Sucker Creek Fish Habitat Assessment

Executive Summary

The Eastern Georgian Bay Stewardship Council (EGBSC) received funding from Environment and Climate Change Canada to carry out a 32-month project to assess spawning, nursery, rearing, and foraging habitat in eight tributaries to eastern Georgian Bay, including Sucker Creek. Fish habitat assessments were focused on Walleye, Lake Sturgeon, and Sucker species, between the river mouths and the first major spawning area or barrier to fish passage.

Sucker Creek is within the Pointe au Baril quaternary watershed draining an area of roughly 116 km^2, with no water control structures. Due to the size of the creek, EGBSC did not expect to find Lake Sturgeon, therefore, the work was focused on Walleye and Sucker species. During the 2016 habitat assessment, EGBSC visited the spawning area sixteen (16) times between April 17 and May 24.

Basic water chemistry measurements (water temperature, dissolved oxygen, pH, conductivity) were recorded on eleven (11) site visits and were within the expected range. Two of the pH readings were below 6.0, which is below the average ideal pH for Walleye. However, the remaining nine measurements were above 6.0. While slightly acidic, these measurements are typical for Canadian Shield waters. Conductivity spiked following a rain event on May 14, likely as a result of runoff from Highway 69 which is located immediately adjacent to the Sucker Creek spawning bed.

Water level and velocity measurements were taken during eleven (11) site visits between April 20 and May 24. There were no water velocity measurements recorded that would exclude Walleye passage, and White Sucker were seen navigating through most areas of the spawning bed, aside from the most upstream end. Water levels at the two most upstream depth stations dropped significantly over the study period (26.1 cm and 32.4 cm). Despite the sharp decline in water levels, there were relatively few Sucker eggs left out of water, due to the steep, gorge-like nature of the spawning bed.

During the five night surveys, no more than seven Walleye were seen during a single visit. It appeared there were very low numbers of Walleye moving into Sucker Creek. This concern was voiced by local residents who were involved in the original restoration of the site, and who continue to check the site on an annual basis. Conversely, several hundred White Sucker were observed on the spawning bed. With low water levels along the main spawning bed, the dorsal fins and sometimes upper bodies of White Sucker were visible above the water. Thousands of White Sucker eggs were observed in different pockets along the spawning area among the rocks. In total, EGBSC counted 248 Walleye eggs and 208 Sucker eggs on the three egg mats that were set. The lack of Sucker eggs on the egg mats was surprising based on the number of White Sucker in the creek. However, there were many more White Sucker eggs in the creek overall, and most of the deposition occurred above where the egg mats had been placed. Although only 248 Walleye eggs were deposited on the egg mats, the number indicated there was a higher level of spawning activity than what would have been assumed from visual observations. The only other fish species observed during site visits was Logperch.

Plankton sampling was conducted during the time when fry would likely be hatching. Samples were visually compared to samples collected from the other tributaries being assessed – Magnetawan River, Seguin River, Shebeshekong River, and Shawanaga River. Relative to the other tributaries assessed, Sucker Creek had greater plankton density than Magnetawan River, but less than Shawanaga River. Sucker Creek plankton density was similar to that of the Seguin and Shebeshekong Rivers.

In the fall of 2016, twenty-one (21) transects were measured across the Sucker Creek spawning bed with the intent of better understanding depth and substrate. In total, all but one of the transects had at least some substrate considered ideal for Walleye spawning and all but three had at least some substrate considered ideal for Sucker species. All twenty-one (21) transects had at least some measurement points that were within the ideal depth range for Walleye.

Surveys were conducted to assess nursery, rearing, and foraging habitat available downstream of the Sucker Creek spawning bed. Aerial photography, bathymetry, and side scan sonar data were collected downstream of the spawning bed where Sucker Creek outlets into Pointe au Baril Channel. In this area, 37% of the shoreline is natural (unaltered), and 64% of the shoreline is altered. Alterations included docks, boathouses, boat launches, riprap, buildings, and hardened walls. A considerable amount of boat traffic was observed in Pointe au Baril Channel.

Underwater surveys were taken for 100 m, spaced approximately 1 km apart from the outlet of Sucker Creek into Pointe au Baril Channel. Based on these surveys, the area around the outlet of Sucker Creek had more garbage than other rivers, with the exception of the Seguin River. Of the eight rivers assessed in 2016 and 2017, the outlets of Sucker Creek and the Seguin River were observed to experience the greatest human impact (boating, docks, marinas, construction businesses, etc.). Sucker Creek is heavily impacted by human activity for approximately 1 km downstream of the spawning bed. Accordingly, there is less natural habitat available along the shorelines in that area for fry once they have hatched.

The underwater surveys showed a prevalence of bedrock shoreline, and a diverse mix of substrate in the nearshore area including bedrock, boulder, cobble, gravel, and soft substrate. The amount of aquatic vegetation varied from sparse to abundant. There was little wood structure, an important component of fish habitat, observed in the surveys. Ninety percent of the area surveyed had no wood structure to sparse wood structure, and 10% (one survey) had abundant wood structure.

Potential issues of concern observed at Sucker Creek are: 1) runoff from the highway and road straight into the creek and the accompanying erosion issues; and 2) the channelization at the downstream end of the creek and the highly developed shoreline. Erosion along the east side of the creek at the spawning bed is introducing sand and fine material to the channel which could accumulate in the spawning area over time, and reduce the amount of interstitial spaces needed for egg deposition. In addition, direct runoff from the highway washes any contaminants straight into the river. It is unknown what impacts the channelization of Sucker Creek and the developed shoreline downstream may be having on larval fish survival.

Overall, EGBSC found Sucker Creek to provide important spawning habitat for White Sucker. EGBSC is not recommending any habitat restoration work at this site. It would be beneficial to re-visit Sucker Creek in a year with low Georgian Bay water levels to understand if low Georgian Bay water levels change accessibility of the spawning bed.

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Project Overview and Methodologies

In 2015, the Eastern Georgian Bay Stewardship Council (EGBSC) received funding from Environment and Climate Change Canada to carry out a 32 month project to assess spawning, nursery, rearing, and foraging habitat in eight tributaries to eastern Georgian Bay, within the Parry Sound District. Lake Sturgeon, Walleye, and Sucker species have been experiencing varying levels of decline in parts of eastern Georgian Bay. Accordingly, fish habitat assessments were focused on these species with the goals of: (1) determining whether there is sufficient habitat available; and (2) identifying and prioritizing opportunities for restoration. Assessments were carried out between the river mouths and the first major spawning area or barrier to fish passage.

EGBSC formed a collaborative working group to aid in the development of a field protocol for data collection. This group consisted of:

- Arunas Liskauskas, Dave Gonder, Chris Davis, and Stephen James – Upper Great Lakes Management Unit, Ministry of Natural Resources and Forestry
- Scott Finucan – Ministry of Natural Resources and Forestry
- Greg Mayne – Environment and Climate Change Canada
- Karl Schiefer – Aquatic Biologist consultant and EGBSC member
- David Bywater – Environmental Scientist, Georgian Bay Biosphere Reserve
- David Sweetnam – Executive Director, Georgian Bay Forever

Two main protocols were considered for this project. The first was the Ontario Stream Assessment Protocol (OSAP), which is a standardized method of measuring and collecting field data in the province of Ontario. This protocol is applicable to wadeable streams. The rivers being considered in this project were non-wadeable. Nevertheless, components of the OSAP protocol were used when assessing spawning beds in late summer and fall.

The other protocol considered for tributary classification was the Rosgen Classification system. This protocol is often used in stream restoration projects. However, the Rosgen Classification system was designed based on U.S. rivers and may not be appropriate for central Ontario rivers. Consequently, the Rosgen Classification was not used.

EGBSC completed broad habitat surveys on each river – Shebeshekong, Seguin, Magnetawan, Shawanaga, Key, Pickerel, Naiscoot, Sucker Creek – to record the location and evaluate the amount and quality of habitat available. During assessments, EGBSC also considered whether there were habitat limitations from human or natural stressors and identified any potential restoration opportunities.

As part of the broad habitat assessments, the following information was collected on each river:

- Basic water quality parameters (pH, conductivity, dissolved oxygen)
- Water temperature
- Water velocity
- Water level fluctuations
- Aerial photographs
- Underwater photographs and videos

- Substrate type
- General size of habitat
- Accessibility of spawning areas during different flow regimes
- Potential limitations or indicators of stress
- Opportunity for restoration

For the assessments, EGBSC used a combination of methods to collect data and brought in standardized protocols where possible. The project advisory team helped guide the technical aspects of this project to ensure the data collected was not only valuable but useable for other work and reports.

To collect high quality imagery of the sites, EGBSC purchased and used a DJI Phantom 3 Advanced quadcopter.

Three software programs were used as part of this project. Pix4D was used to create orthomosaics from the drone photography. Reefmaster was used to map bathymetry and side scan sonar data that was collected using a Lowrance unit. Finally, QGIS 2.18 was used for mapping.

In addition to gathering field data, EGBSC also collected background information and local knowledge when possible. The information that can be shared is provided in the Background Information section.

Background Information

Sucker Creek is located north of Parry Sound in Pointe au Baril (Figure 1). The river and its watershed are situated in the ancestral and traditional territory of the Anishinabek people.

Figure 1. Location of the Sucker Creek spawning bed in relation to Parry Sound

Sucker Creek is located within the Township of the Archipelago (formerly the Geographic Township of Harrison), along the eastern shore of Georgian Bay. The creek is situated within the Pointe au Baril quaternary watershed (116 km^2) which drains a number of small lakes (Argue, Scott, Brewery, and Sucker Lake) via Sucker Creek as it meanders westward approximately 8 km from its headwaters to its outlet into Pointe au Baril Channel, Georgian Bay (Figure 2).

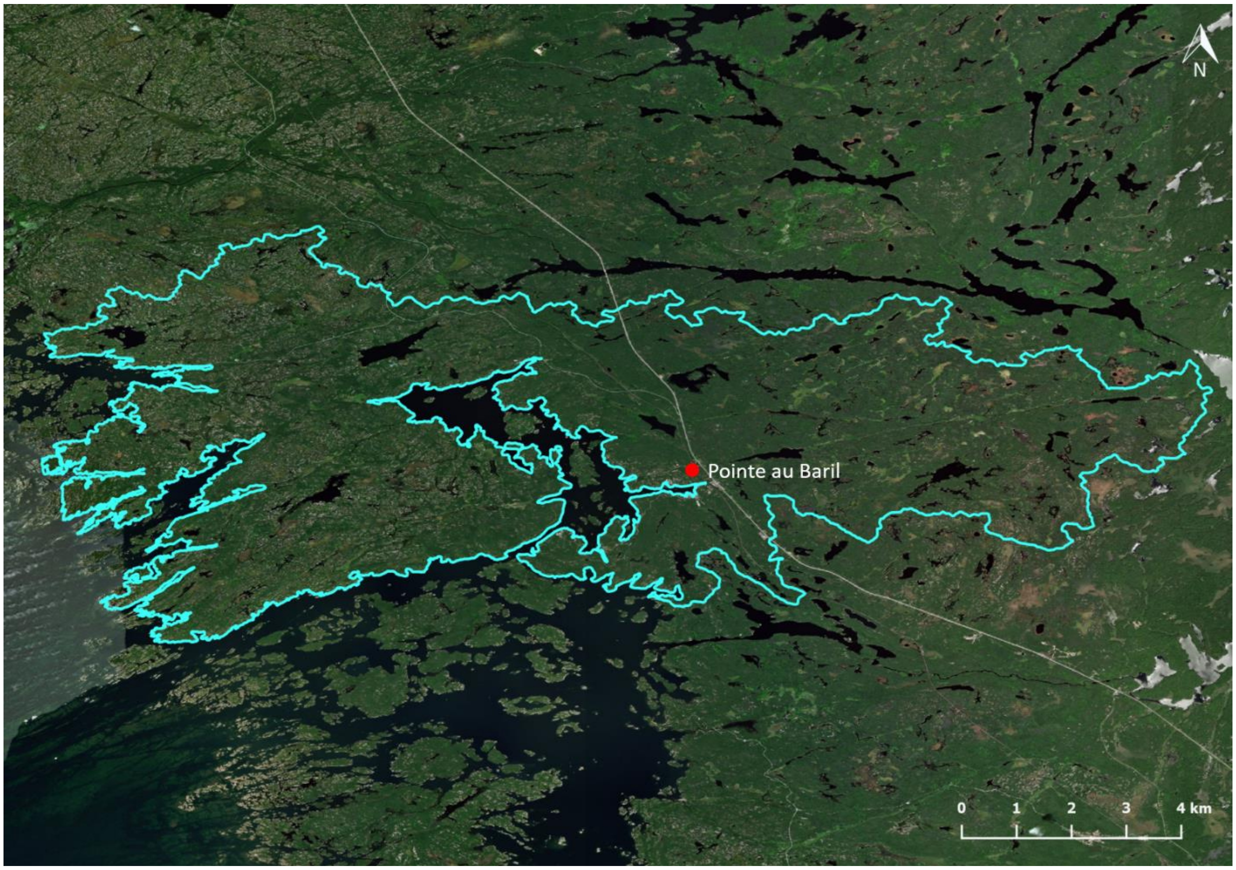

Figure 2. Pointe au Baril quaternary watershed

The only Ministry of Natural Resources and Forestry (MNRF) documentation on Sucker Creek refers to anecdotal information suggesting that the Sucker Creek spawning bed is a Walleye spawning site. No MNRF investigations of Sucker Creek have been documented.

