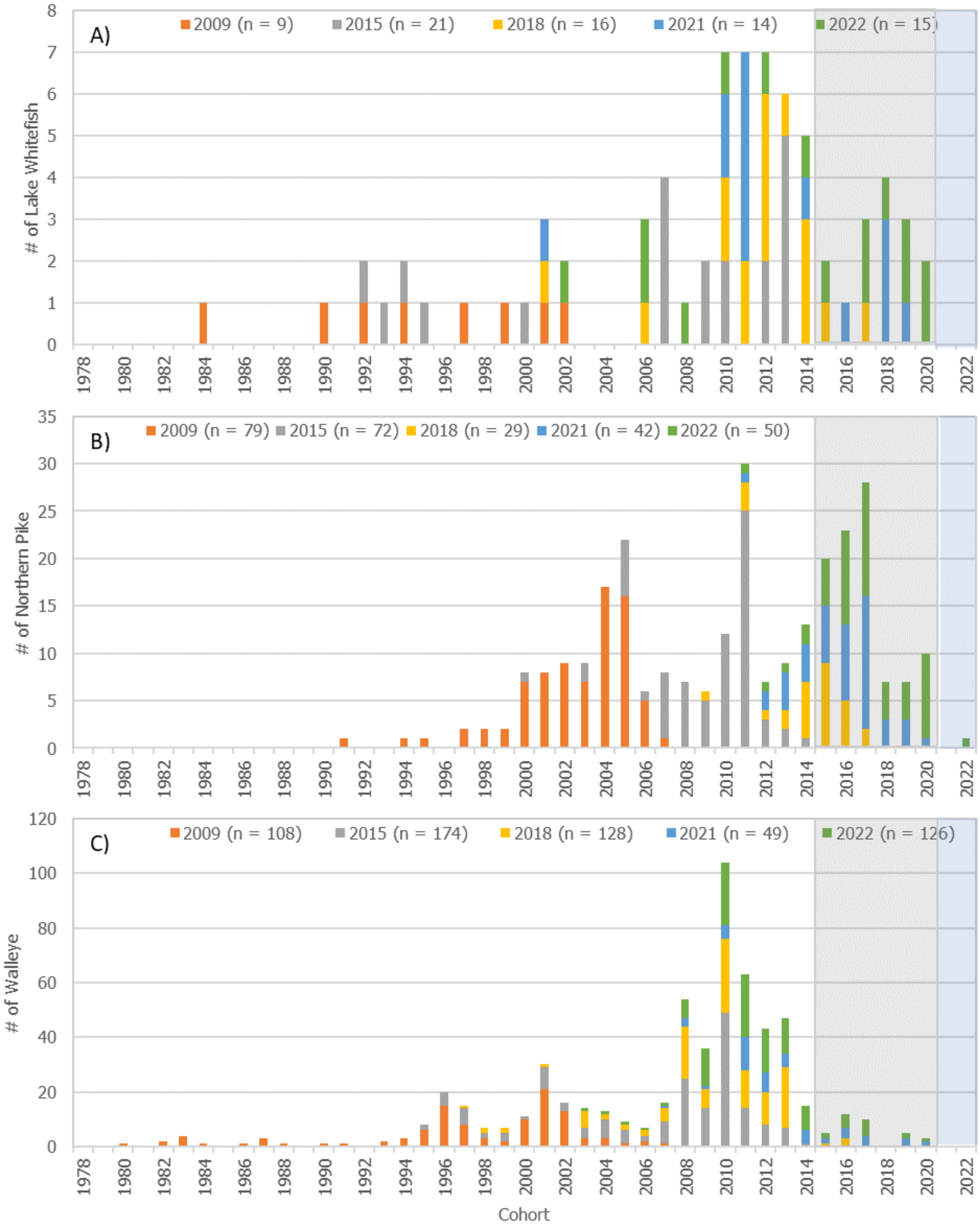


Figure 23: **Cohort breakdown of A) Lake Whitefish B) Northern Pike and C) Walleye caught in standard gang and small mesh index gill nets set in Stephens Lake North in 2009, 2015, 2018, 2021, and 2022. Grey shading indicates fish spawned during Keeyask GS construction.**

4.1.5.4 STEPHENS LAKE SOUTH

Ageing structures were collected from 81 VEC fish captured in Stephens Lake South in 2022. Aged Lake Whitefish (n = 3) ranged from 5–14 years. Aged Northern Pike (n = 15) ranged from 2–6 years. Aged Walleye (n = 63) ranged from 1–18 years with six-year-old fish (*i.e.*, 2016 cohort) captured most frequently (n = 14; 22%).

Cohort frequency distributions for VEC species (n = 744) captured in SGI and SMI gill nets sampled in 2009, 2015, 2018, 2021, and 2022 are provided in Figure 24. Lake Whitefish from various cohorts between 1990 and 2016 were present in the catch, however, too few fish were captured to identify definitive modes in cohort strength. Northern Pike from every cohort between 1997 and 2019 were captured, with the 2004 and 2011 cohorts being the most common. Walleye from every cohort between 1981 and 2021 were captured, with fish from the 2002 and 2013 cohorts the most prevalent.

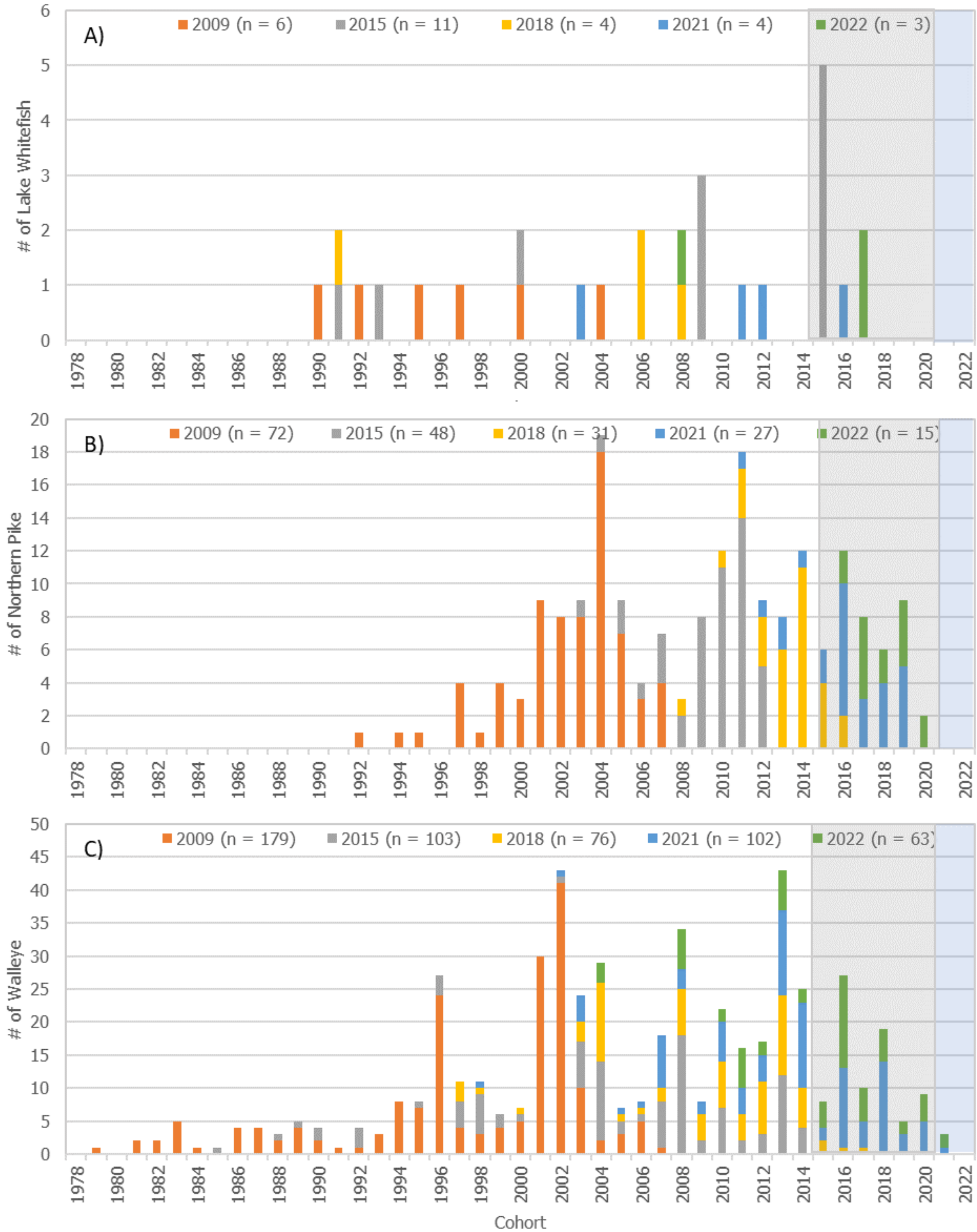


Figure 24: Cohort breakdown of A) Lake Whitefish B) Northern Pike and C) Walleye caught in standard gang and small mesh index gill nets set in Stephens Lake South in 2009, 2015, 2018, 2021, and 2022. Grey shading indicates fish spawned during Keeyask GS construction.

4.1.6 DEFORMITIES, EROSION, LESIONS AND TUMOURS (DELTS)

4.1.6.1 SPLIT LAKE

No DELTs were recorded from the 532 fish examined in 2022 (Table 15). In previous studies, DELTs have represented between 0.2% (n = 1; 2015 and 2021) and 2.6% (n = 9; 2009) of the total catch.

4.1.6.2 KEEYASK RESERVOIR

Of the 201 fish examined during 2022, a single Walleye (0.5%) displayed a DELT (Table 15). In previous studies, DELTs have represented between 0% (2001) and 8.2% (n = 15; 2015) of the total catch.

4.1.6.3 STEPHENS LAKE NORTH

No DELTs were recorded from the 274 fish examined in 2022 (Table 15). In previous studies, DELTs have represented between 0.7% (n = 2; 2015) and 2.6% (n = 6; 2009) of the total catch.

4.1.6.4 STEPHENS LAKE SOUTH

Of the 271 fish examined in 2022, three fish (1.1%) displayed DELTS including one Sauger and two White Sucker (Table 15). In previous studies, DELTs have represented between 0.0% (n = 0; 2018 and 2021) and 3.6% (n = 11; 2009) of the total catch.

