An assessment of potential Walleye spawning habitat within certain tributaries of Lake Scugog and Scugog River

2019

KAWARTHA CONSERVATION

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About Kawartha Conservation

Who we are

We are a watershed-based organization that uses planning, stewardship, science, and conservation lands management to protect and sustain outstanding water quality and quantity supported by healthy landscapes.

Why is watershed management important?

Abundant, clean water is the lifeblood of the Kawarthas. It is essential for our quality of life, health, and continued prosperity. It supplies our drinking water, maintains property values, sustains an agricultural industry, and contributes to a tourism-based economy that relies on recreational boating, fishing, and swimming. Our programs and services promote an integrated watershed approach that balance human, environmental, and economic needs.

The community we support

We focus our programs and services within the natural boundaries of the Kawartha watershed, which extend from Lake Scugog in the southwest and Pigeon Lake in the east, to Balsam Lake in the northwest and Crystal Lake in the northeast – a total of 2,563 square kilometers.

Our history and governance

In 1979, we were established by our municipal partners under the *Ontario Conservation Authorities Act*.
The natural boundaries of our watershed overlap the six municipalities that govern Kawartha Conservation through representation on our Board of Directors. Our municipal partners include the City of Kawartha Lakes, Region of Durham, Township of Scugog, Township of Brock, Municipality of Clarington, Municipality of Trent Lakes, and Township of Cavan Monaghan.

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Executive Summary

As part of a collaborative research project to obtain a better understanding of factors influencing the Lake Scugog aquatic ecosystem, and in particular Walleye populations, Kawartha Conservation undertook a field study on certain tributaries to identify which ones are likely to contain habitat that is suitable for spawning Walleye. In the spring of 2019, 111 stations within 11 tributaries were sampled for key habitat features such as water depth, water velocity, dissolved oxygen, pH, and dominant substrate. The following tributaries had one or more stations that were considered as potential Walleye spawning habitat: Williams Creek, Nonquon River, Blackstock Creek, Sucker Creek, Mariposa Brook, East Cross Creek, Fingerboard Creek, and two unnamed tributaries. Substrate was the most important parameter in differentiating potential Walleye spawning habitat, and several degraded aquatic habitat conditions within the urban tributaries were noted as potential constraints. The results in this report will help to inform future Walleye population monitoring and aquatic habitat rehabilitation efforts.

Acknowledgements

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Introduction

Walleye (*Sander vitreus*) is a fish that has historically been significant to the recreational fishery of Lake Scugog, a shallow warmwater lake that exists along the Trent-Severn Waterway Historic Site. In 2016 the Walleye fishery on this lake and certain connecting tributaries was closed by the Ministry of Natural Resources and Forestry. The following were key reasons for the closure: the Walleye population in Lake Scugog is in serious decline with the population now at an extremely low level of abundance; factors such as over-exploitation, loss of habitat and changes to the fish community in Lake Scugog are having a negative impact on the Walleye population and are affecting recovery; and, Walleye plays an important role in the Lake Scugog fishery and is a significant contributor to the local economy (Ministry of Natural Resources, 2015).

In an effort to assist in the management of Lake Scugog, local community organizations and academic institutions initiated a partnership with the Ontario Trillium Foundation to shed some light on key management issues in Lake Scugog, and in particular those that affect Walleye populations. This collaboration brings together citizens, experts and stakeholders with complementary expertise in varying aspects of the aquatic sciences, fish conservation, and education. The overall goal of the collaboration is to develop knowledge in different aspects of the study of Lake Scugog, which, when brought together, will ensure future conservation and restoration efforts in the lake and connected watercourses are better planned and more sustainable.

There are a significant number of tributaries that enter Lake Scugog and the Scugog River that could provide spawning habitat for Walleye that reside in Lake Scugog. These include a few named and large-sized tributaries (e.g., Nonquon River, East Cross Creek, Mariposa Brook), several named and unnamed medium-sized tributaries (e.g., Blackstock Creek, Fingerboard Creek, etc.), as well several unnamed and small-sized tributaries. Monitoring and research has traditionally been focused on nearshore areas within Lake Scugog while the tributaries flowing into the lake remain relatively understudied, in terms of their potential to support Walleye habitat. The objective of this study is to identify specific locations of potential Walleye spawning habitat along these tributaries using key spawning habitat criteria (e.g., substrate conditions, flow velocity, water chemistry, etc.), as well as by identifying any significant habitat constraints (e.g., physical barriers, habitat degradation, etc.) along these potential migratory pathways.

Locations within the tributaries that are identified as potential Walleye spawning habitat will help to inform candidate locations for ongoing population monitoring (e.g., through the Walleye Watch program), and documented constraints will help to inform habitat rehabilitation efforts (e.g., 'on-the-ground' stewardship projects).

Walleye captured in the Nonquon River in 2005.

Methods

Aquatic habitat data were collected by Kawartha Conservation technical staff by traversing either by-boat (deep water), or by-foot (shallow water) the outlet sections of most major tributaries entering Lake Scugog. Major tributaries were defined as all watercourses mapped by the province of Ontario (i.e., the Ontario Hydrologic Network: a map layer that approximates the location of watercourses) that are 3rd order or higher and that directly outlet into Lake Scugog or Scugog River upstream of the dam in the Town of Lindsay. This geographic area approximates the limits of the Walleye closure.

Along each tributary, numerous aquatic habitat parameters were recorded, including several of which that pertain to Walleye spawning habitat (see Table). In addition, any obvious constraints that may negatively affect Walleye spawning habitat were noted (for example instream barriers). A blank field sheet can be found in Appendix A. These data were entered into a Microsoft Excel® database. A subset of these data including: substrate, depth, velocity, dissolved oxygen, and pH were summarized for each tributary because they are considered important habitat variables for spawning Walleye (see Table), as per information provided by the local Management Biologist (Berube, Personal Communication), and in the Fisheries Management Plan for Zone 17 (Ministry of Natural Resources, 2009). For the purposes of this report, a station was considered as "*potential Walleye spawning habitat*" if recorded habitat values met all five 'acceptable' criteria.

Table: Aquatic habitat parameters recorded at each station.

Parameter	Method	Comments
Station #	Visual	For shallow stations: approximately every 50m or major change in habitat conditions, and every road crossing; for deep stations: approximately every major change in habitat conditions and certain nearshore habitats, and every road crossing.
Coordinates	GPSmap 60C unit	UTM, Easting and Northing, accuracy typically +/- 7m
Water Temperature	YSI multimetre	-
Dissolved Oxygen		-
Turbidity		A measure of water murkiness
pH	Handheld probe	-
Wetted Width	Measuring tape	Wetted edge to wetted edge
Bankfull Width		Top of bank, before water exits channel into floodplain
Point #1 depth	Flow Tracker© velocity metre	Measured at location between the channel midpoint and left bank when facing upstream
Point #1 velocity		
Point #2 depth		Measured at the midpoint of wetted width of stream.
Point #2 velocity		
Point #3 depth		Measured at location between the channel midpoint and right bank when facing upstream
Point #3 velocity		
Dominant Substrate	Visual	Clay (hard pan), silt (gritty), sand (grainy), gravel (2-65mm), cobble (65-250mm), boulder (>250mm), bedrock
Subdominant Substrate		

Table: Threshold values used in the determination of 'acceptable' potential Walleye spawning habitat.

Parameter	Spawning Habitat (Berube, Personal Communication)	Egg Stage (Berube, Personal Communication)	Walleye Spawning Targets (Ministry of Natural Resources, 2009)	'Acceptable', for purposes of this report
Substrate	Gravel/cobble	Cobble (64-250mm) and gravel (2-64mm), well aerated	25-250mm	**Gravel or cobble dominant**
Depth	0.3-1.0	0.3-0.8	0.3-1.5 (up to 4m resting depth close to spawning grounds)	**<1.5m**
Velocity	<2 m/s	1-1.5 m/s	<1.3	**<2 m/s**
Dissolved Oxygen	-	>5 mg/L	-	**>5 mg/L**
pH	-	>5.1	-	**>5.1**

Results

One hundred and eleven stations within eleven tributaries were sampled in ten days between March 26, 2019 and June 7, 2019 (see Table and Figure). Given the time of year, water temperatures were relatively cold and ranged from 0.6 to 17.5 degrees Celsius. The sampled tributaries ranged from small to large, with average wetted widths ranging between 1.2 to 80.0 metres. Most tributaries were wadeable (meaning shallow enough in which a person can walk), with the exception of Nonquon River, Mariposa Brook, and East Cross Creek, all which were sampled by boat. All data collected can be found in Appendix B.

Nine out of eleven of the sampled tributaries (82% of total sampled) had at least one station that was considered potential Walleye spawning habitat, and there were 38 stations (34% of total) considered as potential Walleye spawning habitat. These stations exist within the main channel of the wadeable tributaries, and along certain nearshore areas of the non-wadeable tributaries.

All stations exhibited values for dissolved oxygen, pH, and velocity that were within the range considered 'acceptable'. Dissolved oxygen concentrations ranged from 7.6 to 14.4, well above 5mg/L threshold which is likely due to the relatively cold water temperatures and often swift moving waters. pH values ranged from 7.5 to 10.3, well above 5.1 threshold, which is not surprising given these systems are perennial and mineral rich. Some pH values are unusually high and likely indicate a malfunctioning sampling probe, but regardless no pH limitations were anticipated. Water velocities ranged from 0 metres per second (standing water) to 1.525 metres per second (relatively fast), which are within the threshold of less than 2.0 metres per second. Given that we sampled during a range of hydroperiods (see Figure), these data are reasonably reflective of typical spring conditions, however It would be expected that under very high water flows (e.g., as was recorded for Blackstock in early February 2019) some of the sections would likely exceed the 2.0 metres per second. Regardless, in general water velocities are not expected to be a significant limiting factor given the flow regimes are relatively natural for these systems.

Not all tributaries had 'acceptable' values for depth and substrate. Water depths ranged from 8.0 centimetres to greater than 370 centimetres. The few exceedances that did occur were located in the mid-point of the non-wadeable tributaries (i.e., Nonquon River, Mariposa Brook, and East Cross Creek). The nearshore areas of these tributaries, however, have much shallower depths. The dominant substrates encountered were: clay, silt, sand, gravel, and cobble. Given that these were the only limiting factor, a station having dominant fine substrates (e.g., silt, sand, or clay) versus coarse substrates (e.g., gravel or cobble) was ultimately used to differential between a station that was considered as potential Walleye spawning habitat and those that were not.

The following section provides a summary of the results for each sampled tributary.

Table: Summary of sampling undertaken in Spring of 2019.

