Shawanaga River 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 the Shawanaga River. 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.

During the 2016 spawning season, EGBSC visited the Shawanaga River spawning bed eleven (11) times between April 18 and June 8. Basic water chemistry measurements (water temperature, dissolved oxygen, pH, conductivity) were recorded on all site visits and were within the expected range.

Seven stations were set up on the Shawanaga River to measure water velocity and depth. All water velocity measurements were under 1.0 m/s, and did not appear to be limiting Walleye and White Sucker movement, based on visual observations. The Shawanaga River spawning bed is an ideal shape, long and rectangular, providing ample opportunity for broadcasted eggs to settle out within the substrate. An abundance of high-quality substrate is present at the site as a result of restoration work completed in 1977. There was no sign of the added substrate washing out, and the weirs created in 1977 were still visible.

Many Walleye were observed at the Shawanaga River spawning bed. Typically, Walleye activity is easiest to observe at night by shining a light into the water. At the Shawanaga River spawning bed, Walleye were present in such high numbers that they were visible throughout the spawning bed even during the day. At times, White Sucker were visibly more abundant than Walleye but significantly fewer White Sucker eggs were seen and counted on egg mats. Overall, over 15,000 Walleye eggs were counted on four egg mats that were placed at the site, and 756 Sucker eggs were counted. Redhorse Sucker were also present at the spawning bed. No attempt was made to differentiate White Sucker eggs from the eggs of Redhorse Sucker species. There have been no records of Lake Sturgeon spawning at the Shawanaga River, and based on conversations with members of Shawanaga First Nation, EGBSC did not expect to see any Lake Sturgeon during site visits.

A plankton sample was taken during the time when fry would likely be hatching. This sample was visually compared to samples collected from the other tributaries being assessed in 2016 – Magnetawan River, Seguin River, Shebeshekong River, and Sucker Creek. Relative to the other tributaries assessed, Shawanaga River had the greatest plankton density.

Surveys were conducted to assess nursery, rearing, and foraging habitat available downstream of the Shawanaga River spawning bed. Bathymetry and side scan sonar data were collected downstream of the spawning bed. The shoreline downstream of the spawning bed to the outlet is all natural with a few back bays and wetland areas.

Underwater surveys were taken for 100 m, spaced approximately 1 km apart from the Shawanaga River spawning bed to the outlet. Based on these surveys, there appeared to be a diversity of substrate in the nearshore area including bedrock, boulder, cobble, sand, gravel, clay, and silt. Density of aquatic vegetation ranged from absent to abundant. Areas with no vegetation or sparse vegetation could potentially provide more habitat for different life stages than areas with moderate to abundant

vegetation. Sixty-four percent of the surveys had a moderate to abundant amount of wood structure, which provides habitat and cover for fish. The presence of broken bedrock, with boulder and cobble may also provide habitat and cover for fish. Overall, the natural shorelines offer a good diversity and amount of habitat for many fish species. Based on the 2016 field assessment, EGBSC does not recommend any habitat restoration at this site.

Of concern at the Shawanaga River is the fact that recreational fishing pressure has increased substantially in recent years. This situation may require monitoring. The Upper Great Lakes Management Unit (UGLMU) has shown that strong year classes can be significantly diminished by angling pressure. Concerns regarding angling pressure were documented beginning in 1987, and concern over the number of ice huts and amount of recreational angling was expressed to EGBSC and the Upper Great Lakes Management Unit in 2015.

Another potential concern at the Shawanaga River is the location of the fish sanctuary boundary on the river. During the 2016 assessment, once the Walleye season opened (May 1), anglers were grouped on the legal (west) side of the fish sanctuary, approximately 2 km downstream of the spawning bed. The river is narrow in this area, and anglers are able to target Walleye moving upstream to spawn. The spawning period at the Shawanaga River is longer than most of the other rivers investigated as part of this project, with fish present at the spawning bed for four to five weeks. Walleye were still present at the spawning bed on the fish sanctuary opening date (third weekend in May – May 21 in 2016). Extending the fish sanctuary boundaries to the outlet of the river could potentially reduce angling pressure on Walleye attempting to move upstream to spawn.

Based on population estimates, it does not appear that the previous extended period of low Georgian Bay water levels had an impact on the spawning bed, but it would be beneficial to re-visit the spawning bed during a year of low Georgian Bay water levels to monitor depth, flow, and egg deposition again. EGBSC also recommends further, detailed analysis of the side scan sonar data to supplement the observations from underwater surveys. EGBSC does not recommend any habitat restoration at these sites.

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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

The Shawanaga River is located north of Parry Sound and south of 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 Shawanaga River spawning bed in relation to Parry Sound and Pointe au Baril

The Shawanaga River watershed drains an area of 310 km^2 (Figure 2) (Midwood et al., 2012). The headwaters of the Shawanaga River start near Shawanaga Lake in the Municipality of Whitestone. From there, the river flows west to its confluence with Georgian Bay.

Figure 2. Shawanaga River watershed

The Shawanaga River Walleye population is an important resource to the area, supporting recreational, commercial, and Indigenous fisheries. In the 1950s and 1960s, declines in the size of the Walleye spawning population were first documented. Speculation around the causes of this decline included overfishing, acidification inhibiting recruitment, and an undersized spawning bed. During the 1970s and 1980s, efforts such as spawning habitat improvement and stocking occurred in an attempt to rehabilitate the Walleye population. Since the late 1980s, increased spawner abundance has been noted and the relative abundance of spawning Walleye in the Shawanaga River has remained high. Following the 2006 symposium on the Status of Walleye in the Great Lakes, the proceedings listed Shawanaga River's Walleye population as 'depressed but increasing' indicating that although the population is not back to historical levels, it is improving. It is not known exactly what caused this notable turnaround.

The Shawanaga River is one of the few rivers in eastern Georgian Bay that has had fairly consistent sampling and assessment work done since the 1960s. As such, there is a considerable amount of documentation on the Shawanaga River. Several studies are summarized here.

The Shawanaga River was part of a six year study in the 1960s aimed at solving Walleye conflicts between commercial operators, tourism operators, and sport anglers (Zimmerman, 1967). Annual trap netting, tagging, and creel surveys began in 1962 and ended in 1967. Follow up assessments were done to provide population estimates until 1983, with population assessments being completed on a periodic basis since then. The Upper Great Lakes Management Unit (UGLMU) carried out a study in 1998 and a three-year assessment from 2014 to 2016.

Six years of creel surveys from 1962 to 1967 suggested a decline in Walleye stocks in the Shawanaga Basin. At the time, poor results shown from the creel surveys were thought to have been related to an abundance of forage fish available for Walleye, angler ineffectiveness, and a changing age structure resulting from variable year class recruitment, which showed a low number of certain age classes and put more pressure on the existing age classes. However, some level of decline was also observed from trap netting (Zimmerman, 1967).

The six year study showed that there was a distinct Walleye stock in Shawanaga Basin and Bay, and that the majority of Walleye tagged in that area stayed within three miles of where they had been tagged. Some fish moved considerably farther (up to 69 miles or 111 km). The study also showed that the strong year class recruitment from 1959 and 1960 was still supporting the Walleye stock in 1967. Using the Schnabel method, the study estimated that the Shawanaga Walleye population had peaked in 1965 and that more recent estimates had shown declines (Zimmerman, 1967).

In 1967, other fish species caught during the study included Crappie, Bowfin, Bullhead, Channel Catfish, Muskellunge, Northern Pike, Longnose Gar, Redhorse Sucker species, Perch, Rock Bass, Whitefish, Smallmouth Bass, White Sucker, Pumpkinseed, and Common Carp. Between 1962 and 1967, the number of Redhorse Sucker captured grew and then declined slightly every year after that. During this time, White Sucker were abundant at the site. More than 19,000 White Sucker were caught in 1966 and over 15,000 were caught in 1967. The number of Walleye caught fluctuated from 573 in 1962, up to 1,785 in 1964, and back down to 756 in 1967. The study noted that the Shawanaga River spawning area was vulnerable to changing winds from Georgian Bay and to changes in upstream flow. The author of the study noted that continual flow and minimal water level fluctuations would be the most beneficial for Walleye (Zimmerman, 1967).

A status update on the Walleye population in the Shawanaga Basin in 1973 estimated the number of Walleye to be 1,268. The study indicated there had not been any significant growth in the Walleye population size since 1962. It was suspected that the small size of the spawning bed (estimated to be 400 to 600 ft^2) was the limiting factor for population growth (Thurston, 1973). The population at the mouth of the Shawanaga River (Shawanaga Bay) was estimated to be approximately 639. Too few fish were re-captured to get a more dependable number. The total Walleye population (including immature fish) estimate was 1,907. This figure was similar to estimates from 1964 and 1966. The 1973 sampling revealed a notable change in mean length and the age of most of the fish captured (two, three, and four years). Based on the study, enhancement of the spawning bed was recommended.

The Ministry of Natural Resources (MNR) surveyed the Shawanaga spawning bed and its substrate in 1968. The top 230 feet of the spawning bed was found to have smooth bedrock with large boulder, ranging from one to three feet in size. The size of the substrate was deemed too large for Walleye. Pockets of gravel and cobble were noted, but only in small areas. The downstream section of the spawning bed had more cobble and boulder, but due to water flow, that habitat was not used. A design was created to add more cobble (sized six to twelve (12) inches), move boulders that were in the main spawning area and create weirs perpendicular to stream flow to slow the water flow and keep the cobble in between the weirs from being washed away. The design included boulder placement to extend one edge of the spawning area off an existing point of land to improve flow at the downstream end of the spawning bed, which already had more suitable substrate (Winterton, 1970).

In August 1974, MNR added 1,200 ft^2 of habitat at the spawning bed. Small boulders were added for spawning habitat, and large boulders were added to create back eddies for resting places (Rusk, 1975).

In 1977, the weirs were constructed and more spawning substrate was added, using stone from a nearby rock waterfall. A small rock wall was designed to extend one edge of the spawning bed. A total of 375 cubic yards of rock was placed at the site. In 1978, water flow improvements over the spawning bed were evident due to the enhancement work, and Walleye were observed along the new substrate. Due to concerns about the effect that the healthy White Sucker population was having on spawning Walleye, MNR hired a commercial operator to remove White Sucker from the spawning bed. In three days, 5,220 pounds of White Sucker were removed (Rusk, 1978).

In 1979, another creel survey was done on the lower Shawanaga River and around Shawanaga Island. The survey results showed very poor fishing success for Walleye and poor success for Northern Pike in the Shawanaga River. Around Shawanaga Island, fishing success was fair for Walleye but poor for Northern Pike. The number of rod hours logged in 1979 was significantly less than in 1962. It is suggested in the study that the reduced number of rod hours was due to the lack of fishing success experienced in the 1960s (Thurston, 1979).

