Lake Manitoba and Lake St. Martin Outlet Channel Project

Fisheries Investigations at the Lake St. Martin Outlet Channel Inlet and Outlet - 2018

REPORT

Prepared for Manitoba Infrastructure · March 2019
By North/South Consultants Inc. · 83 Scurfield Blvd. · Winnipeg, MB · R3Y 1G4

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A Draft Report Prepared for

Manitoba Infrastructure

By:

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EXECUTIVE SUMMARY

Flood events in 2011 and 2014 emphasized the need for better water level regulation on Lake Manitoba and Lake St. Martin. Consequently, the Province of Manitoba has committed to enhancing the outlet capacities to better regulate water levels on both lakes and improve flood protection for the people of Manitoba. The Lake Manitoba and Lake St. Martin Outlet Channel Project (the Project) was initiated subsequent to the 2011 flood event and, to date, has included a feasibility assessment, analysis of alternate routes, and the preliminary engineering to construct a diversion channel between Lake Manitoba and Lake St. Martin and a second channel from Lake St. Martin to Lake Winnipeg.

The Project will require an environmental assessment pursuant to *The Environment Act* and *CEAA 2012*, and will also need regulatory approvals pursuant to the *Fisheries Act* and the *Navigation Protection Act*. The environmental assessment process is underway for the Project, and includes the collection of baseline data to describe the existing environment, assess impacts, and provide the basis for future monitoring programs. An understanding of fish utilization at the inlets and outlets of the proposed LMBOC and LSMOC will be required to support the environmental assessment and licence applications required for the Project. This report provides a summary of methods and results for field investigations conducted during spring and fall 2018 to provide baseline information describing fish distribution, movements, and biological activity (emphasis on spawning) at the proposed LSMOC inlet in the north basin of Lake St. Martin inlet and outlet of the LSMOC in Sturgeon Bay.

Field programs were conducted in Lake St. Martin and Sturgeon Bay from May 15 to June 8 and October 12-27 during 2018. A suite of fisheries sampling techniques were used to document fish use of habitat occurring at the proposed LSMOC inlet and outlet locations. Egg mats were used to try and collect fish eggs from spring and fall spawning species, larval fish were collected during spring using a neuston sampler, and experimental gillnets were used during spring and fall to locate concentrations of spawning fish.

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1.0 INTRODUCTION

Widespread record flooding throughout southern Manitoba during 2011 led to water levels in Lake Manitoba and Lake St. Martin that were several feet higher than desirable, resulting in significant damage to hundreds of properties, restricted road access to several communities, and long-term evacuation of four First Nations communities in the vicinity of Lake St. Martin. Heavy precipitation during winter 2013/2014 and spring 2014 again elevated water levels in Lake Manitoba and Lake St. Martin, resulting in a second flood event in areas around Lake Manitoba and Lake St. Martin.

The 2011 and 2014 flood events emphasized the need for better water level regulation on Lake Manitoba and Lake St. Martin. Consequently, the Province of Manitoba has committed to enhancing the outlet capacities to better regulate water levels on both lakes and improve flood protection for the people of Manitoba. The Lake Manitoba and Lake St. Martin Outlet Channel Project (the Project) was initiated subsequent to the 2011 flood event and, to date, has included a feasibility assessment, analysis of alternate routes, and the preliminary engineering to construct a diversion channel between Lake Manitoba and Lake St. Martin and a second channel from Lake St. Martin to Lake Winnipeg (Figure 1).

The Lake Manitoba Outlet Channel (LMBOC) will work with the existing Fairford River Water Control Structure to help regulate water levels and mitigate flooding on Lake Manitoba. The Lake St. Martin Outlet Channel (LSMOC) will also provide flood protection by mitigating increased inflows from operation of the Fairford River Water Control Structure, as well as additional inflows from the planned outlet from Lake Manitoba. Together, the two proposed channels will also assist in mitigating the adverse effects related to operation of the existing flood protection structure in Manitoba (Figure 2).

The Project will require an environmental assessment pursuant to *The Environment Act* and *CEAA 2012*, and will also need regulatory approvals pursuant to the *Fisheries Act* and the *Navigation Protection Act*. The environmental assessment process is underway for the Project, and is being led by Manitoba Infrastructure (MI). North/South Consultants Inc. (NSC) has been contracted by MI to provide technical expertise and collect baseline data to describe the existing environment, assess impacts, and provide the basis for future monitoring programs.

An understanding of fish utilization at the inlets and outlets of the proposed LMBOC and LSMOC will be required to support the environmental assessment and licence applications required for the Project. Fisheries investigations have previously been conducted at the proposed inlet and outlet for the LMBOC (AEE Technical Services 2016) but dedicated studies at the LSMOC inlet and outlet have not been conducted. This report provides a summary of methods and results for field investigations conducted during spring and fall 2018 to provide baseline information describing fish distribution, movements, and biological activity (emphasis on spawning) at the proposed LSMOC inlet in the north basin of Lake St. Martin and the LSMOC outlet in Sturgeon Bay (Figure 1). It is anticipated that the information presented here will assist in the preparation of the Project environmental assessment as well as applications for Project licencing.

2.0 METHODS

2.1 STUDY TIMING

The nature of the study objectives and the timing of the biological activities to be documented dictated that field investigations be conducted at specific times during spring and fall. For example, during spring, larval Lake Whitefish (*Coregonus clupeaformis*) hatch shortly after ice off, adult Walleye (*Sander vitreus*) move to spawning areas and begin to spawn concurrently or shortly thereafter, and larval Walleye hatch about 2-3 weeks after spawning occurs. During fall, Lake Whitefish and Cisco (*Coregonus artedi*) begin to congregate prior to spawning as temperatures decrease below about 8°C, with actual spawning occurring at temperatures ranging from 0-5°C. Consequently, a series of short-duration field campaigns (sampling periods) were conducted during each season, which provided snapshots of biological activity over a broader time period and allowed field investigations to target specific biological occurrences, as well as document general spring and fall fish activity and habitat use.

Spring investigations were initiated shortly after ice break up on Lake St. Martin and Sturgeon Bay and continued into early June to ensure that spawning activities by spring spawning fish species were complete. Previous fall spawning investigations have shown that Lake Whitefish spawning occurs at the beginning of November in the Dauphin River/Sturgeon Bay area (NSC 2016). Consequently, fall investigations were initiated in mid-October and continued until ice formation at the end of the month.

2.2 STUDY DESIGN

Field activities focused on two study areas during spring and fall sampling programs. These included:

- Lake St. Martin, within which sampling focussed on three locations including the entrance to the Dauphin River, the constriction between the two basins of Lake St. Martin (the Narrows), and near the proposed entrance (inlet) to the LSMOC; and
- Nearshore areas of southern Sturgeon Bay to the east of Willow Point and centered around the outlet for the proposed LSMOC.

In general, field activities were conducted to document the occurrence and timing of fish spawning activity, the occurrence, distribution and abundance of fish eggs and larvae, and the occurrence, distribution and abundance of adult fish and their status with respect to spawning activity. Several fisheries sampling methods were used to collect information or document conditions to address specific aspects of the study objectives.

In Lake St. Martin, field investigations included the following:

- Deployment of a temperature logger near the inlet to the LSMOC during the open-water season to document water temperatures during spawning periods;
- Installation of egg mats in the immediate vicinity of the LSMOC inlet during spring and fall to collect fish eggs and document fish spawning activity in that area;

- Sampling with a neuston sampler during spring to determine the presence and abundance of larval Lake Whitefish and other species in Lake St. Martin (*i.e.*, help determine the success of the previous fall's Lake Whitefish spawn); and,
- Sampling with experimental gill nets in the north basin of Lake St, Martin during spring and fall to locate spawning aggregations of large-bodied fish.

In Sturgeon Bay, field investigations included the following:

- Deployment of a temperature logger near the LSMOC outlet during the open-water season to document water temperatures during spawning periods;
- Installation of egg mats during spring and fall in the immediate vicinity of the LSMOC outlet to capture fish eggs and identify spawning locations for spring and fall spawning fish;
- Sampling with neuston tows to determine the presence and abundance of larval Lake Whitefish, Walleye, and other species in nearshore areas (*i.e.*, help determine the success of the fall Lake Whitefish spawn and spring Walleye spawn); and,
- Sampling with experimental gill nets to locate spawning aggregations of large-bodied fish.

2.3 FIELD METHODS

Adult fish utilization and spawning studies have previously been conducted in Lake St. Martin and Sturgeon Bay as part of the Lake St. Martin Emergency Relief Outlet Channel Project (LSMEOCP) monitoring program (NSC 2016). All sampling equipment and methods used in this study were the same as those used during the LSMEOCP to allow for comparison with previous years' data.

2.3.1 Water Temperature

Water temperature was recorded using Onset HOBO Water Temperature Pro v2 loggers (Model U22-001). Loggers were deployed into Lake St. Martin and Sturgeon Bay during the first field campaign of 2018 and were retrieved during fall. While deployed, temperature loggers were operated continuously and were programmed to record water temperature at 15 minute intervals. Logger locations were recorded with a hand-held Global Positioning System (GPS) unit and deployment retrieval dates and times were noted.

2.3.2 Spawning Activity

2.3.2.1 Fish Eggs

Egg mats have frequently been used to collect fish eggs in order to determine spawning habitat preferences and delineate spawning locations (La Haye et al. 2003; Manny et al. 2007; McDougall and MacDonell 2009; Thompson 2009). Egg mats are set in or immediately downstream of areas where spawning is thought to occur; as eggs settle onto the substrate or are stirred up from the river bottom they adhere to the filter material of the egg mat. Egg mats used in this study were comparable to those used during monitoring associated with the LSMEOCP (NSC 2016) and with Walleye and Lake Sturgeon (*Acipenser fulvescens*) spawning investigations at other locations (Manny et al. 2007; Thompson 2009).

Egg mats consisted of 39 x 19 x 9 cm cinder blocks wrapped with air filter material (latex-coated horse hair or fiberglass). The filter material was held in place against the cinder block with bungee cords. Egg mats were deployed by attaching a float and line to the cinder block and lowering the egg mat to the lake bottom. Date, time and, UTM coordinates were recorded for every egg mat that was set.

Location and timing of egg mat deployment was based upon proximity to the LSMOC inlet and outlet, knowledge of local habitat conditions (NSC 2017), and knowledge of the spawning biology of fish species occurring in Lake St. Martin and Sturgeon Bay (NSC 2016). For each egg mat deployed, set location was determined with a hand-held GPS and deployment, set date and time were recorded, and water depth and substrate conditions were noted. In general, egg mats were set during the first field trip of the season and retrieved in the subsequent trip. If a third trip was planned, egg mats were re-set at the same location after the second trip and retrieved in the third trip.

When egg mats were sampled, the filter material was removed and placed into an individually labelled bag. A clean filter was re-attached to the cinder block prior to the egg mat being re-deployed. Retrieved filter materials and contents were kept cool until they were examined for the presence of fish eggs in the NSC laboratory in Winnipeg. Recovered eggs were preserved in 10% formalin for subsequent enumeration and taxonomic identification.

2.3.2.2 Larval Fish

Sampling for larval fish was conducted using a neuston sampler. Neuston samplers are towed behind and to the side of a boat in order to filter organisms from surface waters undisturbed by the boat's propeller and wake. The sampler consists of an aluminum box with a 45 x 45 cm mouth opening equipped with a screen bag and removable cod end constructed of 500 µm Nitex® (Mason and Phillips 1986). During operation, the sampler and tow speed are adjusted so that approximately 30 cm of the mouth opening is submerged and the top of the box is oriented parallel to the surface of the water. Wings on either side of the box and a depressor plate on the bottom of the box control sampler elevation within the water column. Preferred boat speed is 4–6 knots (7–11 km/hr; Mason and Phillips 1986).

Neuston tows were approximately 20 minutes in duration. Start location and end point were recorded with a hand-held GPS. The GPS also provided a track log illustrating the route over which the tow occurred. A General Oceanics (GO) flow meter mounted in the mouth opening of the aluminum box collected data to estimate the volume of water filtered and provide a means of standardizing CPUE. Readings from the GO flow meter were recorded at the beginning and end of each tow. At the completion of each tow, cod end contents were transferred into labelled sampling jars and preserved with 10% formalin for subsequent identification in the NSC laboratory.

2.3.3 Adult Fish Utilization

2.3.3.1 Experimental Gill Nets

Experimental gill nets were set with the intention of identifying fish concentrations indicative of spawning aggregations in the vicinity of the LSMOC inlet (Lake St Martin) and outlet (Sturgeon Bay). In general, net sets were of short duration (less than 2 hours) to minimize fish mortality.

Experimental gill nets were 137.2 m long and consisted of six 22.9 m long by 1.8 m deep panels of 1.5, 2.0, and 3.0 inch stretched twisted nylon mesh and 3.75, 4.25, and 5.0 inch stretched twisted monofilament mesh. Net location, set date and time, and retrieval date and time were recorded along with additional information including water depth, water temperature, and weather conditions.

All fish captured were enumerated by species and sampling location. Each fish (mortalities and live releases) was measured for fork length (± 1 mm) and round weight (± 25 g). All species were examined to determine sexual maturity during either spring or fall by gently applying pressure on the abdomen to try and extrude gametes (*i.e.*, eggs or sperm). All live fish were released following sampling. The gonads of fish that died while in the gill nets were examined internally to determine spawning status. The following sexual maturity codes were used:

Females (F)	Males (M)
2 - maturing to spawn (early pre-spawn)	7 - maturing to spawn (early pre-spawn)
3 - ripe (immediate pre-spawn)	8 – ripe (immediate pre-spawn)
4 - spent (post-spawn)	9 - spent (post-spawn)

Individually numbered Floy® tags were applied to Lake Whitefish captured during fall in Lake St. Martin and Sturgeon Bay. Whitefish are of importance to the Lake St. Martin and Sturgeon Bay commercial fisheries and are known to make large seasonal movements between waterbodies in the area. Additional information describing the timing and patterns of their movements that may be derived from recapturing marked fish may be of value in assessing potential effects related to development of the LMBLSMOC Project.

After whitefish had been measured and examined for sex and state of maturity, individually numbered Floy® FD-94 T-bar Anchor tags were applied to fish deemed to be in good condition and which were greater than 200 mm in length. Tags were inserted below the posterior half of the dorsal fin and anchored between the basal pterygiophores.

2.3.3.2 Hoop Nets

Hoop nets were set in Bear Creek during spring to document movements into and out of the creek by adult fish. The hoop nets were constructed of 6.45 cm^2 nylon mesh with openings measuring 1.2 m in diameter and had wings of variable length. Nets remained in the water continuously through the study period and were checked once daily.

All fish captured were enumerated by species and direction of movement. Each fish was measured for fork length (± 1 mm) and round weight (± 25 g) and examined to determine sexual maturity by gently applying pressure on the abdomen to try and extrude gametes (*i.e.*, eggs or sperm). All live fish were released following sampling.

2.4 DATA ANALYSIS

2.4.1 Water Temperature

Daily mean water temperature was calculated and plotted to illustrate daily changes throughout the monitoring period.

2.4.2 Spawning Activity

2.4.2.1 Fish Eggs

Eggs collected from egg mats were enumerated and tabulated by sampling location and, if possible, by fish species.

2.4.2.2 Larval Fish

All fish were identified to the lowest taxon possible, enumerated, and tabulated by taxon. The volume of water filtered during each tow was calculated by first subtracting the GO flow meter reading recorded at the end of each tow from the reading recorded at the start. This difference was then multiplied by a correction factor unique to the specific GO meter to obtain the distance traveled. Finally, the distance traveled was multiplied by the dimensions of the submerged portion of the neuston sampler (30 x 45 cm) to obtain volume of water sampled. Catch-per-unit-effort was calculated for each tow as the number of fish captured per 100 m^3 of water filtered by the neuston. Track logs of the tows were plotted to show the area sampled.

2.4.3 Adult Fish Utilization

The gillnetting catch was tabulated by species, sampling season and waterbody to allow for comparison between seasons, waterbodies and with previous years data. The frequency of occurrence of each species was calculated as a percentage of the total catch. Catch-per-unit-effort (CPUE) was calculated for the overall catch and by species and site as the number of fish caught per 100 m gillnet gang per hour as follows:

$$CPUE = ((Cx/E)/1.371)$$

Where:

Cx is the total number of fish caught of species x, E is the duration of the net set in hours, and 1.371 is a coefficient to standardize a 137.1 m net to 100 m. Total mean CPUE was calculated by averaging CPUE values from individual net sets.

Mean fork length (mm), weight (g), and condition factor (K) were calculated for each species. Condition factor was calculated for fish where fork length and round weight were measured, using the following formula (after Fulton 1911, in Ricker 1975):

$$K = \text{round weight (g)} \times 10^5/(\text{fork length})^3$$

Length-frequency distributions were typically plotted for each species where $n \geq 12$ fish. Length intervals of 25 mm were used for most species (*e.g.*, 225–249 mm). A 50 mm interval was used for Northern Pike (*Esox lucius*) and a 10 mm interval was used for Yellow Perch (*Perca flavescens*).

3.0 RESULTS

3.1 LAKE ST MARTIN

Ice began to break on Lake St. Martin in mid-April, but the occurrence of fast ice prevented access to the vicinity of the LSMOC inlet until May 8 or 9. Spring field investigations were conducted from May 15 to June 8 during 2018. The spring program included two primary campaigns of three (May 15-17) and two days (June 7-8) duration, respectively, during which most sampling occurred. A third, single day trip (May 30) was also undertaken to remove egg mats. Low water level on Lake St. Martin during the second primary sampling period (hereafter referred to as the second sampling period) precluded safe boat access to the Narrows and, consequently, sampling effort was restricted to areas near the Dauphin River inlet and the LSMOC inlet. Fall field investigations were hampered substantially by unseasonably cold weather and consequent ice formation on Lake St. Martin. The occurrence of thick ice (7-8 cm) along the shore of Lake St. Martin prevented access to the lake on October 18, but air temperature on subsequent days was sufficiently warm for the ice to melt, allowing for a field campaign to be conducted on October 25 and 26.

3.1.1 Water Temperature

Water temperature was approximately 11°C at the onset of the spring monitoring program and was 18°C when spring sampling ended on June 8 (Figure 3). During the sampling period, water temperature increased rapidly to 21°C by the end of May, but cooled again to 15°C in early June (Figure 3).

During fall 2018, water temperature declined rapidly from 10°C on September 18 to less than 1°C by October 15 (Figure 3). Water temperature increased slightly after October 15 and ranged from 2.0-4.5°C during the fall sampling program on October 25-26 (Figure 3).

3.1.2 Spawning Activity

3.1.2.1 Fish Eggs

A total of 20 egg mats were deployed in Lake St. Martin during spring 2018 (Table 1). All were deployed on May 15 in the immediate vicinity of the LSMOC inlet (Figure 4). Water depths at sampling sites ranging from 0.8-1.4 m and substrates ranged from softly compacted sand and gravels to hard compaction cobbles and boulders (Table 1).

Egg mats were retrieved on May 30, 15 days after being deployed. Nineteen of the 20 egg mats set were successfully retrieved; EM-16 could not be re-located and it is assumed that the float became detached or was sunk during a storm event. No fish eggs were recovered from any of the egg mats (Table 1).

3.1.2.2 Larval Fish

A total of 13 neuston tows were conducted on the north basin of Lake St. Martin, nine of which occurred during the first sampling period and three of which occurred during the second sampling period (Table

2). A total of 1,612 larval fish were captured, (Table 3), resulting in an overall mean CPUE of 54.68 (SD ± 94.18) larval fish/100 m^3 (Table 4).

During the first sampling session, sampling effort was distributed equally between the inlet to the Dauphin River, the Narrows, and the immediate vicinity of the LSMOC inlet (Figure 5). A total of 203 larval fish were captured, comprised exclusively of larval Lake Whitefish and Cisco (Table 3). Mean CPUE for the larval fish catch during the first sampling session was 10.28 (SD ± 9.73) fish/100 m^3 (Table 4). Of note, all the larval fish were captured in tows conducted near the inlet to the LSMOC or the inlet to the Dauphin River. No larval whitefish or Cisco were captured in the vicinity of the Narrows, an area long identified as an important spawning area for Lake Whitefish.

Considerably more larval fish were captured during the second sampling period. Although sampling effort was restricted to four neuston tows near the Dauphin River inlet (two tows) and the LSMOC inlet (two tows; Figure 5), 1,409 larval fish were captured (Table 3). The majority of the captured larval fish were Yellow Perch (95%). An additional 2.3% of the catch was comprised of unidentified percid larvae (Table 3). These were believed to have also been perch, but the specimens were too deteriorated to positively identify them to species. The remainder of the catch was comprised of a small number of catostomid larvae (suckers; n = 6; 0.4%), cyprinid larvae (minnow; n = 5; 0.4%), and unidentified larvae (n = 22; 1.6%; Table 3). Lake Whitefish and Cisco, which comprised 100% of the larval fish catch during the first sampling period, were absent from the larval fish catch during the second sampling session. Mean CPUE for the larval fish catch during the second sampling session was 154.58 (SD ± 126.51) fish/100 m^3 of surface water sampled (Table 4).

3.1.3 Adult Fish Utilization

3.1.3.1 Spring

Fishing Effort and Catch

A total of 12 experimental gill nets were set in Lake St. Martin during spring 2018, seven of which were set in the first sampling period and five were set during the second (Table 6). Nets were set in water ranging from 0.9-2.2 m deep, and generally were left in the water for about two hours (Table 6). A total of 384 fish were captured, 92.4% of which were White Sucker (*Catostomus commersoni*; 46.9%), Yellow Perch (17.4%), Northern Pike (12.0%), Shorthead Redhorse (*Moxostoma macrolepidotum*; 8.3%) and Longnose Sucker (*C. catostomus*; 7.8%). Mean CPUE for the total spring catch was 15.23 (SD ± 8.38) fish /100m/hr (Table 7).

Sampling effort was divided between the Narrows (two net sets), the Dauphin River Inlet (two net sets) and near the LSMOC inlet (three net sets; Figure 6) during the first sampling period. A total of 231 fish were captured, a large portion of which were White Sucker (59.3%), Longnose Sucker (13.0%) and Northern Pike (12.6%; Table 6), all species that spawn in early spring (Scott and Crossman 1998; Stewart and Watkinson 2004). Disproportionately fewer fish were captured in nets set in the Narrows compared to the other two areas (Table 6). White Sucker, in particular, comprised a larger portion of the catch at the Dauphin River inlet and near the LSMOC inlet compared to the Narrows (Table 6; Figure 6). Mean CPUE for the first sampling session was 16.26 (SD ± 9.02) fish /100m/hr (Table 7).

