

# **Fish Community Assessment at Freshwater Mussel Index Stations in the Saugeen River Watershed, Ontario, 2019**

Robin C. Gáspárdy, Margaret N. Goguen, D. Andrew R. Drake, and Todd J. Morris

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## TABLE OF CONTENTS

ABSTRACT.....	vi
RÉSUMÉ .....	vii
INTRODUCTION .....	1
METHODS.....	2
Study System and Site Selection.....	2
Fish Community Sampling.....	3
Habitat Sampling .....	3
Sampling Permits and Data Archiving.....	4
RESULTS .....	4
Fish Community Sampling.....	4
Habitat Sampling .....	5
ACKNOWLEDGEMENTS .....	6
REFERENCES .....	6

## LIST OF TABLES

<b>Table 1.</b> Fishes captured at each sampling reach in the Saugeen River watershed. Three sites were sampled within each reach (riffle, run, and pool habitat). Aggregate abundance by location is presented. Individuals identified only to genus or family are not included in species richness, but are included in total abundance. Sites are presented from downstream to upstream order (left to right).....	9
<b>Table 2.</b> Physical characteristics of the habitat sampled at each sampling reach at mussel index stations. Values presented represent mean values across the three sites (riffle, run, pool) at each freshwater mussel index station in the Saugeen River watershed, 2019. Sites are presented in downstream to upstream order (left to right). .....	10
<b>Table 3.</b> Summary of depth, water velocity, and dominant substrate in the riffles, runs, and pools sampled across four sampling reaches at mussel index stations in the Saugeen River watershed. Three distinct habitat types were targeted at each index station based on these physical characteristics to be sampled. ....	10

## LIST OF FIGURES

<b>Figure 1.</b> Freshwater mussel index stations for long-term monitoring in the Saugeen River watershed and the corresponding locations where fish community sampling was conducted in 2019. Three sites representing distinct habitat types (i.e., run, riffle, pool) were sampled using standardized multi-pass seining techniques at each index station. Silver Shiner were detected at fish site IDs 2, 7, 8, and 9. Map labels correspond to mussel index station codes and fish sampling site IDs.....	11
<b>Figure 2.</b> Site photos of the four index stations in the Saugeen River watershed captured during the mussel surveys in 2019.....	12
<b>Figure 3.</b> To assess the fish community in the vicinity of freshwater mussel index stations, three seining sites (a) representing distinct habitats were selected from within a sampling reach that contained the index station (b). The length of the reach is 10 x the wetted width (WW) at the index station.....	13
<b>Figure 4.</b> Location of three seining sites (4 - riffle, 5 - pool, 6 - run) sampled to assess fish community in relation to location of freshwater mussel index station (SG11) provided as an example to illustrate the proximity of seining sites to mussel station. ....	14
<b>Figure 5.</b> Rank abundance of fishes captured (aggregate catch) from three sites in reaches surrounding each of four freshwater mussel index stations in the Saugeen River watershed, 2019. Asterisks (*) indicate known host fishes for SARA-listed Rainbow mussel.....	15
<b>Figure 6.</b> Voucher photos of 124 mm Silver Shiner ( <i>Notropis photogenis</i> ) captured in the run at SGR-SGR-05 mussel index station in the North Saugeen River, 2019, indicating key identification features (Holm et al. 2010). ....	16
<b>Figure 7.</b> Length-frequency of Silver Shiner captured in the Saugeen River watershed, 2019 (n=8). ....	17

## LIST OF APPENDICES

**Appendix A.** Site details for freshwater mussel index stations (latitude and longitude taken at downstream, left corner of area of mussel quadrat survey). Index stations are presented in

downstream to upstream order (top to bottom). Each fish community sampling reach was selected to contain a freshwater mussel index station..... 18

**Appendix B.** Site specific details for fish sampling sites in the Saugeen River watershed in 2019 (latitude and longitude taken at upstream extent of seined area). Three fish sampling sites representing three distinct habitats were sampled within a sampling reach, identified by the mussel index station the reach contains. Sites are presented in downstream to upstream order (top to bottom)..... 19

**Appendix C.** Fish community sampling results indicating the total number of each species captured at each fish sampling site in four river reaches in the Saugeen River watershed, 2019. Reach is identified by the freshwater mussel index station contained within the reach. Bin number is the first, second, or third consecutive seine haul.....20

**Appendix D.** Total length (TL, mm) of all Silver Shiner (*Notropis photogenis*), a SARA-listed Threatened species, captured in the Saugeen River watershed, 2019.....22

**Appendix E.** Physical characteristics of habitat at each site (n=12) sampled for fishes within four river reaches in the Saugeen River watershed, 2019. Reach is identified by the freshwater mussel index station contained within the reach.....23

## ABSTRACT

Gáspárdy, R.C., Goguen, M.N., Drake, D.A.R., and Morris, T.J. 2021. Fish Community Assessment at Freshwater Mussel Index Stations in the Saugeen River watershed, Ontario, 2019. Can. Data Rep. Fish. Aquat. Sci. 1348: vii + 24 p.

Fisheries and Oceans Canada (DFO) conducts sampling at long-term index stations throughout southern Ontario to monitor changes in the distribution and abundance of native freshwater mussel populations, including those listed under the *Species at Risk Act* (SARA). As freshwater mussels rely on host fishes to achieve successful reproduction, knowledge of the fish community can provide insight into changes in mussel distribution and abundance. To determine fish community composition and relative abundance, fish community sampling was conducted in 2019 at four mussel index stations in the Saugeen River watershed. Three distinct habitat types (riffle, run, pool) were sampled using three-pass repeat seining at each index station to provide a representative sample of fish species across habitat types. Twelve sites were sampled (n = 36 seine hauls), resulting in the capture of 672 fishes representing 18 species from six families. The following host species for Rainbow (*Cambarunio iris*), the only SARA-listed mussel in the Saugeen River watershed, were detected: Smallmouth Bass (*Micropterus dolomieu*), Striped Shiner (*Luxilus cornutus*), and Rainbow Darter (*Etheostoma caeruleum*). Silver Shiner (*Notropis photogenis*), a SARA-listed Threatened species, was detected at two index stations: SGR-SGR-05 in the North Saugeen River and SG08 in the Saugeen River main stem. A total of eight Silver Shiner were captured ranging from 58 mm to 124 mm total length (TL) (mean TL 88.5 mm). The capture of Silver Shiner represents a notable finding, given uncertainty in the occurrence of this species in the Saugeen River watershed since 1956, and provides insight into the distribution of the species in the watershed.