Trap netting was repeated on the Shawanaga River in 1982 and 1983 to compare results with the six-year study from 1962-1967 and from 1973. Since the spawning bed enhancement work was done, there had been an improvement in the number of Walleye that were spawning, but the stock had not yet rebounded to the level seen in the 1960s. The study found population abundance in 1982 was the same as it was in 1973, which was greater than in 1966 and 1967, but still less than in 1963 and 1964. In addition, the spawning stock in 1982 consisted of mainly older fish, indicating poor recruitment of younger fish. The abundance of White Sucker was noted again, which was considered to be detrimental to Walleye because it was assumed that White Sucker eggs would smother the Walleye eggs. Catches of White Sucker indicated an old and healthy population. Out of concern for the Walleye spawning population, MNR disposed of 3,575 White Sucker during their sampling (McIntyre, 1982).

In 1983, the same trap netting was carried out with a noticeable increase in the number of three-year-old fish, which would have been from the 1980 year class. In total, 175 Walleye were captured. The number of White Sucker caught between 1982 and 1983 declined from 635 to 257. Despite the decline in the White Sucker catch, an additional 4,617 White Sucker were disposed of (McIntyre, 1983).

In 1984, the Pointe au Baril Fish Hatchery Association was created under the MNR's Community Fisheries Incentive Program (CFIP). The association raised and planted 114,200 Walleye in the Shawanaga River between 1984 and 1988 to help build the spawning population. Walleye sport angling started to develop again on the Shawanaga River in the summer of 1987, which concerned the CFIP group. A request was made to close the Shawanaga River to angling at certain times. A creel survey in the fall and winter of 1988 was completed in order to help MNR decide whether to put such a regulation in place. The 1988 creel survey reported a total of 269 rod hours with fifty-seven (57) Walleye caught (Thurston, 1989). The report does not give further detail as to how the creel results influenced MNR's decision. At some point, a fish sanctuary was established on the Shawanaga River that included the spawning bed and the river downstream for approximately 2 km.

In 1998, the UGLMU carried out a spring Walleye netting project on the Shawanaga River. It had been reported that spawning abundance had improved since the late 1980s and had reached a peak in 1992. Two sites were assessed. At the first site, located at the long-term sampling site at the base of the rapids, 1,966 Walleye were captured. At the second location, set at the mouth of the river, 239 Walleye were captured. Most of the Walleye caught at the mouth of the river were immature Walleye and likely not part of the spawning population. However, the number of small fish captured indicated there was recruitment occurring. Overall, a wide range of age classes were present in the spawning population, but the three, four, nine, and ten (10) year classes made up over 50% of the total sample. The study concluded that the spawning population estimates were improving, and significantly higher than estimates from the mid to late 1960s (Liskauskas, 1998).

The UGLMU's 2015 and 2016 Spring Walleye Index Netting (SWIN) surveys provided an update on the status and characteristics of the spawning population of Walleye at the Shawanaga River. In eight trap net lifts in 2015, 4,018 fish were captured representing nine species. Numerically, Walleye was the most abundant species making up 95% of the total catch with a ratio of 1.5 males to 1 female. In 2016, twelve (12) trap net lifts captured 4,125 fish representing nine species. Again, Walleye was the most dominant species comprising 93% of the total catch with an almost 2:1 ratio of males to females. The Walleye catch per unit effort (CPUE) in 2015 was 477.13, higher than the 2016 CPUE of 321.75, and the 1998 CPUE of 196.6. Multiple year and size classes were present for both males and females in 2016 indicating a level of ongoing natural recruitment despite supporting several intensive fisheries. These SWIN results suggest that the Shawanaga Walleye spawning population remains at high levels of abundance, particularly when compared to historical netting data. In fact, the Walleye population spawning at the Shawanaga River is considered healthy and was described as "arguably the contemporary flagship Walleye stock of Georgian Bay" (James, 2016). During their surveys, the UGLMU also captured Common White Sucker and Redhorse Sucker species, but in lower numbers than anticipated.

The Shawanaga River has always been looked after by Shawanaga First Nation. Since the 1970s, Shawanaga First Nation has monitored the fish harvest and has had guidelines in place, agreed to by community members, to ensure that only enough fish are taken to sustain each family and for cultural ceremonies (GBBR, 2018).

In the late 1990s and early 2000s, the number of Walleye spawning had declined again. To help restore Walleye numbers, Shawanaga First Nation did not harvest any fish during spawning for five years. In addition, Shawanaga First Nation started a hatchery in 2002 and began collecting eggs from spawning fish, raising them in their hatchery, and releasing the fry in order to offset "the tremendous pressure on the walleye population from all resource users, including the traditional harvest, commercial fishing, and sport fishing" (GBBR, 2018, p. 14). In addition to stocking Walleye, Shawanaga First Nation has self-imposed catch limits. No more than three Walleye can be harvested per day, per person, and there is no harvesting at night. Furthermore, the river is shut down every fifth year. Eight to ten fish monitors from the community are hired each year to monitor the Shawanaga River spawning bed 24 hours a day during the peak harvest season. Monitors are responsible for data collection, species protection, and traditional harvesting for the Elders, community members in need, and varies ceremonies held throughout the year (GBBR, 2018).

There were no UGLMU records of Lake Sturgeon spawning at the Shawanaga River, however, Lake Sturgeon have historically been harvested in the river. Based on conversations with members of Shawanaga First Nation, EGBSC did not expect to see any Lake Sturgeon during field investigations in 2016.

Spring Spawning Assessments

In 2016, EGBSC studied the main spawning bed on the Shawanaga River which is situated roughly 4 km from the river mouth (Figure 3). EGBSC worked with Shawanaga First Nation to organize the field work and accessed the site by boat.

EGBSC began spring field work at the Shawanaga River on April 18 and ended on June 8. During this period, the site was visited eleven (11) times, approximately every three to four days whenever possible. Towards the end of the Walleye and Sucker spawning period (end of May), site visits were less frequent.

Figure 3. Location of Shawanaga River spawning bed

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 consistently increased from 6.2˚C on April 18 to 12.9˚C on May 7. Due to a ten (10) day cooling trend from May 7 to 17, there was very little change in water temperature. Water temperatures began increasing after May 17 and reached 16.1˚C by May 23. Walleye were present during each site visit between April 18 and May 23 and as late as May 31. White Sucker were present on all site visits between April 23 and May 31, with the exception of May 23. Redhorse Sucker species were observed on May 23 and 31, and Longnose Sucker on May 23, when water temperature reached 16.1˚C. No fish were observed at the spawning bed on June 8.

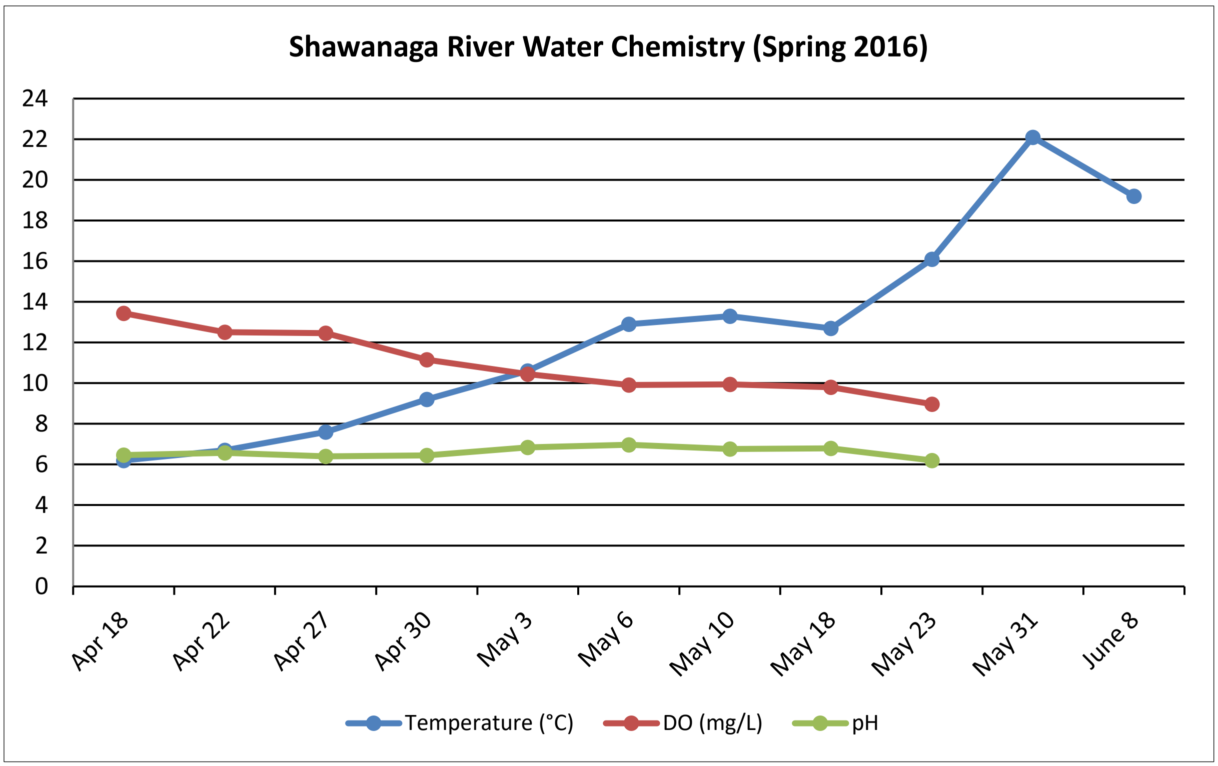

Figure 4. Water temperature (°C), dissolved oxygen (mg/L), and pH measurements taken at the Shawanaga River spawning bed in spring 2016

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. The highest level was recorded on April 18 (13.44 mg/L) and reached a low of 8.97 mg/L on May 23.

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 Shawanaga River spawning bed were above 6.0 (Figure 4). The highest pH level was 6.97 on May 6 and the lowest pH recorded was 6.20 on May 23. The pH readings are mildly acidic and typical for Canadian Shield watersheds.

Conductivity was also measured at the Shawanaga River 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 18 and May 23. Conductivity was consistently low throughout the study period, ranging from 21.2 uS/cm on April 27, April 30, and May 6 to 29.7 uS/cm on May 18.

For complete water chemistry data, refer to Appendix A.

