Keeyask Generation Project

Aquatic Effects Monitoring Plan

Fish Community Monitoring Report

AEMP-2020-09

KEEYASK

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KEEYASK GENERATION PROJECT

AQUATIC EFFECTS MONITORING PLAN

REPORT #AEMP-2020-09

FISH COMMUNITY MONITORING IN THE NELSON RIVER FROM SPLIT LAKE TO STEPHENS LAKE, SUMMER 2019

Prepared for

Manitoba Hydro

By

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SUMMARY

Background

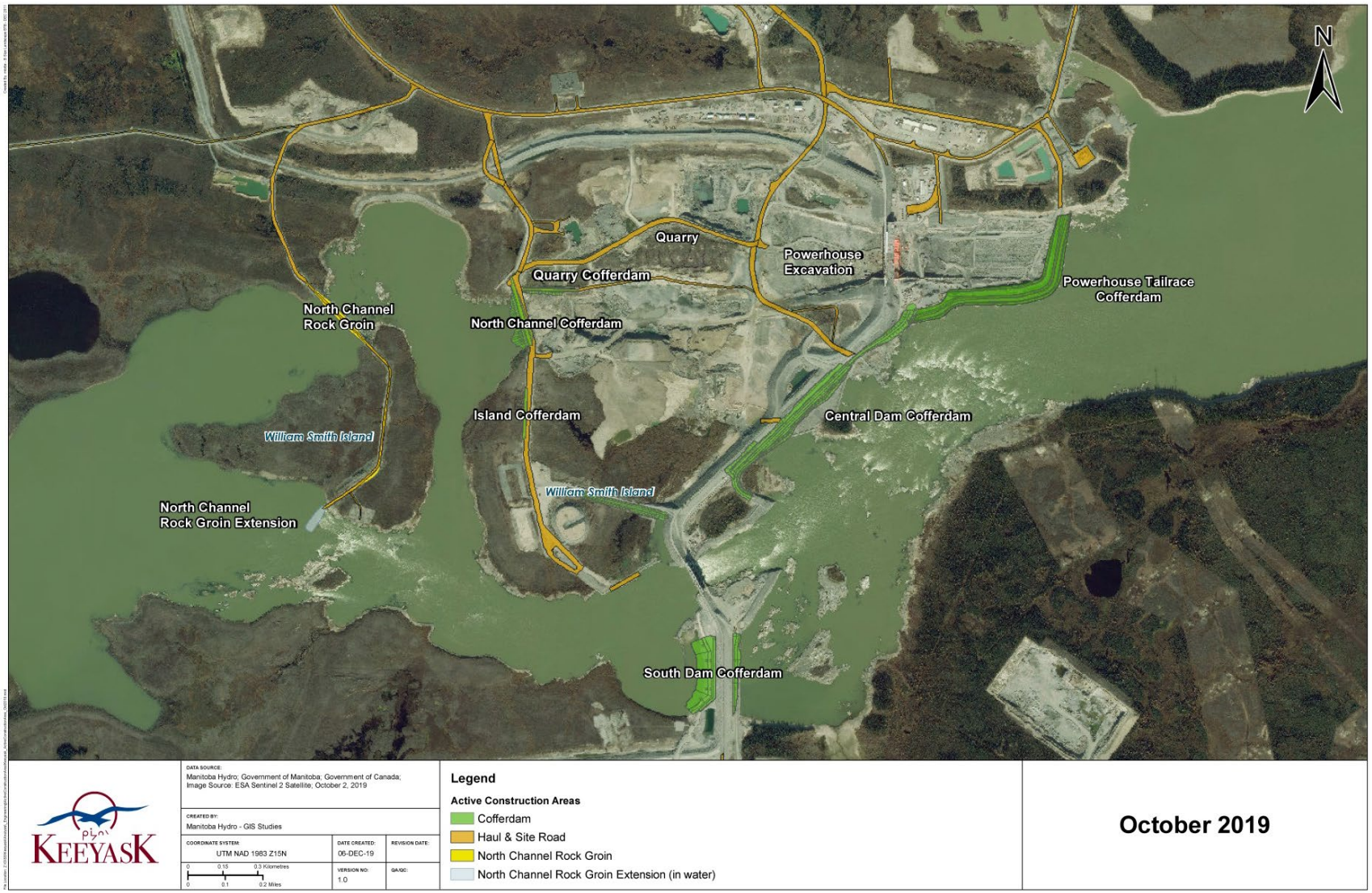
The Keeyask Hydropower Limited Partnership (KHLP) was required to prepare a plan to monitor the effects of construction and operation of the Keeyask Generating Station (GS) on the environment. Besides measuring the accuracy of the predictions made and actual effects of the GS on the environment, monitoring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

Construction of the Keeyask GS began in mid-July 2014 with the construction of cofferdams that blocked flow in the north and central channels of Gull Rapids (see map). During the winter of 2015/2016, the Spillway Cofferdam, which partially blocks the south channel, was constructed. Beginning late in 2016 and continuing in 2017, the Tailrace Cofferdam was constructed. Work was completed in fall 2017 with the exception of an opening that was left to allow fish movement into and out of the cofferdam over the 2017/18 winter. This opening was closed in spring 2018, and the area was dewatered. The spillway was commissioned in August 2018. The South Dam Cofferdam was completed in fall 2018, blocking the channel and forcing the entire flow of the river through the spillway. Almost all work in 2019 was in the dry. The construction activities included the excavation of the tailrace, construction of the tailrace spawning shoal, and completion of the dams and dykes.

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 Gull Rapids, which include several species that are important sources of food to local people, may be affected by operation of the Keeyask GS through reservoir impoundment. Changes in water levels and flow will result in the alteration or loss of existing habitats and the creation of new habitats. Furthermore, 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 to provide the basis for assessing 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 and from Clark Lake to the Keeyask GS were sampled in 2019 and sites in Stephens Lake North and South were sampled in 2018. Fish community data were previously collected in the Nelson River between Clark Lake and the Keeyask GS in 2001, 2002, 2009, and 2015. Since 2009, monitoring was conducted every year in Split Lake, and every third year in Stephens Lake, under the Coordinated Aquatic Monitoring Program (CAMP), a program conducted jointly by the province of Manitoba and Manitoba Hydro. However, different sites were sampled in each year. In this report, only years in which the same sites were sampled previously were used for comparison. These included

2009, 2015, and 2019 for Split Lake; 2001, 2002, 2009, 2015, and 2019 for the Nelson River between Clark Lake and the Keeyask GS; and 2009, 2015, and 2018 for Stephens Lake north and south.



Satellite Imagery - October, 2019

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

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.

For the three Valued Environmental Component (VEC) fish species (i.e., Lake Whitefish, Northern Pike, and Walleye), will a biologically meaningful change in condition factor or growth be observed in the Keeyask reservoir and/or Stephens Lake in comparison to pre-Project conditions?

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 abundance of small-bodied fish captured in small mesh index (SMI) gill nets set in the Keeyask reservoir and Stephens Lake change following construction and during operation of the Project?

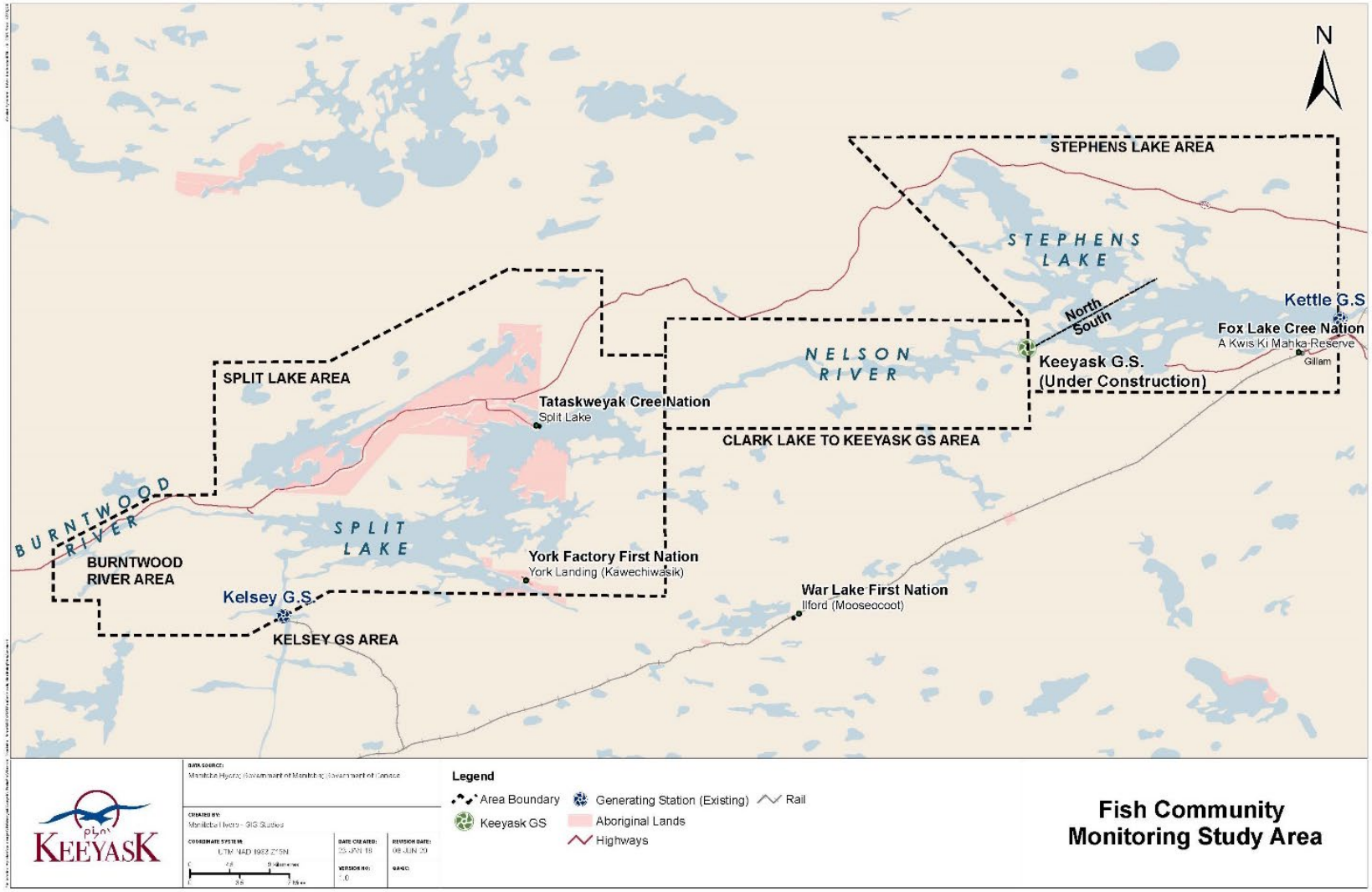
This question is important because the small-bodied fish community is the major food source for species such as Walleye and Northern Pike.

What was done?

Sampling was conducted in Split Lake, the Nelson River between Clark Lake and the Keeyask GS, and Stephens Lake (split into North and South parts for data analysis) in the summer of 2018 and 2019 (see study area map below). Two types of gill nets were used: standard gang index (SGI) which catch large-bodied fish, and SMI which catch small bodied fish (also called forage 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, Northern Pike, and Walleye. All Lake Sturgeon, Lake Whitefish, Northern Pike, Walleye, and White Sucker caught were checked for signs of any abnormalities (including deformities, erosion, lesions, and tumours).

More locations were sampled in the Nelson River between Clark Lake and the Keeyask GS than have been in past years (*i.e.*, in 2001, 2002, and 2015), close to sites that had been chosen to

represent flooded habitat post-Project in the AEMP. These specific sites outlined in the AEMP were not yet fully accessible (*i.e.*, were not fully connected to the Nelson River and not accessible by boat or were situated too close to construction activities to safely sample) but will be once the GS is completed and flooding occurs. In 2019, nets were set in the same kind of habitat, as close as possible to the sites. Data from these sites are presented separately from the sites sampled in all study years. Only data from sites that were sample in all study years were used for comparisons.



Map of the Study Area for the Fish Community Monitoring Program.

What was found?

A total of 2,315 fish representing 20 different species were captured in SGI and SMI gill nets set at standard sites in 2018 (Stephens Lake North and South) and 2019 (Split Lake and Clark Lake to the Keeyask GS). This included 13 large-bodied species and seven forage species. Most species caught in 2018 and 2019 were also caught in previous study years. In all four sampling areas except Stephens Lake North, the part of the catch made up of Walleye (relative abundance) has decreased since sampling began. At the same time, the relative abundance of White Sucker has increased in all four sampling locations. The biggest change 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 2018 and 2019 than during previous studies in all locations.

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 between years in all areas except for Northern Pike. The mean total CPUE of Northern Pike was lower in 2018 and 2019 than in previous sampling years for both Stephens Lake North and the reach of the Nelson River between Clark Lake and Keeyask GS, respectively. In the reach of the Nelson River between Clark Lake and the Keeyask GS, the total CPUE of all fish was lower in 2019 than in 2001, 2002, and 2009. The CPUE of forage fish in all locations has varied among sampling years.

The condition factor (a measure of how fat a fish is at a given size) of Lake Whitefish, Northern Pike, and Walleye were within the range seen in other years for all four sampling locations.

The frequency of external deformities, erosion, lesions, and tumours (collectively referred to as DELTs) observed in Lake Whitefish, Northern Pike, Walleye, White Sucker, Sauger and Lake Sturgeon were within the range seen in other years for all four sampling locations.

What does it mean?

The number and type of fish caught was generally similar between previous studies and the current study. Fish condition was also similar for the three VEC species between years. The part of the catch made up of Walleye has decreased everywhere since sampling began, except for Stephens Lake North. At the same time, the abundance of Northern Pike was lower in Stephens Lake North and the reach of the Nelson River between Clark Lake and Keeyask GS in the most recent study year. The number of Rainbow Smelt in each location has decreased since studies began, a pattern that has been observed throughout northern Manitoba. While we don't have enough information to determine the cause of these changes, ongoing monitoring will help determine if the changes continue in future years.

What will be done next?

Split Lake will continue to be sampled every year as part of the Coordinated Aquatic Monitoring Program (CAMP). Following impoundment, sampling will be conducted in both the Keeyask reservoir and Stephens Lake to monitor the response of the fish community to the newly formed

reservoir and the loss of Gull Rapids. 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. Information collected over several years (both pre and post impoundment) will be compared to see if changes in the fish community have occurred.

ACKNOWLEDGEMENTS

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

Jimmy Lockhart of Fox Lake Cree Nation, Leslie Flett and Saul Mayham of Tataskweyak Cree Nation, and Wayne Wavey of York Factory First 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 Agriculture and Resource Development (previously Manitoba Sustainable Development), Fisheries Branch, under terms of the Scientific Collection Permits #18-19 and #23-19.

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1.0 INTRODUCTION

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

The *Keeyask Generation Project: Response to EIS Guidelines*, completed in June 2012, provides a summary of predicted effects and planned mitigation for the Project. Technical supporting information for the aquatic environment, including a description of the environmental setting, effects and mitigation, and a summary of proposed monitoring and follow-up programs, is provided in the *Keeyask Generation Project Environmental Impact Statement: Aquatic Environment Supporting Volume* (AE SV). As part of the licensing process for the Project, an *Aquatic Effects Monitoring Plan* (AEMP) was developed detailing the monitoring activities of various components of the aquatic environment. This includes 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 fish spawning populations (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 2009–2015 fish community monitoring took place in Split and Assean lakes (annually), and in Stephens Lake (every third year), as part of the

Coordinated Aquatic Monitoring Program (CAMP), a program conducted jointly by the province of Manitoba and Manitoba Hydro (CAMP 2014, CAMP in prep.; CAMP unpublished data).

Construction and operation of the Keeyask GS may affect Nelson River fish populations upstream of Gull Rapids through changes made to existing habitat due to reservoir impoundment. Changes in water levels and flow will result in the alteration or loss of present habitats (*e.g.*, tributaries, rapids, littoral) and the creation of new habitats. Furthermore, these habitat changes will similarly result in changes to the production of aquatic plants, invertebrates, and forage fish. Downstream of Gull Rapids, construction and operation of the generating station 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 due to the footprint of the Keeyask GS and dewatering.

The objective of the sampling conducted in 2018 and 2019 was to collect information on species composition and abundance, as well as selected biological metrics, of the fish community in the reach of the Nelson River between Clark Lake and the Keeyask GS, and in Split and Stephens lakes. These data will be compared to previous years' data to determine if the fish community has changed over time. Any changes detected at this time will be considered when analyzing the results of monitoring following impoundment of the Keeyask reservoir.

Additional sites were sampled in the reach of the Nelson River between Clark Lake and the Keeyask GS in 2019. These locations represent 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.

This report presents the results of fish community sampling conducted in the reach of the Nelson River between Clark Lake and Gull Rapids in 2019 and data collected under the CAMP program for Split Lake (2019) and Stephens lakes (2018).

2.0 STUDY SETTING

The study area for the 2018 and 2019 fish community monitoring program includes Split Lake, the reach of the Nelson River between Clark Lake and the Keeyask GS (formerly Gull Rapids), Stephens Lake North and Stephens Lake South.

Split Lake is immediately downstream of the Kelsey GS at the confluence of the Burntwood and Nelson rivers (Map 1). Due to large inflows from the Nelson and Burntwood rivers, the lake has a 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 (Map 1). 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.

Birthday Rapids is located approximately 10 km downstream of Clark Lake and 30 km upstream of the Keeyask GS (Map 1). The drop in elevation from the upstream to downstream side of Birthday Rapids is approximately 2 m. The 14 km reach of the Nelson River between Birthday Rapids and Gull Lake is characterized as a large somewhat uniform channel with medium to high water velocities. There are a few large bays with reduced water velocity and a number of small tributaries that drain into the Nelson River.

Gull Lake (*i.e.*, the future Keeyask reservoir) is a section of the Nelson River where the river widens, with moderate to low water velocity. Gull Lake is herein defined as the reach of the Nelson River beginning approximately 17 km upstream of the Keeyask GS and 14 km downstream of Birthday Rapids, where the river widens to the north into a bay around a large point of land (Map 1), and extending to the downstream end of Caribou Island, approximately 3 km upstream of the Keeyask GS. Gull Lake has three distinct basins: the first extending from the upstream end of the lake downstream approximately 6 km to a large island; the second extending from the large island to Morris Point (a constriction in the river immediately upstream of Caribou Island); and the third extending from Morris Point to the downstream end of Caribou Island (Map 1).

Gull Rapids, now the site of the Keeyask GS, was located approximately 3 km downstream of Caribou Island on the Nelson River (Map 1). Prior to construction, the rapids were approximately 2 km in length, and the river elevation dropped approximately 11 m along the 2 km length. Two large islands and several small islands occurred within the rapids, prior to the river narrowing; these features are within the Project footprint and have now been either

dewatered, incorporated into the GS or will be flooded after impoundment (Map 2). A summary of construction activities is provided in Section 2.1.

Just below the Keeyask GS, the Nelson River enters Stephens Lake (Maps 1 and 7). Stephens Lake was formed in 1971 by construction of the Kettle GS. Between Gull Rapids and Stephens Lake, there is an approximately 6 km long reach of the Nelson River that, although affected by water regulation at the Kettle GS, remains riverine habitat with moderate velocity. After August 2018, all flow has been passed through the Keeyask GS spillway (see Section 2.1).

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 (Map 1). Kettle GS is located approximately 40 km downstream of Gull Rapids.

2.1 CONSTRUCTION SUMMARY

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

2.2 FLOWS AND WATER LEVELS

From October 2017 to October 2018, Split Lake outflow ranged from about 2,800–4,000 m³/s. Flow typically fell in the range of about 3,000–3,500 m³/s, which is near the historical annual median flow of approximately 3,300 m³/s. Flow was generally higher during the 2017/2018 winter period, gradually declining from about 3,800 m³/s at the end of February 2018 to about 2,800 m³/s by the beginning of May. From early May 2018 to the beginning of July, flow gradually increased to about 3,500 m³/s and remained at that level to the end of July. The flow subsequently declined to about 2,800 m³/s by the end of September. Water levels varied in conjunction with the flows, ranging from about 153.4–155.2 m ASL on Gull Lake.

From October 2018 to October 2019, Split Lake outflows ranged from about 2,600 to 3,700 m³/s. However, over most of the period, outflows ranged from approximately 3,000 to 3,500 m³/s and were near the historical annual median flow of approximately 3,300 m³/s. Outflow increased from about 2,600 to 3,600 m³/s from October to December 2018, and then was variable through the remainder of the winter period. Between June and September 2019, the flow generally ranged from 3,300 to 3,500 m³/s. Flows dropped to about 2,900 m³/s in early October 2019 before rising again to almost 3,700 m³/s by the end of the month. Water levels varied in conjunction with flows, ranging from about 153.2–155.0 m ASL on Gull Lake.

3.0 METHODS

Gillnetting was conducted at project-affected (the Nelson River between Clark Lake and the Keeyask GS and Stephens Lake) and reference (Split Lake) waterbodies in 2018 and 2019. Sampling was conducted in Split Lake from August 23–25 and September 5–6, 2019 (Map 2), and in Stephens Lake North and South from September 2–4, 2018 and August 30 to September 1, 2018, respectively (Map 3). The Nelson River between Clark Lake and the Keeyask GS was sampled from August 7–15, 2019, as outlined in the AEMP (Map 4).

A total of 40 standard gang index (SGI) and 12 small mesh index (SMI) gill net sites were sampled in 2018 and 2019. These included 12 SGI and four SMI sites on Split Lake, ten SGI and two SMI sites on the Nelson River between Clark Lake and the Keeyask GS, and nine SGI and three SMI sites on both Stephens Lake North and South. Sampling was conducted annually in Split Lake and triennially 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, and 2019 for Split Lake; 2001, 2002, 2009, 2015, and 2019 for the Nelson River between Clark Lake and the Keeyask GS; and 2009, 2015, and 2018 for Stephens Lake North and South. These data were compared between years to monitor potential changes occurring independent of GS operation.

An additional six SGI and four SMI gill nets were set in the Nelson River between Clark Lake and the Keeyask GS in 2019, but were not used for between-year comparisons as they have not been sampled in previous years. These sites were prescribed in the AEMP but were not fully accessible pre-impoundment (*i.e.*, were not fully connected to the Nelson River, or were not accessible by boat, or were situated too close to construction activities to safely sample). In 2019, gill nets were set as close as possible (between 0.4 and 2.5 km) to the pre-determined sites in comparable habitat. Once impoundment has occurred, nets will be set in the locations outlined in the AEMP. A single SGI and SMI site (GN-15; Map 4) was sampled in 2015 and 2019 but not in previous sampling years. Because this site was not sampled prior to the onset of construction, it was included only in the analyses of new sites. A single site in present-day Little Gull Lake last sampled in 2015 was not sampled in 2019. It will be sampled in future years when it becomes part of the Keeyask reservoir once full supply level is reached (Map 4).

In this report, ten SGI and two SMI sites in the Nelson River between Clark Lake and the Keeyask GS (referred to herein as standard sites) that were fished in all study years were used for comparison. Data from the additional six SGI and four SMI sites not set in previous years (referred to herein as new sites) are presented separately (Section 4.2).

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 gillnet 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 surveyed 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 lengths. Forage fish species captured in SMI gill nets were bulk weighed.

Ageing structures were collected from a sub-sample of fish, 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; however, 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 throughout 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 accurate age estimates for young fish, but are easier to age, and are thus more accurate for determining ages of older fish than pelvic fin rays and dorsal spines (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 consisted 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 gillnet 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 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. If no DELTs were recorded, then the frequency was 0%.

4.0 RESULTS AND DISCUSSION

Gillnet survey information for 2018 (Stephens Lake North and South) and 2019 (Split Lake and the Nelson River from Clark Lake to the Keeyask GS) in the Keeyask study area is presented in Appendix 1. Due to weather (*i.e.*, extended periods of high wind that prevented safe access to gillnetting sites), monitoring in Split Lake was conducted during two separate sampling periods, August 22–28 and September 4–6, 2019. Water temperatures during sampling in August ranged from 16 to 18°C and remained at 13˚C in September. Water temperature ranged from 14.0 to 18.0°C during sampling in the reach of the Nelson River between Clark Lake and the Keeyask GS (August 7–15, 2019), 10.5 to 15.5°C in Stephens Lake South (August 29–September 1, 2018), and 11.0 to 13.5°C in Stephens Lake North (September 1–4, 2018).