## RÉSUMÉ

Gáspárdy, R.C., Goguen, M.N., Drake, D.A.R., and Morris, T.J. 2021. Fish Community Assessment at Freshwater Mussel Index Stations in the Saugeen River watershed, Ontario, 2019. Can. Data Rep. Fish. Aquat. Sci. 1348: vii + 24 p.

Pêches et Océans Canada (MPO) procède à un échantillonnage à des stations indicatrices à long terme dans le sud de l'Ontario en vue de surveiller les changements qui pourraient survenir dans la répartition et l'abondance des populations indigènes de moules d'eau douce, y compris celles inscrites sur la liste de la *Loi sur les espèces en péril* (LEP). Étant donné que les moules d'eau douce dépendent des poissons hôtes pour assurer leur reproduction, les connaissances sur la communauté de poissons peuvent donner un aperçu des changements qui peuvent survenir dans la répartition et l'abondance des moules. Afin de déterminer la composition de la communauté de poissons et l'abondance relative, on a procédé en 2019 à un échantillonnage de la communauté de poissons à quatre stations indicatrices dans le bassin hydrographique de la rivière Saugeen. On a effectué un échantillonnage au moyen d'une pêche à la senne en trois passages répétés dans trois types d'habitats distincts (radiers, rapides et fosses) à chaque station indicatrice en vue d'obtenir un échantillon représentatif des espèces de poissons présentes dans ces types d'habitats. On a échantillonné douze sites ( $n = 36$  traits de senne), ce qui a permis la capture de 672 poissons représentant 18 espèces de six familles différentes. Pour la villeuse irisée (*Cambarunio iris*), la seule espèce de moule présente dans le bassin hydrographique de la rivière Saugeen qui est inscrite sur la liste de la LEP, on a détecté les espèces hôtes suivantes : l'achigan à petite bouche (*Micropterus dolomieu*), le méné rayé (*Luxilus chrysocephalus*) et le dard arc-en-ciel (*Etheostoma caeruleum*). Le méné miroir (*Notropis photogenis*), une espèce inscrite comme menacée en vertu de la LEP, a été détecté à deux stations indicatrices : SGR-SGR-05 dans la rivière North Saugeen et SG08 dans le cours principal de la rivière Saugeen. Au total, on a capturé huit ménés miroirs, variant de 58 à 124 mm de longueur totale (LT) [LT moyenne de 88,5 mm]. La capture de ménés miroirs constitue une découverte importante compte tenu de l'incertitude liée à l'occurrence de cette espèce dans le bassin hydrographique de la rivière Saugeen depuis 1956, en plus de fournir un aperçu de la répartition de l'espèce dans le bassin hydrographique.

## INTRODUCTION

Fisheries and Oceans Canada (DFO) has the responsibility to provide for the protection and recovery of fishes and mussels listed under the *Species at Risk Act* (2002), hereinafter SARA. To inform scientific aspects of the recovery process, DFO regularly conducts field sampling to satisfy various research objectives for SARA-listed fishes and mussels, such as evaluating the distribution and abundance of species, determining species-habitat relationships, and gaining a better understanding of the influence of threats and recovery actions. DFO data reports are published to support the Species at Risk Program by providing an overview of field activities and providing a medium for archiving data associated with sampling SARA-listed fishes and mussels and their habitat.

Freshwater mussels are critically important components of aquatic ecosystems by functioning as natural environmental filters, providing habitat for algae and invertebrates, providing physical stability to the substrate, and transferring energy from aquatic to terrestrial environments (Haag 2012). Freshwater mussels of the Unionidae family have a complex life cycle involving a parasitic relationship with a vertebrate host, where glochidia (larvae) must encyst to successfully metamorphose into juveniles (Haag 2012). The number and species of viable hosts vary widely among unionids. Some mussel species (e.g., Snuffbox, *Epioblasma triquetra*) are considered host specialists, primarily using one or two fish species (e.g., Logperch, *Percina caprodes*), whereas some species are host generalists (e.g., Giant Floater, *Pyganodon grandis*) and can use up to 30 different fish species (Barnhart et al. 2008; COSEWIC 2011; Haag 2012). Glochidia will not transform if encystment on a suitable host does not occur; therefore, reproduction and survival of freshwater mussel populations requires the presence of their host species.

In recent decades, freshwater mussels have experienced global declines and are one of the most imperilled taxa in the world (Lopes-Lima et al. 2018). Declines are prevalent among freshwater mussel species in Canada, with 35% of Canada's 55 native species being considered at-risk (Ricciardi et al. 1998; Government of Canada 2021). Declines have been primarily driven by the invasion of dreissenid mussels (Zebra Mussel, *Dreissena polymorpha*; Quagga Mussel, *Dreissena rostriformis bugensis*), habitat loss and degradation, and decreasing water quality (Ricciardi et al. 1998; DFO 2019). Forty-two of Canada's native species occur in Ontario with 15 currently listed as Endangered, Threatened, or of Special Concern under SARA (Government of Canada 2021). As part of the SARA recovery framework, a recovery strategy is created for Extirpated, Endangered, and Threatened species and a management plan is created for species of Special Concern. Both documents provide scientific objectives needed to ensure the survival and recovery of a species at risk (SAR) (e.g., DFO 2018a, DFO 2018b). A key recovery measure for unionids is monitoring of SAR mussel populations, host fish populations, and mussel/host habitats (DFO 2018a, DFO 2018b, DFO 2018c, DFO 2019).

Since 1999, a network of 54 index stations in seven watersheds across southern Ontario has been established to monitor freshwater mussel populations with a focus on species that have been assessed as at risk by COSEWIC, the Committee on the Status of Endangered Wildlife in Canada (Metcalf-Smith et al. 2007; Baitz et al. 2008; Upsdell et al. 2012; Sheldon et al. 2020; DFO unpublished data). To complement the freshwater mussel surveys, fish community sampling at the index stations was initiated in 2012 to gain insight into how changes in the fish community may contribute to changes in the mussel community. This data report presents an overview of fish and habitat data collected in the Saugeen River watershed following a

standardized fish community assemblage sampling protocol for wadeable riverine habitats used by DFO Science's Fish Species at Risk Program, in partnership with DFO Science's Freshwater Mussel Species at Risk Research Program. These data will be used to assess how long-term changes in the freshwater mussel community may be influenced by the composition and relative abundance of host fish species.