Prior to the 1980s, Sucker Creek was not known to have had a Walleye spawning population. After work was completed on Highway 69 by the Ministry of Transportation, the Pointe au Baril Fish Hatchery Association created Walleye spawning habitat in Sucker Creek and then began raising and stocking Walleye at the site. Although there is no documentation on the restoration work or any other studies at Sucker Creek in MNRF files, there are anecdotal accounts from numerous Pointe au Baril residents indicating a healthy Walleye spawning population in Sucker Creek at one time. Because of the small size of the tributary, EGBSC did not expect to observe any Lake Sturgeon or Redhorse Sucker spawning activity. Anecdotal reports have only mentioned Walleye and White Sucker spawning in Sucker Creek.

Spring Spawning Assessments

In 2016, EGBSC began spring field work at the Sucker Creek spawning bed (Figure 3) on April 17 and ended on May 24. During this period, the site was visited sixteen (16) times, approximately every three to four days whenever possible. Because Sucker Creek is located adjacent to Highway 69, it is an easily accessible site. Some site visits were solely focused on visual observations for Sucker species and Walleye. White Sucker spawning activity ceased after May 6 and by May 24, water temperature had reached 19.7˚C. Aside from Logperch, no other fish were observed after this date.

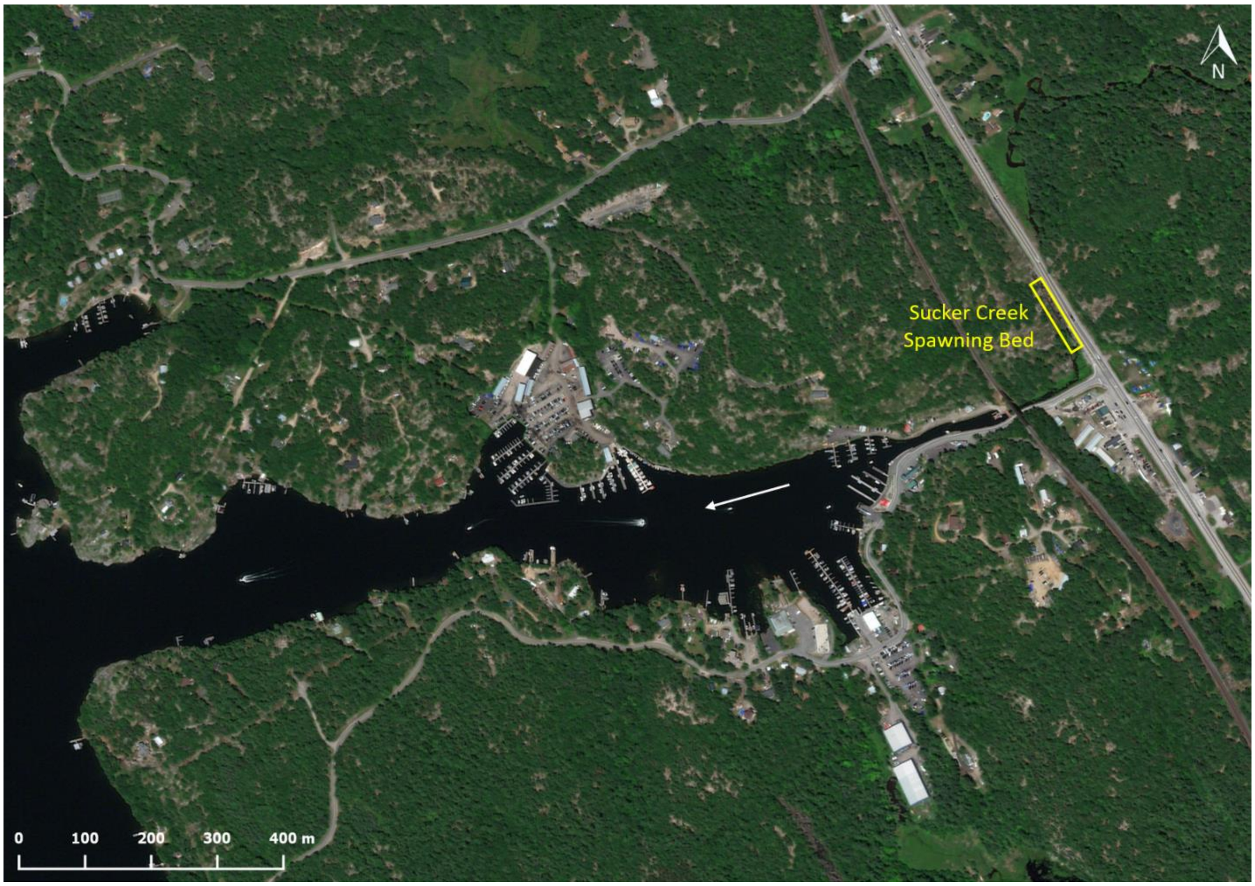

Figure 3. Location of Sucker Creek spawning bed adjacent to Highway 69

Water Chemistry

A YSI PROPLUS metre was used to measure basic water quality parameters on each site visit – water temperature, dissolved oxygen, conductivity, and pH. These parameters were selected because of the influence they can have on fish and fish activity, and to see if the levels recorded indicated any potential issues.

Water temperature is extremely important to fish. Aside from water velocity, water temperature is the main stimulus for spawning. For Walleye, spawning males begin to move towards spawning areas when water temperatures reach 2 to 5˚C. Spawning takes place through a variety of temperatures, but peak spawning typically occurs at 7 to 8˚C (Kerr et al., 1997). Conversely, spawning activity typically ceases once water temperatures reach 10 to 11˚C (Kerr et al., 1997). For Sucker species, spawning takes place between 10 and 16˚C (Hasnain et al., 2010). For Lake Sturgeon, main spawning activity occurs between 13 and 18˚C (Scott & Crossman, 1998). Water temperature also influences the speed and success of egg incubation. Optimal water temperature for egg incubation is 12.2˚C for Walleye, 14.5 ˚C for Lake Sturgeon, 15˚C for White Sucker, and 12.5˚C for Longnose Sucker (Hasnain et al., 2010).

As illustrated in Figure 4, water temperature increased consistently from 4.0˚C on April 17 to 16.6˚C on May 6. Due to a ten (10) day cooling trend from May 7 to 17, there was a drop in water temperature to 10.6˚C on May 10. Water temperatures increased to 15.0˚C on May 12 and then dropped to 12.2˚C on May 16, after which point, temperature steadily increased to 19.7˚C by May 24. Walleye were observed at Sucker Creek between April 20 and April 24. White Sucker were observed at the site between April 23 and May 6. Although not part of this study, Logperch were observed at the site between May 6 and May 10. No fish were observed at the spawning area between May 12 and May 24.

Fish require dissolved oxygen to breathe. Fast flowing, cold water has higher dissolved oxygen concentrations than slow moving, warm water. Cold water can hold more oxygen as it rolls through rapids, which incorporates air from the atmosphere into the water. Dissolved oxygen is typically highest in early spring and declines as water temperatures increase and velocity slows. As shown in Figure 4, dissolved oxygen levels dropped consistently throughout the study period, aside from two short-term increases on May 10 and May 20. The highest level was recorded on April 17 (13.28 mg/L) and reached a low of 7.95 mg/L on May 24.

The pH of water refers to how alkaline or acidic the water is, and is ranked on a scale of 0 to 14. pH will influence how soluble and available nutrients and heavy metals are in a system. pH can also influence fish health and reproductive success. In general, Walleye do best in waterbodies with a pH ranging between 6.0 and 9.0. Reproductive success can be jeopardized at pH levels below 6.0. All pH levels recorded at the Sucker Creek spawning bed were above 6.0, with the exception of measurements taken on April 17 and May 16. The highest pH level was 6.88 on May 20 and the lowest pH recorded was 5.76 on April 17. The pH readings are mildly acidic and typical for Canadian Shield watersheds.

Figure 4 illustrates changes in temperature, dissolved oxygen, and pH over the spawning and egg incubation periods. pH remained relatively stable, while temperature and dissolved oxygen followed a typical pattern for spring.

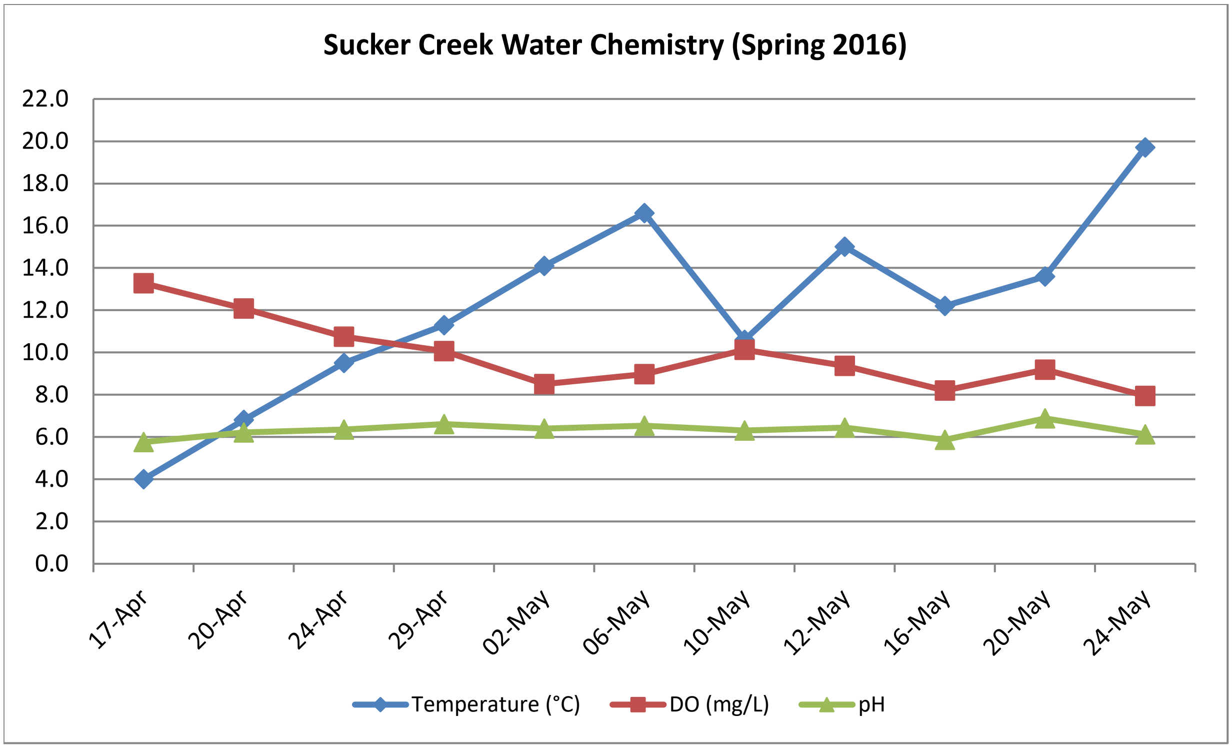

Figure 4. Water temperature (°C), dissolved oxygen (mg/L), and pH measurements taken at the Sucker Creek spawning bed in spring 2016

Conductivity was also measured at Sucker Creek in 2016 (Figure 5). Conductivity measures the ability of water to pass an electrical current and is influenced by geology. For example, a clay substrate will have a high conductivity because of a greater amount of ions in the water. Rivers within the Parry Sound District typically have low conductivity, but conductivity can be significantly affected by stormwater runoff, and a sudden increase or decrease can indicate issues in a waterbody. Conductivity was recorded between April 17 and May 24. Conductivity was consistently low throughout the study period, with the exception of one spike up to 61.4 uS/cm on May 16. This spike may have been related to a large rain event that occurred on May 14 and the resulting highway runoff. The lowest conductivity measured was 19.3 uS/cm on April 24. Overall, conductivity generally stayed within the low 20 to high 30 uS/cm range.

For complete water chemistry data, refer to Appendix A.