A total of 20 fish species were captured during fish community monitoring in the Keeyask study area, including 13 large-bodied species and seven forage species (Table 1). Half of the species (n = 10) were captured in all of the waterbodies surveyed. Two species were captured in only one waterbody: Brook Stickleback (*Culaea inconstans*) in Stephens Lake South and Silver Redhorse (*Moxostoma anisurum*) in Split Lake.

4.1 2001–2019 COMPARISONS

4.1.1 SPECIES COMPOSITION

4.1.1.1 SPLIT LAKE

A total of 472 fish representing 13 species were captured in SGI gill nets set at 12 standard sites in Split Lake in 2019 (Table 2). White Sucker were the most common species captured (35.0%; n = 165), followed by Sauger (19.5%; n = 92), and Walleye (15.3%; n = 72). An additional 385 fish representing 11 species were captured in four SMI gill nets. Spottail Shiner were the most common species captured (44.7%; n = 172) followed by Emerald Shiner (31.7%; n = 122).

Large-bodied species composition of SGI gill nets was similar between sampling years (Table 2). The relative abundance of Lake Whitefish ranged from 1.9% in 2009 to 4.2% in 2019 and Northern Pike from 9.1% in 2019 to 11.9 in 2009. The largest changes in relative abundance were for Walleye which decreased from 40.9% of the catch in 2009 to 15.3% in 2019. At the same time, Sauger increased from 13.8% of the catch in 2009 to 19.5% in 2019. The relative abundance of White Sucker also increased from 18.6% of the catch in 2009 to 35.0% in 2019. Burbot, Freshwater Drum, Lake Sturgeon, and Silver Redhorse were not captured in every sampling year, and never made up a large portion of the catch.

Spottail Shiner was the most commonly captured species in SMI gill nets set in both 2015 (n = 172; 48.5%) and 2019 (n = 172; 44.7%), but made up less of the catch (n=86; 28.8%) in 2009. The largest change in relative abundance in SMI gill nets has been the decline of Rainbow Smelt, decreasing from 35.1% of the catch in 2009 to 1.8% in 2019.

4.1.1.2 NELSON RIVER (CLARK LAKE TO THE KEEYASK GS)

In 2019, 175 fish representing 14 species were captured in SGI gill nets set at ten standard sites in the Nelson River between Clark Lake and the Keeyask GS. Northern Pike was the most common species captured (34.9%; n = 61), followed by White Sucker (19.4%; n = 34), and Walleye (17.1%; n = 30) (Table 3). An additional 133 fish representing nine species were captured in two standard SMI gill nets. Spottail Shiner was the most common species captured (68.4%; n = 91) (Table 3).

Large-bodied species composition of SGI gill nets set in 2019 was similar to previous study years (Table 3). The relative abundance of Lake Whitefish ranged from 4.6% in 2019 to 8.7% in 2009, Northern Pike from 34.4% in 2001 to 61.5% in 2002, and Walleye from 13.3% in 2002 to 28.6% in 2015. The largest changes in relative abundance in 2019 were for Walleye (decreased from 28.6% in 2015 to 17.1% in 2019) and White Sucker (increased from 5.5% in 2002 to 19.4% in 2019).

Spottail Shiner was the most commonly captured species in SMI gill nets in 2001 and 2019. In 2002, very few small bodied fish were captured (n = 20), the majority of which were Troutperch (35.0%; n = 7) and Yellow Perch (35.0%; n = 7) (Table 3). Yellow perch were also the most commonly captured species (54.9%; n = 123) in 2009. In 2015, Emerald Shiner was most commonly captured (61.9%). The largest change in relative abundance in SMI gill nets has been the decline of Rainbow Smelt, which comprised 32.6% of the catch in 2001 and 0.0% in 2019.

4.1.1.3 STEPHENS LAKE NORTH

A total of 227 fish representing seven species were captured in SGI gill nets set at nine standard sites in Stephens Lake North in 2018. Walleye were the most common species captured (51.1%; n = 116), followed by White Sucker (14.1%; n = 32) and Northern Pike (12.8%; n = 29) (Table 4). An additional 177 fish representing ten species were captured in three SMI gill nets. Emerald Shiner were the most common species captured (35.6%; n = 63) followed by Spottail Shiner (26.0%; n = 46).

The large-bodied species composition of SGI gillnets set in 2018 differed from 2015 but was similar to 2009 (Table 4). Sauger (n = 23; 10.1%) and Shorthead Redhorse (n = 3; 1.3%) were caught for the first time in 2018. Burbot, Longnose Sucker, Mooneye and Yellow Perch, were all caught in 2015, but were not present in the catch in 2018. The relative abundance of Lake Whitefish has been relatively consistent, ranging from 5.5% in 2009 to 6.6% in 2018, and Walleye increased from 45.5% in 2009 to 51.1% in 2018. The largest changes in relative

abundance were for Sauger (increased from 0% in 2009 to 10.1% in 2018), White Sucker (increased from 2.6% in 2009 to 14.1% in 2018), and Northern Pike (decreased from 36.2% in 2009 to 12.8% in 2018).

Emerald Shiner was the most commonly captured species in SMI gill nets set in Stephens Lake North in 2018 (35.6%; n = 63) but in 2015 and 2009 Spottail Shiner was the most common (56.6% in 2015 and 42.2% in 2009) (Table 4). In 2018, Cisco (4.5%; n = 8) and Sauger (1.7%; n = 3) were caught for the first time in SMI gill nets. Rainbow Smelt were the second most abundant species caught in SMI gill nets in 2009 (32.0%; n = 66) but their relative abundance dropped to 1.0% (n = 5) in 2015 and 0.6% (n = 1) in 2018.

4.1.1.4 STEPHENS LAKE SOUTH

A total of 211 fish representing eleven species were captured in SGI gill nets set at nine standard sites in 2018 in Stephens Lake South. Walleye were the most common species captured (34.1%; n = 72) followed by White Sucker (29.9%; n = 63), and Northern Pike (15.2%; n = 32) (Table 5). An additional 291 fish representing nine species were captured in three standard SMI gill nets. Emerald Shiner were the most common species captured (46.4%; n = 135) followed by Spottail Shiner (29.2%; n = 85).

Large-bodied species composition captured in SGI gillnets set in 2018 was similar to both 2015 and 2009 (Table 5). In 2018, Shorthead Redhorse (3.3%; n = 7) and Burbot (0.9%; n = 2) were caught for the first time. The largest changes in relative abundance were for Walleye and Northern Pike which decreased by 12.6% and 8.7%, respectively, between 2009 and 2018. The relative abundance of Sauger also decreased from 9.0% (n = 33) in 2009 to 2.4% (n = 5) in 2018, while White Sucker increased from 4.1% of the catch in 2009 to 29.9% in 2018.

Emerald Shiner was the most commonly captured species in SMI gill nets set in 2018 (46.4%; n = 135), while Spottail Shiner was the most common in 2015 (69.6%; n = 277). As in other areas, the relative abundance of Rainbow Smelt has decreased, from 34.6% of the catch in 2009 to 0.0% in 2018 (Table 5).

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 2019 was 29.1 fish/100 m of net/24 h (Table 6). In previous sampling years, mean total CPUE at the same sites ranged from 30.0 fish in 2009 to 32.6 fish in 2015. The mean total CPUE for all fish species captured in SGI gill nets did not differ significantly among years (Dunn's post hoc test, $p < 0.05$) (Figure 1).

Average CPUE for Lake Whitefish, Northern Pike, and Walleye captured in 2019 was 1.3, 2.7, and 4.3 fish/100 m of net/24 h, respectively (Table 6; Figure 2). Average CPUE of Lake

Whitefish (H = 2.16, p = 0.34), Northern Pike (H = 0.09; p = 0.95), and Walleye (H = 1.30, p = 0.52) did not differ significantly among sampling years.

Mean total CPUE for the SMI gillnet catch in 2019 was 134.8 fish/30 m of net/24 h (Table 6). In previous sampling years, mean total CPUE ranged from 90.2 fish in 2009 to 117.3 fish in 2015 (Table 6; Figure 3). Mean CPUE could not be compared statistically among years as too few sites were sampled.

4.1.2.2 NELSON RIVER (CLARK LAKE TO KEEYASK GS)

Mean total CPUE for SGI gill nets set at ten standard sites in the Nelson River between Clark Lake and the Keeyask GS in 2019 was 12.2 fish/100 m of net/24 h (Table 7). In previous sampling years, mean total CPUE at the same sites ranged from 15.0 fish in 2015 to 30.0 fish in 2001 (Table 7). The mean total CPUE for all species captured in SGI gill nets was significantly lower in 2019 than in 2001, 2002, and 2009. Mean total CPUE was also significantly lower in 2015 than in 2002 (Dunn's post hoc test, $p < 0.05$) (Figure 4).

Average CPUE for Lake Whitefish, Northern Pike, and Walleye captured in 2019 were 0.6, 4.2, and 2.1 fish/100 m of net/24 h, respectively (Table 7; Figure 5). Average CPUE of Lake Whitefish (H = 2.44, p = 0.65) and Walleye (H = 3.20, p = 0.52) did not differ significantly among sampling years (Figure 5). Average CPUE of Northern Pike was significantly lower in 2019 than in 2001, 2002, and 2009. Average CPUE was also significantly lower in 2015 than in 2002 (Dunn's post hoc test, $p < 0.05$) (Figure 5).

Mean total CPUE for the SMI gillnet catch in 2019 was 65.4 fish/30 m of net/24 h (Table 7). In previous sampling years, mean total CPUE ranged from 11.5 fish in 2002 to 316.3 fish in 2015 (Table 8; Figure 6). Because only two sites were sampled, mean CPUE could not be compared statistically among years.

4.1.2.3 STEPHENS LAKE NORTH

Mean total CPUE for SGI gill nets set at nine standard sites in 2018 was 21.9 fish/100 m of net/24 h (Table 9). 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 (Dunn's post hoc test, $p < 0.05$) (Figure 7).

Average CPUE for Lake Whitefish, Northern Pike, and Walleye captured in 2018 was 1.4, 2.9, and 11.1 fish/100 m of net/24 h, respectively (Table 9). Average CPUE of Lake Whitefish (H = 2.01, p = 0.37) and Walleye (H = 0.40, p = 0.82) did not differ significantly among sampling years. Average CPUE of Northern Pike (H = 6.64; p = 0.04) was significantly lower in 2018 than in either 2009 or 2015 (Dunn's post hoc test, $p < 0.05$) (Figure 8).

Mean total CPUE for the SMI gillnet catch in 2018 was 71.7 fish/30 m of net/24 h (Table 9). In previous sampling years, mean total CPUE was 66.7 fish in 2009 and 196.5 fish in 2015

(Table 9; Figure 9). Mean CPUE could not be compared statistically among years as too few sites were sampled each year.

4.1.2.4 STEPHENS LAKE SOUTH

Mean total CPUE for SGI gill nets set at nine standard sites in 2018 was 19.8 fish/100 m of net/24 h. In previous sampling years, mean total CPUE at the same sites ranged from 18.4 fish in 2015 to 33.9 fish in 2009 but did not differ significantly among sampling years (Dunn's post hoc test, $p < 0.05$) (Table 10; Figure 10).

Average CPUE for Lake Whitefish, Northern Pike, and Walleye captured in 2019 were 0.3, 3.1, and 6.7 fish/100 m of net/24 h, respectively (Table 10). Average CPUE of Lake Whitefish ($H = 0.47$; $p = 0.79$), Northern Pike ($H = 2.50$; $p = 0.29$), and Walleye ($H = 0.26$; $p = 0.88$) did not differ significantly among sampling years (Figure 11).

Mean total CPUE for the SMI gillnet catch in 2018 was 105.3 fish/30 m of net/24 h (Table 10). In previous sampling years, mean total CPUE ranged from 43.6 fish in 2009 to 134.5 fish in 2015 (Table 10; Figure 12). Mean CPUE could not be compared statistically among years as too few sites were sampled each year.

4.1.3 SIZE AND CONDITION

4.1.3.1 SPLIT LAKE

A total of 146 fish were measured for FL during sampling conducted in 2019. Lake Whitefish had a mean FL of 434 mm (n = 19; range: 307–555) with fish measuring from 400–449 mm and 450–499 mm FL the most frequently captured (Figure 13). Northern Pike had a mean FL of 487 mm (n = 46; range: 240–637) with fish measuring between 500 and 549 mm FL accounting for 23.9% (n = 11) of the catch. Walleye had a mean FL of 292 mm (n = 81; range: 72–620) with fish measuring between 350 and 399 mm FL the most frequently captured (Table 11).

Mean condition factor of fish captured in SGI and SMI gill nets set at standard sites in 2019 was 1.75 for Lake Whitefish (n = 19; range = 0.50–2.11), 0.66 for Northern Pike (n = 46; range = 0.54–1.16), and 1.07 for Walleye (n = 81; range = 068–1.65) (Table 11).

4.1.3.2 NELSON RIVER (CLARK LAKE TO THE KEEYASK GS)

A total of 106 fish were measured for FL during sampling conducted in 2019 (Table 11). Lake Whitefish had a mean FL of 463 mm (n = 8; range: 355–545) with fish measuring 500–549 mm FL accounting for 37.5% (n = 3) of the catch (Figure 14). Northern Pike had a mean FL of 534 mm (n = 68; range: 94–922) with fish measuring 500–549 mm FL accounting for 14.7% (n = 10) of the catch. Walleye had a mean FL of 379 mm (n = 30; range: 181–535) with fish measuring 450–499 mm FL accounting for 23.3% (n = 7) of the catch.

Mean condition factor of fish captured in SGI and SMI gill nets set at standard sites in 2019 was 1.88 for Lake Whitefish (n = 8; range = 1.56–2.11), 0.71 for Northern Pike (n = 68; range = 0.49–0.93), and 1.10 for Walleye (n = 30; 0.90–1.30) (Table 11).

4.1.3.3 STEPHENS LAKE NORTH

A total of 178 fish were measured for FL during sampling conducted in 2018 (Table 11). Lake Whitefish had a mean FL of 383 mm (n = 17; range: 204–502) with fish measuring 350–399 mm FL accounting for 35.3% (n = 6) of the catch (Figure 15). Northern Pike had a mean FL of 498 mm (n = 31; range: 287–874) with fish measuring 450–499 mm FL accounting for 22.6% (n = 7) of the catch. Walleye had a mean FL of 387 mm (n = 130; range: 171–553) with fish measuring 400–449 mm FL accounting for 25.4% (n = 33) of the catch.

Mean condition factor of fish captured in SGI and SMI gill nets set at standard sites in 2018 was 1.52 for Lake Whitefish (n = 17; range = 1.01–1.93), 0.72 for Northern Pike (n = 31; range = 0.47–2.42), and 1.13 for Walleye (n = 130; range = 0.72–3.56) (Table 11).

4.1.3.4 STEPHENS LAKE SOUTH

A total of 114 fish were measured for FL during sampling conducted in 2018 (Table 11). Lake Whitefish had a mean FL of 500 mm (n = 4; range: 477–541) with fish measuring 450–499 mm FL accounting for 75.0% (n = 3) of the catch (Figure 16). Northern Pike had a mean FL of 517 mm (n = 32; range: 231–871) with fish measuring 400–449 mm and 450–499 mm FL the most frequently captured, each accounting for 37.5% (n = 12) of the catch. Walleye had a mean FL of 409 mm (n = 78; range: 158–671) with fish measuring between 450 and 499 mm FL accounting for 21.8% (n = 17) of the catch.

Mean condition factor of fish captured in SGI and SMI gill nets set at standard sites in 2018 was 1.92 for Lake Whitefish (n = 4; range = 1.83–2.02), 0.71 for Northern Pike (n = 32; range = 0.54–1.30), and 1.09 for Walleye (n = 78; range = 0.75–1.62) (Table 11).

4.1.4 AGE

4.1.4.1 SPLIT LAKE

Ageing structures were collected from 143 VEC fish captured in Split Lake in 2019. Aged Lake Whitefish (n = 19) ranged from 1–16 years and aged Northern Pike (n = 46) ranged from 2–7 years, with 4-year old fish (*i.e.*, 2015 cohort) captured most frequently (34.8% of aged fish). Aged Walleye (n = 78) ranged from 0–17 years.

Cohort frequency distributions for VEC species (n = 624) captured in 2009, 2015, and 2019 are provided in Figure 17. Lake Whitefish from the 2007–2010 cohorts were most commonly captured. Few young (*i.e.*, 2011–2019 cohorts) Lake Whitefish were captured. Northern Pike

from every cohort between 1997 and 2017 were captured, with fish from the 2011 cohort accounting for 12.7% (n = 21) of the catch. For Walleye, all cohorts between 1999 and 2019 were represented in the catch, with large numbers of the 2002 and 2012 cohorts captured.

4.1.4.2 NELSON RIVER (CLARK LAKE TO THE KEEYASK GS)

Ageing structures were collected from 97 VEC fish captured in the Nelson River between Clark Lake and the Keeyask GS in 2019. Aged Lake Whitefish (n = 6) ranged from 3–22 years and aged Walleye (n = 30) ranged from 2–18 years. Northern Pike (n = 61) ranged from 1–12 years, with 5-year old fish (*i.e.*, 2014 cohort) the most numerous (24.6% of aged fish).

Cohort frequency distributions for VEC species (n = 506) captured in SGI and SMI gill nets sampled in 2001, 2002, 2015, and 2019 are provided in Figure 18 (fish sampled in 2009 were not aged). Lake Whitefish from nearly every cohort between 1980 and 2016 were captured, however, too few fish were captured in recent years to identify definite modes in cohort strength. Northern Pike from each cohort between 1987 and 2000 were captured in 2001 and 2002, while individuals from each cohort between 2003 and 2018 were captured in 2015 and 2019. Northern Pike from the 2010 cohort were the most common, accounting for 9.5% (n = 26) of the catch. Walleye from nearly every cohort between 1983 and 2017 were captured, however, no definitive modes in cohort strength were obvious.

4.1.4.3 STEPHENS LAKE NORTH

Ageing structures were collected from 173 VEC fish captured in Stephens Lake North in 2018. Aged Lake Whitefish (n = 16) ranged from 2–18 years, aged Northern Pike (n = 29) ranged from 2–10 years, and aged Walleye (n = 128) ranged from 2–21 years.

Cohort frequency distributions for VEC species (n = 636) captured in SGI and SMI gill nets sampled in 2009, 2015, and 2018 are provided in Figure 19. Lake Whitefish from every cohort between 2009 and 2015 were captured, as well as small numbers of cohorts dating back to 1984. Northern Pike from every cohort between 1997 and 2017 were captured, with individuals from the 2005 and 2011 cohorts captured most frequently. Walleye from every cohort between 1993 and 2016 were captured, with the 2010 cohort accounting for 18.5% (n = 76) of the total catch.

4.1.4.4 STEPHENS LAKE SOUTH

Ageing structures were collected from 111 VEC fish captured in Stephens Lake South in 2018. Aged Lake Whitefish (n = 4) ranged from 10–27 years and aged Walleye (n = 76) ranged from 1–21 years. Northern Pike (n = 31) ranged from 2–10 years, with 4-year old fish (*i.e.*, 2014 cohort) the most numerous (35.5% of aged fish).

Cohort frequency distributions for VEC species (n = 530) captured in SGI and SMI gill nets sampled in 2009, 2015, and 2018 are provided in Figure 20. Lake Whitefish from the 1990 to

2015 cohorts 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 2016 were captured, with the 2004 and 2011 cohorts being the most common. Walleye from every cohort between 1981 and 2017 were captured, with fish from the 2002 cohort the most prevalent of the catch.

4.1.5 DEFORMITIES, EROSION, LESIONS AND TUMOURS (DELTS)

4.1.5.1 SPLIT LAKE

Of the 408 fish examined during 2019, two fish (0.5%) displayed DELTs, one Lake Whitefish and one Sauger (Table 12). In previous studies, DELTs have represented between 0.2% (n = 2; 2015) and 2.6% (n = 9; 2009) of the total catch.

4.1.5.2 NELSON RIVER (CLARK LAKE TO THE KEEYASK GS)

Of the 134 fish examined during 2019, two fish (1.5%) displayed DELTs, one Walleye and one White Sucker (Table 12). In previous studies, DELTs have represented between 0% (2001) and 8.2% (n = 15; 2015) of the total catch.

4.1.5.3 STEPHENS LAKE NORTH

Of the 237 fish examined during 2018, two (0.8%) displayed DELTs, one Sauger and one Walleye (Table 12). In previous studies, DELTs have represented between 0.7% (n = 2; 2015) and 2.6% (n = 6; 2009) of the total catch.

4.1.5.4 STEPHENS LAKE SOUTH

No DELTs were recorded from the 185 fish examined in 2018 (Table 12). In previous studies, DELTs have represented between 1.3% (n = 3; 2015) and 3.6% (n = 11; 2009) of the total catch.

4.1.6 DEBRIS MONITORING

Debris levels were primarily low (*i.e.*, covered <5% of the net) in both SGI and SMI gill nets set in Split Lake in 2019. Debris consisted predominately of aquatic vegetation, sticks, and to a lesser extent algae (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 94% of SGI gill nets and 100% of SMI gill nets set in the reach of the Nelson River between Clark Lake and the Keeyask GS in 2019. When present, debris levels

were mostly moderate (*i.e.*, 5–15%) to very high (*i.e.*, >26%) and consisted of aquatic vegetation, algae and/or sticks (Appendix A2-2). In previous study years, debris levels mostly ranged from low to high with a combination of algae, aquatic vegetation, and sticks accounting for the majority of debris.

The amount of debris present in both SGI and SMI gill nets set in Stephens Lake North in 2018 ranged from none (at one site), to low (*i.e.*, <5%) at eight sites, to moderate (*i.e.*, 5–15%) at three sites. The amount of debris present in gill nets set in Stephens Lake South was generally low (*i.e.*, <5%), however, very high (*i.e.*, >26%) levels were measured at one site. In both areas, all debris was composed of sticks (Appendix A2-3). In previous study years, debris levels ranged from none/low to high composed of a combination of algae, aquatic vegetation, and sticks.

4.2 NELSON RIVER (CLARK LAKE TO KEEYASK GS) ADDITIONAL SITES

Eight species (n = 99 fish) were captured in six SGI gill nets set at new sites in the Nelson River between Clark Lake and the Keeyask GS during summer 2019 (Table 13). Northern Pike were the most abundant species captured accounting for 59.6% (n = 59) of the catch. White Sucker (12.1%; n = 12) and Walleye (9.1%; n = 9) were also frequently caught. A further 148 fish representing ten species were caught in four new SMI gill net sets. Spottail Shiner were the most abundant accounting for 65.5% (n = 97) of the SMI gill net catch.

Mean total CPUE for the SGI gillnet catch was 12.0 fish/100 m of net/24 h (Table 14). Average CPUE for Lake Whitefish, Northern Pike, and Walleye were 0.2, 7.1, and 1.1 fish/100 m of net/24 h (Table 15). CPUE for Northern Pike ranged from 0.0 to 13.8 fish/100 m of net/24 h by site. Walleye were the second most abundant VEC species, ranging from 0.0 to 3.2 fish/100 m of net/24 h by site. Lake Whitefish were absent from four of the six sites sampled, with CPUE ranging from 0.0 to 0.8 fish/100 m of net/24 h by site. Mean total CPUE was 39.0 fish/30 m of net/24 h in the four SMI gill nets (Table 14).

Lake Whitefish (n = 2) caught in SGI and SMI gill nets measured 493 and 500 mm FL with condition factors of 1.64 and 1.89 (Table 16). Ageing structures from these fish were poor and ages could not be obtained. Northern Pike (n = 67) had a mean FL of 498 mm (StDev = 215; range 85–852 mm) and a mean condition factor of 0.74 (StDev = 0.09; range 0.55–0.98). Aged Northern Pike (n = 66) ranged from 0–12 years old with 6-year-old fish (n = 11; 16.7%) the most numerous (Table 16). Walleye (n = 11) had a mean FL of 323 mm (StDev = 152; range 73–577 mm) and a mean condition factor of 1.24 (StDev = 0.49; range 0.97–2.71) (Table 16). The 300–349 mm and 450–499 mm FL intervals were the most frequently captured, each accounting for 19.5% of the catch (n = 8; Figure 21). Aged Walleye (n = 10) ranged from 1–12 years old (Table 17). Too few fish were aged to determine definitive modes in cohort strength.