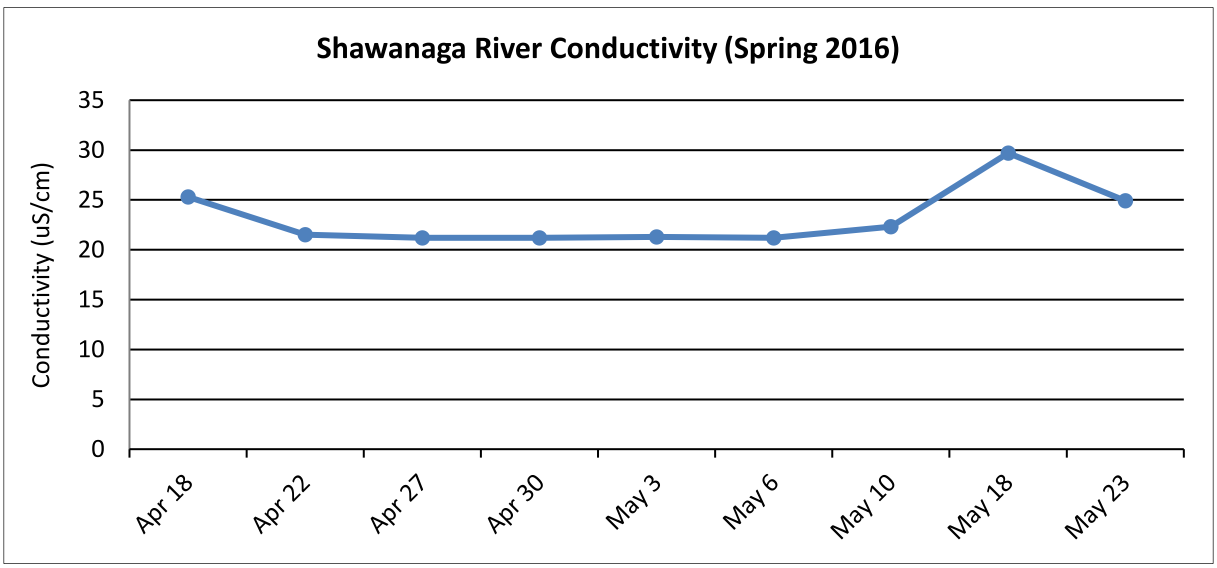

Figure 5. Conductivity measurements (uS/cm) at the Shawanaga River spawning bed in spring 2016

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.

Six stations were established at the Shawanaga River spawning bed to collect information on water velocity from April 18 to June 8 (Figure 6). Figure 7 displays velocity measurements recorded at each station.

Figure 6. Water velocity (1-6) and depth stations (1-7) at the Shawanaga River spawning bed

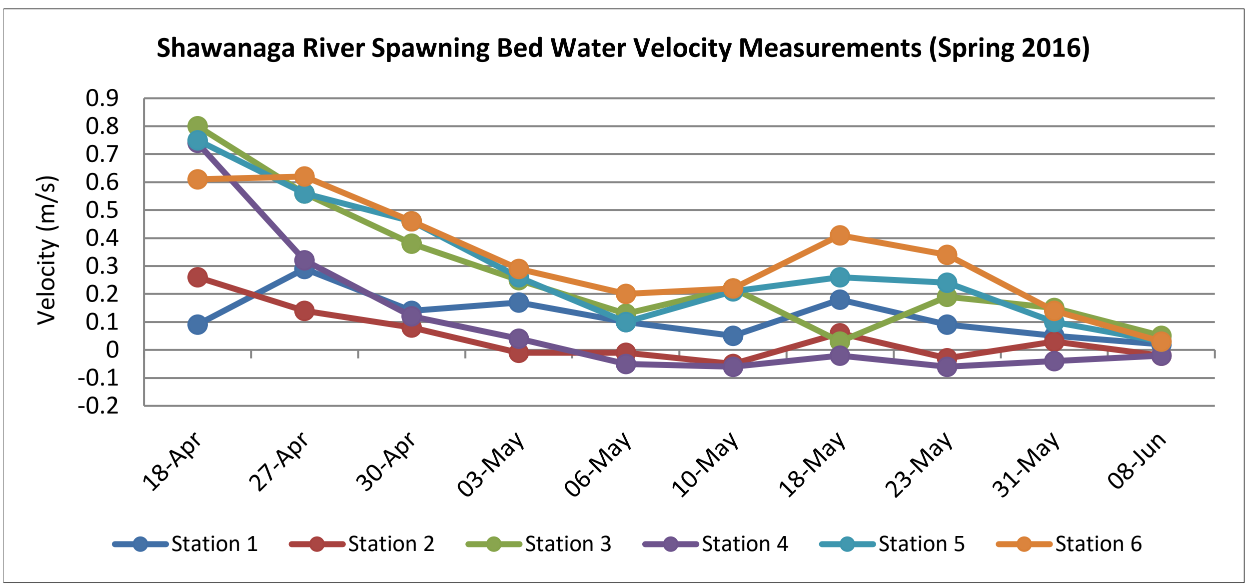

Figure 7. Water velocity measurements at the Shawanaga River spawning bed in spring 2016

At station 1, the highest velocity recorded was 0.29 m/s on April 22 and the lowest velocity recorded was 0.02 m/s on June 8. The highest velocity recorded at station 2 was 0.66 m/s on April 22, while the lowest velocity recorded was -0.01 m/s on May 3 and 6. The negative value indicates that the station had become a back eddy, and water was flowing in the opposite direction. Station 3 had the highest overall velocity which was recorded on April 18 (0.8 m/s). The lowest velocity recorded at station 3 was 0.03 m/s on May

18. On April 18, the highest velocity at station 4 was recorded (0.74 m/s) and the lowest velocity recorded was -0.02 m/s on May 18 and June 8. The second overall highest velocity was recorded at station 5 on April 18 (0.75 m/s). The lowest velocity recorded at station 5 was 0.03 m/s on June 8. At station 6, the highest velocity recorded was 0.62 m/s on April 27 and the lowest velocity recorded was 0.03 m/s on June 8.

With the exception of station 1, all of the highest water velocities were measured on April 18. Water velocity throughout the spawning area was directly correlated with water levels. By May 7, velocity readings at all stations had dropped to near post-freshet levels. A significant rain event on May 14 caused velocities to increase and subsequently diminish as water moved through the watershed. None of the velocities recorded would prevent fish from accessing or spawning at the site.

Water Level Fluctuations

Water levels were recorded at each station (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.

At the Shawanaga River spawning bed, water levels fluctuated throughout the spawning and egg incubation periods. There was an increase in water levels on May 3 at the stations at the lower end of the spawning bed (stations 1-3 and 5), while water levels at stations 4, 6, and 7 continued to decline. Water levels at all stations increased on May 18 following a large rain event on May 14. Water levels declined again by May 23 and increased slightly up until June 8.

Less fluctuation in water level was observed at stations 1, 2, and 5. These stations were at the downstream end of the spawning bed and very close to, or at, Georgian Bay water level. Consequently, these stations were influenced by increasing Georgian Bay water levels throughout the study period as well as short-term, seiche effects from intermittent, strong, westerly winds. Stations 3, 4, 6, and 7 best represent water level changes in the spawning area (refer to Appendix B for complete water level data). Figure 8 illustrates the changes in water level from April 18 to June 8.

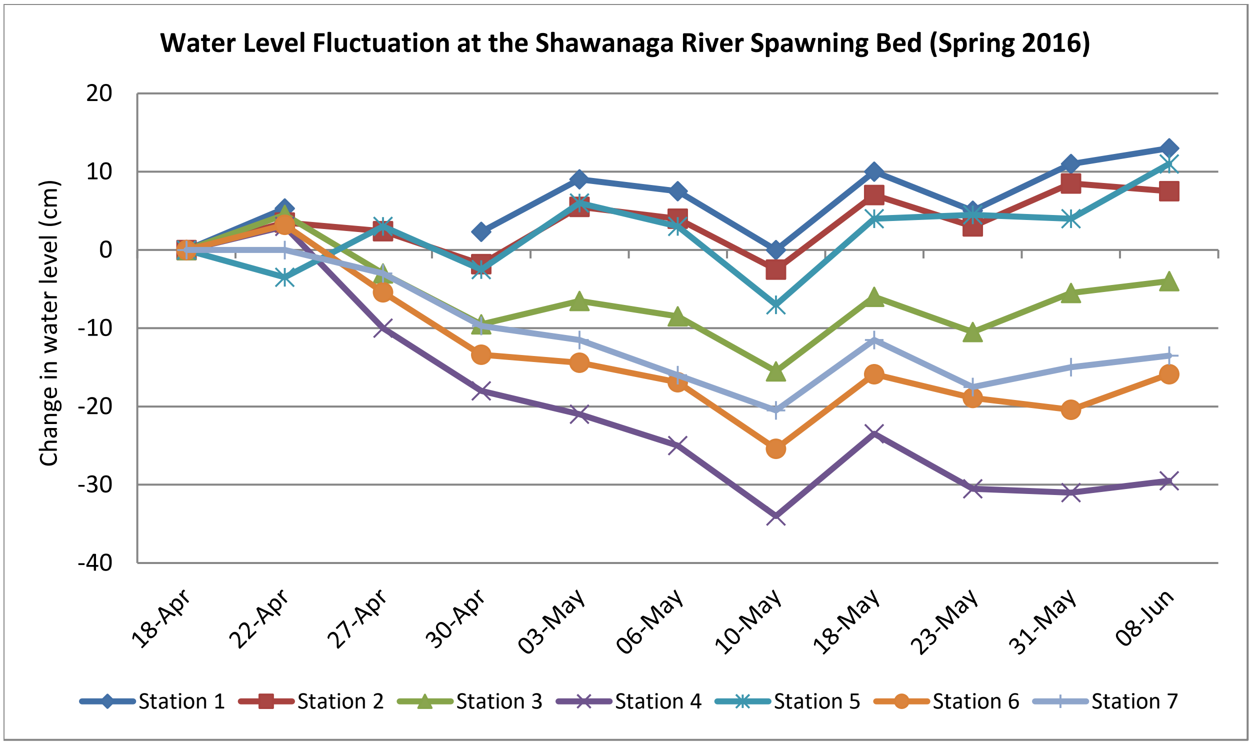

Figure 8. Water level fluctuations at the Shawanaga River spawning bed measured at stations 1-7. Measurements on the first site visit served as the benchmark against which future measurements were compared (i.e., water level up or down compared to the first site visit).

