Keeyask Generation Project

Fisheries Offsetting and Mitigation Plan

Lake Sturgeon Production and Stocking Report

FOMP-2017-01

KEEYASK

Manitoba Sustainable Development Client File 5550.00
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2016 - 2017

KEEYASK GENERATION PROJECT

FISHERIES OFF-SETTING AND MITIGATION PLAN

REPORT #FOMP-2017-01

LAKE STURGEON PRODUCTION AND STOCKING SUMMARY FOR BIRTHDAY RAPIDS AND BURNTWOOD RIVER POPULATIONS

OCTOBER 2015 TO SEPTEMBER 2016: YEAR 3 CONSTRUCTION

Prepared for

Manitoba Hydro

By

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June 2017

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SUMMARY

Background

Construction of the Keeyask Generation Project at Gull Rapids began in July 2014. Before the government allowed construction to begin, the owner, Keeyask Hydropower Limited Partnership (KHLP), had to prepare a plan outlining activities that could reduce the potential effects of the Keeyask Generation Project on fish and water quality in the Nelson River. The plan also explained how the proposed activities would be completed and monitored.

Activities directed at Lake Sturgeon (*Namao* in Cree) were included in the plan because of its importance to the partner First Nations, because the populations in Gull and Stephens lakes were low before the Project and because the generating station will change or destroy habitat. Spawning habitat at Gull Rapids is being lost due to construction of the generating station. Reservoir impoundment will raise water levels, which will change spawning habitat at Birthday Rapids. And altered flows will change young-of-the-year habitat in Stephens Lake.

In April 2017, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) reviewed and maintained the previous (2006) recommendation of listing the Nelson River population of Lake Sturgeon as Endangered. The goal of the KHLP is to have self-sustaining populations of Lake Sturgeon in this area in the future. To help achieve this, the KHLP has made a commitment to produce and release hatchery-reared sturgeon into the Burntwood River and the lower Nelson River until there is a self-sustaining population.

This summary describes the hatchery production and stocking activities from October 2015 to September 2016.

Stocking Program

Lake Sturgeon are produced at the Grand Rapids Fish Hatchery (GRFH) located in Grand Rapids, MB from the eggs and milt (sperm) of wild adults. Offspring are reared in fiberglass troughs using well water, although surface water from the Saskatchewan River is available as a back-up water source in emergency situations. Fish are started on a diet of newly hatched brine shrimp and later transitioned to frozen bloodworm.

Lake Sturgeon are released as larvae (less than 1 month old) and fingerlings (3 to 4 months old) when lack of tank space limits fish growth. At these stages, fish are not large enough to be marked. Instead, tissue samples from individuals representing each family group are preserved to provide a genetic “fingerprint”, allowing future identification of stocked individuals from this family. Each year some of the fingerlings are kept over winter at GRFH and released as yearlings (12 to 15 months old). Prior to release, yearlings are marked with uniquely numbered Passive Integrated Transponder (PIT) tags (8 mm long x 1.4 mm diameter) inserted into the muscle along the fish’s back. PIT tag scanners held over the fish can detect a tag and display the number on a screen. This marking technique helps to identify hatchery-reared fish caught in the river and can be used to assess the movement and growth of individual fish following

stocking. To avoid altering the existing genetic make-up of Lake Sturgeon populations along the Nelson River (and its tributaries), hatchery-reared sturgeon are released into areas that contain the same population of their parents.

GRFH operates under provincially issued Live Fish Handling Permits. Stocking approvals are granted by Manitoba Sustainable Development.

BURNTWOOD RIVER POPULATION (2015 YEAR-CLASS)

Hatchery Production

Eggs and milt were collected in spring 2015 from spawning adults captured below First Rapids. Due to poor hatch (<1%), no Burntwood River larvae or fingerlings were released in 2015. A total of 23 fingerlings were kept at GRFH to grow over the winter of 2015/16. Survival was 100% from the beginning of October 2015 until the spring stocking event in May 2016.

Stocking

On May 31, 2016 all 23 Lake Sturgeon yearlings were transported by truck to the Orr Creek boat launch located on the Burntwood River. Twenty individuals were released by boat at a single location downstream of First Rapids (Site 1, see map below). The remaining three sturgeon were stocked by members of Tataskweyak Cree Nation from shore in a ceremonial release event (Site 2, see map below). Yearlings had an average total length of 32 cm and an average weight of 30 g at the time of stocking.

Stocking sites for Burntwood River Lake Sturgeon (2015 year-class) released into the Burntwood River, May 2016.

BIRTHDAY RAPIDS POPULATION (2016 YEAR-CLASS)

Spawn Camp

Wild Lake Sturgeon adults were captured using gill nets set downstream of Birthday Rapids in May 2016. Adults identified to be spawning fish were maintained in tanks along the shore of the Nelson River for several days. Selected adults received a small dose of hormone to facilitate the release of eggs and milt. Use of this hormone does not present a threat to the Lake Sturgeon or to humans. It is a hormone present within the fish during natural spawn. This method has been successfully used by other sturgeon conservation programs in North America and helps to coordinate egg fertilization activities at the spawn camp.

On May 31, the milt of one male was mixed with the eggs of two females to create two family groups. The total number of eggs collected was estimated to be 497,500. After being transported by air from the spawn camp to Thompson, the fertilized eggs were driven to GRFH.

Hatchery Production

Prior to entering GRFH, the sturgeon eggs were soaked in a disinfectant for 10 minutes to kill any potential pathogens (e.g., viruses) that may have attached to the surface of the egg during fertilization and/or transportation. Hatch began on June 9 resulting in an estimated 440,013 larvae (88% hatch success). From the point of hatch to the end of September, overall survival was 87%.

Following the fingerling release in September, a total of 1,250 fish from the Birthday Rapids population were kept at GRFH to grow over the winter.

Lake Sturgeon fingerlings from the Birthday Rapids population prior to release into Gull Lake, September 2016

Stocking

There were several stocking events in 2016 to release offspring from the Birthday Rapids population. On June 21, an estimated 192,167 larvae were released into an area immediately

downstream of Birthday Rapids (Site 1, see map below). On June 23, an estimated 175,354 larvae were released in Stephens Lake downstream of Gull Rapids (Site 2, see map below). North South Consultants assisted with the stocking.

Due to high survival rates at Grand Rapids Fish Hatchery, another stocking event was required during summer to avoid overcrowding in the hatchery. On July 26, a total of 8,780 sturgeon were released into Stephens Lake (Site 3, see map below). The sturgeon had an average total length of 4 cm and an average weight of 0.3 g at the time of stocking.

On September 27, a total of 780 fingerlings were released into Gull Lake (Site 4 & 5, see map below). Two days later on September 29, a total of 799 fingerlings were released into Stephens Lake (Site 3 & 6, see map below). The fingerlings had an average total length of 11 cm and an average weight of 5.3 g at the time of stocking.

Stocking sites were selected based on having suitable juvenile habitat and included locations where juveniles have been previously captured.

Stocking sites for Birthday Rapids Lake Sturgeon (2016 year-class) released into the Keeyask area, June to September 2016.

Future Activities

Hatchery-reared sturgeon from the Birthday Rapids population will be released as yearlings into the Keeyask area in 2017. Egg and milt collection from wild adults will take place in the Burntwood River in spring 2017.

A final design for the Grand Rapids Fish Hatchery upgrade and expansion project is expected to be completed in 2018. This project is being undertaken to increase the number of yearling Lake

Sturgeon that can be produced at the hatchery and to improve the rearing conditions for the fish. Upgrades are also necessary to reach national and provincial biosecurity standards which have been developed to reduce the risk of pathogens (e.g., virus) from entering and spreading throughout a facility.

ACKNOWLEDGEMENTS

Keeyask Hydropower Limited Partnership is thanked for the resources to produce and stock Lake Sturgeon from the Birthday Rapids and Burntwood River populations.

North South Consultants are thanked for their field assistance in setting up spawn camps, collecting gametes and stocking fish. Joe Hunter (Sustainable Sturgeon Culture) provided valuable expertise during Lake Sturgeon gamete collection. Field staff from Manitoba Hydro's Waterways Management Program are thanked for their assistance with stocking fish.

Staff from the Grand Rapids Generating Station are thanked for their assistance with building and hatchery equipment maintenance.

The collection of Lake Sturgeon broodstock and release of their offspring described in this report was authorized by Manitoba Sustainable Development under the terms of Live Fish Handling Permits.

PRODUCTION AND STOCKING TEAM

Grand Rapids Fish Hatchery

Yhana Michaluk, Supervisor
Laura Groening, Senior Staff
Meagan Alexander, Senior Staff
Jerry Cook, Staff
Morgan Blacksmith, Staff
Bryce Taylor, Staff
Tobias Dolinski, Staff
Gordon Scott, Seasonal Staff
Cory Ferland, Seasonal Staff

Environmental Licensing and Protection Department

Shelley Matkowski, Department Manager
Warren Coughlin, Senior Environmental Specialist
Cheryl Klassen, Environmental Specialist

Grand Rapids Generating Station

Grant Stubson, Station Manager
Fred Senkow, Mechanical Maintenance Supervisor
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Waterways Management Program - North

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1.0 INTRODUCTION

In June 2012, the Keeyask Hydropower Limited Partnership (KHLP) filed an Environmental Impact Statement (EIS) in support of the Keeyask Generation Project (the Project), a 695 MegaWatt hydroelectric generating station (GS) to be built at Gull Rapids on the Nelson River (Map 1). Construction of the Project began in July 2014 following regulatory approval.

As discussed in the EIS, construction and operation of the Project will result in the alteration and destruction of Lake Sturgeon habitat, thereby potentially affecting regional populations.