5.0 SUMMARY AND CONCLUSIONS

- Fish community sampling was conducted using standard gang and small mesh index gill nets in the Nelson River between Clark Lake and Keeyask GS (2019), Split Lake (2019), Stephens Lake North (2018), and Stephens Lake South (2018). Sampling in Split and Stephens lakes was conducted as part of the Coordinated Aquatic Monitoring Program (CAMP). Data collected in the reach of the Nelson River between Clark Lake and the Keeyask GS 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 2018 and 2019. This included 12 SGI and four SMI sites on Split Lake, ten SGI and two SMI sites on the Nelson River between Clark Lake and the Keeyask GS, and nine SGI and three SMI sites on both Stephens Lake North and South. Sampling was conducted in 2009, 2015, and 2019 for Split Lake; in 2001, 2002, 2009, 2015, and 2019 for the Nelson River between Clark Lake and the Keeyask GS; and in 2009, 2015, and 2018 for Stephens Lake North and South. The same sites were sampled in all years and were thus used for between year comparisons.
- An additional six SGI and four SMI gill nets were set in the Nelson River between Clark Lake and the Keeyask GS in 2019 close to sites outlined in the AEMP as new habitat post-impoundment. These sites were defined in the AEMP but were not fully accessible pre-impoundment (*i.e.*, are not fully wetted, are not fully connected to the Nelson River or not accessible by boat, or are situated too close to construction activities to sample safely). In 2019, gill nets were set as close as possible to the pre-determined sites (between 0.4 and 2.5 km) but were not used for between-year comparisons.
- A total of 13 large-bodied and seven small-bodied fish species were captured in the four waterbodies. The large bodied species captured most frequently were Northern Pike, White Sucker, and Walleye, with Sauger being captured frequently in Split Lake and Stephens Lake North. Emerald Shiner, Spottail Shiner, and Trout-perch were the three most frequently captured small-bodied species in all four waterbodies. Rainbow Smelt were not abundant in any of the four waterbodies.
- In Split Lake, mean CPUE for SGI gill nets was 29.1 fish/100 m of net/24 hours and was not significantly different between study years. CPUEs for the three VEC species were 4.25 for Walleye, 2.65 for Northern Pike, and 1.34 for Lake Whitefish. No significant differences in CPUE were evident between study years for each VEC species. Mean total CPUE for SMI gill nets was 134.8 fish/30 m of net/24 hours.
- In the reach of the Nelson River between Clark Lake and Keeyask GS, the mean total CPUE for SGI gill nets set in all sampling years was 12.2 fish/100 m of net/24 hours which was significantly lower than the CPUE observed in 2001, 2002, and 2009, but not 2015. CPUEs for the three VEC species were 4.23 for Northern Pike, 2.07 for Walleye, and 0.56

for Lake Whitefish. Average CPUE of Lake Whitefish and Walleye did not differ significantly among sampling years but CPUE for Northern Pike was significantly lower in 2019 than in 2001, 2002, or 2009. Mean total CPUE for SMI gill nets was 65.4 fish/30 m of net/24 hours.

- In Stephens Lake North, the mean total CPUE for SGI gill nets was 21.9 fish/100 m of net/24 hours and was not significantly different between study years. CPUEs for the three VEC species were 11.1 for Walleye, 2.87 for Northern Pike, and 1.42 for Lake Whitefish. No significant differences in CPUE were recorded between study years for Lake Whitefish and Walleye. Average CPUE of Northern Pike was significantly lower in 2018 than in 2009 and 2015. Mean total CPUE for SMI gill nets was 71.1 fish/30 m of net/24 hours.
- In Stephens Lake South, the mean total CPUE for SGI gill nets was 19.8 fish/100 m of net/24 hours and was not significantly different between study years. CPUEs for the three VEC species were 6.70 for Walleye, 3.10 for Northern Pike, and 0.33 for Lake Whitefish. No significant differences in CPUE were recorded between study years for each VEC species. Mean total CPUE for SMI gill nets was 105.3 fish/30 m of net/24 hours.
- Key questions in the AEMP related to fish community monitoring in the Keeyask area are listed below:
    - *Will the abundance (CPUE) 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?*

      Mean total CPUE in 2018 and 2019 was similar to those of previous study years in all four sampling locations, except for Northern Pike. The mean total CPUE of Northern Pike was lower in 2018 and 2019 than in previous sampling years for both Stephens Lake North and the reach of the Nelson River between Clark Lake and Keeyask GS, respectively. Species composition in the reach of the Nelson River between Clark Lake and the Keeyask GS and in Stephens Lake was comparable to that of previous years, with only a few uncommon species captured in 2019 that were not captured in previous years. However, some trends in relative abundance were seen in all four sampling areas. The relative abundance of Walleye has decreased since sampling began in all waterbodies save Stephens Lake North. At the same time, the relative abundance of White Sucker has increased in all waterbodies.
    - *For the three VEC fish species, will a biologically relevant (and statistically significant) change in condition factor or growth be observed in the Keeyask reservoir and Stephens Lake in comparison to pre-Project conditions?*

      Mean condition factor for Lake Whitefish, Northern Pike and Walleye in 2018 and 2019 were within the ranges seen in all four waterbodies in previous study years.
    - *Will the abundance of small-bodied fish captured in SMI gill nets set in the Keeyask reservoir and Stephens Lake change following construction of the Project?*

CPUE in SMI gill nets was highly variable between study years and waterbodies, although could not be compared statistically because of few sites sampled. The abundance of Rainbow Smelt has decreased dramatically in all four waterbodies since 2009.

- Split Lake will continue to be sampled every year as part of the Coordinated Aquatic Monitoring Program (CAMP). Following impoundment, sampling will be conducted in both the Keeyask reservoir and Stephens Lake to monitor the response of the fish community to the newly formed reservoir and the loss of Gull Rapids.

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TABLES

Table 1: Fish species captured during standard gang and small mesh index gillnetting surveys conducted in the Keeyask study area during summer 2019.

Common Name	Scientific Name	Abbreviation	Split Lake	Nelson River - Clark Lake to the Keeyask GS	Stephens Lake[1]	
					North	South
Brook Stickleback	*Culaea inconstans*	BRST				X
Burbot	*Lota lota*	BURB	X	X		
Cisco	*Coregonus artedi*	CISC	X	X	X	
Emerald Shiner	*Notropis atherinoides*	EMSH	X	X	X	X
Lake Chub	*Couesius plumbeus*	LKCH	X	X		
Lake Sturgeon	*Acipenser fluvescens*	LKST	X	X		
Lake Whitefish	*Coregonus clupeaformis*	LKWH	X	X	X	X
Logperch	*Percina kathae*	LGPR	X	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	
Sauger	*Sander canadensis*	SAUG	X	X	X	X
Shorthead Redhorse	*Moxostoma macrolepidotum*	SHRD	X	X	X	X
Silver Redhorse	*Moxostoma anisurum*	SLRD	X			
Spottail Shiner	*Notropis hudsonius*	SPSH	X	X	X	X
Trout-perch	*Percopsis omiscomaycus*	TRPR	X	X	X	X
Walleye	*Sander vitreus*	WALL	X	X	X	X
White Sucker	*Catostomus commersonii*	WHSC	X	X	X	X
Yellow Perch	*Perca flavescens*	YLPR	X	X	X	X

1 – Sampling occurred in 2018

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 the 2009, 2015, and 2019 study years.

Common Name	SGI						SMI					
	2009		2015		2019		2009		2015		2019	
	n[1]	%	n	%	n	%	n	%	n	%	n	%
Burbot	10	1.9	-	-	4	0.8	-	-	-	-	-	-
Cisco	2	0.4	4	0.7	13	2.8	-	-	1	0.3	29	7.5
Emerald Shiner	-	-	-	-	-	-	29	9.7	45	12.7	122	31.7
Freshwater Drum	-	-	3	0.5	-	-	-	-	-	-	-	-
Lake Chub	3	0.6	5	0.9	5	1.1	14	4.7	35	9.9	24	6.2
Lake Sturgeon	-	-	8	1.4	-	-	-	-	-	-	-	-
Lake Whitefish	10	1.9	22	3.8	20	4.2	-	-	-	-	-	-
Logperch	-	-	-	-	-	-	-	-	-	-	1	0.3
Longnose Sucker	10	1.9	9	1.6	12	2.5	-	-	-	-	-	-
Mooneye	9	1.7	13	2.2	9	1.9	-	-	-	-	-	-
Northern Pike	64	11.9	60	10.3	43	9.1	6	2.0	6	1.7	3	0.8
Rainbow Smelt	27	5.0	1	0.2	-	-	105	35.1	9	2.5	7	1.8
Sauger	74	13.8	112	19.3	92	19.5	1	0.3	5	1.4	5	1.3
Shorthead Redhorse	3	0.6	18	3.1	26	5.5	-	-	-	-	-	-
Silver Redhorse	-	-	-	-	1	0.2	-	-	-	-	-	-
Slimy Sculpin	-	-	-	-	-	-	7	2.3	-	-	-	-
Spottail Shiner	-	-	-	-	-	-	86	28.8	172	48.5	172	44.7
Troutperch	2	0.4	-	-	-	-	42	14.0	65	18.3	12	3.1
Walleye	220	40.9	138	23.8	72	15.3	5	1.7	7	2.0	9	2.3
White Sucker	100	18.6	178	30.7	165	35.0	2	0.7	3	0.8	-	-
Yellow Perch	4	0.7	9	1.6	10	2.1	2	0.7	7	2.0	1	0.3
Total	**538**	**-**	**580**	**-**	**472**	**-**	**299**	**-**	**355**	**-**	**385**	**-**

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 between Clark Lake and the Keeyask GS in 2001, 2002, 2009, 2015 and 2019.

Common Name	SGI										SMI									
	2001		2002		2009		2015		2019		2001		2002		2009		2015		2019	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Burbot	-	-	1	0.3	-	-	-	-	1	0.6	-	-	-	-	-	-	-	-	-	-
Cisco	4	1.1	1	0.3	-	-	1	0.5	1	0.6	-	-	-	-	1	0.4	17	2.5	22	16.5
Emerald Shiner	-	-	-	-	-	-	-	-	-	-	-	-	1	5.0	-	-	413	61.9	2	1.5
Lake Chub	-	-	1	0.3	-	-	-	-	1	0.6	-	-	-	-	-	-	-	-	-	-
Lake Sturgeon	-	-	-	-	1	0.3	1	0.5	1	0.6	-	-	-	-	-	-	-	-	-	-
Lake Whitefish	30	8.5	15	4.9	27	8.7	14	6.6	8	4.6	2	0.7	-	-	-	-	-	-	-	-
Logperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.8
Longnose Sucker	3	0.8	-	-	1	0.3	1	0.5	3	1.7	-	-	1	5.0	-	-	-	-	2	1.5
Mooneye	31	8.7	12	3.9	6	1.9	1	0.5	1	0.6	-	-	-	-	-	-	-	-	-	-
Northern Pike	122	34.4	190	61.5	144	46.2	84	39.4	61	34.9	2	0.7	2	10.0	6	2.7	5	0.7	7	5.3
Rainbow Smelt	6	1.7	12	3.9	13	4.2	-	-	4	2.3	98	32.6	-	-	21	9.4	2	0.3	-	-
Sauger	1	0.3	-	-	-	-	2	0.9	15	8.6	-	-	-	-	-	-	-	-	-	-
Shorthead Redhorse	2	0.6	2	0.6	32	10.3	5	2.3	10	5.7	-	-	-	-	-	-	-	-	-	-
Spottail Shiner	-	-	-	-	-	-	-	-	-	-	146	48.5	2	10.0	33	14.7	214	32.1	91	68.4
Troutperch	-	-	-	-	1	0.3	-	-	-	-	18	6.0	7	35.0	39	17.4	9	1.3	5	3.8
Walleye	66	18.6	41	13.3	57	18.3	61	28.6	30	17.1	2	0.7	-	-	-	-	-	-	-	-
White Sucker	28	7.9	17	5.5	15	4.8	22	10.3	34	19.4	3	1.0	-	-	1	0.4	4	0.6	2	1.5
Yellow Perch	62	17.5	17	5.5	15	4.8	21	9.9	5	2.9	30	10.0	7	35.0	123	54.9	3	0.4	1	0.8
Total	**355**	**-**	**309**	**-**	**312**	**-**	**213**	**-**	**175**	**-**	**301**	**-**	**20**	**-**	**224**	**-**	**667**	**-**	**133**	**-**

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, summer 2009, 2015, and 2018.

Common Name	SGI						SMI					
	2009		2015		2018		2009		2015		2018	
	n	%	n	%	n	%	n	%	n	%	n	%
Burbot	-	-	1	0.3	-	-	-	-	-	-	-	-
Cisco	7	3.0	7	2.1	9	4.0	-	-	-	-	8	4.5
Common Carp	1	0.4	-	-	-	-	-	-	-	-	-	-
Emerald Shiner	-	-	-	-	-	-	34	16.5	180	36.0	63	35.6
Lake Chub	-	-	-	-	-	-	-	-	-	-	-	-
Lake Sturgeon	-	-	-	-	-	-	-	-	-	-	-	-
Lake Whitefish	13	5.5	21	6.2	15	6.6	1	0.5	-	-	2	1.1
Longnose Sucker	-	-	2	0.6	-	-	-	-	-	-	-	-
Mooneye	-	-	42	12.4	-	-	-	-	-	-	-	-
Northern Pike	85	36.2	74	21.9	29	12.8	3	1.5	13	2.6	3	1.7
Rainbow Smelt	16	6.8	6	1.8	-	-	66	32.0	5	1.0	1	0.6
Sauger	-	-	-	-	23	10.1	-	-	-	-	3	1.7
Shorthead Redhorse	-	-	-	-	3	1.3	-	-	-	-	-	-
Spottail Shiner	-	-	-	-	-	-	87	42.2	283	56.6	46	26.0
Troutperch	-	-	-	-	-	-	1	0.5	10	2.0	32	18.1
Walleye	107	45.5	168	49.7	116	51.1	12	5.8	8	1.6	16	9.0
White Sucker	6	2.6	15	4.4	32	14.1	-	-	-	-	-	-
Yellow Perch	-	-	2	0.6	-	-	2	1.0	1	0.2	3	1.7
Total	**235**	**-**	**338**	**-**	**227**	**-**	**206**	**-**	**500**	**-**	**177**	**-**

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, summer 2009, 2015, and 2018.

Common Name	SGI						SMI					
	2009		2015		2018		2009		2015		2018	
	n	%	n	%	n	%	n	%	n	%	n	%
Burbot	-	-	-	-	2	0.9	-	-	-	-	-	-
Cisco	1	0.3	2	0.9	-	-	-	-	-	-	-	-
Emerald Shiner	-	-	-	-	-	-	-	-	53	13.3	135	46.4
Lake Sturgeon	-	-	1	0.4	-	-	-	-	-	-	-	-
Lake Chub	-	-	-	-	-	-	-	-	1	0.3	-	-
Lake Whitefish	6	1.6	6	2.7	4	1.9	-	-	6	1.5	13	4.5
Longnose Sucker	-	-	4	1.8	3	1.4	-	-	5	1.3	-	-
Mooneye	12	3.3	-	-	19	9.0	-	-	-	-	3	1.0
Northern Pike	88	23.9	45	19.9	32	15.2	-	-	5	1.3	-	-
Rainbow Smelt	28	7.6	-	-	-	-	45	34.6	9	2.3	-	-
Sauger	33	9.0	5	2.2	5	2.4	5	3.8	2	0.5	5	1.7
Shorthead Redhorse	-	-	-	-	7	3.3	-	-	-	-	-	-
Spottail Shiner	-	-	-	-	-	-	31	23.8	277	69.6	85	29.2
Troutperch	1	0.3	-	-	1	0.5	41	31.5	31	7.8	23	7.9
Walleye	183	49.7	101	44.7	72	34.1	1	0.8	3	0.8	18	6.2
White Sucker	15	4.1	57	25.2	63	29.9	4	3.1	1	0.3	2	0.7
Yellow Perch	1	0.3	5	2.2	3	1.4	3	2.3	5	1.3	7	2.4
Total	**368**	**-**	**226**	**-**	**211**	**-**	**130**	**-**	**398**	**-**	**291**	**-**

Table 6: Mean catch-per-unit-effort (CPUE) by species and study year for fish captured in standard gang (SGI) and small mesh index (SMI) gill nets set in Split Lake, summer 2009, 2015, and 2019.

Common Name	SGI									SMI								
	2009			2015			2019			2009			2015			2019		
	n[1]	CPUE	Std[2]	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std
Burbot	10	0.53	1.08	-	-	-	4	0.26	0.54	-	-	-	-	-	-	-	-	-
Cisco	2	0.11	0.27	4	0.25	0.66	13	0.85	1.72	-	-	-	1	0.34	0.59	29	10.1	12.3
Emerald Shiner	-	-	-	-	-	-	-	-	-	29	8.31	14.4	45	15.2	14.9	122	43.4	37.6
Freshwater Drum	-	-	-	3	0.13	0.44	-	-	-	-	-	-	-	-	-	-	-	-
Lake Chub	3	0.16	0.29	5	0.27	0.51	5	0.33	0.55	14	4.31	7.46	35	11.9	16.4	24	8.26	14.3
Lake Sturgeon	-	-	-	8	0.36	1.05	-	-	-	-	-	-	-	-	-	-	-	-
Lake Whitefish	10	0.53	0.73	22	1.20	1.41	20	1.34	2.38	-	-	-	-	-	-	-	-	-
Logperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.34	0.60
Longnose Sucker	10	0.51	0.92	9	0.49	0.90	12	0.76	1.39	-	-	-	-	-	-	-	-	-
Mooneye	9	0.52	1.22	13	0.64	1.51	9	0.52	1.12	-	-	-	-	-	-	-	-	-
Northern Pike	64	3.52	3.65	60	3.48	4.38	43	2.65	2.37	6	1.79	1.76	6	2.02	2.67	3	1.06	1.03
Rainbow Smelt	27	1.50	1.95	1	0.04	0.15	-	-	-	105	31.34	6.63	9	3.02	2.68	7	2.57	4.46
Sauger	74	4.28	6.01	112	6.19	3.71	92	5.68	6.00	1	0.29	0.51	5	1.32	1.14	5	1.73	2.12
Shorthead Redhorse	3	0.17	0.42	18	0.99	2.69	26	1.53	3.05	-	-	-	-	-	-	-	-	-
Silver Redhorse	-	-	-	-	-	-	1	0.05	0.19	-	-	-	-	-	-	-	-	-
Slimy Sculpin	-	-	-	-	-	-	-	-	-	7	2.26	3.14	-	-	-	-	-	-
Spottail Shiner	-	-	-	-	-	-	-	-	-	86	26.27	36.1	172	58.3	59.9	172	60.2	67.5
Troutperch	2	0.11	0.26	-	-	-	-	-	-	42	12.85	7.51	65	19.8	16.6	12	3.50	0.53
Walleye	220	12.5	19.39	138	7.88	6.32	72	4.25	3.40	5	1.59	1.48	7	2.37	2.11	9	3.22	2.87
White Sucker	100	5.84	4.39	178	10.2	9.02	165	10.3	5.02	2	0.62	1.07	3	0.98	0.97	-	-	-
Yellow Perch	4	0.21	0.43	9	0.46	0.81	10	0.60	0.80	2	0.62	1.07	7	2.02	3.50	1	0.34	0.60
Total	**538**	**30.0**	**21.3**	**580**	**32.6**	**13.3**	**472**	**29.1**	**7.5**	**299**	**90.2**	**45.6**	**355**	**117.3**	**102.6**	**385**	**134.8**	**124.6**

1 – Number of fish

2 – Standard deviation

Table 7: Mean catch-per-unit-effort (CPUE) by species and study year for fish captured in standard gang index gill nets set between Clark Lake and the Keeyask GS, summer 2001, 2002, 2009, 2015, and 2019.

Common Name	2001			2002			2009			2015			2019		
	n[1]	CPUE	Std[2]	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std
Burbot	-	-	-	1	0.08	0.25	-	-	-	-	-	-	1	0.07	0.23
Cisco	4	0.35	0.85	1	0.08	0.26	-	-	-	1	0.08	0.25	1	0.07	0.21
Emerald Shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Chub	-	-	-	1	0.08	0.26	-	-	-	-	-	-	1	0.08	0.25
Lake Sturgeon	-	-	-	-	0.00	0.00	1	0.06	0.20	1	0.08	0.24	1	0.07	0.23
Lake Whitefish	30	2.59	3.23	15	1.23	1.71	27	1.83	4.16	14	0.93	2.07	8	0.56	1.34
Logperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Longnose Sucker	3	0.25	0.58	-	-	-	1	0.07	0.21	1	0.07	0.23	3	0.22	0.49
Mooneye	31	2.81	6.28	12	0.99	2.86	6	0.41	1.08	1	0.07	0.22	1	0.07	0.22
Northern Pike	122	10.1	6.48	190	15.7	5.86	144	9.55	5.38	84	5.98	4.08	61	4.23	4.24
Rainbow Smelt	6	0.52	0.83	12	0.98	1.87	13	0.87	1.02	-	0.00	0.00	4	0.27	0.66
Sauger	1	0.08	0.24	-	-	-	-	-	-	2	0.14	0.30	15	1.07	1.44
Shorthead Redhorse	2	0.15	0.32	2	0.18	0.56	32	2.09	3.84	5	0.34	0.73	10	0.71	1.59
Spottail Shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Troutperch	-	-	-	-	-	-	1	0.07	0.21	-	-	-	-	-	-
Walleye	66	5.51	6.40	41	3.44	4.43	57	3.69	4.10	61	4.33	3.07	30	2.07	1.93
White Sucker	28	2.34	2.39	17	1.48	2.18	15	0.97	0.94	22	1.54	1.74	34	2.38	3.37
Yellow Perch	62	5.35	10.7	17	1.39	2.87	15	0.99	1.56	21	1.43	1.72	5	0.35	0.75
Total	**355**	**30.0**	**21.7**	**309**	**25.6**	**9.74**	**312**	**20.6**	**7.41**	**213**	**15.0**	**5.49**	**175**	**12.2**	**5.04**

1 – Number of fish

2 – Standard deviation

Table 8: Mean catch-per-unit-effort (CPUE) by species and study year for fish captured in small mesh index gill nets set between Clark Lake and the Keeyask GS, summer 2001, 2002, 2009, 2015, and 2019.

Common Name	2001			2002			2009			2015			2019		
	n[1]	CPUE	Std[2]	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std
Cisco	-	-	-	-	-	-	1	0.45	0.63	17	8.05	11.4	22	10.8	15.3
Emerald Shiner	-	-	-	1	0.60	0.85	-	-	-	413	195.9	260.3	2	0.98	1.39
Logperch	-	-	-	-	-	-	-	-	-	-	-	-	1	0.49	0.70
Lake Whitefish	2	1.19	1.69	-	-	-	-	-	-	-	-	-	-	-	-
Longnose Sucker	-	-	-	1	0.60	0.85	-	-	-	-	-	-	2	0.99	1.40
Northern Pike	2	1.19	1.69	2	1.12	1.58	6	2.67	3.78	5	2.37	3.35	7	3.44	4.86
Rainbow Smelt	98	58.4	82.7	-	-	-	21	9.29	9.56	2	0.95	1.34	-	-	-
Spottail Shiner	146	87.1	123.1	2	1.12	1.58	33	14.7	20.8	214	101.4	142.0	91	44.7	63.2
Troutperch	18	10.6	12.0	7	4.18	5.92	39	16.9	1.31	9	4.32	1.93	5	2.46	2.08
Walleye	2	1.19	1.69	-	-	-	-	-	-	-	-	-	-	-	-
White Sucker	3	1.71	0.95	-	-	-	1	0.45	0.63	4	1.89	2.68	2	0.98	1.39
Yellow Perch	30	17.9	25.3	7	3.91	5.53	123	54.8	77.5	3	1.42	2.01	1	0.49	0.69
Total	**301**	**179.3**	**249.2**	**20**	**11.5**	**1.09**	**224**	**99.3**	**114.3**	**667**	**316.3**	**425.0**	**133**	**65.4**	**86.9**

1 – Number of fish

2 – Standard deviation

Table 9: Mean catch-per-unit-effort (CPUE) by species and study year for fish captured in standard gang (SGI) and small mesh index (SMI) gill nets set in Stephens Lake North, summer 2009, 2015, and 2018.