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. Multiple photos were taken during each flight and then stitched together using Pix4D software to create an orthomosaic showing the entire spawning bed for each visit. The following orthomosaics illustrate changes in water levels at the spawning bed from April 18 to May 23. The orthomosaics show that the spawning bed remained underwater, which is crucial for successful egg incubation. There were no observations of eggs being stranded out of water.

April 18, 2016

April 22, 2016

April 27, 2016

April 30, 2016

May 3, 2016

May 6, 2016

May 10, 2016

May 18, 2016

May 23, 2016

Fish Observations

EGBSC observed fish at the Shawanaga River spawning bed via basic visual observations, snorkel surveys, and underwater videos (Figures 9-11) (refer to Appendix C for a complete list of fish and egg observations). Walleye were observed at the site from April 18 to May 31, but were most abundant between April 23 and May 23. Walleye were visible from the shore in large numbers. The number of Walleye present at the site was too high to accurately count. Common White Sucker were observed at the site between April 23 and May 31 and observed in greatest abundance between April 27 and May 10.

Snorkel surveys were carried out on three occasions to look for Redhorse Sucker species and Lake Sturgeon once velocities diminished. Redhorse Sucker species and Longnose Sucker were observed on May 23, and an estimated thirty (30) to fifty (50) Redhorse species were observed again on May 31. More Common White Sucker were observed during the snorkel survey than Redhorse species. No Lake Sturgeon were observed. Smallmouth Bass were seen on both May 23 (thirty (30) to fifty (50) fish) and on May 31. No fish were observed during a snorkel survey on June 8. Table 1 lists the species seen on each date.


Figure 9. Walleye observed from shore at the Shawanaga River spawning bed


Figure 10. Sucker species captured on video using a GoPro camera

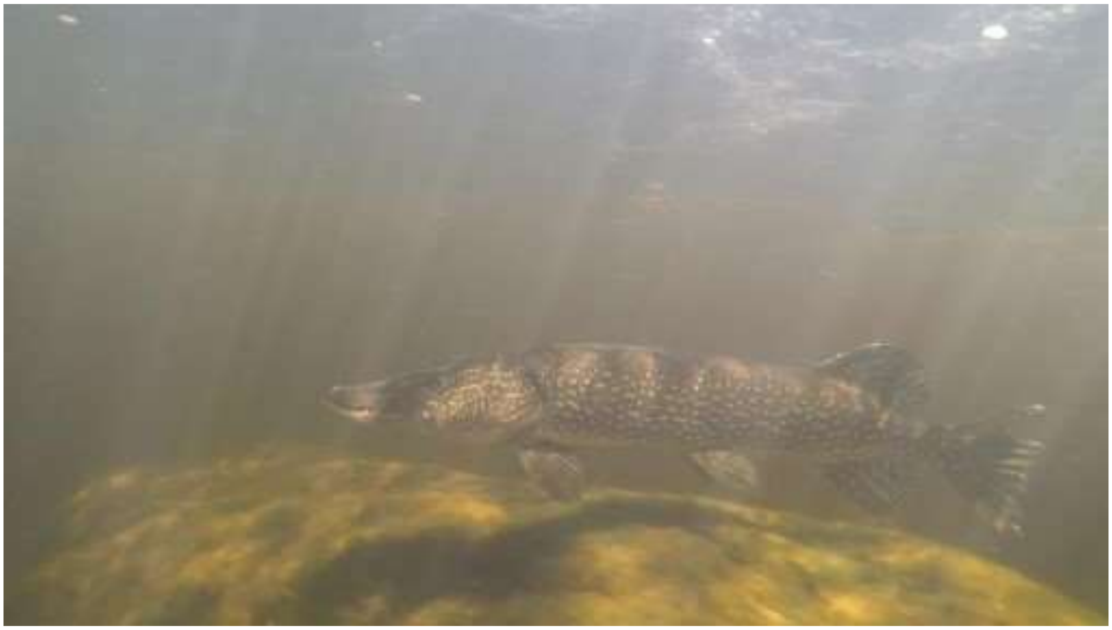

Figure 11. Northern Pike observed during a snorkel survey on May 31, 2016

Table 1. Fish observations at the Shawanaga River spawning bed

Date	Observation Method	Fish Species
18-Apr	Visual	Walleye
23-Apr	Visual	Walleye Common White Sucker
27-Apr	Visual, GoPro video	Walleye Common White Sucker
29-Apr	Visual, GoPro video	Walleye Common White Sucker
03-May	Visual, GoPro video	Walleye Common White Sucker
05-May	Visual	Walleye Common White Sucker
10-May	Visual, GoPro video	Walleye Common White Sucker
18-May	Visual, GoPro video	Walleye Common White Sucker
23-May	Visual, snorkel	Walleye Common White Sucker Longnose Gar Redhorse Sucker species Smallmouth Bass
31-May	Visual, snorkel	Walleye Common White Sucker Redhorse Sucker species Longnose Sucker Smallmouth Bass Logperch Northern Pike

Egg Deposition

EGBSC set four egg mats at the Shawanaga River spawning bed to help assess the amount, type, and location of egg deposition (Figure 12). 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. Had Lake Sturgeon eggs been deposited, they would have also been distinguishable by size and colour.

Figure 12. Location of egg mats installed at the Shawanaga River spawning bed in 2016

Egg mats were installed on April 18. Egg deposition on the mats was extremely dense, a two square inch grid was used to count the eggs. Several grid counts were completed, and the average number of eggs counted in the grid was calculated and then extrapolated to the entire mat. Each egg mat was 720 square inches, and the grid represented 1/180 of the total area. Egg mats 2 and 4 were counted on April 29. Egg mat 2 had 15,690 Walleye eggs and 144 Sucker eggs. Egg mat 4 had 17,580 Walleye eggs and 306 Sucker eggs. Egg mats 1 and 3 were counted on May 3. Egg mat 1 had 8,130 Walleye eggs and 306 Sucker eggs. Egg mat 3 had 16,500 Walleye eggs and no Sucker eggs. In total, there were 57,900 Walleye eggs and 756 Sucker eggs for all four egg mats. The egg mat counts are likely underestimated, due to the density of the eggs deposited on the mats (see Figure 13 for example).

Figure 13. Walleye egg deposition at the Shawanaga River spawning bed

In 2016, egg mats were set at four other spawning areas – Magnetawan River, Sucker Creek, Shebeshekong River, and Seguin River. The highest total Walleye egg counts for those sites were 559, 208, twenty-eight (28), and 144, respectively. At the same sites, the highest total Sucker egg counts were three, 248, thirty-four (34), and 185, respectively. It should be noted, however, that there was much more Sucker egg deposition at Sucker Creek than what was counted on egg mats. There were 756 Sucker eggs counted at Shawanaga River, the highest count for all five rivers, but still a relatively low number.

Although the number of eggs deposited on an egg mat can vary significantly depending on where spawning takes place, egg deposition at the Shawanaga River spawning bed, both on the spawning substrate and on egg mats, was exponentially higher than any other spawning location monitored in 2016. Walleye egg density was so high that many crevices in the rocks had multiple layers of eggs on top of one another (Figure 14). Such a high accumulation of eggs is likely to promote fungal and/or protozoan (Saprolegnia) infestations, which was present at the site (Figure 14). The Shawanaga River spawning bed was the only location where Saprolegnia was observed.

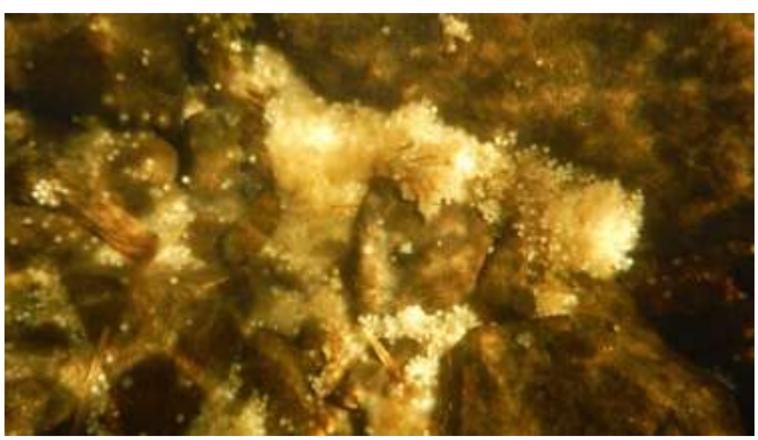

Figure 14. Dense Walleye egg deposition with Saprolegnia

Plankton Sampling

Once eggs incubate and hatch, fish enter their larval stage. Larval Walleye have limited mobility and typically 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 Shawanaga River spawning bed, EGBSC conducted five plankton tows using a 12" diameter, 153 micron plankton net (Figure 15).