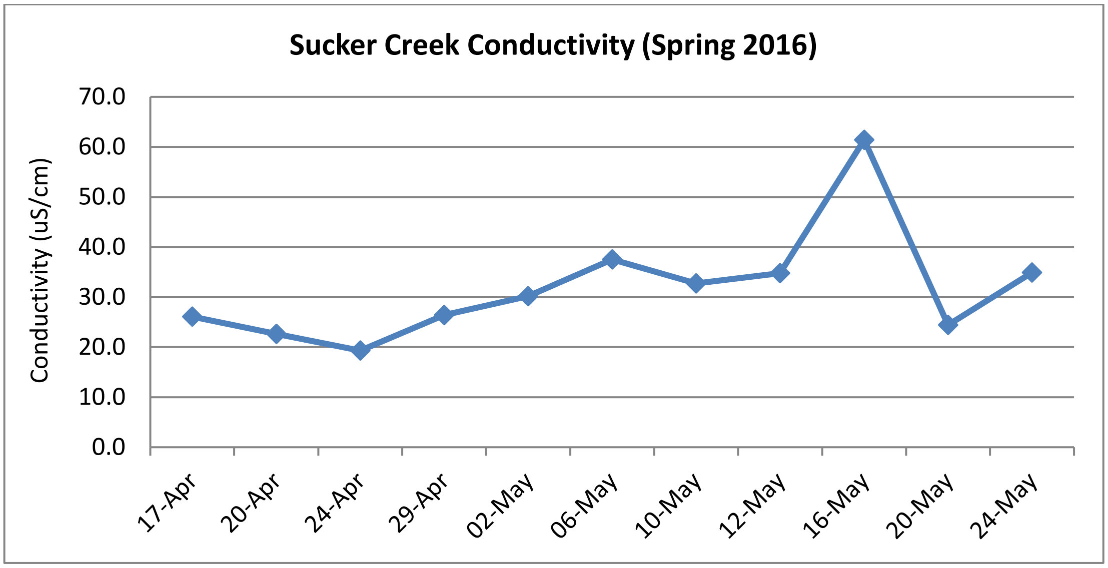

Figure 5. Conductivity measurements (uS/cm) at the Sucker Creek spawning bed in spring 2016

Water Velocity

Water velocity has an influence on fish spawning. Species such as Walleye spawn in areas of fast moving water, during the spring freshet. Walleye prefer velocities less than 2.0 m/s (Kerr et al., 1997) and White Sucker typically spawn in velocities ranging from 0.14 m/s to 0.9 m/s (Twomey et al., 1984). Water velocity is typically high during the spawning period and declines over time.

Water velocity was measured with a Marsh McBirney Flo-mate 2000 flow meter to investigate whether there were areas where the flow would be too fast for fish to swim through. Mean velocity was measured at 60% of the water depth.

Four stations were established at the Sucker Creek spawning bed to collect information on water velocity from April 20 to May 24 (Figure 6). Figure 7 displays velocity measurements recorded at each station. Complete water level and velocity data can be found in Appendix B.

Figure 6. Water velocity (1-4) and water level stations (1,2,4) at the Sucker Creek spawning bed

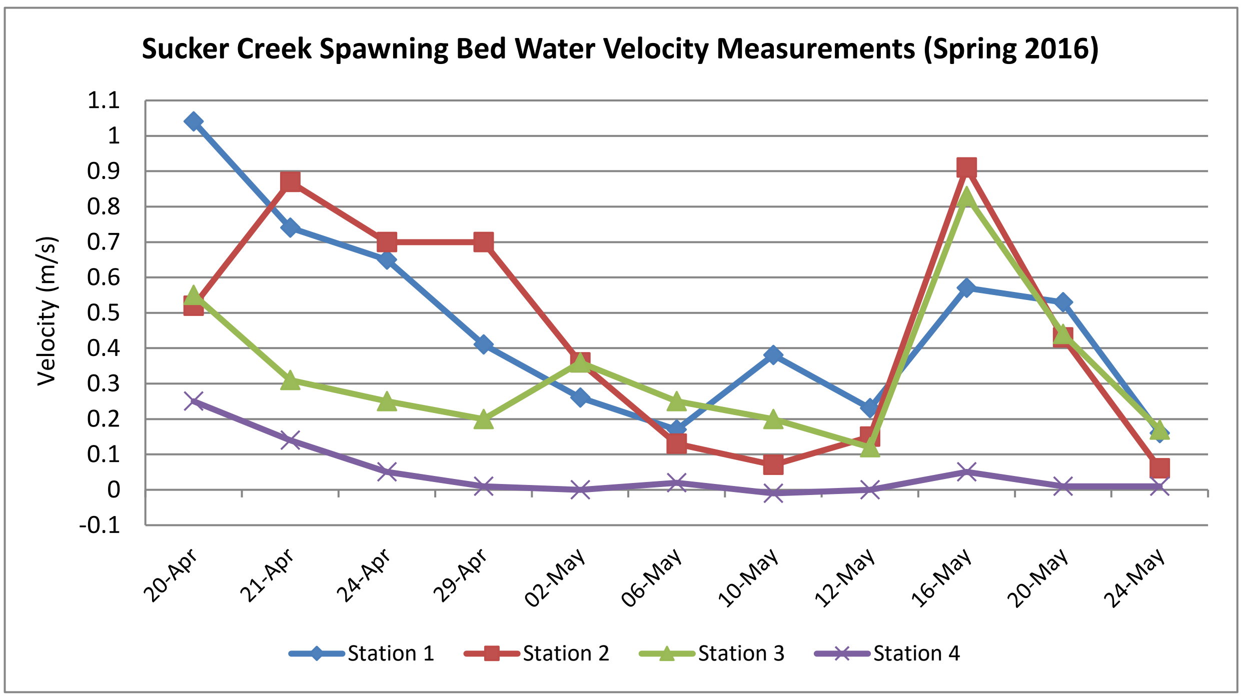

Figure 7. Water velocity measurements at the Sucker Creek spawning bed in spring 2016

At station 1, the highest velocity recorded was 1.04 m/s on April 20 and the lowest velocity recorded was 0.16 m/s on May 24. The highest velocity recorded at station 2 was 0.91 m/s on May 16, while the lowest velocity recorded was 0.06 m/s on May 24. At station 3 the highest velocity was recorded on May 16, 0.83 m/s. The lowest velocity recorded at station 3 was 0.12 m/s on May 12. On April 17, the highest velocity at station 4 was recorded (0.25 m/s) and the lowest velocity recorded was -0.01 m/s on May 10. The negative value indicates that the station had become a back eddy, and water was flowing in the opposite direction.

Velocities in Sucker Creek were highest on April 17 and May 16. The increased flows from the rain event on May 14 were more evident at stations 2 and 3, where flows sharply increased. At station 1, there was also an increase, but it was less dramatic than at stations 2 and 3. This may have to do with where runoff from the highway enters Sucker Creek. There is a lot of erosion along the highway edge, along the small buffer between the highway and the creek, and it is possible that runoff was entering the creek between stations 1 and 2 (Figure 8). Station 4 also experienced an increase on May 16, but it was much less than the other stations. Station 4 was located below the spawning bed and was close to, or at, Georgian Bay water levels. Sucker Creek widens below station 3, which reduces velocities downstream. Overall, velocity was very low at station 4. There were no velocities recorded at Sucker Creek that would exclude Walleye or Sucker species from the spawning area.

Figure 8. Erosion and runoff points into Sucker Creek between stations 1 and 2

Water Level Fluctuations

Water levels were recorded at stations 1, 2, and 4 (Figure 6) to understand how water levels change throughout spawning and egg incubation and how they change along the spawning bed. Typically, when the spring freshet begins, water levels are high. Water levels subsequently decline over the following months. If water levels decline rapidly after the spawning period, deposited eggs may be left out of water and will not hatch.

Stations 1 and 2 were located in the upper reach of the spawning bed and best reflect water level changes where fish were spawning and eggs were incubating. Station 4 was located downstream of the spawning area. This location was very close to Georgian Bay water level and was therefore greatly influenced by wind and seiche effects typical of eastern Georgian Bay.

At the Sucker Creek spawning bed, water levels diminished fairly consistently throughout the spawning and egg incubation period (Figure 9). Stations 1 and 2 followed the same pattern, aside from a small increase in water level at station 1 on April 21 and a small decline in water level at station 2 on May 12. Both stations show a sharp decline in water levels up until May 6, after which they remained fairly stable over the next three site visits, until water levels increased dramatically after the rain event on May 14. After May 14, water levels at both stations declined rapidly. Water levels at station 1 dropped by 32.4 cm over the period of measurement, and by 26.1 cm at station 2.

Water levels at station 4 differed from stations 1 and 2. Station 4 was close to, or at, Georgian Bay water level, and was therefore more influenced by rising Georgian Bay water levels than upstream flow and runoff. At station 4, water levels fluctuated much less severely, only declining by a maximum of 5.7 cm over the measurement period. On May 16, following the rain event on May 14, water levels at station 4 only increased by 0.5 cm and by another 5.5 cm by May 20. Water levels had declined slightly (2 cm) by the last field visit on May 24.

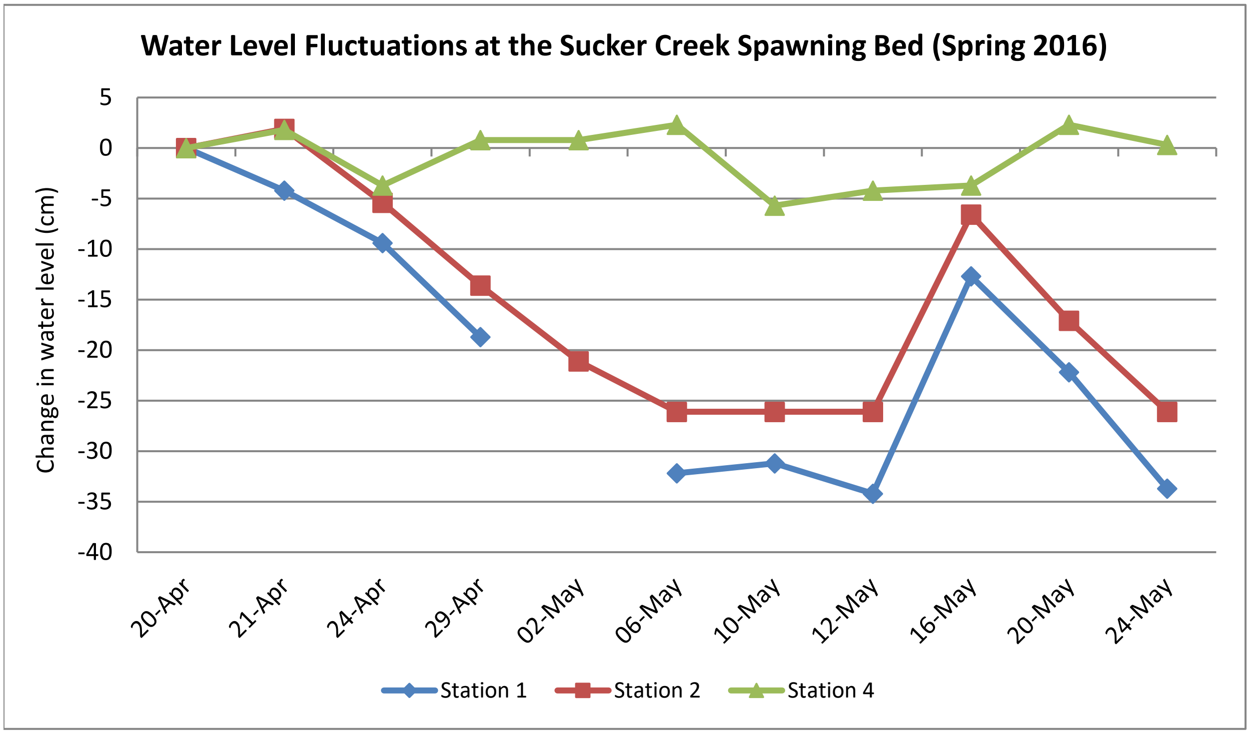

Figure 9. Water level fluctuations at the Sucker Creek spawning bed, measured at stations 1, 2, and 4. Measurements on the first site visit served as the benchmark against which future measurements were compared (i.e., water level up or down compared to the first site visit).

Along the Sucker Creek spawning area, there are a number of short ledges that fish need to ascend to get farther upstream. By April 20, water levels had dropped significantly in portions of the creek. By May 3, when several hundred White Sucker were spawning all along the spawning bed, water levels were much lower. On May 6, White Sucker were still actively spawning, and in many cases, their dorsal fins, and sometimes the upper portion of their bodies were above water due to reduced depth. EGBSC measured the range of water depth available at each ledge to investigate how much depth White Sucker had to navigate upstream. Table 1 lists the range of depths, and for most ledges, the height. Figures 10 - 18 illustrate the low water levels at each ledge on May 6.