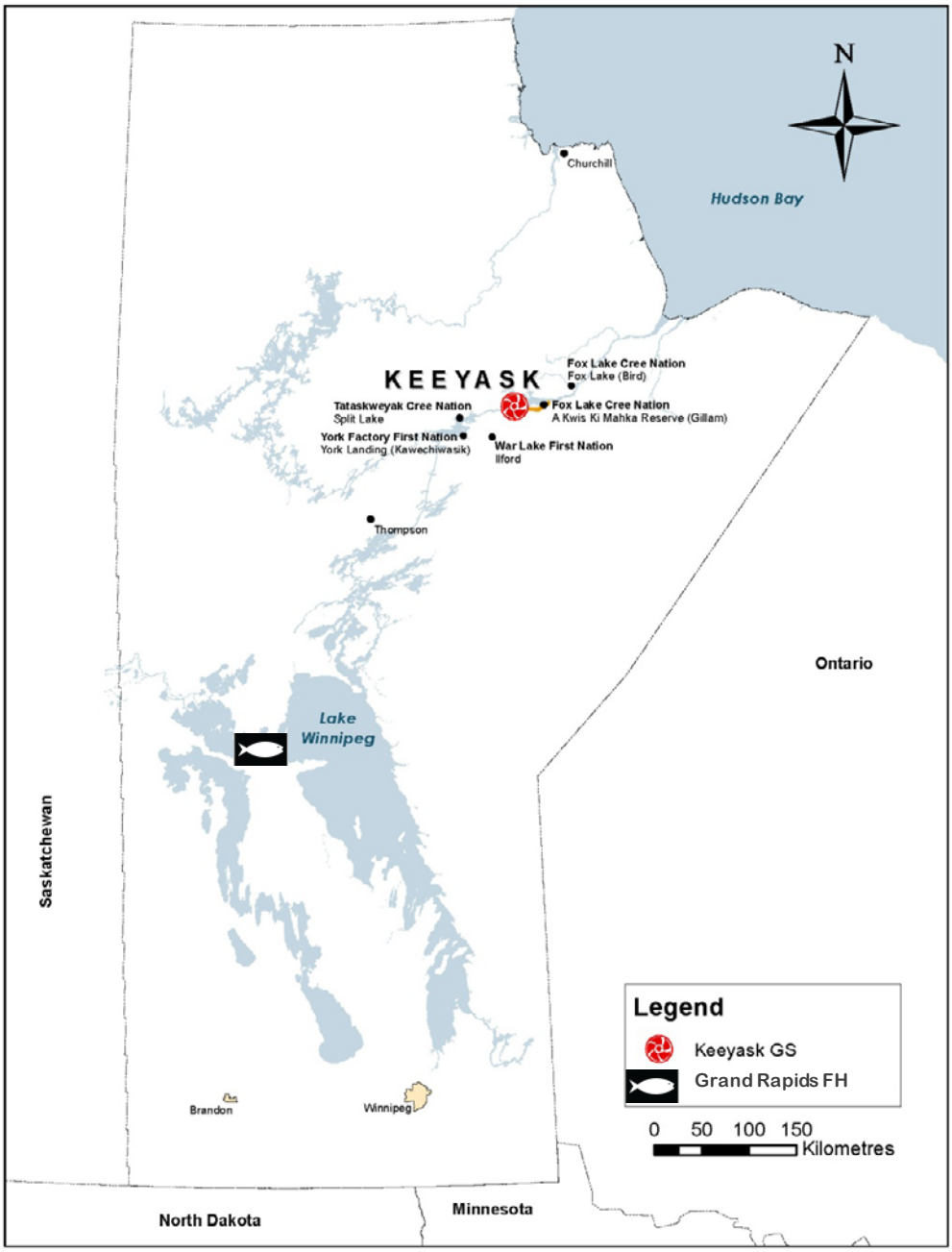
To mitigate impacts of the Project, the KHLP has developed a strategy that involves several components, including:

- management measures during construction to avoid mortality of sturgeon;
- stocking of sturgeon into Stephens Lake during construction to offset potential effects of the loss of spawning habitat in Gull Rapids;
- spawning habitat creation in the tailrace of the GS;
- alterations to habitat upstream of Birthday Rapids, if post-Project monitoring demonstrates that this area is no longer suitable for spawning sturgeon;
- creation of young-of-the-year rearing habitat at the upper end of Gull Lake following impoundment, if post-Project monitoring demonstrates that suitable habitat is not available;
- on-going studies to determine requirements (if any) for upstream fish passage;
- the use of monitoring of downstream movements and mortality to determine the need for any additional fish protection measures related to downstream passage at the GS;
- a conservation stocking program, with the objective of re-establishing a self-sustaining Lake Sturgeon population; and
- a conservation awareness program, highlighting the vulnerability of Lake Sturgeon.

Stocking was identified as being critically important because Stephens Lake may be able to support more Lake Sturgeon than are currently present. Therefore, a conservation stocking plan for the lower Nelson River was designed to address:

- existing low population numbers due to historic effects, in particular a commercial fishery that closed in 1992;
- potential effects of creation of the Keeyask reservoir, including possible emigration of adult Lake Sturgeon in response to water level changes at impoundment, and reduced year class strength in the initial years of impoundment due to changes in spawning and young-of-the-year habitat. These effects are predicted to be restricted to the first years of impoundment, if they occur at all; and

- potential decrease in year class strength of sturgeon in Stephens Lake, due to the alteration and ultimate loss of spawning habitat in Gull Rapids during construction of the GS. This effect is offset during the operation phase by the constructed spawning habitat.



Map 1: Location of Keeyask Generation Project and Grand Rapids Fish Hatchery

An initial 10-year stocking plan was developed and described in the Fisheries Offsetting and Mitigation Plan (FOMP). Lake Sturgeon stocking in the lower Nelson River began in 2013/2014 and has included the release of a variety of stages (larval, fingerling and yearling). During the

initial 10-year plan, the number of sturgeon released at each developmental stage will be dependent upon:

- the number of Lake Sturgeon available at each developmental stage;
- the amount of hatchery space required to enable “normal” growth (of larvae, fingerlings or yearlings); and
- the end goal of maintaining 2,000 fingerlings annually through the winter to be released as yearlings the following spring.

The Keeyask Fisheries Regulatory Review Committee (which will undertake the role of the Lake Sturgeon Advisory Committee described in the *Environment Act* licence) may decide to modify the stocking plan based on annual monitoring activities.

Lake Sturgeon stocking in the lower Nelson River will continue until self-sustaining populations are established. At present, it is anticipated that stocking will occur for at least one full generation (25 years) to restore the historically depleted population.

The purpose of this report is to provide a summary of Lake Sturgeon production at Grand Rapids Fish Hatchery and stocking activities for the Keeyask Generation Project in 2015 and 2016.

2.0 GRAND RAPIDS FISH HATCHERY

The Grand Rapids Fish Hatchery (GRFH) is located in the community of Grand Rapids, MB (Map 1). Constructed in the early 1970's by the province of Manitoba, the building was originally configured for production of Walleye, Whitefish and a variety of trout species. In 1994, GRFH began producing Lake Sturgeon for the Nelson River Sturgeon Board, in support of efforts to conserve upper Nelson River populations.

Manitoba Hydro purchased GRFH in 2007 and the facility was operated in partnership with Manitoba Conservation and Water Stewardship (now Manitoba Sustainable Development) through a Joint Management Committee. At the end of 2012, Manitoba Hydro assumed full operation of the hatchery and currently employs 7 permanent and 2 seasonal staff. Operations and regulatory matters are overseen by Manitoba Hydro's Environmental Licensing and Protection Department. Building and equipment maintenance is conducted in partnership with the Grand Rapids Generating Station.

Since 2012, GRFH has focused its production efforts exclusively on Lake Sturgeon and Walleye. In addition to producing Lake Sturgeon for the Nelson River Sturgeon Board, GRFH began producing Lake Sturgeon for the Keeyask Generation Project in 2013 (Table 2.0-1). All production and stocking activities are conducted under the terms of Live Fish Handling Permits issued by Manitoba Sustainable Development.

Table 2.0-1: Summary of Lake Sturgeon stocking in the Keeyask area since 2014

	Burntwood River			Gull Lake[a]			Stephens Lake		
	# Stocked			# Stocked			# Stocked		
Year	Larvae	Fingerlings	Age-1	Larvae	Fingerlings	Age-1	Larvae	Fingerlings	Age-1
2014	-	-	595	152,926	4,656	-	-	-	-
2015	-	-	-	-	-	423	-	-	418
Total	**0**	**0**	**595**	**152,926**	**4,656**	**423**			**418**

a - from Birthday Rapids to Gull Rapids

GRFH currently has 18 gray fibreglass rearing troughs (4.6 m x 0.55 m x 0.25 m). The troughs have been configured to permit the use of both well water and surface water (Saskatchewan River); however, due to the threat of pathogens, surface water is used minimally. Concrete floor tanks, originally used for fish production, now serve as water reservoirs in a simple sump pump operated water re-circulation system. Water temperature is managed using ambient room temperature and submersible water heaters. Well and surface water can also be blended to achieve desired water temperatures, however, the addition of surface water is avoided unless absolutely necessary.

Total usable rearing area is approximately 46 m^2. Rearing space is shared between the two stocking programs: Keeyask Generation Project and the Nelson River Sturgeon Board.

In order to meet future annual stocking targets, Manitoba Hydro is in the process of upgrading and expanding GRFH. In March 2014, a facility assessment was completed by HDR Inc. which confirmed that the existing infrastructure cannot meet projected Lake Sturgeon production commitments. Upgrades are also necessary to reach national and provincial biosecurity standards which have been developed to reduce the risk of pathogens (e.g., virus) from entering and spreading throughout a facility. Planning for infrastructure upgrades and expansion of GRFH began at the end of 2014 and is being managed by Manitoba Hydro's Power Projects Department.

3.0 BURNTWOOD RIVER POPULATION (2015 YEAR-CLASS)

3.1 PAST PRODUCTION AND STOCKING

Wild Lake Sturgeon adults from the Burntwood River were captured below First Rapids (Map 2) in early June, 2015. On June 8, the milt from four males (M1, M2, M3 & M4) was mixed with the eggs from one female (F1). The total number of eggs collected was estimated to be 51,825. There were few viable eggs when assessed five days after fertilization and only about 100 larvae hatched (< 1% hatch success). No larvae survived from the F1xM2 cross. Poor hatch rates also occurred in 2013 (Klassen 2015). It remains unclear why few eggs collected from Burntwood River adults have hatched.