During the second sampling period, gillnetting effort was restricted to near the Dauphin River (three net sets) and LSMOC (two sets) inlets (Table 6; Figure 6). A total of 153 fish were captured. The majority of the catch was comprised of Yellow Perch (32.7%), White Sucker (28.1%), Shorthead Redhorse (15.7%), and Northern Pike (11.1%; Table 6). Mean CPUE for the total catch during the second sampling session was 13.79 (SD ± 8.16) fish /100m/hr (Table 7).

Size, Condition, and Sexual Maturity

Only a small number of Walleye (n=5) were captured in Lake St. Martin during spring sampling. These fish ranged in length from 279-425 mm (Table 8).

Northern Pike captured in Lake St. Martin had a mean length of 499 mm and ranged in length from 153-883 mm (Table 8). The length-frequency of sampled Northern Pike had a roughly bell shaped distribution, indicating that most age groups of pike were represented in the catch (Figure 7). Young-of-the-year Northern Pike, which generally reach about 150 mm in their first year (Scott and Crossman 1998), were not represented. Modal length interval was 400-449 mm (Figure 7). The mean size and size range of pike captured in this study were comparable to those captured in previous spring investigations at Lake St. Martin (NSC 2016). Sex and maturity were determined for two pike during this study. Both were male fish in an early pre-spawn condition captured during the first sampling period.

In contrast to Northern Pike, the spring Lake Whitefish catch was comprised exclusively of large adult fish ranging in length from 383-440 mm (Table 8). Mean length of the whitefish catch was 409 mm (Table 8) and the modal length interval was 400-424 mm (Figure 8). Surveys conducted from 2012-2015 also captured exclusively large adult Lake Whitefish during spring (NSC 2016).

White Sucker and Shorthead Redhorse had mean lengths of 396 and 371 mm, respectively (Table 8). Length-frequencies for both species were bi-modal in distribution and were comprised of a small group (less than 10% of the catch) of young fish ranging in length from 125-275 mm and a much larger group of adult fish (more than 90% of the catch) ranging from 275-525 mm in length (Figures 9 and 10). In general, White Sucker and Shorthead Redhorse catches from previous spring investigations at Lake St. Martin generally contained few smaller fish and were comprised mostly of large adult fish (NSC 2016), consistent with results observed here.

Sex and maturity were determined for 115 White Sucker captured during the first sampling session (Table 9). These included 40 female fish, 78% of which were in an early pre-spawn condition and 22% of which were on the verge of spawning. In contrast to the females, 81% of the 75 males for which sex and maturity were determined were on the verge of spawning and only 19% were in an early pre-spawn condition. Water temperature at the time was approximately 11°C, conditions generally supportive of spawning by suckers (Scott and Crossman 1998; Stewart and Watkinson 2004). Sex and maturity were determined for only a small number of White Sucker captured during the second sampling session, and included three females in an immediate pre-spawn condition and two males in a post-spawn condition

(Table 9). Taken together, these results indicate that White Sucker spawning would have occurred shortly after the first sampling period. White Sucker in pre-spawn condition were captured in all nets set near the Dauphin River inlet and the LSMOC inlet, suggesting that spawning locations may be widespread across the northern part of Lake St. Martin.

Longnose Sucker captured in Lake St. Martin had a mean length of 513 mm and, unlike White Sucker and Shorthead Redhorse, included only large adult fish (Table 8). Lengths ranged from 381-595 mm and 50% of the Longnose Sucker catch was comprised of fish 525-574 mm in length (Figure 11). Similar size composition for Longnose Sucker spring catches have previously been reported from Lake St. Martin (NSC 2016). Sex and state of maturity were determined for 17 Longnose Sucker in this study, seven of which were females and 10 of which were males (Table 9). All were in an early or immediate pre-spawn condition, suggesting that spawning would have occurred shortly after the first sampling session.

Yellow Perch captured in Lake St. Martin had a mean length of 140 mm and ranged in length from 118-227 mm (Table 8). The modal the length interval was 130-139 mm (Figure 12). Sex and maturity were determined for five perch, all of which were males in early or immediate pre-spawn condition (Table 9). Yellow Perch spawn during spring at water temperatures of 7-12^{o}C (Scott and Crossman1998; Stewart and Watkinson 2004).

3.1.3.2 Fall

Fishing Effort and Catch

A total of seven experimental gill nets were set in Lake St. Martin during a single sampling session conducted on October 25 and 26 (Table 10; Figure 13). Accessibility to the lake was hampered by inclement weather conditions, resulting in reduced sampling effort. Two nets were set at the Narrows on October 25 when high winds prevented access to the north portion of the lake. An additional five nets were set near the LSMOC inlet on October 26 (Figure 13). Nets were set in water ranging from 1.2-2.3 m deep, and were left in the water for approximately two hours (Table 10). Water temperature was 3^{o}C at the time of sampling (Table 10; Figure 3). A total of 180 fish were captured, 63.3% of which were Lake Whitefish and 16.1% were Cisco (Table 11). Small numbers of Walleye, Northern Pike, White Sucker and Yellow Perch comprised the remainder of the catch (Table 11). Mean CPUE for the fall catch was 10.27 (SD ± 5.69) fish /100m/hr (Table 12).

Size, Condition, and Sexual Maturity

As during spring, only a small number of Walleye (n=3) were captured in Lake St. Martin during fall. These fish ranged from 310-460 mm in length (Table 13). Similarly, only a small number (n=10) of Northern Pike were captured during fall. These fish had a mean length of 512 mm and ranged from 220-915 mm in length (Table 13). The modal length interval for the pike catch was 550-549 mm (Figure 7).

As was observed during spring, the fall Lake Whitefish catch was comprised exclusively of larger adult fish. Mean length was 427 mm (Table 13) and 73.7% of the catch was comprised of whitefish that were 400-449 mm in length (Figure 8). Sex and maturity were determined for 62 Lake Whitefish. All of the males (n = 13) and 45 of 49 females were in an early pre-spawn condition, three females were in an immediate pre-spawn condition, and one female had completed spawning (Table 14). The capture of pre-spawning Lake Whitefish at the Narrows was expected, as the area is well known as a whitefish spawning area. However, the abundance of whitefish in pre-spawning condition captured near the LSMOC inlet was unexpected and suggests that spawning may also occur in that vicinity. The lone whitefish in post-spawning condition was also captured near the inlet, further indicating that spawning may occur in the area.

Cisco captured in fall had a mean length of 287 mm, ranged in length from 135-333 mm, and had a modal length interval of 300-324 mm (Table 13; Figure 14). Sex and maturity were determined for 24 male and one female Cisco, most of which (88%) were in an early pre-spawn condition (Table 14). The remaining fish were comprised of males that were in an immediate pre-spawn condition. All but two Cisco were captured in nets set in the Narrows (Table 10; Figure 13), suggesting that the species does not spawn in the vicinity of the LSMOC. The extent to which spawning by Cisco may occur in other areas of the Lake St. Martin north basin has not been determined.

Yellow Perch captured in Lake St. Martin during fall had a mean length of 146 mm and ranged in length from 125-182 mm (Table 13). The length frequency distribution for the fall Yellow Perch catch is provided in Figure 12.

Fish Tagging

Individually numbered Floy® tags were applied to 61 Lake Whitefish captured in Lake St. Martin during fall 2018. Biological and capture data for these fish are provided in Table 15. No fish tagged during previous fisheries investigations in Lake St. Martin or surrounding waterbodies were recaptured in 2018.

3.2 BEAR CREEK

Bear Creek is a tributary entering the north basin of Lake St. Martin to the south of the LSMOC inlet and has historically been known to support spawning by suckers, among other fish species (K. Einarson, *pers comm* 2018). Hoop nets were set to capture upstream and downstream moving fish in Bear Creek at a location approximately 0.5 km inland of Lake St. Martin (NAD83 14U, 555316699E and 5734736N). Approximately 75% of the channel was blocked by the hoopnet wings. Nets were deployed on May 15 and remained in the water until May 17. Water temperature fluctuated from 9 to 12.5^{o}C during this period.

Only two fish were captured, including an adult White Sucker (fork length = 490 mm; weight = 2140 g) moving upstream on May 16, and a small (fork length ≈ 300 mm) Northern Pike moving upstream on May 17. The White Sucker was a female that had not yet spawned and presumably was moving up Bear Creek to spawn. It could not be determined whether the pike had/would have spawned in spring 2018.

It was anticipated that a larger number of fish moving into the creek would have been captured. Water temperature in the creek was at or above that at which spawning occurs for many spring spawning species (Scott and Crossman 1998; Stewart and Watkinson 2004), and it is possible that more fish had entered the creek prior to the study and remained in the creek until after the hoop nets were removed.

3.3 STURGEON BAY

Ice break-up on Sturgeon Bay was abrupt during spring 2018. The bay remained ice covered until May 16 but the entire southern and eastern portion of the bay was largely ice free by May 18. Spring field investigations were conducted from May 23 to June 8 during 2018. The spring program included two campaigns of three days (May 23-25) and one day (June 8) in duration, respectively. During fall, field investigations were hampered by high wind conditions. Sampling occurred on October 12, 16-17 and 27. For analytical purposes, data collected during October 12-17 were considered as one sampling session and data collected on October 27 was considered as second sampling session.

3.3.1 Water Temperature

Water temperature was 12^{o}C at the onset of the spring monitoring program and was 17^{o}C when spring sampling ended on June 8 (Figure 15). As observed in Lake St. Martin, water temperature in Sturgeon Bay declined rapidly from 10^{o}C on September 18 to less than 1^{o}C by October 15 (Figure 15). Water temperature increased slightly after October 15 and ranged from 0.6-3.7^{o}C during the remainder of the fall sampling program (Figure 15).

3.3.2 Spawning Activity

3.3.2.1 Fish Eggs

A total of 19 egg mats were deployed in Sturgeon Bay during spring 2018 (Table 16). All were deployed on May 25 at locations to the east and south of Willow Point and in the immediate vicinity of the LSMOC outlet (Figure 16). Water depths at sampling sites ranging from 0.7-2.7 m and substrates ranged from softly compacted sand to hard compaction cobbles and boulders (Table 16).

Egg mats were retrieved on June 8, 13 days after being deployed. Ten of the 19 egg mats set were successfully retrieved. The remainder of the egg mats could not be re-located and it is assumed that the float marking the mat location became detached from the mat or was sunk during a storm event. No fish eggs were recovered from any of the retrieved egg mats (Table 16).

An additional 20 egg mats were deployed in Sturgeon Bay during fall. All were deployed on October 12 at locations comparable to those used in spring (Figure 17). Water depths at sampling sites ranged from 1.3-2.8 m (Table 17). Substrate conditions were not noted. Egg mats were retrieved on October 27, 15 days after being deployed. All 20 of the egg mats that were set were successfully retrieved, but no fish eggs were recovered (Table 17).

3.3.2.2 Larval Fish

A total of 16 neuston tows were conducted in Sturgeon Bay, 13 of which occurred during the first sampling period and three of which occurred during the second (Table 18). A total of 10,017 larval fish were captured, representing at least five species or taxonomic groups (Table 19). Mean CPUE for the total catch was 283.80 (SD ± 616.13) larval fish/100 m^3 of surface water sampled (Table 20).

During the first sampling session, sampling effort was focussed largely upon nearshore areas of southern Sturgeon Bay, extending from Willow Point eastward and north past the Mantagao River (Figure 18). A single tow was conducted at the mouth of the Dauphin River (NT-08) to determine whether larval fish were drifting into Sturgeon Bay from the river, and two tows were conducted within the Mantagao River (NT-09, NT-10) to determine if larval fish occurred there (Table 19, Figure 18).

A total of 660 larval fish were captured during the first sampling session (Table 19). The majority of the catch (94.7%) was comprised of larval Lake Whitefish or Cisco (88.2% and 6.5%, respectively; Table 3). The remainder was comprised of Yellow Perch (3.0%), catostomids (suckers; 1.2%) and other larvae for which taxonomic group could not identified (1.1%; Table 19). Mean CPUE for the larval fish catch during the first sampling session was 22.40 (SD ± 25.72) fish/100 m^3 (Table 4). Larval Lake Whitefish were captured in all neuston tows except for the upstream most tow conducted in the Mantagao River (NT-10; Table 19; Figure 18). Previous fisheries investigations have shown that the larval whitefish are generally distributed throughout the nearshore areas of southern Sturgeon Bay and originate from known spawning locations in the Dauphin River mainstem and upstream waterbodies including Lake St. Martin, as well as from spawning locations occurring in Sturgeon Bay as indicated by local knowledge (NSC 2016). The capture of larval Lake Whitefish within the Mantagao River has not previously been reported, but suggests that Lake Whitefish spawn in that river system. The extent to which this occurs is not known.

Considerably more larval fish were captured during the second sampling period. Although sampling effort was restricted to three neuston tows conducted in the immediate vicinity of the LSMOC outlet (Figure 18), 9,357 larval fish were captured (Table 19). The catch was comprised almost entirely of larval catostomids (suckers; 76.3%) and unidentified percid larvae (23.7%). A single larval Lake Whitefish was also captured. Larval percids were examined in detail but could not be accurately identified to species. Use of morphometric indices such as myomere counts as well as dentition structure indicated that the larvae were not Walleye. The myomere counts for sampled larvae fell on the overlap between the range of myomeres expected for Yellow Perch and Sauger, but size of larvae and dentition were not indicative of either species. It is possible that the larvae were one of the darter species (small percids) known to occur in Lake Winnipeg (see Stewart and Watkinson 2004 for a list of darter species). Mean CPUE for the larval fish catch during the second sampling session was 1416.49 (SD ± 688.88) fish/100m^3 of surface water sampled (Table 20).

An additional 14 juvenile or adult small- and large-bodied fish were captured in the neuston tows in Sturgeon Bay. These included 11 Emerald Shiner (*Notropis atherinoides*), one Yellow Perch, and two unidentifiable fish.

3.3.3 Adult Fish Utilization

3.3.3.1 Spring

Fishing Effort and Catch

A total of 10 experimental gill nets were set in Sturgeon Bay during spring 2018, seven of which were set in the first sampling period and three during the second (Table 21). Sampling effort was focussed between Willow Point and the Mantagao River, and most nets were set in close proximity to the LSMOC outlet, although two nets were set in and or at the mouth of the Mantagao River during the first sampling period (Figure 19). Nets were set in water ranging from 0.7-3.0 m deep, and were left in the water for 1-2.5 hours (Table 21). A total of 259 fish were captured, including individuals of ten species. Approximately half of the catch (50.6%) was comprised of White Suckers (39.0%) and Shorthead Redhorse (10.8; Table 22). Northern Pike (23.9%) and Walleye (19.3 %) comprised much of the remainder of the catch. Quillback (*Carpiodes cyprinus*), Longnose Sucker, Lake Whitefish, Sauger (*Sander canadensis*), Yellow Perch, and Freshwater Drum (*Aplodinotus grunniens*) all comprised small proportions of the spring catch. Mean CPUE for the spring catch was 9.98 (SD ± 8.13 fish /100m/hr (Table 23).

The majority (86.1%) of fish captured during spring were captured in the first sampling session (Table 22). White Sucker (42.6%), Northern Pike (27.4%), Walleye (14.3%) and Shorthead Redhorse (8.5%) comprised most of the catch (Table 22). The remainder of the catch (7.2%) was comprised of Quillback, Longnose Sucker, Lake Whitefish, Sauger, and Yellow Perch (Table 22). Mean CPUE for the first sampling session was 11.00 (SD ± 9.44) fish /100m/hr (Table 23). In general, catch composition was similar among sampling locations. However, considerably more Northern Pike were captured from a net set near the mouth of the Mantagao River (GN-04; Table 22, Figure 19). It is possible that these fish were leaving the Mantagao following spawning, or were feeding on other fish concentrating at the river mouth.

During the second sampling period, 36 fish were captured in three nets set in the immediate vicinity of the LSMOC outlet (Table 22, Figure 19). Walleye (50.0%), Shorthead Redhorse (25.0%) and White Sucker (16.7%) comprised the majority (91.7%) of the catch (Table 22). Mean CPUE for the total catch during the second sampling session was 9.98 (SD ± 8.13) fish /100m/hr (Table 23).

Size, Condition, and Sexual Maturity

Walleye captured in Sturgeon Bay during spring had a mean length of 372 mm and ranged in length from 234-578 mm (Table 24). The length-frequency distribution of captured Walleye was roughly bell shaped, indicating that most, except the youngest, age groups of Walleye were represented in the catch (Figure 20). Modal length interval was 350-374 mm (Figure 20). The mean size and size range of Walleye captured in this study were comparable to those captured in previous spring investigations on Sturgeon Bay (NSC 2016). Sex and state of maturity were determined for five Walleye captured during the first sampling period. All were males and included two fish in early pre-spawn condition, one in an immediate pre-spawn state, and two that had already spawned (Table 25). Sexual maturity was determined for only one Walleye during the second sampling period - a male that had completed spawning (Table 25).

Similar to the Walleye catch, a broad size range representing most age groups of Northern Pike were captured during the spring. Pike had a mean length of 593 mm and ranged in length from 278-935 mm (Table 24). The length-frequency distribution of captured Northern Pike was bell shaped, and had a modal length interval of 500-549 mm (Figure 21). The mean size and size range of pike captured in this study were comparable to those captured in previous spring investigations in Sturgeon Bay (NSC 2016). Sex and state of maturity were determined for 11 pike captured during the first sampling session. Six of those fish (two female and four males) were in a pre-spawn condition and five (four females and one male) had completed spawning at the time of capture (Table 25).

White Sucker captured in Sturgeon Bay had a mean length of 393 mm and ranged from 150-520 mm in length (Table 24). The length-frequency distribution for White Sucker was bi-modal and comprised of a small group (12% of the catch) of young fish ranging from 150-275 mm in length and a much larger group of adult fish (88% of the catch) ranging from 300-525 mm in length (Figure 22).

Sex and maturity were determined for 53 White Sucker captured during the first sampling session (Table 25). These included 21 female fish, 38.1% of which were in an early pre-spawn condition, 42.9% of which were on the verge of spawning, and 19.0% of which had completed spawning. Similarly, 56.2% of the 32 males examined were in an early pre-spawn condition, 34.4% were on the verge of spawning, and 9.4% had completed spawning. Sex and maturity was not determined for any White Suckers captured during the second sampling session (Table 25). Although some spawning White Suckers were captured in most nets set between Willow Point and the Mantagao River, the largest aggregation (58% of suckers for which sex and maturity were determined) was captured at GN-06, a net that was set just to the south of Willow Point (Figure 19) in an area of gravel, cobble, and boulder substrates. The capture of large numbers of pre-spawning and post-spawning fish at this location suggests that spawning occurred in the immediate vicinity.

A broad size range of Shorthead Redhorse were captured during spring, ranging from juvenile fish 157 mm in length to adults up to 382 mm in length. Mean length for captured fish was 272 mm (Table 25). The length-frequency distribution for the catch is provided in Figure 23. Sex and state of maturity could not be determined for any of the captured redhorse.

3.3.3.2 Fall

Fishing Effort and Catch

Two sampling sessions were conducted at Sturgeon Bay during fall 2018. Seven experimental gill nets were set in total, five of which were set in the first sampling period and two during the second (Table 26). As during spring, sampling effort was focussed between Willow Point and the Mantagao River, and most net nets were set in close proximity to the LSMOC outlet (Figure 24). A single net was set at the mouth of the Mantagao River during the first sampling period (Figure 24). Inclement weather on October 16 prevented retrieval of two nets (GN-14 and GN-15) until the following day, resulting in set durations greater than 24 hours. All other nets were set for three hours or less (Table 26). A total of 355 fish were captured during fall. Cisco (57.2%) and Northern Pike (22.8%) comprised 80% of the catch (Table 27). White Sucker (7.9%) and Lake Whitefish (6.5%) comprised much of the remainder of the catch. Mean CPUE for the fall catch was 6.64 (SD± 4.06) fish /100m/hr (Table 28).

A total of 299 fish were captured during the first sampling session. Cisco (54.2%), Northern Pike (25.1%), Lake Whitefish (7.7%) and White Sucker (7.4%) were most abundant (Table 27). Incidental numbers of Walleye, Yellow Perch, Burbot (*Lota lota*), Shorthead Redhorse, and Sauger were also captured. Mean CPUE for the first sampling session was 5.09 (SD ± 3.28) fish /100m/hr (Table 28).

Considerably fewer fish (n = 56) were captured during the second sampling session, due to lesser sampling effort. As earlier in the fall, Cisco (73.2%), Northern Pike (10.7%), and White Sucker (10.7%) were most abundant (Table 27). Lake Whitefish, which were commonly captured during the first sampling session, were absent from the catch during the second (Table 27). Mean CPUE during the second sampling session was 10.54 (SD ± 3.66) fish /100m/hr (Table 28).

Size, Condition, and Sexual Maturity

Only a small number of Walleye (n=11) were captured in Sturgeon Bay during fall. These were primarily large fish, ranging from 370-473 mm in length and having a mean length of 414 mm (Table 29). The modal length interval for the catch was 425-474 mm (Figure 20).

Northern Pike captured in Sturgeon Bay had a mean length of 572 mm and ranged in length from 389-945 mm (Table 29). Although the mean size was similar to pike captured in spring, proportionally fewer smaller pike (<350 mm in length) and larger pike (>725 mm in length) were captured during fall (Figure 21).

As has been observed in previous fall fisheries investigations in Sturgeon Bay (NSC 2016), all Lake Whitefish captured during fall 2018 were large adult fish ranging in length from 380-453 mm (Table 29) and having a modal length interval of 400-424 mm (Figure 25). Sex and maturity were determined for 21 of the 23 fish captured. These included 14 females and seven males, all of which were in an early pre-spawn condition (Table 30).

Cisco were the most frequently captured fish during fall sampling in Sturgeon Bay. A broad size range were captured (178-368 mm in length) but the majority (82.3%) were larger adults (>275 mm in length (Figure 26). Sex and maturity were determined for 137 Cisco captured during the first sampling session. These included 45 females and 92 males in an early pre-spawn condition (Table 30). An additional 39 Cisco were examined during the second sampling session and included five females and 34 males. Two of the females and two of the males were in an immediate pre-spawn condition; the remaining fish remained in an early pre-spawn condition (Table 30).

White Sucker captured in Sturgeon Bay had a mean length of 431 mm and ranged in length from 159-511 mm in length (Table 29). Although the size range of fish captured was broad, the catch was comprised primarily of larger fish; all but one fish were 350 mm or greater in length (Figure 22).