Table 1. Sucker Creek spawning bed ledge depth ranges and notes

Ledge	Depth Range (cm)	Notes
1	10-15	White Sucker swimming upstream without issue
2	5-15	
3	4-15	15 to 30 cm ledge to ascend
4	4-15	15 to 35 cm ledge to ascend
5	12-25	25 cm ledge to ascend
6	8-15	20 to 25 cm ledge to ascend
7	13-25	gradual slope
8	5-20	20 cm drop
9	8-15	35 cm ledge to ascend

Figure 10. Ledge 1 on May 6, 2016

Figure 11. Ledge 2 on May 6, 2016

Figure 12. Ledge 3 on May 6, 2016

Figure 13. Ledge 4 on May 6, 2016

Figure 14. Ledge 5 on May 6, 2016

Figure 15. Ledge 6 on May 6, 2016

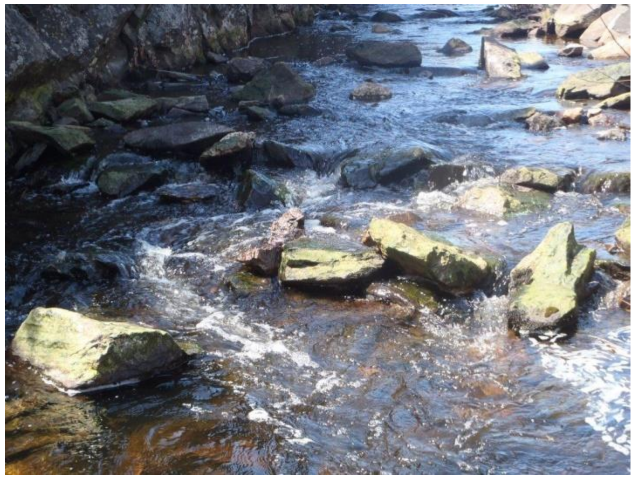

Figure 16. Ledge 7 on May 6, 2016

Figure 17. Ledge 8 on May 6, 2016

Figure 18. Ledge 9 on May 6, 2016

Aerial Photographs

An important component of the spawning bed assessments was taking a series of drone photographs during the spawning and egg incubation period to help evaluate how the spawning area changed throughout the spring freshet. During each visit, weather permitting, EGBSC staff flew a drone to capture photos of the spawning bed. Unlike the other rivers, at Sucker Creek, EGBSC was unable to get overlapping photos of water levels due to the proximity of the creek to the highway. As a result, no orthomosaics can be created from the site. Instead, photos were taken looking upstream at the spawning bed.

April 17, 2016

April 20, 2016

April 24, 2016

April 30, 2016

May 2, 2016

May 6, 2016

May 10, 2016

May 16, 2016

May 20, 2016

May 24, 2016

Several site photos taken looking upstream (Figure 19) and downstream (Figure 20) also show the change in water level at the Sucker Creek spawning bed.

Figure 19. Sucker Creek spawning bed looking upstream. The photo on the left was taken on April 17, 2016 and the photo on the right was taken on May 12, 2016.

Figure 20. Sucker Creek spawning bed looking downstream. The photo on the left was taken on April 17, 2016 and the photo on the right was taken on May 12, 2016.

Fish Observations

Fish observations were gathered visually during the day and night. Due to the narrow width and shallow depth of the spawning area, it was very easy to see fish movement (Figure 21). Night surveys for Walleye began on April 20 and continued until May 5. EGBSC looked for White Sucker during each daytime field visit, and visual observations for Redhorse Sucker species took place on site visits between May 16-24.

Walleye were observed at the site from April 20 to April 23. No more than seven Walleye were spotted during a single survey. It appeared there were very low numbers of Walleye moving into Sucker Creek, which was confirmed by local community members who had been involved in the original restoration of the site and who continue to check on the site on an annual basis. White Sucker were observed at the site between April 23 and May 6. The peak of White Sucker spawning occurred between April 27 and May 6, when an estimated several hundred White Sucker were observed. After May 6, the next site visit occurred on May 10. No fish were present in the creek that day, aside from Logperch. No fish were observed during subsequent site visits on May 12, 16, 19, and 24. Table 2 lists the species seen on each date.

Figure 21. White Sucker observed at the Sucker Creek spawning bed

Table 2. Fish observations at the Sucker Creek spawning bed

Date	Species Observed	Number
20-Apr	Walleye	2
23-Apr	Walleye	7
	White Sucker	30
24-Apr	White Sucker	A few
27-Apr	White Sucker	Hundreds
29-Apr	White Sucker	Hundreds
02-May	White Sucker	Hundreds (fewer than Apr 27 & 29)
03-May	White Sucker	Hundreds (fewer than Apr 27 & 29)
05-May	White Sucker	Hundreds (fewer than Apr 27 & 29)
06-May	White Sucker	Hundreds (fewer than Apr 27 & 29)
	Logperch	Abundant
10-May	Logperch	Abundant

Water levels declined fairly dramatically at Sucker Creek over the spawning and egg incubation period. This did not seem to prevent White Sucker from accessing the creek, but it may have limited movement and affected the success of reproduction. In many areas, dorsal fins of the fish were visible above the water, and in some cases, a portion of their upper bodies were out of water (Figure 22).

Figure 22. White Sucker observed partially out of water at the Sucker Creek spawning bed on May 3, 2016

Egg Deposition

EGBSC set three egg mats at the Sucker Creek spawning bed to help assess the amount, type, and location of egg deposition (Figures 23-26). Egg mats were only placed on a small portion of the spawning bed, and therefore, only represent a small portion of the entire spawning area. Based on size, eggs could be differentiated between Walleye and Sucker species, but it was not possible to identify the Sucker eggs to species level. However, no Longnose or Redhorse Sucker species were observed during any of the site visits. Had Lake Sturgeon eggs been deposited, they would have also been distinguishable by size and colour.

Figure 23. Location of egg mats installed at the Sucker Creek spawning bed in 2016

Figure 24. Egg mat 1 installed on April 17, 2016

Figure 25. Egg mat 2 installed on April 17, 2016

Figure 26. Egg mat 3 installed on April 17, 2016

Egg mats were installed on April 17. Table 3 details when egg mats were checked and the number of eggs counted. Although Walleye were last observed on April 23, Walleye continued to spawn at Sucker Creek at least up until May 6. In total, 248 Walleye eggs and 208 White Sucker eggs were counted at Sucker Creek. Much of the egg deposition was observed upstream of where the egg mats were placed (Figure 27).

Table 3. Egg deposition on the egg mats at Sucker Creek spawning bed

Date	Egg Mat	Walleye Eggs	Sucker Eggs
Apr 29	1	0	0
	2	0	23
	3	Not counted	Not counted
Apr 30	1	57	45
	2	41	12
	3	119	54
May 6	1	Egg mat missing	Egg mat missing
	2	Egg mat missing	Egg mat missing
	3	31	74

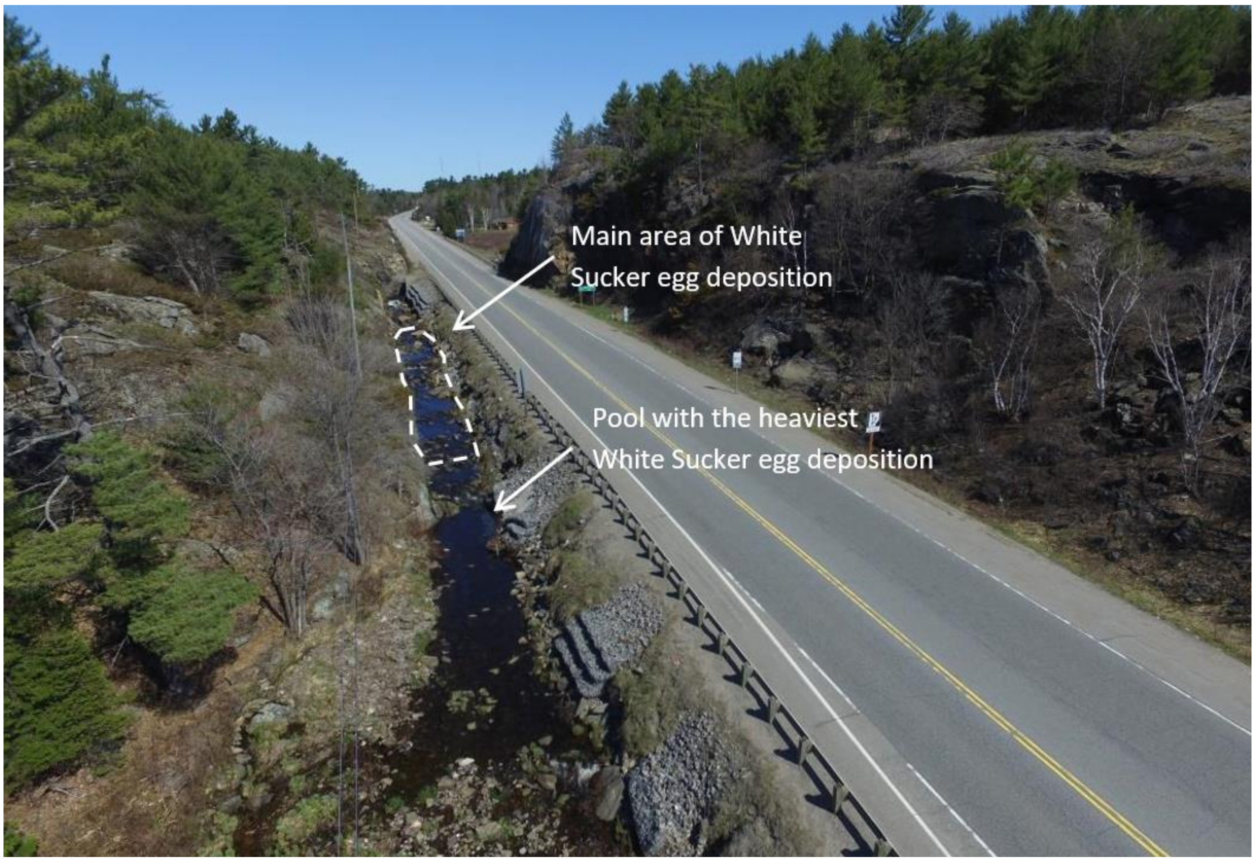

Figure 27. Areas of the heaviest White Sucker egg deposition at the Sucker Creek spawning bed

As previously mentioned, several hundred White Sucker were observed spawning at the Sucker Creek spawning bed. While there was not a lot of egg deposition on the egg mats (although egg mats 1 and 2 could not be counted following peak spawning activity), thousands of White Sucker eggs accumulated in a number of areas along the creek. Due to the narrow, gorge-like shape of the spawning bed, White Sucker eggs were deposited in any pooled or quiet areas along the shorelines, in the upper reaches of the spawning bed (Figures 28-29).

Figure 28. Sucker egg deposition at the Sucker Creek spawning bed

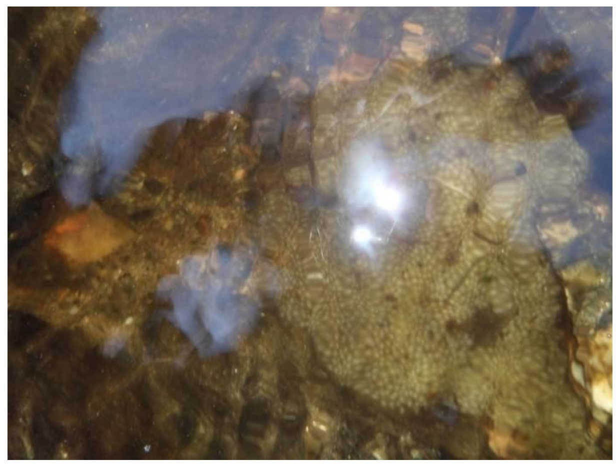

Figure 29. Sucker eggs settled in calm areas of the Sucker Creek spawning bed

With declines in water levels, some eggs were observed stranded out of water of on May 6 (Figure 30). While there were many eggs stranded out of water along the edges of the creek, there were also many areas of egg deposition that remained underwater.

Figure 30. Stranded White Sucker eggs on May 6, 2016

Plankton Sampling

Once eggs incubate and hatch, fish enter their larval stage. Larval Walleye have limited mobility and move by drifting with water flow and wave action. Shortly after hatching, Walleye need to feed on zooplankton to ensure survival, growth, and development. The availability of zooplankton is a major factor in surviving this life stage. To help evaluate the amount of zooplankton downstream of the Sucker Creek spawning bed, EGBSC conducted four plankton tows using a 12" diameter, 153 micron plankton net (Figure 31).