Common Name	SGI									SMI								
	2009			2015			2018			2009			2015			2018		
	n[1]	CPUE	Std[2]	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std
Burbot	-	-	-	1	0.09	0.27	-	-	-	-	-	-	-	-	-	-	-	-
Cisco	7	0.54	1.39	7	0.98	2.17	9	0.86	1.14	-	-	-	-	-	-	8	3.3	3.4
Common Carp	1	0.08	0.25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Emerald Shiner	-	-	-	-	-	-	-	-	-	34	11.6	20.0	180	84.6	114.4	63	26.7	34.7
Lake Whitefish	13	1.06	1.47	21	2.25	2.42	15	1.42	2.16	1	0.31	0.53	-	-	-	2	0.9	1.6
Longnose Sucker	-	-	-	2	0.21	0.45	-	-	-	-	-	-	-	-	-	-	-	-
Mooneye	-	-	-	42	2.80	8.40	-	-	-	-	-	-	-	-	-	-	-	-
Northern Pike	85	6.72	3.18	74	7.26	4.92	29	2.87	3.00	3	0.95	0.06	13	6.19	8.72	3	1.1	1.0
Rainbow Smelt	16	1.27	1.03	6	0.76	1.66	-	-	-	66	21.3	14.4	5	1.25	2.17	1	0.3	0.6
Sauger	-	-	-	-	-	-	23	2.28	3.94	-	-	-	-	-	-	3	1.3	1.3
Shorthead Redhorse	-	-	-	-	-	-	3	0.30	0.90	-	-	-	-	-	-	-	-	-
Spottail Shiner	-	-	-	-	-	-	-	-	-	87	27.6	19.7	283	98.4	38.7	46	18.6	13.6
Walleye	107	8.82	9.57	168	18.8	24.1	116	11.1	7.38	1	0.34	0.59	10	2.66	2.88	32	11.6	11.1
White Sucker	6	0.49	0.64	15	1.17	1.44	32	3.13	3.12	12	3.95	3.77	8	2.92	1.72	16	6.5	2.5
Yellow Perch	-	-	-	2	0.27	0.54	-	-	-	2	0.62	1.07	1	0.54	0.94	3	1.3	1.3
Total	235	19.0	10.1	338	34.6	31.9	227	21.9	11.3	206	66.7	44.3	500	196.5	159.5	177	71.7	50.0

1 – Number of fish

2 – Standard deviation

Table 10: Mean catch-per-unit-effort (CPUE) by species and study year for fish captured in standard gang (SGI) and small mesh index (SMI) gill nets set in Stephens Lake South, summer 2009, 2015, and 2018.

Common Name	SGI									SMI								
	2009			2015			2018			2009			2015			2018		
	n[1]	CPUE	Std[2]	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std	n	CPUE	Std
Burbot	-	-	-	-	-	-	2	0.25	0.49	-	-	-	-	-	-	-	-	-
Cisco	1	0.08	0.23	2	0.13	0.38	-	-	-	-	-	-	-	-	-	-	-	-
Emerald Shiner	-	-	-	-	-	-	-	-	-	-	-	-	53	17.3	17.1	135	48.0	41.6
Lake Chub	-	-	-	-	-	-	-	-	-	-	-	-	1	0.38	0.66	-	-	-
Lake Sturgeon	-	-	-	1	0.11	0.32	-	-	-	-	-	-	-	-	-	-	-	-
Lake Whitefish	6	0.48	0.69	6	0.47	0.52	4	0.33	0.54	-	-	-	6	2.15	3.08	13	3.99	6.91
Longnose Sucker	-	-	-	4	0.42	1.27	3	0.36	0.74	-	-	-	5	1.30	2.25	-	-	-
Mooneye	12	1.01	3.02	-	-	-	19	1.61	2.80	-	-	-	-	-	-	3	0.92	1.59
Northern Pike	88	8.93	11.7	45	3.58	3.84	32	3.10	2.41	-	-	-	5	2.07	1.82	-	-	-
Rainbow Smelt	28	2.49	2.77	-	-	-	-	-	-	45	15.4	13.4	9	2.46	3.33	-	-	-
Sauger	33	2.77	7.29	5	0.34	0.44	5	0.58	0.72	5	1.59	2.75	2	0.93	1.62	5	2.52	2.53
Shorthead Redhorse	-	-	-	-	-	-	7	0.69	1.59	-	-	-	-	-	-	-	-	-
Spottail Shiner	-	-	-	-	-	-	-	-	-	31	10.3	10.0	277	92.9	95.0	85	29.5	26.1
Troutperch	1	0.09	0.27	-	-	-	1	0.14	0.41	41	13.6	12.7	31	12.5	10.0	23	10.9	9.55
Walleye	183	16.6	21.4	101	8.43	5.60	72	6.70	6.72	1	0.37	0.63	3	0.90	0.81	18	6.52	5.84
White Sucker	15	1.28	1.68	57	4.51	2.66	63	5.79	6.77	4	1.27	2.20	1	0.26	0.45	2	0.61	1.06
Yellow Perch	1	0.14	0.42	5	0.40	0.75	3	0.24	0.48	3	1.05	1.10	5	1.30	2.25	7	2.26	2.90
Total	**368**	**33.9**	**29.4**	**226**	**18.4**	**8.69**	**211**	**19.8**	**16.5**	**130**	**43.6**	**38.2**	**398**	**134.5**	**108.3**	**291**	**105.3**	**68.6**

1 – Number of fish

2 – Standard deviation

Table 11: Fork length (FL), weight and condition factor (K) for Lake Whitefish, Northern Pike and Walleye caught in the Keeyask Area during studies in 2001, 2002, 2009, 2015, and 2019.

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	2,435	1.93	64	513	1,294	0.77	222	369	741	1.29
	2015	22	404	1,159	1.65	66	495	1,032	0.68	145	342	530	1.09
	2019	19	434	1,453	1.75	46	487	833	0.66	81	292	363	1.07
Clark Lake to the Keeyask GS	2001	31	416	1,674	1.73	124	483	1,201	0.77	68	420	1,206	1.30
	2002	15	406	1,659	1.69	190	561	1,669	0.77	41	470	1,643	1.37
	2009	27	455	1,894	1.76	150	539	1,487	0.76	57	433	1,268	1.30
	2015	13	419	1,357	1.60	89	564	1,503	0.68	61	402	942	1.13
	2019	8	463	1,960	1.88	68	534	1,524	0.71	30	379	706	1.10
Stephens Lake North	2009	14	388	1,581	1.91	88	547	1,416	0.74	119	428	1,284	1.40
	2015	21	361	1,044	1.45	87	571	1,533	0.66	176	382	771	1.15
	2018	17	383	991	1.52	31	498	958	0.72	130	387	692	1.13
Stephens Lake South	2009	6	486	2,528	2.04	88	529	1,449	0.75	184	442	1,345	1.40
	2015	12	284	1,043	1.42	50	520	1,268	0.69	104	413	984	1.15
	2018	4	500	1,952	1.92	32	517	1,173	0.71	78	409	823	1.09

1 – Number of fish

Table 12: 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 Nelson River between Clark Lake and the Keeyask GS, Stephens Lake North and Stephens Lake South during the 2001, 2002, 2009, 2015, 2018 and 2019 study years.

	Study Year																	
	2001			2002			2009			2015			2018			2019		
	n	DELTs	%	n	DELTs	%	n	DELTs	%	n	DELTs	%	n	DELTs	%	n	DELTs	%
Split Lake																		
Lake Sturgeon	-	-	-	-	-	-	0	0	0.0	8	0	0.0	-	-	-	0	0	0.0
Lake Whitefish	-	-	-	-	-	-	10	1	10.0	22	0	0.0	-	-	-	20	1	5.0
Northern Pike	-	-	-	-	-	-	64	0	0.0	66	0	0.0	-	-	-	46	0	0.0
Sauger	-	-	-	-	-	-	29	2	6.9	0	0	0.0	-	-	-	96	1	1.0
Walleye	-	-	-	-	-	-	223	5	2.2	145	0	0.0	-	-	-	81	0	0.0
White Sucker	-	-	-	-	-	-	18	1	5.6	181	1	0.6	-	-	-	165	0	0.0
	-	**-**	**-**	**-**	**-**	**-**	**344**	**9**	**2.6**	**422**	**1**	**0.2**	**-**	**-**	**-**	**408**	**2**	**0.5**
Clark Lake to Keeyask GS																		
Lake Sturgeon	0	0	0.0	0	0	0.0	1	0	0.0	1	0	0.0	-	-	-	1	0	0.0
Lake Whitefish	30	0	0.0	15	1	6.7	27	3	11.1	13	0	0.0	-	-	-	8	0	0.0
Northern Pike	122	0	0.0	190	1	0.5	150	3	2.0	89	8	9.0	-	-	-	61	0	0.0
Sauger	1	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	-	-	-	0	0	0.0
Walleye	66	0	0.0	41	0	0.0	57	1	1.8	61	7	11.5	-	-	-	30	1	3.3
White Sucker	28	0	0.0	17	1	5.9	16	0	0.0	19	0	0.0	-	-	-	34	1	2.9
	247	**0**	**0.0**	**263**	**3**	**1.1**	**251**	**7**	**2.8**	**183**	**15**	**8.2**	**-**	**-**	**-**	**134**	**2**	**1.5**
Stephens Lake North																		
Lake Sturgeon	-	-	-	-	-	-	0	0	0.0	0	0	0.0	0	0	0.0	-	-	-
Lake Whitefish	-	-	-	-	-	-	14	0	0.0	21	0	0.0	17	0	0.0	-	-	-
Northern Pike	-	-	-	-	-	-	88	2	2.3	87	1	1.1	32	0	0.0	-	-	-
Sauger	-	-	-	-	-	-	0	0	0.0	0	0	0.0	26	1	3.8	-	-	-
Walleye	-	-	-	-	-	-	119	4	3.4	176	1	0.6	130	1	0.8	-	-	-
White Sucker	-	-	-	-	-	-	6	0	0.0	15	0	0.0	32	0	0.0	-	-	-
	-	**-**	**-**	**-**	**-**	**-**	**227**	**6**	**2.6**	**299**	**2**	**0.7**	**237**	**2**	**0.8**	**-**	**-**	**-**

Table 12: 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 Nelson River between Clark Lake and the Keeyask GS, Stephens Lake North and Stephens Lake South during the 2001, 2002, 2009, 2015, 2018 and 2019 study years (continued).

	Study Year																	
	2001			2002			2009			2015			2018			2019		
	n	DELTs	%	n	DELTs	%	n	DELTs	%	n	DELTs	%	n	DELTs	%	n	DELTs	%
Stephens Lake South																		
Lake Sturgeon	-	-	-	-	-	-	0	0	0.0	1	0	0.0	0	0	0.0	-	-	-
Lake Whitefish	-	-	-	-	-	-	6	0	0.0	12	0	0.0	4	0	0.0	-	-	-
Northern Pike	-	-	-	-	-	-	88	4	4.5	50	0	0.0	32	0	0.0	-	-	-
Sauger	-	-	-	-	-	-	14	2	14.3	0	0	0.0	8	0	0.0	-	-	-
Walleye	-	-	-	-	-	-	184	3	1.6	104	3	2.9	78	0	0.0	-	-	-
White Sucker	-	-	-	-	-	-	11	2	18.2	58	0	0.0	63	0	0.0	-	-	-
	-	**-**	**-**	**-**	**-**	**-**	**303**	**11**	**3.6**	**225**	**3**	**1.3**	**185**	**0**	**0.0**	**-**	**-**	**-**

Table 13. Total number (n) and relative abundance (%) of fish, by species, captured in all standard gang and small mesh index gill nets set at new sites between Clark Lake and the Keeyask GS, 2019.

Common Name	Standard Index		Small Mesh	
	n	%	n	%
Cisco	-	-	1	0.7
Emerald Shiner	-	-	10	6.8
Lake Whitefish	2	2.0	-	-
Logperch	-	-	1	0.7
Mooneye	6	6.1	2	1.4
Northern Pike	59	59.6	8	5.4
Sauger	4	4.0	-	-
Shorthead Redhorse	4	4.0	-	-
Spottail Shiner	-	-	97	65.5
Troutperch	-	-	22	14.9
Walleye	9	9.1	2	1.4
White Sucker	12	12.1	3	2.0
Yellow Perch	3	3.0	2	1.4
Total	**99**	**-**	**148**	**-**

Table 14: Mean catch-per-unit-effort (CPUE) by species of fish captured in standard gang and small mesh index gill nets set at new sites between Clark Lake and the Keeyask GS, summer 2019.

Common Name	Standard Index			Small Mesh		
	n[1]	CPUE	Std[2]	n	CPUE	Std
Cisco	-	-	-	1	0.27	0.54
Emerald Shiner	-	-	-	10	2.47	1.91
Lake Whitefish	2	0.24	0.37	-	-	-
Logperch	-	-	-	1	0.27	0.54
Mooneye	6	0.78	1.31	2	0.49	0.58
Northern Pike	59	7.05	5.22	8	2.02	2.58
Sauger	4	0.51	0.63	-	-	-
Shorthead Redhorse	4	0.50	0.62	-	-	-
Spottail Shiner	-	-	-	97	25.7	31.0
Troutperch	-	-	-	22	5.86	7.79
Walleye	9	1.11	1.23	2	0.54	1.08
White Sucker	12	1.47	2.08	3	0.80	1.59
Yellow Perch	3	0.39	0.65	2	0.54	1.08
Total	**99**	**12.04**	**3.93**	**148**	**39.0**	**39.8**

1 – Number of fish

2 – Standard deviation

Table 15: Mean catch-per-unit-effort (CPUE) by species and site of VEC fish captured in standard gang index gill nets set at new sites between Clark Lake and the Keeyask GS, summer 2019.

Site	Species					
	LKWH		NRPK		WALL	
	n	CPUE	n	CPUE	n	CPUE
GN-09	0	0.00	8	6.29	4	3.15
GN-10	0	0.00	15	10.6	0	0.00
GN-11	1	0.66	21	13.8	3	1.97
GN-15	1	0.77	12	9.30	1	0.77
GN-16	0	0.00	0	0.00	0	0.00
GN-17	0	0.00	3	2.29	1	0.76
Total	**2**	**0.24**	**59**	**7.05**	**9**	**1.11**

Table 16: Mean fork length, weight, and condition factor (K) of fish, by species, captured in standard gang index gill nets set at new sites between Clark Lake and the Keeyask GS, summer 2019.

Species	Length (mm)				Weight (g)				K			
	n[1]	Mean	Std[2]	Range	n	Mean	Std	Range	n	Mean	Std	Range
Cisco	1	114	-	-	1	15	-	-	1	1.01	-	-
Lake Whitefish	2	497	5	493–500	2	2,155	148	2050–2,260	2	1.76	0.17	1.64–1.89
Logperch	1	74	-	-	1	4	-	-	1	1.09	-	-
Mooneye	7	150	25	105–175	8	40	25	4–71	7	1.21	0.10	1.09–1.35
Northern Pike	67	498	215	85–852	67	1,403	1,289	5–4,990	67	0.74	0.09	0.55–0.98
Sauger	4	262	89	175–384	4	196	188	50–470	4	0.89	0.07	0.83–0.97
Shorthead Redhorse	4	393	58	315–454	4	910	324	490–1,240	4	1.46	0.15	1.33–1.62
Walleye	11	323	153	73–577	11	885	1,503	4–5,200	11	1.24	0.49	0.97–2.71
White Sucker	15	320	153	72–495	15	903	752	4–2,370	15	1.58	0.29	1.00–1.95
Yellow Perch	5	118	30	84–150	5	28	18	8–50	5	1.49	0.11	1.35–1.62
Total	**117**	**-**	**-**	**-**	**118**	**-**	**-**	**-**	**117**	**-**	**-**	**-**

1 – Number of fish measured

2 – Standard deviation

Table 17: Age and cohort for Northern Pike and Walleye caught in standard gang and small mesh index gill nets set at new sites in the Nelson River between Clark Lake and the Keeyask GS.

Age	Cohort	Species	
		Northern Pike	Walleye
0	2019	8	-
1	2018	-	1
2	2017	4	2
3	2016	6	-
4	2015	8	1
5	2014	5	2
6	2013	11	1
7	2012	2	-
8	2011	9	-
9	2010	4	1
10	2009	5	1
11	2008	1	-
12	2007	2	1

FIGURES

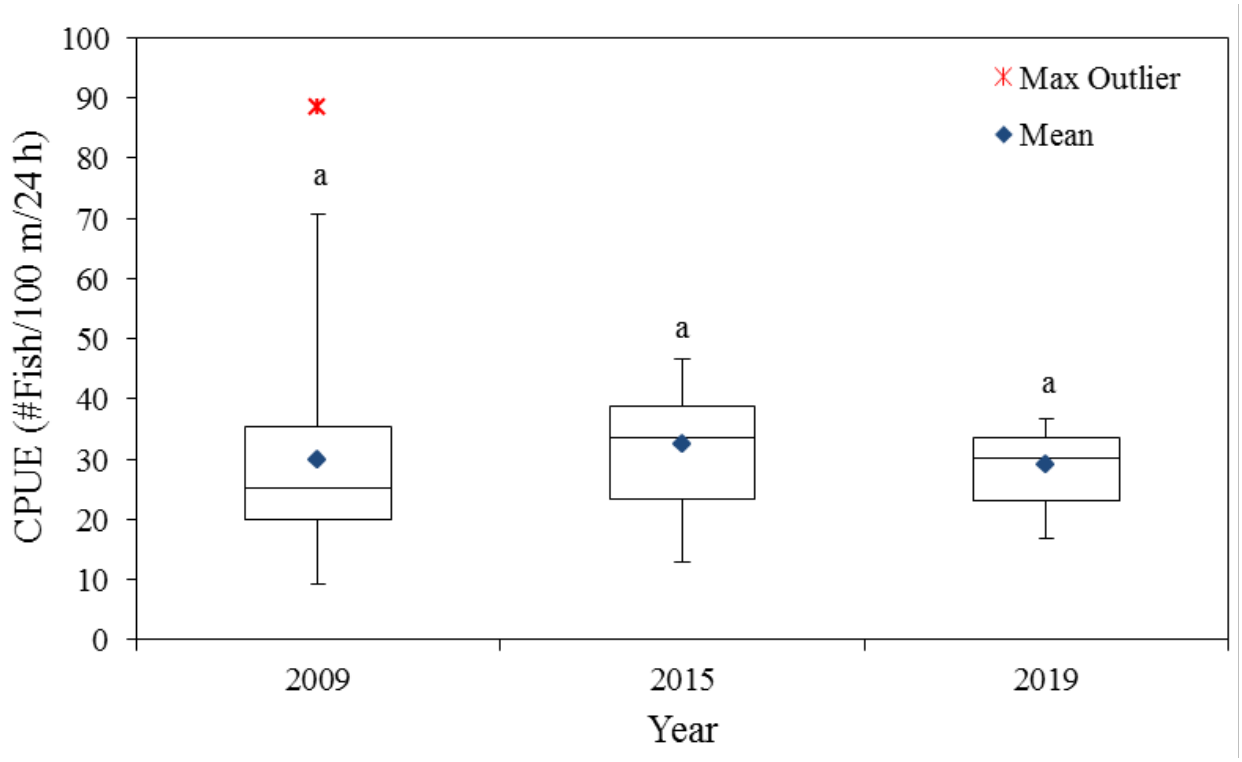


Figure 1: **Mean total CPUE for all fish species captured in standard gang index gill nets set in Split Lake in 2009, 2015, and 2019. Letters denote significant differences in CPUE between study years.**

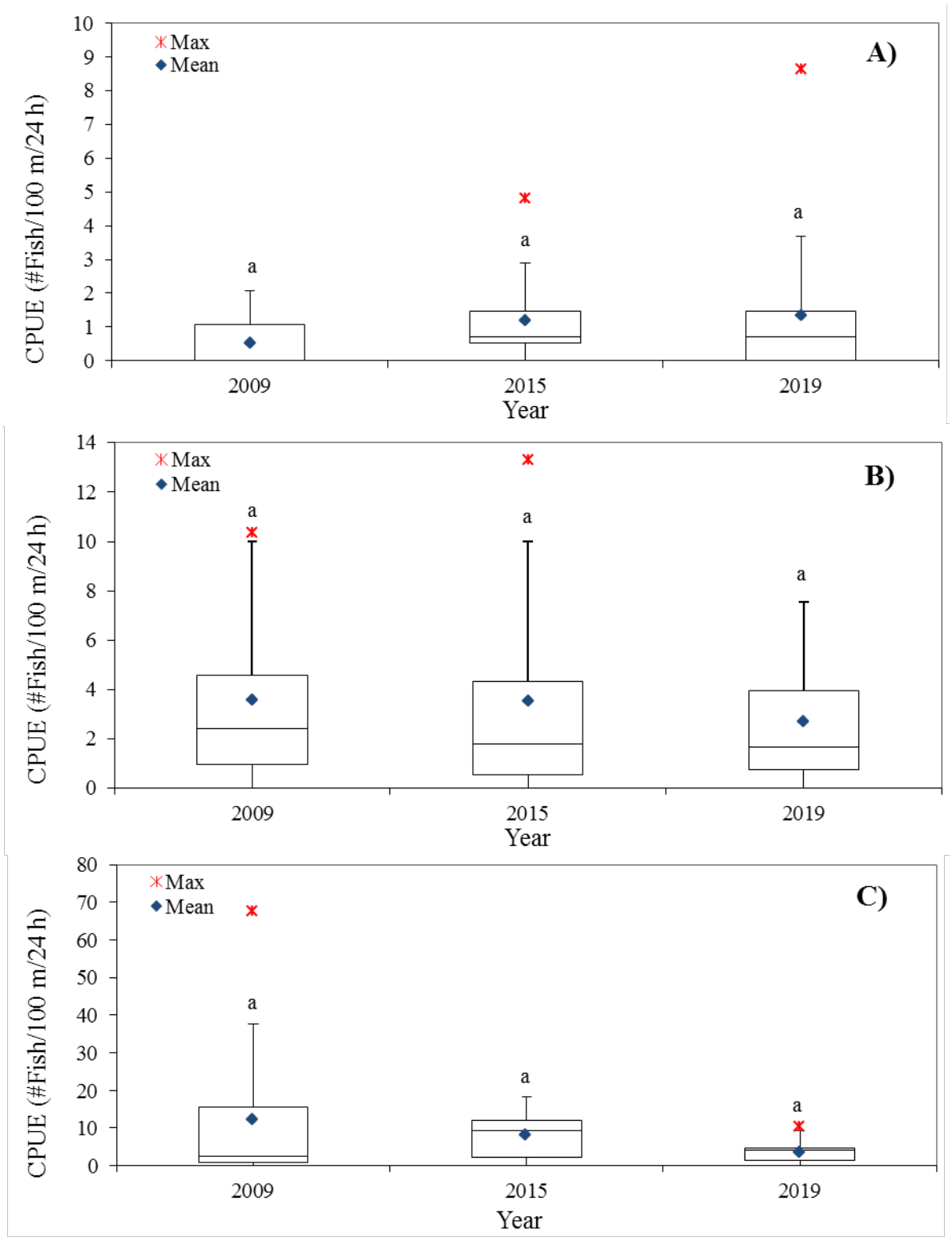


Figure 2: **Mean total CPUE for A) Lake Whitefish, B) Northern Pike and C) Walleye captured in standard gang index gill nets set in Split Lake in 2009, 2015, and 2019. Letters denote significant differences in CPUE between study years**

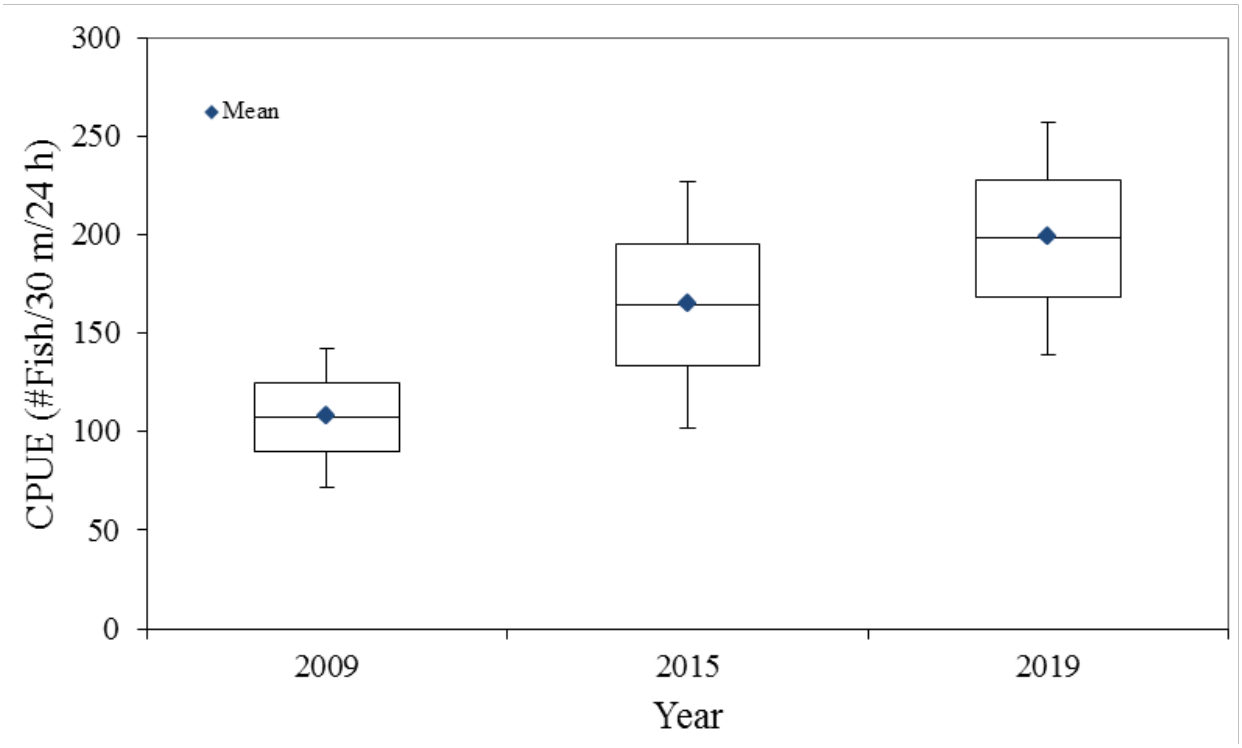


Figure 3: Mean total CPUE for all fish species captured in small mesh index gill nets set in Split Lake in 2009, 2015, and 2019.