Table 15: Number (n) and percentage of catch (%) of deformities, erosion, lesions, and tumours (DELTs) recorded on fish captured in standard gang (SGI) and small mesh (SMI) index gill nets set in Split Lake, the Keeyask reservoir, Stephens Lake North, and Stephens Lake South during the 2001, 2002, 2009, 2015, 2018, 2019, 2021, and 2022 study years.

	Study Year																							
	2001			2002			2009			2015			2018			2019			2021			2022		
	n	DELTs	%	n	DELTs	%	n	DELTs	%	n	DELTs	%	n	DELTs	%	n	DELTs	%	n	DELTs	%	n	DELTs	%
Split Lake																								
Lake Sturgeon	-	-	-	-	-	-	0	0	0	8	0	0	-	-	-	0	0	0	2	0	0	4	0	0
Lake Whitefish	-	-	-	-	-	-	10	1	10	22	0	0	-	-	-	20	1	5	25	0	0	26	0	0
Northern Pike	-	-	-	-	-	-	64	0	0	66	0	0	-	-	-	46	0	0	58	0	0	33	0	0
Sauger	-	-	-	-	-	-	29	2	6.9	0	0	0	-	-	-	96	1	1	151	1	0.7	102	0	0
Walleye	-	-	-	-	-	-	223	5	2.2	145	0	0	-	-	-	81	0	0	96	0	0	163	0	0
White Sucker	-	-	-	-	-	-	18	1	5.6	181	1	0.6	-	-	-	165	0	0	188	0	0	204	0	0
Total	**-**	**-**	**-**	**-**	**-**	**-**	**344**	**9**	**2.6**	**422**	**1**	**0.2**	**-**	**-**	**-**	**408**	**2**	**0.5**	**520**	**1**	**0.2**	**532**	**0**	**0**
Clark Lake to Keeyask GS																								
Lake Sturgeon	0	0	0	0	0	0	1	0	0	1	0	0	-	-	-	1	0	0	0	0	0	7	0	0
Lake Whitefish	30	0	0	15	1	6.7	27	3	11.1	13	0	0	-	-	-	8	0	0	9	0	0	9	0	0
Northern Pike	122	0	0	190	1	0.5	150	3	2	89	8	9	-	-	-	61	0	0	113	1	0.9	22	0	0
Sauger	1	0	0	0	0	0	0	0	0	0	0	0	-	-	-	0	0	0	40	3	7.5	28	0	0
Walleye	66	0	0	41	0	0	57	1	1.8	61	7	11.5	-	-	-	30	1	3.3	60	0	0	98	1	1.0
White Sucker	28	0	0	17	1	5.9	16	0	0	19	0	0	-	-	-	34	1	2.9	65	3	4.6	37	0	0
Total	**247**	**0**	**0**	**263**	**3**	**1.1**	**251**	**7**	**2.8**	**183**	**15**	**8.2**	**-**	**-**	**-**	**134**	**2**	**1.5**	**287**	**7**	**2.4**	**201**	**1**	**0.5**
Stephens Lake North																								
Lake Sturgeon	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	-	-	-	0	0	0	0	0	0
Lake Whitefish	-	-	-	-	-	-	14	0	0	21	0	0	17	0	0	-	-	-	14	0	0	14	0	0
Northern Pike	-	-	-	-	-	-	88	2	2.3	87	1	1.1	32	0	0	-	-	-	46	0	0	52	0	0
Sauger	-	-	-	-	-	-	0	0	0	0	0	0	26	1	3.8	-	-	-	14	0	0	19	0	0
Walleye	-	-	-	-	-	-	119	4	3.4	176	1	0.6	130	1	0.8	-	-	-	153	0	0	128	0	0
White Sucker	-	-	-	-	-	-	6	0	0	15	0	0	32	0	0	-	-	-	39	0	0	61	0	0
Total	**-**	**-**	**-**	**-**	**-**	**-**	**227**	**6**	**2.6**	**299**	**2**	**0.7**	**237**	**2**	**0.8**	**-**	**-**	**-**	**266**	**0**	**0**	**274**	**0**	**0**

Table 15: Number (n) and percentage of catch (%) of deformities, erosion, lesions and tumours (DELTs) recorded on fish captured in standard gang (SGI) and small mesh index (SMI) gill nets set in Split Lake, the Keeyask reservoir, Stephens Lake North and Stephens Lake South during the 2001, 2002, 2009, 2015, 2018, 2019, 2021, and 2022 study years (continued).

	Study Year																							
	2001			2002			2009			2015			2018			2019			2021			2022		
	n	**DELTs**	**%**	**n**	**DELTs**	**%**	**n**	**DELTs**	**%**	**n**	**DELTs**	**%**	**n**	**DELTs**	**%**	**n**	**DELTs**	**%**	**n**	**DELTs**	**%**	**n**	**DELTs**	**%**
Stephens Lake South																								
Lake Sturgeon	-	-	-	-	-	-	0	0	0	1	0	0	0	0	0	-	-	-	1	0	0	1	0	0
Lake Whitefish	-	-	-	-	-	-	6	0	0	12	0	0	4	0	0	-	-	-	4	0	0	3	0	0
Northern Pike	-	-	-	-	-	-	88	4	4.5	50	0	0	32	0	0	-	-	-	27	0	0	15	0	0
Sauger	-	-	-	-	-	-	14	2	14.3	0	0	0	8	0	0	-	-	-	28	0	0	54	1	1.9
Walleye	-	-	-	-	-	-	184	3	1.6	104	3	2.9	78	0	0	-	-	-	107	0	0	63	0	0
White Sucker	-	-	-	-	-	-	11	2	18.2	58	0	0	63	0	0	-	-	-	114	0	0	135	2	1.5
Total	**-**	**-**	**-**	**-**	**-**	**-**	**303**	**11**	**3.6**	**225**	**3**	**1.3**	**185**	**0**	**0**	**-**	**-**	**-**	**281**	**0**	**0**	**271**	**3**	**1.1**

4.1.7 DEBRIS MONITORING

The majority of SGI and SMI gill nets in Split Lake in 2022 had no or low (*i.e.*, <5%) levels of debris. However, four of 12 SGI nets and one of four SMI nets had high or very high (>16%) numbers of Zebra Mussels (Appendix A2-1). In previous study years, debris levels ranged from none/low to very high, consisting primarily of algae and sticks.

Debris was present in 14 of 17 (82%) SGI gill nets and 4 of 7 (57%) SMI gill nets set in the reach of the Keeyask reservoir in 2022. When present, debris levels were mostly low (*i.e.*, < 5%) to moderate (*i.e.*, 5–15%) and mostly consisted of aquatic vegetation and sticks (Appendix A2-2). Zebra Mussels were documented as very high (*i.e.,* >26%) and moderate at two sites (GN-05 and GN-17, respectively). In previous study years, debris levels mostly ranged from low to very high with a combination of algae, aquatic vegetation, and sticks accounting for the majority of debris.

All SGI and SMI gill nets set in Stephens Lake North in 2022 had some level of debris, ranging from low (*i.e.*, <5%) at six sites, to moderate (*i.e.*, 5–15%) at five sites, and very high (*i.e.*, >26%) at one site (Appendix A2-3). The amount of debris present in gill nets set in Stephens Lake South was generally low (*i.e.*, <5%; 4 sites) to moderate (*i.e.*, 5–15%; 5 sites) (Appendix A2-4). Three sites had no debris present. In both areas, the dominant debris was composed of sticks (Appendix A2-3 and A2-4). In previous study years, debris levels ranged from none/low to high and included a combination of algae, aquatic vegetation, and sticks.

4.2 KEEYASK RESERVOIR ADDITIONAL SITES

Ten species (n = 175 fish) were captured in seven SGI gill nets set within newly flooded areas of the Keeyask reservoir during summer 2022 (Table 16). Northern Pike were the most abundant species captured accounting for 50.9% (n = 89) of the catch. Mooneye (10.9%; n = 19) were the next most frequently caught. An additional 269 fish representing ten species were caught at four new SMI gill net sites. Spottail Shiner were the most abundant species accounting for 75.8% (n = 204) of the SMI gill net catch.

Table 16. Total number (n) and relative abundance (%) of fish, by species, captured in all standard gang and small mesh index gill nets set at newly flooded sites in the Keeyask reservoir, summer 2019, 2021 and 2022. Because sites were not fully accessible prior to reservoir impoundment, 2019 sites were set as close as possible to sites prescribed in the AEMP and set in 2022, however, the three years are not directly comparable.

	Standard Index						Small Mesh					
	2019		2021		2022		2019		2021		2022	
Common Name	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Burbot	-	-	1	0.7	1	0.6	-	-	-	-	-	-
Cisco	-	-	1	0.7	-	-	1	0.7	12	4.5	5	1.9
Emerald Shiner	-	-	-	-	-	-	10	6.8	11	4.1	-	-
Logperch	-	-	-	-	-	-	1	0.7	-	-	-	-
Lake Chub	-	-	-	-	-	-	-	-	-	-	-	-
Lake Sturgeon	-	-	-	-	-	-	-	-	-	-	-	-
Lake Whitefish	2	2.0	1	0.7	8	4.6	-	-	-	-	-	-
Longnose Sucker	-	-	7	4.9	10	5.7	-	-	1	0.4	-	-
Mooneye	6	6.1	-	-	19	10.9	2	1.4	-	-	5	1.9
Northern Pike	59	59.6	66	46.2	89	50.9	8	5.4	16	6.0	11	4.1
Rainbow Smelt	-	-	2	1.4	-	-	-	-	2	0.7	12	4.5
Sauger	4	4.0	9	6.3	14	8.0	-	-	-	-	3	1.1
Shorthead Redhorse	4	4.0	14	9.8	3	1.7	-	-	-	-	-	-
Silver Redhorse	-	-	-	-	-	-	-	-	-	-	-	-
Slimy Sculpin	-	-	-	-	-	-	-	-	-	-	1	0.4
Spottail Shiner	-	-	-	-	-	-	97	65.5	141	52.6	204	75.8
Troutperch	-	-	-	-	-	-	22	14.9	35	13.1	19	7.1
Walleye	9	9.1	9	6.3	14	8.0	2	1.4	9	3.4	2	0.7
White Sucker	12	12.1	23	16.1	12	6.9	3	2.0	2	0.7	1	0.4
Yellow Perch	3	3.0	10	7.0	5	2.9	2	1.4	39	14.6	6	2.2
Total	**99**	**-**	**143**	**-**	**175**	**-**	**148**	**-**	**268**	**-**	**269**	**-**

Mean total CPUE for the SGI gillnet catch was 20.8 fish/100 m of net/24 h which did not differ significantly from previous sampling years (2019 and 2021; H = 6.9, p = 0.46) (Table 17; Figure 25). Average CPUE for Lake Whitefish, Northern Pike, and Walleye was 0.9, 10.9, and 1.6 fish/100 m of net/24 h, respectively (Table 17). Mean CPUE of each species did not differ significantly from previous sampling years (Figure 26). Northern Pike were present at all seven SGI sites sampled (CPUE range: 0.8-34.6 fish/100 m of net/24 h), Walleye were present at all but two sites (CPUE range: 0.0-4.7 fish/100 m of net/24 h) and Lake Whitefish were absent from six of the seven sites sampled (CPUE range: 0.0 to 6.2 fish/100 m of net/24 h) (Table 18). Mean total CPUE was 62.0 fish/30 m of net/24 h in the four SMI gill nets (Table 17; Figure 27).