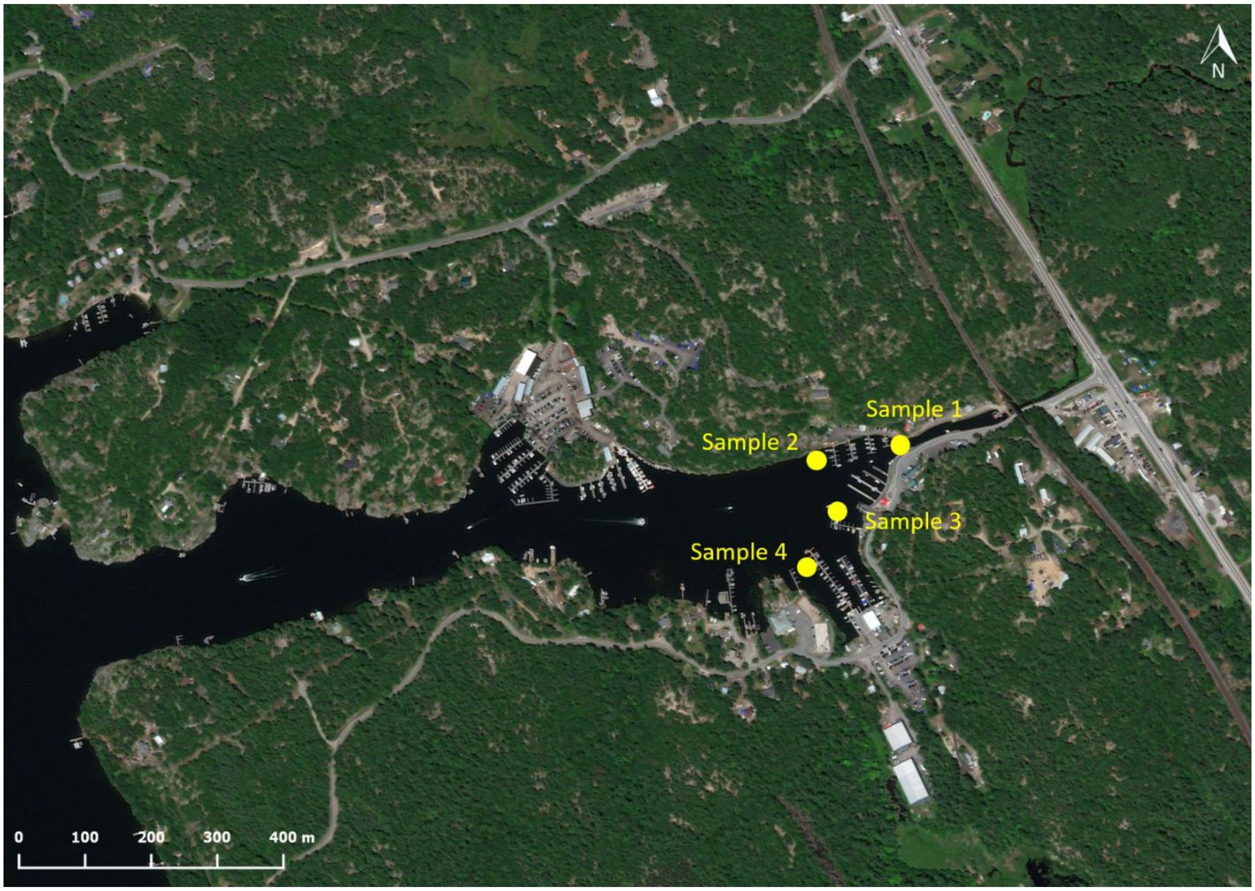

Figure 31. Plankton sampling locations downstream of the Sucker Creek spawning bed in 2016

EGBSC did not identify and count the zooplankton in the samples. Only a visual observation of the samples could be made and compared with the four other rivers sampled in 2016. An example of a sample taken downstream of Sucker Creek is shown in Figure 32. Relative to the samples from the other four rivers sampled in 2016, Sucker Creek had plankton abundance similar to that of the Seguin and Shebeshekong Rivers. Plankton abundance downstream of Sucker Creek was less than at the Shawanaga River but more than at the Magnetawan River.

Figure 32. Plankton sample taken downstream of Sucker Creek in 2016

Spawning Bed Measurements

Reproductive success for Walleye, Lake Sturgeon, and White Sucker is optimized when water depth, velocity, and appropriately sized substrate are present at the same location within a spawning area. The optimal substrate size for Walleye egg incubation ranges from gravel (0.2 to 6.4 cm) to cobble (6.4 to 25 cm) (Kerr et al., 1997). The optimal substrate size for Lake Sturgeon ranges from 10 to 60 cm in diameter (Golder Associates Ltd., 2011). White Sucker spawn on a clean bottom of coarse sand to gravel ranging from 2 to 16 mm in size (Twomey et al., 1984). Optimal depth for spawning Walleye ranges from 30 to 100 cm (Kerr et al., 1997) and 10 to 200 cm for Lake Sturgeon spawning (Golder Associates Ltd., 2011).

In the fall of 2016, transects were measured across the Sucker Creek spawning bed with the intent of better understanding depth and substrate. Transects were completed later in the season, when it was safe to wade across the spawning bed; because of this, only depth and substrate information was collected, not velocity. Any velocity data collected would not have been the same as during the spawning season.

EGBSC completed twenty-one (21) transects across the spawning bed, spaced roughly 6 m apart. Along each transect (bankfull width), depth measurements were taken at five points (see Figure 33 for example). Substrate was estimated in percentages at two locations along each transect with the aid of a grid marked at 10 cm increments. In addition to depth and substrate, any aquatic vegetation was noted at each point, and shoreline vegetation was recorded for each transect.

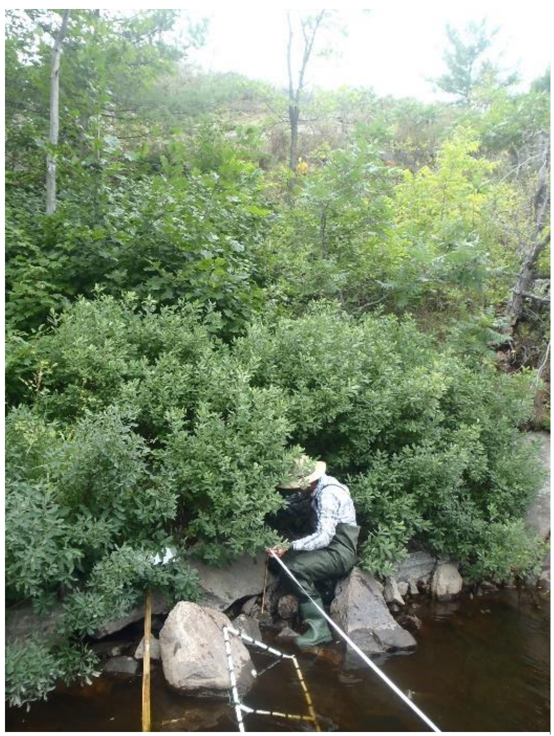

Figure 33. Measuring bankfull width and depths along transect 17

In total, all but one of the transects had at least some substrate considered ideal for Walleye spawning and all but three had at least some substrate considered ideal for Sucker species. All twenty-one (21) transects had at least some measurement points that were within the ideal depth range for Walleye. This evaluation was based on identifying ideal spawning habitat only. It does not indicate the actual amount of spawning, as fish will spawn in areas without ideal substrate and/or depth. In addition, habitat was only assessed along specific transect lines, and therefore does not represent the entire spawning bed. The measurements are a sample of the spawning bed and serve as an indicator of potential site limitations. Complete transect data is provided in Appendix D.

Erosion Issues

The Sucker Creek spawning bed is confined by a steep rock cliff on the west side and Highway 69 on the east side. There is little room between the shoulder of the highway and the spawning bed. Erosion is an issue along much of the spawning area, due to highway runoff (Figures 34 and 35). Some of the gabion baskets that were installed have started to fail and landscaping cloth is visible where the riprap placed for erosion control has fallen into the water. Based on the state of the erosion, EGBSC anticipates that erosion control will be done in the future to protect the highway. It would be extremely important for that erosion control work to take the spawning area into consideration so that the spawning area is not negatively impacted. It would also provide an opportunity to mix native plant material in with the erosion control work to help control some of the runoff moving into the creek.

Figure 34. Areas of erosion between the highway and Sucker Creek (looking upstream)

Figure 35. Slumping gabion baskets and exposed landscape fabric (looking downstream)

Nursery, Rearing, and Foraging Habitat

Until they become mobile, newly hatched fry of most riverine spawning species are dispersed largely according to water currents. In lake environments, wind-driven current can be a major factor in dispersing fry. Accordingly, the availability of nursery habitat in the downstream (or down-wind) vicinity of spawning sites is an important factor in reproductive success.

EGBSC completed surveys downstream of the Sucker Creek spawning bed to determine if there is habitat – nursery, rearing, and foraging – for Walleye and Sucker fry. To assess nursery, rearing, and foraging habitat, EGBSC combined bathymetry and side scan sonar data, as well as, underwater survey data. The purpose of the underwater surveys was to help ground truth what was being displayed from the sonar data. In addition, EGBSC compared the length of natural shoreline (unaltered) downstream of each spawning bed to the length of altered shoreline. Natural shorelines are critical for maintaining water quality and fish habitat. Natural shorelines help to slow runoff from roads, houses, and other areas of development, improving water filtration and filtering nutrients before they reach the watercourse. Natural vegetation along watercourses helps to create shade and moderate temperature. Natural debris (branches, leaves, etc.) that fall into the water are a source of food for aquatic insects, which in turn, are a source of food for certain fish, such as White Sucker.

There were a number of challenges associated with gathering and interpreting the data collected. First, there is very little information on nursery, rearing, and foraging habitat for Sucker species. More information is available for Walleye, but it is quite vague. For example, adult Walleye are described as being found between 2 to 10 m depth, this wide range makes it challenging to focus in on specific habitat. EGBSC focused survey efforts in the nearshore area at depths of approximately 1.5 m. Second, once eggs hatch, the larvae drift downstream, according to currents and wind. It is not possible to say how far the larvae drift, and this distance likely varies river by river. Third, side scan sonar data was collected to help identify the type of substrate present in the river and identify areas with vegetation and boulders (.sl2 files are available upon request). However, in some areas, interpretation of the side scan data was very difficult making it challenging to discern between different types of substrate. In the areas where the substrate was not clear, that information was not used in determining fish habitat due to a lack of confidence in interpretation. Finally, the fourth challenge was integrating all of the data collected.

Underwater Surveys

Underwater videos were taken by snorkelling for 100 m approximately every 1 km, using a GoPro camera (areas such as marinas that were unsafe to swim in front of were avoided). In total, EGBSC carried out five underwater surveys. Each survey location has been identified in Figure 36. A bathymetry map is presented in Appendix E.

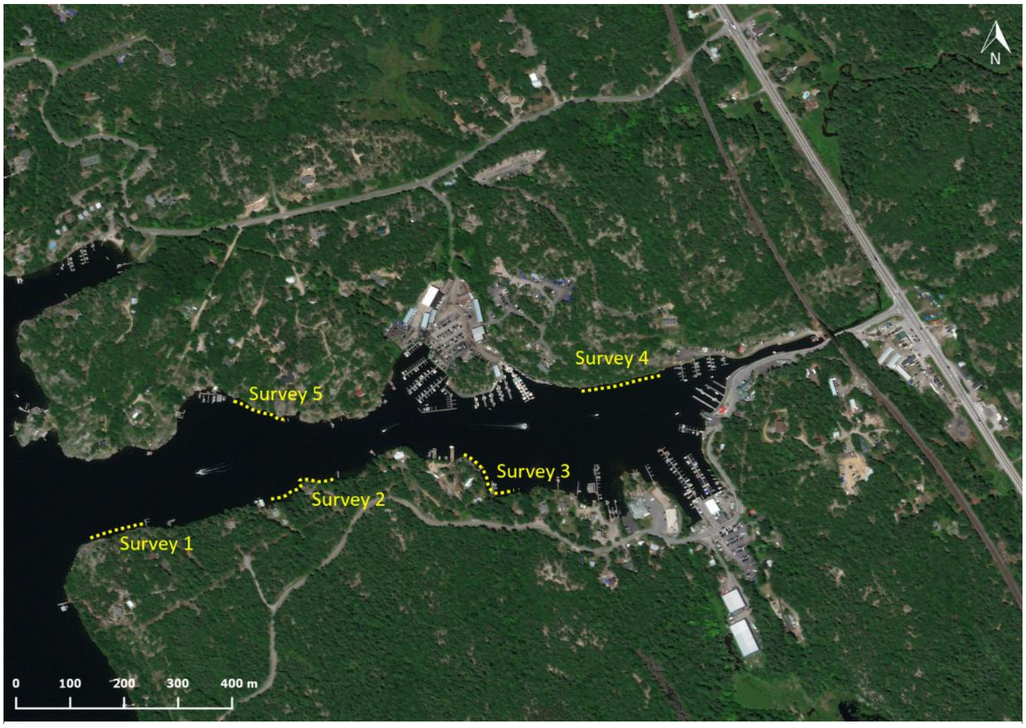

Figure 36. Underwater survey locations downstream of the Sucker Creek spawning bed

For each underwater survey, types of substrate and aquatic vegetation, as well as, abundance of aquatic vegetation and woody debris (sticks, branches, logs) were recorded. Aquatic vegetation and woody debris offer cover for fish at various life stages and provide cover for predatory fish to ambush their prey. Classifications and definitions of abundance are detailed in Table 4. Each of the five underwater surveys is summarized in Table 5.