Fish Tagging

Individually numbered Floy® tags were applied to four Lake Whitefish captured in Sturgeon Bay during fall 2018. Biological and capture data for these fish are provided in Table 31. No fish tagged during previous fisheries investigations in Sturgeon Bay or surrounding waterbodies were recaptured in 2018.

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Table 1. Location, set, and catch information for egg mats set in Lake St. Martin, spring 2018.

Site	Location [1]		Set Date	Lift Date	Duration (days)	Water Depth (m)	Substrate		Fish Eggs (n)
	Easting	Northing					Composition	Compaction	
EM-1	556438	5737929	15 May	30 May	15	1.2	Sand and gravel	Soft	0
EM-2	556369	5737920	15 May	30 May	15	1.4	Sand and gravel	Soft	0
EM-3	556318	5737878	15 May	30 May	15	1.2	Gravel	Hard	0
EM-4	556264	5737842	15 May	30 May	15	0.8	Gravel	Soft	0
EM-5	556397	5737664	15 May	30 May	15	1.2	Gravel and cobble	Hard	0
EM-6	556394	5737637	15 May	30 May	15	1.4	Gravel	Soft	0
EM-7	556362	5737590	15 May	30 May	15	1.4	Gravel and cobble	Hard	0
EM-8	556451	5737583	15 May	30 May	15	1.1	Sand and gravel	Soft	0
EM-9	556744	5736540	15 May	30 May	15	1.4	Sand and gravel	Soft	0
EM-10	556696	5736584	15 May	30 May	15	1.2	Sand and gravel	Soft	0
EM-11	556588	5736722	15 May	30 May	15	1.2	Sand and gravel	Soft	0
EM-12	556555	5736883	15 May	30 May	15	1.1	Gravel	Hard	0
EM-13	556544	5736910	15May	30 May	15	1.1	Gravel	Hard	0
EM-14	556531	5737038	15 May	30 May	15	1.2	Gravel	Hard	0
EM-15	556547	5737101	15 May	30 May	15	1.2	Gravel	Hard	0
EM-16	556535	5737225	15 May	lost	-	0.9	Gravel and boulder	Hard	-
EM-17	556509	5737275	15 May	30 May	15	0.9	Gravel and boulder	Hard	0
EM-18	556492	5737361	15 May	30 May	15	0.9	Boulder	Hard	0
EM-19	556475	5737428	15 May	30 May	15	1.1	Sand and gravel	Hard	0
EM-20	556465	5737462	15 May	30 May	15	1.1	Sand and gravel	Soft	0

1 - UTM coordinates; NAD83, Zone 14U; site locations illustrated on Figure 4

Table 2. The location, distance, duration, and volume of water filtered for neuston tows conducted in Lake St. Martin, spring 2018.

Neuston Tow	Date	Start Location [1]		End Location		Duration (minutes)	Tow Distance [2] (m)	Volume [3] (m^3)
		Easting	Northing	Easting	Northing			
Trip 1								
NT-1	16 May	547243	5740663	547096	5740337	20	1736	234
NT-2	16 May	547096	5740337	545885	5740818	12	1625	219
NT-3	16 May	545825	5740724	547228	5741737	20	1426	193
NT-4	17 May	547882	5734065	545985	5733573	20	1735	234
NT-5	17 May	546013	5733639	544982	5734347	30	1670	226
NT-6	17 May	545024	5734351	543797	5733589	20	1695	229
NT-7	17 May	555084	5738113	556343	5737303	20	1691	228
NT-8	17 May	556282	5737279	556895	5736051	20	1646	222
NT-9	17 May	556789	5736008	555333	5736678	20	1719	232
Trip 2								
NT-10	07 June	556263	5736603	555520	5737710	20	1699	229
NT-11	07 June	554838	5736573	556530	5736259	21	1762	238
NT-12	07 June	547496	5741018	546572	5741126	20	1546	209
NT-13	07 June	546544	5741292	545922	5741650	23	1579	213

1 - UTM coordinates; NAD 83 Zone 14U; neuston tow locations illustrated in Figure 5

2 - Tow distance (m) calculated as the number of flow meter revolutions x the GO flow meter constant (26873) divided by 999999

3 - Volume filtered calculated as the tow distance (m) x 0.135 m^2

Table 3. Tow- and taxon-specific summary of larval fish catches from neuston sampling in Lake St. Martin, spring 2018.

Taxon	Tow-Specific [1] Catch - Trip 1											Tow-Specific Catch - Trip 2						Spring Total	
	1	2	3	4	5	6	7	8	9	Total	RA (%) [2]	10	11	12	13	Total	RA (%)	Total	RA (%)
Cyprinids	-	-	-	-	-	-	-	-	-	0	0.0	-	1	1	4	6	0.4	6	0.4
Catostomids	-	-	-	-	-	-	-	-	-	0	0.0	-	1	1	3	5	0.4	5	0.3
Coregonines	-	-	-	-	-	1	-	-	-	1	0.5	-	-	-	-	0	0.0	1	0.1
Cisco	7	9	8	-	-	-	2	3	8	37	18.2	-	-	-	-	0	0.0	37	2.3
Lake Whitefish	30	54	25	-	-	-	11	27	18	165	81.3	-	-	-	-	0	0.0	165	10.2
Percids	-	-	-	-	-	-	-	-	-	0	0.0	-	28	4	-	32	2.3	32	2.0
Yellow Perch	-	-	-	-	-	-	-	-	-	0	0.0	742	357	128	117	1344	95.4	1344	83.4
Unidentified Larvae	-	-	-	-	-	-	-	-	-	0	0.0	16	1	1	4	22	1.6	22	1.4
Total:	37	63	33	0	0	1	13	30	26	203	100.0	758	388	135	128	1409	100.0	1612	100.0

1 - neuston tow number

2 - relative fish species abundance calculated as a percentage of the total catch

Table 4. Tow- and taxon-specific catch-per-unit-effort (CPUE; # fish/100 m^3) calculated for larval fish catches from neuston sampling in Lake St. Martin, spring 2018.

Taxon	Tow-Specific [1] CPUE - Trip 1									Mean ± SD [2]
	1	2	3	4	5	6	7	8	9	
Cyprinids	-	-	-	-	-	-	-	-	-	0
Catostomids	-	-	-	-	-	-	-	-	-	0
Coregonines	-	-	-	-	-	0.44	-	-	-	0.05 ± 0.15
Cisco	2.99	4.10	4.15	-	-	-	0.88	1.35	3.45	1.88 ± 1.79
Lake Whitefish	12.80	24.61	12.98	-	-	-	4.82	12.15	7.75	8.35 ± 8.23
Percids	-	-	-	-	-	-	-	-	-	0
Yellow Perch	-	-	-	-	-	-	-	-	-	0
Unidentified Larvae	-	-	-	-	-	-	-	-	-	0
Total:	15.79	28.72	17.14	0.00	0	0.44	5.69	13.50	11.20	10.28 ± 9.73

Taxon	Tow-Specific CPUE [1] - Trip 2				Mean ± SD	Spring Total
	10	11	12	13		Mean ± SD
Cyprinids	-	0.42	0.48	1.88	0.69 ± 0.82	0.21 ± 0.53
Catostomids	-	0.42	0.48	1.41	0.58 ± 0.59	0.18 ± 0.41
Coregonines	-	-	-	-	-	0.03 ± 0.12
Cisco	-	-	-	-	-	1.30 ± 1.72
Lake Whitefish	-	-	-	-	-	5.78 ± 7.83
Percids	-	11.77	1.92	0.00	3.42 ± 5.64	1.05 ± 3.26
Yellow Perch	323.46	150.11	61.32	54.89	147.44 ± 125.13	45.37 ± 94.50
Unidentified Larvae	6.97	0.42	0.48	1.88	2.44 ± 3.10	0.75 ± 1.94
Total:	330.43	163.15	64.67	60.05	154.58 ± 126.51	54.68 ± 94.18

1 - neuston tow number

2 - standard deviation

Table 5. Location and set information for standard index gillnet gangs set in Lake St. Martin, spring 2018.

Site	Location [1]		Set Date	Set Time	Duration (hrs)	Depth (m)		Water Temperature (°C)
	Easting	Northing				Start	End	
Trip 1								
GN-01	556332	5737736	15 May	16:20	0.75	1.5	1.5	12.6
GN-02	556844	5736546	16 May	9:45	1.75	0.9	1.2	11.5
GN-03	554977	5738220	16 May	10:15	2.00	1.1	1.8	11.5
GN-04	547255	5740669	16 May	14:00	2.75	1.5	1.5	11.5
GN-05	546278	5741655	16 May	14:15	2.00	1.5	1.5	11.5
GN-06	546060	5733637	17 May	7:20	3.33	2.2	2.2	10.8
GN-07	544584	5733854	17 May	10:23	0.28	2.2	2.2	10.0
Trip 2								
GN-08	555920	5737889	07 Jun	11:15	1.17	1.8	1.8	18.1
GN-09	556612	5736715	07 Jun	11:38	2.87	1.2	1.2	18.1
GN-10	547613	5741061	07 Jun	15:15	1.58	-	-	18.1
GN-11	546648	5741130	08 Jun	7:27	1.13	-	-	18.0
GN-12	546859	5742923	08 Jun	8:12	1.30	-	-	18.0

1 - UTM coordinates; NAD83, Zone 14U; site locations illustrated on Figure 6

Table 6. Site- and species-specific summary of fish catches from standard index gillnet gangs set in Lake St. Martin, spring 2018.

Species	Site-Specific [1] Catch - Trip 1									Site-Specific Catch - Trip 2							Spring Total	
	1	2	3	4	5	6	7	Total	RA (%) [2]	8	9	10	11	12	Total	RA (%)	Total	RA (%)
Carp	-	-	-	-	-	-	-	0	0.0	-	-	1	-	-	1	0.7	1	0.3
Longnose Sucker	5	2	4	10	4	2	3	30	13.0	-	-	-	-	-	0	0.0	30	7.8
White Sucker	6	43	42	29	8	2	7	137	59.3	2	6	30	4	1	43	28.1	180	46.9
Shorthead Redhorse	-	-	2	4	2		-	8	3.5		4	12	2	6	24	15.7	32	8.3
Northern Pike	3	2	14	8	1	1	-	29	12.6	3	6	1	3	4	17	11.1	46	12.0
Cisco	-	-	-	-	-	-	-	0	0.0	-	-	1	1	-	2	1.3	2	0.5
Lake Whitefish	-	-	-	3	1	5	-	9	3.9	2	3	7	-	-	12	7.8	21	5.5
Yellow Perch	6	1	7	1	1	1	-	17	7.4	21	27	1	-	1	50	32.7	67	17.4
Walleye	-	-	-	1			-	1	0.4	2		2	-	-	4	2.6	5	1.3
Total:	20	48	69	56	17	11	10	231	100.0	30	46	55	10	12	153	100.0	384	100.0

1 - gillnet sampling sites

2 - relative fish species abundance calculated as a percentage of the total catch

Table 7. Site- and species-specific catch-per-unit-effort (CPUE; # fish/100m/hr) calculated for fish captured in standard index gillnet gangs set in Lake St. Martin, spring 2018.

Species	Site-Specific CPUE - Trip 1							Mean ± SD [1]
	GN-01	GN-02	GN-03	GN-04	GN-05	GN-06	GN-07	
Carp	-	-	-	-	-	-	-	0.00 ± 0.00
Longnose Sucker	4.86	0.83	1.46	2.65	1.46	0.44	7.72	2.78 ± 2.63
White Sucker	5.84	17.92	15.32	7.69	2.92	0.44	18.02	9.73 ± 7.29
Shorthead Redhorse	-	-	0.73	1.06	0.73	-	-	0.36 ± 0.46
Northern Pike	2.92	0.83	5.11	2.12	0.36	0.22	-	1.65 ±1.86
Cisco	-	-	-	-	-	-	-	0.00 ± 0.00
Lake Whitefish	-	-	-	0.8	0.36	1.09	-	0.32 ± 0.45
Yellow Perch	5.84	0.42	-	0.27	0.36	0.22	-	1.38 ± 2.15
Walleye	-	-	2.55	0.27	-	-	-	0.04 ± 0.10
Total:	19.45	20.01	25.16	14.85	6.2	2.41	25.74	16.26 ± 9.02

Species	Site-Specific CPUE - Trip 2					Mean ± SD	Spring Total
	GN-08	GN-09	GN-10	GN-11	GN-12		Mean ± SD
Carp	-	-	0.46	-	-	0.09 ± 0.21	0.04 ± 0.13
Longnose Sucker	-	-	-	-	-		1.62 ± 2.41
White Sucker	1.25	1.53	13.82	2.57	0.56	3.95 ± 5.57	7.32 ± 7.01
Shorthead Redhorse	0.00	1.02	5.53	1.29	3.37	2.24 ± 2.21	1.14 ± 1.68
Northern Pike	1.88	1.53	0.46	1.93	2.24	1.61 ± 0.69	1.63 ± 1.44
Cisco	-	-	0.46	0.64	0.00	0.22 ± 0.31	0.09 ± 0.22
Lake Whitefish	1.25	0.76	3.22	-	-	1.05 ± 1.33	0.62 ± 0.95
Yellow Perch	13.13	6.87	0.46	-	0.56	4.20 ± 5.74	2.56 ± 4.08
Walleye	1.25	-	0.92	-	-	0.43 ± 0.61	0.20 ± 0.43
Total:	18.76	11.70	25.34	6.44	6.73	13.79 ± 8.16	15.23 ± 8.38

1 - standard deviation

Table 8. Mean size and condition factor (K) for fish species captured in standard index gillnet gangs set in Lake St. Martin, spring 2018.

Species	Fork Length (mm)				Round Weight (g)				K		
	n	Mean	SD [1]	Range	n	Mean	SD	Range	n	Mean	Range
Carp	1	540	-	-	1	3760	-	-	1	2.39	-
Longnose Sucker	24	513	48	381-595	24	1867	492	400-2750	24	1.35	0.72-1.72
White Sucker	171	396	86	136-576	158	1184	397	50-2310	158	1.57	0.75-2.57
Shorthead Redhorse	31	371	54	173-430	30	829	247	340-1280	30	1.50	1.33-1.84
Northern Pike	44	499	163	153-883	40	882	602	100-2830	40	0.70	0.48-0.88
Cisco	2	187	25	169-205	2	63	18	50-75	2	0.95	0.87-1.04
Lake Whitefish	20	409	16	383-440	20	860	170	550-1190	20	1.25	0.91-1.51
Yellow Perch	66	140	17	118-227	-	-	-	-	-	-	-
Walleye	5	380	58	279-425	5	516	192	200-700	5	0.89	0.79-0.94

1 - standard deviation

Table 9. Species- and sampling period-specific sex and state of maturity for spring spawning fish species captured in Lake St. Martin, spring 2018.

Species and Sex	Spawning Condition – Trip 1				Spawning Condition – Trip 2			
	Early Pre-Spawn	Immediate Pre-spawn	Post-Spawn	Total	Early Pre-Spawn	Immediate Pre-spawn	Post-Spawn	Total
Shorthead Redhorse								
Female	-	-	-	0	-	-	-	0
Male	3	-	-	3	6	-	-	6
White Sucker								
Female	31	9	-	40	-	3	-	3
Male	14	61	-	75	-	-	2	2
Longnose Sucker								
Female	4	3	-	7	-	-	-	0
Male	7	3	-	10	-	-	-	0
Northern Pike								
Female	-	-	-	0	-	-	-	0
Male	2	-	-	2	-	-	-	0
Yellow Perch								
Female	-	-	-	0	-	-	-	0
Male	3	2	-	5	-	-	-	0

Table 10. Location and set information for standard index gillnet gangs set in Lake St. Martin, fall 2018.

Site	Location [1]		Set Date	Set Time	Duration (hrs)	Depth (m)		Water Temperature (°C)
	Easting	Northing				Start	End	
GN-13	545182	5734179	25-Oct-18	13:30	1.92	1.8	1.8	2.9
GN-14	544310	5733714	25-Oct-18	14:00	2.08	1.8	2.3	2.9
GN-15	555880	5737819	26-Oct-18	9:30	1.92	1.4	1.8	3.4
GN-16	556096	5737546	26-Oct-18	9:50	2.08	1.7	1.4	3.4
GN-17	555474	5737725	26-Oct-18	11:35	1.92	1.3	1.8	3.4
GN-18	556243	5737222	26-Oct-18	12:20	1.92	1.2	1.5	3.4
GN-19	556244	5736786	26-Oct-18	13:45	1.50	-	-	3.4

1 - UTM coordinates; NAD83, Zone 14U; site locations illustrated on Figure 13

Table 11. Site- and species-specific summary of fish catches from standard index gillnet gangs set in Lake St. Martin, fall 2018.

Species	Site-Specific Catch							Total	RA (%) [1]
	GN-13	GN-14	GN-15	GN-16	GN-17	GN-18	GN-19		
White Sucker	3	1	2	1	3	2	3	15	8.3
Northern Pike	1	1	1	4	1	-	2	10	5.6
Cisco	7	20	-	-	1	-	1	29	16.1
Lake Whitefish	9	8	13	11	13	19	41	114	63.3
Yellow Perch	1	-	3	4	-	1	-	9	5.0
Walleye	-	1	-	1	1	-	-	3	1.7
Total:	21	31	19	21	19	22	47	180	100.0

1 - relative fish species abundance calculated as a percentage of the total catch

Table 12. Site- and species-specific catch-per-unit-effort (CPUE; # fish/100m/hr) calculated for fish captured in standard index gillnet gangs set in Lake St. Martin, fall 2018.

Species	Site-Specific CPUE							Mean ± SD [1]
	GN-13	GN-14	GN-15	GN-16	GN-17	GN-18	GN-19	
White Sucker	1.14	0.35	0.76	0.35	1.14	0.76	1.46	0.85 ± 0.42
Northern Pike	0.38	0.35	0.38	1.40	0.38	-	0.97	0.55 ± 0.47
Cisco	2.66	7.00	-	-	0.38	-	0.49	1.50 ± 2.60
Lake Whitefish	3.42	2.80	4.95	3.85	4.95	7.23	19.94	6.73 ± 6.00
Yellow Perch	0.38	-	1.14	1.40	-	0.38	-	0.47 ± 0.58
Walleye	-	0.35	-	0.35	0.38	-	-	0.15 ± 0.19
Total:	7.99	10.85	7.23	7.35	7.23	8.37	22.85	10.27 ± 5.69

1 - standard deviation

Table 13. Mean size and condition factor (K) for fish species captured in standard index gillnet gangs set in Lake St. Martin, fall 2018.

Species	Fork Length (mm)				Round Weight (g)				K		
	n	Mean	SD [1]	Range	N	Mean	SD	Range	n	Mean	Range
White Sucker	15	385	90	204-485	15	1078	549	100-1900	15	1.58	1.16-1.82
Northern Pike	10	512	176	220-915	9	854	407	140-1300	9	1.55	0.67-1.31
Cisco	29	287	52	135-333	29	469	199	40-700	29	1.75	0.64-2.26
Lake Whitefish	114	427	25	378-493	113	1063	196	700-1900	113	1.35	0.98-1.72
Yellow Perch	9	146	18	125-182	9	50	14	40-80	9	1.61	1.10-2.05
Walleye	3	372	78	310-460	3	627	368	380-1050	3	1.15	1.08-1.28

1 - standard deviation

Table 14. Species- and sampling period-specific sex and state of maturity for fall spawning fish species captured in Lake St. Martin, fall 2018.

Species and Sex	Early Pre-Spawn	Immediate Pre-spawn	Post-Spawn	Total
Cisco				
Female	1	-	-	1
Male	21	3	-	24
Lake Whitefish				
Female	45	3	1	49
Male	13	-	-	13

Table 15. Biological and capture information for fish marked with individually numbered Floy® tags in Lake St. Martin, fall 2018.

Floy-Tag	Tag Pre-Fix	Species	Tag Date	Capture Location [1]	Fish ID	Fork Length (mm)	Round Weight (g)	Condition Factor (K)	Sex	Maturity
114026	NSC	Lake Whitefish	26-Oct	GN-19	154	402	900	1.39	M	7
114027	NSC	Lake Whitefish	26-Oct	GN-19	155	427	1030	1.32	F	2
114028	NSC	Lake Whitefish	26-Oct	GN-19	156	444	1300	1.49		
114029	NSC	Lake Whitefish	26-Oct	GN-19	157	443	1150	1.32	M	7
114030	NSC	Lake Whitefish	26-Oct	GN-19	158	446	1150	1.30		
114031	NSC	Lake Whitefish	26-Oct	GN-19	159	405	870	1.31	M	7
114032	NSC	Lake Whitefish	26-Oct	GN-19	160	440	1090	1.28		
114033	NSC	Lake Whitefish	26-Oct	GN-19	161	425	1040	1.35		
114034	NSC	Lake Whitefish	26-Oct	GN-19	162	450	1200	1.32	F	2
114035	NSC	Lake Whitefish	26-Oct	GN-19	163	409	990	1.45		
114036	NSC	Lake Whitefish	26-Oct	GN-19	164	402	800	1.23		
114037	NSC	Lake Whitefish	26-Oct	GN-19	165	395	740	1.20		
114038	NSC	Lake Whitefish	26-Oct	GN-19	166	407	800	1.19	F	2
114039	NSC	Lake Whitefish	26-Oct	GN-19	167	420	1050	1.42		
114040	NSC	Lake Whitefish	26-Oct	GN-19	168	430	1200	1.51	F	2
114041	NSC	Lake Whitefish	26-Oct	GN-19	169	432	1100	1.36	F	2
114042	NSC	Lake Whitefish	26-Oct	GN-19	170	425	1140	1.49	F	2
114043	NSC	Lake Whitefish	26-Oct	GN-19	171	416	1040	1.44	F	2
114044	NSC	Lake Whitefish	26-Oct	GN-19	172	403	950	1.45		
114045	NSC	Lake Whitefish	26-Oct	GN-19	173	403	840	1.28		
114046	NSC	Lake Whitefish	26-Oct	GN-19	174	408	900	1.33	F	2
114047	NSC	Lake Whitefish	26-Oct	GN-19	175	449	1220	1.35	F	2
114048	NSC	Lake Whitefish	26-Oct	GN-19	176	390	940	1.58		
114501	NSC	Lake Whitefish	26-Oct	GN-18	112	470	1270	1.22		
114502	NSC	Lake Whitefish	26-Oct	GN-18	114	415	940	1.32		
114503	NSC	Lake Whitefish	26-Oct	GN-18	115	420	970	1.31		

Table 15. continued.