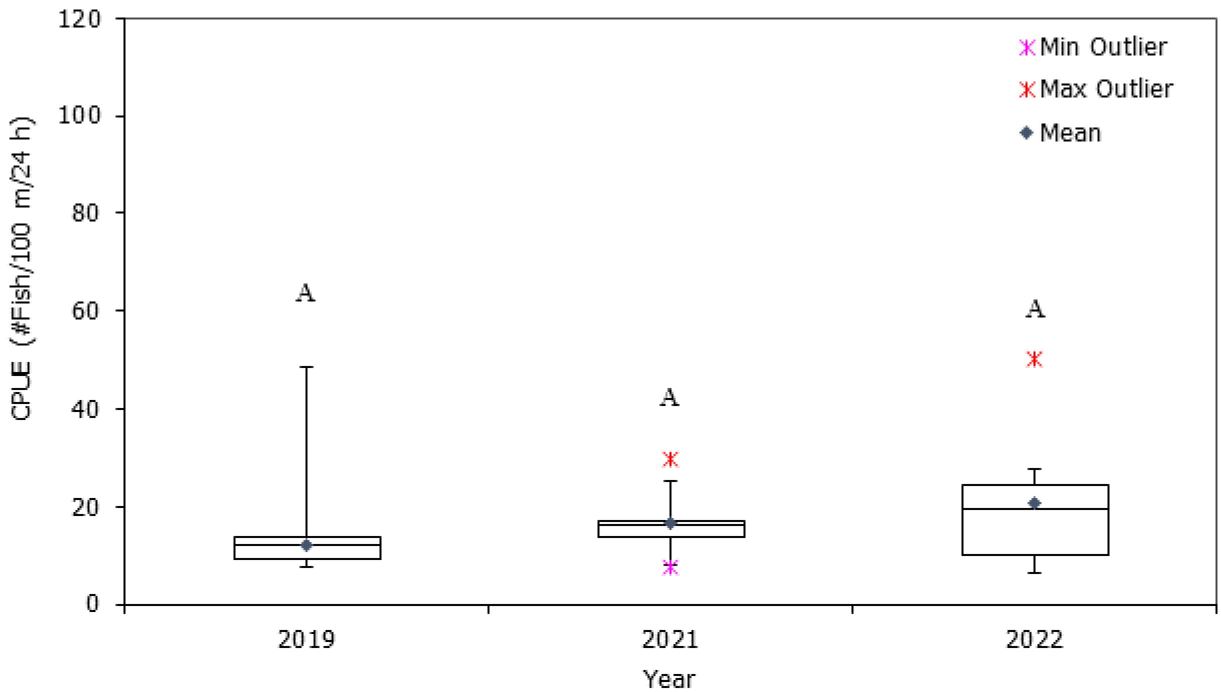


Figure 25: Mean total CPUE for all fish species captured in standard gang index gill nets set in newly flooded areas in the Keeyask reservoir. Letters denote significant differences in CPUE between study years.

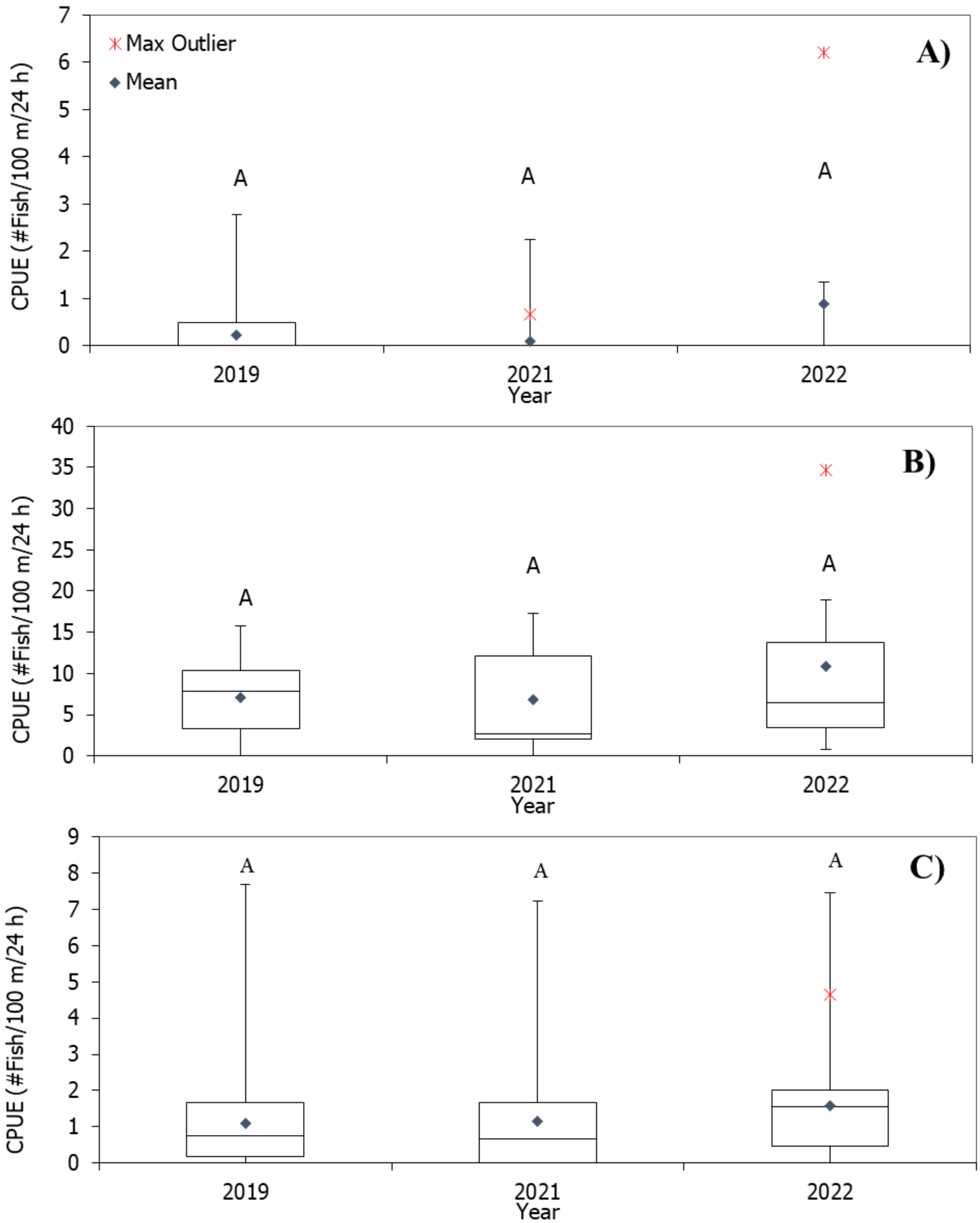


Figure 26: Mean total CPUE for A) Lake Whitefish, B) Northern Pike and C) Walleye captured in standard gang index gill nets set set in newly flooded areas in the Keeyask reservoir. Letters denote significant differences in CPUE between study years.

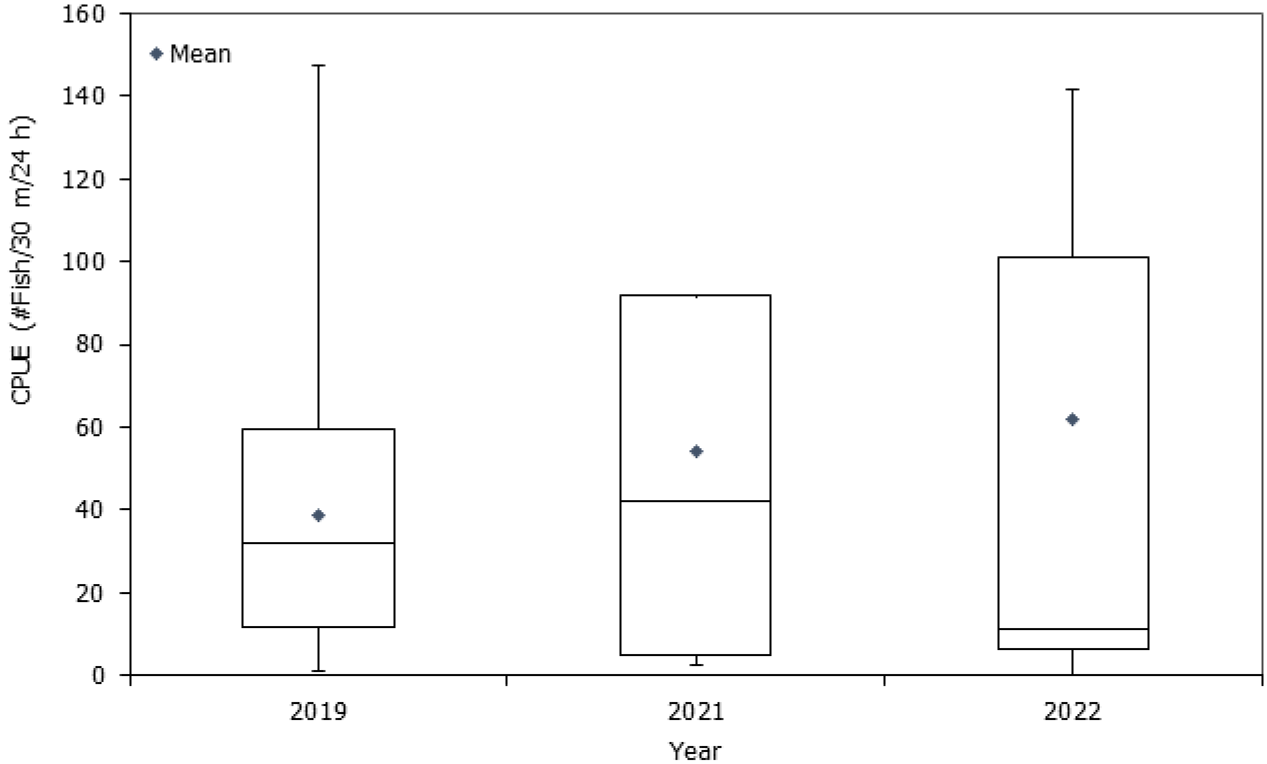


Figure 27: Mean total CPUE for all fish species captured in small mesh index gill nets set in newly flooded areas in the Keeyask reservoir.