Tributary Name	Outlet location into Lake Scugog	Map #	Date Sampled	# of stations
Williams Creek	Lake Scugog, southwest shore, Port Perry	1	Apr4	5
Cawkers Creek	Lake Scugog, southwest shore, Port Perry	2	Apr4	10
Unnamed	Lake Scugog, west shore of Scugog Island	3	Apr11	1
Nonquon River	Lake Scugog, west shore	4	Apr10, Apr11	19
Fingerboard Creek	Lake Scugog, northwest shore	5	Jun7	12
Unnamed	Lake Scugog, east shore of Scugog Island	6	Apr9	6
Unnamed	Lake Scugog, southeast shore	7	Mar26,Apr2	14
Blackstock Creek	Lake Scugog, southeast shore	8	May28	9
Mariposa Brook	Scugog River, west shore	9	May30	12
East Cross Creek	Scugog River, east shore	10	May30	6
Sucker Creek	Scugog River, east shore, Lindsay	11	Apr8	17

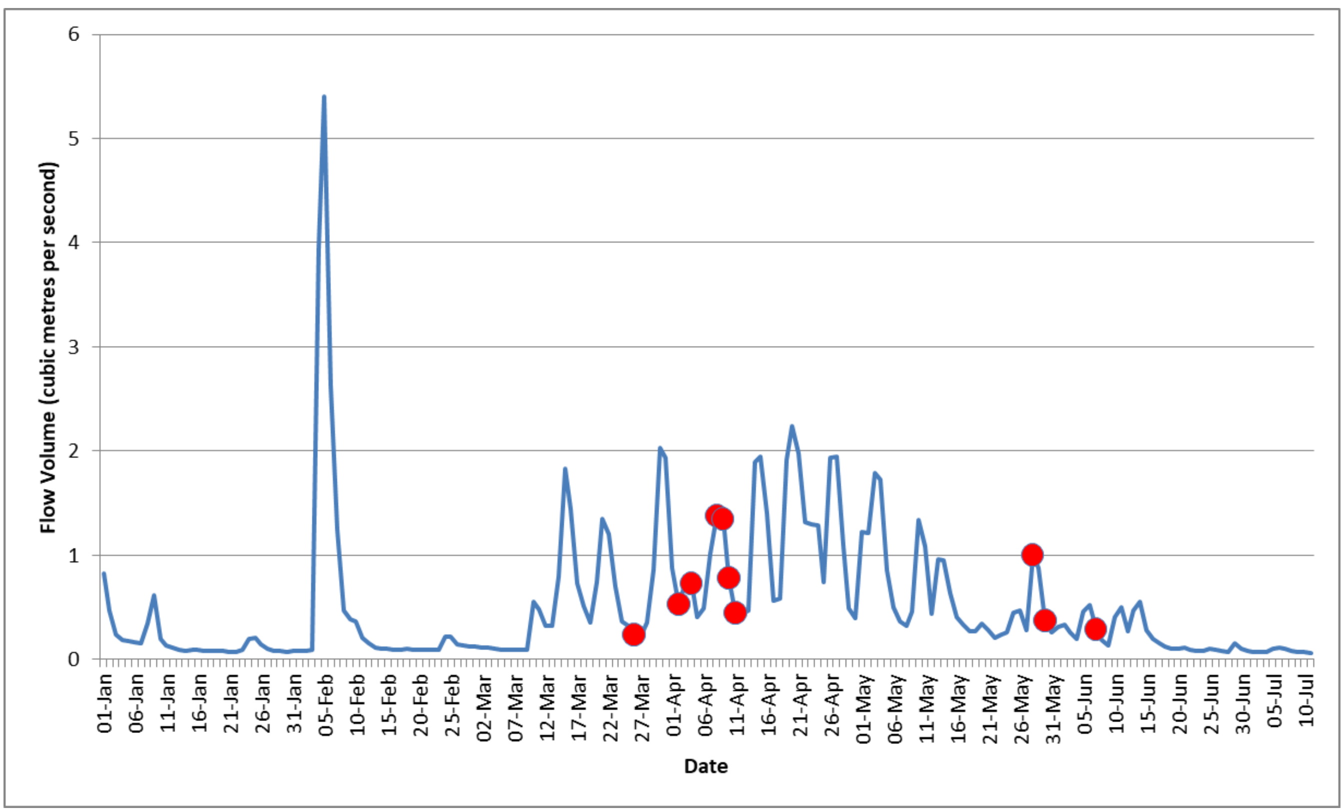


Figure: Graph showing flow volumes for Blackstock Creek at Beacock Road, between January 1, 2019 and July 10, 2019. Red dots represent sampling dates.

Figure: Map showing the locations of tributaries, and stations, that were sampled in this study.

Tributary: Williams Creek (#1 on map)

Williams Creek outlets into Lake Scugog within the Town of Port Perry, adjacent to the public boat launch on Old Rail Line. Sampling was undertaken between Old Rail Line and Perry Street. The sampled section flows through a mixed land use (forest, marsh, and manicured lawn) adjacent to an urban environment. It is a small sized (2.7 metres average wetted width), permanently flowing watercourse.

A few stations (2) along its length are considered potential Walleye spawning habitat (see Table and Figure). The gravel that exists at Station 3 has been recently added to this section as part of the substrate restoration component of an outlet dredging project undertaken approximately 5 years ago.

One constraint that was noted for the sampled s0ection is that this tributary is relatively degraded as indicated by historical channelization, sediment accumulation, garbage, and eroded banks. There were no potential migratory barriers noted.

Representative habitat conditions of potential Walleye spawning habitat (Station 3).

Williams Creek flows through two steel culverts under Old Rail Line before emptying into Lake Scugog.

A side channel entering Williams Creek (Station 2, looking upstream).

Representative photo of degraded conditions (eroded banks), from Perry Street looking upstream.

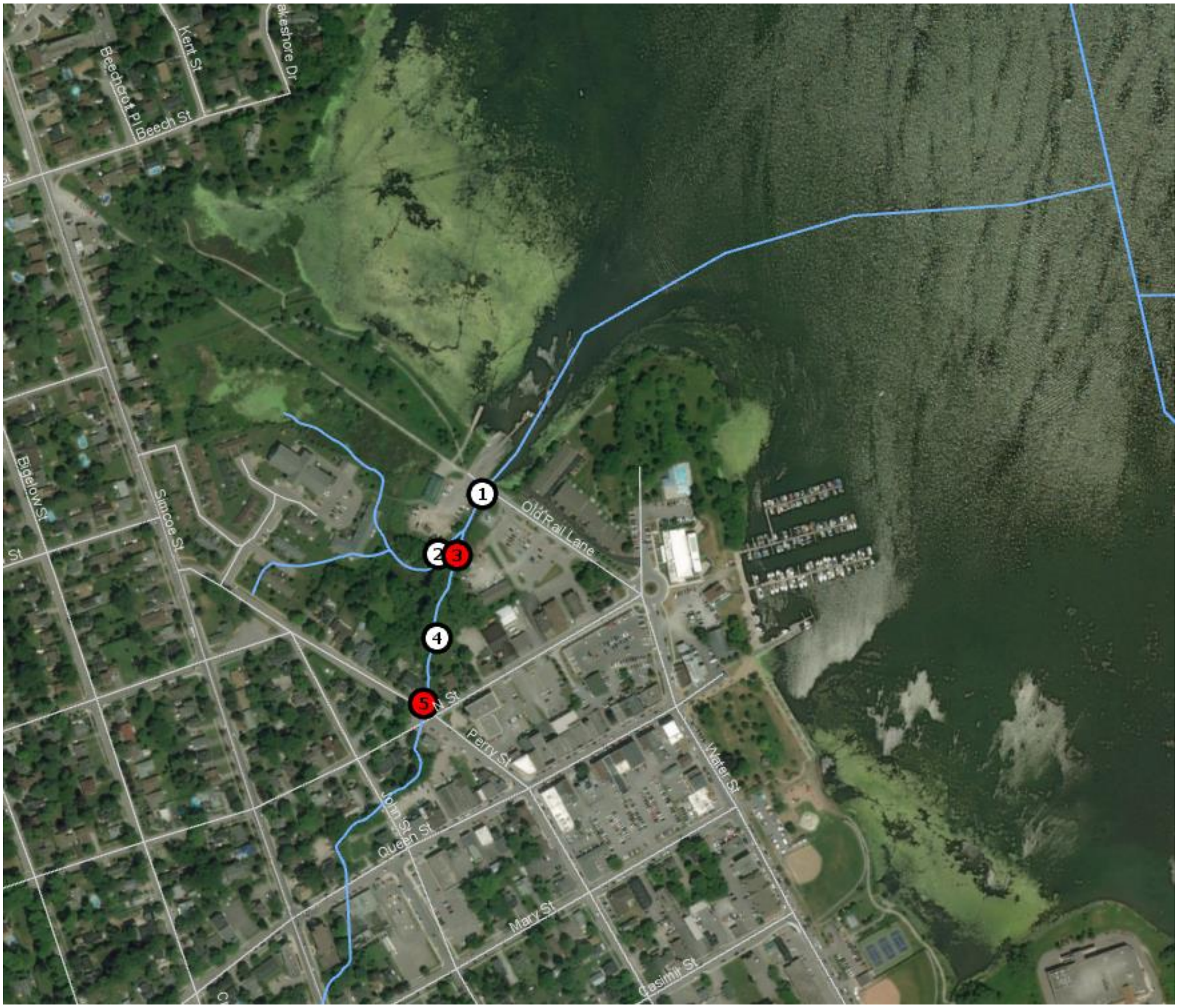


Figure: Location of stations along Williams Creek. Red is potential Walleye spawning habitat. Scale 1:5000.

Table: Habitat data collected at each station along Williams Creek.

Station #	Substrate (dominant)	Depth (cm)	Width (m)	Velocity (m/s)	Dissolved Oxygen (mg/L)	pH
1	Sand	35	5.4	0.00	14.4	7.9
2	Silt	22	1.2	0.01	9.9	7.9
3	**Gravel**	**16**	**2.0**	**0.07**	**13.6**	**8.1**
4	Sand	8	2.1	0.14	13.6	8.1
5	**Gravel**	**10**	**1.3**	**0.14**	**13.2**	**8.2**

Tributary: Cawkers Creek (#2 on map)

Cawkers Creek outlets into Lake Scugog, within the Town of Port Perry (north end), into the provincially significant Port Perry North wetland. Sampling was undertaken between this wetland (just downstream of Simcoe Road) and Old Simcoe Road. The sampled section flows through a mixed land use (forest, and marsh), with adjacent forests and residential properties. It is a moderate sized (3.4 metres average wetted width), permanently flowing watercourse.

There are no stations along its length that are considered potential Walleye spawning habitat, due to the fine substrates that dominate this tributary (see Table and Figure). However, there exists an area with some coarse substrate immediately upstream of Station 3 which may be worth investigating as potential.

There were two beaver dams that exist between Simcoe Road and Lake Scugog, but these are not considered significant constraints.

Riffle area (immediately upstream of Station 3), that is likely the best habitat section for spawning Walleye.

Beaver dam (approximately 300mm high), between Simcoe Road and Lake Scugog.

Representative habitat conditions within Cawkers Creek (Station 1, looking upstream).

Beaver dam (approximately 300mm high), between Simcoe Road and Lake Scugog.

Figure: Location of stations along Cawkers Creek. Red is potential Walleye spawning habitat. Scale 1:5000.

Table: Habitat data collected at each station along Cawkers Creek.

Station #	Substrate (dominant)	Depth (cm)	Width (m)	Velocity (m/s)	Dissolved Oxygen (mg/L)	pH
1	Silt	102	8.0	0.04	13.3	8.2
2	Sand	86	2.5	0.16	13.6	8.0
3	Sand	39	4.7	0.08	13.5	8.0
4	Sand	35	3.3	0.24	13.6	8.0
5	Sand	20	2.3	0.24	13.6	8.0
6	Sand	29	2.2	0.30	13.5	8.0
7	Sand	41	2.6	0.20	13.5	8.0
8	Sand	50	2.8	0.21	13.5	8.0
9	Sand	92	4.0	0.38	13.1	8.1
10	Sand	68	2.0	0.18	12.9	8.0

Tributary: Unnamed (#3 on map)

This tributary outlets into Lake Scugog along the west shore of Scugog Island, west of Stephenson Point Road. Sampling was undertaken where this tributary crosses underneath Stephenson Point Road. This tributary is a small sized watercourse that flows mostly through natural habitats, and residential land use. Its outlet exists in a swamp that is back-flooded (8.0 metres average wetted width) by water levels within Lake Scugog.

There were no stations identified as potential Walleye spawning habitat (see Table and Figure). However, the localized rip-rap that was installed as erosion protection at the base of the culvert may be worth investigating as potential Walleye spawning habitat.

There were no potential migratory barriers identified within the sampling area.

Outlet of Unnamed Tributary (Station 1, looking downstream).

Wetland existing east of Stephenson Point Road (Station 1, looking upstream).

Figure: Location of stations along the Unnamed Tributary. Red is potential Walleye spawning habitat. Scale 1:2500.

Table: Habitat data collected at each station along the Unnamed Tributary.