Table 4. Definitions of aquatic vegetation and wood structure abundances

Abundance	Sparse	Moderate	Abundant
Aquatic vegetation	Observed in small, inconsistent patches	Observed consistently along the substrate, camera moves easily through the area	Consistent and thick, difficult to move camera through the area
Wood structure	1-2 branches or sticks	2 logs and/or several branches or sticks (<10)	>3 logs and/or >10 branches

Table 5. Summary of findings from five underwater surveys

Survey	Substrate	Woody Debris	Aquatic Vegetation	Notes
1	Bedrock with some cobble, boulder and large gravel	Sparse	Sparse vegetation but abundant algae	Steep slope
2	Soft with one small patch of bedrock near middle	Sparse	Moderate to abundant	Several YOY Centrarchid spp., freshwater mussel shells
3	Half soft, half bedrock with pockets of gravel, cobble, and boulder	None	Moderate to abundant	

Survey	Substrate	Woody Debris	Aquatic Vegetation	Notes
4	Half soft, half bedrock with pockets of gravel, cobble, and boulder	None	Sparse to moderate	Freshwater mussels, Percid spp.
5	Half soft, half bedrock with pockets of gravel, cobble, and boulder	Abundant	Sparse to moderate	

The following list of aquatic vegetation (submergent, emergent, and floating) was recorded from the five surveys: Richardson's Pondweed, Tapegrass, Coontail, Potamogeton species (at least two species), Canada Waterweed, Flat-stemmed Pondweed, Large-leaved Pondweed, Freshwater Sponge, algae, Ceratophyllum spp., Bulrush spp., Sedge spp., Common Cattail, White Water Lily. Tapegrass, algae, and Ceratophyllum spp. were the most dominant species, observed in all five of the surveys.

Shoreline Characteristics

Along each of the five underwater surveys, shoreline characteristics were also recorded and photographed. Downstream of the Sucker Creek spawning bed to the outlet into Pointe au Baril Channel, the shoreline is approximately 37% natural (unaltered) and 63% altered (Figure 38). Types of shoreline alterations included docks, boathouses, boat launches, hardened walls, and riprap. Photos of the shoreline from each survey can be found in Appendix F.

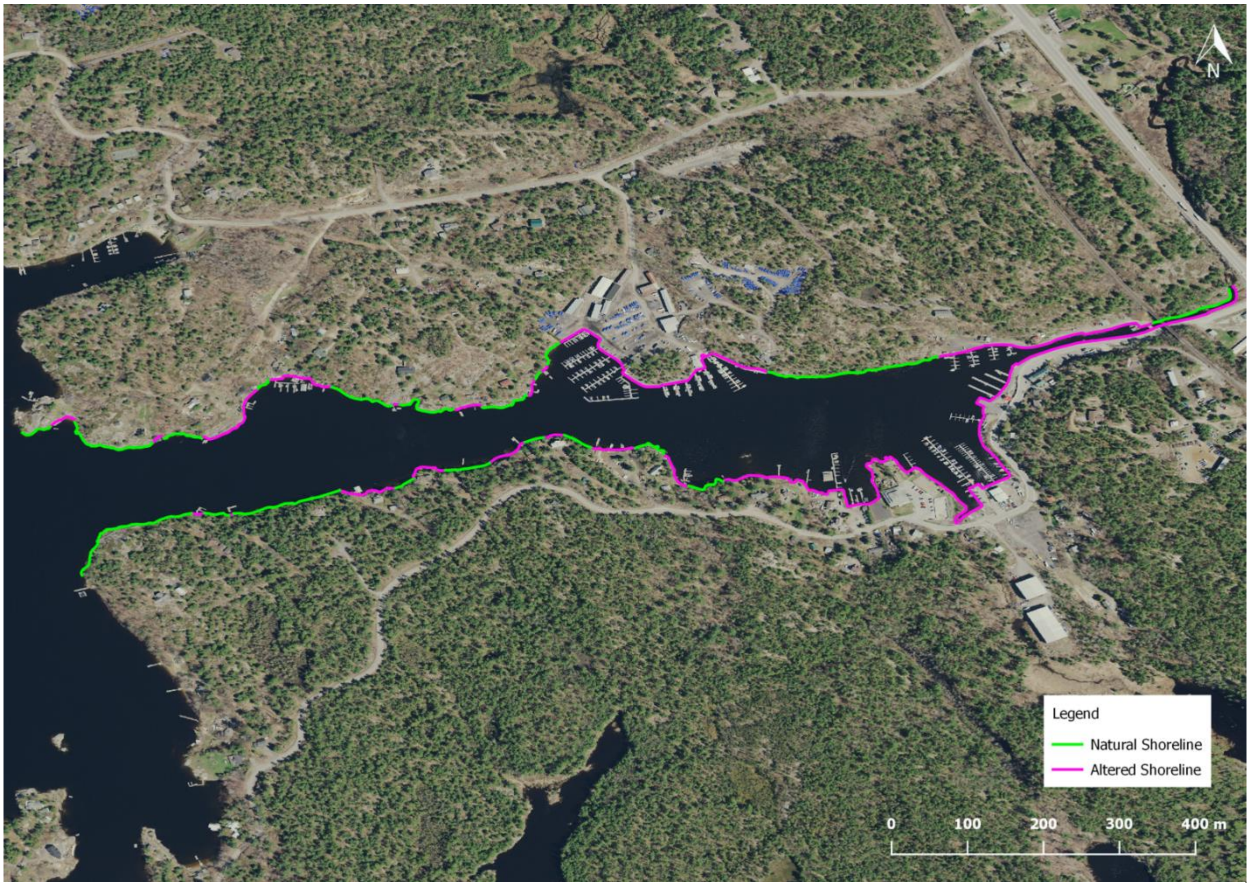

Figure 37. Natural and altered shoreline downstream of the Sucker Creek spawning bed

Shoreline substrate was also recorded and photographed for each of the surveys. Only the shoreline substrate that was visible was recorded. Four of the five surveys had a bedrock shoreline, and one survey had bedrock and eroding sand. Table 6 lists the shoreline characteristics of each survey.

Table 6. Shoreline characteristics along the underwater surveys

Survey	Shoreline Characteristics
1	Bedrock shoreline, little vegetation on the immediate shoreline; shrubs and trees farther back
2	Immediate bedrock shoreline; mainly cottages with mowed grass, some mature trees and shoreline vegetation, long rock wall
3	Bedrock shoreline with shrubs, trees and herbaceous species, cottages and docks; ended in small bay with emergents
4	Steep cliff and 1 small area of eroded bare sand
5	Steep bedrock slope; ended just before a large boathouse, large house with many docks and boats

In addition to substrate, shoreline vegetation that could be identified was recorded for each survey. The following list of shoreline vegetation was recorded from the five surveys: Reed Canary Grass, Goldenrod spp., Grass spp., Sweet Gale, Meadowsweet, Poplar, Maple spp., White Birch, White Pine, Red Oak, Eastern White Cedar, Common Ground Juniper, Red Pine, Bracken Fern, and Staghorn Sumac. Sweet Gale, Meadowsweet, and Common Ground Juniper were recorded for multiple surveys. White Pine, White Birch, Maple spp., Eastern White Cedar, and Red Oak were the most abundant tree species. No terrestrial or aquatic invasive species were observed in the survey locations.

Additional Underwater Surveys

In addition to the five surveys described above, EGBSC also carried out four extra surveys in the channelized section of Sucker Creek, downstream of the spawning area and upstream of the outlet into Pointe au Baril Channel (Figure 39). Substrate was sampled from the boat at three points along each transect as this section was too deep for wading.

Figure 38. Additional surveys conducted immediately downstream of the Sucker Creek spawning bed

All transects had a sand bottom with some cobble, likely riprap used on the road side of the creek as bank stabilization that had washed into the creek. Transect 1 also had a small amount of muck (a mix of sand, silt, and clay).

Shoreline vegetation along the transects was quite diverse. The following species were identified along the shoreline: Spotted-Joe Pye Weed, Goldenrod spp., Sensitive Fern, Sedge spp., Pickerelweed, Steeplebush, Wild Clematis, Common Cattail, Common Ground Juniper, Sweet Gale, Meadowsweet, Staghorn Sumac, Grass spp., Purple Loosestrife (invasive species), Wild Red Raspberry, Yarrow, Alder spp., Ribes spp., Birch spp., Maple spp., Pine spp., Red Oak, and other Fern species. The dominant shoreline vegetation included Goldenrod spp., Sensitive Fern, Sweet Gale, Meadowsweet, Alder spp., Grass spp., and Sedge spp.

The following aquatic vegetation was identified: Pickerelweed, White Water Lily, Tapegrass, Potamogeton spp., and Ceratophyllum spp.

Impacts of Human Activities

The downstream portion of Sucker Creek is heavily impacted by human activities. At the base of the spawning bed, the creek has been altered to turn 90° and flow west to Pointe au Baril Channel. For this portion, the creek runs between a large rock cliff on the north side and a road on the south side. This continues downstream of the main spawning area, to the train bridge. At that point, Sucker Creek is then channelized by roads on both sides of the creek. Given the close proximity of the roads, Sucker Creek receives runoff from the roads and surrounding areas quickly and without much natural filtration of sediment, debris, or potential contaminants.

In general, channelized systems without natural meanders or shorelines offer limited fish habitat. There are fewer overhanging branches to provide food for aquatic insects which in turn, feed many fish species. There is a short section upstream of the train bridge that has quite a lot of natural vegetation (Figure 40); however, downstream of the train bridge, there is no natural vegetation along the rest of the creek (Figure 41), and there is no shade at that part of the creek, which influences water temperature. With channelized banks, there are also fewer areas of shelter for fish.

Figure 39. Sucker Creek looking upstream to Highway 69

Figure 40. Sucker Creek looking downstream from the train bridge

Based on the limited information available on life stage requirements for White Sucker, young of the year fish tend to prefer sand and gravel substrates and a moderate current. Juvenile White Sucker need slow runs, shoreline edges and backwater pools. Young Suckers feed on the surface, in eddies, backwaters, and gentle currents (Twomey et. al, 1984). Overall, White Sucker feed on benthic invertebrates, and rely on many types of cover, including exposed tree roots, logs, branches, undercut banks, and overhanging vegetation. Based on the 2016 assessment, these types of habitat exist only in a short section of Sucker Creek, between the downstream end of the spawning bed and the train bridge and are similarly limited as Sucker Creek outlets into Pointe au Baril Channel.

Beyond the outlet of Sucker Creek into Pointe au Baril Channel, the area downstream is heavily influenced by human activity with marinas, docks, buildings, retaining walls, and heavy boat traffic. This area is a main access point to Georgian Bay, which results in heavy boat traffic. In the underwater surveys, more garbage was observed in the creek and surrounding area than all of the other rivers assessed, with the exception of the Seguin River.

Discussion and Recommendations

Water chemistry measurements that were monitored (water temperature, dissolved oxygen, pH, and conductivity) were generally normal and typical of what one would expect from a Canadian Shield watershed. There was no indication of water quality having any adverse effects on fish spawning or egg incubation. While two of the pH readings were below the ideal pH range for Walleye, the other nine readings were within the ideal range, and there was no 'acid pulse' detected from the pH measurements. One notable increase in conductivity following the May 14 rain event was likely due to runoff from the highway and adjacent parking areas going straight into the creek. Although there was a large jump in conductivity, the reading of 61.4 uS/cm is still considered a low reading. In seasons with higher amounts of rainfall, conductivity readings may be higher than 2016, as there were only two rain events between April and June in 2016.

Flow in Sucker Creek during the spring spawning and egg incubation period is dependent on natural phenomena – winter snow load, rainfall, and air temperature affecting melting rate during the freshet. There are no upstream water control structures in the Sucker Creek watershed. There was only one velocity reading that exceeded 1.0 m/s, which would not prevent Walleye from accessing the spawning area. With so few Walleye being observed at the spawning bed, it is not possible to say with confidence which areas of the spawning bed Walleye use or access; however, egg deposition on the egg mats showed that Walleye were at least using the spawning bed up to the location of egg mat 1. In addition, the low to moderate water velocities recorded, along with a spawning bed morphology that offered numerous resting areas throughout, suggests that Walleye would have not been excluded from any areas of the spawning bed. Based on visual observations, water velocities did not prevent White Sucker from accessing the spawning bed, as White Sucker were observed throughout almost the entire spawning area, with the exception of the very most upstream end.

There was a substantial drop in water level at the two stations farthest upstream, and several pockets of White Sucker eggs were observed stranded out of water along the edges of the creek. However, most of the areas with egg deposition remained underwater. The steep shoreline and gorge-like nature of the spawning area minimizes the number of areas that are potentially vulnerable to egg stranding associated with decreasing water levels. On May 3, less water depth in the spawning bed made passage more challenging for White Sucker, and fish could be seen easily from the banks. Despite low water levels, White Sucker seemed to still be able to navigate upstream.

The Sucker Creek spawning area is small, but it has an abundant amount of ideally sized substrate for spawning Walleye and White Sucker. The spawning bed is well suited as a spawning area for White Sucker, and there was a substantial White Sucker run observed in 2016. Out of the eight rivers assessed in 2016 and 2017, Sucker Creek was one of three tributaries that had significant Sucker spawning activity, where several hundred fish were observed. The other sites were the Shawanaga River (White Sucker and Redhorse Sucker species) and the Harris branch of the Naiscoot River (Redhorse Sucker species). Most of the White Sucker observed were small in size and there was a noticeable lack of large White Suckers. This suggests that a highly successful year class was being recruited to the spawning population. This was also the case at the Shebeshekong River, where over 100 small White Sucker were observed.