From the point of hatch to the end of September, survival was approximately 25%. A total of 23 Burntwood River fingerlings remained at the end of September. Therefore, the decision was made to keep all of the fish at GRFH overwinter for further growth. At the end of September this group of sturgeon had an average total length of 124 mm (range: 112 to 147 mm) and an average weight of 8.6 g (range: 7.1 to 12.3 g).

Klassen et al. (2016) provides additional detail on the past production activities for the Burntwood River sturgeon (2015 year-class).

3.2 WINTER GROW-OUT (2015/16)

All fingerlings maintained at GRFH for the winter were held together in a single gray trough. Throughout the winter grow-out period sturgeon were fed bloodworm twice daily at 08:00 and 13:00. Overall winter survival was 100% (Table 3.2-1).

Fish were reared in well water for the duration of the winter grow-out and the average temperature was 14.8°C (range: 7.4 to 17.0°C) between October 1 and the spring stocking event in late May (Figure 3.2-1). Temperatures were dropped at the end of April to replicate ambient river temperature prior to stocking, which is evident by the decline in temperature shown in Figure 3.2-1.

Table 3.2-1: Survival (%) of the Burntwood River sturgeon (2015 YC) at GRFH from Oct 1, 2015 to May 31, 2016.

Families	Oct 1 (2015)	Recount (+/-)	Number of Fish Removed			May 31 (2016)	Survival (%)
			Mortality	Transfer	Release		
F1xM1/M3/M4	23	0	0	0	0	23	100.0

Water quality samples were tested weekly from rearing troughs throughout winter. Parameters assessed included dissolved oxygen (DO; EcoSense DO 200A, Pentair), dissolved carbon dioxide (dCO_2; GO2P, Oxyguard International), pH (EcoSense pH 100A, YSI Environmental), total ammonia nitrogen (TAN; HI96700C Low Range Photometer, Hanna Instruments), un-ionized ammonia (UIA; Calculated by multiplying TAN with a multiplication factor based on temperature and pH, Emerson et al. 1975) and nitrite-nitrogen (NO_2-N; test kit, LaMotte; Photo 1).

Average monthly water quality values, with the exception of nitrite-nitrogen, are plotted in Figure 3.2-2. A detailed summary of monthly values are presented in Table A1-1. Recommended threshold values for sturgeon production are listed in Table A1-3. Average monthly values were within acceptable limits for DO (>4 mg/L), dCO_2 (< 10 mg/L), pH (< 8.5), and NO_2-N (< 0.2 mg/L). The toxic form of ammonia (UIA) did reach, and occasionally exceed, threshold levels (0.01 mg/L); however, fish health did not appear to be compromised.

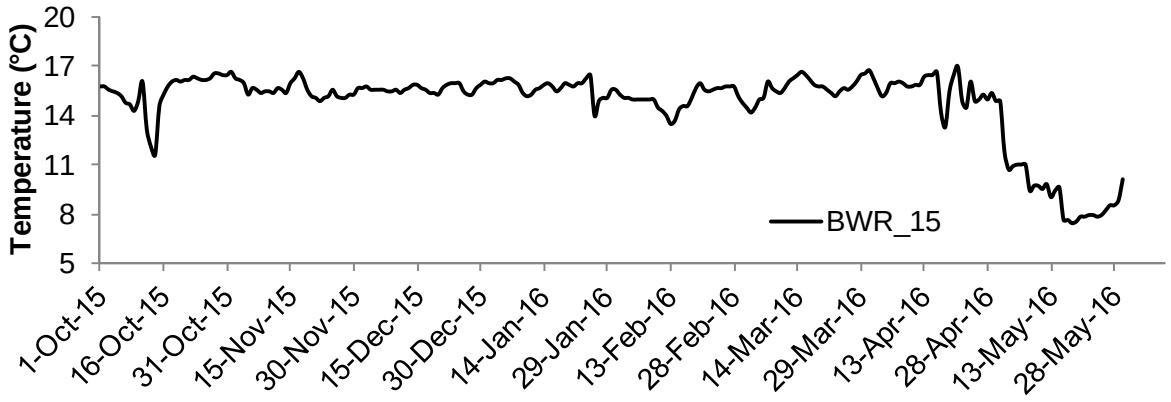


Figure 3.2-1: Average daily water temperature (°C) in rearing troughs holding Burntwood River sturgeon (2015 YC) at GRFH from Oct 1, 2015 to May 31, 2016

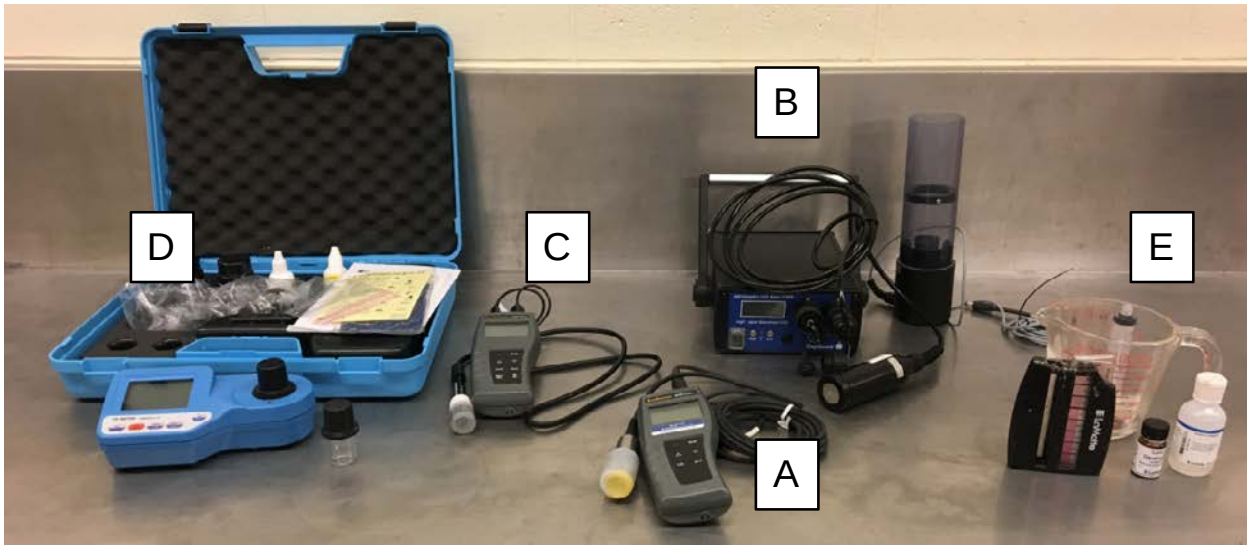


Photo 1: Equipment used to test dissolved oxygen (A), dissolved carbon dioxide (B), pH (C), total ammonia nitrogen (D) and nitrite-nitrogen (E) at GRFH

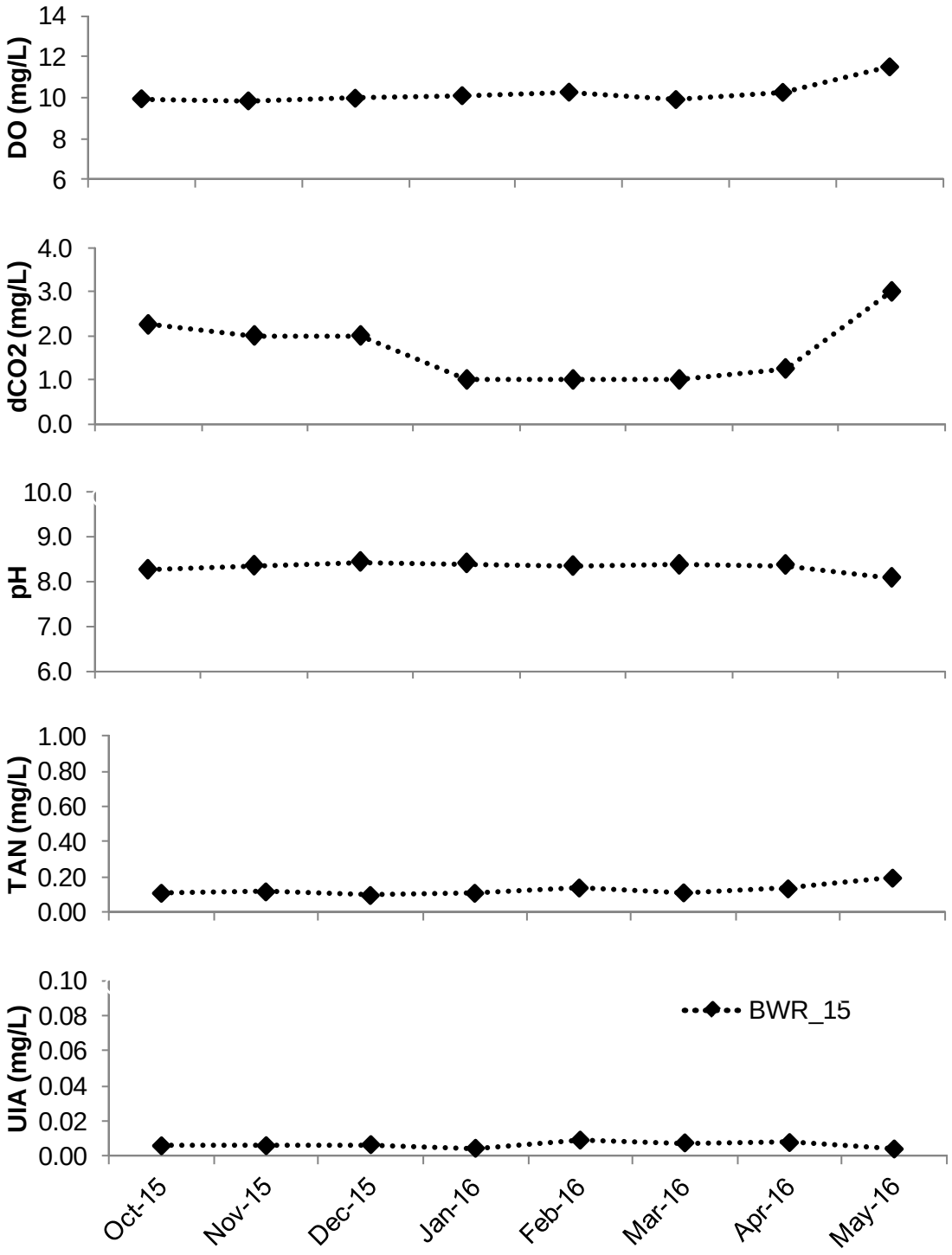


Figure 3.2-2: Average monthly dissolved oxygen (DO), dissolved carbon dioxide (dCO2), pH, total ammonia nitrogen (TAN) and un-ionized ammonia (UIA) values for troughs holding Burntwood River sturgeon (2015 YC) at GRFH from Oct 1, 2015 to May 31, 2016.