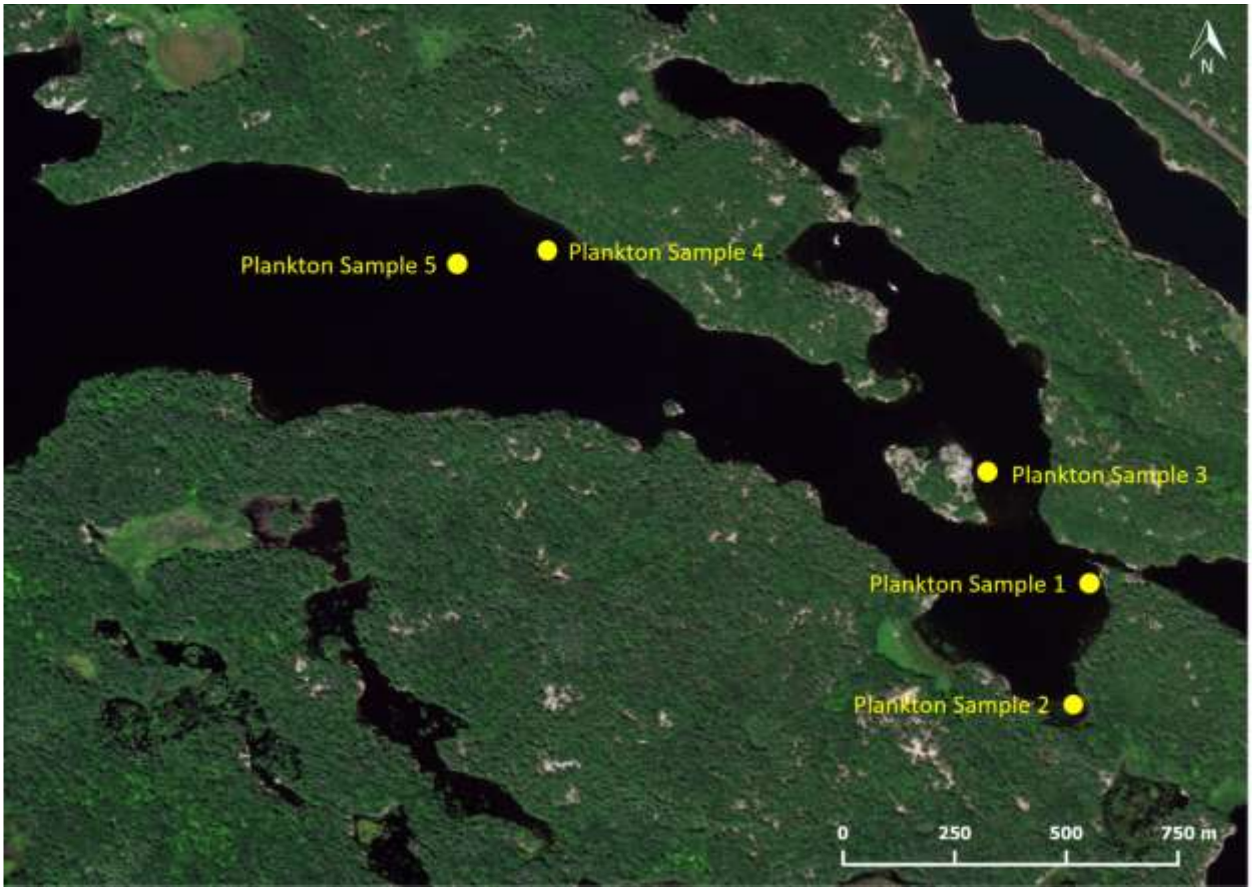

Figure 15. Plankton sampling locations on the Shawanaga River in 2016

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 at the Shawanaga River is shown in Figure 16. Relative to the samples from the other four rivers sampled in 2016, the Shawanaga River had the highest plankton density.

Figure 16. Plankton sample from the Shawanaga River 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 Shawanaga River spawning bed with the intent of identifying areas “ideal” for spawning Walleye and Sucker species (information from members of Shawanaga First Nation indicated that Lake Sturgeon do not spawn at this spawning bed). Transects were completed later in the season, when it was safe to wade and swim across the spawning bed; because of this, only depth and substrate information was collected. Any velocity data collected would not have representative of velocities during the spawning season.

EGBSC completed nine transects across the spawning bed, spaced roughly 6 m apart (Figure 17). Along each transect (bankfull width), depth measurements were taken at six points (see Figure 18 for example). Unfortunately, rather than measuring depth at bankfull, an error was made in which actual depths were recorded. Unlike depth at bankfull, actual depths measured in the fall do not give an indication of conditions during the spawning period.

Substrate was estimated for each transect as a whole and recorded in percentages. In addition to depth and substrate, any aquatic vegetation was noted at each point, and shoreline vegetation was recorded for each transect.

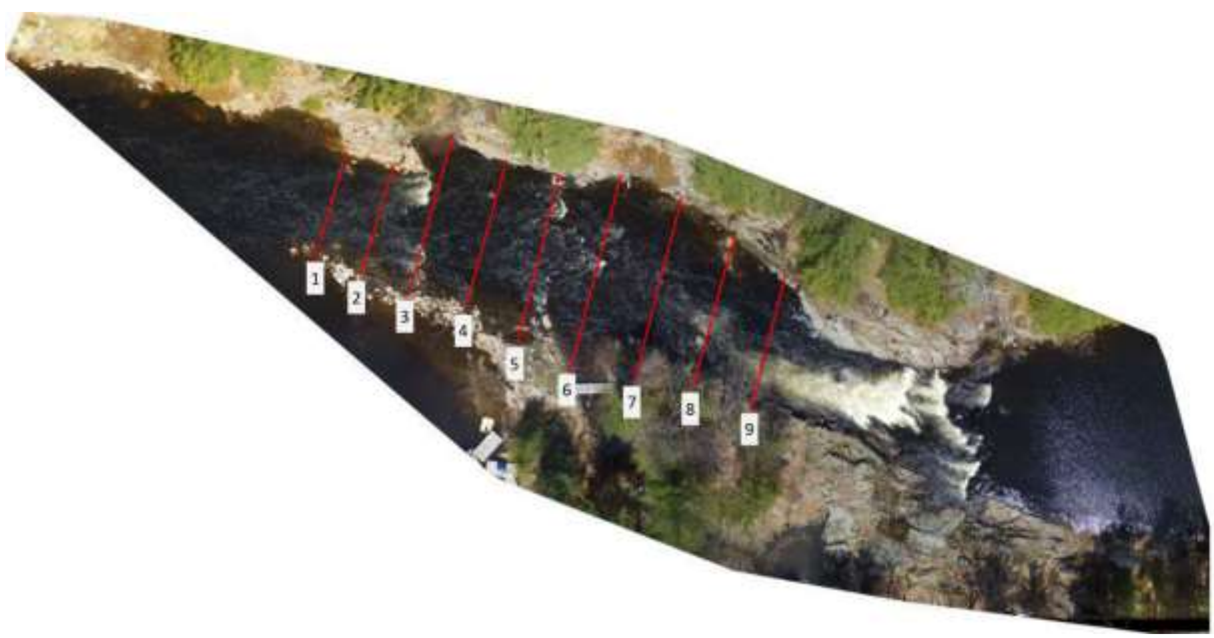

Figure 17. Spawning bed measurement transects at the Shawanaga River spawning bed

Figure 18. Measuring bankfull width and depths along transect 3

In total, eight of the nine transects had at least some substrate considered ideal for Walleye spawning. None of the nine transects had substrate of a small enough size to be considered ideal for Sucker spawning, according to the literature. 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. In addition, substrate was only evaluated 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.

After looking through the spring orthomosaics, and flow and depth data, Scott Finucan, Aquatic Ecosystem Science Specialist with MNRF commented that the Shawanaga River spawning bed has a much different morphology than other typical bedrock channels along eastern Georgian Bay, likely due to the past restoration work. With stable flows and a diverse mix of substrate, Mr. Finucan stated that the Shawanaga River spawning bed would provide much more available habitat to Walleye than other rivers, such as the Magnetawan (S. Finucan, personal communication, 2016).

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 Shawanaga River spawning bed to determine if there is habitat – nursery, rearing, and foraging – for Walleye, Lake Sturgeon, 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 and Lake Sturgeon, 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 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 900 m, using a GoPro camera. In total, EGBSC carried out eleven (11) underwater surveys. Each survey location has been identified in Figure 19. See Appendix E for bathymetry maps.

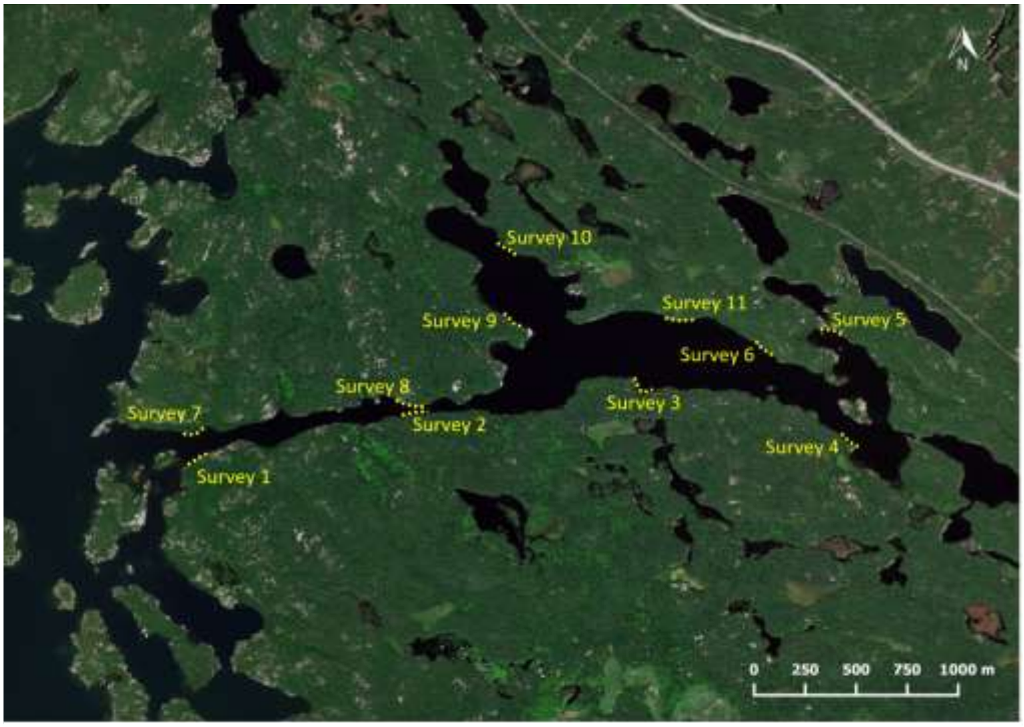

Figure 19. Underwater survey locations downstream of the Shawanaga River spawning bed

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 2. Each of the nine underwater surveys is summarized in Table 3.

Table 2. 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 3. Summary of findings from underwater surveys

Survey	Substrate	Woody Debris	Aquatic Vegetation	Notes
1	Bedrock with a few pockets of cobble; a layer of soft substrate on top of bedrock	Sparse	Very sparse vegetation	
2	Bedrock steeply dropping off with broken boulders, mainly small boulder and cobble with some large boulders	Sparse	No vegetation except algae and Freshwater Sponge	Lots of shelter and hiding places for fish within the rocks
3	Bedrock with soft substrate on top	Moderate	Mainly sparse vegetation at the base of rocks with areas of moderate vegetation	Abundant freshwater mussels

Survey	Substrate	Woody Debris	Aquatic Vegetation	Notes
4	Small boulder, large boulder and cobble at the base of a bedrock slope	Moderate	Abundant vegetation at the base of rocks aside from 1/4 of the survey with sparse vegetation	Some excellent structure between the rocks and the 2 logs
5	Bedrock with cobble	Moderate	Sparse vegetation	Very little vegetation, but good amount of structure with rocks; structure improves near the end of the survey
6	Mainly soft, with areas of small cobble and areas of exposed bedrock	Abundant	Moderate vegetation	Freshwater mussels
7	Substrate appears soft by may be bedrock underneath given lower amount of vegetation growth	Abundant	Sparse vegetation with patches of moderate vegetation	
8	Mainly cobble and small boulder, with some large boulder	Moderate	Moderate vegetation growth at the base of the rocky slope	Lots of hiding places and shelter for fish near the end (larger rocks, deeper nooks and crannies)
9	Bedrock, with some boulder and areas with soft substrate	Sparse	Moderate vegetation at the base of the bedrock slope	
10	Soft substrate for half of the survey and soft substrate for remaining half but with a lack of vegetation growth (likely clay or bedrock underneath)	Sparse	Moderate vegetation for half and abundant vegetation for half	Abundant freshwater mussels
11	Soft substrate, steeply sloped for the last two thirds of the survey	Abundant	Moderate vegetation with a small area of abundant vegetation	Freshwater mussels

The following list of aquatic vegetation (submergent, emergent, and floating) was recorded from the nine surveys: Richardson's Pondweed, Tapegrass, Coontail, Potamogeton spp., Canada Waterweed, Fern-leaf Pondweed, White Water Lily, Yellow Water Lily, Pickerelweed, Freshwater Sponge, and algae. Tapegrass was the most dominant species, observed in all but one survey.