## **METHODS**

### **STUDY SYSTEM AND SITE SELECTION**

The Saugeen River watershed is located within the Lake Huron drainage in southwestern Ontario and has a drainage area of 4,052 km<sup>2</sup>, representing the third largest watershed in the province (DWSP 2015). There are five major subwatersheds within the Saugeen River watershed: North Saugeen River, Rocky Saugeen River, Beatty Saugeen River, South Saugeen River, and Teeswater River. Between 2006 and 2011, a total of 17 sites were sampled for freshwater mussels in the Saugeen River watershed using a qualitative timed-search survey method (Morris et al. 2007; McNichols-O'Rourke et al. 2012). Based on mussel abundance, community species richness, and the occurrence of SAR observed during the qualitative surveys, four sites were selected as long-term monitoring index stations (Sheldon et al. 2020). The sites were located throughout the watershed with one site in each of the North Saugeen River, Beatty Saugeen River, Teeswater River, and main Saugeen River (Figure 1, Figure 2, Appendix A). In 2011, the initial surveys of the four index stations were completed using a quantitative quadrat survey method (Sheldon et al. 2020). In July and August 2019, the four index stations were sampled for the second time, representing the first monitoring event (DFO unpublished data). Fish community assessments were completed in conjunction with the first monitoring events in 2019 and are hereafter outlined in this report.

To select fish sampling sites in proximity to mussel index stations, crews arrived at the index station and measured the wetted width of the river using a laser range finder. The wetted width was used to determine the length of the river reach (10 x wetted width) containing the index station, which typically contained at least one run-riffle-pool sequence (Stanfield 2005). Within each reach containing an index station, a single run, riffle, and pool were selected for fish sampling and each constituted a sampling site, allowing for a representative sample of species among habitat types (Figure 3, Figure 4), consistent with fish community assessment sampling methods used by DFO Science's Fish Species at Risk Research Program (Glass et al. 2016; Barnucz et al. 2020). Once each habitat type was identified, sampling started with the downstream-most site to minimize disturbance of the other sites within the reach. Reaches are referenced hereafter by the mussel index station code to link the fish community data with the mussel monitoring data.

## **FISH COMMUNITY SAMPLING**

### **Seining**

Fish community sampling followed the general methods outlined in Glass et al. (2016) and Barnucz et al. (2020). Sampling occurred on September 16<sup>th</sup> and 17<sup>th</sup>, 2019 using a bag seine (9.14 m length and 1.8 m height; 1.8 x 1.8 x 1.8 m bag dimensions). The seine was constructed of 3 mm heavy delta mesh and mounted on two hardwood poles. Seining is a simple gear to operate, requiring minimal equipment and expertise, and is deployable in many wadeable riverine habitats to produce reliable estimates of species richness (Guy et al. 2009). While seining does not typically capture the large-bodied fishes in the system, seining in late summer/early fall allows for juveniles to be detected when present in shallow water, providing a representation of most species present. Three successive seine hauls were performed in a downstream direction in each of the three habitat types (sites) in each reach. In riffle and run habitats with increased water velocity, the seine was pulled rapidly to exceed the water velocity and maintain the efficiency of the net (Guy et al. 2009; Glass et al. 2016). Effort was made to seine the entire area of the habitat type to a maximum area of 8 m (site width) by 15 m (site length), and not exceeding the maximum depth of the seine (1.8 m) or the wadeable depth by the operator. Actual sampled area (site length and site width) was measured after seining. Distance from shore was measured from the edge of sampled area to nearest shoreline. Captured fishes were removed from the seine and held in bankside aquaria until processing occurred.

### **Enumeration of Fishes**

Fishes were processed separately based on the order of each haul, which allowed species composition and abundance to be partitioned into the first, second, or third haul at each sampling site. Captured fishes were identified to the lowest practical level of taxonomic resolution (typically species), enumerated, and the minimum and maximum total length, per species, was recorded for each haul. In addition, individual total lengths (mm) were taken for any SARA-listed and COSEWIC-assessed SAR fishes captured. Care was taken to minimize the physical handling of fishes during capture and processing, thereby reducing capture stress and incidental mortalities. At least one representative specimen of each species from each sampling site was vouchered, either by preservation in 10% formalin or digital photograph for subsequent species identification and verification in the laboratory. Fishes were released downstream from the sampling site to avoid recapture in upstream sites at the same reach.

## **HABITAT SAMPLING**

The habitat type at each site was recorded (i.e., run, riffle, or pool). Habitat sampling methods followed Glass et al. (2016) and Barnucz et al. (2020). Aquatic habitat variables were measured at the midpoint of the site after fishes were processed and released. Surface water temperature (°C), conductivity (µS), pH, turbidity (NTU), and dissolved oxygen (mg/L) were measured approximately 0.2 m beneath the water's surface using a YSI EX02 multiparameter sonde, which was deployed and allowed to stabilize for approximately 1 minute before measurements were recorded. Water clarity (m) was measured using a 120 cm Fieldmaster turbidity tube. Air temperature (°C) was measured using a Kestrel 3000 wind meter. Substrate composition within the seined area was analyzed by obtaining a handful of bed material within the center of the site. The percent coverage (%) of each substrate type was qualitatively evaluated within an approximate 4 m<sup>2</sup> area at the midpoint of the site. The evaluation involved visually assessing the coverage of different substrate classes based on the approximate median particle diameters

based on a modified Wentworth substrate classification (Bain 1999): clay (<0.005 mm), silt (0.005–0.05 mm), sand (0.05–2 mm), gravel (2–65 mm), cobble (65–250 mm), boulder (250–4000 mm), bedrock (>4000 mm, solid unweathered rock), hardpan (compacted layer of soil), rubble (broken manmade material), and organic (plant and animal material, excluding mussels). Water depth (m) and water velocity (m/s) were measured in three representative locations within the boundaries of the seined area (deep, shallow, and mid-depth) using a metre stick and a Swoffer 2100 current velocity meter, respectively. The Swoffer 2100 was deployed at approximately 50% of the water depth. Wetted stream channel width (m) was measured at the midpoint of the seining site perpendicular to the bank, using a Nikon Laser 1200S waterproof laser range finder. Site location (latitude, longitude) was determined using a Garmin Montana 600 handheld GPS unit using a Backroads Mapbook Ontario GPS chip.