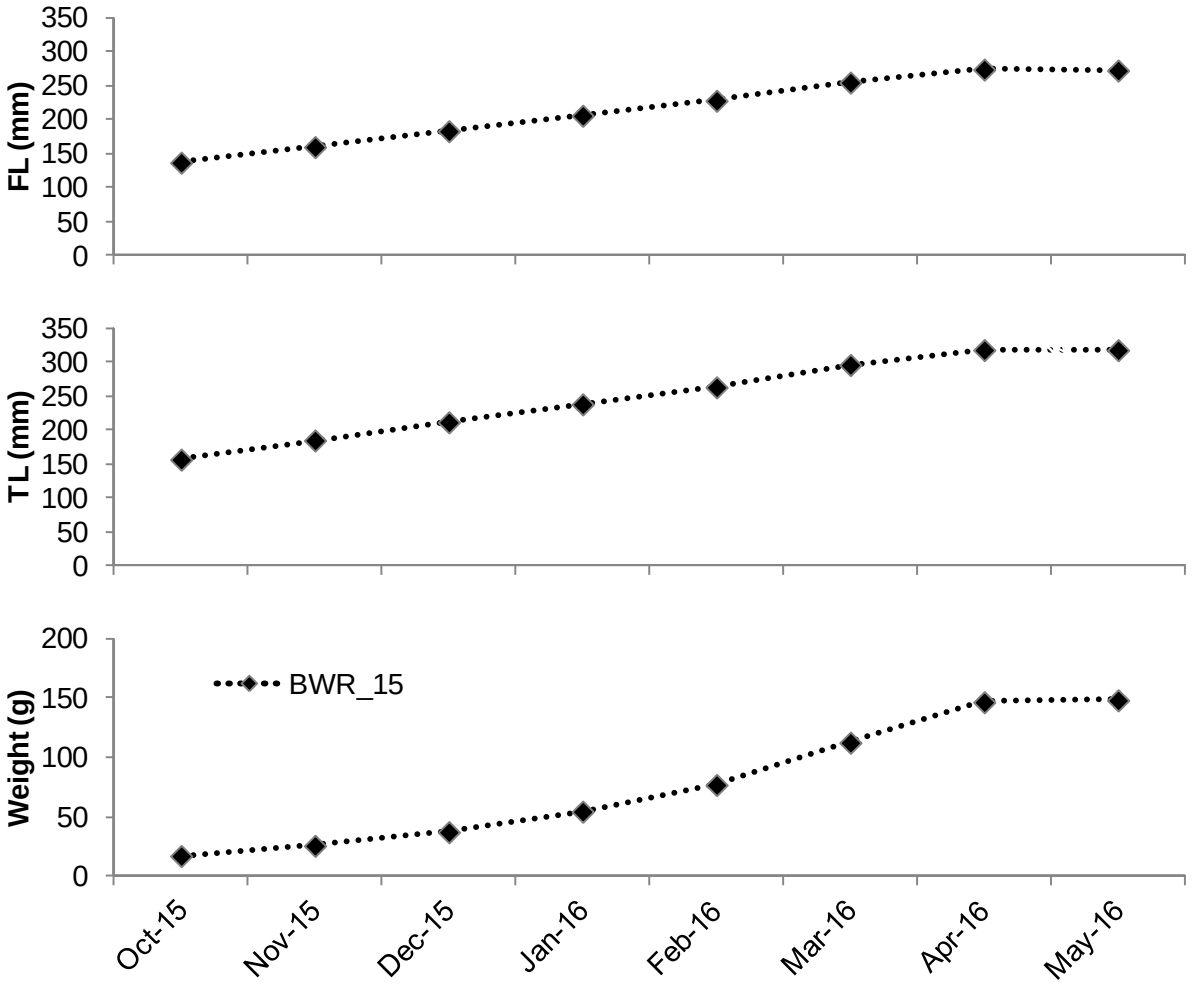


Figure 3.2-3: Average fork length (FL), total length (TL) and weight (g) for Burntwood River sturgeon (2015 year-class) at month end measurements.

At the end of each month, 15 Burntwood River sturgeon were randomly selected and measured. Monthly average sizes (Figure 3.2-3) for the Burntwood River sturgeon were the highest observed at GRFH to date and likely the result of the low rearing density (Figure 3.2-4).

On May 13, 2016 all 23 yearlings were measured. They had an average fork length of 272 mm (range: 231 to 318 mm), average total length of 318 mm (range: 267 to 376 mm) and average weight of 148.1 g (range: 87.5 to 204.5 g).

The Burntwood River sturgeon were implanted with a passive integrated transponder (PIT) tag on February 5, allowing them to be individually identified at a later date.

Tissue samples (pectoral fin) were collected from 18 Burntwood River sturgeon on April 4, 2016 and sent to RPC Science & Engineering in Fredericton, New Brunswick. All samples tested negative for Numao Virus using a virus specific qPCR test. Yearlings were cleared by the provincial fish health officer for stocking.

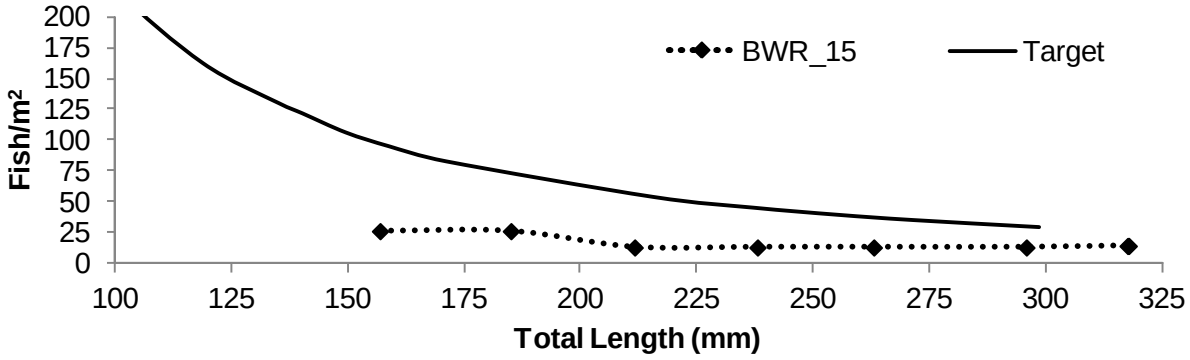


Figure 3.2-4: Average rearing density (fish per m^2) of Burntwood River sturgeon (2015 YC) at total length (mm).

3.3 SPRING YEARLING STOCKING (2016)

On May 31 all 23 yearlings were transported to the Orr Creek boat launch by truck. With the help of Manitoba Hydro's Waterways Management boat patrol crew, 20 yearlings were released downstream of First Rapids at Site 1 following a period of acclimation (Map 2; Table 3.3-1, Table A2-1).

Members from Tataskweyak Cree Nation (TCN) participated in a ceremonial release of the remaining 3 sturgeon into the Burntwood River from shore at Site 2 following a period of acclimation (Map 2; Table 3.3-1). Participation of TCN at this stocking event was coordinated and supported by the Kischi Sipi Namao Committee.

Table 3.3-1: Number of Burntwood River sturgeon (2015 YC) stocked into the Burntwood River in 2016

Lot ID	Population	Family	Date	Number	Age	Waterbody	Site ID
LKST-15-BWR	Burntwood R	F1xM1/M3/M4	31-May-16	20	13 months	Burntwood R	1
LKST-15-BWR	Burntwood R	F1xM1/M3/M4	31-May-16	3	13 months	Burntwood R	2
spring yearlings = 23							

Map 2: Stocking locations for Burntwood River sturgeon (2015 YC) released into Burntwood River in 2016. First Rapids is marked as 'A'.

3.4 POST-STOCKING RECAPTURES

A total of 618 Burntwood River yearlings have been released into the Burntwood River since the first yearling stocking event in 2014. Juvenile monitoring programs have caught a total of 4 Burntwood River sturgeon released by the Grand Rapids Fish Hatchery as yearlings. Fish were identified by their PIT tags.

Two of the sturgeon were recaptured in the Burntwood River and two were recaptured downstream in Gull Lake. Additional information about recaptured hatchery-reared sturgeon can be found in Henderson et al. (2015), Burnett et al. (2016) and Burnett et al. (2017).

4.0 BIRTHDAY RAPIDS POPULATION (2016 YEAR-CLASS)

4.1 GAMETE COLLECTION (2016)

Lake Sturgeon broodstock were collected from the Nelson River downstream of Birthday Rapids (Map 3) in collaboration with North South Consultants. Two females were injected with a primer dose (20%) of Gonadotropin Releasing Hormone (GnRH; Product No. H-4070, Bachem Americas, Inc., Torrance, CA, USA) on May 29. The remaining dose (80%) was administered 12 hours later on May 30. Two males were injected with the same hormone on May 30. No primer dose was administered to the males because some milt was already being expressed naturally (Table 4.1-1).

Table 4.1-1: Tag numbers, weight and hormone (GnRH) dose used during gamete collection for Lake Sturgeon broodstock collected in the Nelson River at Birthday Rapids, May 2016.