Table 17: Mean catch-per-unit-effort (CPUE) by species of fish captured in standard gang (# fish/100 m of net/24 h) and small mesh (# fish/30 m of net/24 h) index gill nets set at newly flooded sites in the Keeyask reservoir, summer 2019, 2021 and 2022. Because sites were not fully accessible prior to reservoir impoundment, 2019 sites were set as close as possible to sites prescribed in the AEMP and set in 2022, however, the three years are not directly comparable.

Common Name	Standard Index									Small Mesh								
	2019			2021			2022			2019			2021			2022		
	n[1]	CPUE	Std[2]	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std
Burbot	-	-	-	1	0.1	0.4	1	0.1	0.3	-	-	-	-	-	-	-	-	-
Cisco	-	-	-	1	0.1	0.3	-	-	-	1	0.3	0.5	12	3.0	3.6	5	1.1	1.6
Emerald Shiner	-	-	-	-	-	-	-	-	-	10	2.5	1.9	11	2.9	5.7	-	-	-
Logperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Sturgeon	2	0.2	0.4	1	0.1	0.3	-	-	-	-	-	-	-	-	-	-	-	-
Lake Whitefish	-	-	-	-	-	-	8	0.9	2.3	1	0.3	0.5	-	-	-	-	-	-
Longnose Sucker	-	-	-	7	1.0	1.8	10	1.1	1.5	-	-	-	1	0.4	0.7	-	-	-
Mooneye	6	0.8	1.3	-	-	-	19	2.2	5.9	2	0.5	0.6	-	-	-	5	1.1	2.5
Northern Pike	59	7.0	5.2	66	6.8	6.6	89	10.9	12.2	8	2.0	2.6	16	4.0	4.4	11	2.6	2.2
Rainbow Smelt	-	-	-	2	0.2	0.4	-	-	-	-	-	-	2	0.5	1.0	12	2.8	4.7
Sauger	4	0.5	0.6	9	1.1	2.0	14	1.5	3.5	-	-	-	-	-	-	3	0.6	1.4
Shorthead Redhorse	4	0.5	0.6	14	1.9	2.6	3	0.3	0.4	-	-	-	-	-	-	-	-	-
Slimy Sculpin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.2	0.5
Silver Redhorse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spottail Shiner	-	-	-	-	-	-	-	-	-	97	25.7	31.0	141	35.5	47.5	204	47.3	73.2
Trout-perch	-	-	-	-	-	-	-	-	-	22	5.9	7.8	35	8.2	15.5	19	4.1	8.4
Walleye	9	1.1	1.2	9	1.2	1.5	14	1.6	1.6	2	0.5	1.1	9	2.3	3.4	2	0.5	0.6
White Sucker	12	1.5	2.1	23	2.9	3.3	12	1.4	2.0	3	0.8	1.6	2	0.5	0.6	1	0.2	0.5
Yellow Perch	3	0.4	0.6	10	1.0	0.9	5	0.6	1.0	2	0.5	1.1	39	10.0	15.8	6	1.4	2.6
Total	**99**	**12.0**	**3.9**	**143**	**16.4**	**6.8**	**175**	**20.8**	**15.2**	**148**	**39.0**	**39.8**	**218**	**54.4**	**61.8**	**269**	**61.0**	**83.3**

1 – Number of fish

2 – Standard deviation

Table 18: Mean catch-per-unit-effort (CPUE) by species and site of VEC fish captured in standard gang index and small mesh gill nets set at newly flooded sites in the Keeyask reservoir, summer 2019, 2021 and 2022.

Area	Site	Lake Whitefish						Northern Pike						Walleye					
		2019		2021		2022		2019		2021		2022		2019		2021		2022	
		n[1]	CPUE	n	CPUE	n	CPUE	n	CPUE	n	CPUE	n	CPUE	n	CPUE	n	CPUE	n	CPUE
Backbays	GN-09	-	-	-	-	-	-	8	6.3	14	11.1	7	6.5	4	3.1	-	-	-	-
	GN-10	-	-	-	-	-	-	15	10.6	18	13.1	21	19.7	-	-	-	-	1	0.9
	GN-11	1	0.7	-	-	-	-	21	13.8	4	2.7	9	7.9	3	2.0	1	0.7	2	1.8
	GN-15	1	0.8	1	0.7	8	6.2	12	9.3	3	2.0	7	5.4	1	0.8	2	1.4	6	4.7
Little Gull Lake	GN-14[2]	-	-	-	-	-	-	-	-	25	16.6	42	34.6	-	-	-	-	-	-
Upstream of Keeyask GS	GN-16	-	-	-	-	-	-	-	-	-	-	1	0.8	-	-	2	2.0	3	2.3
	GN-17	-	-	-	-	-	-	3	2.3	2	2.0	2	1.5	1	0.8	4	4.1	2	1.5

1 – Number of fish

2 – Little Gull Lake was not sampled in 2019

Lake Whitefish (n = 8) caught in SGI and SMI gill nets measured an average of 299 mm FL (StDev = 159; range = 161–543 mm) with a mean weight of 935g (StDev = 1325; range = 50–3480 g) and a mean condition factor of 1.44 (StDev = 0.45; range = 1.02–2.17; Table 19). Northern Pike (n = 100) had a mean FL of 358 mm (StDev = 120; range = 107–650 mm), mean weight of 498g (StDev = 498; range = 6–2500g) and a mean condition factor of 0.78 (StDev = 0.10; range = 0.49–0.99; Table 19). Walleye (n = 16) had a mean FL of 303 mm (StDev = 107; range = 189–516 mm), a mean weight of 421g (StDev = 428; range = 60–1540g), and a mean condition factor of 1.09 (StDev = 0.15; range = 0.80–1.34; Table 19).

Table 19: Mean fork length, weight, and condition factor (K) of VEC species, captured in standard gang and small mesh index gill nets set at newly flooded sites in the Keeyask reservoir, summer 2022.

Species	n[1]	Length (mm)				Weight (g)				K (Condition)			
		Mean	Std[2]	Min	Max	Mean	Std	Min	Max	Mean	Std	Min	Max
Lake Whitefish	8	299	159	161	543	935	1326	50	3480	1.44	0.45	1.02	2.17
Northern Pike	100	358	120	107	650	498	498	6	2500	0.78	0.10	0.49	0.99
Walleye	16	303	107	189	516	421	428	60	1540	1.09	0.15	0.80	1.34

1 – Number of fish measured

2 – Standard deviation

A total of 387 VEC species captured in SGI and SMI gill nets set at newly flooded sites of the Keeyask reservoir (2019, 2021, and 2022) were measured for FL. Length frequency distributions are provided in Figure 28. Too few Lake Whitefish (n = 11) were captured to define length-frequency modes. Northern Pike measuring between 300 and 399 mm FL made up the majority of the catch (15%). Walleye in the 50–99 mm FL interval were captured most frequently (27%), followed by the 450-499 mm FL interval (23%) (Figure 28).

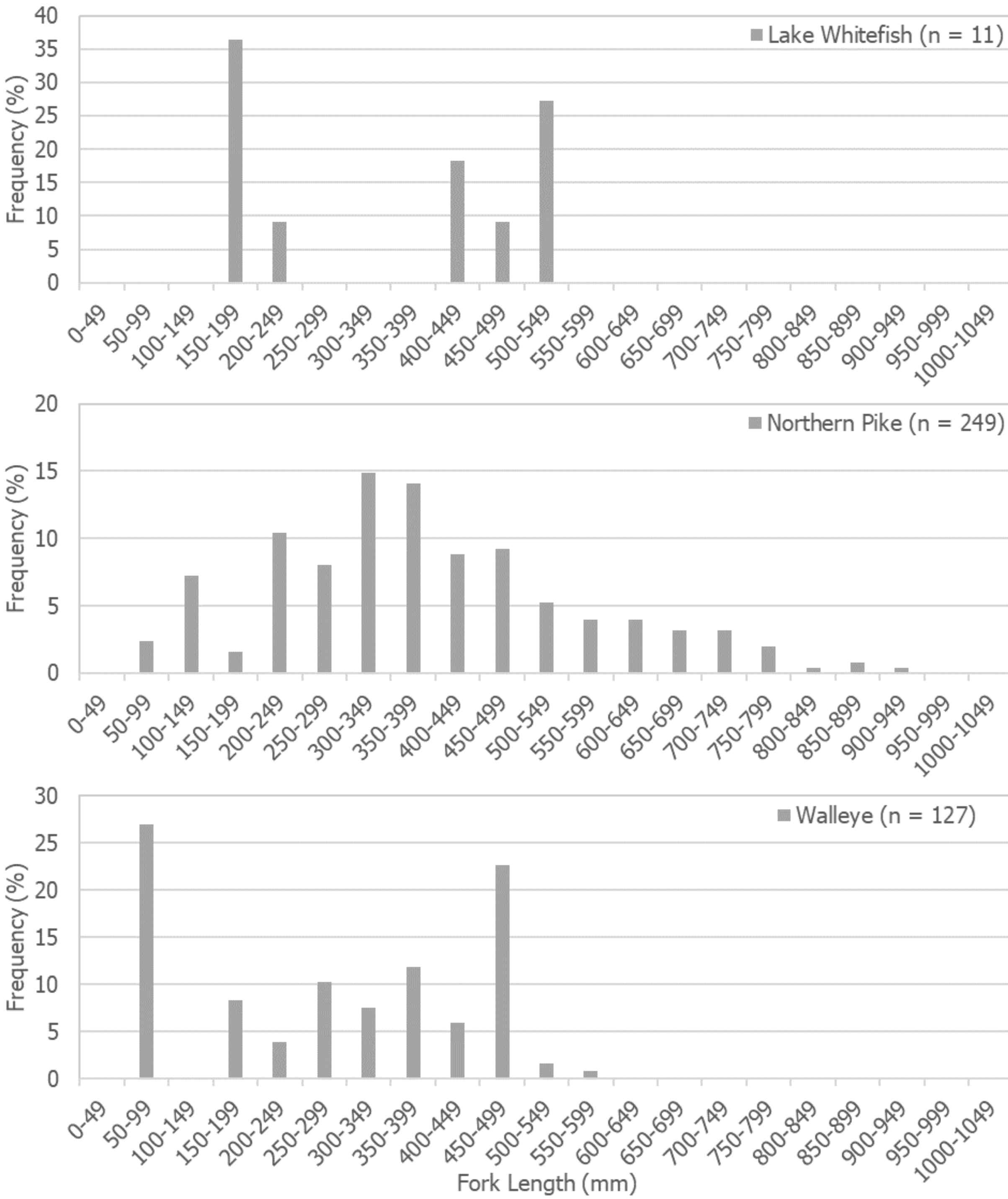


Figure 28: Fork length-frequency distribution of A) Lake Whitefish B) Northern Pike and C) Walleye captured in standard gang and small mesh index gill nets set at newly flooded sites in the Keeyask reservoir, summer 2019, 2021, and 2022.