Aquatic macrophytes were classified using a visual assessment in which the field crew assessed the percent composition of the following vegetation classes within the sample area to a total of 100%: open water, emergent vegetation, submerged vegetation, and floating vegetation. The dominant species of vegetation was identified and recorded, as well as all other vegetation species present within the sampling area.

Riparian vegetation within 3 m of the bank was assessed visually by determining the percent composition of riparian vegetation types (deciduous, coniferous, herbaceous, shrubs, or none) occurring in the riparian zone directly adjacent to the sampling site.

## **SAMPLING PERMITS AND DATA ARCHIVING**

Sampling for this project was conducted under Standard Operating Protocol GWACC-116 Live Capture Seine Netting, approved by the DFO and Environment and Climate Change Canada Animal Care Committee (operated under approval of the Canadian Council on Animal Care). Data associated with the collections in this report are housed under the project code “2019-MFCA” in the Biodiversity Science database within the Great Lakes Laboratory for Fisheries and Aquatic Sciences. Every effort has been made to ensure the accuracy of data contained in this report; however, species identities and other sampling results may be revised as part of a long-term data archiving process. Data associated with this report may be obtained by contacting the Great Lakes Laboratory for Fisheries and Aquatic Sciences.

## **RESULTS**

### **FISH COMMUNITY SAMPLING**

Twelve sites across four index stations were sampled in the Saugeen River watershed (Figure 1, Appendix B). A total of 672 fishes representing 18 species from six families were captured, including one SARA-listed species [Silver Shiner (*Notropis photogenis*)]; individuals unable to be identified to species were included in total abundance but not species richness (Table 1). The most abundant species were Common Shiner (*Luxilus cornutus*) and Rosyface Shiner (*Notropis rubellus*), making up a combined 63% (34.7% and 28.4%, respectively) of the total catch (Figure 5). Fishes of the family Leuciscidae (10 species) were the most abundant family present making up 89.0% of the total catch, and fishes of the family Catostomidae (three species) were second-most abundant at 7.4% of total catch.

Of the species detected, none were detected at all four sampling locations. Five species (White Sucker (*Catostomus commersonii*), Common Shiner, River Chub (*Nocomis micropogon*), Bluntnose Minnow (*Pimephales notatus*), and Rosyface Shiner) were detected at three of four

locations. Rosyface Shiner and Common Shiner were not detected at SG11 in the Teeswater River, however, small individuals identified as *Luxilus* sp. and *Notropis* sp. were detected and may represent these species.

The fewest total number of fishes were captured at SG08 in the main stem of the Saugeen River, but this site produced the highest species richness with 12 species detected, four of which were detected only at this location: *Ichthyomyzon* sp. juvenile lamprey, Striped Shiner (*Luxilus chrysocephalus*), Smallmouth Bass (*Micropterus dolomieu*), and Northern Hogsucker (*Hypentellium nigricans*).

Rainbow (*Cambarunio iris*; formerly *Villosa iris*) is the only SARA-listed mussel species in the Saugeen River watershed and has been detected at all four index stations in recent qualitative and/or quantitative mussel surveys (Morris et al. 2007; McNichols-O'Rourke et al. 2012; Sheldon et al. 2020). Rainbow use the following hosts: Mottled Sculpin (*Cottus bairdi*), Green Sunfish (*Lepomis cyanellus*), Greenside Darter (*Etheostoma blennioides*), Largemouth Bass (*Micropterus salmoides*), Rainbow Darter (*Etheostoma caeruleum*), Rock Bass (*Ambloplites rupestris*), Smallmouth Bass, Striped Shiner (*Luxilus chrysocephalus*), and Yellow Perch (*Perca flavescens*) (Watters et al. 2009; COSEWIC 2015). Of these host species, none were detected at SG05; Smallmouth Bass was detected at SG08; Rainbow Darter was detected at SG11 and SG08; and Striped Shiner was detected at SG08, though juvenile *Luxilus* were detected at SG11 and SG04a but not identified to species (Table 1).

Silver Shiner, a SARA-listed Threatened species, was captured at four sites across the North Saugeen River (SGR-SGR-05) index station and the Saugeen River main stem index station (SG08) (Figure 1). A total of eight Silver Shiner individuals were captured (Table 1, Figure 6, Appendix C); individuals were captured in all three habitat types sampled at SG08, and in the pool site at SGR-SGR-05. Total length (TL) of Silver Shiner ranged from 58 mm to 124 mm, with a mean of 88.5 mm TL, possibly representing three age classes (Figure 7, Appendix D). Very few records of Silver Shiner exist in the Saugeen River watershed and their distribution and abundance within the system is poorly known (Bouvier et al. 2012).

## HABITAT SAMPLING

Mean abiotic habitat features for the three sites within the sampling reach at each mussel index station are summarized in Table 2. Overall, the mean surface water temperature was cool, 17.61°C (range 15.13 – 19.35), mean dissolved oxygen was 10.06 mg/L (range 9.35 – 10.69), mean pH was 9.72 (range 8.99 – 12.80), and mean conductivity was 455.6 µS (range 371.2 – 558.0). Water clarity was high with a mean turbidity of 7.13 NTU (range 1.37 – 13.00) and mean turbidity tube reading of 0.70 m (range 0.37 – greater than 1.2 m).

Depth, water velocity, and substrate were used to define habitat type and were summarized across the sampling reaches (Table 3). Riffles sampled were shallow (mean depth 0.24 m), with fast-flowing water (mean water velocity 0.46 m/s), with cobble and gravel dominant substrates. Runs sampled were deep (mean 0.66 m), moderately fast-flowing (mean 0.23 m/s), with cobble and boulder dominant substrates. Pools were moderately deep (mean 0.37 m), with slow or no flow (mean 0.05 m/s), with sand and silt dominant substrates. These physical features at each site sampled are presented in Appendix E.

All sites were dominated by open water with no aquatic vegetation present, except for 5% of emergent vegetation (Arrowhead, *Sagittaria* sp.) present in the pool at site SG04a (Appendix E).

Riparian vegetation at the majority of sites was dominated by herbaceous vegetation, with two sites at SGR-SGR-05 with bare shoreline and no herbaceous vegetation within 3 m of the water line (Appendix E).

Overall, these results provide important baseline information to assess fish community patterns and the relationship between freshwater mussels and their host species.