Shoreline Characteristics

Along each of the underwater surveys, shoreline characteristics were also recorded and photographed. The Shawanaga River, downstream of the spawning bed to the outlet, has almost 100% natural shoreline (Figure 20). For the eleven (11) underwater surveys, no shoreline alterations were observed. The natural shoreline along the surveys consisted of forest (eight surveys), forest with a small wetland fringe (six surveys), and bedrock with patchy vegetation (seven surveys). Some surveys had more than one type of natural vegetation. Photos of the shoreline from each survey can be found in Appendix F. It is important to note that surveys did not cover the entire length of the shoreline. For example, there are several pockets of wetland along the shoreline, but these did not coincide with any of the survey locations.

Figure 20. Natural and altered shoreline downstream of the Shawanaga River spawning bed

Shoreline substrate was also recorded and photographed for each of the surveys. Only the shoreline substrate that was visible was recorded. Six of the eleven (11) surveys had a bedrock shoreline, two of the surveys had low sloped shoreline with softer substrate, and three of the surveys had a mix of bedrock, cobble, boulder, and soft substrate. Table 4 lists the shoreline characteristics of each survey.

Table 4. Shoreline characteristics along the underwater surveys

Survey	Shoreline Characteristics
1	Sloped bedrock, gentle at the beginning and gradually becoming steeper
2	Bedrock steeply sloping into the water, with boulders at the water's edge
3	Low sloping bedrock shoreline
4	Bedrock shoreline with broken boulders into water
5	Bedrock shoreline with sparse vegetation
6	Low sloped shoreline
7	Low sloped shoreline
8	Rocky shore with bedrock outcrops, mainly bedrock and boulder
9	Steep bedrock slope at the beginning, becoming more gradual farther along
10	Low sloped shoreline with soft substrate and small boulders on immediate shoreline behind vegetation

11	Steeply sloped bedrock shoreline with pockets of lower sloped shore, lined with Sweet Gale and some pockets of cobble and boulder

In addition to substrate, shoreline vegetation that could be identified was recorded for each survey (Table 5). Sweet Gale, Meadowsweet, Alder spp., and Ground Juniper were recorded for multiple surveys. Trees such as White Pine, White Birch, Maple spp., and Red Oak were also recorded for multiple surveys. No invasive species were observed in the survey locations (aquatic or terrestrial).

Table 5. Shoreline vegetation observed along the underwater surveys

Survey	Shoreline Vegetation
1	Sweet Gale, Meadowsweet, Alder spp., White Pine, Red Oak
2	Eastern White Cedar, White Pine, White Birch, Northern Bush Honeysuckle, Ground Juniper, Polypody Fern, Grass spp., Ferns, Moss, Lichen
3	Sweet Gale, Meadowsweet, Ground Juniper, Alder spp., Trembling Aspen, Black Spruce, Maple spp.
4	Sweet Gale, Meadowsweet, White Pine, Ground Juniper, Red Oak, White Birch, Maple spp., Moss
5	Meadowsweet, Sweet Gale, Ground Juniper, White Pine, Red Oak, White Birch, Maple spp., White Cedar, Grass spp., Sedges
6	Meadowsweet, Sweet Gale, Alder spp., Red Oak, White Pine, White Birch, Grass spp., Sedges
7	Blue Flag Iris, Sweet Gale, Alder spp., Meadowsweet, Red Oak, Bulrush spp.
8	Meadowsweet, Sweet Gale, Ground Juniper, Alder spp., Northern Bush Honeysuckle, Canada Mayflower
9	Sweet Gale, White Pine, Maple spp., Ground Juniper, Canada Mayflower, White Pine, Red Oak, Trembling Aspen, Ferns, Grass spp., Moss
10	Sweet Gale, Alder spp., White Birch, White Pine, Maple spp., Sedges, Grass spp.
11	Ground Juniper, Meadowsweet, Alder spp., White Pine, White Cedar, Red Oak, Bulrush spp.

In addition to the eleven surveys described above, EGBSC also carried out four extra surveys to further investigate habitat types. Along the Shawanaga River, areas of bedrock are frequently broken up with pockets of low sloping shoreline with Sweet Gale lining the immediate shoreline and Alder species set farther back (Figure 21). Because this type of habitat occurred frequently, one Sweet Gale area was surveyed to get a better idea of what this habitat type offers under the water. The survey revealed sand and gravel substrate and many submerged branches of Sweet Gale that provide excellent habitat for benthic invertebrates and hiding places for smaller fish (Figure 22). Based on this survey, this type of area is believed to contribute to fish food production in the system and offer excellent habitat for smaller fish.

Figure 21. Example of Sweet Gale lining the shoreline


Figure 22. Underwater photos from the Sweet Gale survey site

The Shawanaga River has a number of bays with wetland habitat (Figure 23). One survey of a wetland close to the spawning area was completed. The wetland was located between two bedrock outcrops. The majority of the substrate was soft, with bedrock and large boulders located at the beginning and end of the survey, associated with the bedrock outcrops. There were some sticks visible along the survey, and lots of areas for cover around the large boulders. The vegetation in the fringe of the wetland area was moderate. The species in this survey were the same as those recorded in the original eleven (11) underwater surveys. Because the underwater video was taken on the fringe of the wetland, vegetation density would have increased considerably closer to the shoreline.

Figure 23. Wetland area underwater survey location

The third survey carried out was along the island directly downstream of the spawning bed (Figure 24). Because of its position directly downstream of the spawning bed, it is possible that larval fish could drift to this location, depending on current. The underwater survey was carried out from the east side of the island, around the southeast side, and ended on the northeast side. Despite a moderate to abundant amount of vegetation, the substrate underwater was mainly cobble, small boulder, and large boulder, with bedrock outcrops. There was fairly thick algae present on the east side, in addition to Freshwater Sponge.

Figure 24. Underwater survey along the island immediately downstream of the spawning bed

The fourth survey was carried out at the outlet of a tributary to determine if it offered different habitat than the other eleven (11) surveys (Figure 25). This survey was fairly similar to others with a bedrock shoreline and softer substrate at the base of the shoreline slope. Submerged vegetation changed from sparse (for approximately one quarter of the survey) to moderate and abundant (three quarters of the survey).

Figure 25. Underwater survey at the outlet of a tributary

Discussion and Recommendations

Water chemistry measurements that were monitored (water temperature, dissolved oxygen, pH, and conductivity) were all 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.

Flow in the Shawanaga River 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 Shawanaga River watershed. Water levels and velocities in 2016 were likely typical of most springs. Water velocities did not exceed 0.8 m/s for any of the readings and did not appear to impede movement of fish throughout the spawning bed. Water level fluctuations were observed but did not result in any loss of spawning habitat and no eggs were seen stranded. The depth stations at the downstream end of the spawning bed experienced less water level fluctuation than the stations closer to the upstream end, as the downstream end of the spawning bed is at, or close to, Georgian Bay water levels. The shoreline morphology in the spawning area is relatively steep, which makes the site less vulnerable to egg stranding as flows diminish. The shape of the spawning bed also provides ample opportunity for broadcasted eggs to settle into the substrate.

It is possible that egg stranding could become an issue with low Georgian Bay water levels. However, despite the fact that Georgian Bay experienced an extended period of low water levels from 1996-2013, many Walleye observed on the spawning bed in 2016 were from year classes from that time period. Evidently, this population was able to reproduce successfully even during the extended period of low Georgian Bay water levels.

During daytime site visits, Walleye were abundant and visible from shore. There were also several hundred Suckers spawning at the site, including White Sucker and Redhorse Sucker species. The amount of egg deposition on the egg mats was dense, with a total of over 57,900 Walleye eggs. There were only 756 Sucker eggs deposited on the mats which was surprising given that Sucker species appeared to be more abundant than Walleye during site visits. However, sampling done by the UGLMU near the downstream end of the spawning bed resulted in higher catches of Walleye than Sucker species, which may help explain why there were far fewer Sucker eggs. It is also possible that if Walleye eggs were thickly deposited on the mats first, Sucker eggs may not have stuck as well to the egg mats. In addition to the egg mats, eggs were also visible in most areas of the spawning bed in high abundance.

The Shawanaga River spawning bed has a large amount of high-quality spawning habitat. Nevertheless, there were two minor concerns identified during the project:

1. The presence of algae on much of the spawning substrate (this was observed in most spawning areas).
2. Walleye egg density was so high that many crevices in the rocks had multiple layers of eggs on top of one another. Such a high accumulation of eggs is likely to promote fungal and/or protozoan (Saprolegnia) infestations, which was observed.

In addition to high quality spawning habitat, the shoreline downstream of the spawning bed is unaltered for 4 km and provides a variety of habitat for various life stages for Sucker species and Walleye.

In summary, the Shawanaga River spawning area is doing exceptionally well, especially when compared to the other rivers surveyed as part of this project. As the Walleye population has grown at the Shawanaga River, the fishing pressure has also grown significantly. Anecdotal reports refer to over fifty (50) fishing boats being counted in one day and some anglers still fishing into December. There is concern that increased angling pressure may have impacts on the Shawanaga River Walleye population.

The Walleye season in Fisheries Management Zone 14 (Georgian Bay) opens on May 1. The spawning bed and approximately 2 km of river downstream of the spawning bed are protected as a fish sanctuary until the third Saturday in May. The other roughly 2 km of river between the fish sanctuary boundary and the outlet of the river into Georgian Bay is not protected. Accordingly, anglers are able to legally fish within the Shawanaga River, downstream of the fish sanctuary, when the Walleye season opens on May 1. Because the river is narrow at that boundary of the fish sanctuary downstream to the outlet, anglers are able to directly target Walleye that are moving upstream to spawn.