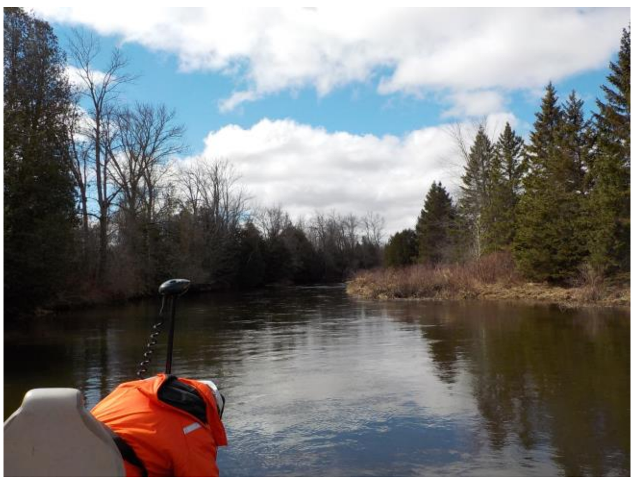
Station #	Substrate (dominant)	Depth (cm)	Width (m)	Velocity (m/s)	Dissolved Oxygen (mg/L)	pH
1	Silt	45	8.0	0.09	11.9	8.0

Tributary: Nonquon River (#4 on map)

The Nonquon River outlets into Lake Scugog along its western shore near King's Bay subdivision, into the provincially significant Nonquon Rivermouth wetland. Sampling was undertaken between Lake Scugog to an upstream location within a large swamp adjacent to Cookson Road un-assumed road allowance. The sampled section flows through a mixed land use (marsh, swamp, residential) with adjacent farmlands and residential properties. This tributary is a large sized (18.7 metres average wetted width), permanently flowing watercourse and is the only tributary within this study that has been confirmed in past studies (and anecdotally) as supporting spawning Walleye.

There are several stations (4) that are considered potential Walleye spawning habitat (see Table and Figure). These occur in a relatively small section of the Nonquon River, just upstream of the River Road bridge in Seagrave. In addition, the cobble install at the footing of the new River Road bridge abutments may be worth investigating as potential Walleye spawning habitat.

There are no potential migratory barriers identified within the sampling area. There was however, evidence of one old beaver dam near Station 15.



Representative photo of potential Walleye spawning habitat (looking upstream at Station 11).

Outlet of Nonquon River just before emptying into Lake Scugog near Kings Bay.

Shoreline habitat along the lower Nonquon River. Invasive *Phragmites* plant (upstream of Station 9).

Representative photo of potential Walleye spawning habitat (Station 14, looking downstream).

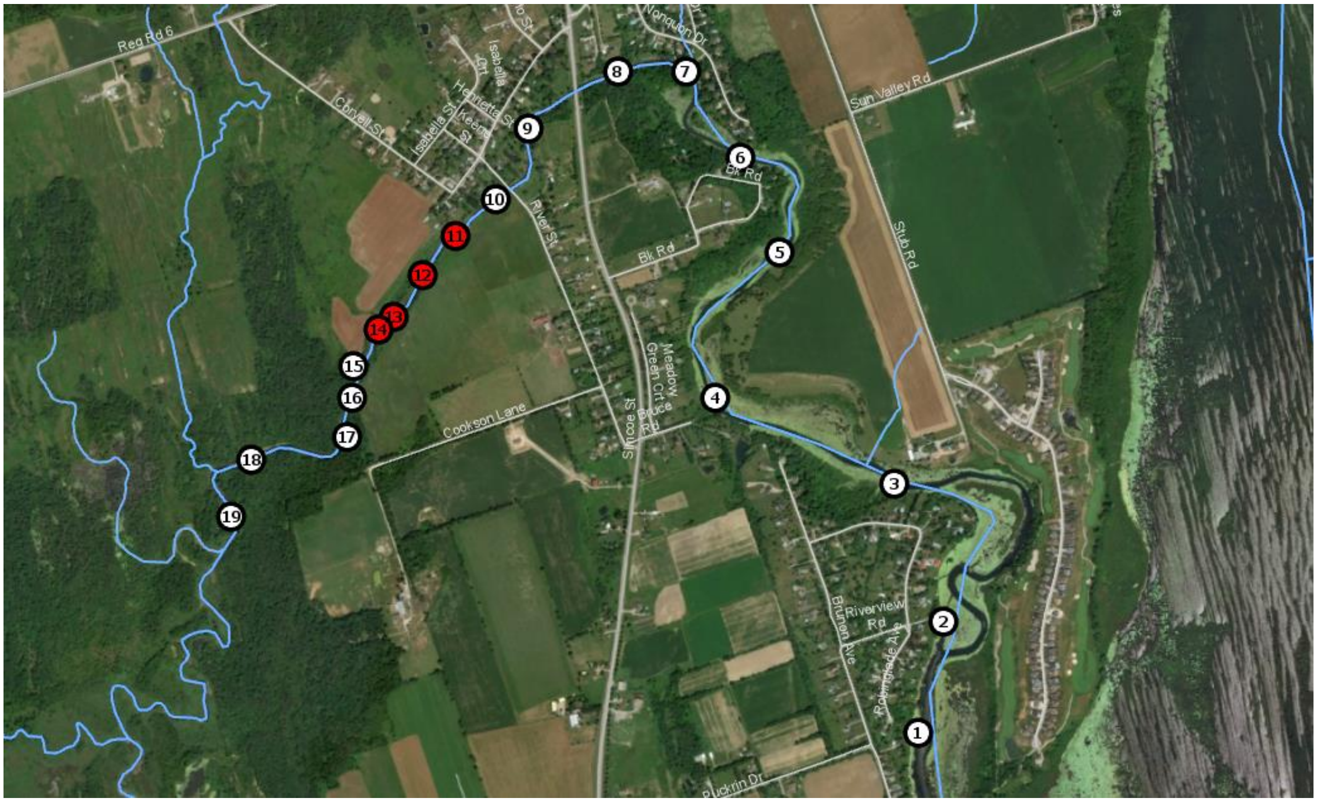


Figure: Location of stations along Nonquon River. Red is potential Walleye spawning habitat. Scale 1:15000.

Table: Habitat data collected at each station along Nonquon River.

Station #	Substrate (dominant)	Depth (cm)	Width (m)	Velocity (m/s)	Dissolved Oxygen (mg/L)	pH
1	Silt	70	18.0	-	11.0	8.0
2	Silt	100	17.0	-	10.9	8.0
3	Silt	240	32.0	-	11.0	7.9
4	Silt	230	16.0	-	10.6	7.9
5	Silt	230	13.0	-	10.6	8.0
6	Silt	140	21.0	-	9.9	8.0
7	-	180	18.0	0.44	10.0	8.2
8	-	190	10.0	-	10.6	8.1
9	Sand	130	24.0	-	10.0	7.9
10	Sand	100	26.0	-	10.6	8.0
11	**Cobble**	**100**	**24.0**	**-**	**10.7**	**8.0**
12	**Cobble**	**80**	**25.0**	**-**	**10.5**	**8.0**
13	**Cobble**	**95**	**20.0**	**0.61**	**10.6**	**7.9**
14	**Gravel**	**60**	**10.0**	**0.71**	**10.5**	**7.9**
15	Sand	90	15.0	0.36	10.9	8.0
16	Silt	150	20.0	-	10.6	8.0
17	Silt	120	15.0	-	10.7	8.0
18	Silt	100	13.0	-	10.9	8.1
19	Sand	140	18.0	0.58	10.2	7.9

An assessment of potential Walleye spawning habitat within certain tributaries of Lake Scugog and Scugog River (Kawartha Conservation, 2019)

Tributary: Fingerboard Creek (#5 on map)

Fingerboard Creek outlets into Lake Scugog at the northwest shore, into the provincially significant Lake Scugog Number 17 wetland. Sampling was undertaken between a location within the marsh upstream to Zion Road. The sampled section flows through a mixed land use (large wetland, road ditch, and residential lands) with adjacent farmlands. This tributary is a moderate sized (1.7 metres average wetted width), permanently flowing watercourse.

There are several (6) stations within the mid-reaches of Fingerboard Creek that are considered potential Walleye spawning habitat (see Table and Figure). These mostly occur in the ditch on the west side of Fingerboard Road.

There are no identified potential barriers to migration, however there were evidence of beaver activity in the large marsh near the outlet of the tributary. Given the tributary flows through the road ditch, any maintenance works undertaken on Fingerboard Road could have an impact on aquatic habitats within this section of Fingerboard Creek.

Potential Walleye spawning habitat (Station 3, looking upstream along Fingerboard Road).

Representative habitat conditions near the outlet of Fingerboard Creek (Station 1, looking downstream).

Representative habitat conditions at Ramsey Road (Station #2, looking upstream).

Representative habitat conditions near Zion Road (Station 11, looking downstream).

Figure: Location of stations along Fingerboard Creek. Red is potential Walleye spawning habitat. Scale 1:15000.

Table: Habitat data collected at each station along Fingerboard Creek.

Station #	Substrate (dominant)	Depth (cm)	Width (m)	Velocity (m/s)	Dissolved Oxygen (mg/L)	pH
1	Silt	30	-	-	-	7.5
2	Sand	86	6.4	0.03	9.1	8.0
3	**Gravel**	**38**	**1.6**	**0.21**	**10.0**	**8.0**
4	**Gravel**	**13**	**2.7**	**0.41**	**10.0**	**8.0**
5	**Gravel**	**56**	**2.2**	**0.11**	**9.8**	**7.9**
6	**Cobble**	**25**	**2.8**	**0.25**	**9.6**	**7.9**
7	**Cobble**	**20**	**1.9**	**0.22**	**9.6**	**7.9**
8	**Gravel**	**32**	**1.5**	**0.25**	**9.6**	**8.0**
9	Sand	35	2.3	0.18	9.5	7.9
10	Sand	25	2.8	0.12	8.8	8.0
11	Sand	23	1.3	0.22	8.3	7.9
12	Sand	39	1.7	0.11	7.6	7.8

Tributary: Unnamed (#6 on map)

This tributary outlets into Lake Scugog on the east shore of Scugog Island, east of Mueller Lane. Sampling was undertaken between the outlet of this tributary upstream to a section within a large cedar forest. The sampled section flows through a mixed land use (manicured lawn, forest, and swamp), with adjacent cedar forests. This tributary is a moderate sized (2.6 metres average wetted width), permanently flowing watercourse with a small pond (25 metres wide by 55 metres long) near its outlet. Upstream of Mueller Lane, the tributary flows clean and as such has the potential to contain sensitive coldwater fish communities (e.g., Brook Trout), although this is unconfirmed.

There is one station that is considered potential Walleye spawning habitat (see Table and Figure), that exists at the downstream side of the pond outlet.

There is one potential migratory barrier identified within the sampling area: the pond outlet (approximately 1000mm high), which also acts as the control structure for the pond. However, given the habitat conditions upstream of this pond are not likely suitable (i.e., fine substrates) for spawning Walleye, it is not considered a significant constraint.

Representative photo of potential Walleye spawning habitat at the tributary outlet (Station 1).

Migratory barrier to fish passage. This is also the water outlet control for the pond.

The instream pond, Station 2.

Representative photo of habitat conditions upstream of Mueller Lane (Station 6, looking downstream).