A total of 71 fish were captured in a single gill net set in Little Gull Lake on August 16, 2022 (GN/SN-14; Map 4). The catch was made up of three species including Cisco, Northern Pike, and White Sucker. Total CPUE and was higher than in 2021 (Table 20).

Table 20: Mean catch-per-unit-effort (CPUE) by species of fish captured in standard gang (# fish/100 m of net/24 h) and small mesh (# fish/30 m of net/24 h) index gill nets set in Little Gull Lake in summer 2021 and 2022.

Common Name	Standard Index					Small Mesh			
	2021		2022			2021		2022	
	n	CPUE	n	CPUE		n	CPUE	n	CPUE
Burbot	-	-	-	-		-	-	-	-
Cisco	-	-	-	-	-	-	-	-	-
Emerald Shiner	-	-	-	-	-	-	-	-	-
Logperch	-	-	-	-	-	-	-	-	-
Lake Chub	-	-	-	-	-	-	-	-	-
Lake Sturgeon	-	-	-	-	-	-	-	-	-
Lake Whitefish	-	-	-	-	-	-	-	-	-
Longnose Sucker	-	-	-	-	-	-	-	-	-
Mooneye	-	-	19	15.7		-	-	5	5.7
Northern Pike	25	16.6	42	34.6		6	5.5	4	4.5
Rainbow Smelt	-	-	-	-	-	-	-	-	-
Sauger	-	-	-	-	-	-	-	-	-
Shorthead Redhorse	-	-	-	-	-	-	-	-	-
Slimy Sculpin	-	-	-	-	-	-	-	-	-
Silver Redhorse	-	-	-	-	-	-	-	-	-
Spottail Shiner	-	-	-	-	-	-	-	-	-
Trout-perch	-	-	-	-	-	-	-	-	-
Walleye	-	-	-	-	-	-	-	-	-
White Sucker	-	-	-	-	-	-	-	1	1.1
Yellow Perch	-	-	-	-	-	-	-	-	-
Total	**25**	**16.6**	**61**	**50.3**		**6**	**5.5**	**10**	**11.3**

5.0 DISCUSSION

The primary objective of the fish community monitoring program is to assess whether the Project has caused a change in select fish community metrics compared to baseline and, if so, the magnitude, direction, and duration of these changes. Data collected in 2022 represents the second year of sampling following impoundment and the first year of operation monitoring. All years prior to 2021 are considered baseline sampling. The fish community in Stephens Lake has been affected by progressive changes at Gull Rapids and downstream following the start of construction in 2014. The metrics presented in this report represent fish capture rates and species composition, as well as parameters related to the growth, condition, and health of VEC species. Evaluation of these metrics will allow evaluation of predictions made in the EIS.

Effects to the fish community were predicted to occur primarily as a result of changes in the quality and quantity of aquatic habitat, changes in water quality, and changes in the availability of lower trophic levels as forage. It was predicted that newly flooded habitat in the reservoir would initially be of low quality due to low DO conditions, shoreline instability, and the absence of aquatic plants. In the long-term, the EIS predicted that there will be an increase in fish abundance in the reservoir in response to an increase in aquatic habitat; however, there will also be a shift in the fish community towards species that prefer lacustrine (*e.g.*, Walleye) rather than riverine (*e.g.*, Longnose Sucker) conditions.

The EIS predicted that the fish community would not change immediately after full supply level was reached as short-term monitoring (*i.e.*, less than 4 years) data may not have the power to detect changes in fish communities immediately after impoundment. Rather, a lag response is expected, whereby changes in the fish populations and communities are expected to occur gradually after Project completion. Sampling conducted in 2022 likely occurred too soon after impoundment to detect changes in the large-bodied fish community, given that most large bodied species are not fully recruited to the gear until 4 years of age. Further, changes in populations as a result of increased foraging and spawning habitat would take time to become apparent, however, community changes due to an absence of recruitment and large-scale adult emigration, would be possible to detect.

Standard gang and small mesh index gillnetting was conducted in both upstream reference (Split Lake) and Project-affected (the Keeyask reservoir and Stephens Lake) sites between 2001 and 2022. However, because not all sites were sampled in all years, a subset of years was chosen in which the same sites were sampled to ensure comparability. These included 2009, 2015, 2019, 2021, and 2022 for Split Lake; 2001, 2002, 2009, 2015, 2019, 2021, and 2022 for the Keeyask reservoir; and 2009, 2015, 2018, 2021, and 2022 for Stephens Lake North and South. Data collected during baseline studies (*i.e.*, pre-2021) were compared to those collected post-impoundment (*i.e.*, 2021 and 2022). These sites are referred to as standard sites. Additional, newly flooded sites were sampled within the reservoir in 2021 and 2022. These sites were not included in standard site comparisons and are discussed separately below (Section 5.2).

5.1 BASELINE VS. POST-IMPOUNDMENT COMPARISONS

The AEMP identified three key questions for fish community monitoring in the Keeyask area.

Is the abundance (CPUE) and species composition of the fish communities in the Keeyask reservoir and Stephens Lake changing as a result of impoundment and operation of the Project?

The overall mean CPUE of all fish species captured in standard gang and small mesh gill nets in 2022 did not differ significantly between baseline and post-impoundment in the Keeyask reservoir or Stephens Lake. Average CPUE of VEC species captured in standard gang index gill nets were also compared between years. The largest change in CPUE was observed for Northern Pike. As observed in 2021, Northern Pike CPUE was lower in standard sites fished in the Keeyask reservoir than in any other year. However, it is likely that the observed decrease in Northern Pike abundance may be the result of post-impoundment sampling locations. Prior to reservoir flooding, sampling sites included shallow nearshore areas typically preferred by Northern Pike. Flooding changed many of these areas to deeper offshore habitats, which is not preferred Northern Pike habitat. The EIS predicted that that the number of Northern Pike in the Keeyask reservoir may increase post-impoundment due to the availability of spawning and foraging habitats in flooded areas. Northern Pike were the most commonly captured species in the newly flooded areas sampled in the Keeyask reservoir, suggesting that Northern Pike may have shifted to these areas. Therefore, the decrease in Northern Pike CPUE is likely an artefact of sampling and does not reflect a decrease in abundance within the reservoir as a whole.

Species composition of the fish communities in all sampling locations were relatively similar to that of previous years, although some differences were observed. The relative abundance of Walleye decreased between baseline and post-impoundment in both Split Lake and Stephens Lake South. Similarly, the relative abundance of White Sucker increased in all waterbodies. The relative abundance of Shorthead Redhorse also increased in the Keeyask reservoir.

As previously discussed, it is too soon after impoundment to identify the extent to which the fish community will change within the Keeyask area; it is expected that additional changes will be observed with continued monitoring.

For the three VEC fish species, is a biologically relevant (and statistically significant) change in condition factor or growth observed in the Keeyask reservoir and Stephens Lake in comparison to pre-Project conditions?

Fish size and condition were compared between baseline and post impoundment and some differences were observed. Mean fork length and condition of Walleye was significantly lower during post-impoundment than baseline in all four monitoring areas. Average condition of Lake Whitefish was significantly lower during post-impoundment in Split Lake and Stephens Lake North and did not differ between the two time periods in the Keeyask reservoir. Northern Pike showed a higher condition in post-impoundment years in Split Lake, the Keeyask reservoir, and Stephens Lake South.

Similar to CPUE, it may be too soon after impoundment to identify the magnitude of changes in fish condition and growth; it is expected that additional changes will be observed with continued monitoring.

Is the abundance of small-bodied fish captured in SMI gill nets set in the Keeyask reservoir and Stephens Lake changing following construction of the Project?

Catch per Unit of Effort (CPUE) in SMI gill nets was highly variable between study years and waterbodies and could not be compared statistically because too few sites were sampled. The CPUE (#fish/30m of net/24h) for all fish captured within SMI gill nets during the second year of post-impoundment monitoring in the Keeyask reservoir fell within ranges observed in previous years (2022 CPUE: 28 fish, baseline CPUE: 12–316 fish), however, the overall catch was low. Mean CPUE in small mesh gill nets set in newly flooded sites was higher (62 fish).

Mean CPUE in SMI nets in Stephens Lake North was slightly lower than in previous sampling years (CPUE = 66 fish, baseline CPUE = 67–197 fish) but fell into the range seen in previous years in Stephens Lake South (59 fish, baseline CPUE = 44–135 fish). The abundance of Rainbow Smelt has decreased in all sampled waterbodies since 2009, a pattern that has been observed throughout Northern Manitoba.

It was predicted in the EIS that impoundment of the Keeyask reservoir would result in a loss of some the inundation of terrestrial vegetation near the mouths of several tributaries resulting from higher water levels could result in a short-term increase in spawning habitat for Northern Pike. Walleye and Lake Whitefish were predicted to continue to spawn at Birthday Rapids and find alternative spawning habitat within the Keeyask reservoir. Although no young-of-the-year (YOY) Walleye (spawned in spring 2022) or Lake Whitefish (spawned in fall 2021) were captured in 2022, one-year old fish of both species were captured, indicating that recruitment has continued to occur for both species post-impoundment. Northern Pike spawned in both spring 2021 and 2022 were captured.