With the exception of the first few site visits when conditions were still very cold, on each trip up the river, there were always two or more boats with anglers in the narrows, adjacent to the fish sanctuary boundary. After May 21, 2016 (third Saturday in May), anglers were seen fishing upstream at the base of the spawning bed. In 2016, Walleye were present at the spawning bed until at least May 31. In order to improve the efficacy of the fish sanctuary on the Shawanaga River, it may be necessary to extend the boundary downstream to the outlet of the river where it widens. Adjusting the fish sanctuary boundary in this way could potentially result in less direct targeting of spawning Walleye. Alternatively, a later Walleye season opening date could possibly serve a similar purpose.

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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- Karl Schiefer – Aquatic Biologist consultant and EGBSC member
- David Bywater – Environmental Scientist, Georgian Bay Biosphere Reserve
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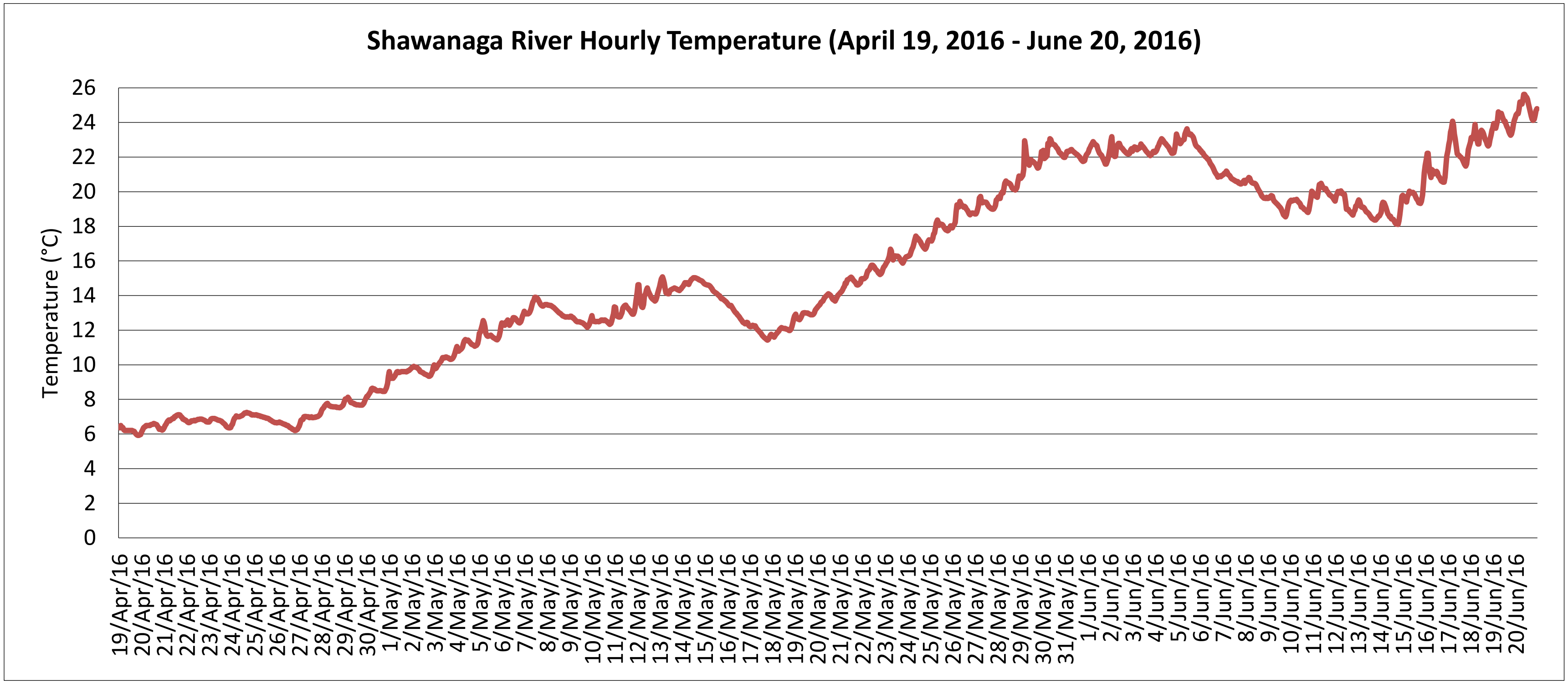
Appendix A – Water Chemistry

Date	Time	Temperature (°C)	DO (mg/L)	DO (%)	pH	Conductivity
18 Apr	11:54	6.2	13.44	108.5	6.46	25.3
22 Apr	13:15	6.7	12.50	102.4	6.57	21.5
27 Apr	17:30	7.6	12.46	104.5	6.40	21.2
30 Apr	14:30	9.2	11.15	96.7	6.45	21.2
3 May	10:50	10.6	10.45	93.7	6.84	21.3
6 May	11:50	12.9	9.91	93.9	6.97	21.2
10 May	12:40	13.3	9.94	94.9	6.76	22.3
18 May	16:00	12.7	9.80	92.5	6.79	29.7
23 May	11:58	16.1	8.97	90.4	6.20	24.9
31 May	10:30	22.1	n/a	n/a	n/a	n/a
08 Jun	11:00	19.2	n/a	n/a	n/a	n/a



Shawanaga River Hourly Temperature (April 19, 2016 - June 20, 2016)
Temperature (°C)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
19/Apr/16
20/Apr/16
21/Apr/16
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1/Jun/16
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9/Jun/16
10/Jun/16
11/Jun/16
12/Jun/16
13/Jun/16
14/Jun/16
15/Jun/16
16/Jun/16
17/Jun/16
18/Jun/16
19/Jun/16
20/Jun/16

Appendix B – Water Level and Velocity

Benchmark	Date	Depth (cm)
1	18-Apr	63
1	22-Apr	57.7
1	27-Apr	
1	30-Apr	60.7
1	03-May	54
1	06-May	55.5
1	10-May	63
1	18-May	53
1	23-May	58
1	31-May	52
1	08-Jun	50
2	18-Apr	12
2	22-Apr	8.5
2	27-Apr	9.6
2	30-Apr	13.8
2	03-May	6.5
2	06-May	8
2	10-May	14.5
2	18-May	5
2	23-May	9
2	31-May	3.5
2	08-Jun	1
3	18-Apr	15.5
3	22-Apr	11
3	27-Apr	18.5
3	30-Apr	25
3	03-May	22
3	06-May	24
3	10-May	31
3	18-May	21.5
3	23-May	26
3	31-May	21
3	08-Jun	19.5
4	18-Apr	29
4	22-Apr	26
4	27-Apr	39
4	30-Apr	47
4	03-May	50
4	06-May	54
4	10-May	63
4	18-May	52.5
4	23-May	59.5
4	31-May	60
4	08-Jun	58.5
5	18-Apr	18
5	22-Apr	21.5

5	27-Apr	15
5	30-Apr	20.5
5	03-May	12
5	06-May	15
5	10-May	25
5	18-May	14
5	23-May	13.5
5	31-May	14
5	08-Jun	7
6	18-Apr	7.6
6	22-Apr	4.4
6	27-Apr	13
6	30-Apr	21
6	03-May	22
6	06-May	24.5
6	10-May	33
6	18-May	23.5
6	23-May	26.5
6	31-May	28
6	08-Jun	23.5
7	18-Apr	n/a
7	22-Apr	44.5
7	27-Apr	47.5
7	30-Apr	54.2
7	03-May	56
7	06-May	60.5
7	10-May	65
7	18-May	56
7	23-May	62
7	31-May	59.5
7	08-Jun	58

Date	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
18-Apr	0.09 m/s	0.26 m/s	0.8 m/s	0.74 m/s	0.75 m/s	0.61 m/s
27-Apr	0.29 m/s	0.14 m/s	0.56 m/s	0.32 m/s	0.56 m/s	0.62 m/s
30-Apr	0.14 m/s	0.08 m/s	0.38 m/s	0.12 m/s	0.46 m/s	0.46 m/s
03-May	0.17 m/s	-0.01 m/s	0.25 m/s	0.04 m/s	0.26 m/s	0.29 m/s
06-May	0.1 m/s	-0.01 m/s	0.13 m/s	-0.05 m/s	0.1 m/s	0.2 m/s
10-May	0.05 m/s	-0.05 m/s	0.22 m/s	-0.06 m/s	0.21 m/s	0.22 m/s
18-May	0.18 m/s	0.06 m/s	0.03 m/s	-0.02 m/s	0.26 m/s	0.41 m/s
23-May	0.09 m/s	-0.03 m/s	0.19 m/s	-0.06 m/s	0.24 m/s	0.34 m/s
31-May	0.05 m/s	0.03 m/s	0.15 m/s	-0.04 m/s	0.1 m/s	0.14 m/s
08-Jun	0.02 m/s	-0.02 m/s	0.05 m/s	-0.02 m/s	0.03 m/s	0.03 m/s
18-Apr	0.09 m/s	0.26 m/s	0.8 m/s	0.74 m/s	0.75 m/s	0.61 m/s

Appendix C – Visual Observations

Date	Observation Method	Fish Species
18-Apr	Visual	Walleye
23-Apr	Visual	Walleye Common White Sucker
27-Apr	Visual, GoPro video	Walleye Common White Sucker
29-Apr	Visual, GoPro video	Walleye Common White Sucker
03-May	Visual, GoPro video	Walleye Common White Sucker
05-May	Visual	Walleye Common White Sucker
10-May	Visual, GoPro video	Walleye Common White Sucker
18-May	Visual, GoPro video	Walleye Common White Sucker
23-May	Visual, snorkel	Walleye Common White Sucker Longnose Gar Redhorse Sucker species Smallmouth Bass
31-May	Visual, snorkel	Walleye Common White Sucker Redhorse Sucker species Longnose Sucker Smallmouth Bass Logperch Northern Pike Large schools of Shiner species

Egg Mat	Grid Count	Date Set	Date Counted	Sucker Eggs	Walleye Eggs	Notes
1	a	18-Apr	03-May	0	53	Egg counts underestimated overall because of multiple layers of eggs and Saprolegnia make counting difficult
	b			1	66	All egg mats had some eggs on bottom side
	c			1	58	photos 173-184
	d			1	21	
	e			4	36	
	f			3	37	
2	a	18-Apr	29-Apr	2	118	Egg counts underestimated overall because of multiple layers of eggs and Saprolegnia make counting difficult
	b			2	73	All egg mats had some eggs on bottom side
	c			0	66	Took photos of all egg mats 1 (30-45), 2 (46-54), 3 (59-60), 4 (61-67)

	d			0	88	
	e			0	108	
	f			1	70	
3	a	18-Apr	03-May	0	109	Egg counts underestimated overall because of multiple layers of eggs and Saprolegnia make counting difficult
	b			0	66	All egg mats had some eggs on bottom side
	c			0	88	photos 185-189
	d			0	96	
	e			0	89	
	f			0	102	
4	a	18-Apr	29-Apr	12	55	Egg counts underestimated overall because of multiple layers of eggs and Saprolegnia make counting difficult
	b			0	121	All egg mats had some eggs on bottom side
	c			7	86	
	d			0	115	
	e			1	93	
	f			0	116	

Egg Mat Extrapolation

Several grid counts on each egg mat were completed. The average number of eggs counted in the grid was calculated and then extrapolated to the entire mat. Each egg mat was 720 square inches, and the grid represented 1/180 of the total area.