In 2016, there was a low number of Walleye observed in Sucker Creek. It was interesting to note that the Walleye spawning population at Sucker Creek was in such a depressed state, yet the nearby Shawanaga Walleye population, which essentially shares the same waters, was in a state of exceptional abundance. So few Walleye were observed that it was not possible to identify specific locations of spawning activity. However, the presence of 248 Walleye eggs on the egg mats clearly indicates some degree of spawning activity at the downstream end of the rapids, where the mats were located.

Based on visual observations, it was surprising to have collected more Walleye eggs on the egg mats than White Sucker eggs. This is likely due to the location of the egg mats. Most of the White Sucker activity was observed upstream of the egg mats. The two egg mats located the farthest upstream were re-set on April 30 and subsequently went missing. Accordingly, those two egg mats could not be counted after the main period of White Sucker activity which was observed between April 27 and May 2. Despite the low number of White Sucker eggs on the egg mats, there were thousands of White Sucker eggs observed along the creek, within the rocky substrate. There was no way of directly correlating the number of eggs counted on the egg mats to the actual number of spawning fish present.

In 2016, egg mats were set at four other spawning areas (Shawanaga River, Shebeshekong River, Seguin River, and Magnetawan River). The highest total Walleye egg counts for those sites were 57,900, twenty-eight (28), 144, and 559, respectively. The number of Walleye eggs counted in Sucker Creek was the third lowest of the five rivers. The highest total Sucker egg counts for those same sites were 756, thirty-four (34), 185, and three (3), respectively. The Sucker egg count from the egg mats at Sucker Creek was the second highest.

There were two potential issues of concern observed at Sucker Creek. The first issue is the runoff from the highway and road straight into the creek. Erosion along the east side of the creek at the spawning bed got worse as the season progressed. This erosion would introduce sand and fine material which could accumulate in the spawning area over time, and reduce the amount of interstitial spaces needed for egg deposition. In addition, direct runoff from the highway would wash any contaminants straight into the creek.

The second potential issue is the channelization at the downstream end of the creek, and the highly developed shoreline into Pointe au Baril Channel. It is unknown how far larval fish drift after hatching, and it would vary depending on current and wind. There was far less natural shoreline downstream of the creek than along the other rivers assessed. Moreover, there is a high degree of human activity downstream of the spawning bed as the area is a main access point to Georgian Bay. It is unknown what impacts the channelization and developed shoreline may be having on larval fish success.

In summary, Sucker Creek provides important spawning habitat for White Sucker. This is significant given that in some areas of eastern Georgian Bay, Sucker populations are experiencing declines. EGBSC is not recommending any habitat restoration work at this site. It would be beneficial to re-visit Sucker Creek in a year with low Georgian Bay water levels to understand if low Georgian Bay water levels change accessibility of the spawning bed. EGBSC also recommends further, detailed analysis of the side scan sonar data to supplement the observations from underwater surveys and provide more in-depth insights into nursery, rearing, and foraging habitat (.sl2 files available upon request).

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- Scott Finucan – Ministry of Natural Resources and Forestry
- Greg Mayne – Environment and Climate Change Canada
- Karl Schiefer – Aquatic Biologist consultant and EGBSC member
- David Bywater – Environmental Scientist, Georgian Bay Biosphere Reserve
- David Sweetnam – Executive Director, Georgian Bay Forever

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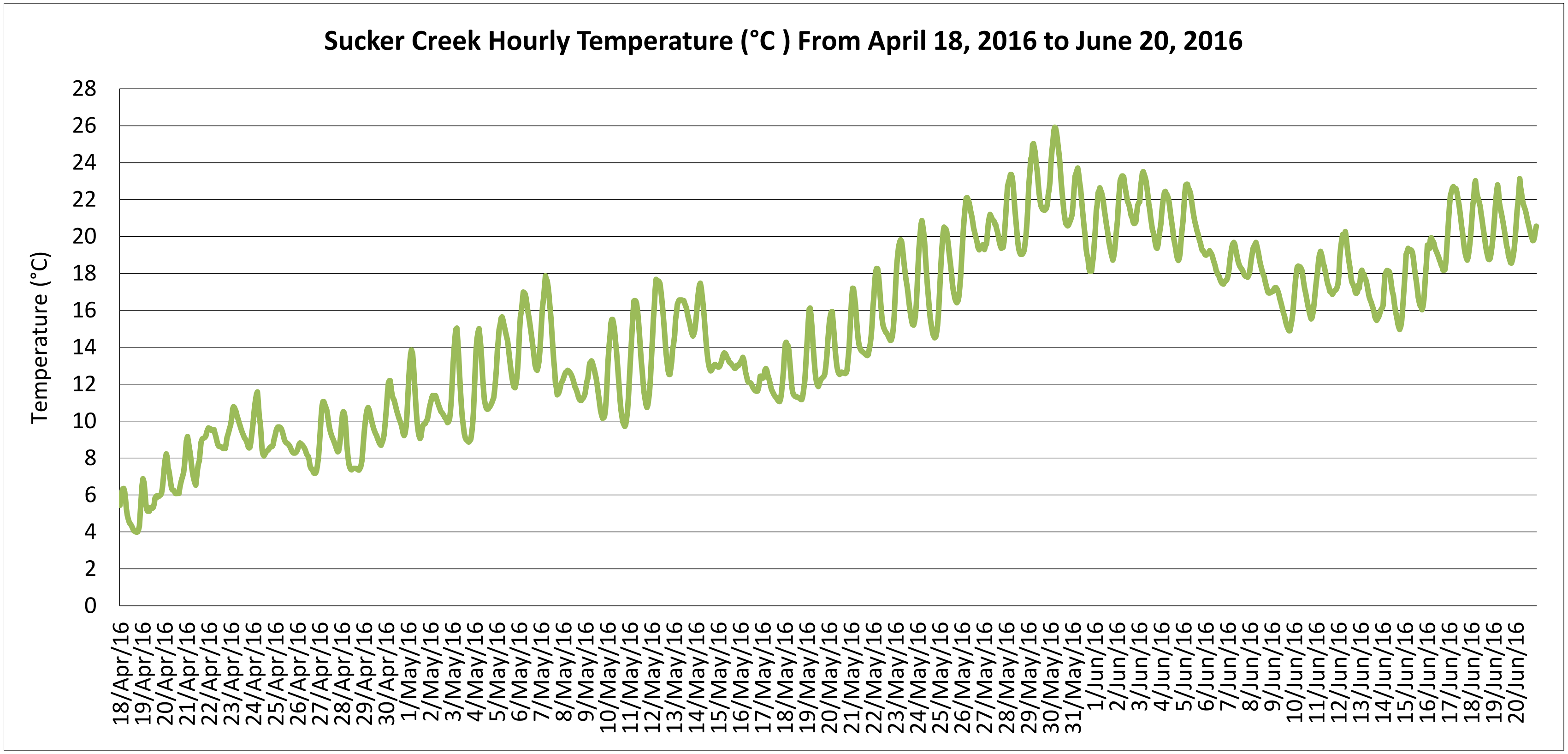
Appendix A – Water Chemistry

Date	Time	Temperature (°C)	DO (mg/L)	DO (%)	pH	Conductivity
17-Apr	10:16	4.0	13.28	103.1	5.76	26.1
20-Apr	20:35	6.8	12.08	99.7	6.22	22.6
24-Apr	16:15	9.5	10.75	94.2	6.35	19.3
29-Apr	18:32	11.3	10.07	92.3	6.61	26.4
02-May	18:10	14.1	8.51	83.0	6.40	30.2
06-May	15:00	16.6	8.97	92.2	6.54	37.5
10-May	11:00	10.6	10.13	91.0	6.30	32.7
12-May	13:40	15.0	9.37	93.1	6.45	34.8
16-May	17:44	12.2	8.20	76.5	5.87	61.4
20-May	10:08	13.6	9.19	88.5	6.88	24.4
24-May	14:55	19.7	7.95	86.7	6.12	34.9


Sucker Creek Hourly Temperature (°C) From April 18, 2016 to June 20, 2016
Temperature (°C)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
18/Apr/16
19/Apr/16
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20/Jun/16

Appendix B – Water Level and Velocity

Benchmark	Date	Depth (cm)
1	20-Apr	17.8
1	21-Apr	22
1	24-Apr	27.2
1	29-Apr	36.5
1	06-May	50
1	10-May	49
1	12-May	52
1	16-May	30.5
1	20-May	40
1	24-May	51.5
2	20-Apr	19.4
2	21-Apr	17.5
2	24-Apr	24.8
2	29-Apr	33
2	02-May	40.5
2	06-May	45.5
2	10-May	45.5
2	12-May	45.5
2	16-May	26
2	20-May	36.5
2	24-May	45.5
4	20-Apr	21.3
4	21-Apr	19.5
4	24-Apr	25
4	29-Apr	20.5
4	02-May	20.5
4	06-May	19
4	10-May	27
4	12-May	25.5
4	16-May	25
4	20-May	19
4	24-May	21

	Water Velocity (m/s)			
Date	Station 1	Station 2	Station 3	Station 4
20-Apr	1.04	0.52	0.55	0.25
21-Apr	0.74	0.87	0.31	0.14
24-Apr	0.65	0.7	0.25	0.05
29-Apr	0.41	0.7	0.2	0.01
02-May	0.26	0.36	0.36	0
06-May	0.17	0.13	0.25	0.02
10-May	0.38	0.07	0.2	-0.01
12-May	0.23	0.15	0.12	0
16-May	0.57	0.91	0.83	0.05
20-May	0.53	0.43	0.44	0.01
24-May	0.16	0.06	0.17	0.01

Appendix C – Visual Observations

Date	Species Observed	Number
20-Apr	Walleye	2
23-Apr	Walleye	7
	White Sucker	30
24-Apr	White Sucker	A few
27-Apr	White Sucker	Hundreds
29-Apr	White Sucker	Hundreds
02-May	White Sucker	Hundreds (fewer than Apr 27 & 29)
03-May	White Sucker	Hundreds (fewer than Apr 27 & 29)
05-May	White Sucker	Hundreds (fewer than Apr 27 & 29)
06-May	White Sucker	Hundreds (fewer than Apr 27 & 29)
	Logperch	Abundant
10-May	Logperch	Abundant
12-May	no fish observed	
16-May	no fish observed	
19-May	no fish observed	
24-May	no fish observed	

Egg Mat	Date Set	Date Counted	Sucker Eggs	Walleye Eggs
1	17-Apr	29-Apr	0	0
2	17-Apr	29-Apr	23	0
3	17-Apr	30-Apr	54	119
1	29-Apr	30-Apr	45	57
2	29-Apr	30-Apr	12	41
1	30-Apr	missing	n/a	n/a
2	30-Apr	missing	n/a	n/a
3	30-Apr	06-May	74	31
		Total	**248**	**208**

Appendix D – Transect Data

Transect 1

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 0.53	0.44		Grid 1 - 100% bedrock	None
(2) 1.58	0.98			None
(3) 2.63	0.81		Grid 2 - 40% bedrock, 40% cobble, 15% lg boulder, 5% sand	None
(4) 3.68	0.88			None
(5) 4.73	0.84			None

Transect 2

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 0.47	0.36		Grid 1 - 80% bedrock, 20% sand	None
(2) 1.41	0.83			None
(3) 2.35	0.49		Grid 2 - 60% cobble, 30% sm boulder, 5% lg stone, 5% sand	None
(4) 3.29	0.46			None
(5) 4.23	0.35			None

Transect 3

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 0.43	0.43		Grid 1 - 100% bedrock	Algae
(2) 1.28	1.04			None
(3) 2.13	1.30		Grid 2 - 100% bedrock	None
(4) 2.98	1.05			None
(5) 3.83	0.55			None

Transect 4

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 0.45	0.57		Grid 1 - 100% bedrock	None
(2) 1.35	0.72			None
(3) 2.25	1.05		Grid 2 - 75% lg boulder, 15% cobble, 5% sm stone, 5% lg stone	None
(4) 3.15	1.18			None
(5) 4.05	1.07			None

Transect 5

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 0.64	0.25		Grid 1 - 55% bedrock, 35% cobble, 10% lg boulder	None
(2) 1.92	0.26			None
(3) 3.20	0.52		Grid 2 - 85% lg boulder, 10% cobble, 5% lg stone	None
(4) 4.48	0.56			None
(5) 5.76	0.42			None

Transect 6

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 0.59	0.34		Grid 1 - 45% lg boulder, 30% cobble, 10% lg stone, 10% sm stone, 5% sand	None
(2) 1.76	0.53			None
(3) 2.93	0.65		Grid 2 - 40% cobble, 30% lg boulder, 15% lg stone, 10% small stone, 5% sand	None
(4) 4.10	0.62			None
(5) 5.27	0.45			None

Transect 7

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 0.55	0.22		Grid 1 - 65% cobble, 15% lg stone, 15% sm stone, 5% sand	Algae
(2) 1.65	0.45			None
(3) 2.75	0.37		Grid 2 - 30% lg boulder, 30% cobble, 20% lg stone, 15% sm stone, 5% sand	None
(4) 3.85	0.39			None
(5) 4.95	0.38			None