5.2 NEWLY FLOODED AREAS

As discussed previously, the EIS predicted that fish habitat in the Keeyask reservoir would decrease in both quality and quantity due to low DO conditions, shoreline instability, and the absence of aquatic plants for the first five to ten years following impoundment. These changes would be most pronounced in newly flooded areas and backbays of the reservoir where water is poorly mixed and has long residency times. Here, the creation of new littoral habitats in unstable environments (*i.e.*, eroding shorelines, fluctuating water levels) could reduce the amount of rearing habitat available to many species of fish in the short-term.

Sampling was conducted within seven newly flooded areas in 2022 including four backbays, one previously isolated lake now connected to the Keeyask reservoir via flooded terrestrial habitat (Little Gull Lake), and two sites near the newly built GS (Map 4). Areas near these sites were sampled for the first time in 2019 but were not fully accessible pre-impoundment (*i.e.*, were not fully connected to the Nelson River, were not accessible by boat, or were situated too close to construction activities to sample).

All three VEC species were captured in the newly flooded areas in 2022, and CPUEs did not differ from previous sampling years (2019 and 2021). Northern Pike were the most commonly captured species at all sites and were captured in the largest numbers in the backbays and in Little Gull Lake.

Three species were captured within Little Gull Lake including Cisco (n = 24), Northern Pike (n = 46), and White Sucker (n = 1). This represents an increase over 2021 when 31 Northern Pike were captured.

6.0 SUMMARY AND CONCLUSIONS

- Fish community sampling in 2022 was conducted using standard gang and small mesh index gill nets in the Keeyask reservoir, Split Lake, Stephens Lake North, and Stephens Lake South. Sampling in Split and Stephens lakes was conducted as part of the Coordinated Aquatic Monitoring Program (CAMP). Data collected in the reach of the Keeyask reservoir was collected as per the Keeyask Generation Project Aquatic Effects Monitoring Plan (AEMP).
- A total of 40 standard gang index (SGI) and 12 small mesh index (SMI) gill net sites were sampled in 2022, which represented the second year of monitoring since impoundment of the Keeyask reservoir in fall 2020 and the first year of monitoring since the GS became fully operational. This included 12 SGI and four SMI sites on Split Lake, ten SGI and two SMI sites on the Keeyask reservoir, and nine SGI and three SMI sites on both Stephens Lake North and South. Sampling was conducted in 2009, 2015, 2019, 2021 and 2022 for Split Lake; in 2001, 2002, 2009, 2015, 2019, 2021 and 2022 for the Keeyask reservoir; and in 2009, 2015, 2018, 2021 and 2022 for Stephens Lake North and South. The same sites were sampled in all years and were used for between year and baseline and post-impoundment monitoring comparisons.
- An additional seven SGI and five SMI gill nets were set in the Keeyask reservoir in 2022 at sites outlined in the AEMP as newly flooded habitat post-impoundment. These sites were defined in the AEMP and were accessible for the second time since impoundment and were not used for between-year comparisons.
- Sampling conducted in 2022 likely occurred too soon after impoundment to identify (long-term) changes in fish abundance, given that most species are not fully recruited to the gear until 4 years of age. Further, changes in populations as a result of increased feeding and spawning habitat will take time to become apparent. However, potential changes due to factors such as mass mortality due to impoundment, an absence of recruitment and large-scale adult emigration, are possible to identify.
- Key questions in the AEMP related to fish community monitoring in the Keeyask area are listed below:
    - *Is the abundance (CPUE) and species composition of the fish communities in the Keeyask reservoir and Stephens Lake changing as a result of impoundment and operation of the Project?*

      The overall mean CPUE of all fish species captured in standard gang and small mesh gill nets in 2022 did not differ significantly between baseline in the Keeyask reservoir or Stephens Lake. Average CPUE of VEC species captured in standard gang index gill nets were also compared between years. The largest change in CPUE was observed for Northern Pike. As observed in 2021, Northern Pike CPUE was lower in standard sites fished in the Keeyask reservoir than in any other year. However, this is likely a sampling artefact in that sites that provided preferred habitat prior to impoundment were flooded and Northern Pike moved to shallower areas. The EIS predicted that that the number of Northern Pike in the Keeyask reservoir may increase post-impoundment due to the availability of spawning and foraging habitats in flooded areas. Northern Pike were the most commonly captured species in the newly flooded areas sampled in the reservoir post-impoundment.

Species composition of the fish communities in all sampling locations were relatively similar to that of previous years, although some differences were observed. The relative abundance of Walleye has decreased between baseline and post-impoundment in both Split Lake and Stephens Lake South. At the same time, the relative abundance of White Sucker has increased in all waterbodies. The relative abundance of Shorthead Redhorse has also increased in the Keeyask reservoir.

It is too soon after impoundment to identify the extent to which the fish community will change within the Keeyask area; it is expected that additional changes will be observed with continued monitoring.

- *For the three VEC fish species, is a biologically relevant (and statistically significant) change in condition factor or growth observed in the Keeyask reservoir and Stephens Lake in comparison to pre-Project conditions?*

  Fish size and condition were compared between baseline and post impoundment years and some differences were observed. Mean fork length and condition of Walleye was significantly lower during post-impoundment than baseline in all four monitoring areas. Average condition of Lake Whitefish was significantly lower during post-impoundment in Split Lake and Stephens Lake North and did not differ between the two time periods in the Keeyask reservoir. Northern Pike showed a higher condition in post-impoundment years in Split Lake, the Keeyask reservoir, and Stephens Lake South.

- *Is the abundance of small-bodied fish captured in SMI gill nets set in the Keeyask reservoir and Stephens Lake changing following construction of the Project?*

  Catch per Unit of Effort (CPUE) in SMI gill nets was highly variable between study years and waterbodies and could not be compared statistically because too few sites were sampled. The CPUE (#fish/30m of net/24h) for all fish captured within SMI gill nets during the second year of post-impoundment monitoring in the Keeyask reservoir fell within ranges observed in previous years (2022 CPUE: 28 fish, baseline CPUE: 12–316 fish), however, the overall catch was low. Mean CPUE in small mesh gill nets set in newly flooded sites was higher (62 fish). The abundance of Rainbow Smelt has decreased in all four waterbodies since 2009, a pattern that has been observed throughout Northern Manitoba.

  Although no young-of-the-year (YOY) Walleye (spawned in spring 2022) or Lake Whitefish (spawned in fall 2021) were captured in 2022, one-year old fish of both species were captured, indicating that recruitment has continued to occur for both species post-impoundment. Northern Pike spawned in both spring 2021 and 2022 were captured.

- Sampling was conducted within seven newly flooded areas in 2022 including four backbays, one previously isolated lake now connected to the Keeyask reservoir via flooded terrestrial habitat (Little Gull Lake), and two sites near the newly built GS. All three VEC species were captured in the newly flooded areas in 2022, and CPUE's did not differ from 2019 or 2021. Northern Pike were the most commonly captured species at all new sites and were captured in the largest numbers in the backbays and in Little Gull Lake.
- The EIS predicted that effects to the fish community would primarily occur due to changes in the quality and quantity of aquatic habitat, and changes in water quality and lower trophic levels. However, changes in the fish populations and communities are expected to occur gradually after Project completion and would take time to become apparent. Large-scale community changes due to an absence of recruitment or mass emigration would be possible to detect earlier post-impoundment. The EIS predicted an increase in the number of fish leaving the Keeyask reservoir due to changes in water level and velocities following impoundment. No changes in overall abundance of common fish species were observed. The abundance of Northern Pike at pre-construction monitoring sites in the Keeyask reservoir was lower in 2022 than any previous sampling year. However, this is likely a sampling artefact in that sites that provided preferred habitat prior to impoundment were flooded and Northern Pike moved to shallower areas. Northern Pike were the most commonly captured species in the newly flooded areas sampled in the reservoir post-impoundment. Recruitment of all VEC species has continued in the years immediately following reservoir impoundment. Although no young-of-the-year (YOY) Walleye (spawned in spring 2022) or Lake Whitefish (spawned in fall 2021) were captured in 2022, one-year old fish of both species were captured in the Keeyask reservoir. Northern Pike spawned in both spring 2021 and 2022 were captured.

7.0 LITERATURE CITED

Barth, C.C., D.L. Neufeld, and R.L. Bretecher. 2003. Results of fisheries investigations conducted in tributaries of the Nelson River between Birthday Rapids and Gull Rapids, Manitoba, spring 2001. A report prepared for Manitoba Hydro by North/South Consultants Inc. 39 pp.

Bretecher, R.L., C. Dyck, and R.A. Remnant. 2007. Results of fish community investigations conducted in the reach of the Nelson River between the outlet of Clark Lake and Gull Rapids (including Gull Lake), 2003. A report prepared for Manitoba Hydro by North/South Consultants Inc. 252 pp.

Cassin, J. and R.A. Remnant. 2008. Results of fish spawning investigations conducted in Gull Rapids Creek, Pond 13, and selected tributaries to Stephens Lake, spring 2005 and 2006. A report prepared for Manitoba Hydro by North/South Consultants Inc. 35 pp.

Cooley, M. and M. Johnson. 2008. An evaluation of Walleye condition from Stephens Lake. A report prepared for Manitoba Hydro by North/South Consultants Inc. 47 pp.

Cooley, P. and L. Dolce. 2008. Aquatic habitat utilization studies in Stephens Lake: macrophyte distribution and biomass, epiphytic invertebrates, and fish catch-per-unit-effort in flooded habitat. A report prepared for Manitoba Hydro by North/South Consultants Inc. 62 pp.

CAMP (Coordinated Aquatic Monitoring Program). 2014. Three Year Summary Report (2008-2010). Report prepared for Manitoba/Manitoba Hydro MOU Working Group by North/South Consultants Inc., Winnipeg.

CAMP (Coordinated Aquatic Monitoring Program). In prep. Six Year Summary Report (2008-2013). Report prepared for the Manitoba/Manitoba Hydro MOU Working Group by North/South Consultants Inc. Winnipeg, MB. In preparation.

Dunmall, K.M., J. Holm, and R.L. Bretecher. 2003. Results of index gillnetting studies conducted in Assean Lake, Manitoba, summer 2001. A report prepared for Manitoba Hydro by North/South Consultants Inc. 56 pp.