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## REFERENCES

- Bain, M.B. 1999. Substrate. *In* Aquatic habitat assessment: common methods. *Edited by* M.B. Bain and N.J. Stevenson. American Fisheries Society, Bethesda, Maryland. pp. 95–104.
- Baitz, A., Veliz, M., Brock, H., and Staton, S.K. 2008. A monitoring program to track the recovery of endangered freshwater mussels in the Ausable River, Ontario. Prepared for the Ausable River Recovery Team, the Interdepartmental Recovery Fund and Fisheries and Oceans Canada., Ausable Bayfield Conservation Au. Exeter, Ontario.
- Barnhart, M.C., Haag, W.R., and Roston, W.N. 2008. Adaptations to host infection and larval parasitism in Unionoida. *Am. Benthol. Soc.* **27**(2): 370–394.
- Barnucz, J., Reid, S.M., and Drake, D.A.R. 2020. Targeted surveys for Eastern Sand Darter in the upper Ausable River and Big Otter Creek, Ontario, 2018. *Can. Data Rep. Fish. Aquat. Sci.* **1312**: iv + 26 p. Available from <https://waves-vagues.dfo-mpo.gc.ca/Library/40893753.pdf>.
- Bouvier, L.D., Schroeder, B.S., and Mandrak, N.E. 2012. Information in support of a Recovery Potential Assessment of Silver Shiner (*Notropis photogenis*) in Canada. *Can. Sci. Advis. Secr. Res. Doc.* **2012/130**: iv + 33 p. Available from <https://waves-vagues.dfo-mpo.gc.ca/Library/329626.pdf>.
- COSEWIC. 2011. COSEWIC assessment and status report on the Snuffbox *Epioblasma triquetra* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Available from [https://wildlife-species.canada.ca/species-risk-registry/virtual\\_sara/files/cosewic/sr\\_epioblasme\\_tricorne\\_snuffbox\\_0912\\_e.pdf](https://wildlife-species.canada.ca/species-risk-registry/virtual_sara/files/cosewic/sr_epioblasme_tricorne_snuffbox_0912_e.pdf).
- COSEWIC. 2015. COSEWIC assessment and status report on the Rainbow *Vilosa iris* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Available from [http://www.registrelep-sararegistry.gc.ca/default\\_e.cfm](http://www.registrelep-sararegistry.gc.ca/default_e.cfm).
- DFO (Fisheries and Oceans Canada). 2018a. Recovery strategy and action plan for the Mapleleaf (*Quadrula quadrula*) in Canada (Great Lakes-Upper St. Lawrence population) [Proposed]. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa. Available from [https://sararegistry.gc.ca/virtual\\_sara/files/plans/RaAp-Mapleleaf-v00-2016Aug05-Eng.pdf](https://sararegistry.gc.ca/virtual_sara/files/plans/RaAp-Mapleleaf-v00-2016Aug05-Eng.pdf).

- DFO (Fisheries and Oceans Canada). 2018b. Recovery strategy and action plan for the Rainbow (*Vilosa iris*) in Canada [Proposed]. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa.
- DFO (Fisheries and Oceans Canada). 2018c. Management Plan for the Wavyrayed Lampmussel (*Lampsilis fasciola*) in Canada. Species at Risk Act Management Plan Series. Fisheries and Oceans Canada, Ottawa.
- DFO (Fisheries and Oceans Canada). 2019. Recovery Strategy For Northern Riffleshell, Snuffbox, Round Pigtoe, Salamander Mussel, and Rayed Bean in Canada. In Species at Risk Act Recovery Strategy Series. Ottawa: Fisheries and Oceans Canada. Available from <https://waves-vagues.dfo-mpo.gc.ca/Library/40858054.pdf>.
- DWSP (Drinking Water Source Protection). 2015. Watershed Characterization. Approved Assessment Report for the Saugeen Valley Source Protection Area. Drinking Water Source Protection Act for Clean Water. Available from [http://home.waterprotection.ca/wp-content/uploads/AR/SVCA/SVSPA\\_Ch2\\_2016\\_Final.pdf](http://home.waterprotection.ca/wp-content/uploads/AR/SVCA/SVSPA_Ch2_2016_Final.pdf).
- Glass, W.R., Gaspard, R., Barnucz, J., Bouvier, L.D., and Mandrak, N.E. 2016. Silver Shiner (*Notropis photogenis*) in Ontario: Distribution and Habitat Use. Can. Manuscr. Rep. Fish. Aquat. Sci. **3105**: iv + 27 p. Available from <https://waves-vagues.dfo-mpo.gc.ca/Library/364932.pdf>.
- Government of Canada. 2021. Species at Risk Public Registry. Available from [https://wildlife-species.canada.ca/species-risk-registry/sar/index/default\\_e.cfm](https://wildlife-species.canada.ca/species-risk-registry/sar/index/default_e.cfm).
- Guy, C.S., Braaten, P.J., Herzog, D.P., Pitlo, J., and Rogers, S. 2009. Warmwater Fishes in Rivers. In Standard Methods for Sampling North American Freshwater Fishes. Edited by S.A. Bonar, W.A. Hubert, and D.W. Willis. American Fisheries Society. pp. 59–84.
- Haag, W.R. 2012. North American freshwater mussels. Cambridge University Press, New York, New York, U.S.A.
- Holm, E., Mandrak, N.E., and Burrige, M.E. 2010. Silver Shiner (*Notropis photogenis*). In The ROM field guide to freshwater fishes of Ontario. Royal Ontario Museum. pp. 198–199.
- Lopes-Lima, M., Burlakova, L.E., Karatayev, A.Y., Mehler, K., Seddon, M., and Sousa, R. 2018. Conservation of freshwater bivalves at the global scale: diversity, threats and research needs. Hydrobiologia **810**: 1–14.
- McNichols-O'Rourke, K.A., Robinson, A., and Morris, T.J. 2012. Summary of freshwater mussel timed search surveys in southwestern Ontario in 2010 and 2011. Can. Manuscr. Rep. Fish. Aquat. Sci. **3009**: vi + 42 p. Available from <https://waves-vagues.dfo-mpo.gc.ca/Library/349416.pdf>.
- Metcalf-Smith, J.L., McGoldrick, D.J., Zanatta, D.T., and Grapentine, L.C. 2007. Development of a Monitoring Program for Tracking the Recovery of Endangered Freshwater Mussels in the Sydenham River, Ontario. Environment Canada, Burlington.
- Morris, T.J., Granados, M., and Edwards, A. 2007. A Preliminary Survey of the Freshwater Mussels of the Saugeen River Watershed, Ontario. Can. Manuscr. Rep. Fish. Aquat. Sci. **2809**: v + 30 pp. Available from <https://waves-vagues.dfo-mpo.gc.ca/Library/329626.pdf>.
- Ricciardi, A., Neves, R.J., and Rasmussen, J.B. 1998. Impending extinctions of North American freshwater mussels (*Unionoida*) following the zebra mussel (*Dreissena polymorpha*)