Floy-Tag	Tag Pre-Fix	Species	Tag Date	Capture Location	Fish ID	Fork Length (mm)	Round Weight (g)	Condition Factor (K)	Sex	Maturity
114504	NSC	Lake Whitefish	26-Oct	GN-18	116	426	1020	1.32		
114509	NSC	Lake Whitefish	26-Oct	GN-19	134	442	1150	1.33		
114510	NSC	Lake Whitefish	26-Oct	GN-19	135	460	1340	1.38		
114511	NSC	Lake Whitefish	26-Oct	GN-19	136	410	1020	1.48	F	2
114512	NSC	Lake Whitefish	26-Oct	GN-19	137	452	1300	1.41		
114513	NSC	Lake Whitefish	26-Oct	GN-19	138	422	960	1.28		
114514	NSC	Lake Whitefish	26-Oct	GN-19	139	457	1220	1.28		
114515	NSC	Lake Whitefish	26-Oct	GN-19	140	484	1400	1.23		
114516	NSC	Lake Whitefish	26-Oct	GN-19	141	454	1140	1.22		
114517	NSC	Lake Whitefish	26-Oct	GN-19	142	461	1330	1.36		
114519	NSC	Lake Whitefish	26-Oct	GN-19	143	423	950	1.26		
114520	NSC	Lake Whitefish	26-Oct	GN-19	144	443	1150	1.32	F	2
114521	NSC	Lake Whitefish	26-Oct	GN-19	146	447	1150	1.29		
114523	NSC	Lake Whitefish	26-Oct	GN-19	147	446	1170	1.32		
114524	NSC	Lake Whitefish	26-Oct	GN-19	152	431	1060	1.32		
114525	NSC	Lake Whitefish	26-Oct	GN-19	153	452	1200	1.30		
114530	NSC	Lake Whitefish	25-Oct	GN-14	23	481	1480	1.33		
114531	NSC	Lake Whitefish	25-Oct	GN-14	24	415	1130	1.58	F	3
114532	NSC	Lake Whitefish	25-Oct	GN-14	25	418	940	1.29	F	2
114534	NSC	Lake Whitefish	26-Oct	GN-15	54	442	1110	1.29		
114535	NSC	Lake Whitefish	26-Oct	GN-15	55	394	930	1.52		
114536	NSC	Lake Whitefish	26-Oct	GN-15	57	444	1100	1.26		
114537	NSC	Lake Whitefish	26-Oct	GN-15	58	404	800	1.21		
114538	NSC	Lake Whitefish	26-Oct	GN-15	59	401	1000	1.55		
114539	NSC	Lake Whitefish	26-Oct	GN-15	66	435	1020	1.24	F	2
114540	NSC	Lake Whitefish	26-Oct	GN-16	76	447	1080	1.21		
114541	NSC	Lake Whitefish	26-Oct	GN-16	77	441	1110	1.29		

Table 15. continued.

Floy-Tag	Tag Pre-Fix	Species	Tag Date	Capture Location	Fish ID	Fork Length (mm)	Round Weight (g)	Condition Factor (K)	Sex	Maturity
114543	NSC	Lake Whitefish	26-Oct	GN-16	82	421	1010	1.35		
114544	NSC	Lake Whitefish	26-Oct	GN-17	94	436	1050	1.27		
114545	NSC	Lake Whitefish	26-Oct	GN-17	95	456	1350	1.42		
114546	NSC	Lake Whitefish	26-Oct	GN-17	96	427	1170	1.50		
114547	NSC	Lake Whitefish	26-Oct	GN-17	97	408	860	1.27		
114548	NSC	Lake Whitefish	26-Oct	GN-17	98	420	1000	1.35		
114549	NSC	Lake Whitefish	26-Oct	GN-17	99	413	1030	1.46		
114550	NSC	Lake Whitefish	26-Oct	GN-17	100	440	1150	1.35		

1 - capture locations illustrated on Figure 13

Table 16. Location, set, and catch information for egg mats set in Sturgeon Bay, spring 2018.

Site	Location [1]		Set Date	Lift Date	Duration (days)	Water Depth (m)	Substrate		Fish Eggs (n)
	Easting	Northing					Composition	Compaction	
EM-1	573419	5750909	25-May	08-Jun	13	0.8	Sand	Soft	0
EM-2	573444	5750957	25-May	08-Jun	13	0.9	Sand	Soft	0
EM-3	573465	5751011	25-May	lost	-	0.7	Sand	Soft	-
EM-4	573490	5751071	25-May	lost	-	1.2	Cobble and Boulder	Hard	-
EM-5	573517	5751117	25-May	lost	-	1.4	Sand	Soft	-
EM-6	573050	5751255	25-May	08-Jun	13	0.8	Cobble and Boulder	Hard	0
EM-7	573106	5751286	25-May	lost	-	0.9	Cobble and Boulder	Hard	-
EM-8	573168	5751337	25-May	08-Jun	13	0.8	Sand and Gravel	Hard	0
EM-9	573226	5751381	25-May	lost	-	0.8	Sand and Gravel	Hard	-
EM-10	573272	5751428	25-May	08-Jun	13	1.0	Cobble and Boulder	Hard	0
EM-11	572988	5751482	25-May	08-Jun	13	0.9	Sand and Boulder	Hard	0
EM-12	573037	5751480	25-May	08-Jun	13	0.8	Sand and Gravel	Hard	0
EM-13	573060	5751476	25-May	08-Jun	13	0.7	Cobble and Boulder	Hard	0
EM-14	573102	5751470	25-May	08-Jun	13	0.7	Sand and Boulder	Hard	0
EM-15	573172	5751454	25-May	lost	-	2.7	Sand	Hard	-
EM-16	573394	5752201	25-May	lost	-	0.9	Sand and Boulder	Hard	-
EM-17	573419	5752165	25-May	08-Jun	13	1.1	Sand and Boulder	Hard	0
EM-18	573444	5752148	25-May	lost	-	1.2	Cobble and Boulder	Hard	-
EM-19	573468	5752124	25-May	lost	-	1.3	Cobble and Boulder	Hard	-

1 - UTM coordinates; NAD83, Zone 14U; site locations illustrated on Figure 16

Table 17. Location, set, and catch information for egg mats set in Sturgeon Bay, fall 2018.

Site	Location [1]		Set Date	Lift Date	Duration (days)	Water Depth (m)	Fish Eggs (n)
	Easting	Northing					
EM-1	574135	5750741	12-Oct	27-Oct	15	1.8	0
EM-2	573920	5750886	12-Oct	27-Oct	15	1.6	0
EM-3	573884	5751159	12-Oct	27-Oct	15	1.8	0
EM-4	573621	5751216	12-Oct	27-Oct	15	1.6	0
EM-5	573558	5151382	12-Oct	27-Oct	15	1.7	0
EM-6	573421	5751473	12-Oct	27-Oct	15	1.3	0
EM-7	573553	5751628	12-Oct	27-Oct	15	1.5	0
EM-8	573514	5751852	12-Oct	27-Oct	15	1.4	0
EM-9	573495	5751984	12-Oct	27-Oct	15	1.3	0
EM-10	573814	5751990	12-Oct	27-Oct	15	1.9	0
EM-11	573777	5751819	12-Oct	27-Oct	15	1.9	0
EM-12	573750	5751639	12-Oct	27-Oct	15	1.8	0
EM-13	573704	5751449	12-Oct	27-Oct	15	1.9	0
EM-14	573696	5751349	12-Oct	27-Oct	15	1.7	0
EM-15	573812	5751291	12-Oct	27-Oct	15	2.0	0
EM-16	573690	5752084	12-Oct	27-Oct	15	1.6	0
EM-17	573842	5752248	12-Oct	27-Oct	15	2.7	0
EM-18	573819	5752563	12-Oct	27-Oct	15	2.8	0
EM-19	573822	5752720	12-Oct	27-Oct	15	2.6	0
EM-20	573889	5752895	12-Oct	27-Oct	15	2.5	0

1 - UTM coordinates; NAD83, Zone 14U; site locations illustrated on Figure 17

Table 18. The location, distance, duration, and volume of water filtered for neuston tows conducted in Sturgeon Bay, spring 2018.

Neuston Tow	Date	Start Location [1]		End Location		Duration (minutes)	Tow Distance [2] (m)	Volume [3, 4] (m^3)
		Easting	Northing	Easting	Northing			
Trip 1								
NT-1	23-May	573514	5751562	574680	5750064	21	-	229
NT-2	23-May	574657	5750130	575922	5748998	25	1872	253
NT-3	23-May	576025	5749207	576573	5748765	16	-	175
NT-4	23-May	576598	5748740	578265	5748644	20	1828	247
NT-5	23-May	578331	5748676	580019	5749276	21	1867	252
NT-6	23-May	573435	5751649	573578	5753361	25	1762	238
NT-7	23-May	573561	5753338	572143	5753360	20	1523	206
NT-8	23-May	565458	5756815	564655	5757090	25	2169	293
NT-9	24-May	582601	5747036	583900	5746375	21	1835	248
NT-10	24-May	583900	5746375	584843	5744699	26	1999	270
NT-11	24-May	580491	5749337	580468	5750878	22	1717	232
NT-12	24-May	580598	5750884	580843	5752572	20	1688	228
NT-13	24-May	580815	5752657	578743	5752126	11	-	120
Trip 2								
NT-14	08-Jun	573650	5752247	573571	5750891	21	1592	215
NT-15	08-Jun	573675	5750991	574846	5749798	20	1695	229
NT-16	08-Jun	573717	5753294	572455	5753306	19	1521	205

1 - UTM coordinates; NAD 83 Zone 14U; neuston tow locations illustrated in Figure 18

2 - Tow distance (m) calculated as the number of flow meter revolutions x the GO flow meter constant (26873) divided by 999999

3 - Volume filtered calculated as the tow distance (m) x 0.135 m^2

4 - the GO flow meter did not function properly for NT-01, NT-03, and NT-13. The volume of water filtered was estimated for those tows using their respective durations and the ratio of average water volume filtered (239.5 m^3) and the average tow duration (21.9 minutes) with the tow durations for NT-01, NT-03, and NT-13 to and average water volume (239.5 m^3) from tows for which the GO flow meter functioned properly.

Table 19. Tow- and taxon-specific summary of larval fish catches from neuston sampling in Sturgeon Bay, spring 2018.

Taxon	Tow-Specific Catch - Trip 1													Total	RA (%) [1]
	NT-1	NT-2	NT-3	NT-4	NT-5	NT-6	NT-7	NT-8	NT-9	NT-10	NT-11	NT-12	NT-13		
Catostomids	-	-	-	-	-	-	-	8	-	-	-	-	-	8	1.2
Cisco		4				18		12	1	-	1	-	7	43	6.5
Lake Whitefish	25	101	69	27	16	209	55	49	5	-	5	7	14	582	88.2
Percids	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0.0
Yellow Perch	-	-	-	-	-	-	-	-	15	5	-	-	-	20	3.0
Unidentified Larvae	-	-	-	-	-	1	-	-	6	-	-	-	-	7	1.1
Total:	25	105	69	27	16	228	55	69	27	5	6	7	21	660	100.0

Taxon	Tow-Specific Catch - Trip 2			Total	RA (%) [1]
	NT-14	NT-15	NT-16		
Catostomids	2144	4032	960	7136	76.3
Cisco	-	-	-	0	0.0
Lake Whitefish	1	-	-	1	0.0
Percids	664	896	660	2220	23.7
Yellow Perch	-	-	-	0	0.0
Unidentified Larvae	-	-	-	0	0.0
Total:	2809	4928	1620	9357	100.0

Spring Total	
Total	RA (%)
7144	71.3
43	0.4
583	5.8
2220	22.2
20	0.2
7	0.1
10017	100.0

1 - relative fish species abundance calculated as a percentage of the total catch

Table 20. Tow- and taxon-specific catch-per-unit-effort (CPUE; # fish/100 m^3) calculated for larval fish catches from neuston sampling in Sturgeon Bay, spring 2018.

Taxon	Tow-Specific Catch - Trip 1													Mean ± SD [1]
	NT-1	NT-2	NT-3	NT-4	NT-5	NT-6	NT-7	NT-8	NT-9	NT-10	NT-11	NT-12	NT-13	
Catostomids	-	-	-	-	-	-	-	2.73	-	-	-	-	-	0.21 ± 0.76
Cisco	-	1.58	-	-	-	7.57	0.00	4.10	0.40	0.00	0.43	-	5.83	1.53 ± 2.59
Lake Whitefish	10.92	39.96	39.43	10.94	6.35	87.86	26.76	16.73	2.02	-	2.16	3.07	11.67	19.84 ± 24.47
Percids	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Yellow Perch	-	-	-	-	-	-	-	-	6.06	1.85	-	-	-	0.61 ± 1.71
Unidentified Larvae	-	-	-	-	-	0.42	-	-	2.42	-	-	-	-	0.22 ± 0.67
Total:	10.92	41.54	39.43	10.94	6.35	95.85	26.76	23.56	10.90	1.85	2.59	3.07	17.50	22.40 ± 25.72

Taxon	Tow-Specific Catch - Trip 2			Mean ± SD	Spring Total Mean ± SD
	NT-14	NT-15	NT-16		
Catostomids	997.44	1762.06	467.57	1075.69 ± 650.78	201.86 ± 494.39
Cisco	-	-	-	0	1.24 ± 2.40
Lake Whitefish	0.47	0.00	-	0.16 ± 0.27	16.15 ± 23.28
Percids	308.91	391.57	321.46	340.64 ± 44.55	63.87 ± 138.28
Yellow Perch	-	-	-	0	0.49 ± 1.55
Unidentified Larvae	-	-	-	0	0.18 ± 0.61
Total:	1306.81	2153.62	789.03	1416.49 ± 688.88	283.80 ± 616.13

1 - standard deviation

Table 21. Location and set information for standard index gillnet gangs set in Sturgeon Bay, spring 2018.

Site	Location [1]		Set Date	Set Time	Duration (hrs)	Depth (m)		Water Temperature (°C)
	Easting	Northing				Start	End	
Trip 1								
GN-01	573403	5751653	23-May-18	11:05	1.42	1.3	1.4	13.0
GN-02	575954	5749062	23-May-18	12:15	2.08	2.1	3.0	13.0
GN-03	574725	5750445	23-May-18	12:45	2.42	2.3	2.7	13.0
GN-04	580638	5749421	24-May-18	7:10	2.08	1.6	1.8	12.4
GN-05	582548	5746885	24-May-18	7:25	1.33	0.8	0.8	12.4
GN-06	573715	5752769	25-May-18	15:30	2.25	1.4	2.7	12.5
GN-07	573558	5750928	25-May-18	15:45	1.67	0.7	1.2	12.5
Trip 2								
GN-08	573544	5752324	08-Jun-18	13:05	1.17	1.1	1.2	16.7
GN-09	573638	5750867	08-Jun-18	13:37	1.47	1.1	1.2	16.7
GN-10	572952	5751353	08-Jun-18	14:30	1.00	0.7	1.0	16.7

1 - UTM coordinates; NAD83, Zone 14U; site locations illustrated on Figure 19

Table 22. Site- and species-specific summary of fish catches from standard index gillnet gangs set in Sturgeon Bay, spring 2018.

Species	Site-Specific Catch - Trip 1									Site-Specific Catch - Trip 2					Spring Total	
	1	2	3	4	5	6	7	Total	RA (%) [1]	8	9	10	Total	RA (%)	Total	RA (%)
Quilback	-	-	-	1	-	-	-	1	0.4	-	-	-	0	0.0	1	0.4
Longnose Sucker	-	-	2	-	-	-	-	2	0.9	-	-	-	0	0.0	2	0.8
White Sucker		11	33	11	-	40	-	95	42.6	1	3	2	6	16.7	101	39.0
Shorthead Redhorse	-	4		7	2	5	1	19	8.5	-	5	4	9	25.0	28	10.8
Northern Pike	2	1	5	33	3	9	8	61	27.4	-	-	1	1	2.8	62	23.9
Lake Whitefish	-	-	1	-	-	-	-	1	0.4	-	-	-	0	0.0	1	0.4
Sauger	-	1	-	-	-	2	-	3	1.3	-	-	-	0	0.0	3	1.2
Yellow Perch	-	8	-	-	1	-	-	9	4.0	-	1	-	1	2.8	10	3.9
Walleye	-	4	-	27	-	-	1	32	14.3	6	3	9	18	50.0	50	19.3
Freshwater Drum	-	-	-	-	-	-	-	0	0.0	-	-	1	1	2.8	1	0.4
Total:	2	29	41	79	6	56	10	223	100.0	7	12	17	36	100.0	259	100.0

1 - relative fish species abundance calculated as a percentage of the total catch

Table 23. Site- and species-specific catch-per-unit-effort (CPUE; # fish/100m/hr) calculated for fish captured in standard index gillnet gangs set in Sturgeon Bay, spring 2018.

Species	Site-Specific CPUE - Trip 1							Mean ± SD [1]
	GN-01	GN-02	GN-03	GN-04	GN-05	GN-06	GN-07	
Quilback	-	-	-	0.35	-	-	-	0.05 ± 0.13
Longnose Sucker	-	-	0.60	-	-	-	-	0.09 ± 0.23
White Sucker	-	3.85	9.96	3.85	-	12.97	-	4.38 ± 5.21
Shorthead Redhorse	-	1.40	0.00	2.45	1.09	1.62	0.44	1.00 ± 0.91
Northern Pike	1.03	0.35	1.51	11.55	1.64	2.92	3.50	3.21 ± 3.83
Lake Whitefish	-	-	0.30	-	-	-	-	0.04 ± 0.11
Sauger	-	0.35	-	-	-	0.65	-	0.14 ± 0.26
Yellow Perch	-	2.80	-	-	0.55	-	-	0.48 ± 1.04
Walleye	-	1.40	-	9.45	0.00	0.00	0.44	1.61 ± 3.50
Freshwater Drum	-	-	-	-	-	-	-	0
Total:	1.03	10.15	12.37	27.66	3.28	18.15	4.38	11.00 ± 9.44

Species	Site-Specific CPUE - Trip 2			Mean ± SD	Spring Total Mean ± SD
	GN-08	GN-09	GN-10		
Quilback	-	-	-	0	0.04 ± 0.11
Longnose Sucker	-	-	-	0	0.06 ± 0.19
White Sucker	0.63	1.49	1.46	1.19 ± 0.49	3.42 ± 4.53
Shorthead Redhorse	-	2.49	2.92	1.80 ± 1.57	1.24 ± 1.12
Northern Pike	-	-	0.73	0.24 ± 0.42	2.32 ± 3.45
Lake Whitefish	-	-	-	0	0.03 ± 0.10
Sauger	-	-	-	0	0.10 ± 0.22
Yellow Perch	-	0.50	-	0.17 ± 0.29	0.38 ± 0.88
Walleye	3.75	1.49	6.56	3.94 ± 2.54	2.31 ± 3.29
Freshwater Drum	-	-	0.73	0.24 ± 0.42	0.07 ± 0.23
Total:	4.38	5.97	12.40	7.58 ± 4.25	9.98 ± 8.13

1 - standard deviation

Table 24. Mean size and condition factor (K) for fish species captured in standard index gillnet gangs set in Sturgeon Bay, spring 2018.

Species	Fork Length (mm)				Weight (g)				K		
	n	Mean	SD [1]	Range	n	Mean	SD	Range	n	Mean	Range
Quilback	1	444	-	-	1	1910	-	-	1	2.18	
Longnose Sucker	2	512	71	462-562	2	2295	912	1650-2940	2	1.66	1.66 ± 1.67
White Sucker	58	393	93	150-520	54	1099	487	50-2050	54	1.51	0.93 ± 1.97
Shorthead Redhorse	26	272	70	157-382	26	367	241	70-1000	26	1.59	1.20 ± 2.40
Northern Pike	61	593	165	278-935	58	1686	1148	180-4200	58	0.75	0.58 ± 0.97
Lake Whitefish	1	438	-	-	1	1350	-	-	1	1.61	-
Sauger	3	385	20	363-402	3	590	66	520-650	3	1.03	1.00 ± 1.09
Yellow Perch	11	170	34	138-232	2	190	57	150-230	2	1.55	1.25 ± 1.84
Walleye	49	372	60	234-578	49	612	317	150-2150	49	1.10	0.91 ± 1.40
Freshwater Drum	1	450	-	-	1	1500	-	-	1	1.65	-

1 - standard deviation

Table 25. Species- and sampling period-specific sex and state of maturity for spring spawning fish species captured in Sturgeon Bay, fall 2018.

Species and Sex	Spawning Condition – Trip 1				Spawning Condition – Trip 2			
	Early Pre-Spawn	Immediate Pre-spawn	Post-Spawn	Total	Early Pre-Spawn	Immediate Pre-spawn	Post-Spawn	Total
Longnose Sucker								
Female	1	-	-	1	-	-	-	0
Male	-	-	-	0	-	-	-	0
White Sucker								
Female	8	9	4	21	-	-	-	0
Male	18	11	3	32	-	-	-	0
Northern Pike								
Female	-	2	4	6	-	-	-	0
Male	1	3	1	5	-	-	-	0
Sauger								
Female	-	3	-	3	-	-	-	0
Male	-	-	-	0	-	-	-	0
Walleye								
Female	-	-	-	0	-	-	-	0
Male	2	1	2	5	-	-	1	1
Yellow Perch								
Female	1	-	-	1	-	-	-	0
Male	3	-	-	3	-	-	-	0

Table 26. Location and set information for standard index gillnet gangs set in Sturgeon Bay, fall 2018.

Site	Location [1]		Set Date	Set Time	Duration (hrs)	Depth (m)		Water Temperature (°C)
	Easting	Northing				Start	End	
Trip 1								
GN-11	574048	5752890	12-Oct-18	9:45	2.50	4.1	4.7	1.6
GN-12	574257	5750685	12-Oct-18	10:05	2.78	2.0	2.8	1.6
GN-13	573507	5752175	12-Oct-18	12:40	2.83	1.8	2.1	1.6
GN-14	573907	5751658	16-Oct-18	9:22	25.80	2.0	2.5	0.6
GN-15	574167	5751098	16-Oct-18	9:33	25.23	2.5	2.5	0.6
Trip 2								
GN-16	573611	5751644	27-Oct-18	8:50	1.83	1.8	2.1	3.5
GN-17	574032	5751290	27-Oct-18	9:00	2.00	4.0	4.5	3.5

1 - UTM coordinates; NAD83, Zone 14U; site locations illustrated on Figure 24

Table 27. Site- and species-specific summary of fish catches from standard index gillnet gangs set in Sturgeon Bay, fall 2018.