Dunmall, K.M., J.E. MacDonald, and R.L. Bretecher. 2004. Results of summer index gillnetting studies conducted in Split Lake and Clark Lake, and spring investigations of adult and larval fish communities in portions of the Burntwood River, Grass River, and Nelson River, flowing into Split Lake, Manitoba, 2001. A report prepared for Manitoba Hydro by North/South Consultants Inc. 98 pp.

Holm, J. 2005. Results of fish community investigations conducted in Clark Lake, 2004. A report prepared for Manitoba Hydro by North/South Consultants Inc. 98 pp.

Holm, J. 2010. Results of index gillnetting studies conducted in the Keeyask Study Area, summer 2009. A report prepared for Manitoba Hydro by North/South Consultants Inc. 94 pp.

Holm, J. and R.A. Remnant. 2004. Results of summer index gillnetting studies conducted in Split Lake and Clark Lake, and spring investigations of adult and larval fish communities in portions of the Burntwood, Grass, and Nelson rivers flowing into Split Lake, Manitoba, 2002. A report prepared for Manitoba Hydro by North/South Consultants Inc. 113 pp.

Holm, J., V.L. Richardson, and R.L. Bretecher. 2003. Results of index gillnetting studies conducted in Assean Lake, Manitoba, summer 2002. A report prepared for Manitoba Hydro by North/South Consultants Inc. 64 pp.

Horne, B.D. 1994. Norway House commercial fishery debris monitoring program, 1993 – Year I. A report prepared for Manitoba Hydro, the Province of Manitoba, and the Norway House Fisherman's Cooperative by North/South Consultants Inc. 27 pp.

Hrenchuk, C.L., and A.R. Loeppky. 2022. Fish community monitoring in the Nelson River from Split Lake to Stephens Lake, summer 2021. Keeyask Generation Project Aquatic Effects Monitoring Report #AEMP-202207. A report prepared for Manitoba Hydro by North/South Consultants Inc. xvi + 92 pp.

Johnson, M.W. 2005. Results of fish community investigations conducted in the Assean River watershed, Manitoba, spring and fall 2002. A report prepared for Manitoba Hydro by North/South Consultants Inc. 115 pp.

Johnson, M.W. 2007. Results of fish community investigations conducted in the reach of the Nelson River between Clark Lake and Gull Rapids (including Gull Lake), 2004. A report prepared for Manitoba Hydro by North/South Consultants Inc. 142 pp.

Johnson, M.W. and C.R. Parks. 2005. Results of fish community investigations conducted in the reach of the Nelson River between Clark Lake and Gull Rapids, 2002. A report prepared for Manitoba Hydro by North/South Consultants Inc. 198 pp.

Keeyask Hydropower Limited Partnership (KHLP). 2012. Keeyask Generation Project Environmental Impact Statement: Aquatic Environment Supporting Volume, Winnipeg, MB. 1,745 pp.

Keeyask Hydropower Limited Partnership (KHLP). 2014. Keeyask Generation Project: aquatic effects monitoring plan. A draft report prepared by Keeyask Hydropower Limited Partnership, Winnipeg, Manitoba. 216 pp. + appendices.

Kroeker, D.S. and W. Jansen. 2006 (revised). Results of fish community investigations conducted in tributaries of the Nelson River between Clark Lake and Gull Rapids, Manitoba, 2003. A report prepared for Manitoba Hydro by North/South Consultants Inc. 58 pp.

Lawrence, M.J., C.R. Fazakas, L. Zrum, C.L. Bezte, and W.J. Bernhardt. 1999. The Split Lake aquatic ecosystem: a synthesis of Split Lake biological and environmental data, January 1997 – October, 1998. A report prepared for the Tataskweyak Environmental Monitoring Agency by North/South Consultants Inc. 87 pp.

MacDonald, J. 2007. Results of fish community investigations in Gull Rapids and Stephens Lake, 2004. A report prepared for Manitoba Hydro by North/South Consultants Inc. 99 pp.

Pisiak, D.J. 2005a. Results of summer index gillnetting 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. A report prepared for Manitoba Hydro by North/South Consultants Inc. 159 pp.

Pisiak, D.J. 2005b. Results of summer index gillnetting 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, 2003: Year 3. A report prepared for Manitoba Hydro by North/South Consultants Inc. 289 pp.

Pisiak, D.J, T. Kroeker, and R.A. Remnant. 2004. Results of summer index gillnetting 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. A report prepared for Manitoba Hydro by North/South Consultants Inc. 94 pp.

Remnant, R.A., N.J. Mochnacz, and J.E. MacDonald. 2004a. Results of fisheries investigations conducted in the Assean River watershed, Manitoba, spring and fall, 2001. A report prepared for Manitoba Hydro by North/South Consultants Inc. 88 pp.

Remnant, R.A., C.R. Parks, and J.E. MacDonald. 2004b. Results of fisheries investigations conducted in the reach of the Nelson River between Clark Lake and Gull Rapids (including Gull Lake), 2001. A report prepared for Manitoba Hydro by North/South Consultants Inc. 132 pp.

Richardson, V.L. and J. Holm. 2005. Results of fish investigations conducted in tributary streams of the Nelson River between Birthday Rapids and Gull Rapids, 2002. A report prepared for Manitoba Hydro by North/South Consultants Inc. 82 pp.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Fisheries Research Board of Canada, Bulletin No. 191. 382 pp.

APPENDICES

APPENDIX 1: GILLNET SURVEY INFORMATION FOR SPLIT LAKE, KEEYASK RESERVOIR, STEPHENS LAKE NORTH, AND STEPHENS LAKE SOUTH, SUMMER 2022

Table A1-1: Standard gang and small mesh index gillnet survey information, Split Lake, summer 2022.

Site	Date Set	UTM coordinates			Duration (dec. hours)	Depth (m)		velocity	substrate	Vegetation	Water Temp
		Zone	Easting	Northing		1.5"	5"				
GN-03	31-Aug-22	14V	316502	6237900	24.00	4.4	5.2	None	Soft	None	17.0
GN-05	30-Aug-22	14V	673421	6236277	25.92	4.3	4.2	None	Soft	None	19.0
GN-06	30-Aug-22	14V	673577	6233734	25.42	4.0	5.2	None	Soft	None	19.0
GN-13	27-Aug-22	14V	669796	6221754	26.00	6.1	8.5	Low	Soft	None	19.0
GN-15	27-Aug-22	14V	657319	6221777	23.00	6.0	8.5	Low	Soft	None	19.0
GN-18	28-Aug-22	14V	669506	6225215	22.92	4.7	4.8	None	Soft	None	19.0
GN-20	31-Aug-22	14V	683272	6236541	24.17	9.9	9.0	None	Soft	None	17.0
GN-21	30-Aug-22	14V	675124	6233458	24.75	2.0	14.8	None	Soft	None	19.0
GN-22	31-Aug-22	14V	678003	6233145	24.42	10.1	6.3	None	Soft	None	17.0
GN-26	28-Aug-22	15V	670868	6225594	23.25	4.8	12.0	None	Soft	None	19.0
GN-28	27-Aug-22	14V	657623	6221578	24.08	4.8	4.7	Low	Soft	None	19.0
GN-29	28-Aug-22	14V	670725	6222032	23.17	4.6	10.5	Low	Soft	None	19.0
		Small Mesh Sites				**16 mm**	**25 mm**				
SN-03	31-Aug-22	14V	316520	6237931	24.00	2.6	4.4	None	Soft	None	17.0
SN-06	30-Aug-22	14V	673472	6233858	25.42	3.7	4.0	None	Soft	None	19.0
SN-20	31-Aug-22	15V	683229	6236561	24.17	9.7	9.9	None	Soft	None	17.0
SN-26	28-Aug-22	14V	670857	6225625	23.25	4.5	4.8	None	Soft	None	19.0

Table A1-2: Standard gang and small mesh index gillnet survey information, Keeyask reservoir, summer 2022.

Site	Date Set	UTM coordinates			Duration (dec. hours)	Depth (m)		Velocity	Substrate	Vegetation	Water Temp
		Zone	Easting	Northing		1.5"	5"				
GN-01	10-Aug-22	15V	326101	6239781	24.42	5.1	6.7	Medium	Hard	None	18.0
GN-02	10-Aug-22	15V	329952	6242327	24.57	5.1	6.1	Low	Hard	None	18.0
GN-03	10-Aug-22	15V	331432	6241978	24.85	5.5	5.4	Low	Hard	None	18.0
GN-04	12-Aug-22	15V	333758	6243138	19.63	5.0	6.4	Low	Hard	None	18.0
GN-05	12-Aug-22	15V	336224	6244848	19.93	5.7	6.8	Low	Soft	None	18.0
GN-06	12-Aug-22	15V	339712	6245046	21.58	5.0	5.3	None	-	None	18.0
GN-07	13-Aug-22	15V	345114	6245298	20.70	5.9	6.6	None	Hard	None	18.0
GN-08	13-Aug-22	15V	347449	6243605	19.82	8.3	9.1	None	Hard	None	18.0
GN-09	14-Aug-22	15V	351208	6239725	18.90	3.4	3.2	None	Soft	Medium	18.0
GN-10	13-Aug-22	15V	350706	6247093	18.65	2.3	2.2	Low	-	None	18.0
GN-11	16-Aug-22	15V	354573	6248755	19.95	3.6	5.1	None	-	None	18.0
GN-12	14-Aug-22	15V	355573	6245267	19.48	7.5	6.9	Medium	-	None	18.0
GN-13	14-Aug-22	15V	355347	6243364	19.08	6.3	6.2	Medium	Hard	None	18.0
GN-14	16-Aug-22	15V	357074	6249137	21.22	3.0	2.7	High	-	None	18.0
GN-15	16-Aug-22	15V	358301	6248371	22.55	6.9	6.9	Low	-	None	18.0
GN-16	15-Aug-22	15V	360758	6246353	23.30	8.4	9.8	None	Soft	None	18.0
GN-17	15-Aug-22	15V	360142	6245543	22.68	7.4	7.4	Low	-	None	18.0
			Small Mesh			**16 mm**	**25 mm**				
SN-01	10-Aug-22	15V	326052	6239776	24.42	5.0	5.1	Medium	Hard	None	19.5
SN-06	12-Aug-22	15V	339737	6245019	21.58	5.2	5.0	None	Hard	None	16.4
SN-09	14-Aug-22	15V	351238	6239713	18.90	3.0	3.4	Low	-	-	19.4
SN-11	15-Aug-22	15V	360783	6246356	23.30	7.2	8.4	High	Hard	None	19.3
SN-14	16-Aug-22	15V	358347	6248246	22.55	6.9	6.2	Low	Soft	None	19.7
SN-15	16-Aug-22	15V	357054	6249121	21.22	2.5	3.0	None	Soft	None	19.9
SN-16	16-Aug-22	15V	354542	6248767	19.95	3.4	3.6	Low	Hard	None	18.0

Table A1-3: Standard gang and small mesh index gillnet survey information, Stephens Lake North, summer 2022.