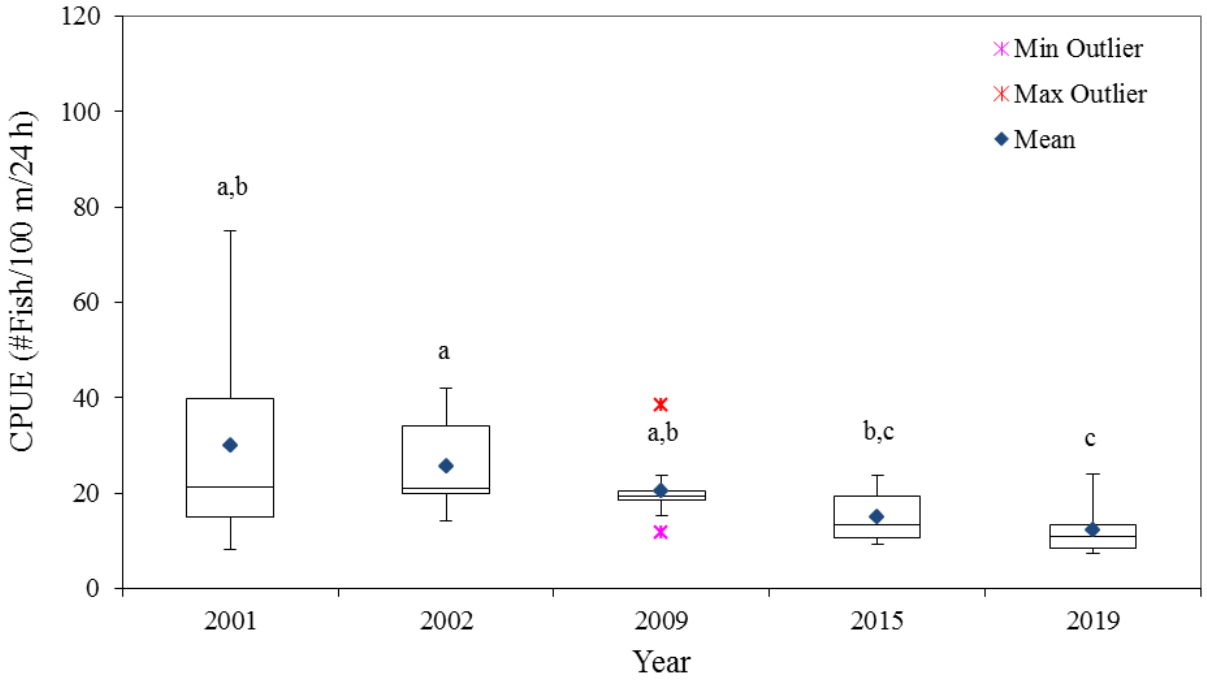


Figure 4: **Mean total CPUE for all fish species captured in standard gang index gill nets set between Clark Lake and the Keeyask GS in 2001, 2002, 2009, 2015, and 2019. Letters denote significant differences in CPUE between study years.**

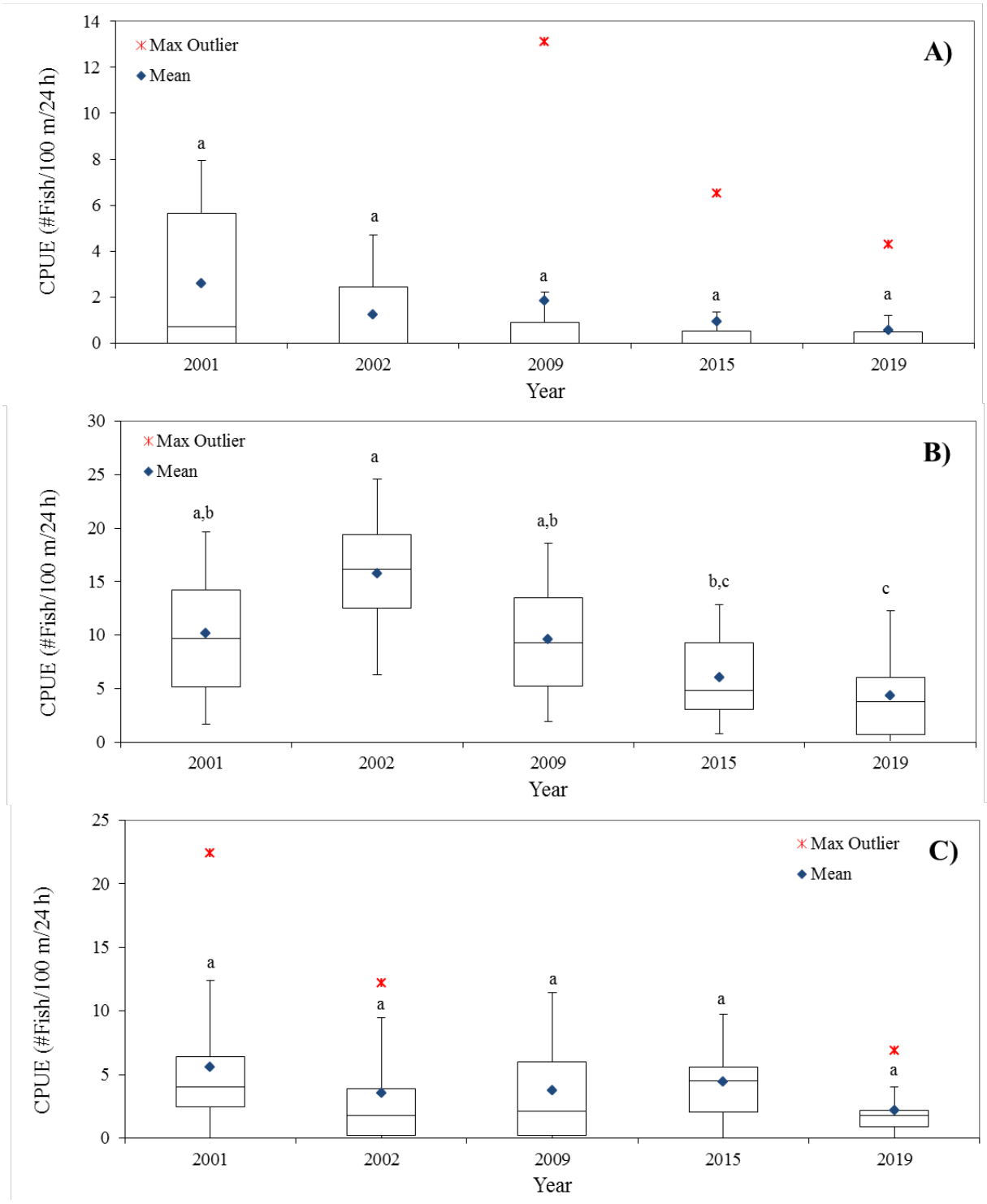


Figure 5: **Mean total CPUE for A) Lake Whitefish, B) Northern Pike and C) Walleye captured in standard gang index gill nets set between Clark Lake and the Keeyask GS in 2001, 2002, 2009, 2015, and 2019. Letters denote significant differences in CPUE between study years.**

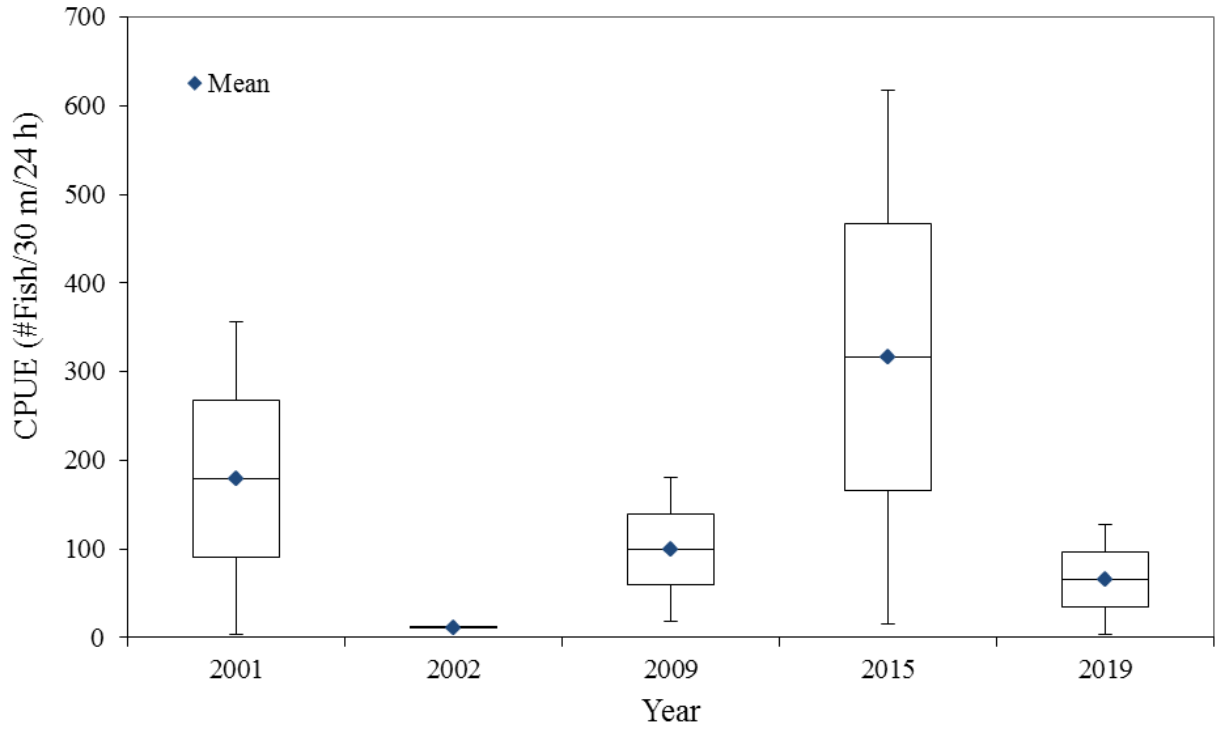


Figure 6: Mean total CPUE for all fish species captured in small mesh index gill nets set between Clark Lake and the Keeyask GS in 2001, 2002, 2009, 2015, and 2019.

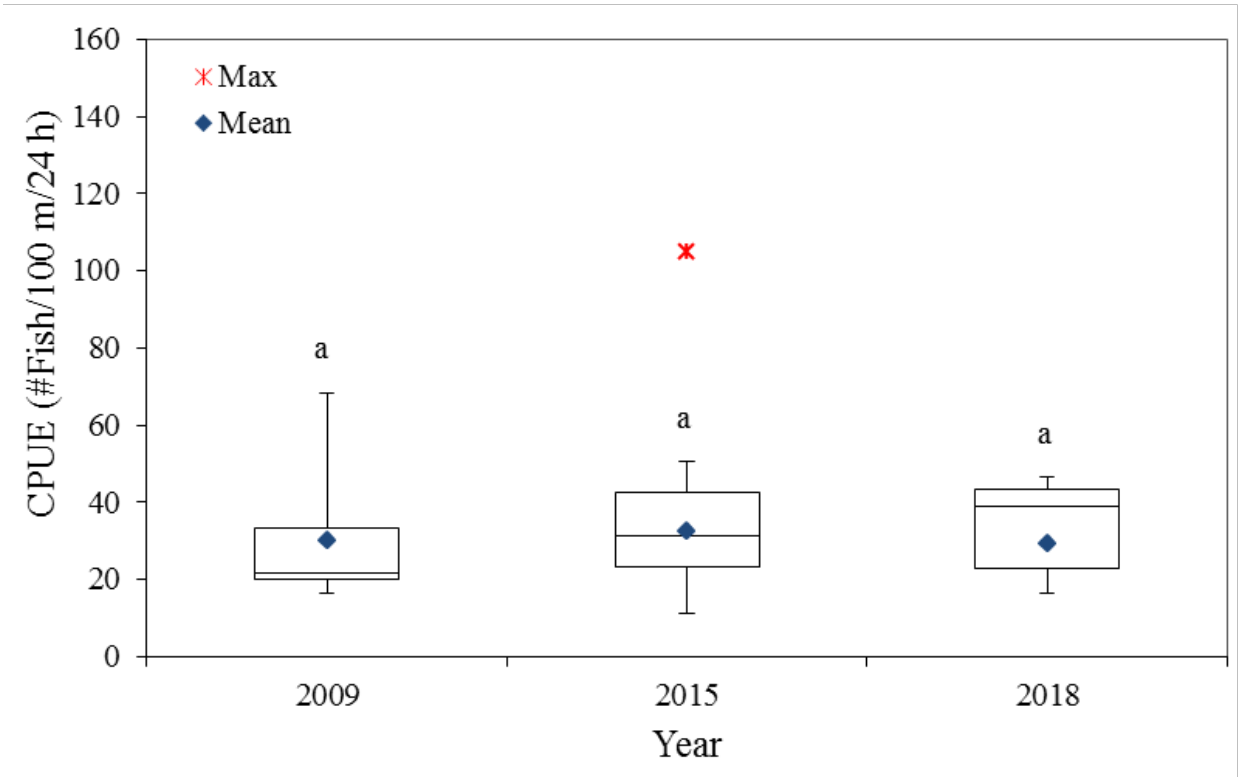


Figure 7: **Mean total CPUE for all fish species captured in standard gang index gill nets set in Stephens Lake North in 2009, 2015, and 2018. Letters denote significant differences in CPUE between study years.**

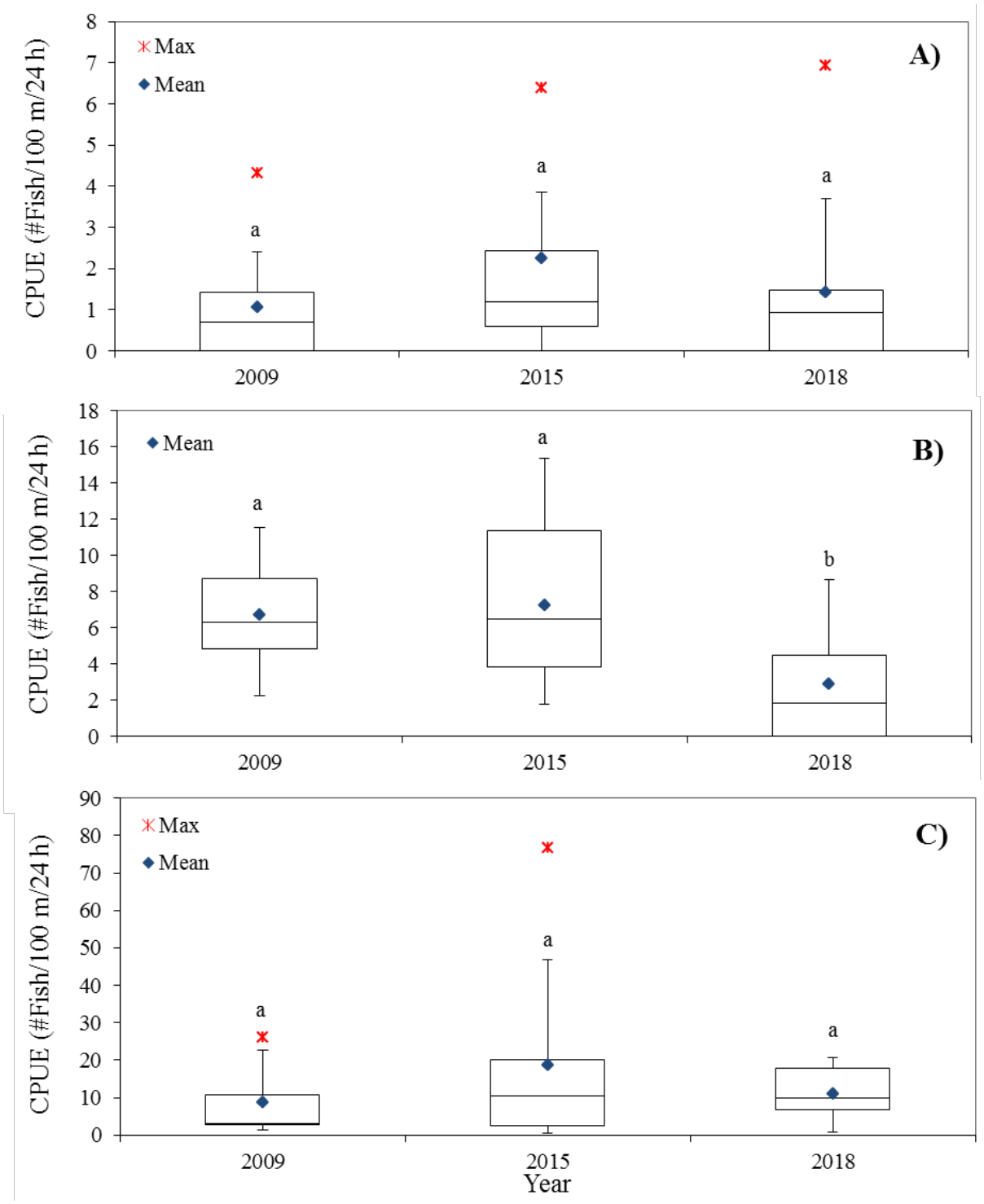


Figure 8: **Mean total CPUE for A) Lake Whitefish, B) Northern Pike and C) Walleye captured in standard gang index gill nets set in Stephens Lake North in 2009, 2015, and 2018. Letters denote significant differences in CPUE between study years.**

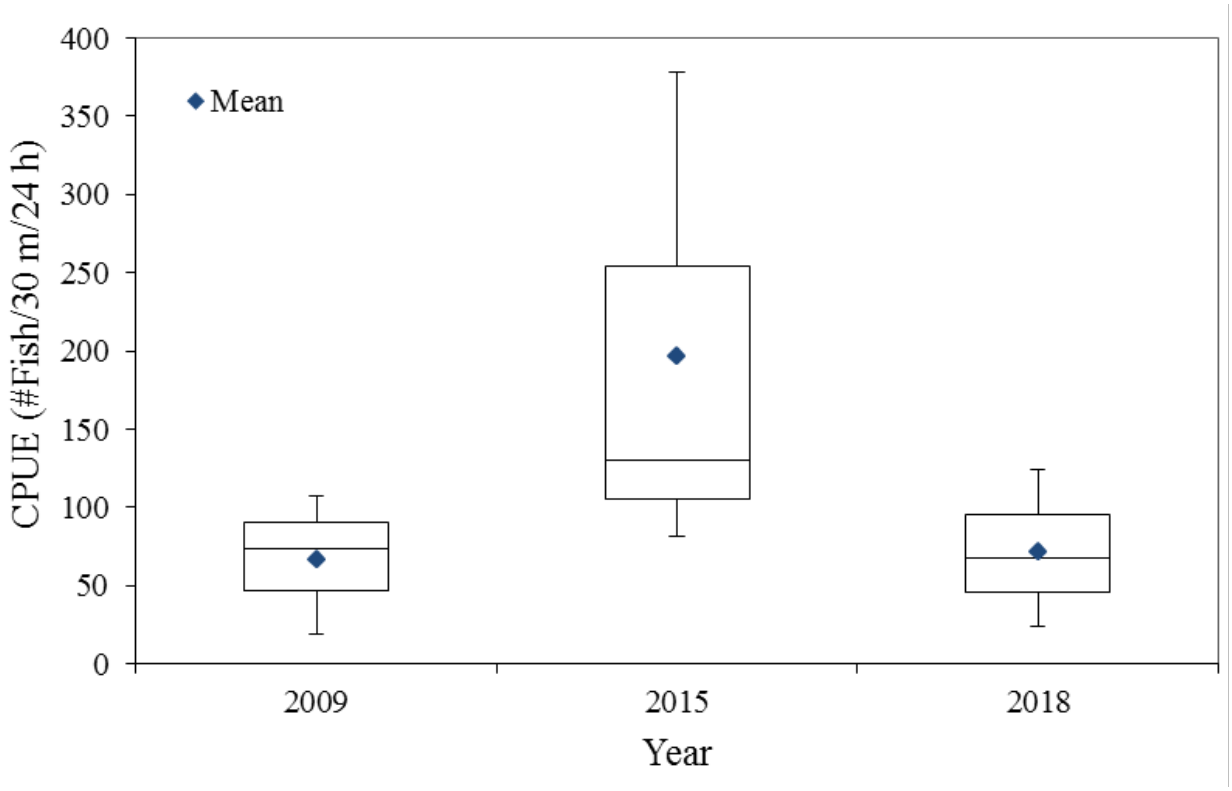


Figure 9: Mean total CPUE for all fish species captured in small mesh index gill nets set in Stephens Lake North in 2009, 2015, and 2018.