Species	Site-Specific Catch - Trip 1							Site-Specific Catch - Trip 2				Spring Total	
	GN-11	GN-12	GN-13	GN-14	GN-15	Total	RA (%) [1]	GN-16	GN-17	Total	RA (%)	Total	RA (%)
White Sucker	3	1	1	11	6	22	7.4	2	4	6	10.7	28	7.9
Shorthead Redhorse	-	-	-	-	2	2	0.7		1	1	1.8	3	0.8
Northern Pike	13	11	4	24	23	75	25.1	3	3	6	10.7	81	22.8
Cisco	2	26	2	78	54	162	54.2	14	27	41	73.2	203	57.2
Lake Whitefish	1		3	14	5	23	7.7	-	-	0	0.0	23	6.5
Burbot	-	-	-	-	2	2	0.7	-	-	0	0.0	2	0.6
Sauger	-	-	-	1		1	0.3	-	-	0	0.0	1	0.3
Yellow Perch	-	-	-	2	1	3	1.0	-	-	0	0.0	3	0.8
Walleye	1	2	-	4	2	9	3.0	1	1	2	3.6	11	3.1
Total:	20	40	10	134	95	299	100.0	20	36	56	100.0	355	100.0

1 - relative fish species abundance calculated as a percentage of the total catch

Table 28. Site- and species-specific catch-per-unit-effort (CPUE) calculated for fish captured in standard index gillnet gangs set in Sturgeon Bay, fall 2018.

Species	Site-Specific CPUE - Trip 1						Site-Specific CPUE - Trip 2			Fall Total
	GN-11	GN-12	GN-13	GN-14	GN-15	Mean ± SD [1]	GN-16	GN-17	Mean ± SD	Mean ± SD
White Sucker	0.88	0.26	0.26	0.31	0.17	0.38 ± 0.28	0.80	1.46	1.13 ± 0.47	0.59 ± 0.47
Shorthead Redhorse	0.00	0.00	0.00	0.00	0.06	0.01 ± 0.03	0.00	0.36	0.18 ± 0.26	0.06 ± 0.14
Northern Pike	3.79	2.88	1.03	0.68	0.66	1.81 ± 1.44	1.19	1.09	1.14 ± 0.07	1.62 ± 1.22
Cisco	0.58	6.81	0.51	2.21	1.56	2.34 ± 2.60	5.57	9.85	7.71 ± 3.02	3.87 ± 3.59
Lake Whitefish	0.29	0.00	0.77	0.40	0.14	0.32 ± 0.29	0.00	0.00	0.00	0.23 ± 0.29
Burbot	0.00	0.00	0.00	0.00	0.06	0.01 ± 0.03	0.00	0.00	0.00	0.01 ± 0.02
Sauger	0.00	0.00	0.00	0.03	0.00	0.01 ± 0.01	0.00	0.00	0.00	0.01 ± 0.01
Yellow Perch	0.00	0.00	0.00	0.06	0.03	0.02 ± 0.03	0.00	0.00	0.00	0.01 ± 0.02
Walleye	0.29	0.52	0.00	0.11	0.06	0.20 ± 0.21	0.40	0.36	0.38 ± 0.02	0.25 ± 0.20
Total:	5.84	10.48	2.57	3.79	2.75	5.09 ± 3.28	7.96	13.13	10.54 ± 3.66	6.64 ± 4.06

1 - standard deviation

Table 29. Mean size and condition factor (K) for fish species captured in standard index gillnet gangs set in Sturgeon Bay, fall 2018.

Species	Fork Length (mm)				Weight (g)				K		
	n	Mean	SD [1]	Range	n	Mean	SD	Range	n	Mean	Range
White Sucker	28	431	65	159-511	28	1373	420	80-1900	28	1.65	1.25-2.36
Shorthead Redhorse	3	399	40	364-442	3	1143	467	700-1630	3	1.72	1.45-1.89
Northern Pike	81	572	99	389-945	80	1442	786	390-5250	80	0.72	0.54-0.96
Cisco	203	301	39	178-368	203	478	188	70-970	203	1.62	0.74-2.67
Lake Whitefish	23	414	16	380-453	23	1009	126	740-1350	23	1.42	1.25-1.94
Burbot	2	597	28	577-616	2	2225	332	1990-2460	2	1.04	1.04-105
Sauger	1	366	-	-	1	410	-	-	1	0.84	-
Yellow Perch	3	150	27	130-180	3	43	6	40-50	3	1.39	0.86-1.82
Walleye	11	414	31	370-473	11	795	222	510-1150	11	1.10	0.78-1.38

1 - standard deviation

Table 30. Species- and sampling period-specific sex and state of maturity for fall spawning fish species captured in Sturgeon Bay, fall 2018.

Species and Sex	Spawning Condition – Trip 1				Spawning Condition – Trip 2			
	Early Pre-Spawn	Immediate Pre-spawn	Post-Spawn	Total	Early Pre-Spawn	Immediate Pre-spawn	Post-Spawn	Total
Cisco								
Female	45	-	-	45	3	2	-	5
Male	92	-	-	92	32	2	-	34
Lake Whitefish								
Female	14	-	-	14	-	-	-	0
Male	7	-	-	7	-	-	-	0

Table 31. Biological and capture information for fish marked with individually numbered Floy® tags in Sturgeon Bay, fall 2018.

Floy-Tag	Pre-Fix	Species	Tag Date	Capture Location [1]	Fish ID	Fork Length (mm)	Round Weight (g)	Condition Factor (K)	Sex	Maturity
114526	NSC	Lake Whitefish	12-Oct	GN-11	2	416	1050	1.46	F	2
114527	NSC	Lake Whitefish	12-Oct	GN-13	61	425	960	1.25		
114528	NSC	Lake Whitefish	12-Oct	GN-13	62	420	950	1.28		
114529	NSC	Lake Whitefish	12-Oct	GN-13	63	411	1350	1.94	F	2

1 - capture locations illustrated on Figure 24

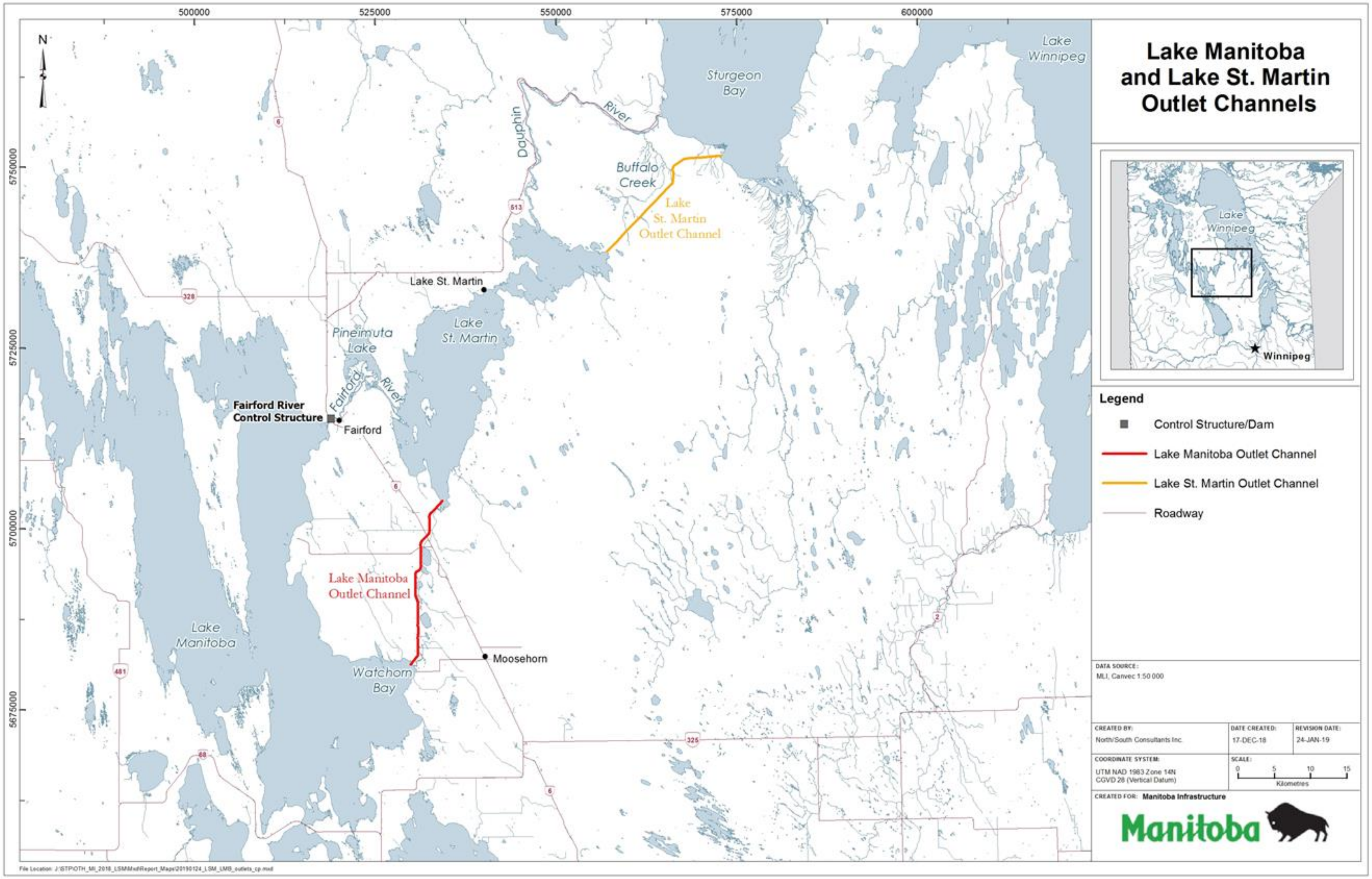


Figure 1. Location of the proposed Lake Manitoba and Lake St. Martin Outlet Channels in central Manitoba.

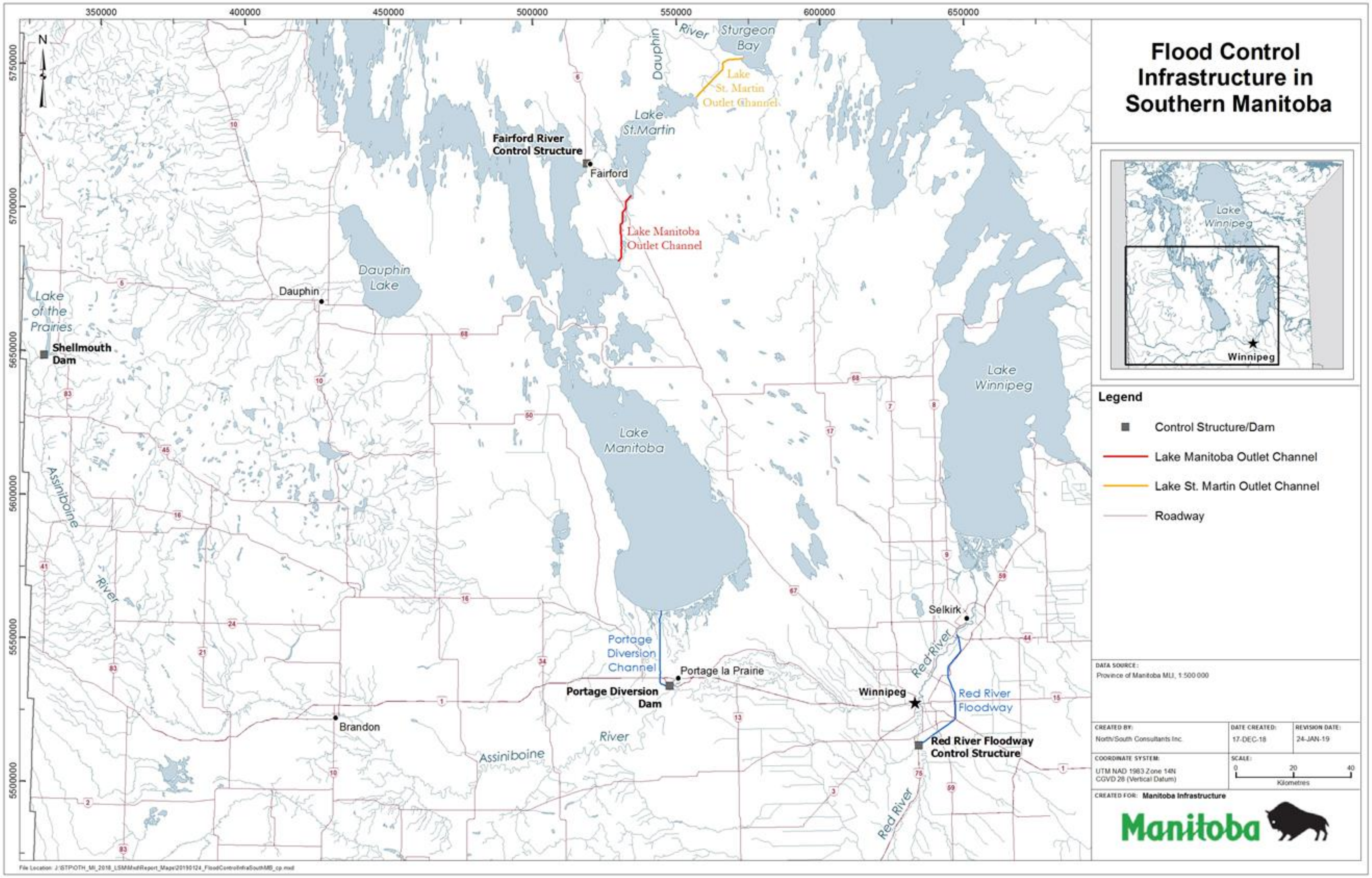


Figure 2. Location of key components of the provincial flood control system in southern Manitoba.

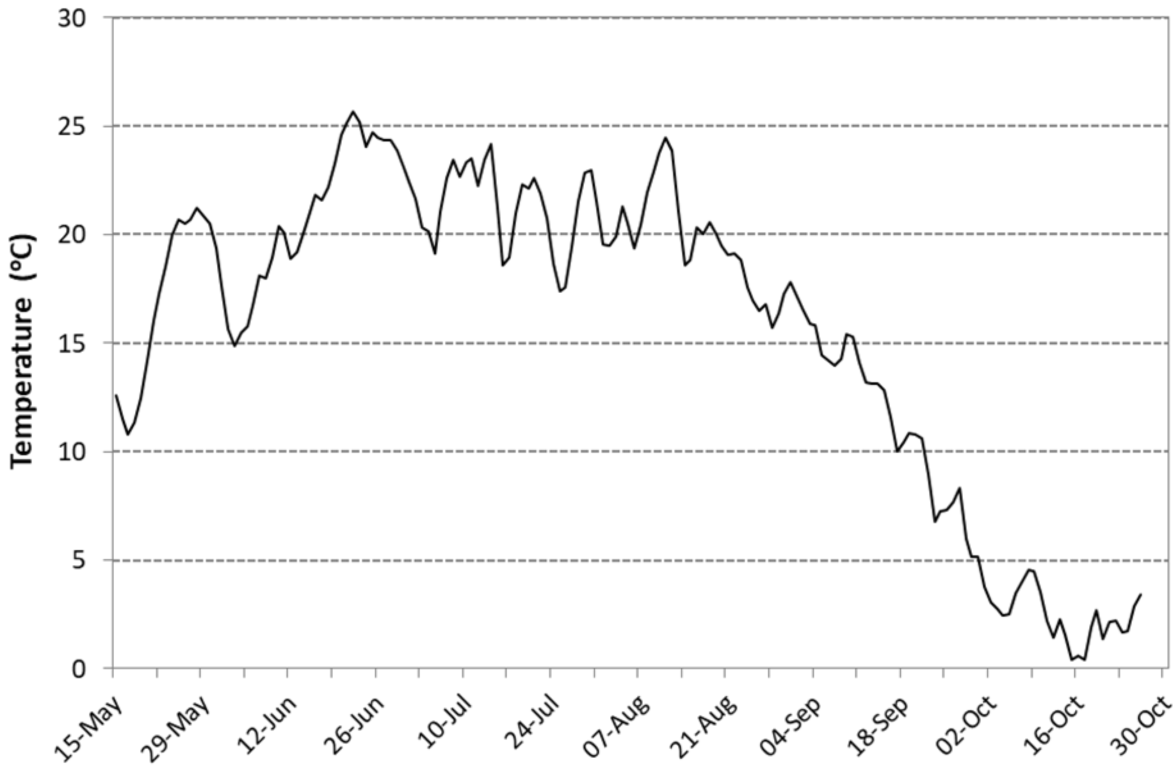


Figure 3. Mean daily water temperature in Lake St. Martin, 2018.

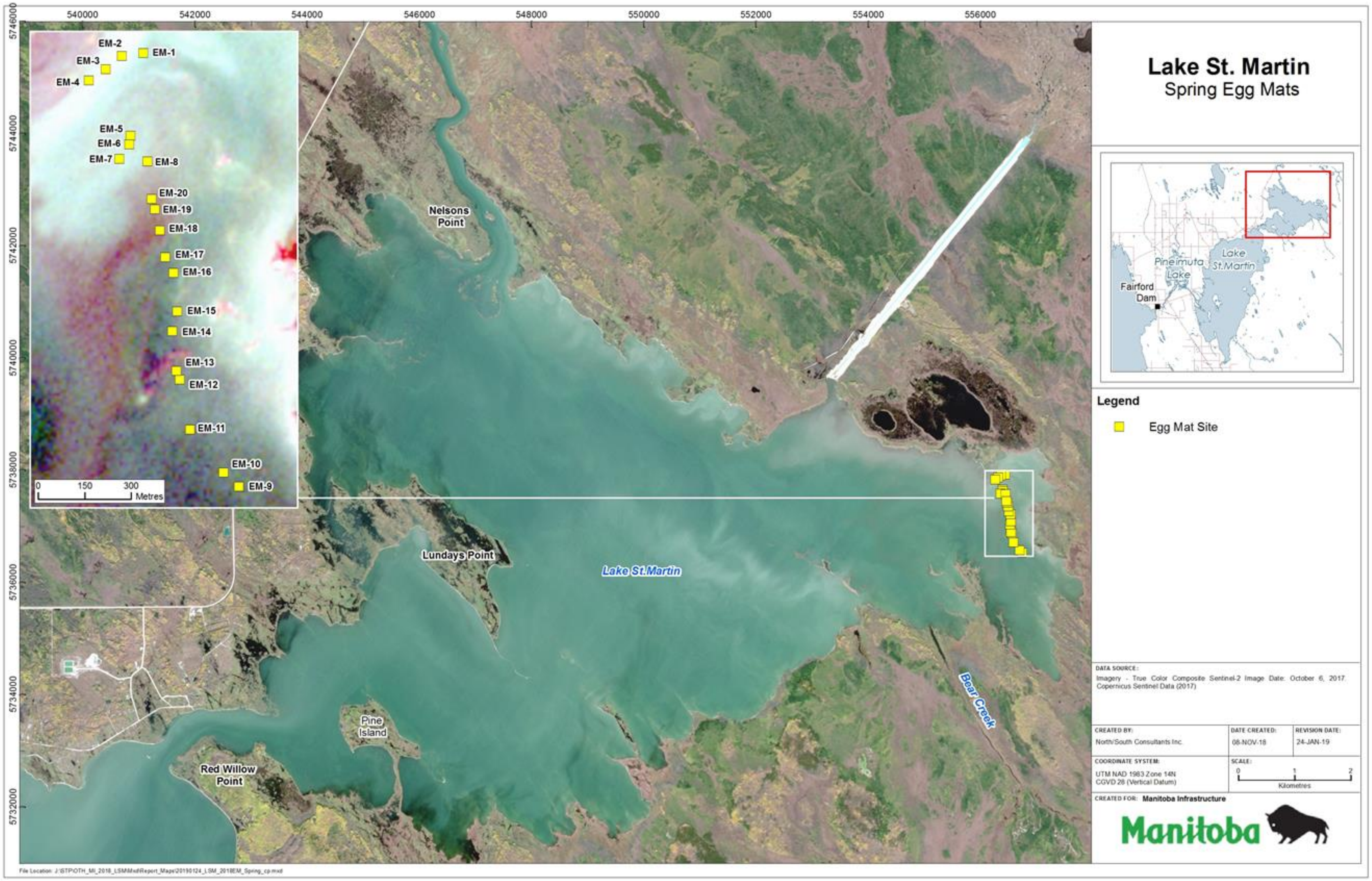


Figure 4. The location of egg mat sampling sites in Lake St. Martin, spring 2018.

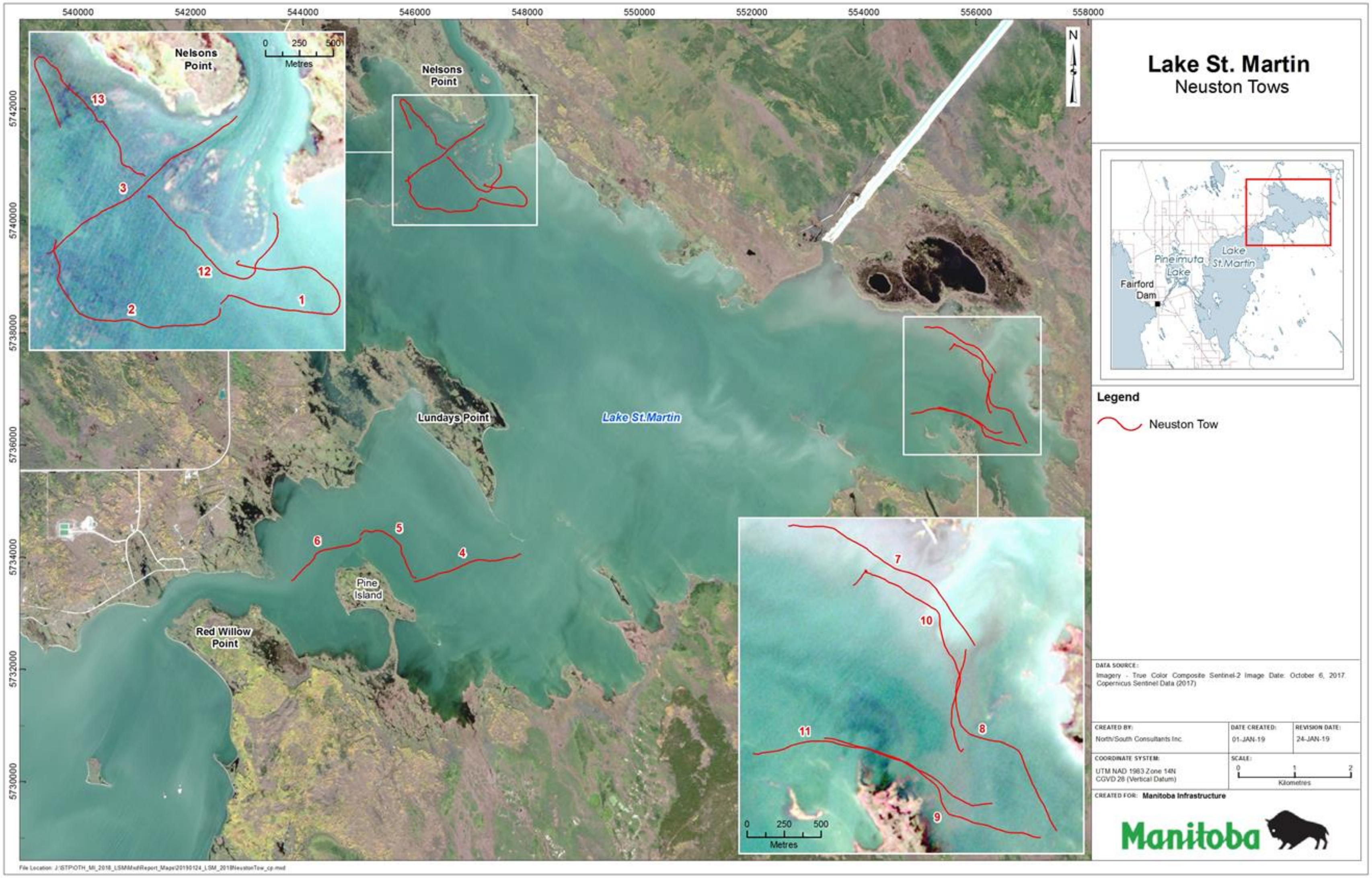


Figure 5. The location of neuston tows in Lake St. Martin, spring 2018.