Site	Date Set	UTM Coordinates			Duration (dec. hours)	Depth (m)		Velocity	Substrate	Vegetation	Water Temp
		Zone	Easting	Northing		1.5"	5"				
GN-01	31-Aug-22	15V	359138	6265591	22.62	3.7	9.5	Low	Soft	Low	15.0
GN-02	31-Aug-22	15V	358370	6244592	22.67	5.9	8.2	Low	Soft	Low	15.0
GN-04	31-Aug-22	15V	362524	6264795	22.67	4.5	1.9	None	Soft	None	15.0
GN-05	31-Aug-22	15V	359603	6262296	22.55	1.8	2.7	High	Soft	High	15.0
GN-09	31-Aug-22	15V	364694	6259046	22.28	6.4	2.6	None	Soft	None	15.0
GN-26	28-Aug-22	15V	369262	6251847	22.88	6.1	4.2	None	Soft	None	20.0
GN-31	28-Aug-22	15V	367067	6248997	23.43	1.8	5.4	None	Soft	None	20.0
GN-34	28-Aug-22	15V	368170	6249412	23.30	4.2	2.3	None	Soft	None	20.0
GN-35	28-Aug-22	15V	370279	6249934	22.32	3.3	2.7	None	Soft	None	20.0
Small Mesh						**16 mm**	**25 mm**				
SN-04	31-Aug-22	15V	362524	6264795	22.67	1.9	-	None	Soft	None	15.0
SN-09	31-Aug-22	15V	364587	6259176	22.28	3.1	6.4	Low	Soft	None	15.0
SN-34	28-Aug-22	15V	368296	6249508	23.30	1.9	4.2	Low	Soft	None	20.0

Table A1-4: Standard gang and small mesh index gillnet survey information, Stephens Lake South, summer 2022.

Site	Date Set	UTM Coordinates			Duration (dec. hours)	Depth (m)		Velocity	Substrate	Vegetation	Water Temp
		Zone	Easting	Northing		1.5"	5"				
GN-13	24-Aug-22	15V	397618	6249312	25.4	12.7	3	Low	Soft	Low	19.0
GN-14	24-Aug-22	15V	397093	6248242	24.55	2.7	3.4	Low	Soft	Low	19.0
GN-15	25-Aug-22	15V	397242	6251256	22.78	6.1	11.1	Low	Soft	Low	18.5
GN-16	25-Aug-22	15V	395066	6252172	22.88	6.1	3.8	None	Soft	Medium	18.5
GN-17	24-Aug-22	15V	392767	6247121	23.33	2.3	3.9	Low	Soft	None	19.0
GN-22	25-Aug-22	15V	387363	6246236	23.05	3.4	2.9	Low	Soft	-	18.5
GN-30	27-Aug-22	15V	371048	6246188	24.08	3.2	3.5	None	Soft	Low	19.0
GN-32	27-Aug-22	15V	369506	6247298	23.25	14.9	15.8	Low	Soft	None	19.0
GN-33	27-Aug-22	15V	368175	6246988	22.27	9.1	4.5	Medium	Soft	Medium	19.0
Small Mesh						**16 mm**	**25 mm**				
SN-14	24-Aug-22	15V	396949	6248165	24.55	2.3	2.7	Low	Soft	Low	19.0
SN-22	25-Aug-22	15V	387363	6246236	23.05	2.9	3.1	Low	Soft	-	18.5
SN-32	27-Aug-22	15V	369388	6247400	23.25	14.2	14.9	Low	Soft	Low	19.0

APPENDIX 2: OCCURENCE OF DEBRIS IN STANDARD GANG AND SMALL MESH INDEX GILL NETS SET THROUGHOUT THE KEEYASK STUDY AREA, SUMMER 2022

Table A2-1: Occurrence of debris in standard gang and small mesh index gill nets set in Split Lake, summer 2022.

Gillnet Type	Site	Quantity of Debris	Type of Debris (%)							
			Terrestrial Vegetation	Terrestrial Moss	Sticks	Algae	Aquatic Vegetation	Aquatic Moss	Silt/Mud	Zebra Mussels
Standard Gang	GN-03	None	-	-	-	-	-	-	-	-
	GN-05	None	-	-	-	-	-	-	-	-
	GN-06	None	-	-	-	-	-	-	-	-
	GN-13	Moderate (5-15%)	-	-	25	-	-	-	-	75
	GN-15	High (16-25%)	-	-	25	-	-	-	-	75
	GN-18	None	-	-	-	-	-	-	-	-
	GN-20	Low (< 5%)	-	-	-	-	-	-	-	100
	GN-21	Very High (> 26%)	-	-	-	-	-	-	-	100
	GN-22	Low (< 5%)	-	-	-	-	-	-	-	100
	GN-26	Very High (> 26%)	-	-	-	-	-	-	-	100
	GN-28	None	-	-	-	-	-	-	-	-
	GN-29	Very High (> 26%)	-	-	-	-	-	-	-	100
Small Mesh	SN-03	None	-	-	-	-	-	-	-	-
	SN-06	None	-	-	-	-	-	-	-	-
	SN-20	Low (< 5%)	-	-	-	-	-	-	-	100
	SN-26	Very High (> 26%)	-	-	-	-	-	-	-	100

Table A2-2: Occurrence of debris in standard gang and small mesh index gill nets set in the Keeyask reservoir, summer 2022.

Gillnet Type	Site	Quantity of Debris	Type of Debris (%)							
			Terrestrial Vegetation	Terrestrial Moss	Sticks	Algae	Aquatic Vegetation	Aquatic Moss	Silt/Mud	Zebra Mussels
Standard Gang	GN-01	Low (< 5%)	-	-	-	-	100	-	-	-
	GN-02	Moderate (5-15%)	-	-	20	-	80	-	-	-
	GN-03	Moderate (5-15%)	-	-	40	-	60	-	-	-
	GN-04	Low (< 5%)	-	-	-	-	100	-	-	-
	GN-05	Very High (> 26%)	-	-	10	-	-	-	-	90
	GN-06	None	-	-	-	-	-	-	-	-
	GN-07	Moderate (5-15%)	-	-	-	-	100	-	-	-
	GN-08	Low (< 5%)	-	-	100	-	-	-	-	-
	GN-09	None	-	-	-	-	-	-	-	-
	GN-10	Moderate (5-15%)	-	-	-	-	100	-	-	-
	GN-11	Low (< 5%)	-	-	100	-	-	-	-	-
	GN-12	Very High (> 26%)	-	-	50	-	50	-	-	-
	GN-13	Low (< 5%)	-	-	10	-	90	-	-	-
	GN-14	None	-	-	-	-	-	-	-	-
	GN-15	Low (< 5%)	-	-	100	-	-	-	-	-
	GN-16	Low (< 5%)	-	-	100	-	-	-	-	-
	GN-17	Moderate (5-15%)	-	-	50	-	-	-	-	50
Small Mesh	SN-01	Low (< 5%)	-	-	-	-	100	-	-	-
	SN-06	None	-	-	-	-	-	-	-	-
	SN-09	None	-	-	-	-	-	-	-	-
	SN-11	Low (< 5%)	-	-	100	-	-	-	-	-
	SN-14	None	-	-	-	-	-	-	-	-
	SN-15	Low (< 5%)	-	-	100	-	-	-	-	-
	SN-16	Low (< 5%)	-	-	100	-	-	-	-	-

Table A2-3: Occurrence of debris in standard gang and small mesh index gill nets set in Stephens Lake North, summer 2022.

Gillnet Type	Site	Quantity of Debris	Type of Debris (%)							
			Terrestrial Vegetation	Terrestrial Moss	Sticks	Algae	Aquatic Vegetation	Aquatic Moss	Silt/Mud	Zebra Mussels
Standard Gang	GN-01	Moderate (5-15%)	-	-	100	-	-	-	-	-
	GN-02	Moderate (5-15%)	-	-	100	-	-	-	-	-
	GN-04	Low (< 5%)	-	-	100	-	-	-	-	-
	GN-05	Low (< 5%)	-	-	100	-	-	-	-	-
	GN-09	Moderate (5-15%)	-	-	100	-	-	-	-	-
	GN-26	Low (< 5%)	-	-	80	-	10	10	-	-
	GN-31	Very High (>26%)	-	-	-	-	70	30	-	-
	GN-34	Low (< 5%)	-	-	100	-	-	-	-	-
	GN-35	Moderate (5-15%)	-	-	40	-	10	30	20	-
Small Mesh	SN-04	Low (< 5%)	-	-	100	-	-	-	-	-
	SN-09	Moderate (5-15%)	-	-	100	-	-	-	-	-
	SN-34	Low (< 5%)	-	-	100	-	-	-	-	-

Table A2-4: Occurrence of debris in standard gang and small mesh index gill nets set in Stephens Lake South, summer 2022.

Gillnet Type	Site	Quantity of Debris	Type of Debris (%)						
			Terrestrial Vegetation	Terrestrial Moss	Sticks	Algae	Aquatic Vegetation	Aquatic Moss	Silt/Mud
Standard Gang	GN-13	Low (< 5%)	-	-	100	-	-	-	-
	GN-14	None	-	-	-	-	-	-	-
	GN-15	None	-	-	-	-	-	-	-
	GN-16	Moderate (5-15%)	-	-	80	20	-	-	-
	GN-17	Moderate (5-15%)	-	-	100	-	-	-	-
	GN-22	Low (< 5%)	-	-	100	-	-	-	-
	GN-30	Low (< 5%)	-	-	50	-	-	50	-
	GN-32	Moderate (5-15%)	-	-	60	-	40	-	-
	GN-33	Moderate (5-15%)	-	-	60	-	20	20	-
Small Mesh	SN-14	None	-	-	-	-	-	-	-
	SN-22	Low (< 5%)	-	-	100	-	-	-	-
	SN-32	Moderate (5-15%)	-	-	60	-	40	-	-