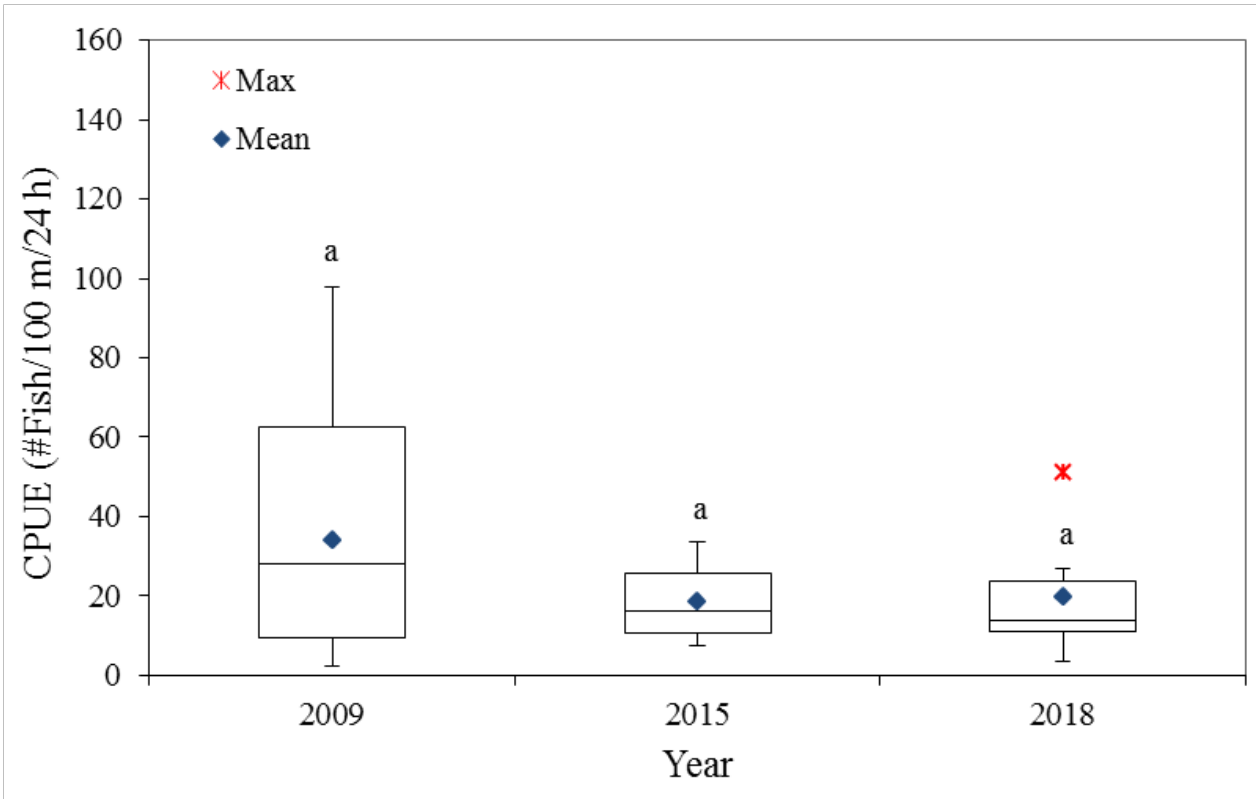


Figure 10: **Mean total CPUE for all fish species captured in standard gang index gill nets set in Stephens Lake South in 2009, 2015, and 2018. Letters denote significant differences in CPUE between study years.**

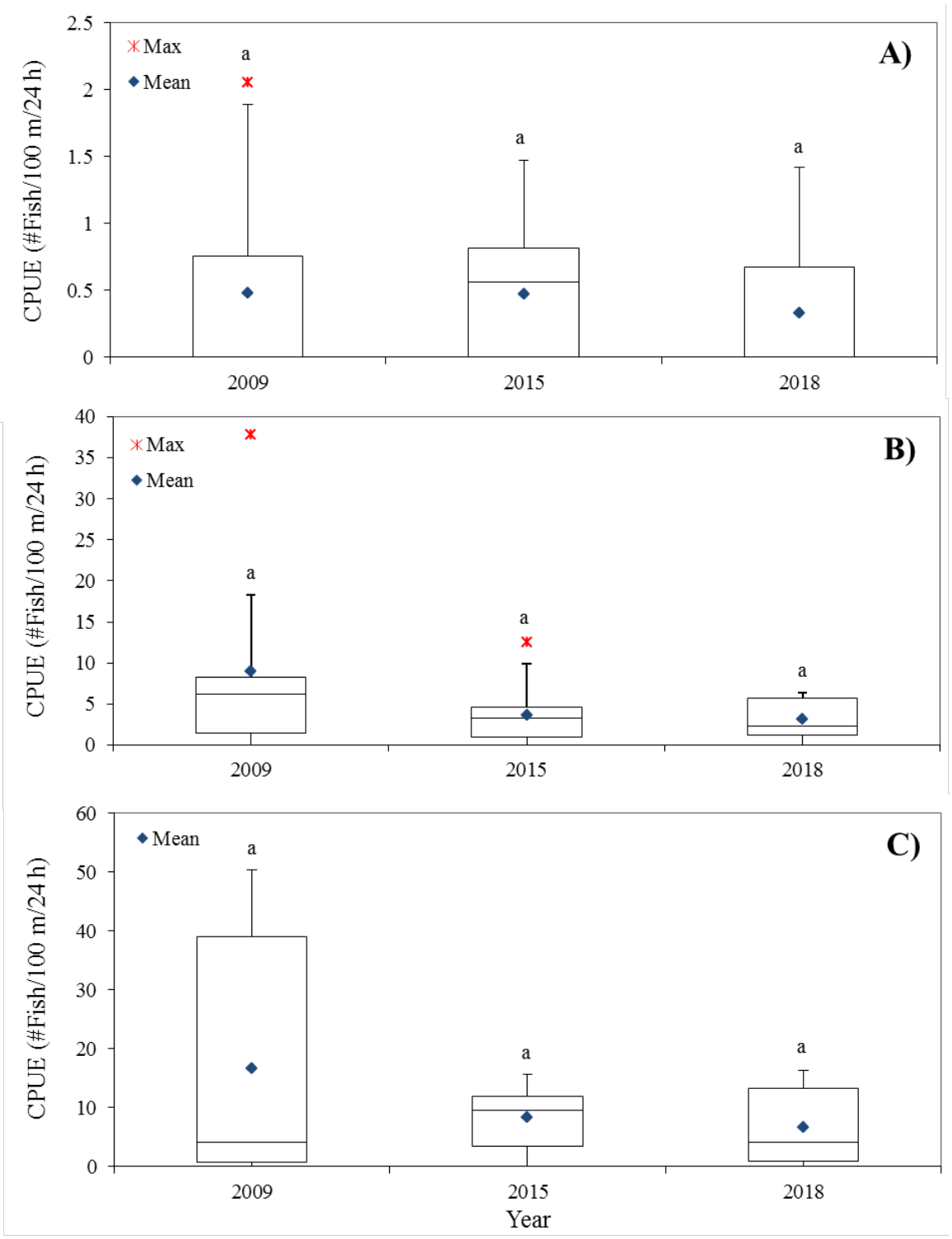


Figure 11: **Mean total CPUE for A) Lake Whitefish, B) Northern Pike and C) Walleye captured in standard gang index gill nets set in Stephens Lake South in 2009, 2015, and 2018. Letters denote significant differences in CPUE between study years.**

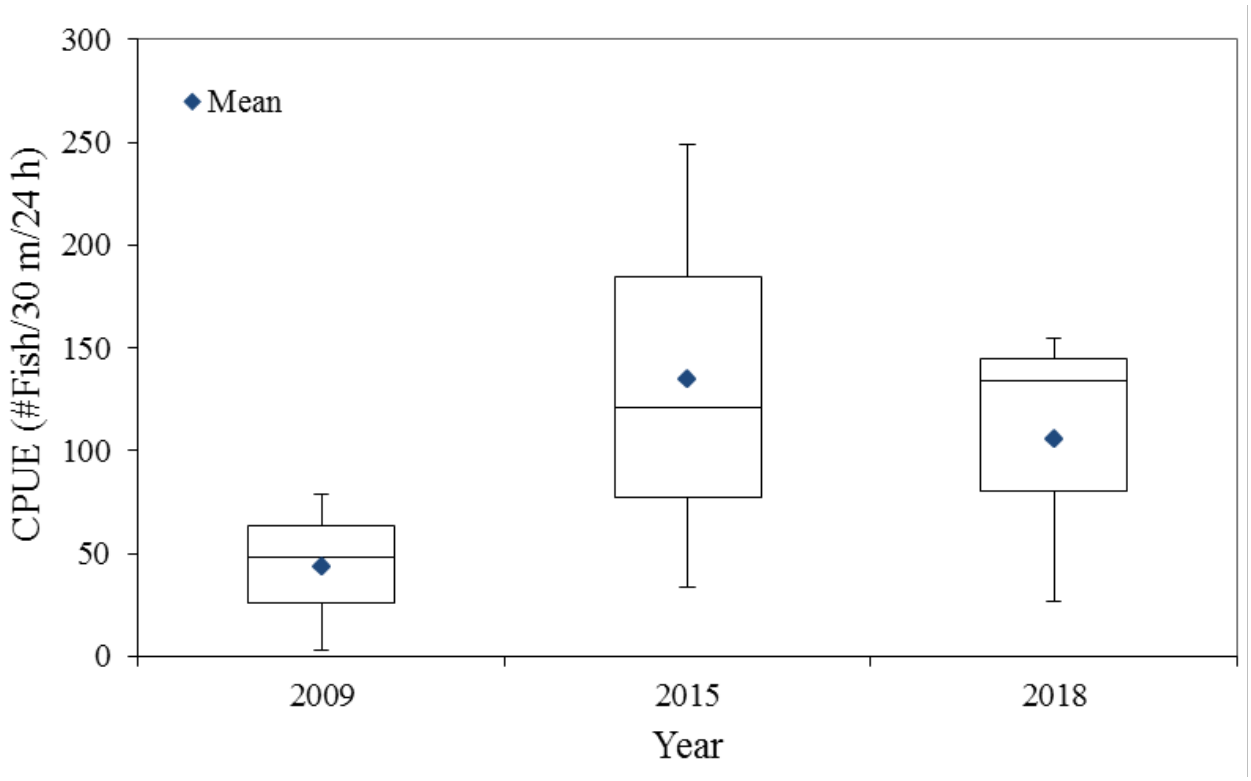


Figure 12: Mean total CPUE for all fish species captured in small mesh index gill nets set in Stephens Lake South in 2009, 2015, and 2018.

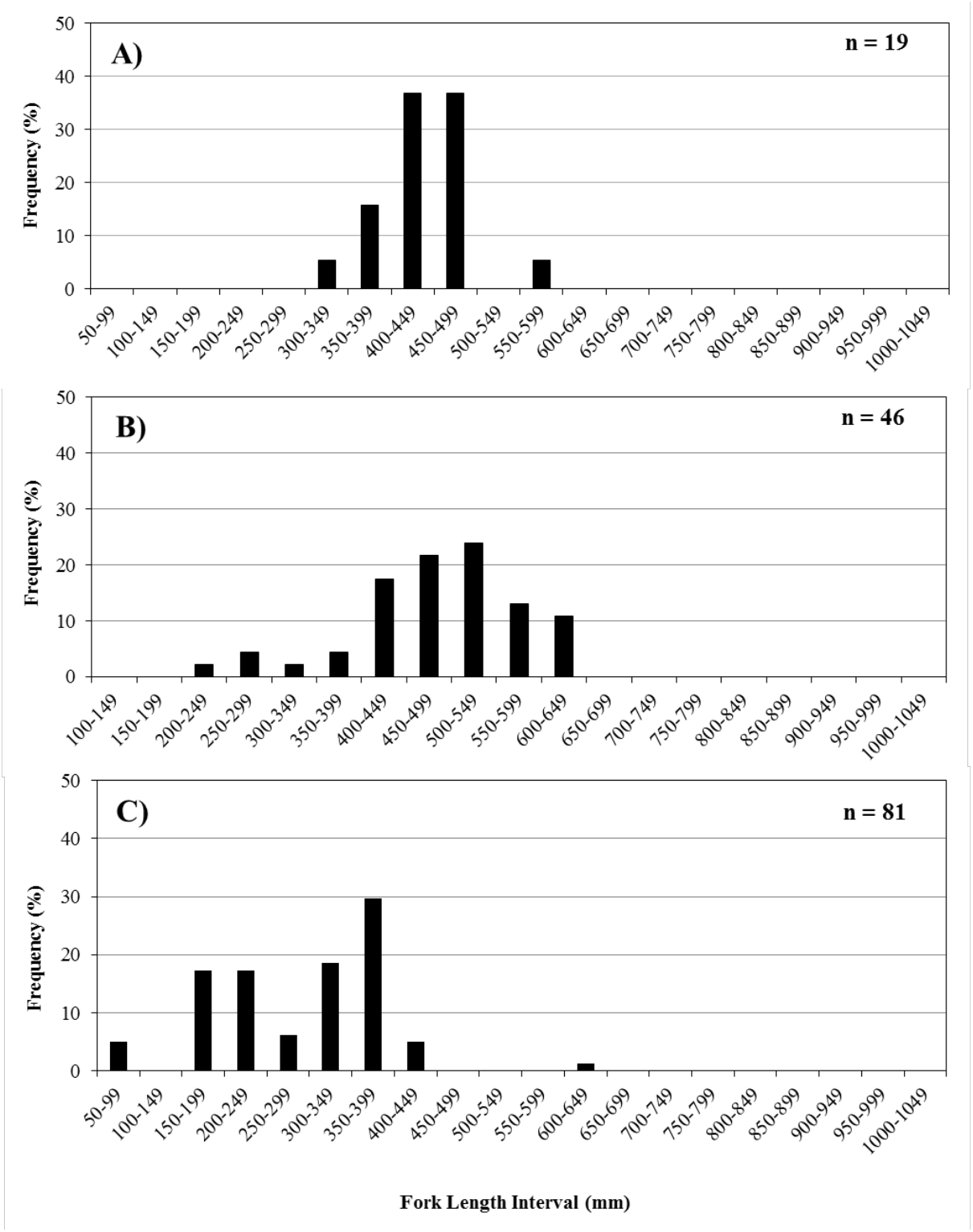


Figure 13: Fork length frequency distribution of A) Lake Whitefish B) Northern Pike and C) Walleye captured in standard gang index gill nets in Split Lake, summer 2019.

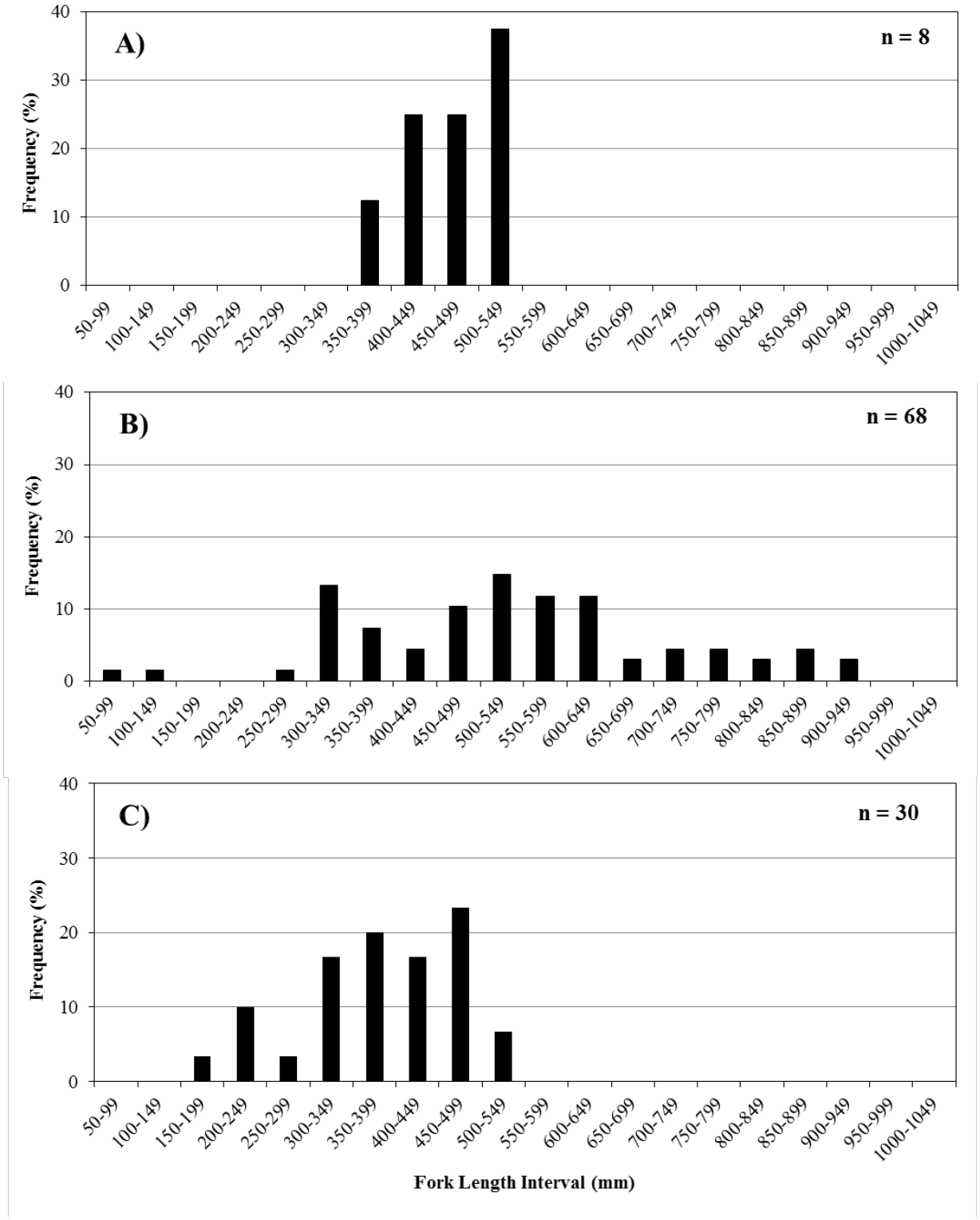


Figure 14: Fork length frequency distribution of A) Lake Whitefish B) Northern Pike and C) Walleye captured in standard gang index gill nets between Clark Lake and the Keeyask GS, summer 2019.

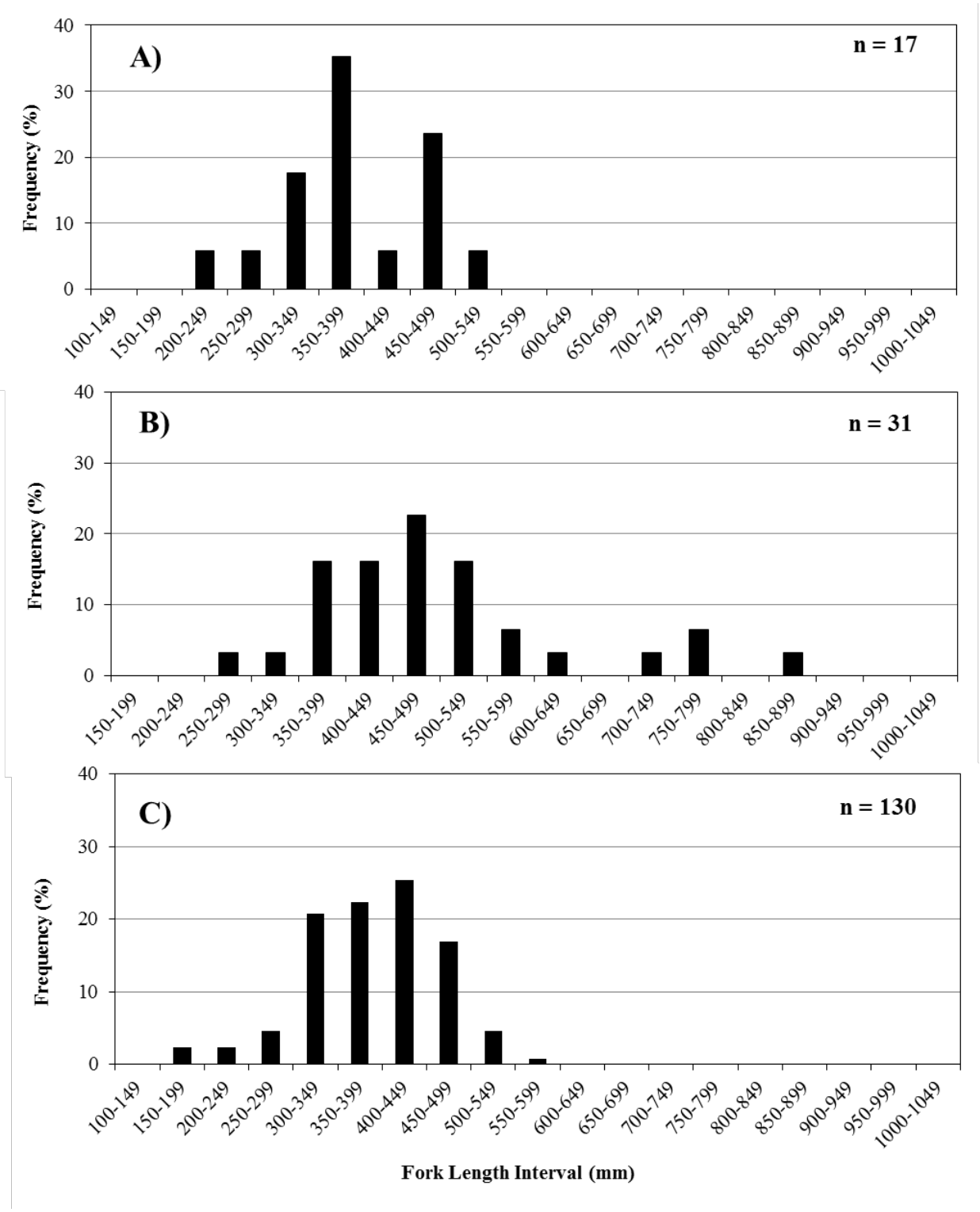


Figure 15: Fork length frequency distribution of A) Lake Whitefish B) Northern Pike and C) Walleye captured in standard gang index gill nets in Stephens Lake North, summer 2018.

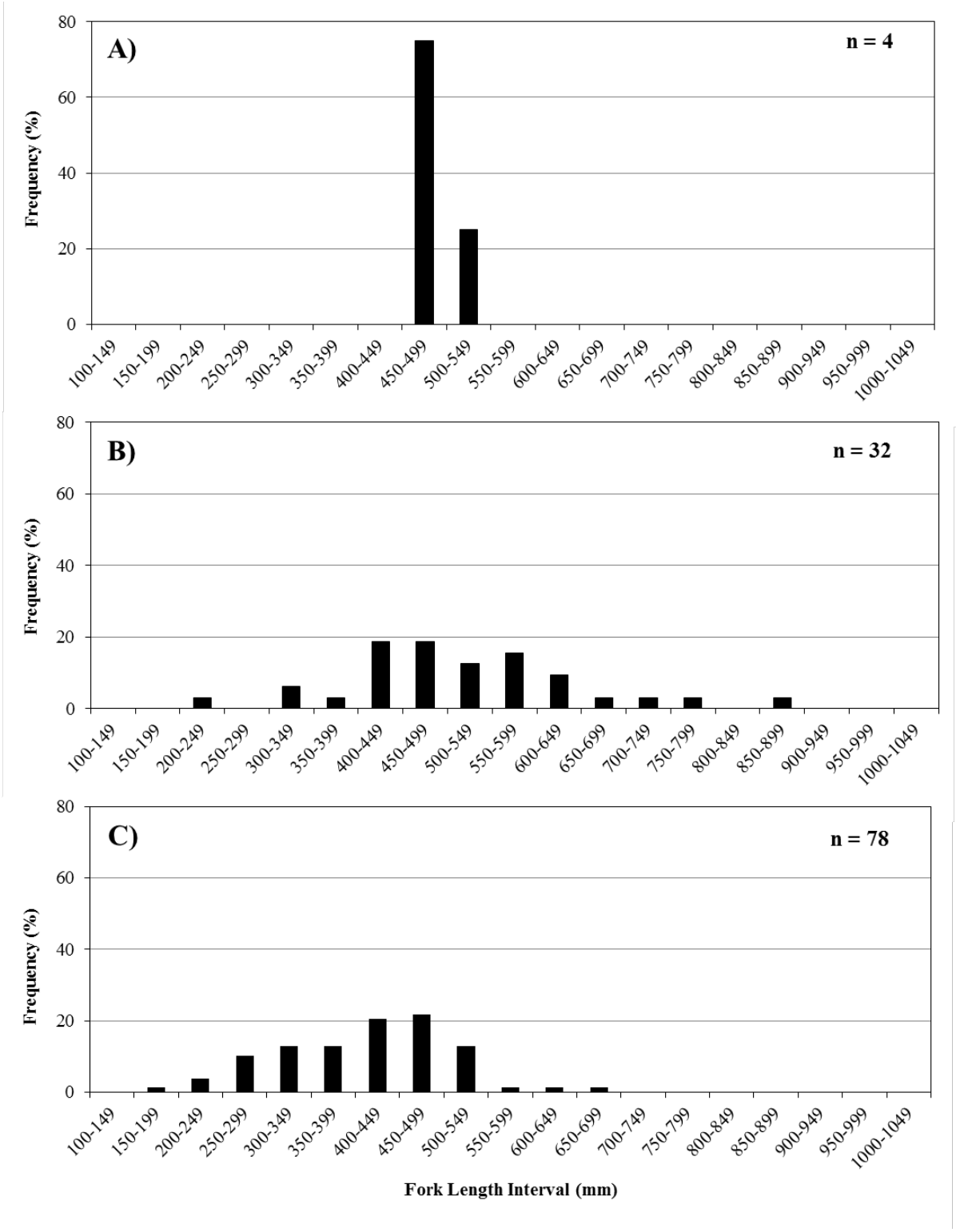


Figure 16: Fork length frequency distribution of A) Lake Whitefish B) Northern Pike and C) Walleye captured in standard gang index gill nets in Stephens Lake South, summer 2018.