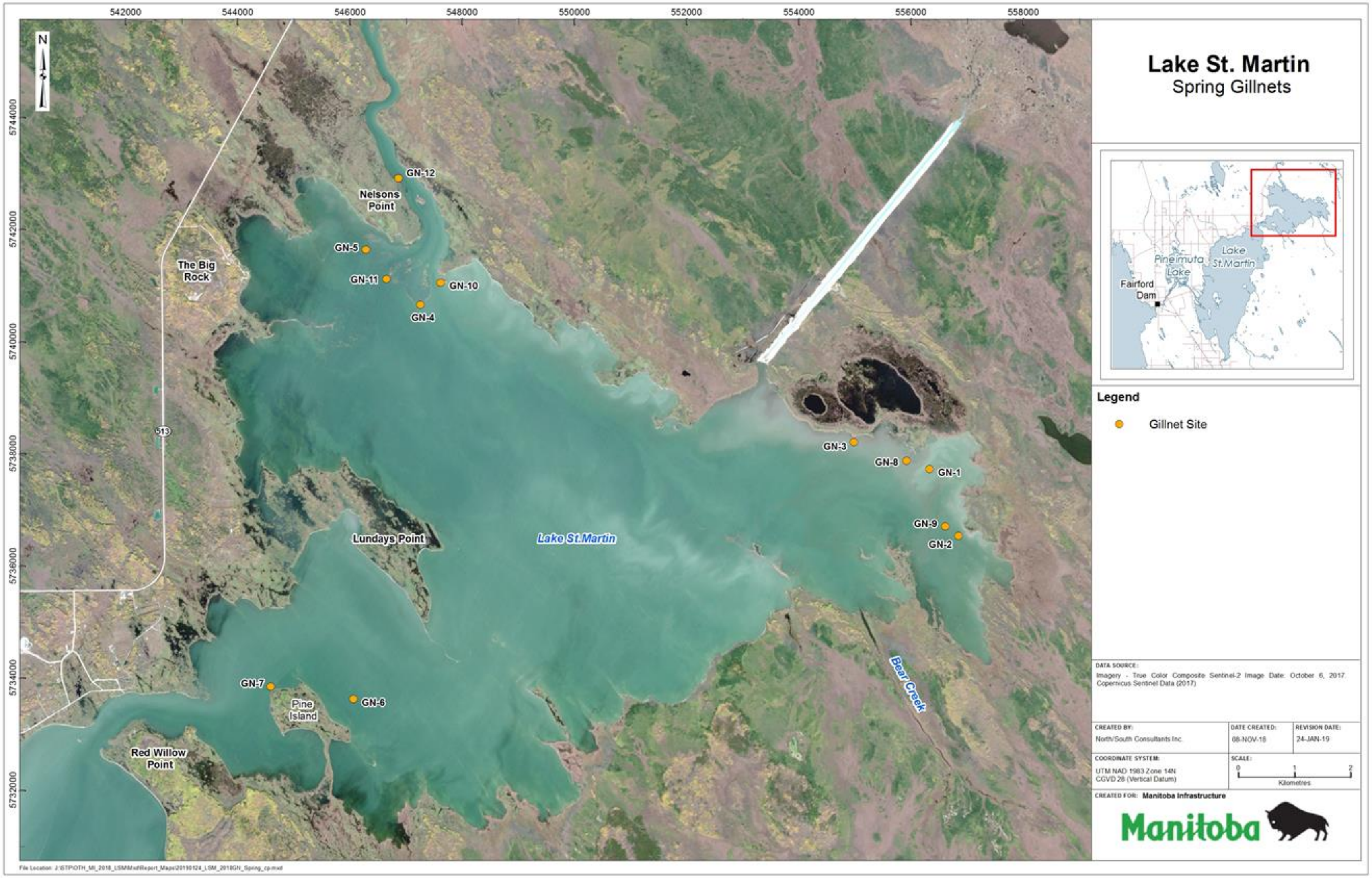
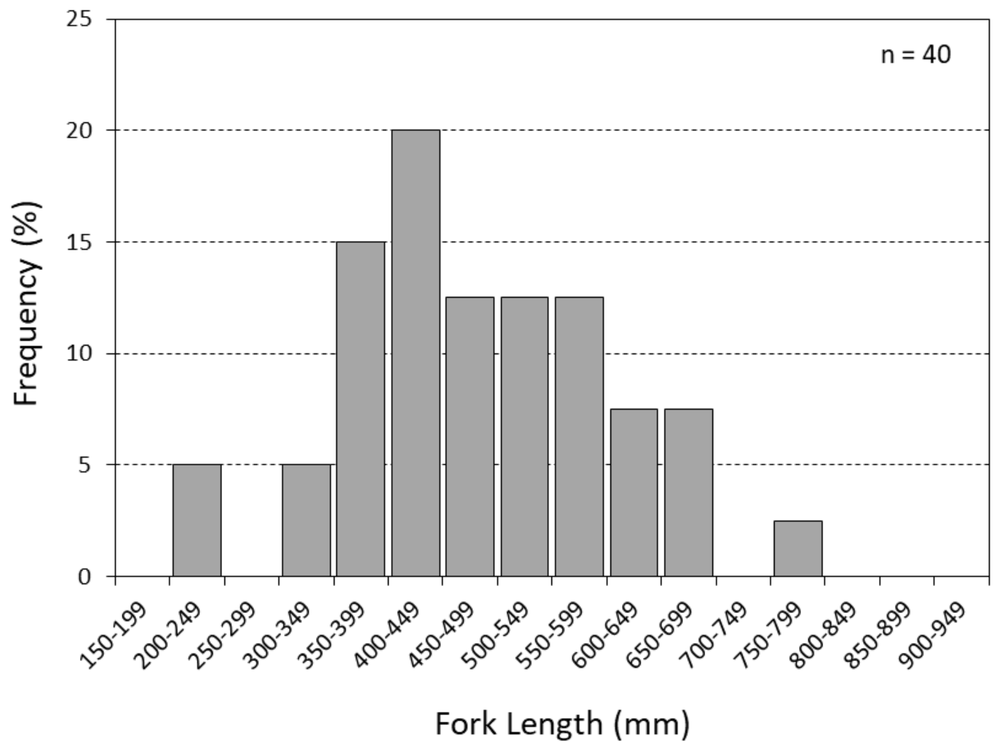


Figure 6. The location of gillnet sites sampled in Lake St. Martin, spring 2018.



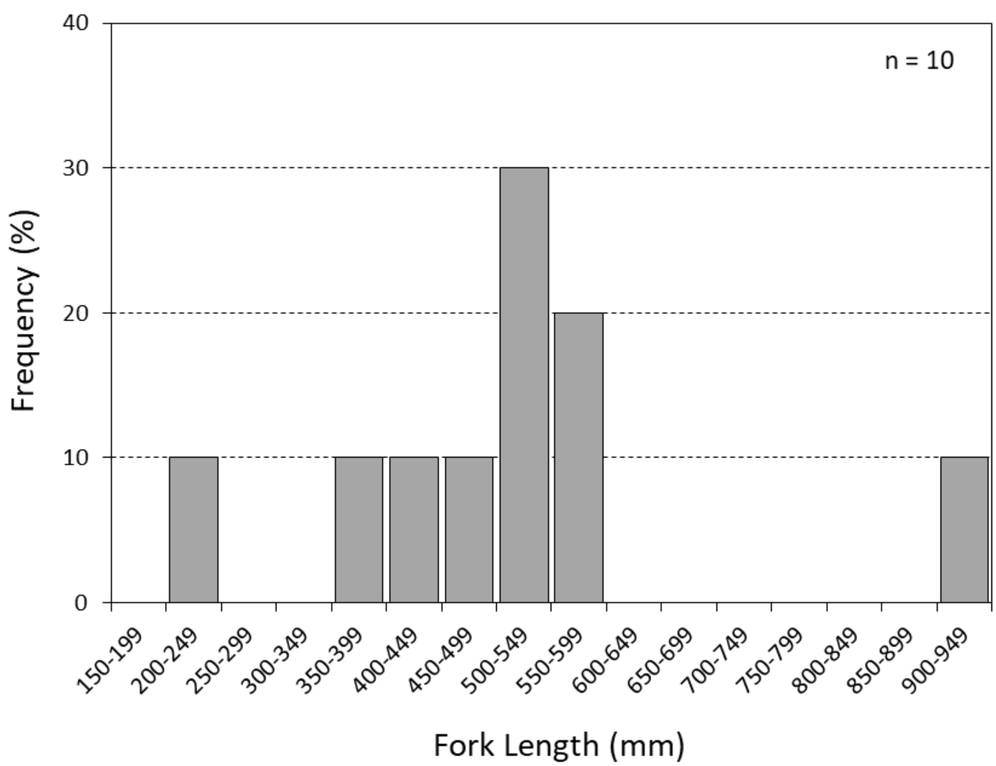
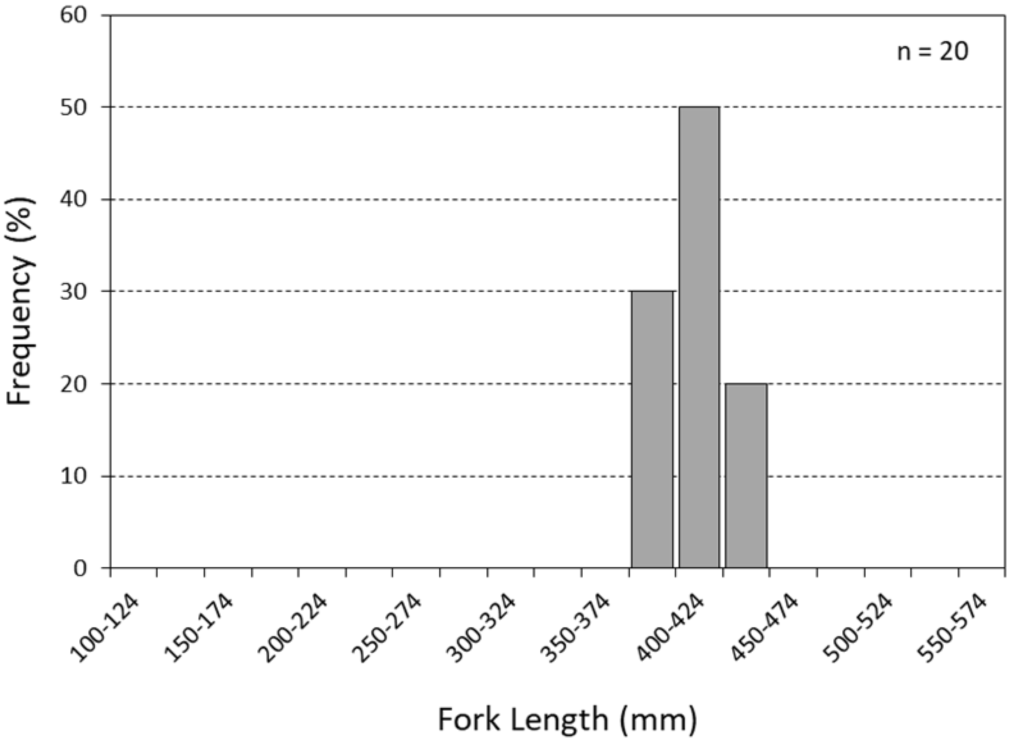


Figure 7. Length-frequency distribution for Northern Pike captured in standard index gillnet gangs set in Lake St. Martin, spring (top) and fall (bottom) 2018.



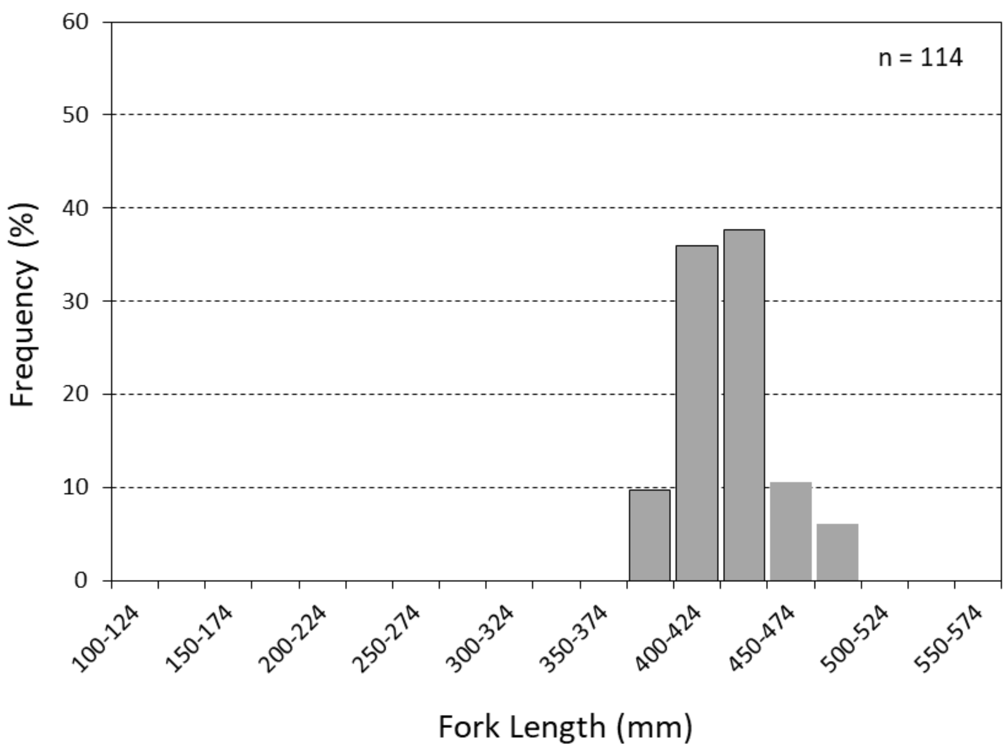
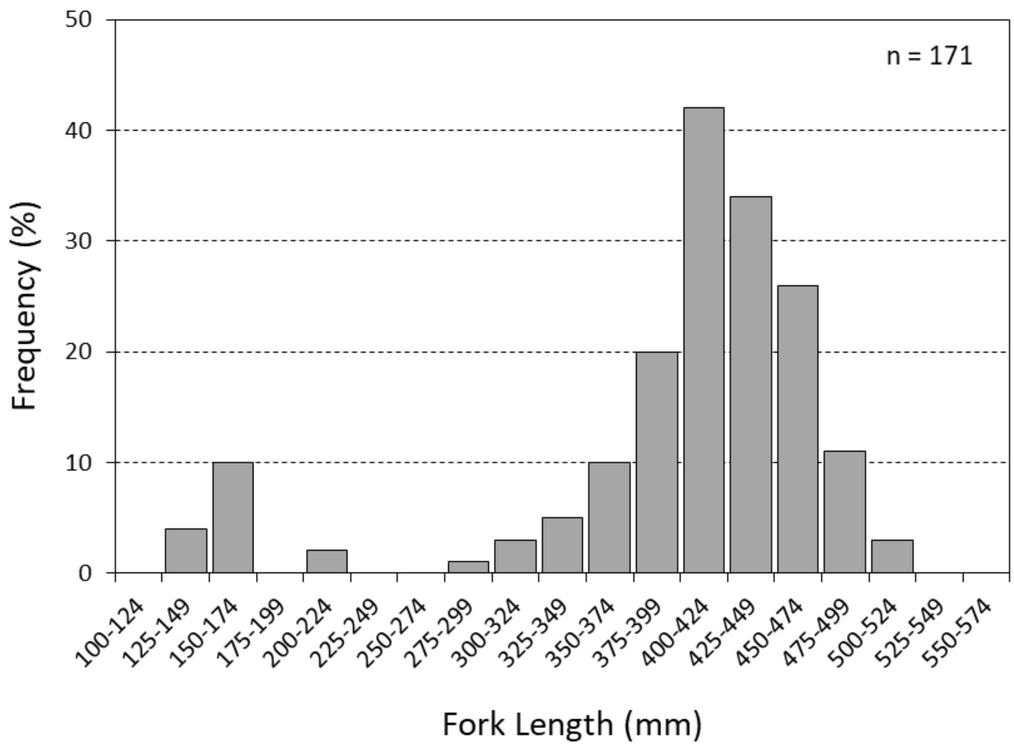


Figure 8. Length-frequency distribution for Lake Whitefish captured in standard index gillnet gangs set in Lake St. Martin, spring (top) and fall (bottom) 2018.



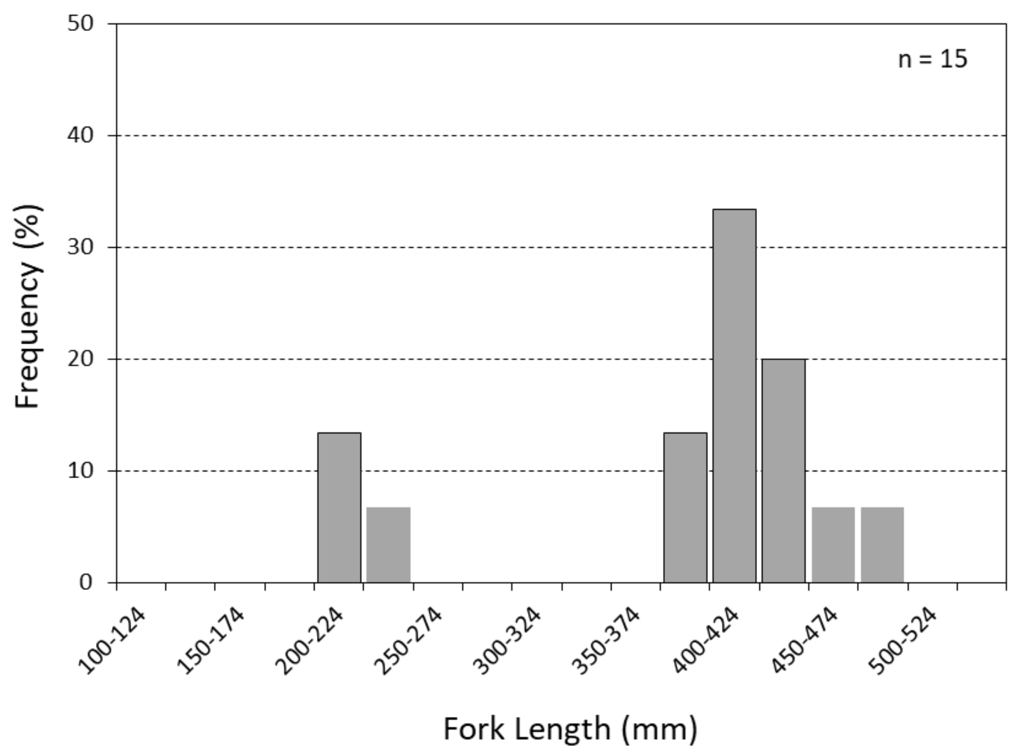


Figure 9. Length-frequency distribution for White Sucker captured in standard index gillnet gangs set in Lake St. Martin, spring (top) and fall (bottom) 2018.

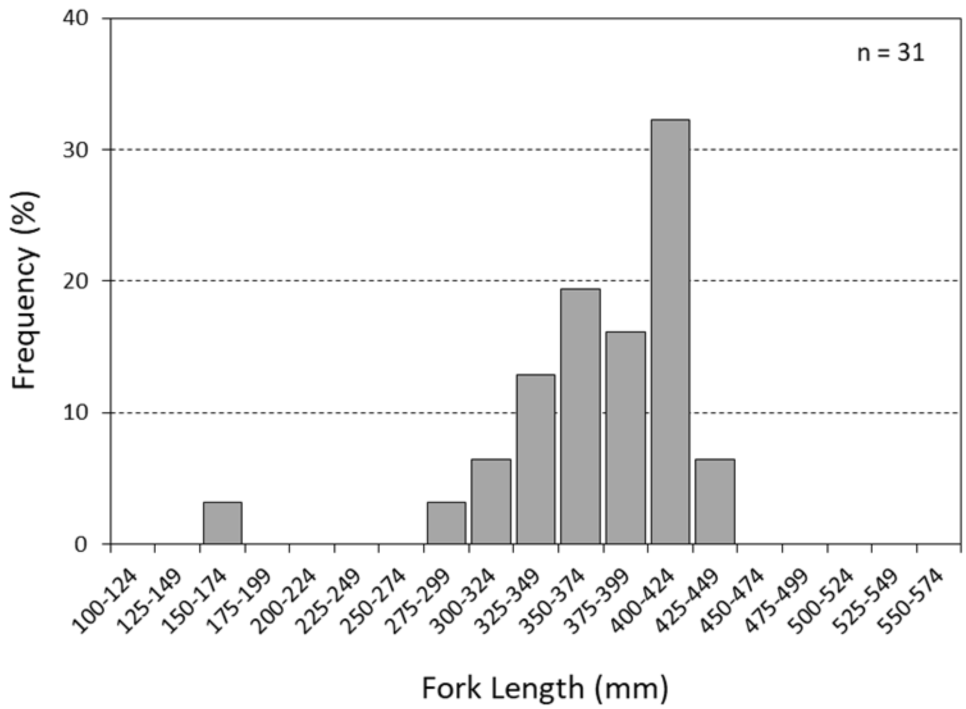


Figure 10. Length-frequency distribution for Shorthead Redhorse captured in standard index gillnet gangs set in Lake St. Martin, spring 2018.