Floy Tag ID	Hatchery ID	Weight (Kg)	Injection Date	Injection Time	GnRH (µg/Kg)	Solution		
						GnRH (µl)[1]	Ringer's (µl)[2]	Total (µl)
Females								
80375	F1	19.5	29-May	19:31	3.0	5.9	384.1	390.0
			30-May	07:05	13.0	25.4	364.6	390.0
94083	F2	29.1	29-May	19:30	3.0	8.7	573.3	582.0
			30-May	07:02	13.0	37.8	544.2	582.0
Males								
48926	M1	25.9	29-May			No primer dose		
			30-May	07:07	5.0	13.0	505.0	518.0
107245	M2	10.0	29-May			No primer dose		
			30-May	07:08	5.0	5.0	195.0	200.0

[1] GnRH solution = 10µg GnRH per µl

[2] Saline solution used to transport GnRH into fish muscle during injections

A third female was captured but released before the injections of GnRH because she was expressing eggs naturally. There was no quality milt or transportation available for the eggs at the time. Although the water temperatures were cooler than previous years, the observation of this female suggested that the wild population was spawning. Therefore, the amount of GnRH administered to the females was similar to the previous year despite the cooler temperatures

(i.e., 12.3 to 14.4°C in 2015 vs. 9.5 to 12.1°C in 2016). Water temperature affects the physiology of fish and influences the timing of spawn.

Administration of GnRH is useful for conservation aquaculture programs because it stimulates the production of sex steroids (estradiol and testosterone) necessary for maturation and production of eggs and milt. Research on the use of GnRH during Lake Sturgeon gamete collection suggests no lasting negative effects on broodstock health or human consumption complications (Genz et al. 2014).

On May 31, eggs were not observed at the expected time of 07:00. At 09:00 a flexible transparent hose was used to check if eggs were present in the oviduct of both females. When removed the hose contained ovarian fluid but no eggs. Water temperature in the tank was 9.7°C. It was acknowledged at this time that the amount of GnRH administered had likely been too low. While it was felt that the females would eventually release eggs later that day at the lower temperatures, delaying the fertilization activities into the late afternoon or evening would jeopardize the transportation arrangements made for the eggs.

At 11:00 the decision was made to try and increase the water temperature in the female holding tank to speed up the release of eggs. This was done by stopping the flow of fresh water into the tank and re-circulating the water using a pump. By 13:00 the tank was 13.1°C and eggs were present in the oviduct of both females (Photo 2). Eggs were first detected on the bottom of the holding tank at roughly 14:30 when the water temperature was 15.1°C. Eggs were collected from F2 at 15:00 and from F1 at 15:30. Water temperature in the tank had reached 16.1°C.

Photo 2: Field crew checking for the presence of eggs in the oviduct of female Lake Sturgeon at the Birthday Rapids spawn camp, May 2016

Prior to egg collection females were anesthetized using clove oil in order to make collection activities easier on the fish and field staff. A small incision was also made in the abdomen to allow for the eggs to leave the body quickly, reducing the amount of time females were out of the water. The incision was sutured and the decision was made to place the females in the male holding tank so they had immediate access to fresh water during recovery. The male tank was 12.1 °C at 15:30.

A large volume of milt had been collected from M2 earlier in the day at 13:30. M1 did not express quality milt when checked at the same time. M1 was rechecked at 16:00 but no milt could be collected. The eggs of F1 and F2 were fertilized with the milt of M2 at approximately 16:10 creating two family groups (i.e., F1xM2 and F2xM2). Tissue samples (pectoral fin) were collected and preserved from all broodstock for virus testing and for future genetic identification of offspring produced at GRFH.

Following fertilization, bentonite clay was added to the eggs to prevent them from clumping together and this process took approximately 40 min. The eggs were transported by helicopter to Thompson and then driven to GRFH, arriving at the hatchery around 22:30. Hatchery staff finished disinfecting the eggs, estimating the total number of eggs and setting the eggs up in the incubation jars by 02:30 the following morning.

4.2 BROODSTOCK CARE (2016)

The male broodstock were released shortly after the egg fertilization activities but the female broodstock were held at the spawn camp overnight for further recovery. At 08:00 on June 1, F2 was found unresponsive and had died sometime during the night. Following release, F1 rested at the shoreline for a brief period before swimming away. Unfortunately, F1 did not survive and was found by another field crew shortly after.

Activities conducted at the 2016 Birthday Rapids spawn camp were carefully documented and can provide a valuable resource from which to learn. It is felt that the female sturgeon died from the rapid temperature increase and decrease, a stressor amplified by the already stressful events during routine egg collection. It should be noted that broodstock from previous years and other spawn camps have been held for several days on shore, anesthetized prior to egg collection and subjected to an abdominal incision/sutures without mortality.

It has been acknowledged by the field crew that there was a lack of attention spent on broodstock recovery following the unusual circumstances of the 2016 spawn camp. In the future, roles and responsibilities will be more clearly defined among members of the spawn camp team prior to the egg collection and fertilization activities with greater emphasis placed on broodstock recovery and monitoring.

The field crew also identified a number of decisions that could have reduced or eliminated the risk of broodstock mortality at the 2016 Birthday Rapids spawn camp, including:

- using a higher total dose of GnRH;
- maintaining some fresh water to the female holding tank to slow the temperature increase or adding some fresh water on an hourly basis;
- stopping the recirculation system when eggs were detected in the oviduct and slowly adding fresh water;

- using a larger tank to administer the anesthetic and being more careful when measuring out and adding the anesthetic; and/or
- placing the females into the warm water tank following egg collection to slowly bringing them down to ambient river temperatures.

4.3 HATCH (2016)

There were an estimated 220,000 eggs from the F1 cross (50 eggs/ml) and 277,500 from the F2 cross (37 eggs/ml) for a total of 497,500. Eggs were placed into McDonald hatching jars for incubation. Average incubation temperature was 13.4°C (range: 12.3 to 15.0°C; Figure 4.3-1) and hatch occurred from June 9 – 11. Well water was used exclusively during this period and following hatch.

Five days after egg collection, fertilization rate was assessed. The average proportion of viable eggs was calculated from samples collected within incubation jars from both the F1 and F2 families. The average proportion of viable eggs from each family was then multiplied by the total egg volume of that family to estimate hatch success. The overall average proportion of viable eggs was 88% (F1 = 83%; F2 = 93%). Therefore, the total number of hatched larvae was calculated to be 440,013 (F1 = 182,400; F2 = 257,613).

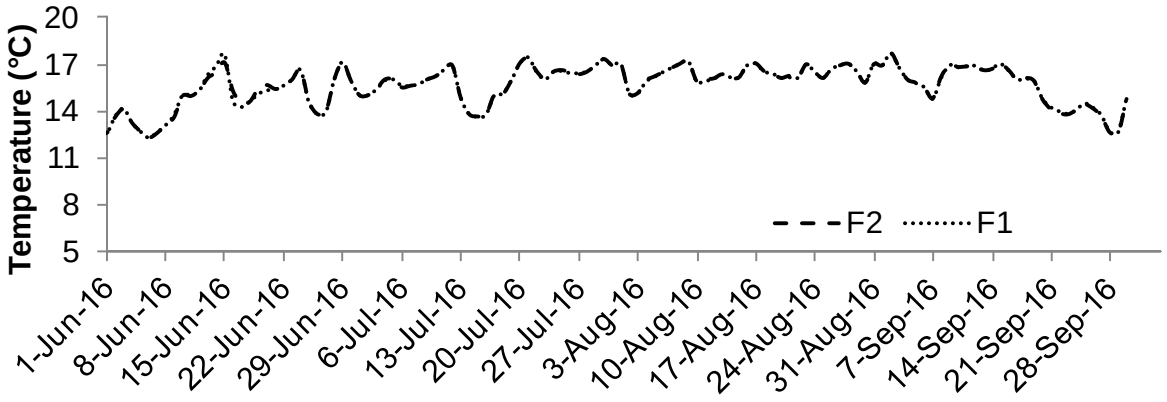


Figure 4.3-1: Average daily water temperature (°C) in rearing troughs holding Birthday Rapids sturgeon (2016 YC) at GRFH from June 1 to September 30, 2016

Thirty whole body samples from each of the two families were collected on June 12 and sent to RPC Science and Engineering in Fredericton, New Brunswick. All samples tested negative for Numao virus using a virus specific qPCR test, and larvae were cleared by the provincial fish health officer for stocking.

4.4 LARVAL STOCKING AND TRANSFERS (2016)

It was necessary to stock out a large number of larvae due to the limited rearing capacity at GRFH (Photo 3). Larval stocking took place in late June and July.

On June 21, an estimated 192,167 larvae were transported by truck to the Keeyask camp. Larvae were shipped in a large insulated tank that was supplied with oxygen. With assistance from North South Consultants, the larvae were transferred by boat to the base of Birthday Rapids and released at Site 1, following a period of acclimation (Map 3; Table 4.4-1). The river temperature was 16°C.

On June 23, an estimated 175,354 larvae were transported in the same way but released into Stephens Lake downstream of Gull Rapids at Site 2, following a period of acclimation (Map 3; Table 4.4-1). The river temperature was 18°C.