- invasion. *J. Anim. Ecol.* **67**: 613–619.
- Sheldon, M.N., McNichols-O'Rourke, K.A., and Morris, T.J. 2020. Summary of initial surveys at index stations for long-term monitoring of freshwater mussels in southwestern Ontario between 2007 and 2018. *Can. Manuscr. Rep. Fish. Aquat. Sci.* **3203**: vii + 85 p. Available from <https://waves-vagues.dfo-mpo.gc.ca/Library/40887236.pdf>.
- Stanfield, L.W. 2005. Ontario Stream Assessment Protocol, Version 7. Fish and Wildlife Branch, Ontario Ministry of Natural Resources, Peterborough, Ontario.
- Upsdell, B., Veliz, M., and Jean, K. 2012. Monitoring Ausable River ecosystem recovery with freshwater mussel species at risk. Ausable Bayfield Conservation Authority, Exeter, Ontario. Prepared for Fisheries and Oceans Canada and Ministry of Natural Resources' Species at Risk Stewardship Fund.
- Watters, G.T., Hoggarth, M.A., and Stansbery, D.H. 2009. *The Freshwater Mussels of Ohio*. The Ohio State University Press, Columbus, Ohio.

**Table 1.** Fishes captured at each sampling reach in the Saugeen River watershed. Three sites were sampled within each reach (riffle, run, and pool habitat). Aggregate abundance by location is presented. Individuals identified only to genus or family are not included in species richness, but are included in total abundance. Sites are presented from downstream to upstream order (left to right).

Scientific name	Common name	North Saugeen SGR-05	Teeswater SG11	Main Saugeen SG08	Beatty Saugeen SG04a	Total
<b>CATOSTOMIDAE</b>						
<i>Catostomus commersonii</i>	White Sucker	3	1	-	18	22
<i>Hypentelium nigricans</i>	Northern Hogsucker	-	-	3	-	3
<i>Moxostoma erythrurum</i>	Golden Redhorse	1	1	-	-	2
<i>Moxostoma</i> sp.	Redhorse sp.	19	4	-	-	23
<b>CENTRARCHIDAE</b>						
<i>Micropterus dolomieu</i> **	Smallmouth Bass**	-	-	1	-	1
<b>LEUCISCIDAE</b>						
<i>Leuciscidae</i>	Minnow family	-	2	-	2	4
<i>Luxilus chrysocephalus</i> **	Striped Shiner**	-	-	3	-	3
<i>Luxilus cornutus</i>	Common Shiner	69	-	5	159	233
<i>Luxilus</i> sp.**	Shiner sp. ( <i>Luxilus</i> sp.)**	-	15	-	39	54
<i>Nocomis biguttatus</i>	Hornyhead Chub	16	-	-	-	16
<i>Nocomis micropogon</i>	River Chub	3	2	4	-	9
<i>Notropis photogenis</i> *	Silver Shiner *	2	-	6	-	8
<i>Notropis rubellus</i>	Rosyface Shiner	64	-	19	108	191
<i>Notropis volucellus</i>	Mimic Shiner	-	-	1	1	2
<i>Notropis</i> sp.	Shiner sp. ( <i>Notropis</i> sp.)	-	-	6	-	6
<i>Pimephales notatus</i>	Bluntnose Minnow	3	5	-	15	23
<i>Rhinichthys cataractae</i>	Blacknose Dace	-	-	1	1	2
<i>Semotilus atromaculatus</i>	Creek Chub	26	-	-	21	47
<b>ESOCIDAE</b>						
<i>Esox lucius</i>	Northern Pike	-	1	-	-	1
<b>PERCIDAE</b>						
<i>Etheostoma caeruleum</i> **	Rainbow Darter**	-	2	3	-	5
<i>Etheostoma nigrum</i>	Johnny Darter	-	-	2	13	15
<i>Percina maculata</i>	Blackside Darter	-	-	-	1	1
<b>PETROMYZONTIDAE</b>						
<i>Ichthyomyzon</i> sp.	Juvenile Lamprey ( <i>Ichthyomyzon</i> sp.)	-	-	1	-	1
<b>Total Individuals</b>		<b>206</b>	<b>33</b>	<b>55</b>	<b>378</b>	<b>672</b>
<b>No. species</b>		<b>9</b>	<b>6</b>	<b>11</b>	<b>9</b>	<b>18</b>
<b>No. families represented</b>		<b>2</b>	<b>4</b>	<b>5</b>	<b>3</b>	<b>6</b>