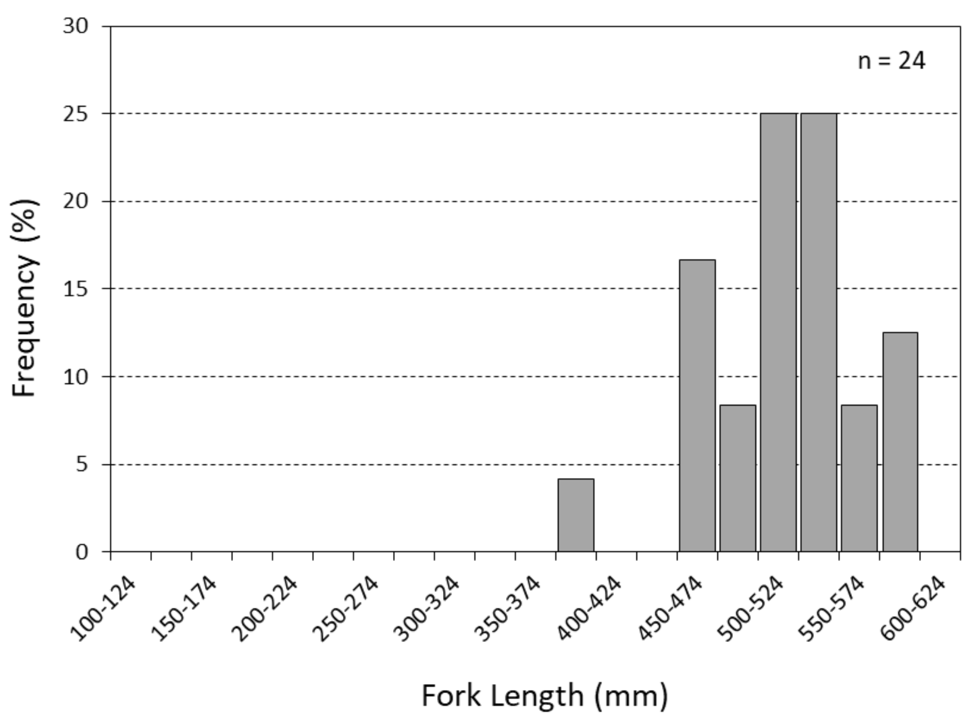
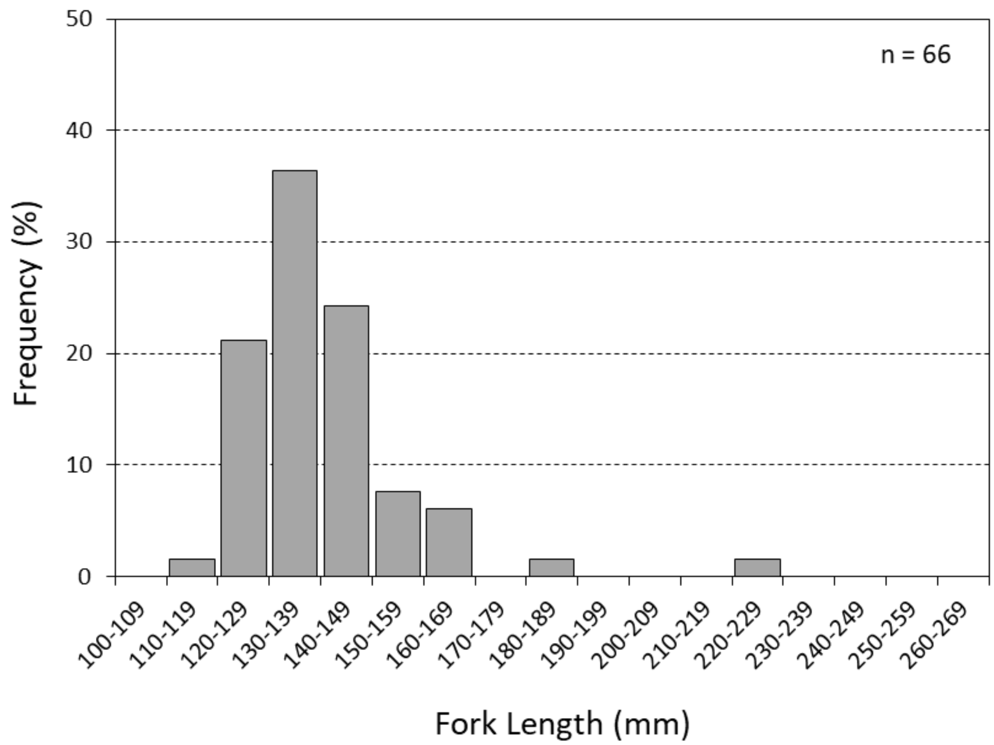


Figure 11. Length-frequency distribution for Longnose Sucker captured in standard index gillnet gangs set in Lake St. Martin, spring 2018.



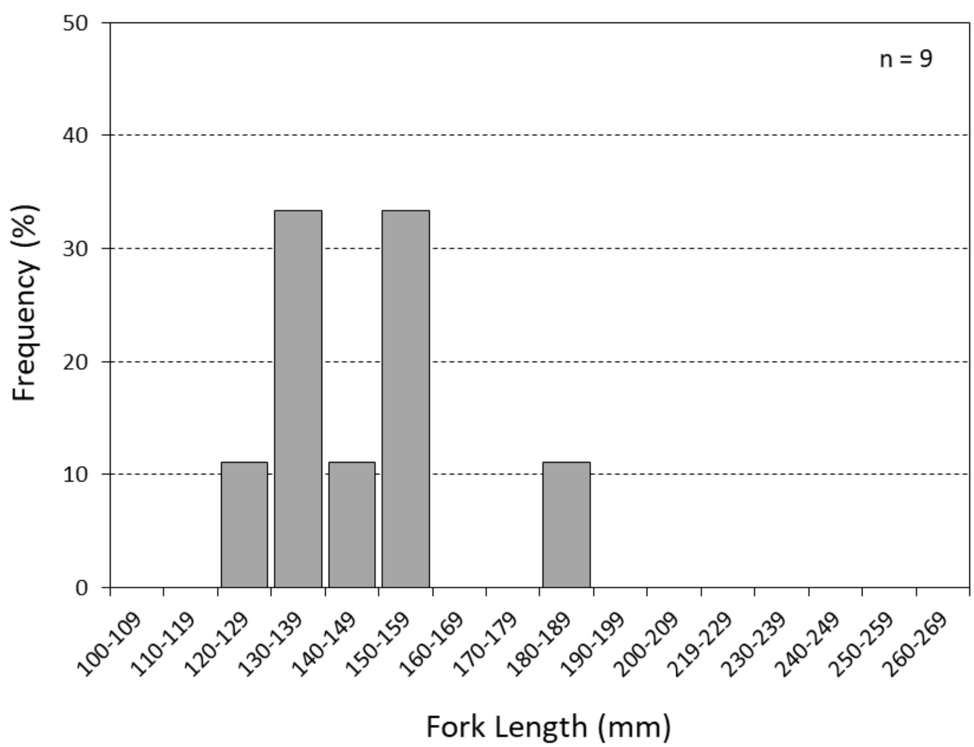


Figure 12. Length-frequency distribution for Yellow Perch captured in standard index gillnet gangs set in Lake St. Martin, spring (top) and fall (bottom) 2018.

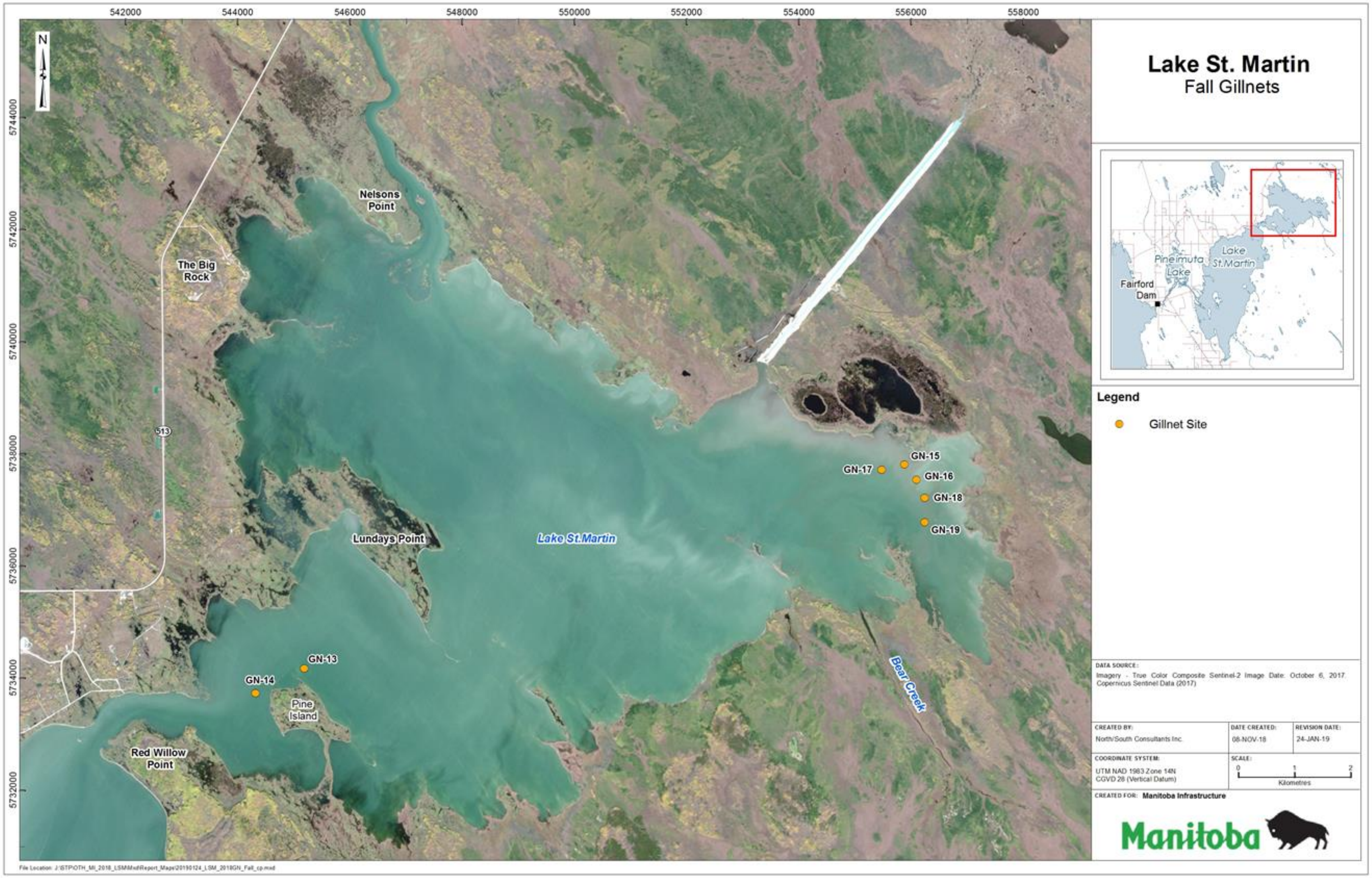


Figure 13. The location of gillnet sites sampled in Lake St. Martin, fall 2018.

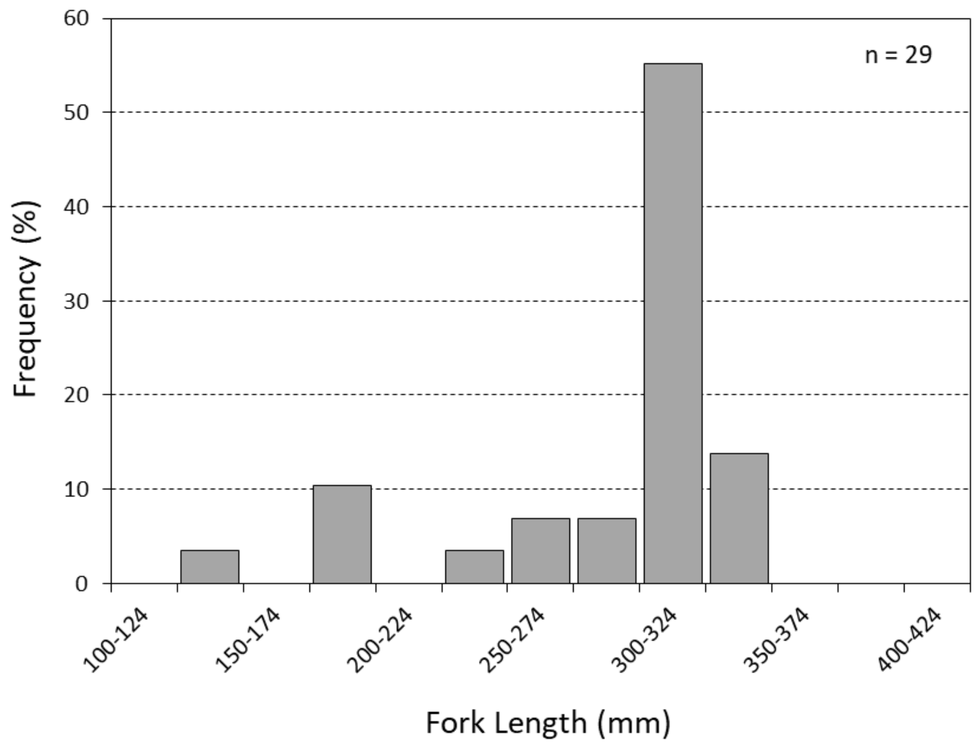


Figure 14. Length-frequency distribution for Cisco captured in standard index gillnet gangs set in Lake St. Martin, fall 2018.

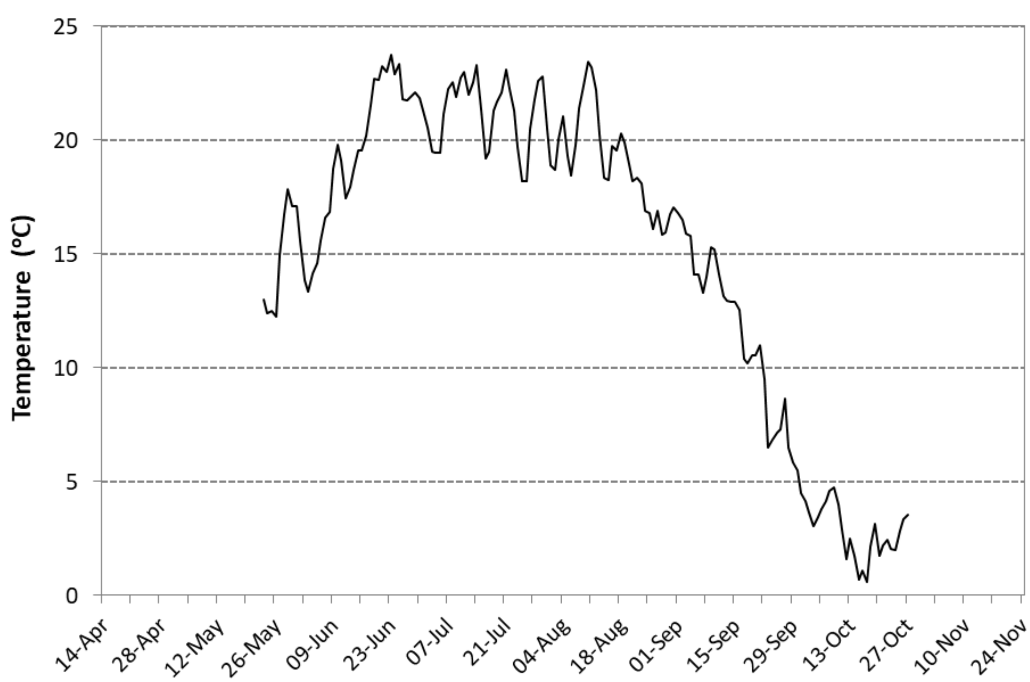


Figure 15. Mean daily water temperature in Sturgeon Bay, 2018.

Figure 16. The location of egg mat sampling sites in Sturgeon Bay, spring 2018.

Figure 17. The location of egg mat sampling sites in Sturgeon Bay, fall 2018.

Figure 18. The location of neuston tows in Sturgeon Bay, spring 2018.

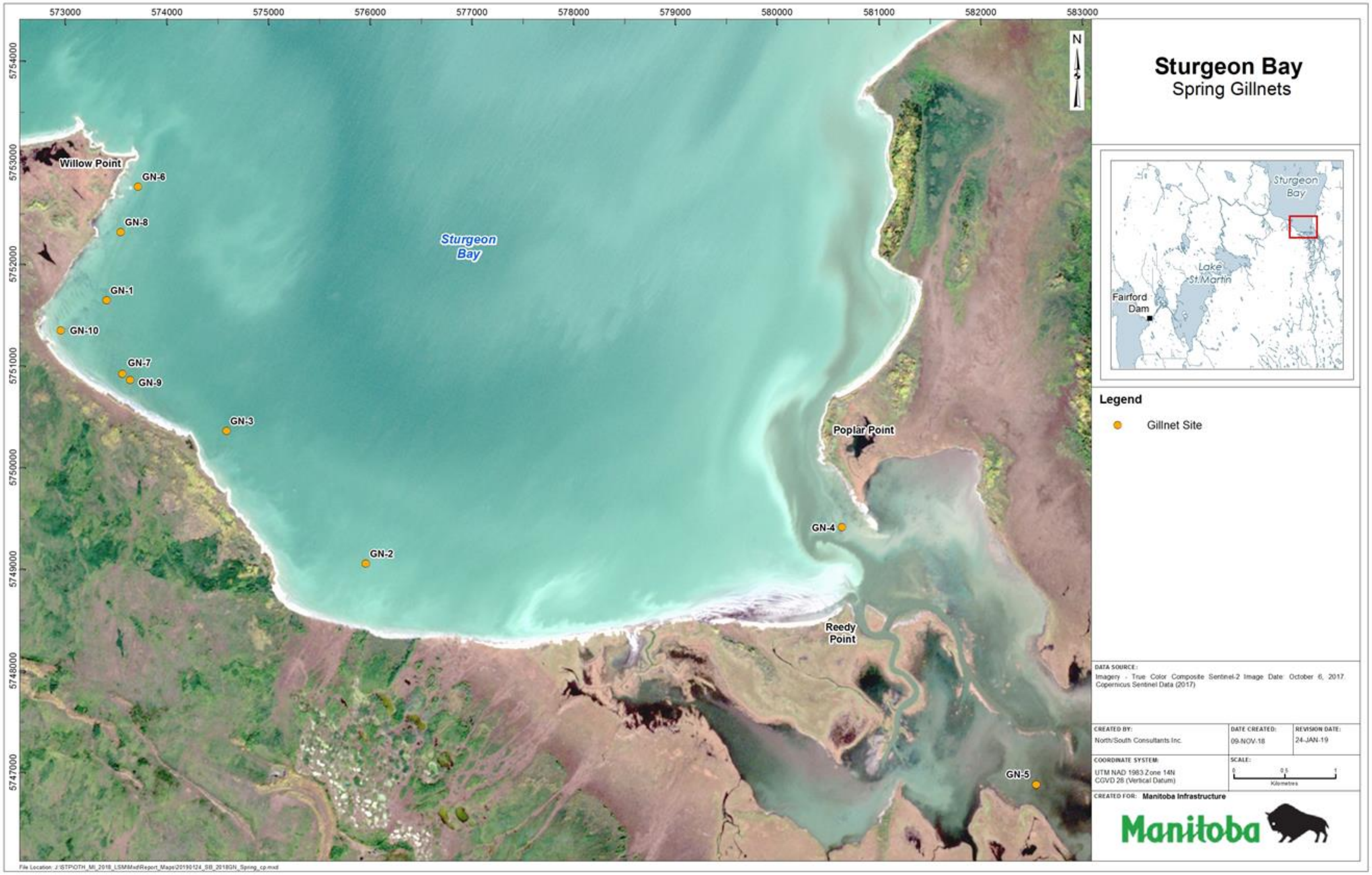


Figure 19. The location of gillnet sites sampled in Sturgeon Bay, spring 2018.