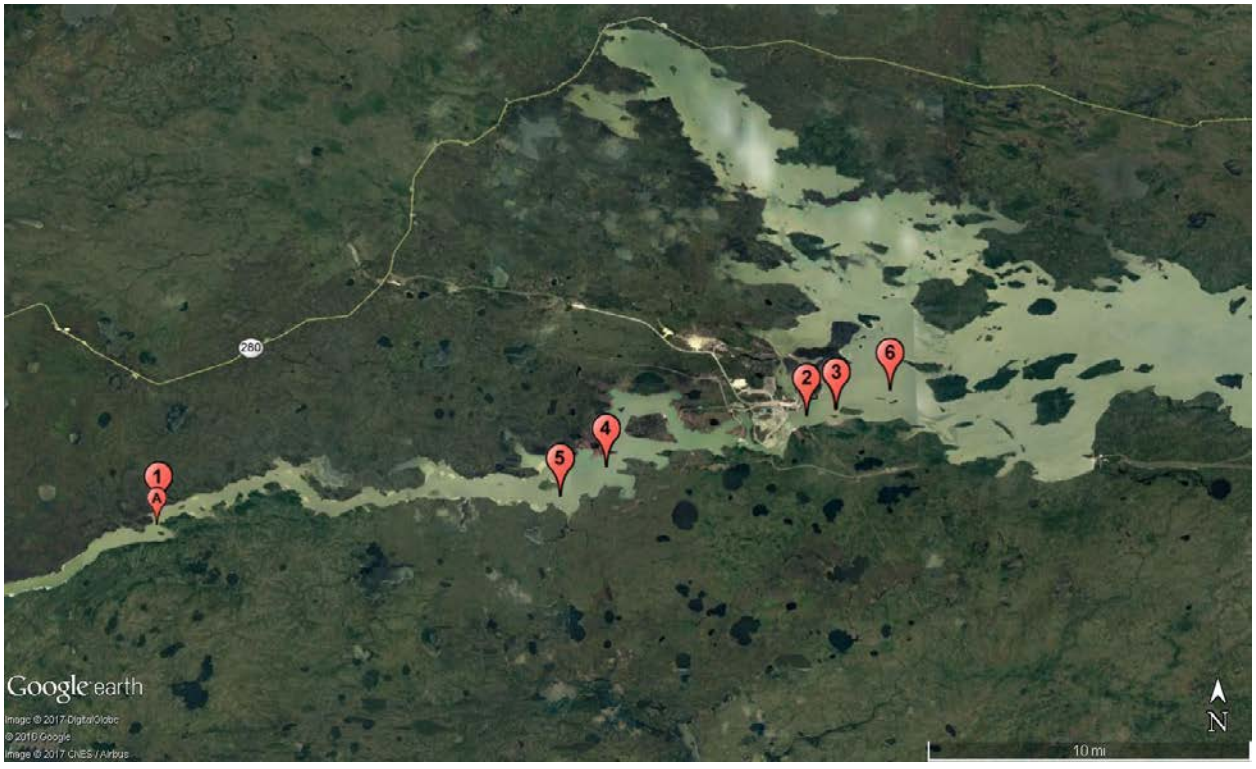
On July 26, a total of 8,780 sturgeon (aged 6 weeks) were transported by truck to the Keeyask camp. With assistance from North South Consultants, the fish were transferred by boat and released into Stephens Lake at Site 3, following a period of acclimation (Map 3; Table 4.4-1). The river temperature was 18°C.

There is currently no effective method to mark larval fish prior to release, so it is difficult to determine if they are surviving and being recaptured in future population studies. Instead, tissue samples from individuals representing each family group are preserved to provide a genetic "fingerprint", allowing future identification of stocked individuals from this family.

Photo 3: Field crew releasing sturgeon larvae into the Keeyask area, June 2016

Table 4.4-1: Number of Birthday Rapids sturgeon (2016 YC) released into the Keeyask area in 2016

Lot ID	Population	Family	Date	Number	Age	Waterbody	Site ID
LKST-16-BDR	Birthday Rapids	F1xM2	21-Jun-16	81,648	1.5 weeks	Birthday Rapids	1
LKST-16-BDR	Birthday Rapids	F2xM2	21-Jun-16	110,519	1.5 weeks	Birthday Rapids	1
LKST-16-BDR	Birthday Rapids	F1xM2	23-Jun-16	68,545	1.5 weeks	Stephens Lake	2
LKST-16-BDR	Birthday Rapids	F2xM2	23-Jun-16	106,809	1.5 weeks	Stephens Lake	2
LKST-16-BDR	Birthday Rapids	F1xM2	26-Jul-16	4,050	6 weeks	Stephens Lake	3
LKST-16-BDR	Birthday Rapids	F2xM2	26-Jul-16	4,730	6 weeks	Stephens Lake	3
Larvae = 367,521							
LKST-16-BDR	Birthday Rapids	F1xM2	27-Sep-16	314	3 months	Gull Lake	4
LKST-16-BDR	Birthday Rapids	F1xM2	27-Sep-16	233	3 months	Gull Lake	5
LKST-16-BDR	Birthday Rapids	F2xM2	27-Sep-16	233	3 months	Gull Lake	5
LKST-16-BDR	Birthday Rapids	F1xM2	29-Sep-16	215	3 months	Stephens Lake	3
LKST-16-BDR	Birthday Rapids	F2xM2	29-Sep-16	238	3 months	Stephens Lake	3
LKST-16-BDR	Birthday Rapids	F2xM2	29-Sep-16	346	3 months	Stephens Lake	6
Fingerlings = 1,579							



Map 3: Stocking locations for Birthday Rapids sturgeon (2016 YC) released into the Keeyask area in 2016. Birthday Rapids is marked as 'A'

In 2016, GRFH also provided larvae to Dr. Gary Anderson (University of Manitoba) in support of his Industrial Research Chair in Lake Sturgeon Conservation Aquaculture. A total of 4,021 Birthday Rapids larvae (F1 = 2,021; F2 = 2,000) were randomly selected from the rearing

troughs and transferred to the Animal Holding Facility located at the University of Manitoba on June 27 (Table 4.5-1).

4.5 SUMMER GROW-OUT (2016)

Overall survival was high (> 85%) for both Birthday Rapids sturgeon families over the summer (Table 4.5-1). The majority of mortalities occurred during the months of June and July.

Brine shrimp was first offered to the sturgeon on June 19 and chopped bloodworm was first introduced on July 3. All sturgeon were feeding on whole bloodworm by August 9 when fish had an average total length greater than 39 mm and average weight greater than 0.27 g. Fish were fed to satiation three times daily at 0:800, 13:00 and 17:00.

The Birthday Rapids sturgeon were maintained in 100% well water throughout the summer grow-out. Using well water reduces the risk of introducing pathogens (e.g., virus) that could be present in river water. From June 12 to September 30, the average water temperature was 15.9°C (range 12.6°C to 17.7°C; Figure 4.3-1).

Table 4.5-1: Survival (%) of Birthday Rapids sturgeon (2016 YC) at GRFH from June 1 to September 30, 2016.

Family	Month-Yr	Start of Month	Recount (+/-)	Number of Fish Removed			End of Month	Survival (%)
				Mortality	Transfer	Release		
F1	Jun-16	182,400	0	22,227	2,051[a]	150,193	7,929	87.8
	Jul-16	7,929	0	2,404	0	4,050	1,475	70.0
	Aug-16	1,475	-46	41	0	0	1388	97.1
	Sep-16	1,388	0	1	0	762	625	99.9
	Overall	**182,400**	**-46**	**24,673**	**2,051**	**155,005**	**625**	**86.5**
F2	Jun-16	257,614	0	31,002	2,030[b]	217,328	7,254	88.0
	Jul-16	7,254	0	1,039	0	4,730	1,485	85.7
	Aug-16	1,485	-17	25	0	0	1,443	98.3
	Sep-16	1,443	0	1	0	817	625	99.9
	Overall	**257,614**	**-17**	**32,067**	**2,030**	**222,875**	**625**	**87.6**

[a] 30 to RPC for virus testing; 2,021 to University of Manitoba

[b] 30 to RPC for virus testing; 2,000 to University of Manitoba

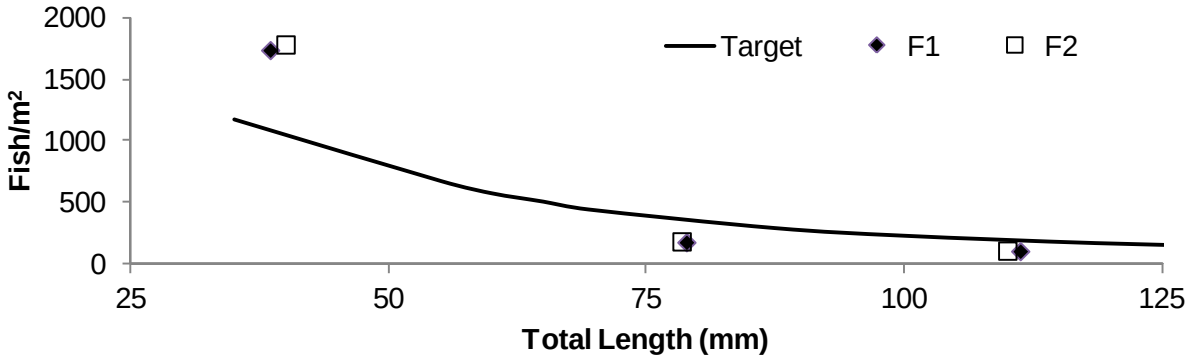


Figure 4.5-1: Average rearing density (fish per m^2) of Birthday Rapids sturgeon (2016 YC) at total length (mm)

Prior to the spring and summer stocking events, average rearing densities were above target values. However, after the larval stocking events, rearing densities remained below suggested rearing densities (Figure 4.5-1). This was done to improve water quality and encourage fish growth.

Water quality samples were tested weekly from rearing troughs throughout summer. Parameters assessed included dissolved oxygen (DO), dissolved carbon dioxide (dCO_2), pH, total ammonia nitrogen (TAN), un-ionized ammonia (UIA) and nitrite-nitrogen (NO_2-N).

Average monthly water quality values, with the exception of nitrite-nitrogen, are plotted in Figure 4.5-2. A detailed summary of monthly values are presented in Table A1-2. Recommended threshold values for sturgeon production are listed in Table A1-3. Average monthly values were within acceptable limits for DO (>4 mg/L), dCO_2 (< 10 mg/L) and NO_2-N (< 0.2 mg/L). The pH and toxic form of ammonia (UIA) did reach, and occasionally exceed, the threshold levels of 8.5 and 0.01 mg/L, respectively; however, fish health did not appear to be compromised.