Transect 8

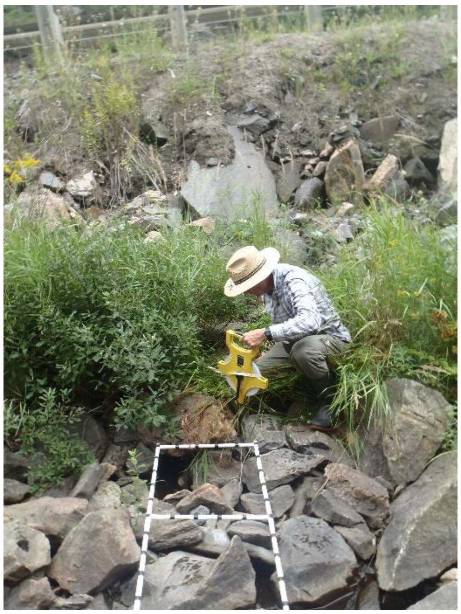
Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 0.50	0.49		Grid 1 - 50% lg boulder, 35% cobble, 10% sm stone, 5% lg stone	None
(2) 1.49	0.45			None
(3) 2.48	0.24		Grid 2 - 70% lg boulder, 25% cobble, 5% lg stone	None
(4) 3.47	0.37			None
(5) 4.46	0.36			None

Transect 9

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 0.57	0.27		Grid 1 - 60% cobble, 30% lg boulder, 5% lg stone, 5% sm stone	Bugleweed algae
(2) 1.71	0.50			None
(3) 2.85	0.57		Grid 2 - 60% lg boulder, 35% cobble, 5% sand	None
(4) 3.99	0.45			None
(5) 5.13	0.47			None

Transect 10

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 0.42	0.19		Grid 1 - 50% lg boulder, 45% cobble, 5% lg stone	None
(2) 1.26	0.43			None
(3) 2.10	0.49		Grid 2 - 60% cobble, 25% lg boulder, 5% lg stone, 5% sm stone	None
(4) 2.94	0.35			None
(5) 3.78	0.59			None



Transect 11

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 0.43	0.28		Grid 1 - 55% cobble, 40% lg boulder, 5% sm stone	Algae
(2) 1.29	0.72			None
(3) 2.15	0.45		Grid 2 - 70% lg boulder, 15% cobble, 15% lg stone	None
(4) 3.01	0.48			None
(5) 3.87	0.36			None

Transect 12

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 0.48	0.52		Grid 1 - 60% lg boulder, 35% cobble, 5% sm stone	None
(2) 1.43	0.54			None
(3) 2.38	0.48		Grid 2 - 60% cobble, 35% large boulder, 5% sand	None
(4) 3.30	0.35			None
(5) 4.28	0.25			None

Transect 13

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 0.40	0.28		Grid 1 - 65% cobble, 15% lg stone, 15% sm stone, 5% sand	Algae
(2) 1.19	0.14			None
(3)1.98	0.29		Grid 2 - 45% lg boulder, 30% bedrock, 15% cobble, 10% lg stone	None
(4) 2.77	0.45			None
(5) 3.56	0.45			None

Transect 14

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 0.49	0.05		Grid 1 - 70% lg boulder, 15% lg stone, 10% cobble, 5% sm stone	Algae
(2) 1.46	0.23			None
(3) 2.43	0.33		Grid 2 - 60% cobble, 25% lg boulder, 15% lg stone	None
(4) 3.40	0.12			None
(5) 4.37	0.33			None

Transect 15

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 0.41	0.38		Grid 1 - 50% cobble, 40% lg boulder, 5% lg stone, 5% sand	Algae
(2) 1.22	0.35			None
(3) 2.03	0.48		Grid 2 - 75% lg boulder, 15% cobble, 5% sm stone, 5% sand	None
(4) 2.84	0.34			None
(5) 3.65	0.33			None

Transect 16

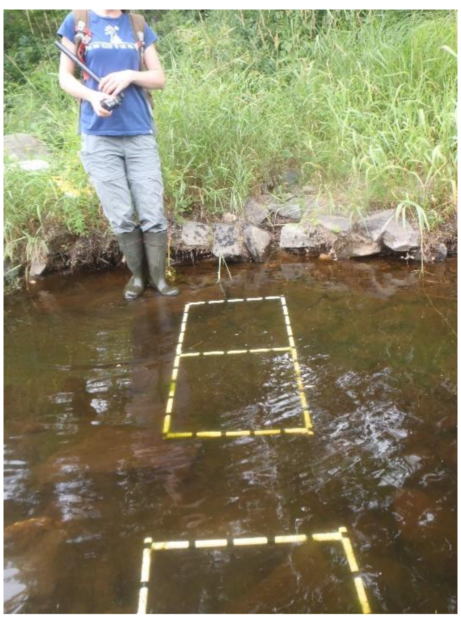
Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 0.39	1.01		Grid 1 - 80% bedrock, 20% lg boulder	None
(2) 1.17	0.87			None
(3) 1.95	0.59		Grid 2 - 35% bedrock, 30% sm stone, 25% cobble, 10% lg boulder	None
(4) 2.73	0.55			None
(5) 3.52	0.50			None

Transect 17

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 0.49	0.90		Grid 1 - 70% cobble, 30% lg boulder	None
(2) 1.47	1.04			None
(3) 2.45	0.82		Grid 2 - 60% sm boulder, 40% cobble	None
(4) 3.43	0.59			None
(5) 4.41	0.20			None

Transect 18

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 0.70	0.00		Grid 1 - 75% cobble, 20% sm boulder, 5% lg stone	None
(2) 2.10	0.76			None
(3) 3.50	0.79		Grid 2 - 85% sm boulder, 10% cobble, 5% sm stone	None
(4) 4.90	0.79			None
(5) 6.30	0.26			None



Transect 19

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) n/a	n/a		Grid 1 - 80% sm stone, 20% sand	None
(2) n/a	n/a		Grid 2 - 40% sm stone, 35% lg stone, 25% cobble	None
(3) n/a	n/a		Grid 3 - 50% cobble, 40% lg boulder, 10% lg stone	None
(4) n/a	n/a		Grid 4 - 50% cobble, 40% lg boulder, 10% lg stone	None
(5) n/a	n/a			None

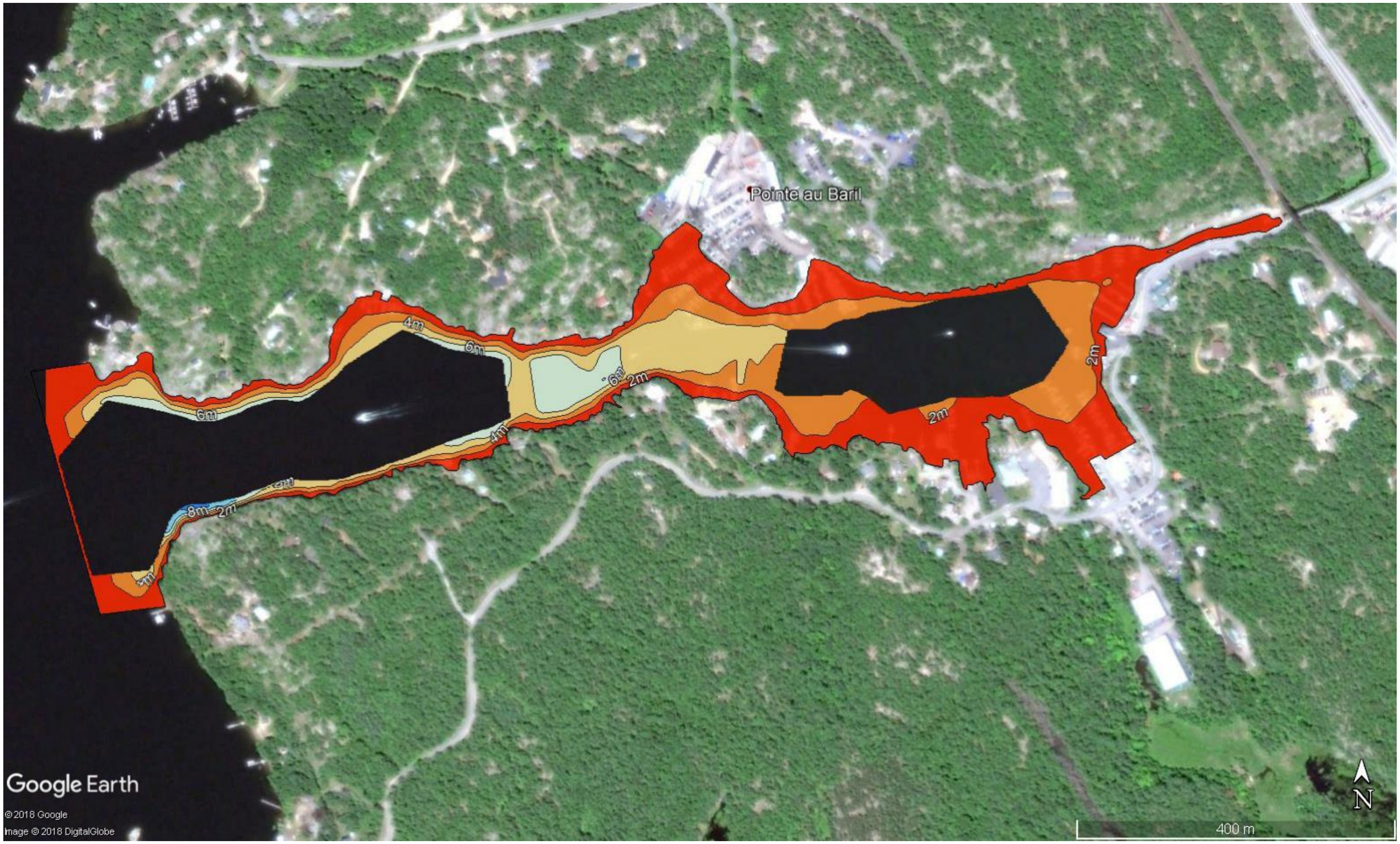
Transect 20

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) n/a	n/a		Grid 1 - dense veg - sand and rock (likely cobble) but roots to thick to measure	None
(2) n/a	n/a		Grid 2 - 60% cobble, 30% lg stone, 10% sm stone	None
(3) n/a	n/a		Grid 3 - 50% sm boulder, 40% cobble, 5% lg stone, 5% sm stone	None
(4) n/a	n/a		Grid 4 - 45% cobble, 40% sm boulder, 5% lg stone, 5% sm stone, 5% sand	None
(5) n/a	n/a			None

Transect 21

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 1.82	0.73		Grid 1 - 80% sand, 20% small stone	None
(2) 5.46	0.85		Grid 2 - 100% sand	None
(3) 9.10	0.36		Grid 3 - 80% cobble, 10% lg stone, 5% sm boulder, 5% sm stone	None
(4) 12.74	0.83		Grid 4 - 40% bedrock, 40% lg boulder, 10% sm stone, 5% sand, 5% lg stone	None
(5) 16.38	0.29			None

Appendix E – Bathymetry Map

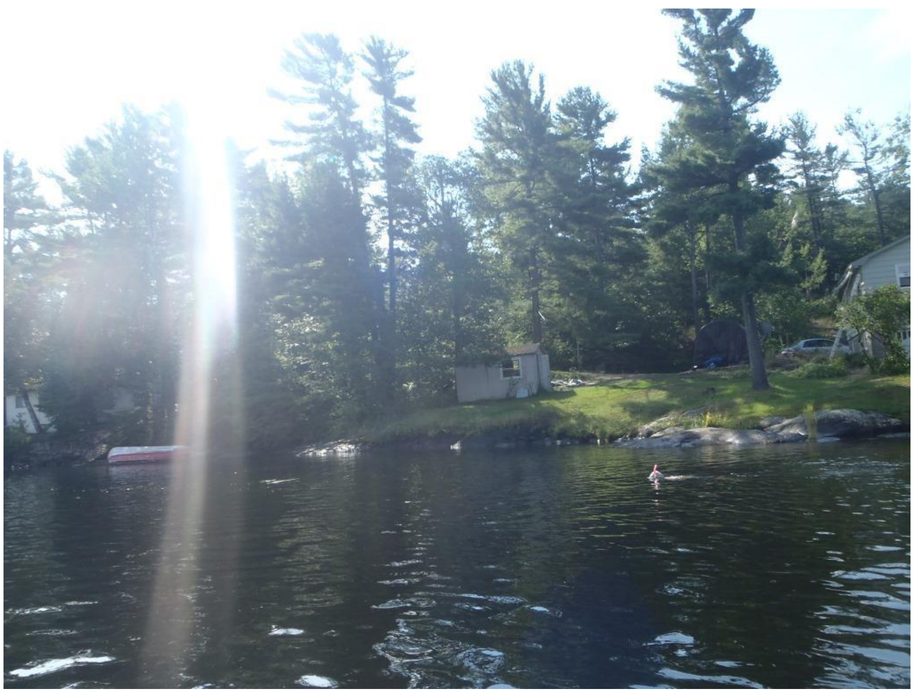


Appendix F – Shoreline Photos

Underwater Surveys – shoreline photos

Survey 1

Survey 2



Survey 3

Survey 4

Survey 5