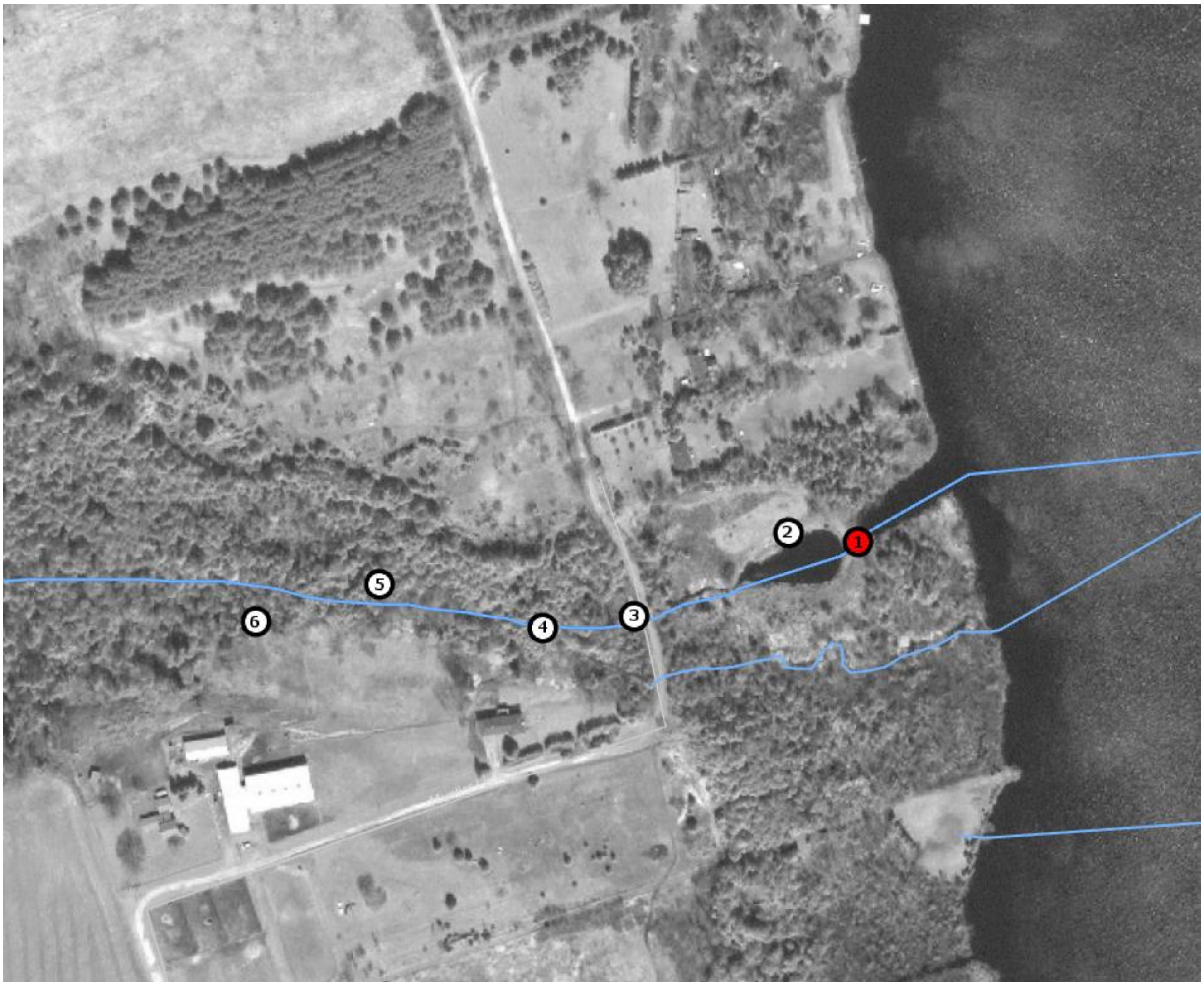


Figure: Location of stations along the Unnamed Tributary. Red is potential Walleye spawning habitat. Scale 1:2500.

Table: Habitat data collected at each station along the Unnamed Tributary.

Station #	Substrate (dominant)	Depth (cm)	Width (m)	Velocity (m/s)	Dissolved Oxygen (mg/L)	pH
1	**Gravel**	**57**	**5.5**	**0.10**	**11.9**	**8.3**
2	Silt	-	25	0.00	11.1	8.2
3	Sand	48	1.7	0.24	11.9	8.0
4	Sand	36	1.9	0.22	12.0	8.1
5	Sand	37	2.2	0.20	12.1	8.1
6	Sand	38	1.6	0.16	12.0	8.1

Tributary: Unnamed (#7 on map)

This tributary outlets into Lake Scugog in the southeast shore. Sampling was undertaken between Highway 7A and at its outlet, where the tributary intersects the historic man-made canals. The sampled section flows through a mostly forested valley with adjacent lands being crop fields. It is a moderate sized (4.4 metres average wetted width), permanently flowing watercourse.

Given that the majority of the stations sampled exhibited coarse substrates, several stations (8) along its length are considered potential Walleye spawning habitat (see Table and Figure).

One constraint was noted along the sampling area: the concrete box culvert at Highway 7A was elevated above the water surface by approximately 150mm at the time of survey. This perched culvert is a potential migratory barrier for all resident fishes, including Lake Scugog Walleye, provided they migrate up that far.

Representative habitat conditions of potential Walleye spawning habitat (Station 9, looking downstream).

Perched concrete box culvert under Highway 7A (immediately upstream of Station 1).

Representative habitat conditions of potential Walleye spawning habitat (Station 3, looking upstream).

Representative habitat conditions near the tributary outlet (Station 13, looking downstream).

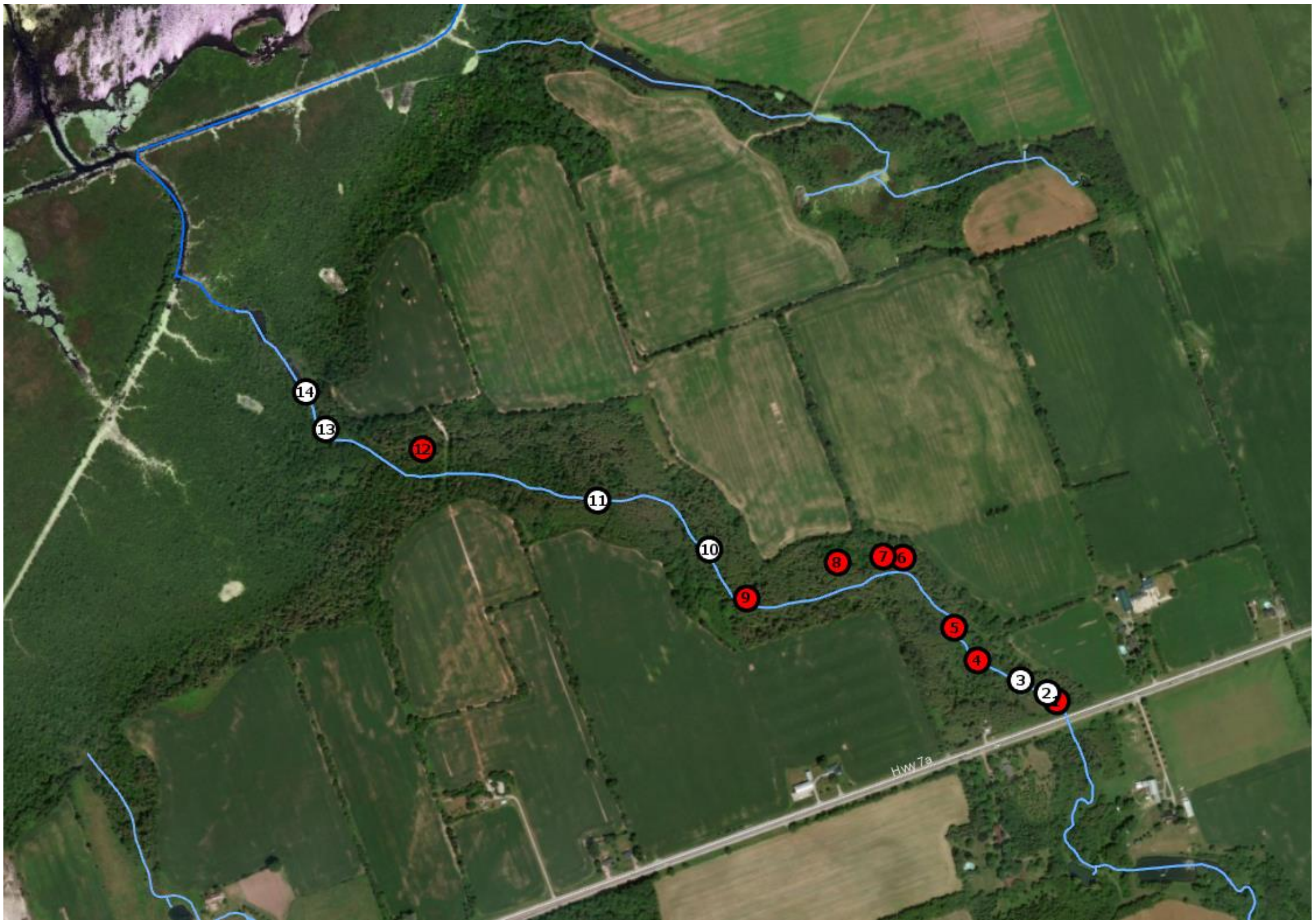


Figure: Location of stations along Unnamed Tributary. Red is potential Walleye spawning habitat. Scale 1:7,500.

Table: Habitat data collected at each station along Unnamed Tributary.

Station #	Substrate (dominant)	Depth (cm)	Width (m)	Velocity (m/s)	Dissolved Oxygen (mg/L)	pH
1	**Gravel**	**28**	**2.9**	**0.29**	**13.4**	**7.6**
2	Sand	38	4.7	0.11	13.5	7.7
3	Sand	9	6.0	0.15	13.6	7.8
4	**Cobble**	**15**	**3.0**	**0.22**	**13.5**	**7.9**
5	**Gravel**	**19**	**6.5**	**0.09**	**13.7**	**7.9**
6	**Gravel**	**13**	**5.3**	**0.11**	**13.8**	**8.0**
7	**Gravel**	**20**	**4.3**	**0.15**	**13.6**	**8.2**
8	**Gravel**	**19**	**4.9**	**0.08**	**13.6**	**8.0**
9	**Gravel**	**10**	**4.0**	**0.36**	**13.6**	**8.1**
10	Sand	22	4.1	0.13	13.7	8.2
11	Sand	40	4.5	0.05	13.6	8.2
12	**Gravel**	**30**	**3.7**	**0.11**	**13.6**	**8.2**
13	Sand	27	3.2	0.17	13.5	8.2
14	Sand	29	4.0	0.09	13.4	8.2

Tributary: Blackstock Creek (#8 on map)

Blackstock Creek outlets into Lake Scugog, along the southeast shore, northwest of the Village of Blackstock. Sampling was undertaken between Beacock Road and a downstream location within a large cedar forest on route to Lake Scugog. The sampled section flows through a forest valley with adjacent farmlands. This tributary is a moderate sized (6.5 metres average wetted width), permanently flowing watercourse.

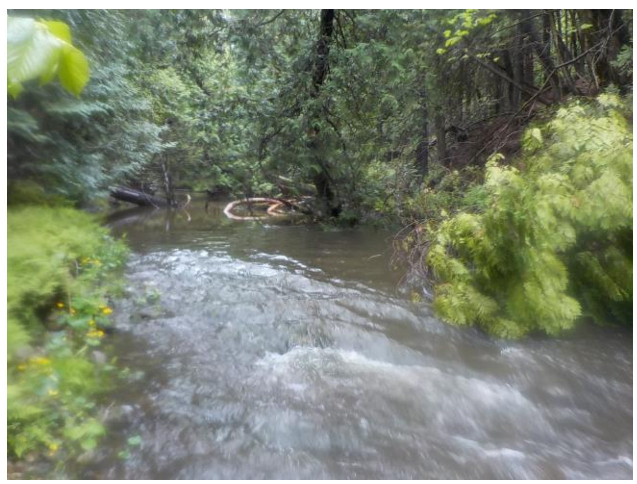
There are several (5) stations within the mid-reaches of Blackstock Creek that are considered potential Walleye spawning habitat (see Table and Figure). Although the downstream section of this tributary was not sampled, it is also likely to exhibit potential Walleye spawning habitat with similar habitat conditions to Stations 6 to 9.

There are no potential migratory barriers, and no other significant habitat constraints identified within the sampling area.

Representative photo of potential Walleye spawning habitat (Station 7, looking downstream).

Representative habitat conditions on Blackstock Creek (Station 5, looking downstream).

Beacock Road over Blackstock Creek (Station #1, looking upstream).



Representative photo of potential Walleye spawning habitat (Station 9, looking upstream).