\* SARA-listed species

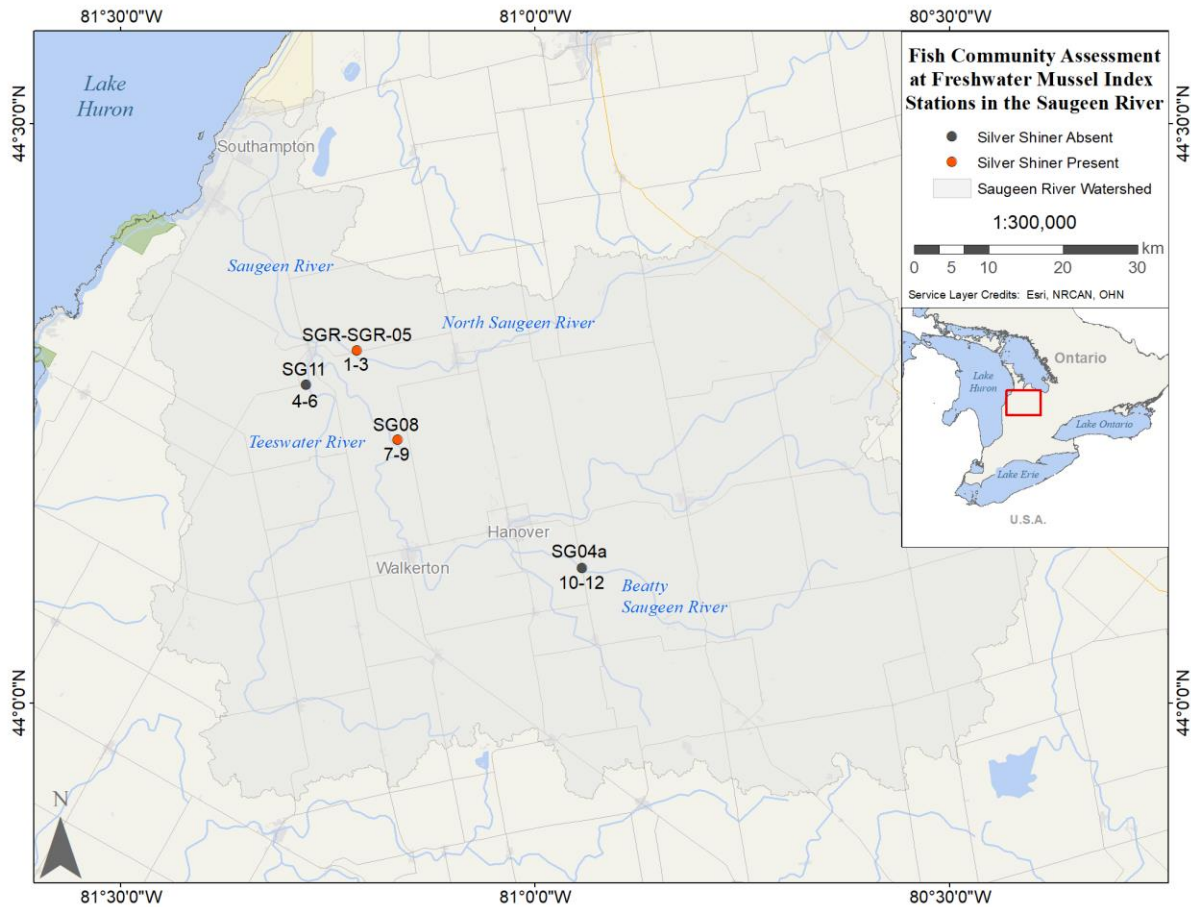
\*\* Host species of Rainbow (*Cambarunio iris*)

**Table 2.** Physical characteristics of the habitat sampled at each sampling reach at mussel index stations. Values presented represent mean values across the three sites (riffle, run, pool) at each freshwater mussel index station in the Saugeen River watershed, 2019. Sites are presented in downstream to upstream order (left to right).

	<b>SGR- SGR-05</b>	<b>SG11</b>	<b>SG08</b>	<b>SG04a</b>	<b>Overall</b>
Air temperature (°C)	26.2	19.5	21.2	19.4	<b>21.6</b>
Water temperature (°C)	19.3	18.2	17.8	15.2	<b>17.6</b>
Conductivity (µS)	371.6	460.2	558.0	432.7	<b>455.6</b>
Dissolved oxygen (mg/L)	10.6	9.6	9.8	10.2	<b>10.1</b>
pH	11.5	9.1	9.2	9.1	<b>9.7</b>
Turbidity (NTU)	11.6	10.2	5.3	1.4	<b>7.1</b>
Water clarity (m)	0.4	0.4	0.9	> 1.2	<b>0.7</b>
Depth (m)	0.2	0.3	0.6	0.5	<b>0.4</b>
Water velocity (m/s)	0.3	0.3	0.2	0.2	<b>0.2</b>
Wetted width (m)	25.0	29.7	48.7	19.3	<b>30.7</b>
Distance from shore (m)	0.0	0.0	6.7	1.3	<b>2.0</b>
Site width (m)	8.0	8.0	8.0	8.0	<b>8.0</b>
Site length (m)	13.3	13.3	12.3	15.0	<b>13.5</b>
Area sampled (m <sup>2</sup> )	107.0	107.0	99.0	120.0	<b>108.0</b>
Total area sampled (m <sup>2</sup> )	320.0	320.0	296.0	360.0	<b>1296.0</b>

**Table 3.** Summary of depth, water velocity, and dominant substrate in the riffles, runs, and pools sampled across four sampling reaches at mussel index stations in the Saugeen River watershed. Three distinct habitat types were targeted at each index station based on these physical characteristics to be sampled.

		<b>Depth (m)</b>	<b>Water velocity (m/s)</b>	<b>Dominant substrate</b>
<b>Riffle</b>	<b>Mean</b>	<b>0.24</b>	<b>0.46</b>	Cobble, gravel
	Range	(0.14 - 0.52)	(0.23 - 0.79)	
<b>Run</b>	<b>Mean</b>	<b>0.66</b>	<b>0.23</b>	Cobble, boulder
	Range	(0.33 - 1.10)	(0.05 - 0.46)	
<b>Pool</b>	<b>Mean</b>	<b>0.37</b>	<b>0.05</b>	Sand, silt
	Range	(0.16 - 1.12)	(0.00 - 0.18)	



**Figure 1.** Freshwater mussel index stations for long-term monitoring in the Saugeen River watershed and the corresponding locations where fish community sampling was conducted in 2019. Three sites representing distinct habitat types (i.e., run, riffle, pool) were sampled using standardized multi-pass seining techniques at each index station. Silver Shiner were detected at fish site IDs 2, 7, 8, and 9. Map labels correspond to mussel index station codes and fish sampling site IDs.