At the end of each month, 15 Birthday Rapids sturgeon were randomly selected and measured from each rearing trough. Both families grew at similar rates and at the end of September fingerlings had an overall average total length of 111 mm (range: 90 to 130 mm) and average weight of 5.25 g (range: 2.69 to 7.90 g).

Fingerlings were cleared for fall stocking by the provincial fish health officer, despite not being tested for Numao Virus. This was due to a number of reasons including: 1) sturgeon tested negative for Numao Virus in spring, 2) sturgeon were not exposed to surface water during the summer, 3) GRFH adheres to biosecurity protocols limiting the risk of virus introduction and spread, and 4) sturgeon did not display any health issues throughout the summer.

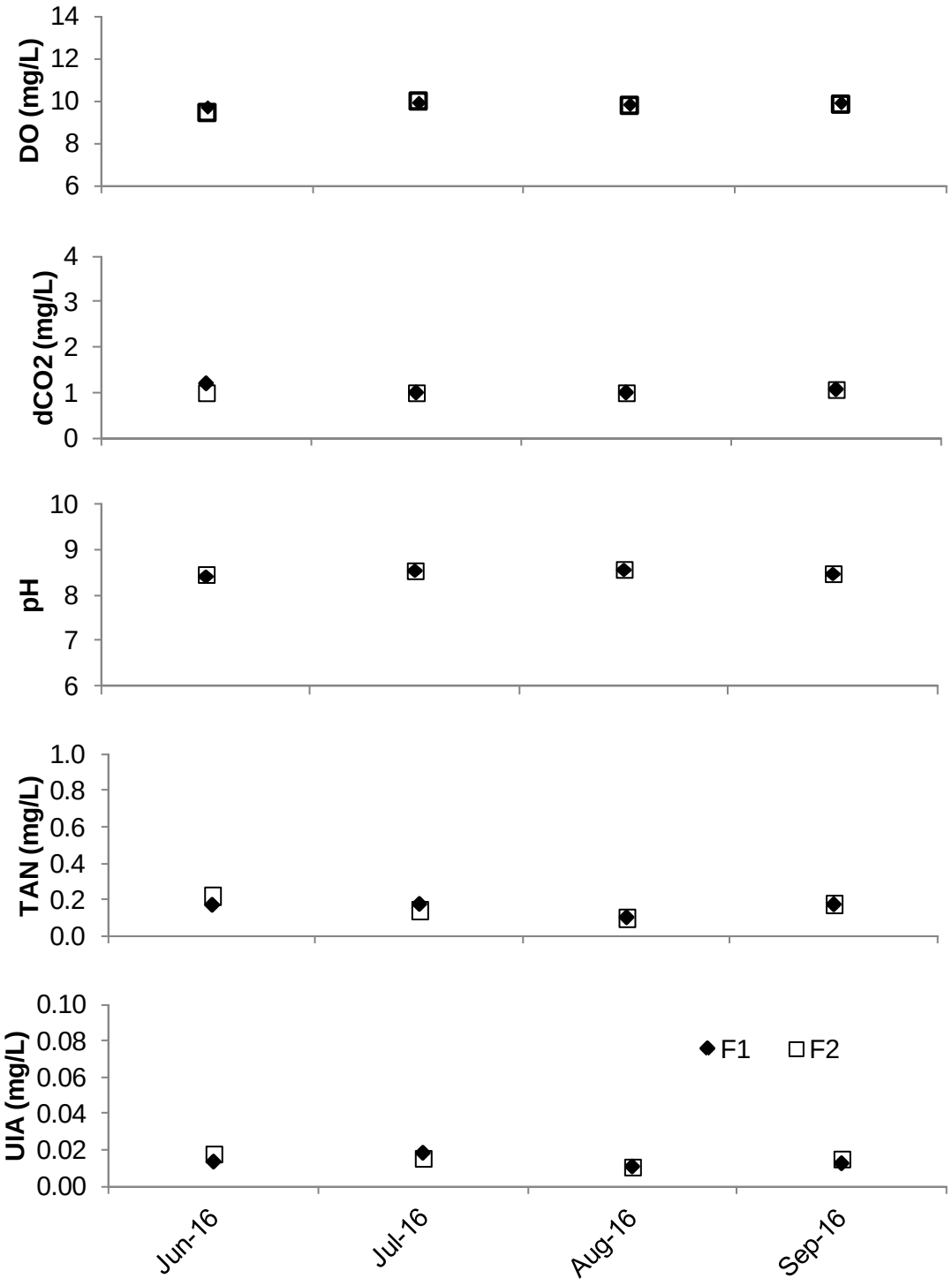


Figure 4.5-2: Average monthly dissolved oxygen (DO), dissolved carbon dioxide (dCO2), pH, total ammonia nitrogen (TAN) and un-ionized ammonia (UIA) values for troughs holding Birthday Rapids sturgeon (2016 YC) at GRFH from June 1 to September 30, 2016

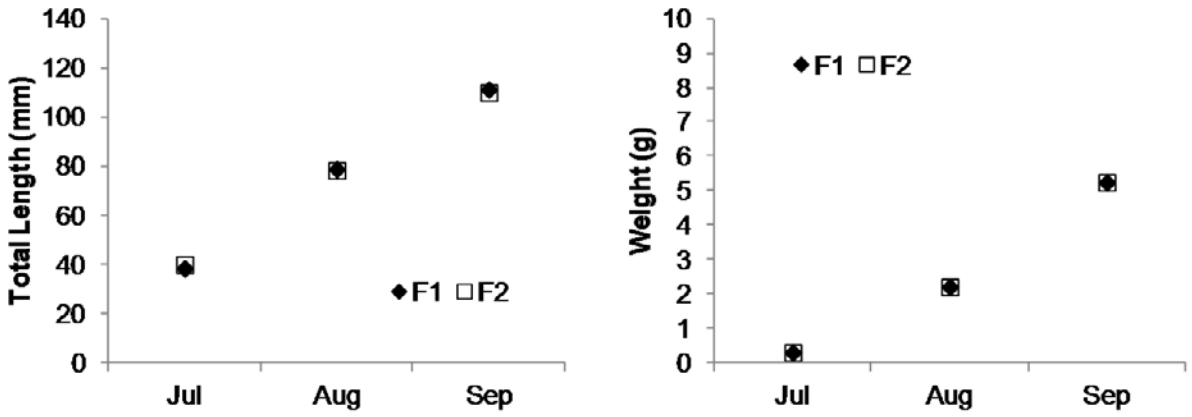


Figure 4.5-3: Average total length (TL) and weight (g) for Birthday Rapids sturgeon (2016 year-class) at month end measurements.

4.6 FALL FINGERLING STOCKING (2016)

On September 27, a total of 780 fall fingerlings were transported by hatchery staff to the Keeyask construction camp boat launch on Gull Lake using the truck and fish transport trailer. With assistance from boat patrol crews from Manitoba Hydro's Waterways Management Program, the Birthday Rapids fingerlings were released at Site 4 and Site 5, following a period of acclimation (Map 3; Table 4.4-1). The river temperature was 12°C.

On September 29, a total of 799 fall fingerlings were transported by hatchery staff to the Keeyask construction camp boat launch on Stephens Lake using the truck and fish transport trailer. With assistance from boat patrol crews from Manitoba Hydro's Waterways Management Program, the Birthday Rapids fingerlings were released at Site 3 and Site 6, following a period of acclimation (Map 3; Table 4.4-1). The river temperature was 12°C.

4.7 POST-STOCKING RECAPTURES

A total of 841 Birthday Rapids yearlings have been released into the Keeyask area since the first yearling stocking event in 2015 (Gull Lake = 423; Stephens Lake = 418). Juvenile monitoring programs have caught a total of 18 Birthday Rapids sturgeon released by the Grand Rapids Fish Hatchery as yearlings. Fish were identified by their PIT tags.

Ten recaptured individuals had been released into Gull Lake. Nine were recaptured in Gull Lake and one was recaptured downstream in Stephens Lake. The other eight recaptured individuals had been released into Stephens Lake. All eight were recaptured in Stephens Lake.

Additional information about recaptured hatchery-reared sturgeon can be found in Henderson *et al*. (2015), Burnett *et al*. (2016) and Burnett *et al*. (2017).

5.0 PRODUCTION AND STOCKING ACTIVITIES IN 2016/17

A total of 1,250 Birthday Rapids fingerlings were kept at the hatchery for the 2016/17 winter grow-out period. Fish will be released as yearlings into the Keeyask area during spring 2017, pending virus test results. Specific stocking locations have yet to be determined.

In collaboration with North South Consultants, Lake Sturgeon broodstock capture and gamete collection will take place in the Burntwood River downstream of First Rapids during spring 2017.

Grand Rapids Fish Hatchery will continue to support Dr. Gary Anderson's studies on Lake Sturgeon conservation aquaculture. Collaboration on other Lake Sturgeon projects will be considered when opportunities arise.

A final design for the Grand Rapids Fish Hatchery upgrade and expansion project is expected to be completed in 2018. This project is being undertaken to increase the number of yearling Lake Sturgeon that can be produced at the hatchery and to improve the rearing conditions for the fish. Upgrades are also necessary to reach national and provincial biosecurity standards which have been developed to reduce the risk of pathogens (*e.g.*, virus) from entering and spreading throughout a facility.

6.0 LITERATURE CITED

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APPENDIX 1:
WATER QUALITY

Table A1-1: Mean (± SD), minimum and maximum Dissolved Oxygen (mg/L), Dissolved Carbon Dioxide (mg/L) pH, Total Ammonia-Nitrogen (mg/L) and Un-ionized Ammonia (mg/L) values for Burntwood River Lake Sturgeon (2015 YC) reared at Grand Rapids Fish Hatchery.