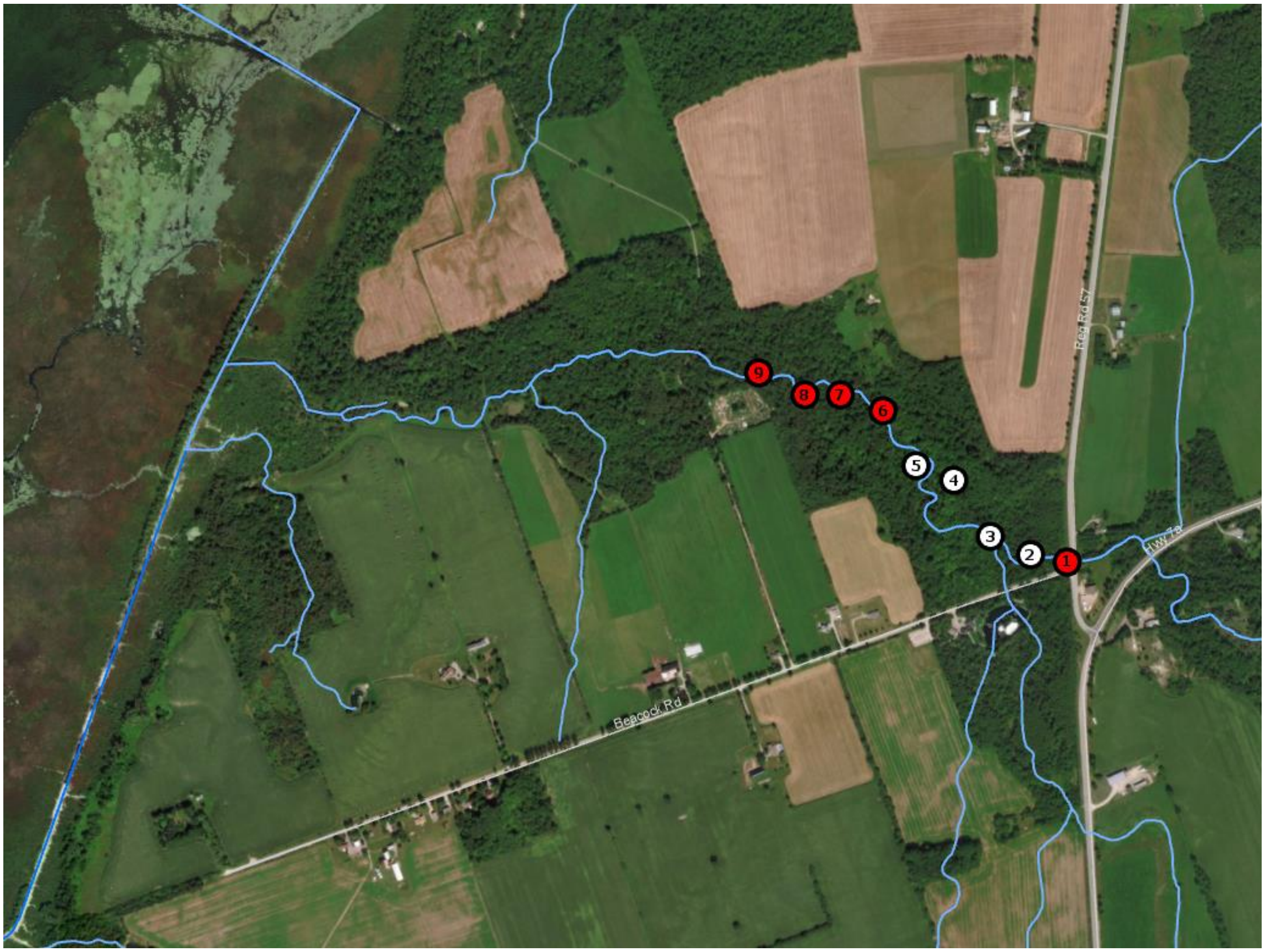


Figure: Location of stations along Blackstock Creek. Red is potential Walleye spawning habitat. Scale 1:10000.

Table: Habitat data collected at each station along Blackstock Creek.

Station #	Substrate (dominant)	Depth (cm)	Width (m)	Velocity (m/s)	Dissolved Oxygen (mg/L)	pH
1	**Gravel**	**38**	**4.5**	**0.46**	**9.7**	**7.7**
2	Sand	32	6.9	0.33	9.7	7.6
3	Sand	30	7.6	0.33	9.7	7.6
4	Sand	61	5.7	0.20	9.7	7.7
5	Sand	72	5.6	0.19	9.7	7.7
6	**Gravel**	**36**	**8.3**	**0.44**	**9.7**	**7.7**
7	**Cobble**	**87**	**7.6**	**0.18**	**8.7**	**7.7**
8	**Gravel**	**48**	**7.0**	**0.25**	**9.7**	**7.7**
9	**Cobble**	**30**	**5.7**	**0.57**	**10.1**	**7.6**

Tributary: Mariposa Brook (#9 on map)

Mariposa Brook outlets into the Scugog River, along its western shore, directly across from East Cross Creek. Sampling was undertaken between the Scugog River and Elm Tree Road. The sampled section flows through wetlands with adjacent farmlands. This tributary is a large sized (43.2 metres average wetted width), permanently flowing watercourse. The majority of the sample area was too deep to accurately access substrate conditions but, given it is relatively low gradient, the main channel is likely is dominated by fine substrates.

There are several (6) sections within the mid-reaches that are considered potential Walleye spawning habitat (see Table and Figure). These areas are typically associated with outer bends of the meandering tributary, where coarse substrates dominate instead of fines in localized nearshore areas.

There are no potential migratory barriers, nor any other significant habitat constraints, identified within the sampling area.

Potential Walleye spawning habitat, immediately downstream of Elm Tree Road (Station 10).

Representative habitat conditions of Mariposa Brook (Station 8, looking upstream).

Representative photo of potential Walleye spawning habitat along outer bend (Station 3).

Beaver lodge along the bank of Mariposa Brook.

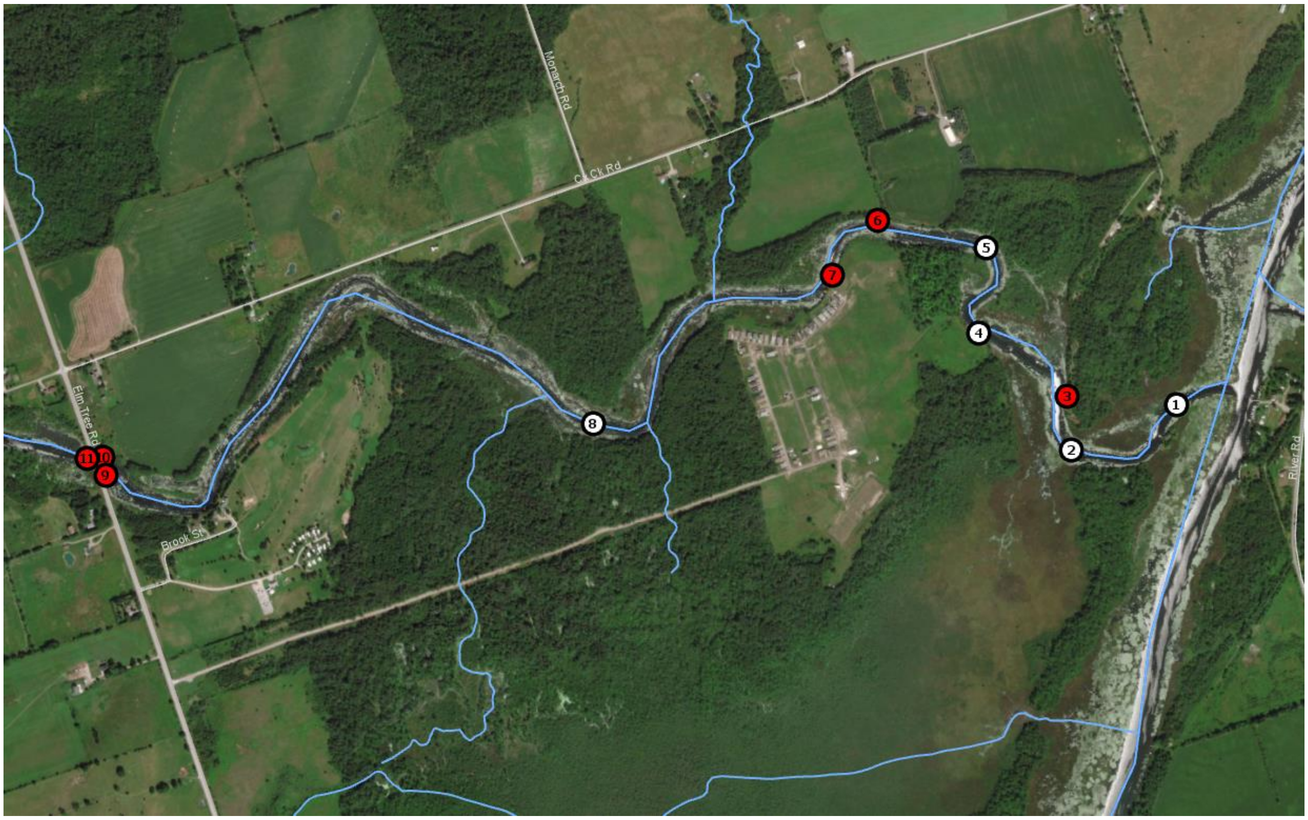


Figure: Location of stations along Mariposa Brook. Red is potential Walleye spawning habitat. Scale 1:10000.

Table: Habitat data collected at each station along Mariposa Brook.

Station #	Substrate (dominant)	Depth (cm)	Width (m)	Velocity (m/s)	Dissolved Oxygen (mg/L)	pH
1	Sand	370	64	-	8.8	9.1
2	-	170	80	-	9.1	9.1
3	**Gravel**	**-**	**Along shore (75m)**	**-**	**9.1**	**8.6**
4	Clay	-	Along shore	-	-	-
5	-	250	55	-	10.3	9.3
6	**Gravel**	**-**	**Along shore (30m)**	**-**	**10.8**	**8.6**
7	**Cobble**	**-**	**Along shore (15m)**	**-**	**-**	**-**
8	-	210	25	-	9.9	9.3
9	**Cobble**	**-**	**Along shore (15m)**	**-**	**10.0**	**9.3**
10	**Gravel**	**100**	**15**	**-**	**-**	**-**
11	**Gravel**	**150**	**20**	**-**	**9.9**	**9.9**

Tributary: East Cross Creek (#10 on map)

East Cross Creek outlets into the Scugog River along its eastern shore, at River Road, directly across from Mariposa Brook. Sampling was undertaken between River Road and to a location upstream where this tributary intersects Stony Creek. The sampled section flows through a large wetland with adjacent farmlands. The tributary is relatively low gradient and as such the main channel is dominated by fine substrates. It is a large sized (33.7 average wetted width), permanently flowing watercourse.

There are two stations near the outlet of East Cross Creek that are considered potential Walleye spawning habitat (see Table and Figure), and both are associated with man-made structures that includes coarse materials used for the construction of River Road and a historic roadway that no longer spans the tributary.

There are no potential migratory barriers, nor any other significant habitat constraints, identified within the sampling area.

Potential Walleye spawning habitat along the east side of River Road (Station 1).

Representative habitat conditions along East Cross Creek (Station 4, looking downstream).

Potential Walleye spawning habitat along the old road bed (Station 2).

Potential Walleye spawning habitat along the west side of River Road (Station 1).