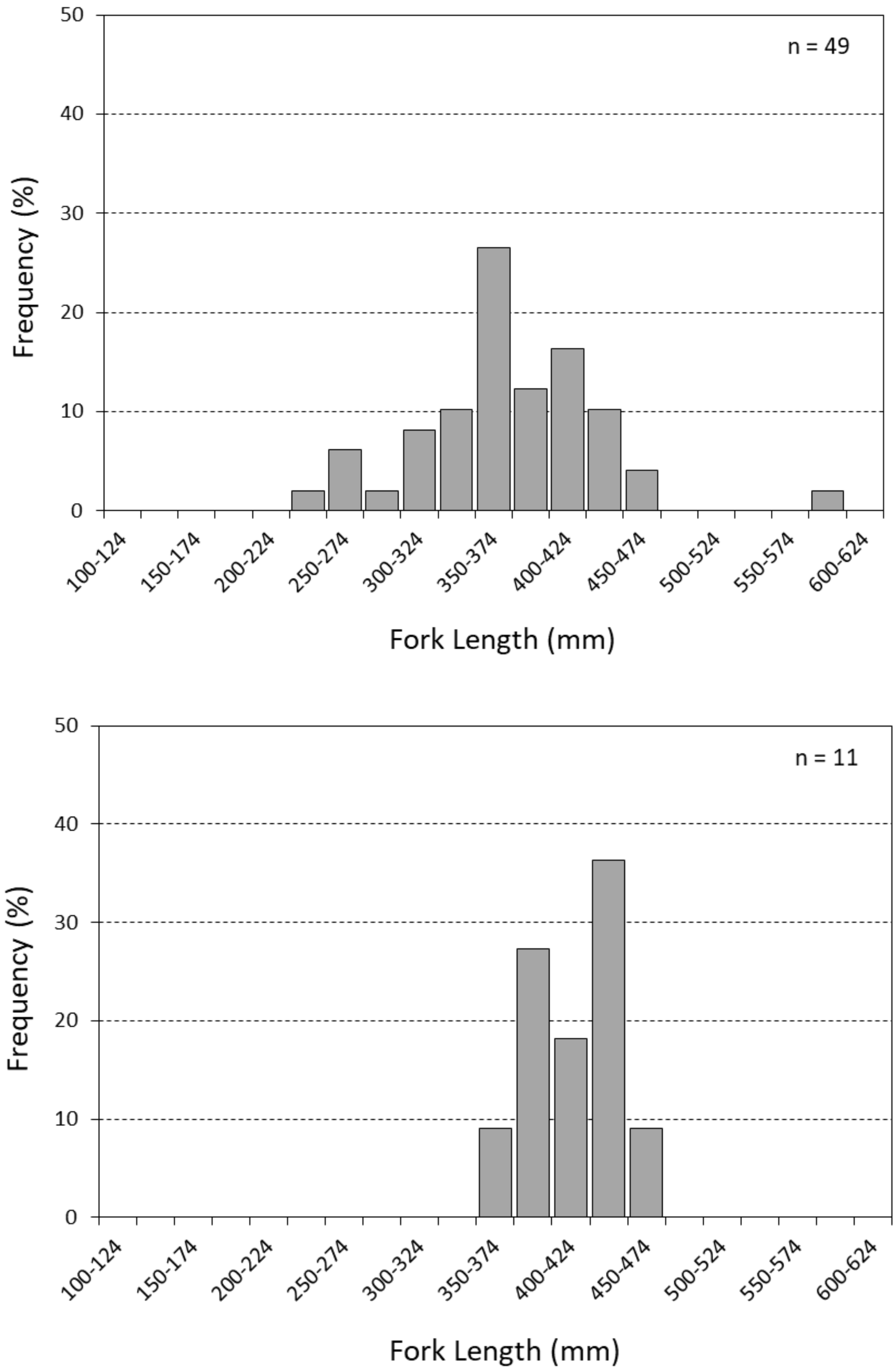
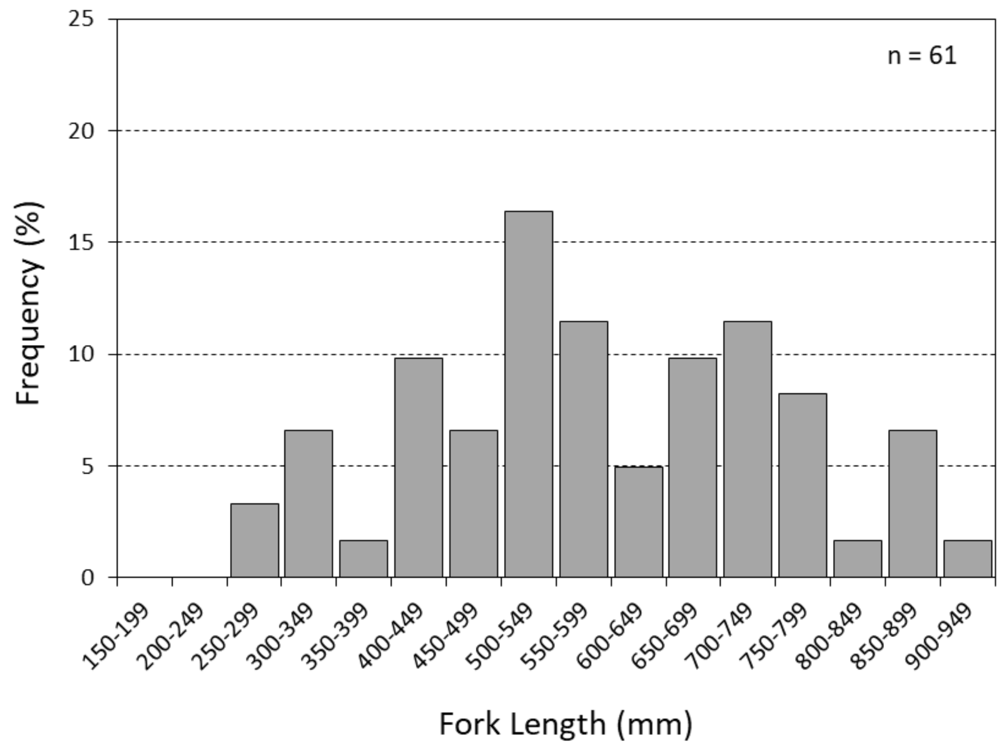


Figure 20. Length-frequency distribution for Walleye captured in standard index gillnet gangs set in Sturgeon Bay, spring (top) and fall (bottom) 2018.



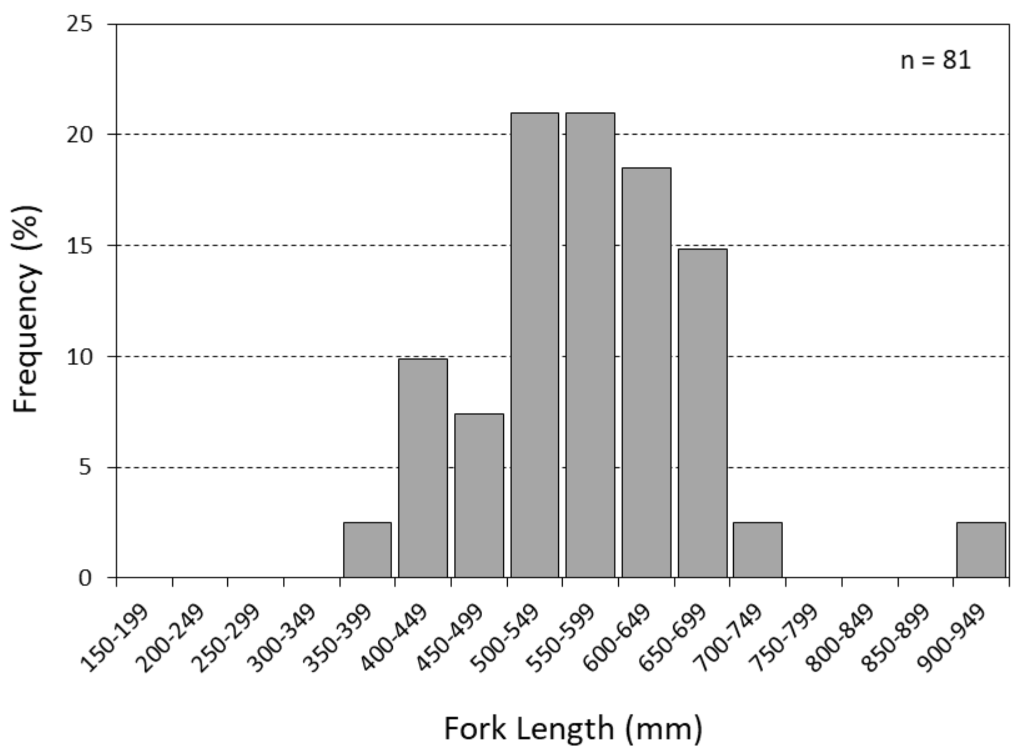
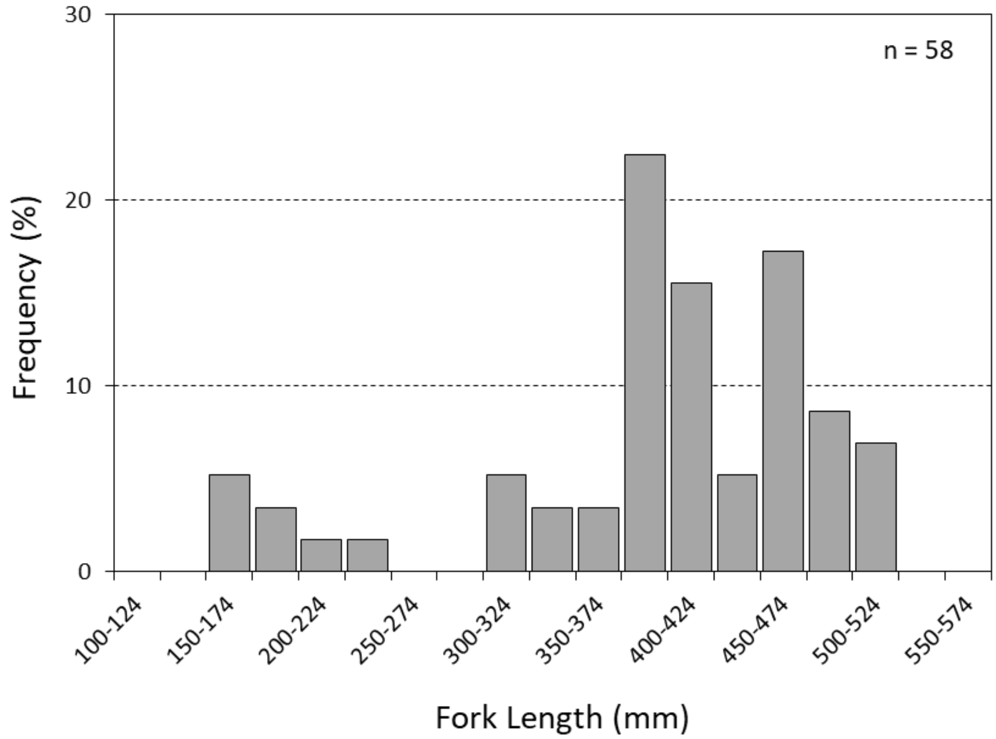


Figure 21. Length-frequency distribution for Northern Pike captured in standard index gillnet gangs set in Sturgeon Bay, spring (top) and fall (bottom) 2018.



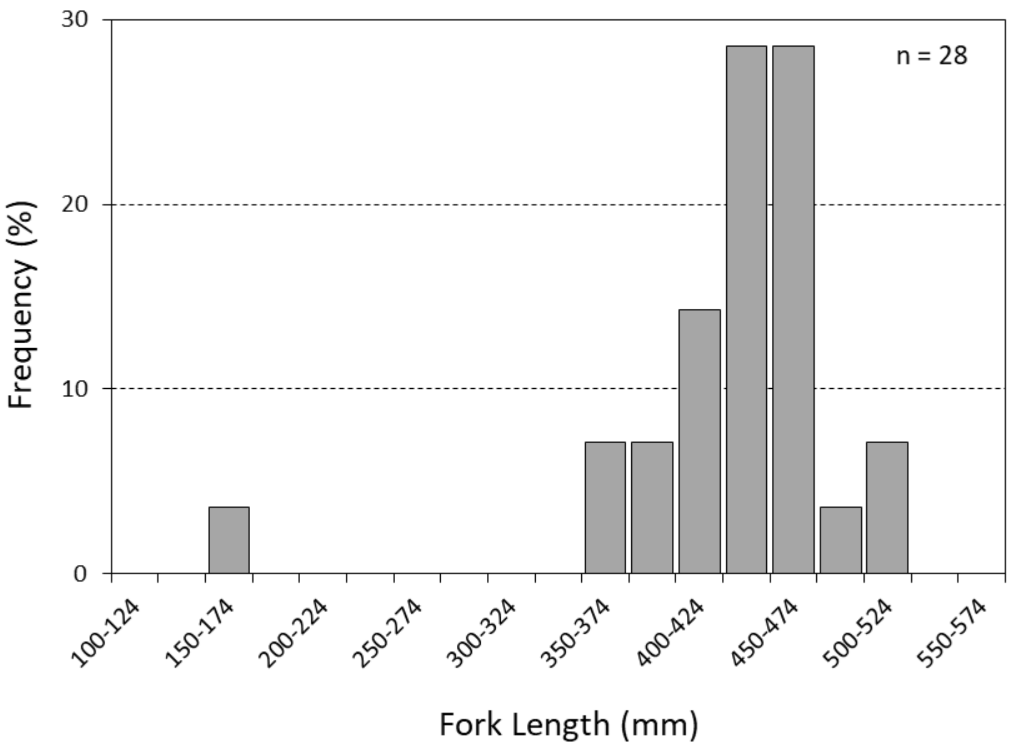


Figure 22. Length-frequency distribution for White Sucker captured in standard index gillnet gangs set in Sturgeon Bay, spring (top) and fall (bottom) 2018.

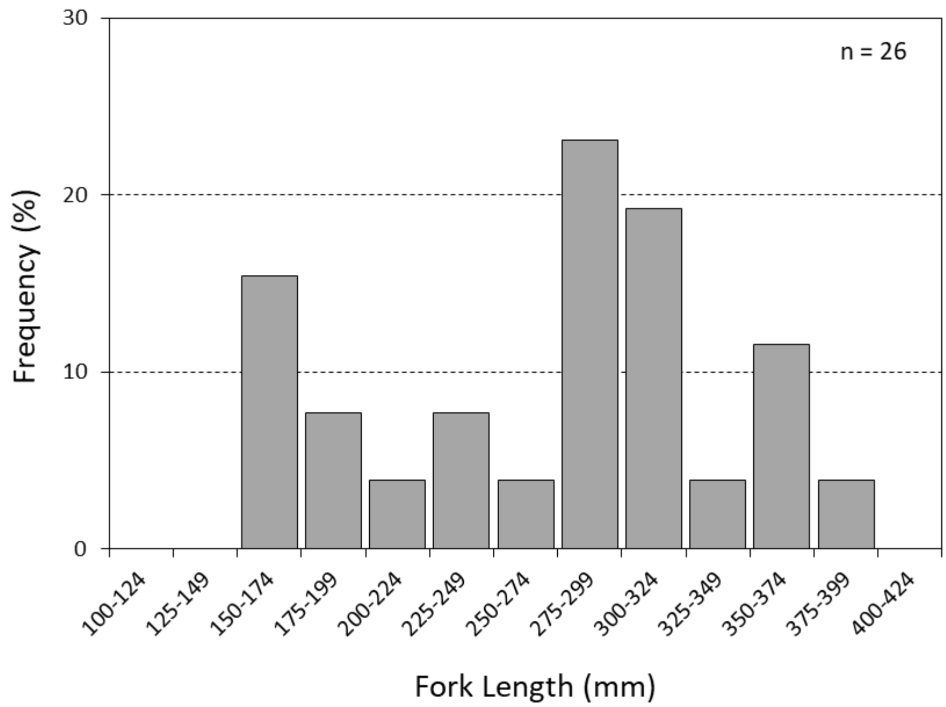


Figure 23. Length-frequency distribution for Shorthead Redhorse captured in standard index gillnet gangs set in Sturgeon Bay, spring 2018.

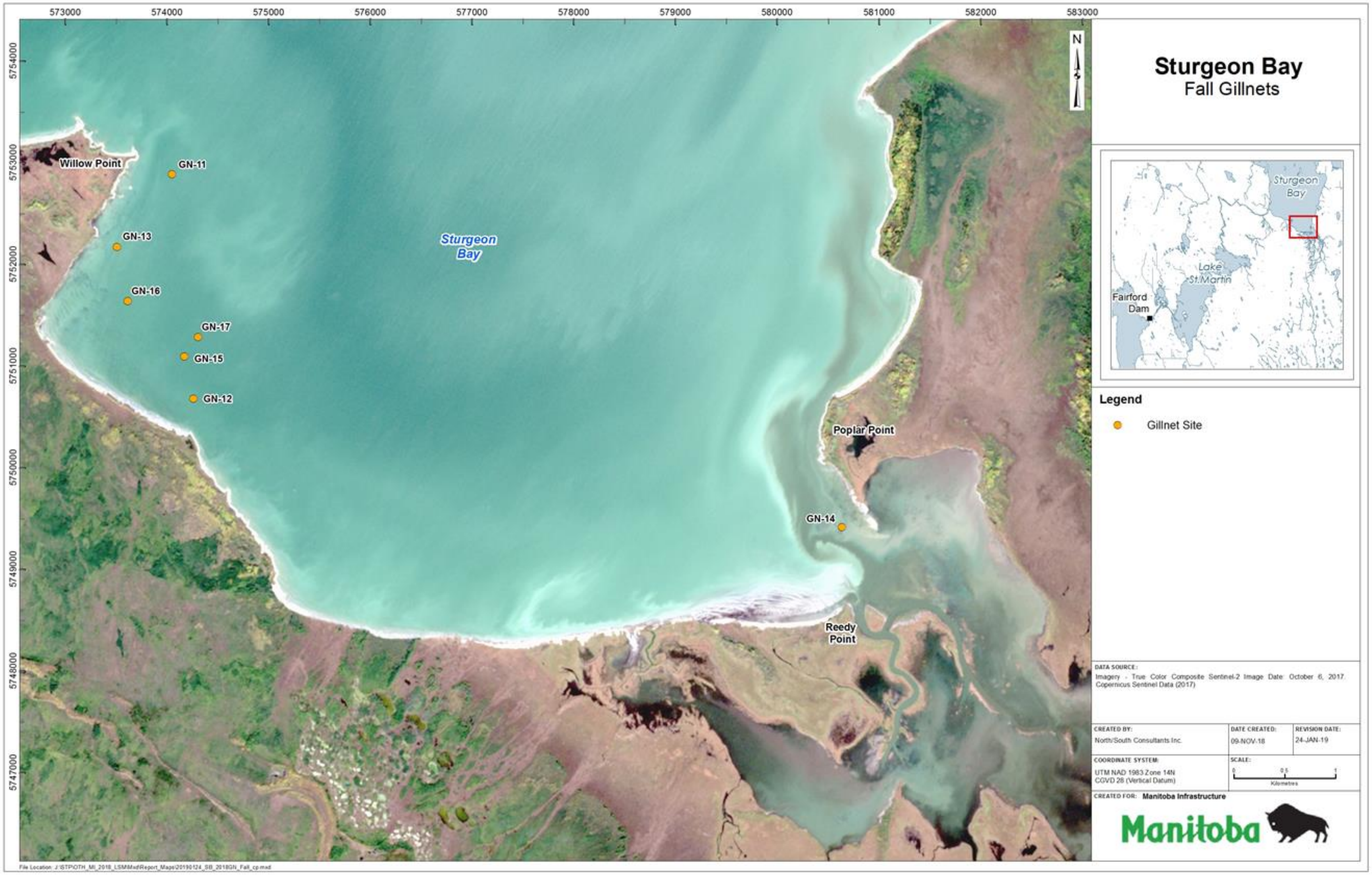


Figure 24. The location of gillnet sites sampled in Sturgeon Bay, fall 2018.

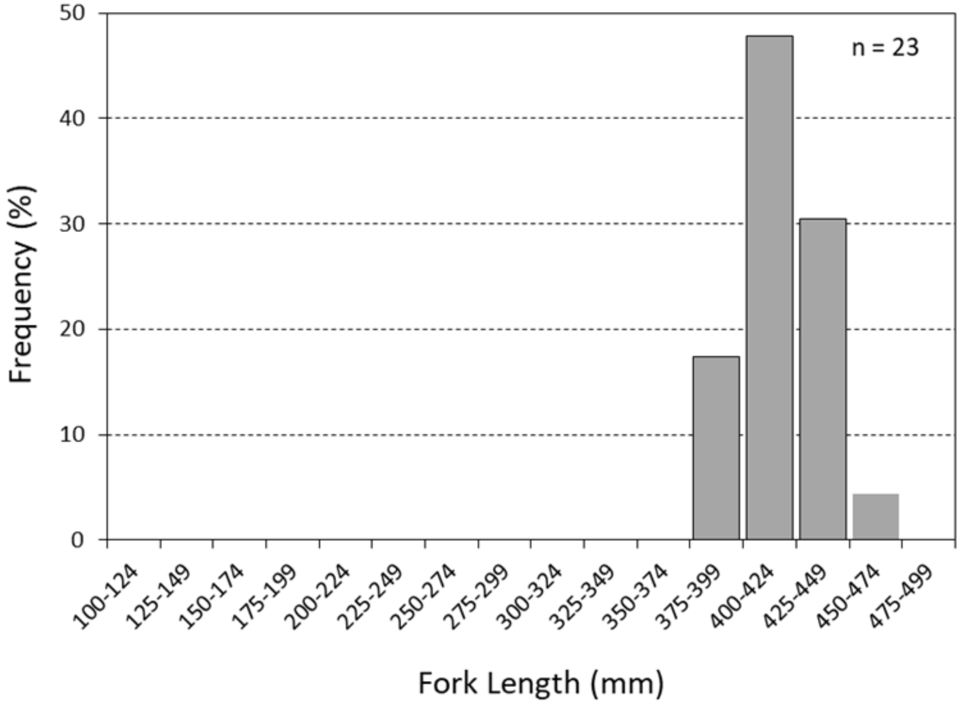


Figure 25. Length-frequency distribution for Lake Whitefish captured in standard index gillnet gangs set in Sturgeon Bay, fall 2018.

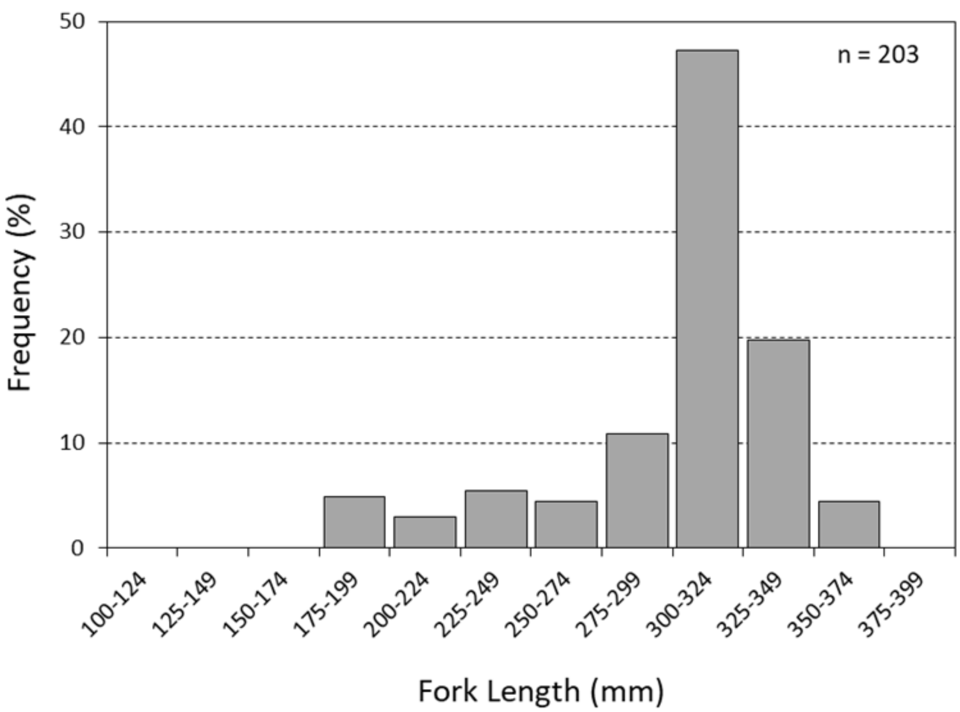


Figure 26. Length-frequency distribution for Cisco captured in standard index gillnet gangs set in Sturgeon Bay, fall 2018.