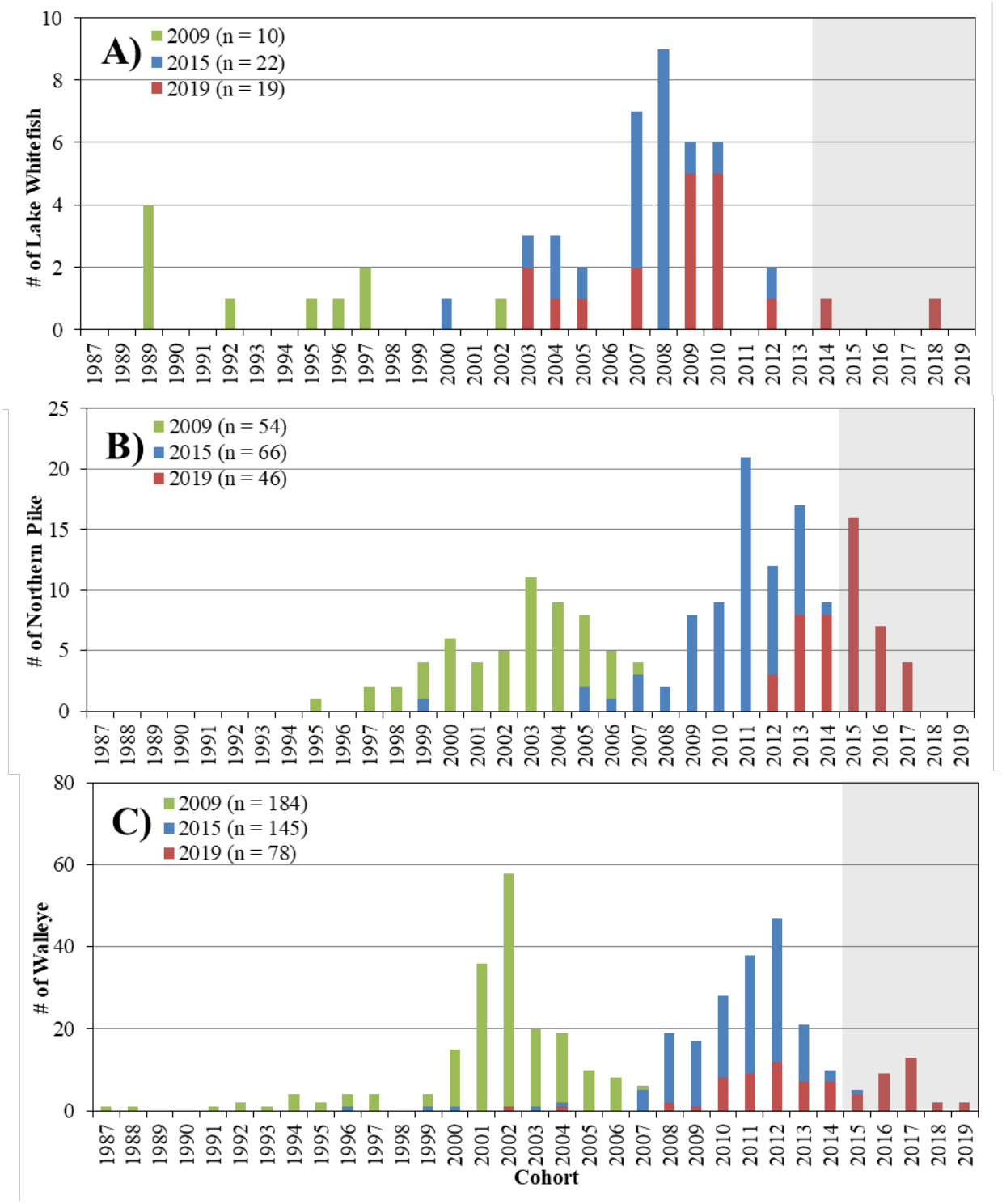


Figure 17: Cohort frequency distributions for A) Lake Whitefish B) Northern Pike and C) Walleye captured in standard gang and small mesh index gill nets set in Split Lake in 2009, 2015, and 2019. Grey shading indicates fish spawned during Keeyask GS construction.

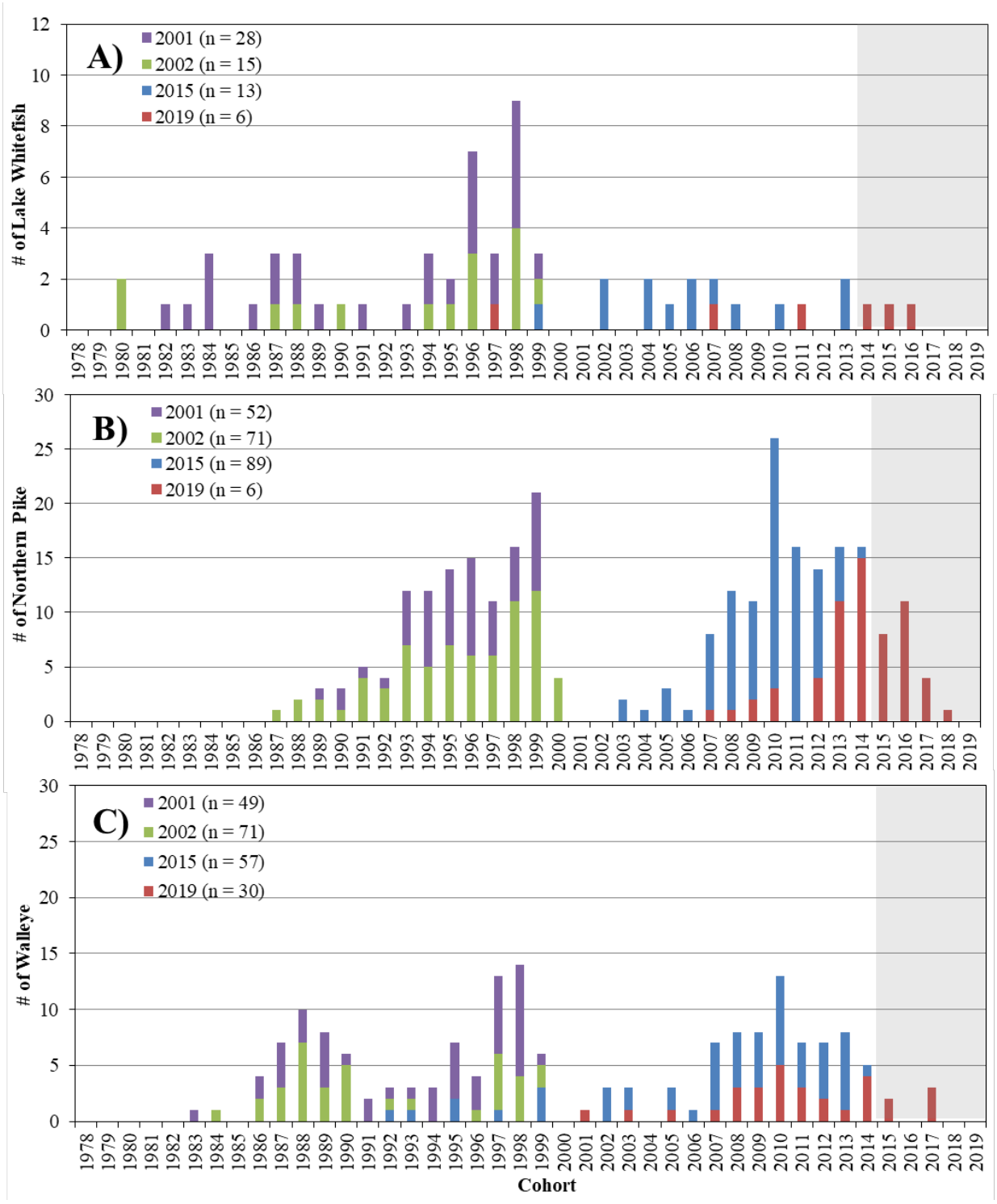


Figure 18: **Cohort breakdown of A) Lake Whitefish B) Northern Pike and C) Walleye caught in standard gang and small mesh index gill nets set between Clark Lake and the Keeyask GS in 2001, 2002, 2015, and 2019. Grey shading indicates fish spawned during Keeyask GS construction.**

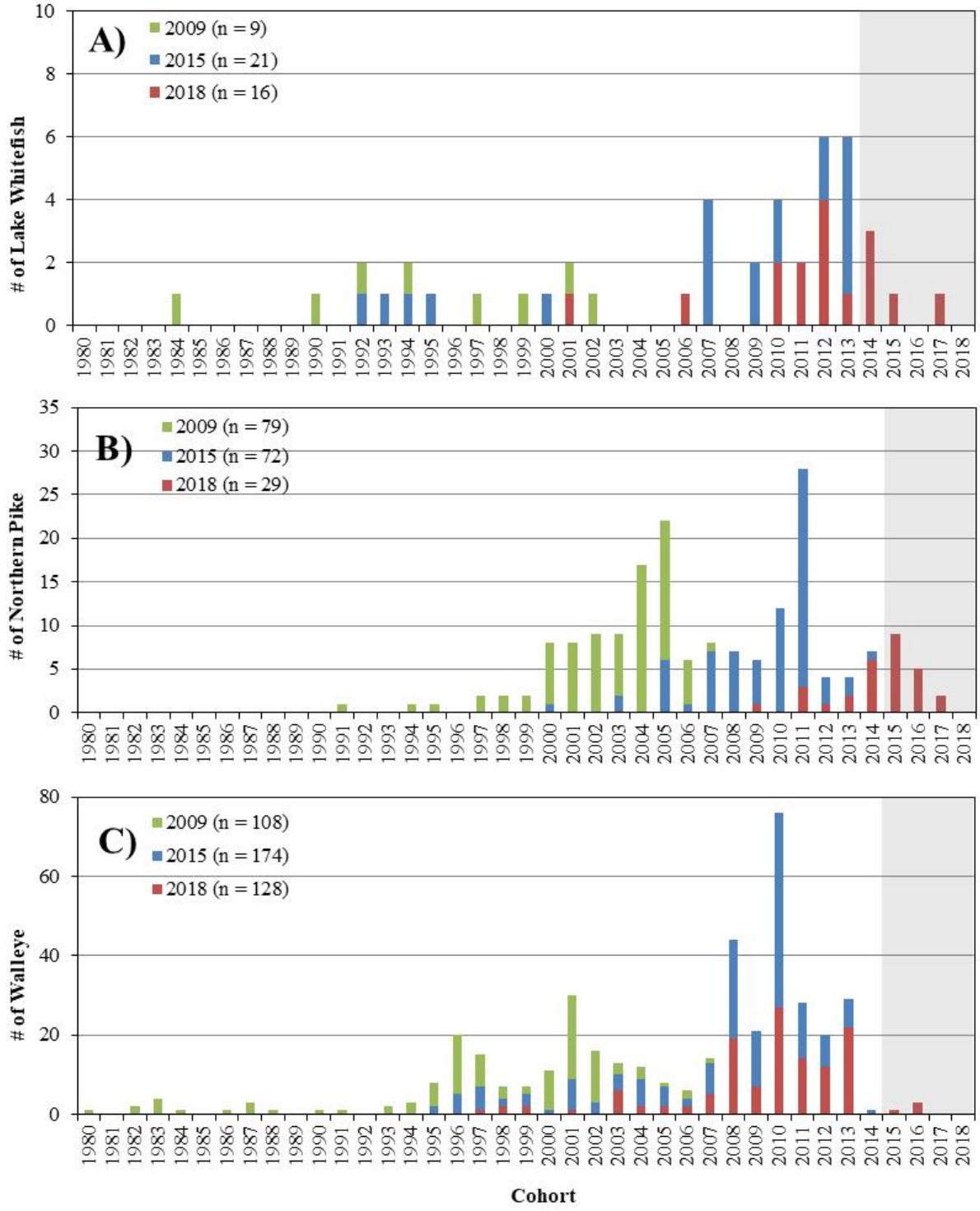


Figure 19: Cohort breakdown of A) Lake Whitefish B) Northern Pike and C) Walleye caught in standard gang and small mesh index gill nets set in Stephens Lake North in 2009, 2015, and 2018. Grey shading indicates fish spawned during Keeyask GS construction.

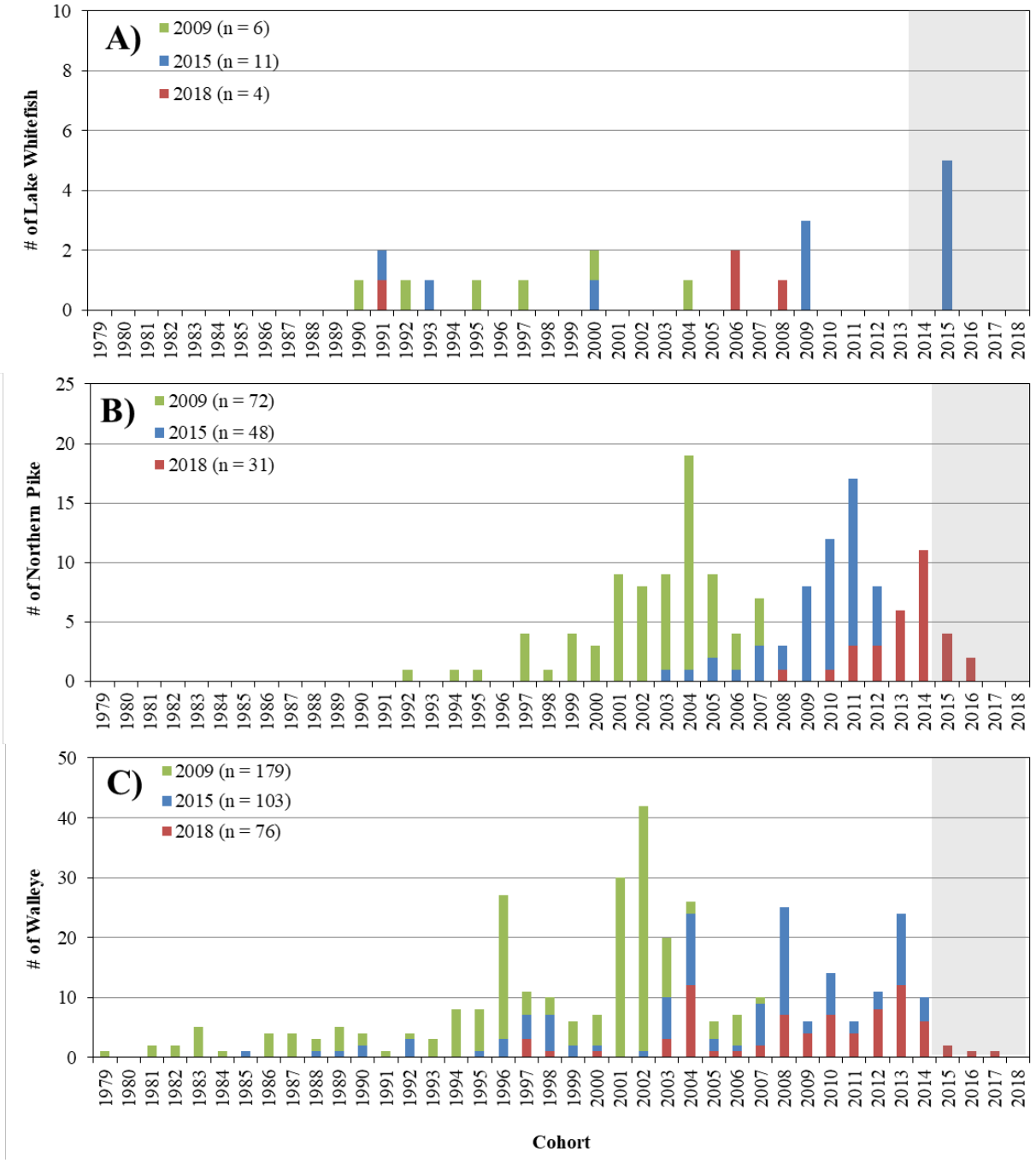


Figure 20: Cohort breakdown of A) Lake Whitefish B) Northern Pike and C) Walleye caught in standard gang and small mesh index gill nets set in Stephens Lake South in 2009, 2015, and 2018. Grey shading indicates fish spawned during Keeyask GS construction.

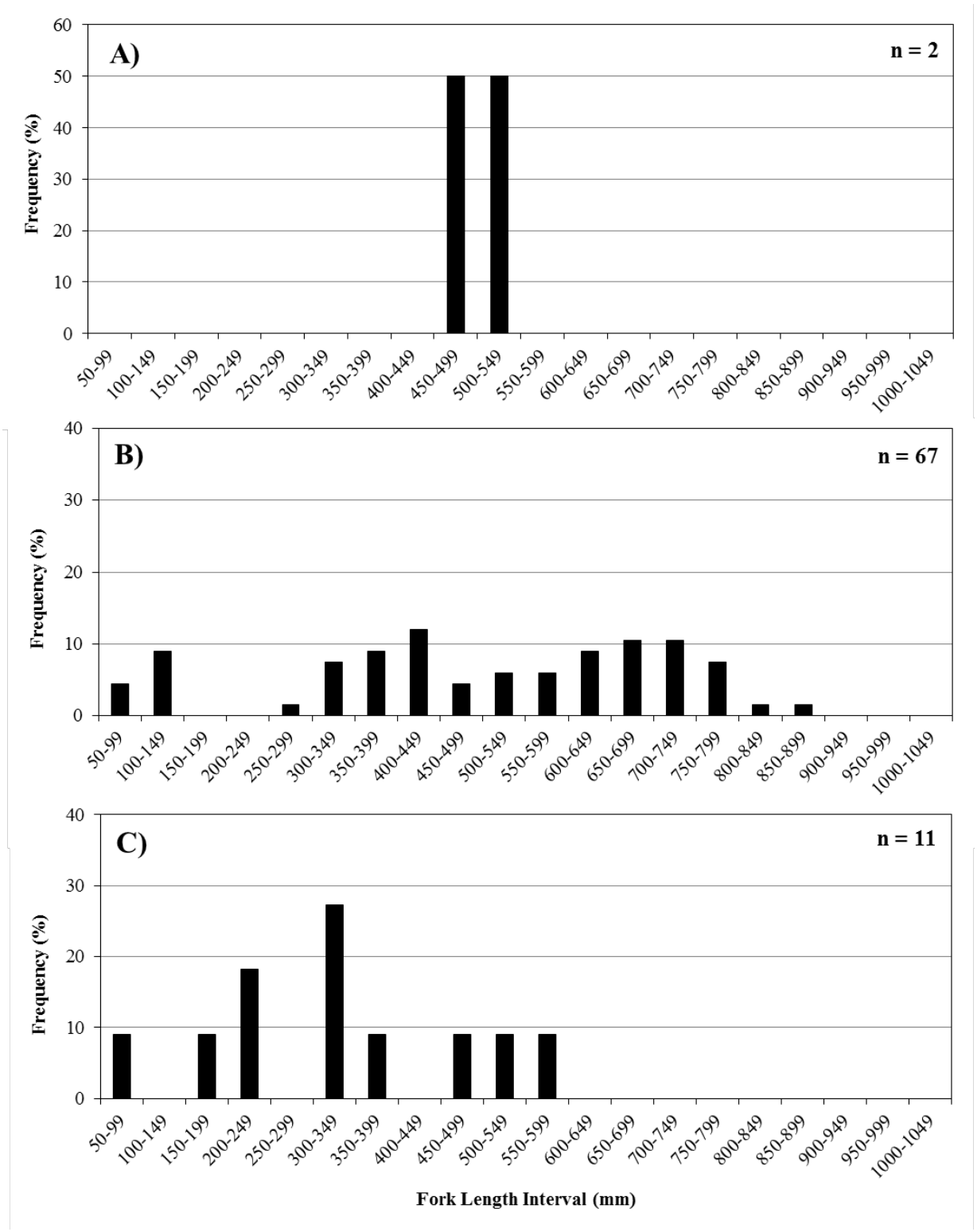
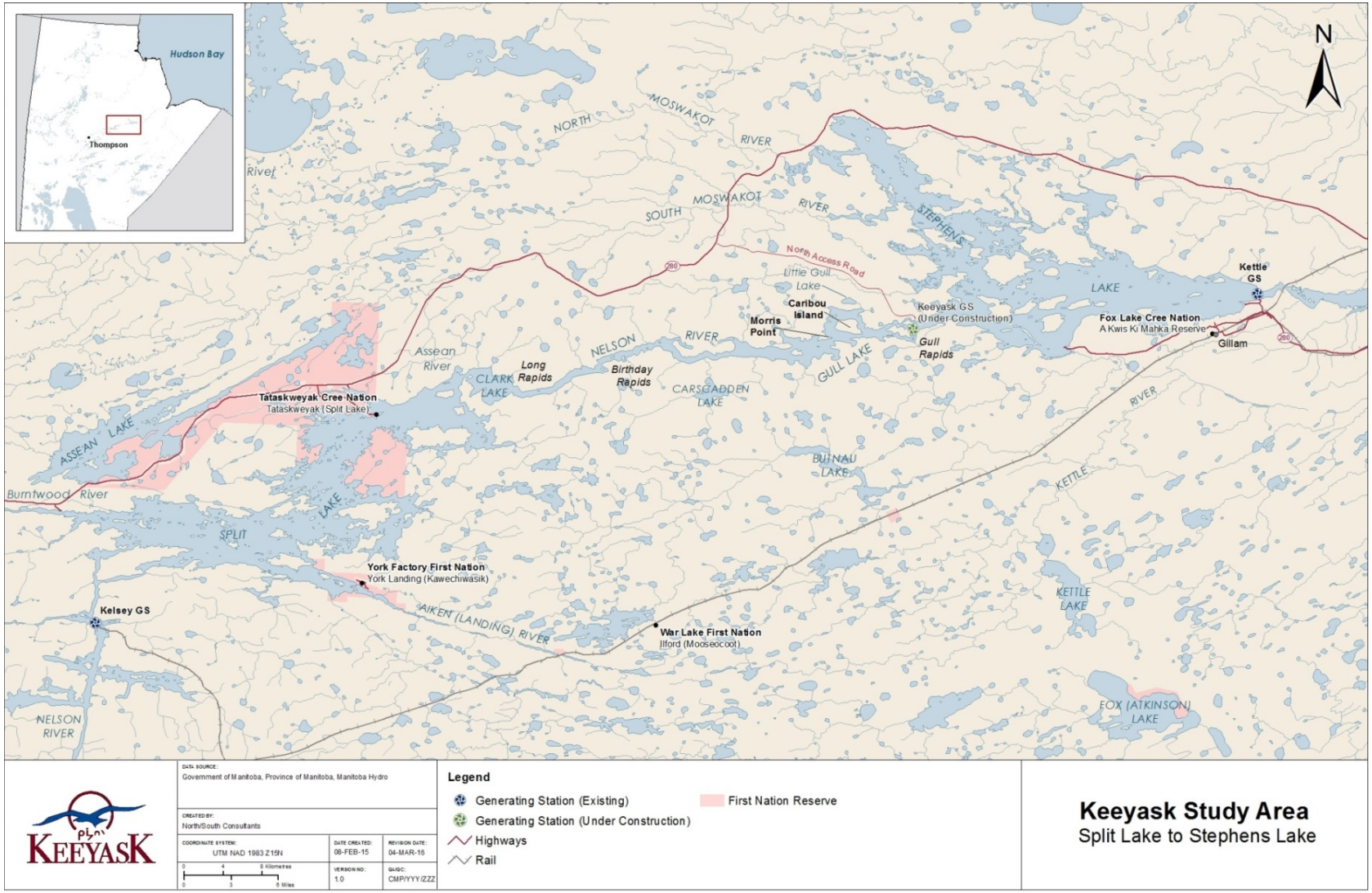
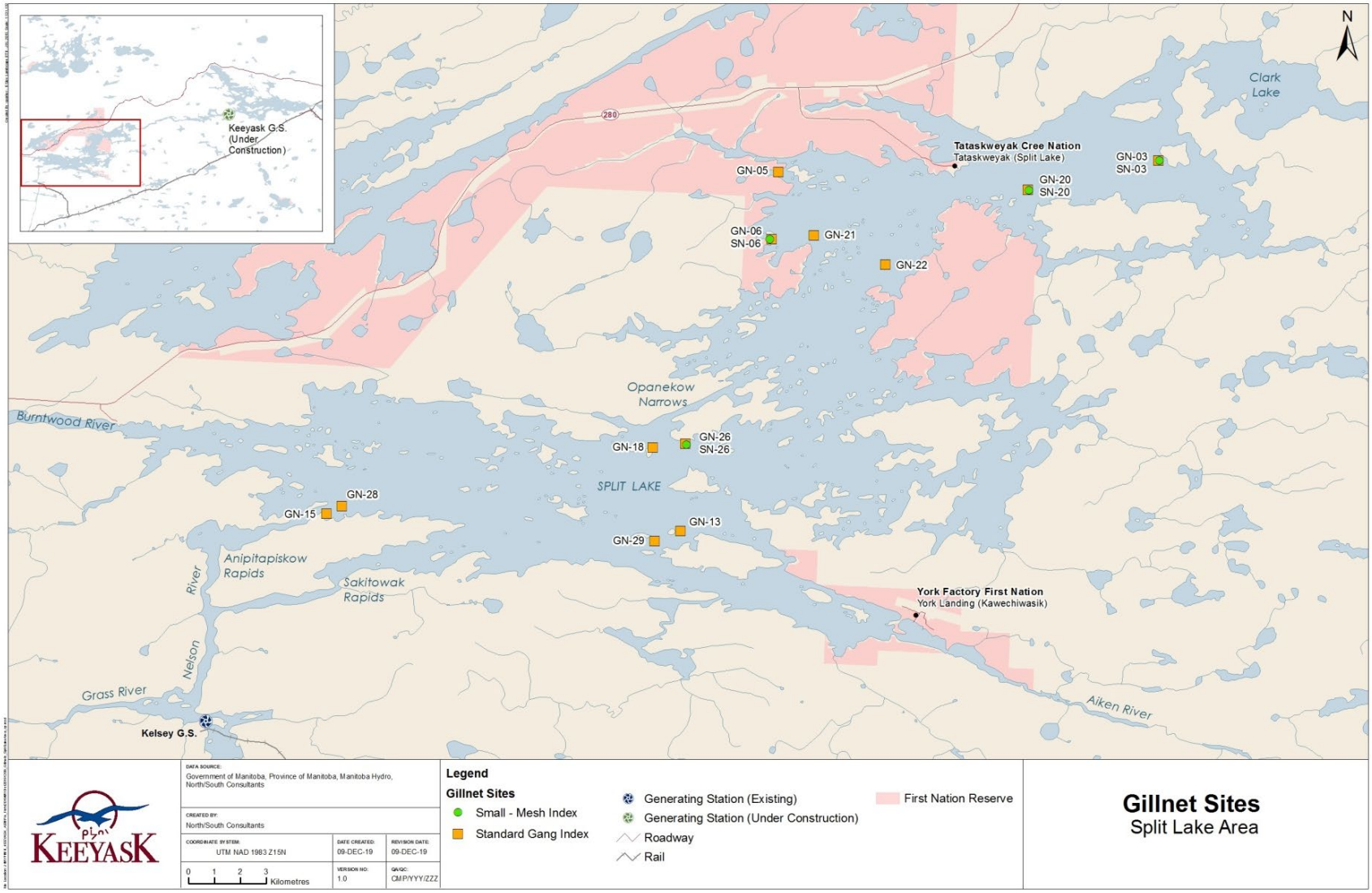


Figure 21: Fork length-frequency distribution of A) Lake Whitefish B) Northern Pike and C) Walleye captured in standard gang and small mesh index gill nets set at new sites between Clark Lake and the Keeyask GS, summer 2019.