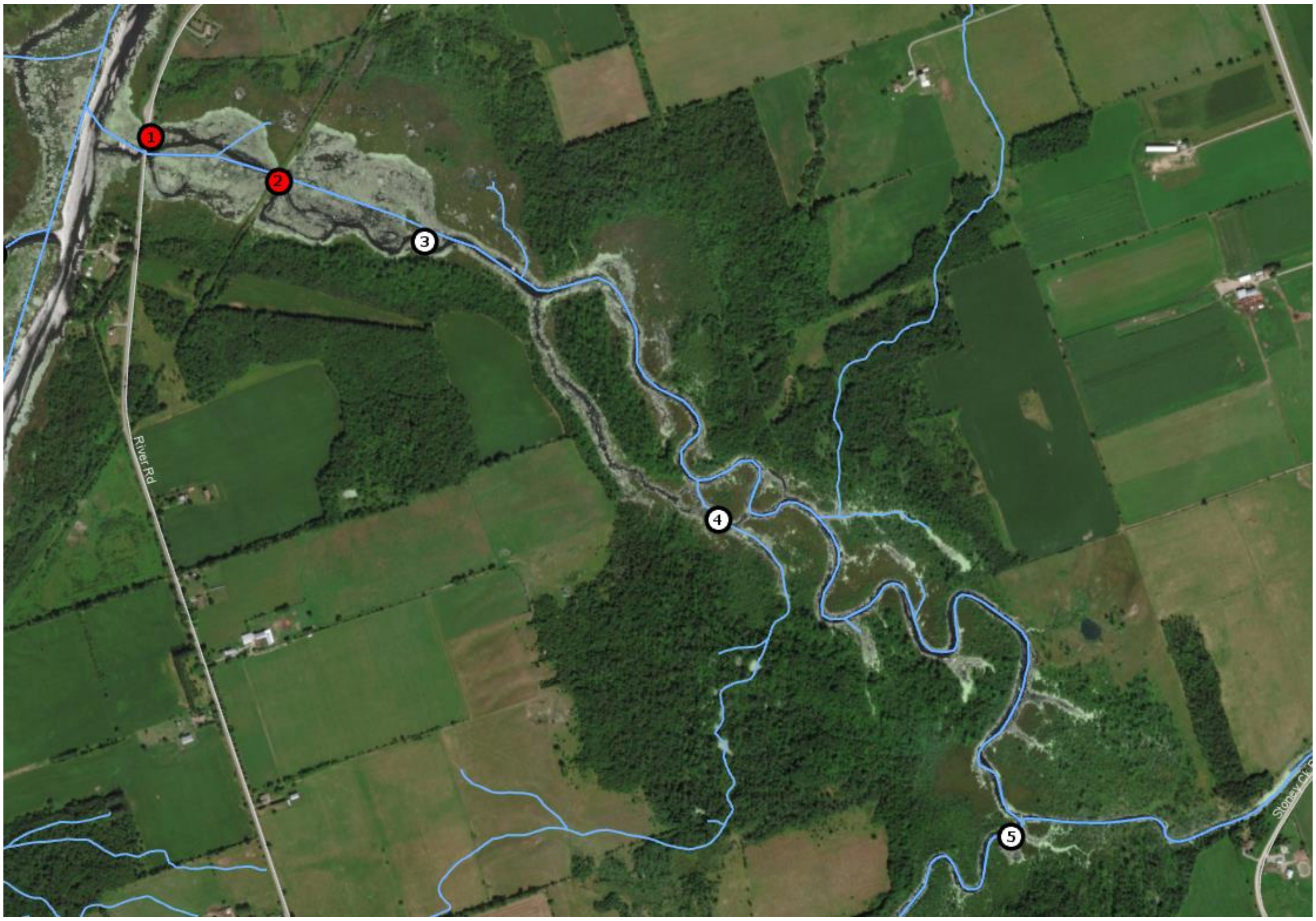


Figure: Location of stations along East Cross Creek. Red is potential Walleye spawning habitat. Scale 1:10000.

Table: Habitat data collected at each station along East Cross Creek.

Station #	Substrate (dominant)	Depth (cm)	Width (m)	Velocity (m/s)	Dissolved Oxygen (mg/L)	pH
1	**Gravel**	**-**	**Causeway (160m)**	**-**	**7.8**	**9.7**
2	**Gravel**	**-**	**Old road/rail bed (140m)**	**-**	**13.7**	**9.4**
3	Silt	80	40	-	9.3	9.9
4	Sand	100	26	-	8.5	10.3
5	Silt	90	35	-	11.1	10.3

Tributary: Sucker Creek (#11 on map)

Sucker Creek outlets into the Scugog River within the Town of Lindsay (south end), adjacent to the cemetery, west of Lindsay Street South. Sampling was undertaken between the Scugog River and the Rail Trail, along its main channel and along its two main branches that meet in the golf course. The sampled section flows through a mixed land use (forest, and marsh), with adjacent commercial properties and a golf course, and is also considered a municipal drain (Ops 21-74, and Ops 20-74). This tributary is a moderate sized (3.1 metres average wetted width) permanently flowing watercourse.

There are several (5) stations along its length are considered potential Walleye spawning habitat (see Table and Figure). However, the most probable locations exist adjacent to the cemetery, near the outlet of Sucker Creek.

One constraint that was noted for the sampled section is that this tributary is relatively degraded as indicated by its murky water, significant bank erosion, sediment deposits, and garbage within its channel. There were no potential migratory barriers noted.

Representative habitat conditions along the outlet of Sucker Creek (Station 1, looking upstream).

Looking upstream at the intersection of the two branches (Station 6 and 12), in the golf course.

Large sediment plume into Scugog River, from the murky waters of Sucker Creek.

Representative habitat conditions along north branch (Station 7, looking upstream), and bank erosion.

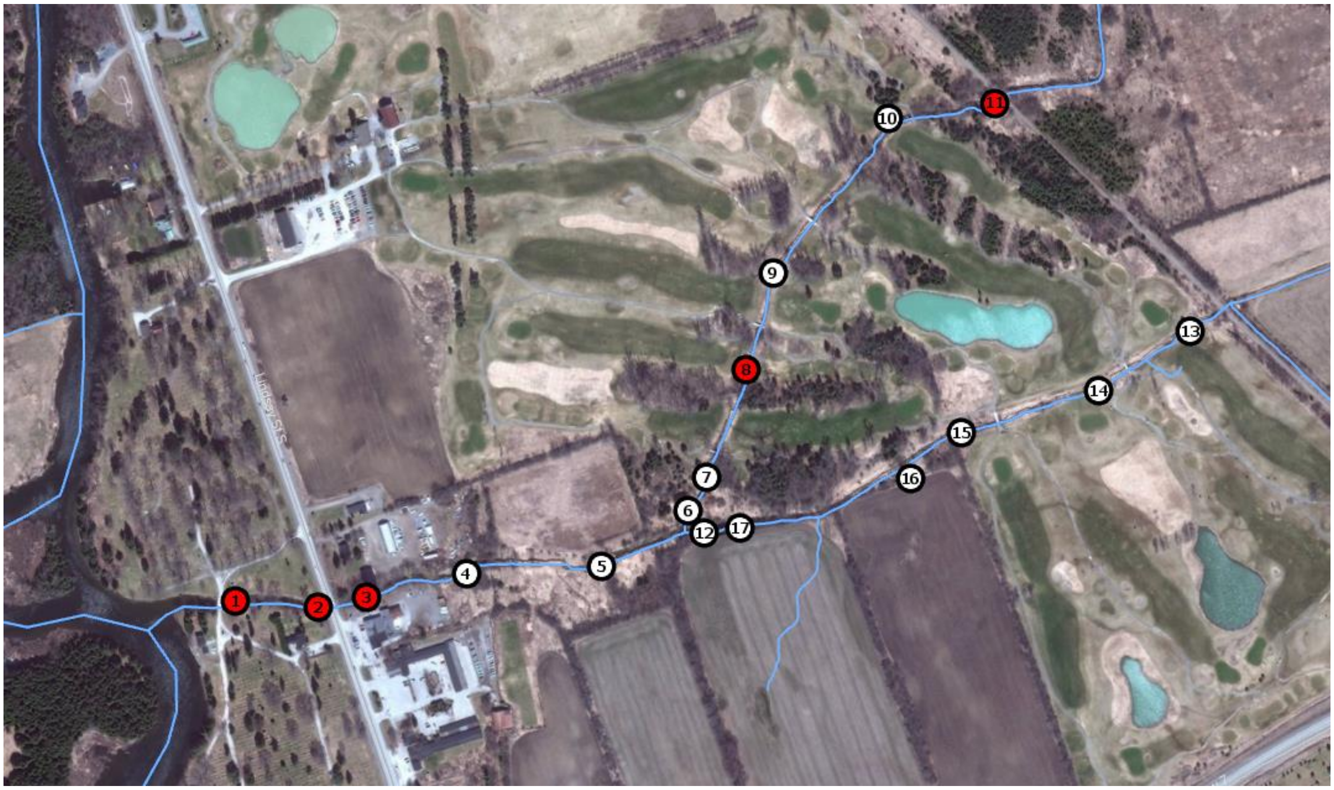


Figure: Location of stations along Sucker Creek. Red is potential Walleye spawning habitat. Scale 1:5000.

Table: Habitat data collected at each station along Sucker Creek.

Station #	Substrate (dominant)	Depth (cm)	Width (m)	Velocity (m/s)	Dissolved Oxygen (mg/L)	pH
1	**Gravel**	**52**	**7.9**	**0.26**	**11.8**	**8.3**
2	**Gravel**	**31**	**4.4**	**0.69**	**11.9**	**7.8**
3	**Gravel**	**35**	**5.8**	**0.25**	**11.8**	**7.8**
4	Sand	63	3.4	0.36	11.8	7.9
5	Clay	69	2.2	0.67	11.7	7.8
6	Sand	39	2.4	0.70	12.0	7.9
7	Sand	58	2.2	0.56	12.0	7.8
8	**Gravel**	**63**	**1.9**	**0.50**	**12.1**	**7.9**
9	Clay	73	3.2	0.26	12.1	7.9
10	Clay	59	1.5	0.56	12.2	7.9
11	**Gravel**	**23**	**3.6**	**0.72**	**12.2**	**7.8**
12	Clay	27	1.7	1.17	11.3	7.7
13	Silt	41	2.3	0.43	10.9	7.7
14	Silt	47	2.2	0.34	10.9	7.8
15	Sand	34	2.1	0.63	10.8	7.8
16	Sand	28	2.7	0.43	10.9	7.8
17	Sand	39	2.4	0.25	11.0	7.8

Discussion

The results of this study indicate that several sections along numerous tributaries draining into Lake Scugog or the Scugog River likely have suitable spawning habitat for Walleye, based on the following physical habitat parameters: substrate, depth, velocity, dissolved oxygen, and pH. Nearly all of the tributaries sampled (Cawkers Creek and an Unnamed Tributary on the west side of Scugog Island are the only exceptions), have one or more sections that meet all habitat criteria. The habitat parameter that was the most determining factor in classifying a section as potential Walleye spawning habitat was substrate (e.g., coarse vs. fine) given that there are no physical habitat limitations for any of the other spawning habitat parameters.

There are, however, some aquatic habitat constraints within certain tributaries that might further influence their capability of supporting spawning Walleye. Williams Creek and Sucker Creek, in particular, are noteworthy because they exist within urban environments and exhibit relatively degraded aquatic habitat conditions (for example, significant bank erosion, sediment accumulation, litter, dredged channels, etc.). Certain activities could also affect the habitat quality in other tributaries, for example it is likely that regular maintenance works occur in the ditch adjacent to Fingerboard Road, through which Fingerboard Creek flows. There were no significant impediments to migration for Walleye (e.g., physical barriers, beaver dams) within any sampled sections that would prevent access to identified potential Walleye spawning habitat.

This report advances our understanding of Walleye habitat in numerous tributaries of Lake Scugog and the Scugog River, yet data gaps do remain. The term 'potential' Walleye spawning habitat is emphasized in this report because it is understood that there is no confirmation that Lake Scugog Walleye currently, or historically, use all of these tributaries for spawning purposes. To our knowledge there are only two tributaries that have been confirmed to support spawning populations: Nonquon River (Kawartha Conservation and Ministry of Natural Resources, 2009) and Osler Marsh (Hockley, Personal Communication). If Walleye do use these tributaries for spawning purposes, however, it is reasonable to assume that they would be found in close proximity to sections classified in this report as potential Walleye spawning habitat.

Therefore, a logical next step would be to use these data to confirm whether or not Walleye are actually using these habitats, for example, by having Walleye Watch participants visit the locations with 'red circles' in this report during the Walleye spawning period. In addition, there are several other tributaries that were not sampled for the purposes of this report that also have the potential to support spawning Walleye, and as such should also be included in future research and monitoring efforts, including: Osler Marsh (known to support spawning habitat, but was not sampled for this report due to time constraints), several other relatively small tributaries that flow into Lake Scugog or Scugog River (could provide seasonal habitat, but were not sampled given they were not in scope of this report), and the Scugog River (specifically nearshore areas and areas with fast currents).

References

Berube, M. 2019. Personal Communication. Email to Kawartha Conservation dated: Feb 13, 2019, entitled: RE: Lake Scugog Tribs Walleye Spawning Suitability Study Info.

Hockley, C. 2019. Personal Communication. Scugog Lake Stewards Annual General Meeting, April 25, 2019.