Parameter	Mth-Yr	F1				
		N[a]	Mean	SD[b]	Min	Max
Dissolved O_2 (mg/L)	Oct-15	4	9.95	0.32	9.57	10.36
	Nov-15	5	9.85	0.21	9.47	10.00
	Dec-15	4	9.98	0.25	9.83	10.35
	Jan-16	4	10.10	0.18	9.84	10.25
	Feb-16	5	10.27	0.14	10.13	10.46
	Mar-16	4	9.91	0.05	9.85	9.96
	Apr-16	4	10.26	0.14	10.10	10.42
	May-16	5	11.50	0.44	10.82	11.97
	Total	**35**	**10.25**	**0.58**	**9.47**	**11.97**
Dissolved CO_2 (mg/L)	Oct-15	4	2.25	0.50	2.00	3.00
	Nov-15	5	2.00	0.00	2.00	2.00
	Dec-15	4	2.00	0.00	2.00	2.00
	Jan-16	4	1.00	0.00	1.00	1.00
	Feb-16	5	1.00	0.00	1.00	1.00
	Mar-16	4	1.00	0.00	1.00	1.00
	Apr-16	4	1.25	0.50	1.00	2.00
	May-16	5	3.00	0.71	2.00	4.00
	Total	**35**	**1.71**	**0.79**	**1.00**	**4.00**
pH	Oct-15	4	8.26	0.10	8.12	8.34
	Nov-15	5	8.35	0.03	8.31	8.40
	Dec-15	4	8.43	0.03	8.40	8.46
	Jan-16	4	8.40	0.01	8.38	8.41
	Feb-16	5	8.34	0.03	8.29	8.37
	Mar-16	4	8.37	0.05	8.33	8.44
	Apr-16	4	8.37	0.07	8.30	8.44
	May-16	5	8.08	0.08	7.96	8.18
	Total	**35**	**8.32**	**0.12**	**7.96**	**8.46**
Total Ammonia (mg/L)	Oct-15	4	0.11	0.04	0.07	0.16
	Nov-15	5	0.12	0.04	0.06	0.16
	Dec-15	4	0.10	0.01	0.09	0.11
	Jan-16	4	0.11	0.05	0.08	0.18
	Feb-16	5	0.14	0.08	0.01	0.22
	Mar-16	4	0.11	0.04	0.08	0.16
	Apr-16	4	0.14	0.11	0.05	0.29
	May-16	5	0.20	0.11	0.09	0.38
	Total	**35**	**0.13**	**0.07**	**0.01**	**0.38**
UIA (mg/L)	Oct-15	4	0.01	0.00	0.00	0.01
	Nov-15	5	0.01	0.00	0.00	0.01
	Dec-15	4	0.01	0.00	0.01	0.01
	Jan-16	4	0.00	0.01	0.00	0.01
	Feb-16	5	0.01	0.01	0.00	0.02
	Mar-16	4	0.01	0.00	0.01	0.01
	Apr-16	4	0.01	0.01	0.00	0.02
	May-16	5	0.00	0.00	0.00	0.01
	Total	**35**	**0.01**	**0.00**	**0.00**	**0.02**

a Number of water samples per month

b Standard Deviation

Table A1-2: Mean (± SD), minimum and maximum Dissolved Oxygen (mg/L), Dissolved Carbon Dioxide (mg/L) pH, Total Ammonia-Nitrogen (mg/L) and Un-ionized Ammonia (mg/L) values for Birthday Rapids Lake Sturgeon (2016 YC) reared at Grand Rapids Fish Hatchery.

Parameter	Mth-Yr	F1					F2				
		N[a]	Mean	SD[b]	Min	Max	N[a]	Mean	SD[b]	Min	Max
Dissolved O_2 (mg/L)	Jun-16	12	9.73	0.57	9.03	10.56	12	9.45	0.80	8.14	10.54
	Jul-16	10	9.94	0.40	9.31	10.53	10	9.99	0.42	9.52	10.75
	Aug-16	15	9.85	0.24	9.42	10.37	15	9.78	0.18	9.50	10.08
	Sep-16	14	9.93	0.43	9.26	10.61	14	9.84	0.49	9.16	10.58
	Total	**51**	**9.86**	**0.42**	**9.03**	**10.61**	**51**	**9.76**	**0.53**	**8.14**	**10.75**
Dissolved CO_2 (mg/L)	Jun-16	10	1.20	0.42	1.00	2.00	10	1.00	0.00	1.00	1.00
	Jul-16	10	1.00	0.00	1.00	1.00	10	1.00	0.00	1.00	1.00
	Aug-16	15	1.00	0.00	1.00	1.00	15	1.00	0.00	1.00	1.00
	Sep-16	14	1.07	0.27	1.00	2.00	14	1.07	0.27	1.00	2.00
	Total	**49**	**1.06**	**0.24**	**1.00**	**2.00**	**49**	**1.02**	**0.14**	**1.00**	**2.00**
pH	Jun-16	12	8.42	0.10	8.27	8.57	12	8.48	0.06	8.37	8.58
	Jul-16	10	8.55	0.08	8.45	8.68	10	8.56	0.08	8.47	8.68
	Aug-16	15	8.57	0.08	8.42	8.72	15	8.59	0.07	8.47	8.71
	Sep-16	14	8.48	0.04	8.44	8.57	14	8.50	0.04	8.44	8.59
	Total	**51**	**8.51**	**0.10**	**8.27**	**8.72**	**51**	**8.53**	**0.08**	**8.37**	**8.71**
Total Ammonia (mg/L)	Jun-16	12	0.17	0.12	0.01	0.37	12	0.22	0.18	0.00	0.53
	Jul-16	10	0.17	0.07	0.07	0.30	10	0.14	0.06	0.05	0.21
	Aug-16	15	0.10	0.04	0.04	0.20	15	0.10	0.05	0.02	0.20
	Sep-16	14	0.17	0.06	0.11	0.30	14	0.18	0.08	0.09	0.34
	Total	**51**	**0.15**	**0.08**	**0.01**	**0.37**	**51**	**0.16**	**0.11**	**0.00**	**0.53**
UIA (mg/L)	Jun-16	12	0.01	0.01	0.00	0.04	12	0.02	0.02	0.00	0.06
	Jul-16	10	0.02	0.01	0.00	0.04	10	0.02	0.01	0.00	0.03
	Aug-16	15	0.01	0.01	0.00	0.02	15	0.01	0.01	0.00	0.02
	Sep-16	14	0.01	0.01	0.01	0.03	14	0.02	0.01	0.01	0.04
	Total	**51**	**0.01**	**0.01**	**0.00**	**0.04**	**51**	**0.01**	**0.01**	**0.00**	**0.06**

a Number of water samples analyzed per month

b Standard Deviation

Table A1-3: Reported Lake Sturgeon threshold values for Dissolved Oxygen, Dissolved Carbon Dioxide, pH, Ammonia-Nitrogen and Nitrite Nitrogen.

Parameter	Threshold Values	References
Dissolved O_2 (mg/L)	> 6.0	Hochleithner and Gessner 2012
	> 4.0	Chebanov and Galich 2011
	> 5.0	Mims et al 2002
	> 6.0	Dettlaff et al 1993
Dissolved CO_2 (mg/L)	< 10.0	Hochleithner and Gessner 2012
	< 10.0	Chebanov and Galich 2011
pH	6.5 to 8.0	Hochleithner and Gessner 2012
	6.5 to 7.5	Chebanov and Galich 2011
	6.5 to 8.5	Mims et al 2002
	6.5 to 8.0	Dettlaff et al 1993
Ammonia NH_3-N (mg/L)	< 0.010	Hochleithner and Gessner 2012
	< 0.003	Chebanov and Galich 2011
	< 0.010	Mims et al 2002
Nitrite Nitrogen (mg/L)	0.1 to 0.2	Chebanov and Galich 2011
	< 0.1	Mims et al 2002

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APPENDIX 2:
LAKE STURGEON STOCKING

Table A2-1: Biological and PIT tag information for hatchery-reared Lake sturgeon yearlings released into the Burntwood River, May 2016. Description of release sites are provided in section 3.3 of report.

Lake Sturgeon		Final Hatchery Measurement				Stocking Activity	
PIT Tag ID	Family	Date	Fork Length (mm)	Total Length (mm)	Weight (g)	Date	Site ID[a]
900067000058204	F1xM1/3/4	13-May-16	272	325	146	31-May-16	1
900067000058205	F1xM1/3/4	13-May-16	266	309	137	31-May-16	1
900067000058215	F1xM1/3/4	13-May-16	292	338	182	31-May-16	1
900067000058226	F1xM1/3/4	13-May-16	292	340	171	31-May-16	1
900067000058231	F1xM1/3/4	13-May-16	231	270	88	31-May-16	1
900067000058232	F1xM1/3/4	13-May-16	303	351	188	31-May-16	1
900067000058248	F1xM1/3/4	13-May-16	267	312	140	31-May-16	1
900067000058277	F1xM1/3/4	13-May-16	275	333	155	31-May-16	1
900067000058293	F1xM1/3/4	13-May-16	291	338	177	31-May-16	1
900067000058310	F1xM1/3/4	13-May-16	269	305	144	31-May-16	1
900067000058311	F1xM1/3/4	13-May-16	261	304	118	31-May-16	1
900067000058313	F1xM1/3/4	13-May-16	281	325	157	31-May-16	1
900067000058319	F1xM1/3/4	13-May-16	276	320	137	31-May-16	1
900067000058320	F1xM1/3/4	13-May-16	247	293	154	31-May-16	1
900067000058321	F1xM1/3/4	13-May-16	282	323	146	31-May-16	1
900067000058330	F1xM1/3/4	13-May-16	275	314	149	31-May-16	1
900067000058336	F1xM1/3/4	13-May-16	265	317	163	31-May-16	1
900067000058341	F1xM1/3/4	13-May-16	269	316	156	31-May-16	1
900067000058343	F1xM1/3/4	13-May-16	234	267	96	31-May-16	1
900067000058368	F1xM1/3/4	13-May-16	254	294	99	31-May-16	1
900067000058381	F1xM1/3/4	13-May-16	256	299	121	31-May-16	1
900067000058391	F1xM1/3/4	13-May-16	318	376	205	31-May-16	1
900067000058394	F1xM1/3/4	13-May-16	289	335	180	31-May-16	1

[a] Three Burntwood River yearlings were released from shore at site 2