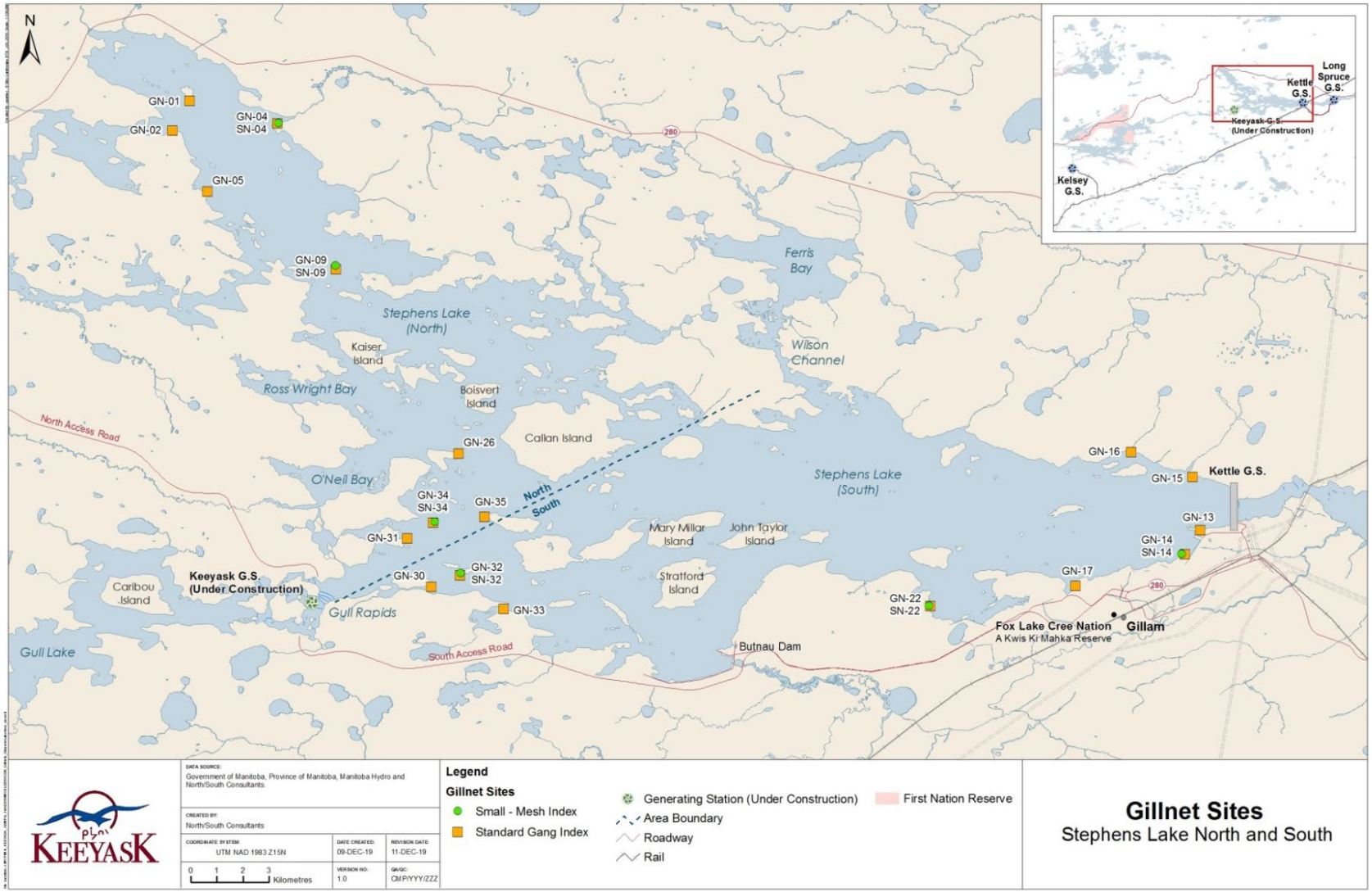
MAPS



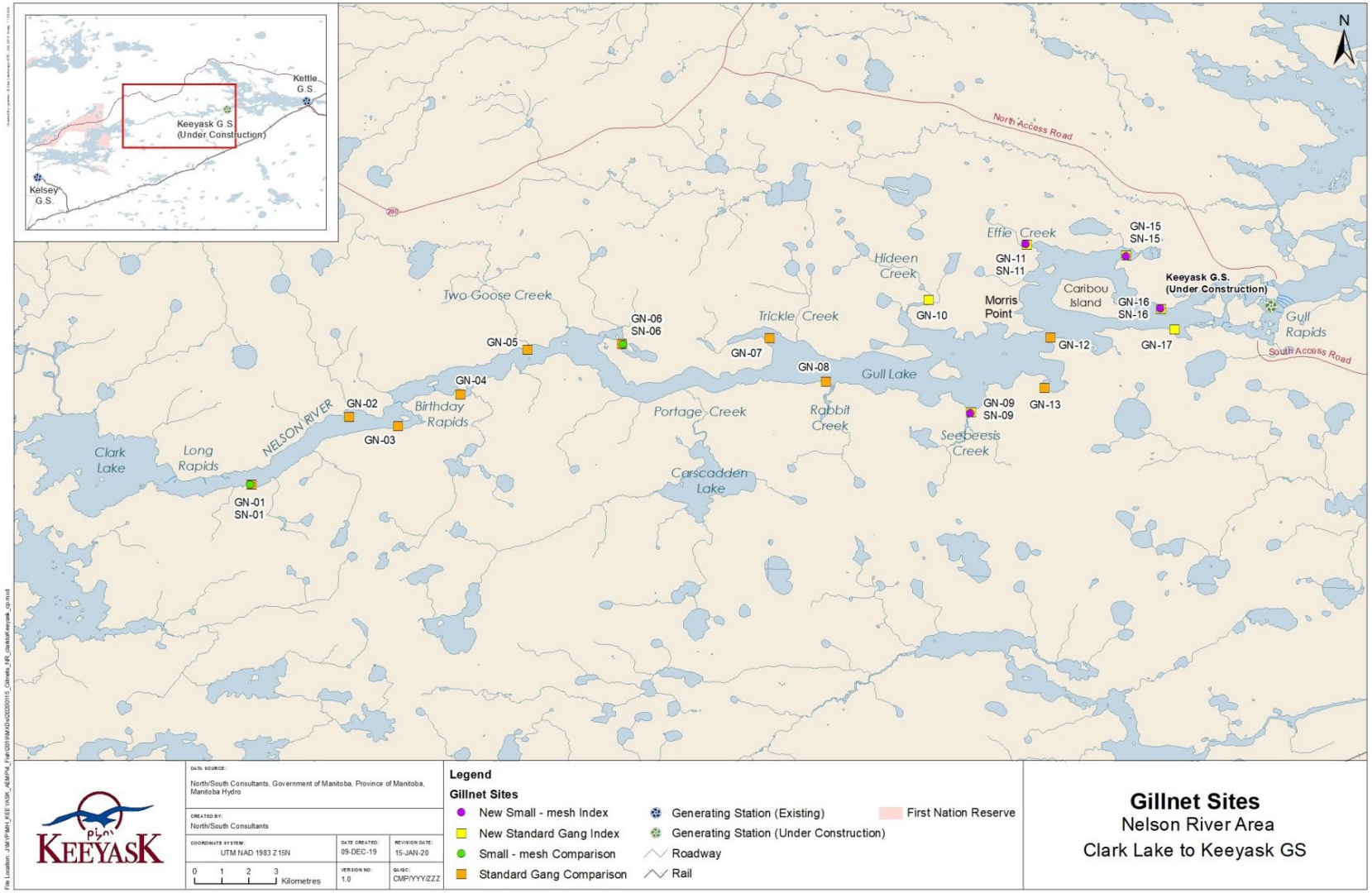
Map 1: Map of Nelson River showing the site of Keeyask Generating Station and the fish community study setting.



Map 2: Standard gang and small mesh index gillnetting sites in Split Lake, summer 2019.



Map 3: Standard gang and small-mess index gillnetting sites set in Stephens Lake North and South, summer 2018.



Map 4: Standard gang and small mesh index gillnetting sites set in the reach of the Nelson River from Clark Lake to the Keeyask GS, summer 2019.

APPENDICES

APPENDIX 1: GILLNET SURVEY INFORMATION FOR SPLIT LAKE, STEPHENS LAKE, AND IN THE REACH OF THE NELSON RIVER BETWEEN CLARK LAKE AND GULL RAPIDS, SUMMER 2018 AND 2019

Table A1-1: Standard gang and small mesh index gillnet survey information, Split Lake, summer 2019.

Site	Date Set	UTM coordinates			Duration (dec. hours)	Depth (m)		velocity	substrate	Vegetation	Water Temp
		Zone	Easting	Northing		1.5"	5"				
GN-03	04-Sep-19	15V	316430	6237847	23.23	3.6	4.1	None	Soft	None	13.0
GN-05	24-Aug-19	14V	673580	6236334	23.95	2.5	2.3	None	Soft	None	17.0
GN-06	05-Sep-19	14V	673546	6233722	21.75	3.6	3.8	None	Soft	None	13.0
GN-13	23-Aug-19	14V	671015	6222208	22.50	5.0	3.4	None	Soft	None	16.0
GN-15	23-Aug-19	14V	657348	6221692	27.05	2.1	2.1	None	Soft	None	16.0
GN-18	22-Aug-19	14V	669674	6225325	20.27	3.1	3.1	None	Soft	None	17.5
GN-20	04-Sep-19	14V	683220	6236494	23.42	7.5	9.1	None	Soft	None	13.0
GN-21	24-Aug-19	14V	675159	6234028	26.43	3.9	3.8	None	Soft	None	17.0
GN-22	24-Aug-19	14V	678002	6233133	26.27	8.6	11.2	None	Soft	None	17.0
GN-26	22-Aug-19	14V	670909	6225583	19.90	8.2	5.8	None	Soft	None	17.0
GN-28	23-Aug-19	14V	657901	6222037	27.48	6.5	14.2	None	Soft	None	16.0
GN-29	22-Aug-19	14V	670055	6221742	20.42	4.0	4.1	None	Soft	None	18.0
Small Mesh Sites						**16 mm**	**25 mm**				
SN-03	04-Sep-19	15V	316461	6237853	23.23	3.4	3.6	None	Soft	None	13.0
SN-06	05-Sep-19	14V	673471	6233716	21.75	4.1	3.5	None	Soft	None	13.0
SN-20	04-Sep-19	14V	683256	6236471	23.42	7.2	7.5	None	Soft	None	13.0
SN-26	22-Aug-19	14V	670952	6225558	19.90	10.8	8.2	None	Soft	None	17.0

Table A1-2: Standard gang and small mesh index gillnet survey information, Clark Lake to the Keeyask GS, summer 2019.

Site	Date Set	UTM Coordinates			Duration (dec. hours)	Depth (m)		Velocity	Substrate	Vegetation	Water Temp
		Zone	Easting	Northing		1.5"	5"				
GN-15	7-Aug-19	15V	358334	6248281	22.58	1.8	1.9	Low	Soft	Medium	17.0
GN-12	7-Aug-19	15V	355548	6245253	21.83	5.0	2.6	High	Hard	None	17.0
GN-17	8-Aug-19	15V	360118	6245541	22.93	2.3	2.3	Medium	Soft	None	18.0
GN-16	8-Aug-19	15V	359625	6246307	22.97	4.9	7.9	Medium	Soft	None	18.0
GN-11	9-Aug-19	15V	354659	6248689	26.67	0.9	1.0	Low	Soft	Low	14.0
GN-10	9-Aug-19	15V	351042	6246628	24.67	1.1	1.1	None	Soft	High	14.0
GN-13	10-Aug-19	15V	355321	6243386	26.92	1.5	1.4	None	Soft	None	17.0
GN-07	10-Aug-19	15V	345164	6245220	25.58	2.4	2.0	None	Soft	None	17.0
GN-06	11-Aug-19	15V	339705	6245008	24.42	1.4	1.2	Low	Soft	Low	14.0
GN-05	11-Aug-19	15V	336220	6244788	24.33	7.3	1.8	Medium	Hard	None	16.0
GN-08	12-Aug-19	15V	347239	6243614	25.75	4.4	4.9	Medium	Soft	None	16.0
GN-04	12-Aug-19	15V	333724	6243147	24.75	1.6	3.2	Medium	Soft	None	16.0
GN-03	13-Aug-19	15V	331438	6241969	25.75	4.5	2.7	Low	Soft	None	16.0
GN-02	13-Aug-19	15V	329615	6242319	25.08	3.7	5.5	Low	Soft	Low	16.0
GN-01	13-Aug-19	15V	326017	6239813	24.33	2.0	3.7	Medium	Soft	None	16.0
GN-09	14-Aug-19	15V	352597	6242484	22.25	1.8	2.0	None	Soft	None	17.0
Small Mesh						**16 mm**	**25 mm**				
SN-15	7-Aug-19	15V	358339	6248250	22.58	1.5	1.8	Low	Soft	Medium	17.0
SN-16	8-Aug-19	15V	359599	6246313	22.97	4.3	4.9	Low	Soft	Low	18.0
SN-11	9-Aug-19	15V	354631	6248707	26.67	1.6	0.9	Medium	Soft	None	14.0
SN-06	11-Aug-19	15V	339735	6244990	24.42	3.2	1.4	Low	Soft	Low	14.0
SN-01	13-Aug-19	15V	325977	6239816	24.33	1.7	2.0	Medium	Soft	None	16.0
SN-09	14-Aug-19	15V	352584	6242453	22.25	1.2	1.8	None	Soft	None	17.0

Table A1-3: Standard gang and small mesh index gillnet survey information, Stephens Lake North, summer 2019.

Site	Date Set	UTM Coordinates			Duration (dec. hours)	Depth (m)		Velocity	Substrate	Vegetation	Water Temp
		Zone	Easting	Northing		1.5"	5"				
GN-01	01-Sep-18	15	359007	6265599	18.20	5.5	8.4	Low	Soft	Low	13.5
GN-02	01-Sep-18	15	358353	6264473	18.72	2.6	8.9	Low	-	Low	13.5
GN-04	01-Sep-18	15	362365	6264748	17.83	3.0	3.2	None	Soft	None	13.5
GN-05	02-Sep-18	15	359690	6262134	23.42	1.2	2.2	-	-	Low	11.0
GN-09	02-Sep-18	15	364605	6259161	23.57	6.2	7.8	Low	-	None	11.0
GN-26	03-Sep-18	15	369295	6252115	20.15	8.3	3.0	Low	-	Low	11.0
GN-31	03-Sep-18	15	367335	6248876	18.97	1.9	3.0	Low	-	Low	11.5
GN-34	03-Sep-18	15	368336	6249478	18.97	2.0	4.4	None	-	Low	11.0
GN-35	03-Sep-18	15	370295	6249702	19.55	2.1	3.0	Low	-	Low	11.0
Small Mesh						**16 mm**	**25 mm**				
SN-04	01-Sep-18	15	362404	6264741	17.83	2.2	3.0	None	Soft	None	13.5
SN-09	02-Sep-18	15	364595	6259292	23.57	6.2	6.2	Low	-	Low	11.0
SN-34	03-Sep-18	15	368379	6249504	18.97	2.0	2.0	None	-	Low	11.0

Table A1-4: Standard gang and small mesh index gillnet survey information, Stephens Lake South, summer 2019.

Site	Date Set	UTM Coordinates			Duration (dec. hours)	Depth (m)		Velocity	Substrate	Vegetation	Water Temp
		Zone	Easting	Northing		1.5"	5"				
GN-13	29-Aug-18	15	397678	6249179	18.43	2.5	1.8	Low	-	Low	12.5
GN-14	29-Aug-18	15	397099	6248262	19.15	3.4	3.1	Low	-	Low	12.5
GN-15	29-Aug-18	15	397380	6251226	17.55	9.9	7.8	None	-	None	12.5
GN-16	30-Aug-18	15	395035	6252172	30.03	2.7	6.2	-	-	-	12.0
GN-17	30-Aug-18	15	392904	6247053	24.60	1.8	3.1	-	-	-	15.0
GN-22	30-Aug-18	15	387352	6246289	26.07	2.5	3.9	-	-	-	14.5
GN-30	31-Aug-18	15	368251	6247019	13.93	3.9	3.3	Low	-	None	12.5
GN-32	31-Aug-18	15	369353	6247461	14.23	9.4	14.7	Low	-	-	13.5
GN-33	31-Aug-18	15	371028	6246169	14.80	1.9	2.1	-	-	-	13.5
Small Mesh						**16 mm**	**25 mm**				
SN-14	29-Aug-18	15	396974	6248265	19.15	3.4	3.4	Low	-	None	12.5
SN-22	30-Aug-18	15	387302	6246284	26.07	2.3	2.5	Low	-	Low	14.5
SN-32	31-Aug-18	15	369366	6247527	14.23	8.0	9.4	Low	Soft	None	13.5

APPENDIX 2:
OCCURENCE OF DEBRIS IN STANDARD GANG AND SMALL MESH INDEX GILL NETS SET THROUGHOUT THE KEEYASK STUDY AREA, SUMMER 2018 AND 2019

Table A2-1: Occurrence of debris in standard gang and small mesh index gill nets set in Split Lake, summer 2019.

Gillnet Type	Site	Quantity of Debris	Type of Debris (%)						
			Terrestrial Vegetation	Terrestrial Moss	Sticks	Algae	Aquatic Vegetation	Aquatic Moss	Silt/Mud
Standard Gang	GN-03	None	-	-	-	-	-	-	-
	GN-20	Low (< 5%)	-	-	-	-	100	-	-
	GN-05	Low (< 5%)	-	-	-	-	100	-	-
	GN-06	Low (< 5%)	-	-	10	-	90	-	-
	GN-26	Low (< 5%)	-	-	-	-	100	-	-
	GN-29	None	-	-	-	-	-	-	-
	GN-15	Moderate (5-15%)	-	-	10	90	-	-	-
	GN-28	Very High (> 26%)	-	-	95	-	5	-	-
	GN-18	None	-	-	-	-	-	-	-
	GN-13	Low (< 5%)	-	-	50	-	50	-	-
	GN-21	Low (< 5%)	-	-	100	-	-	-	-
	GN-22	None	-	-	-	-	-	-	-
Small Mesh	SN-03	None	-	-	-	-	-	-	-
	SN-06	Low (< 5%)	-	-	10	-	90	-	-
	SN-20	Low (< 5%)	-	-	-	-	100	-	-
	SN-26	Low (< 5%)	-	-	100	-	-	-	-

Table A2-2: Occurrence of debris in standard gang and small mesh index gill nets set between Clark Lake and the Keeyask GS, summer 2019.

Gillnet Type	Site	Quantity of Debris	Type of Debris (%)						
			Terrestrial Vegetation	Terrestrial Moss	Sticks	Algae	Aquatic Vegetation	Aquatic Moss	Silt/Mud
Standard Gang	GN-15	Low (< 5%)	-	-	-	-	100	-	-
	GN-12	Low (< 5%)	-	-	-	-	100	-	-
	GN-17	Moderate (5-15%)	-	-	100	-	-	-	-
	GN-16	Moderate (5-15%)	-	-	-	100	-	-	-
	GN-11	Moderate (5-15%)	-	-	90	-	10	-	-
	GN-10	Very High (> 26%)	-	-	-	-	100	-	-
	GN-13	Very High (> 26%)	-	-	-	-	100	-	-
	GN-07	Very High (> 26%)	-	-	-	-	100	-	-
	GN-06	Moderate (5-15%)	-	-	-	-	100	-	-
	GN-05	None	-	-	-	-	-	-	-
	GN-08	Low (< 5%)	-	-	100	-	-	-	-
	GN-04	Moderate (5-15%)	-	-	-	90	10	-	-
	GN-03	Moderate (5-15%)	-	-	5	95	-	-	-
	GN-02	Low (< 5%)	-	-	100	-	-	-	-
	GN-01	Very High (> 26%)	-	-	-	100	-	-	-
	GN-09	High (16-25%)	-	-	-	50	50	-	-
Small Mesh	SN-15	Low (< 5%)	-	-	-	-	100	-	-
	SN-16	Moderate (5-15%)	-	-	-	100	-	-	-
	SN-11	Moderate (5-15%)	-	-	90	-	10	-	-
	SN-06	Moderate (5-15%)	-	-	-	-	100	-	-
	SN-01	Very High (> 26%)	-	-	-	100	-	-	-
	SN-09	High (16-25%)	-	-	-	50	50	-	-

Table A2-3: Occurrence of debris in standard gang and small mesh index gill nets set in Stephens Lake North, summer 2019.

Gillnet Type	Site	Quantity of Debris	Type of Debris (%)						
			Terrestrial Vegetation	Terrestrial Moss	Sticks	Algae	Aquatic Vegetation	Aquatic Moss	Silt/Mud
Standard Gang	GN-01	Low (< 5%)	-	-	100	-	-	-	-
	GN-02	Moderate (5-15%)	-	-	100	-	-	-	-
	GN-04	Moderate (5-15%)	-	-	100	-	-	-	-
	GN-05	Low (< 5%)	-	-	100	-	-	-	-
	GN-09	Low (< 5%)	-	-	100	-	-	-	-
	GN-26	Low (< 5%)	-	-	100	-	-	-	-
	GN-31	None	-	-	-	-	-	-	-
	GN-34	Low (< 5%)	-	-	100	-	-	-	-
	GN-35	Low (< 5%)	-	-	100	-	-	-	-
Small Mesh	SN-04	Moderate (5-15%)	-	-	100	-	-	-	-
	SN-09	Low (< 5%)	-	-	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 2019.

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	Low (< 5%)	-	-	100	-	-	-	-
	GN-15	None	-	-	-	-	-	-	-
	GN-16	Moderate (5-15%)	-	-	100	-	-	-	-
	GN-17	Very High (> 26%)	-	-	100	-	-	-	-
	GN-22	Low (< 5%)	-	-	100	-	-	-	-
	GN-30	Low (< 5%)	-	-	100	-	-	-	-
	GN-32	Low (< 5%)	-	-	100	-	-	-	-
	GN-33	Moderate (5-15%)	-	-	100	-	-	-	-
Small Mesh	SN-14	Low (< 5%)	-	-	100	-	-	-	-
	SN-22	Low (< 5%)	-	-	100	-	-	-	-
	SN-32	Low (< 5%)	-	-	100	-	-	-	-