Kawartha Conservation and Ministry of Natural Resources. 2009. Nonquon River Fisheries Management Plan. Lindsay, Ontario. Available online at: https://www.kawarthaconservation.com/library?view=document&id=33:nonquon-river-fisheries-management-plan&catid=59:watershed-management-plans.

Ministry of Natural Resources. 2009. Fish Plan for Zone 17. Available online at: https://docs.ontario.ca/documents/2644/264321.pdf.

Ministry of Natural Resources. 2015. Walleye recreational fishery on Lake Scugog. Available online at: http://apps.mnr.gov.on.ca/public/files/er/Walleye-recreational-fishery-on-lake-scugog.pdf

Appendix

Appendix A: Blank field sheet.

Lake Scugog Tributaries Walleye Spawning Habitat Study – Kawartha Conservation

Date (yyyy/mm/dd):___________________ Time (HH:mm): _________________ Crew: _________________________________

Tributary Name:____ Segment ID (e.g., 1B3):________________________

Contact Info (property #, landowner name, phone #, etc.):

____

Station #	Coordinates (Easting) (Northing)	Water Temp. (°C)	Dissolved Oxygen (mg/L)	pH	Wetted Width (m)	Bankfull Width (m)	Point #1		Point #2		Point #3		Substrate (dominant)	Substrate (subdominant)
							Depth (cm)	Velocity (m/s)	Depth (cm)	Velocity (m/s)	Depth (cm)	Velocity (m/s)		

Stream Bottom Defined: |yes / no| Stream Banks Prominent: |yes / no|
Stream Bottom Live Roots: |yes / no| Stream Banks Continuous: |yes / no|
Stream Bottom Terrestrial Plants: |yes / no| Aquatic invertebrates? |yes / no| EPT?: ______________________________

Photo Name	Photo Description

Appendix B: Raw data

Date	Tributary Name	Map#	FieldSheetStation #	Station#	Easting	Northing	Substrate (dominant)	Substrate (subdominant)	Depth (avg)	Velocity (avg)	Dissolved Oxygen (mg/L)	pH	Water Temp (°C)	Turbidity (NTU)	Wetted Width (m)	Bankfull Width (m)	Point #1 Depth (cm)	Point #1 Velocity (m/s)	Point #2 Depth (cm)	Point #2 Velocity (m/s)	Point #3 Depth (cm)	Point #3 Velocity (m/s)
April 4, 2019	Williams Creek	1	1	1	664486	4885850	Sand	Silt	35	0.00	14.4	7.9	6.5	6.5	5.4	8.0	37	0.000	36	0.000	31	0.000
April 4, 2019	Williams Creek	1	2	2	664442	4885790	Silt	Sand	22	0.01	9.9	7.9	6.8	4.1	1.2	-	20	0.006	26	0.022	20	0.001
April 4, 2019	Williams Creek	1	3	3	664461	4885789	Gravel	Cobble	16	0.07	13.6	8.1	7.6	2.7	2.0	-	13	0.101	16	0.064	18	0.043
April 4, 2019	Williams Creek	1	4	4	664441	4885707	Sand	Gravel	8	0.14	13.6	8.1	7.1	2.5	2.1	3.0	10	0.206	6	0.208	8	0.009
April 4, 2019	Williams Creek	1	5	5	664428	4885642	Gravel	Sand	10	0.14	13.2	8.2	6.0	2.5	1.3	2.7	9	0.108	10	0.284	11	0.025
April 4, 2019	Cawkers Creek	2	1	1	663672	4887263	Silt	Sand	102	0.04	13.3	8.2	0.6	6.7	8.0	-	130	0.128	100	0.000	77	0.000
April 4, 2019	Cawkers Creek	2	2	2	663649	4887251	Sand	Clay	86	0.16	13.6	8.0	0.7	7.3	2.5	4.4	90	0.138	92	0.223	77	0.107
April 4, 2019	Cawkers Creek	2	3	3	663582	4887212	Sand	Silt	39	0.08	13.5	8.0	0.9	6.8	4.7	6.2	30	0.097	50	0.028	36	0.112
April 4, 2019	Cawkers Creek	2	4	4	663501	4887138	Sand	Silt	35	0.24	13.6	8.0	1.3	7.5	3.3	3.9	32	0.231	46	0.249	27	0.227
April 4, 2019	Cawkers Creek	2	5a	5	663480	4887115	Sand	Clay	20	0.24	13.6	8.0	1.4	7.0	2.3	3.0	20	0.301	23	0.265	17	0.151
April 4, 2019	Cawkers Creek	2	5b	6	663468	4887115	Sand	Silt	29	0.30	13.5	8.0	1.5	7.4	2.2	5.2	30	0.419	34	0.361	23	0.118
April 4, 2019	Cawkers Creek	2	6	7	663460	4887059	Sand	Silt	41	0.20	13.5	8.0	1.8	7.1	2.6	3.4	31	0.153	46	0.278	46	0.157
April 4, 2019	Cawkers Creek	2	7	8	663456	4887008	Sand	Silt	50	0.21	13.5	8.0	1.9	6.8	2.8	4.0	47	0.190	52	0.217	50	0.214
April 4, 2019	Cawkers Creek	2	8	9	663723	4887305	Sand	Silt	92	0.38	13.1	8.1	2.4	7.6	4.0	10.0	88	0.980	91	0.082	98	0.092
April 4, 2019	Cawkers Creek	2	9	10	663750	4887362	Sand	Silt	68	0.18	12.9	8.0	2.4	9.6	2.0	3.0	68	0.106	71	0.179	66	0.267
April 11, 2019	Unnamed	3	1	1	667101	4890526	Silt	Cobble	45	0.09	11.9	8.0	2.4	2	8.0	-	-	-	45	0.091	-	-
April 10, 2019	Nonquon River	4	12	1	665137	4894451	Silt	Sand	70	-	11.0	8.0	5.2	2	18.0	-	-	-	70	-	-	-
April 10, 2019	Nonquon River	4	11	2	665217	4894801	Silt	Sand	100	-	10.9	8.0	4.6	2	17.0	-	-	-	100	-	-	-
April 10, 2019	Nonquon River	4	10	3	665063	4895234	Silt	Sand	240	-	11.0	7.9	4.4	2	32.0	-	-	-	240	-	-	-
April 10, 2019	Nonquon River	4	9	4	664499	4895504	Silt	Sand	230	-	10.6	7.9	4.0	3	16.0	-	-	-	230	-	-	-
April 10, 2019	Nonquon River	4	8	5	664701	4895961	Silt	Sand	230	-	10.6	8.0	3.8	3	13.0	-	-	-	230	-	-	-
April 10, 2019	Nonquon River	4	7	6	664580	4896259	Silt	Sand	140	-	9.9	8.0	3.7	3	21.0	-	-	-	140	-	-	-
April 10, 2019	Nonquon River	4	1	7	664406	4896528	-	-	180	0.44	10.0	8.2	3.0	3	18.0	-	-	-	180	0.444	-	-
April 10, 2019	Nonquon River	4	2	8	664192	4896528	-	-	190	-	10.6	8.1	3.1	3	10.0	-	-	-	190	-	-	-
April 10, 2019	Nonquon River	4	3	9	663910	4896349	Sand	Silt	130	-	10.0	7.9	3.0	3	24.0	-	-	-	130	-	-	-
April 10, 2019	Nonquon River	4	4	10	663807	4896127	Sand	Cobble	100	-	10.6	8.0	3.0	3	26.0	-	-	-	100	-	-	-
April 10, 2019	Nonquon River	4	5	11	663681	4896014	Cobble	Sand	100	-	10.7	8.0	3.0	3	24.0	-	-	-	100	-	-	-
April 10, 2019	Nonquon River	4	6	12	663577	4895890	Cobble	Sand	80	-	10.5	8.0	3.1	3	25.0	-	-	-	80	-	-	-
April 11, 2019	Nonquon River	4	7	13	663487	4895758	Cobble	Sand	95	0.61	10.6	7.9	2.6	3	20.0	-	-	-	95	0.611	-	-
April 11, 2019	Nonquon River	4	6	14	663438	4895717	Gravel	Sand	60	0.71	10.5	7.9	2.6	3	10.0	-	-	-	60	0.705	-	-
April 11, 2019	Nonquon River	4	5	15	663361	4895605	Sand	Cobble	90	0.36	10.9	8.0	2.6	4	15.0	-	-	-	90	0.356	-	-
April 11, 2019	Nonquon River	4	4	16	663357	4895504	Silt	Sand	150	-	10.6	8.0	2.6	3	20.0	-	-	-	150	-	-	-
April 11, 2019	Nonquon River	4	3	17	663339	4895382	Silt	Sand	120	-	10.7	8.0	2.6	3	15.0	-	-	-	120	-	-	-
April 11, 2019	Nonquon River	4	2	18	663039	4895310	Silt	Sand	100	-	10.9	8.1	2.5	2	13.0	-	-	-	100	-	-	-
April 11, 2019	Nonquon River	4	1	19	662976	4895132	Sand	Silt	140	0.58	10.2	7.9	2.5	3	18.0	-	-	-	140	0.581	-	-
June 7, 2019	Fingerboard Creek	5	1	1	666149	4898673	Silt	Sand	30	-	-	7.5	17.0	2	-	-	-	-	30	-	-	-
June 7, 2019	Fingerboard Creek	5	2	2	666197	4899806	Sand	Cobble	86	0.03	9.1	8.0	13.2	0	6.4	-	83	0.037	91	0.033	85	0.022
June 7, 2019	Fingerboard Creek	5	3	3	666195	4900207	Gravel	Sand	38	0.21	10.0	8.0	14.5	1	1.6	2.0	31	0.175	38	0.232	46	0.213
June 7, 2019	Fingerboard Creek	5	4	4	666148	4900207	Gravel	Sand	13	0.41	10.0	8.0	14.5	1	2.7	3.0	18	0.160	10	0.697	10	0.367
June 7, 2019	Fingerboard Creek	5	5	5	666125	4900412	Gravel	Sand	56	0.11	9.8	7.9	14.4	1	2.2	3.0	59	0.178	62	0.149	48	0.015
June 7, 2019	Fingerboard Creek	5	6	6	666107	4900458	Cobble	Gravel	25	0.25	9.6	7.9	14.5	2	2.8	-	24	0.286	31	0.288	20	0.176
June 7, 2019	Fingerboard Creek	5	7	7	666143	4900613	Cobble	Gravel	20	0.22	9.6	7.9	14.9	2	1.9	-	26	0.172	24	0.318	11	0.179
June 7, 2019	Fingerboard Creek	5	8	8	666145	4900658	Gravel	Sand	32	0.25	9.6	8.0	15.1	2	1.5	2.0	26	0.084	34	0.295	36	0.366
June 7, 2019	Fingerboard Creek	5	9	9	666132	4900747	Sand	Cobble	35	0.18	9.5	7.9	15.3	2	2.3	3.0	30	0.239	38	0.173	36	0.119
June 7, 2019	Fingerboard Creek	5	10	10	666140	4901079	Sand	Gravel	25	0.12	8.8	8.0	17.2	3	2.8	3.0	26	0.100	26	0.128	24	0.133
June 7, 2019	Fingerboard Creek	5	11	11	666128	4901151	Sand	Gravel	23	0.22	8.3	7.9	17.5	2	1.3	3.0	22	0.315	28	0.307	18	0.032
June 7, 2019	Fingerboard Creek	5	12	12	666137	4901193	Sand	Gravel	39	0.11	7.6	7.8	16.9	2	1.7	4.5	42	0.108	44	0.120	32	0.111
April 9, 2019	Unnamed	6	1	1	670874	4894133	Gravel	Silt	57	0.10	11.9	8.3	3.8	11	5.5	-	63	0.049	62	0.036	46	0.202
April 9, 2019	Unnamed	6	2	2	670838	4894138	Silt	Sand	-	0.00	11.1	8.2	4.7	3	25.0	-	-	0.000	-	0.000	-	0.000
April 9, 2019	Unnamed	6	3	3	670759	4894095	Sand	Silt	48	0.24	11.9	8.0	3.7	7	1.7	1.9	42	0.026	56	0.412	47	0.272
April 9, 2019	Unnamed	6	4	4	670712	4894089	Sand	Silt	36	0.22	12.0	8.1	3.7	6	1.9	2.6	39	0.409	29	0.212	39	0.039
April 9, 2019	Unnamed	6	5	5	670628	4894111	Sand	Silt	37	0.20	12.1	8.1	3.8	5	2.2	2.7	34	0.066	43	0.319	34	0.211
April 9, 2019	Unnamed	6	6	6	670564	4894092	Sand	Silt	38	0.16	12.0	8.1	3.8	5	1.6	1.9	36	0.048	42	0.223	36	0.211
March 26, 2019	Unnamed	7	1	1	672413	4886865	Gravel	Sand	28	0.29	13.4	7.6	0.8	1.7	2.9	-	30	0.341	29	0.369	26	0.156