Egg Mat	Extrapolated Totals	
	Sucker Eggs	Walleye Eggs
1	300	8130
2	150	15,690
3	0	16,500
4	600	17,580

Appendix D – Transect Data

Transect 1

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 1.15		0.95	90% lg boulder 10% sm boulder	algae
(2) 3.45		1.6		algae
(3) 5.75		1.8		algae
(4) 8.05		2.1		algae
(5) 10.35		1.4		algae
(6) 12.65		0.2		algae

Transect 2

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 1.25		0.9	90% lg boulder 10% bedrock	algae
(2) 3.75		0.95		algae
(3) 6.25		1.75		algae
(4) 8.75		0.9		algae
(5) 11.25		0.5		algae
(6) 13.75		0.25		algae

Transect 3

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 1.65		0.35	85% lg boulder 5% sm boulder 5% cobble 5% bedrock	algae
(2) 4.95		0.55		algae
(3) 8.25		0.9		algae
(4) 11.55		1		algae
(5) 14.85		0.4		algae
(6) 18.15		0.1		algae

Transect 4

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 1.6		0.15	75% lg boulder 20% sm boulder 5% cobble	algae
(2) 4.7		0.4		algae
(3) 7.8		0.5		algae
(4) 10.9		1		algae
(5) 14.0		1		algae
(6) 17.1		0.35		algae, one tree sapling, buttonbush

Transect 5

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 1.6		0.85	50% lg boulder 25% sm boulder 25% cobble	algae
(2) 5.1		0.45		algae
(3) 8.5		1.25		algae
(4) 11.9		0.8		algae
(5) 15.3		0.2		bulrush, algae
(6) 18.7		0		none (dry rock)

Transect 6

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 1.8		0.6	25% lg boulder 25% sm boulder 50% cobble	algae
(2) 5.4		1.1		algae
(3) 9.0		0.9		algae
(4) 12.6		0.6		algae
(5) 16.2		0.7		algae
(6) 19.8		0.15		grass, arrowhead, bulrush, algae

Transect 7

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 1.7		dry land	60% cobble 30% sm boulder 20% lg boulder	algae
(2) 5.0		0.25		algae
(3) 8.3		0.75		algae
(4) 11.6		0.7		algae
(5) 14.9		0.75		algae
(6) 18.2		0.25		grasses

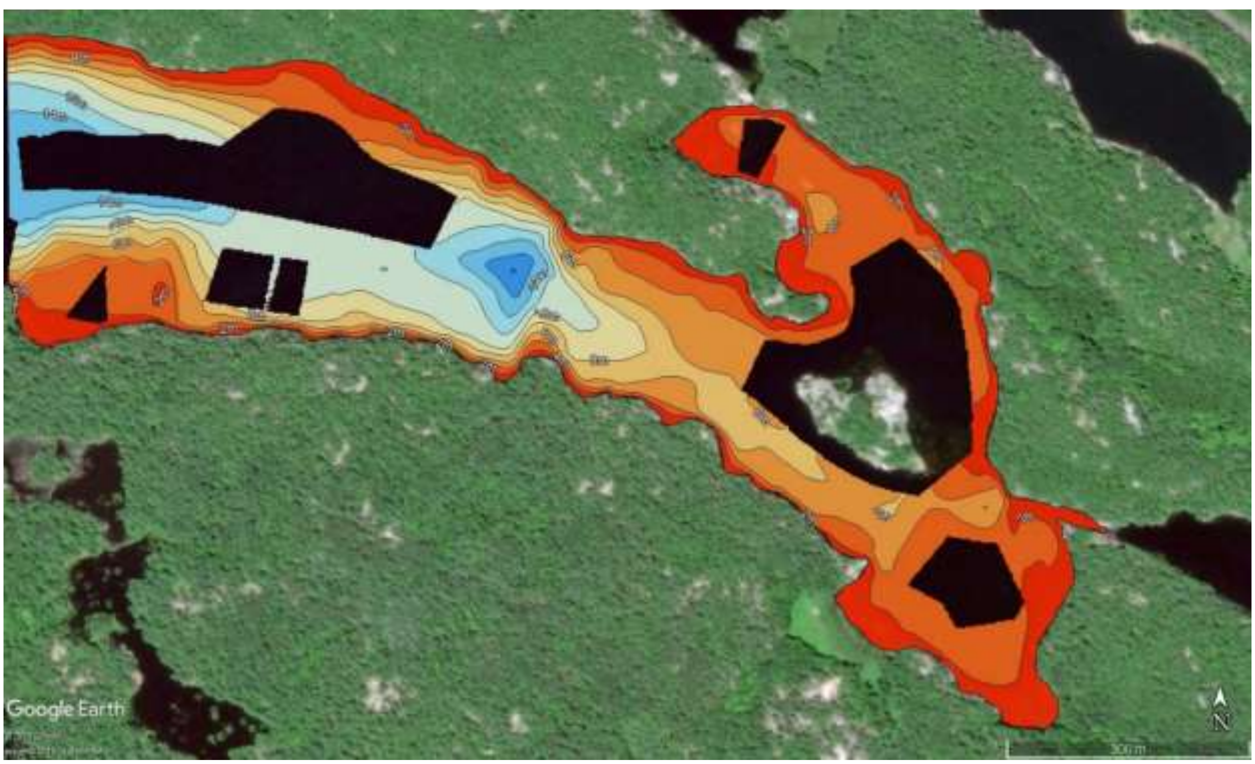
Transect 8

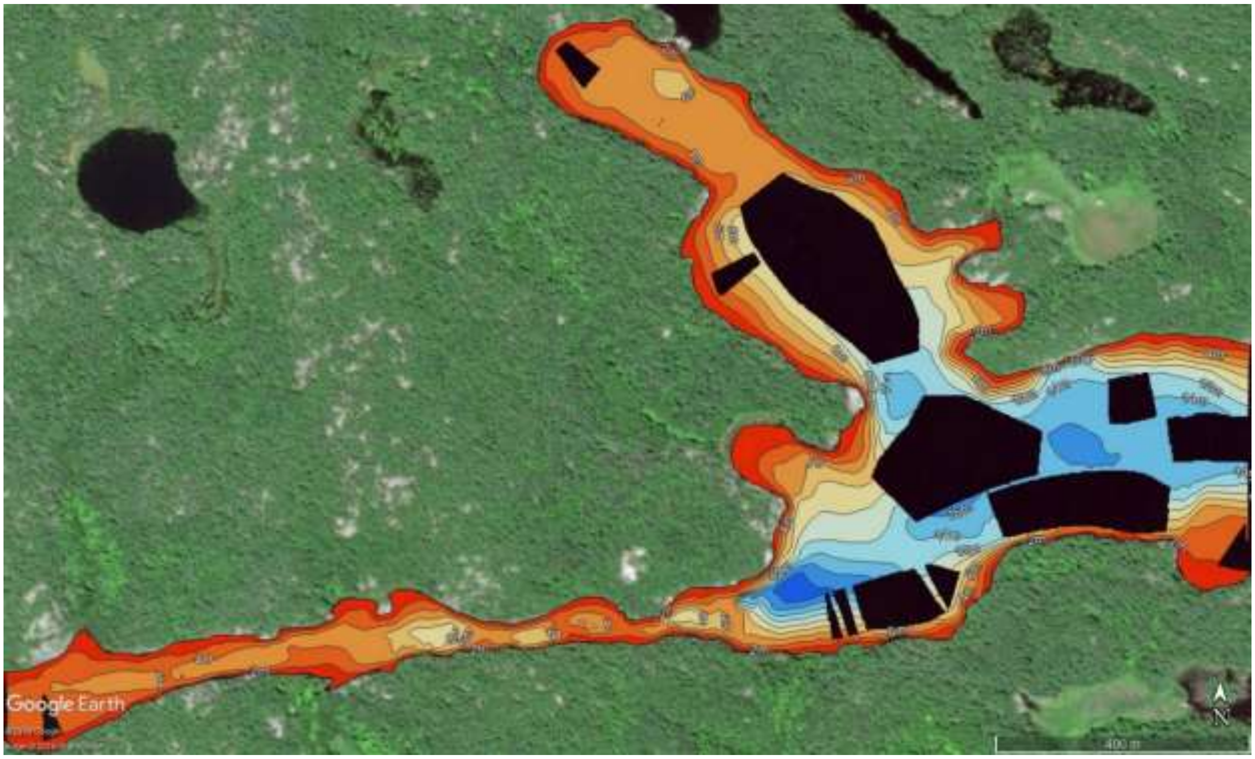
Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 1.45		0	20% sm boulder 10% lg boulder 70% cobble	algae
(2) 4.4		0.35		algae
(3) 7.3		0.95		algae
(4) 10.2		0.95		algae
(5) 13.1		0.85		algae
(6) 16.0		0.35		algae, patch of grass

Transect 9

Point	Depth (m)		Particle sizes	Aquatic vegetation present
	Bankfull	Present		
(1) 1.25		0.4	75% cobble 15% sm boulder 10% lg boulder	algae - only periphyton on rocks - much better than DS sections (transects 8 and 9 much less)
(2) 3.8		0.85		algae
(3) 6.3		1.8		algae
(4) 8.8				algae
(5) 11.3				algae
(6) 13.8		0.75		algae

Appendix E – Bathymetry Maps




Google Earth
N
400 m


Google Earth
N
400 m

Appendix F – Shoreline Photos

Underwater Surveys – shoreline photos

Survey 1

Survey 2

Survey 3

Survey 4

Survey 5

Survey 6

Survey 7

Survey 8

Survey 9

Survey 10

Survey 11

Survey 12 – representative of the many areas with patches of Sweet Gale along the shoreline

Survey 13 – representative of small bays with wetland habitat

Survey 14 – island directly downstream of the spawning bed

Survey 15 – area near the outlet of a tributary into the Shawanaga River