Date	Tributary Name	Map#	FieldSheetStation #	Station#	Easting	Northing	Substrate (dominant)	Substrate (subdominant)	Depth (avg)	Velocity (avg)	Dissolved Oxygen (mg/L)	pH	Water Temp (°C)	Turbidity (NTU)	Wetted Width (m)	Bankfull Width (m)	Point #1 Depth (cm)	Point #1 Velocity (m/s)	Point #2 Depth (cm)	Point #2 Velocity (m/s)	Point #3 Depth (cm)	Point #3 Velocity (m/s)
March 26, 2019	Unnamed	7	2	2	672397	4886879	Sand	Gravel	38	0.11	13.5	7.7	0.9	2.7	4.7	8.6	30	0.142	41	0.111	42	0.091
March 26, 2019	Unnamed	7	3	3	672353	4886901	Sand	Gravel	9	0.15	13.6	7.8	1.0	2.8	6.0	10.9	10	0.097	8	0.168	9	0.187
March 26, 2019	Unnamed	7	4	4	672278	4886935	Cobble	Gravel	15	0.22	13.5	7.9	0.9	2.4	3.0	3.0	17	0.253	15	0.222	13	0.174
March 26, 2019	Unnamed	7	5	5	672239	4886991	Gravel	Cobble	19	0.09	13.7	7.9	0.8	2.6	6.5	9.4	23	0.070	18	0.075	16	0.124
March 26, 2019	Unnamed	7	6	6	672151	4887109	Gravel	Sand	13	0.11	13.8	8.0	0.7	3.8	5.3	6.8	19	0.111	18	0.167	3	0.057
April 2, 2019	Unnamed	7	1	7	672119	4887111	Gravel	Sand	20	0.15	13.6	8.2	1.0	1.9	4.3	6.8	17	0.086	22	0.239	20	0.125
April 2, 2019	Unnamed	7	2	8	672040	4887102	Gravel	Sand	19	0.08	13.6	8.0	0.9	2.4	4.9	5.9	12	0.044	20	0.061	25	0.121
April 2, 2019	Unnamed	7	3	9	671885	4887041	Gravel	Cobble	10	0.36	13.6	8.1	0.9	1.8	4.0	4.8	12	0.390	9	0.149	8	0.529
April 2, 2019	Unnamed	7	4	10	671823	4887124	Sand	Gravel	22	0.13	13.7	8.2	0.9	2.2	4.1	5.5	23	0.153	16	0.208	28	0.026
April 2, 2019	Unnamed	7	5	11	671632	4887206	Sand	Gravel	40	0.05	13.6	8.2	1.0	2.0	4.5	7.5	37	0.010	46	0.121	37	0.027
April 2, 2019	Unnamed	7	6	12	671334	4887294	Gravel	Sand	30	0.11	13.6	8.2	1.1	2.4	3.7	5.4	25	0.043	30	0.162	34	0.130
April 2, 2019	Unnamed	7	7	13	671170	4887327	Sand	Silt	27	0.17	13.5	8.2	1.4	3.2	3.2	7.3	33	0.218	31	0.218	16	0.061
April 2, 2019	Unnamed	7	8	14	671135	4887392	Sand	Silt	29	0.09	13.4	8.2	1.6	4.5	4.0	9.0	26	0.096	46	0.169	14	0.002
May 28, 2019	Blackstock Creek	8	1	1	673668	4888811	Gravel	Sand	38	0.46	9.7	7.7	11.6	-	4.5	8.0	36	0.428	40	0.480	39	0.480
May 28, 2019	Blackstock Creek	8	2	2	673589	4888826	Sand	Gravel	32	0.33	9.7	7.6	11.6	-	6.9	7.5	38	0.313	33	0.401	25	0.279
May 28, 2019	Blackstock Creek	8	3	3	673502	4888865	Sand	Clay	30	0.33	9.7	7.6	11.5	-	7.6	8.0	37	0.187	29	0.527	24	0.281
May 28, 2019	Blackstock Creek	8	4	4	673424	4888988	Sand	Clay	61	0.20	9.7	7.7	11.3	-	5.7	9.1	88	0.157	62	0.191	32	0.262
May 28, 2019	Blackstock Creek	8	5	5	673341	4889018	Sand	Clay	72	0.19	9.7	7.7	11.3	-	5.6	7.6	66	0.259	88	0.120	62	0.181
May 28, 2019	Blackstock Creek	8	6	6	673269	4889138	Gravel	Cobble	36	0.44	9.7	7.7	11.3	-	8.3	10.0	32	0.505	36	0.217	40	0.594
May 28, 2019	Blackstock Creek	8	7	7	673176	4889172	Cobble	Gravel	87	0.18	8.7	7.7	11.3	-	7.6	9.0	76	0.107	98	0.151	88	0.277
May 28, 2019	Blackstock Creek	8	8	8	673099	4889172	Gravel	Cobble	48	0.25	9.7	7.7	11.3	-	7.0	-	43	0.142	52	0.243	48	0.362
May 28, 2019	Blackstock Creek	8	9	9	673000	4889221	Cobble	Gravel	30	0.57	10.1	7.6	11.2	-	5.7	-	26	0.677	28	0.663	36	0.372
May 30, 2019	Mariposa Brook	9	1	1	680140	4906122	Sand	Silt	370	-	8.8	9.1	15.2	2	64.0	-	-	-	370	-	-	-
May 30, 2019	Mariposa Brook	9	2	2	679876	4906008	-	-	170	-	9.1	9.1	15.3	2	80.0	-	-	-	170	-	-	-
May 30, 2019	Mariposa Brook	9	3a	3	679865	4906143	Gravel	Cobble	-	-	9.1	8.6	15.2	2	Along shore (75m)	-	-	-	-	-	-	-
May 30, 2019	Mariposa Brook	9	4	4	679643	4906301	Clay	Sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-
May 30, 2019	Mariposa Brook	9	5	5	679663	4906516	-	-	250	-	10.3	9.3	15.0	2	55.0	-	-	-	250	-	-	-
May 30, 2019	Mariposa Brook	9	6	6	679389	4906585	Gravel	Cobble	-	-	10.8	8.6	15.2	2	Along shore (30m)	-	-	-	-	-	-	-
May 30, 2019	Mariposa Brook	9	7	7	679275	4906446	Cobble	Sand	-	-	-	-	-	-	Along shore (15m)	-	-	-	-	-	-	-
May 30, 2019	Mariposa Brook	9	8	8	678674	4906073	-	-	210	-	9.9	9.3	14.6	2	25.0	-	-	-	210	-	-	-
May 30, 2019	Mariposa Brook	9	9	9	677443	4905962	Cobble	Boulder	-	-	10.0	9.3	14.9	3	Along shore (15m)	-	-	-	-	-	-	-
May 30, 2019	Mariposa Brook	9	10a	10	677441	4905990	Gravel	Sand	100	-	-	-	-	-	15.0	-	-	-	100	-	-	-
May 30, 2019	Mariposa Brook	9	10b	11	677402	4905987	Gravel	Cobble	150	-	9.9	9.9	14.6	2	20.0	-	-	-	150	-	-	-
May 30, 2019	East Cross Creek	10	1	1	680495	4906387	Gravel	Silt	-	-	7.8	9.7	15.8	2	Along Causeway (160m)	-	-	-	-	-	-	-
May 30, 2019	East Cross Creek	10	2a	2	680783	4906287	Gravel	Sand	-	-	13.7	9.4	17.1	2	Along Oldrail Shore (140m)	-	-	-	-	-	-	-
May 30, 2019	East Cross Creek	10	3	3	681112	4906150	Silt	Sand	80	-	9.3	9.9	16.2	3	40.0	-	-	-	80	-	-	-
May 30, 2019	East Cross Creek	10	4	4	681772	4905523	Sand	Silt	100	-	8.5	10.3	15.7	1	26.0	-	-	-	100	-	-	-
May 30, 2019	East Cross Creek	10	5	5	682433	4904810	Silt	Sand	90	-	11.1	10.3	16.4	3	35.0	-	-	-	90	-	-	-
April 8, 2019	Sucker Creek	11	1	1	681255	4911503	Gravel	Sand	52	0.26	11.8	8.3	3.0	30	7.9	11.5	64	0.476	53	0.231	38	0.077
April 8, 2019	Sucker Creek	11	2	2	681344	4911496	Gravel	Sand	31	0.69	11.9	7.8	2.8	32	4.4	-	10	0.844	42	0.753	40	0.469
April 8, 2019	Sucker Creek	11	3	3	681396	4911507	Gravel	Sand	35	0.25	11.8	7.8	3.0	61	5.8	15	25	0.094	30	0.250	50	0.413
April 8, 2019	Sucker Creek	11	4	4	681502	4911532	Sand	Gravel	63	0.36	11.8	7.9	3.1	33	3.4	10.0	70	0.390	60	0.447	60	0.250
April 8, 2019	Sucker Creek	11	5	5	681647	4911540	Clay	Sand	69	0.67	11.7	7.8	3.2	25	2.2	3.3	73	0.641	72	0.718	63	0.649
April 8, 2019	Sucker Creek	11	1	6	681741	4911582	Sand	Clay	39	0.70	12.0	7.9	3.4	13	2.4	-	36	0.778	40	0.821	40	0.508
April 8, 2019	Sucker Creek	11	2	7	681759	4911635	Sand	Clay	58	0.56	12.0	7.8	3.5	10	2.2	7.9	56	0.760	60	0.663	59	0.255
April 8, 2019	Sucker Creek	11	3	8	681802	4911750	Gravel	Clay	63	0.50	12.1	7.9	3.5	10	1.9	7.2	55	0.476	66	0.468	67	0.548
April 8, 2019	Sucker Creek	11	4	9	681830	4911853	Clay	Sand	73	0.26	12.1	7.9	3.6	7	3.2	8.0	75	0.328	75	0.322	68	0.120
April 8, 2019	Sucker Creek	11	5	10	681953	4912018	Clay	Sand	59	0.56	12.2	7.9	3.7	6	1.5	10.0	55	0.496	65	0.615	56	0.555
April 8, 2019	Sucker Creek	11	6	11	682068	4912035	Gravel	Cobble	23	0.72	12.2	7.8	3.7	6	3.6	5.8	24	0.863	26	0.895	18	0.406
April 8, 2019	Sucker Creek	11	7	12	681737	4911579	Clay	Sand	27	1.17	11.3	7.7	3.6	33	1.7	2.9	19	1.525	35	1.094	26	0.891
April 8, 2019	Sucker Creek	11	8	13	682277	4911791	Silt	Sand	41	0.43	10.9	7.7	3.8	6	2.3	10.3	38	0.574	45	0.222	40	0.480
April 8, 2019	Sucker Creek	11	9	14	682179	4911728	Silt	Sand	47	0.34	10.9	7.8	4.0	10	2.2	8.3	50	0.242	53	0.434	39	0.347
April 8, 2019	Sucker Creek	11	10	15	682032	4911683	Sand	Clay	34	0.63	10.8	7.8	4.2	15	2.1	8.3	28	0.755	40	0.561	33	0.584
April 8, 2019	Sucker Creek	11	11	16	681977	4911633	Sand	Clay	28	0.43	10.9	7.8	4.2	20	2.7	3.6	33	0.476	27	0.351	23	0.451
April 8, 2019	Sucker Creek	11	12	17	681795	4911581	Sand	Clay	39	0.25	11.0	7.8	4.4	38	2.4	9.8	45	0.252	43	0.456	30	0.029