a) SGR-SGR-05



b) SG11

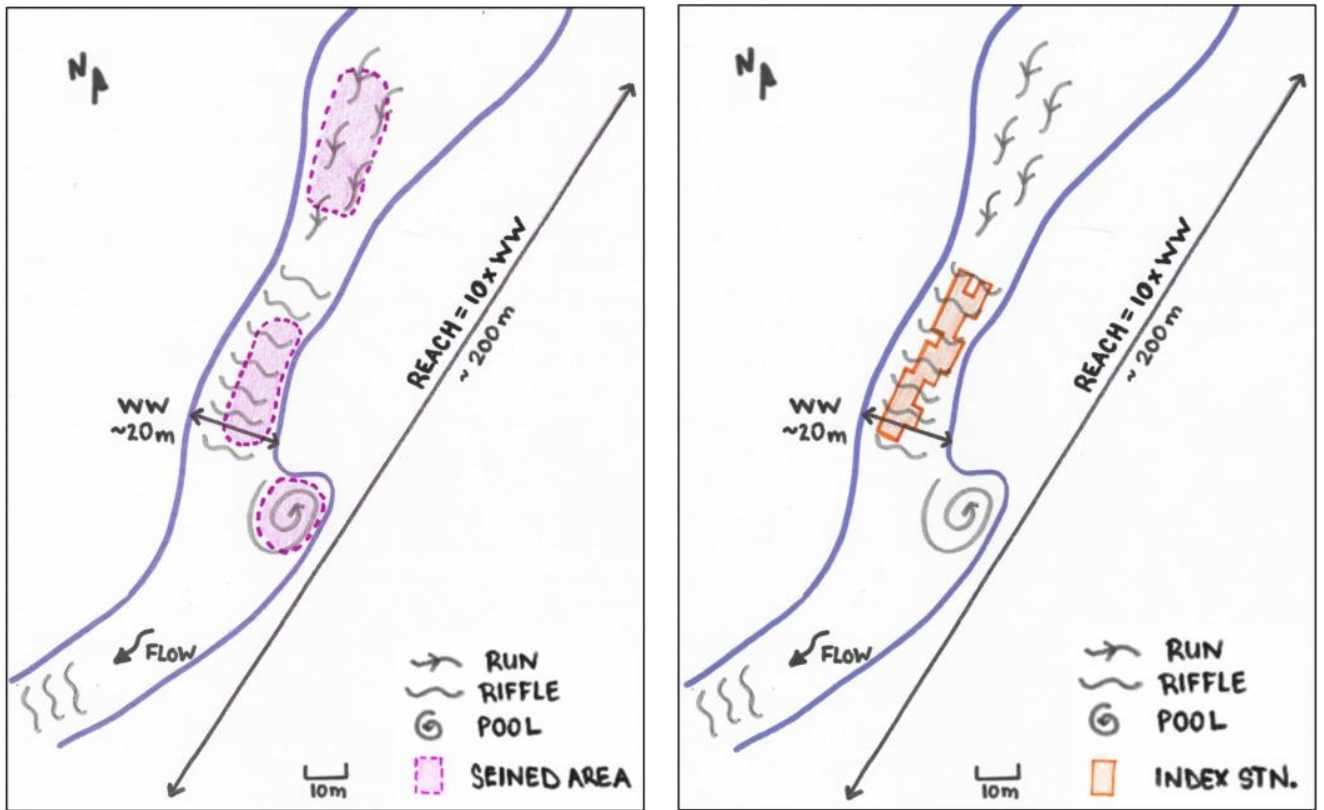


c) SG08



d) SG04a

**Figure 2.** Site photos of the four index stations in the Saugeen River watershed captured during the mussel surveys in 2019.

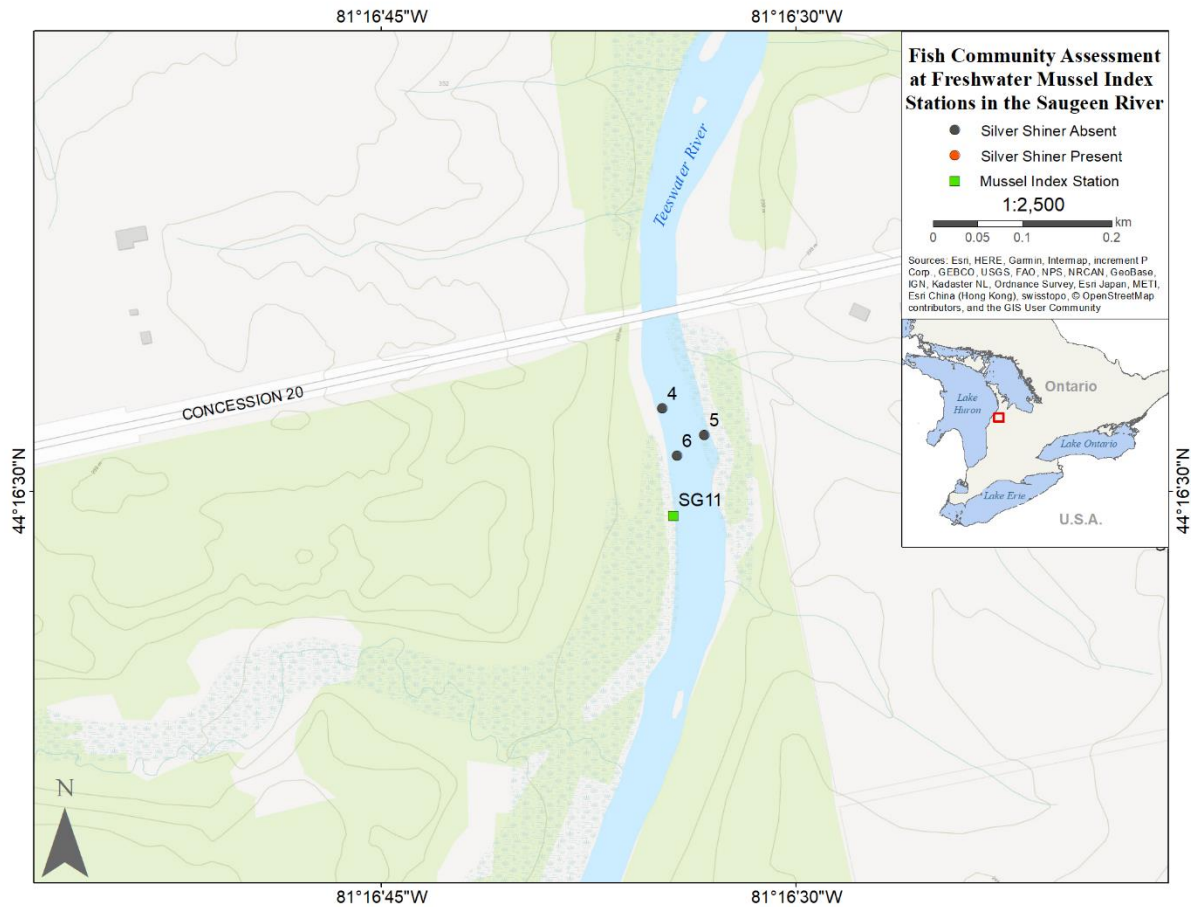


a) Fish community seining sites at three distinct habitat types (run, riffle, pool)

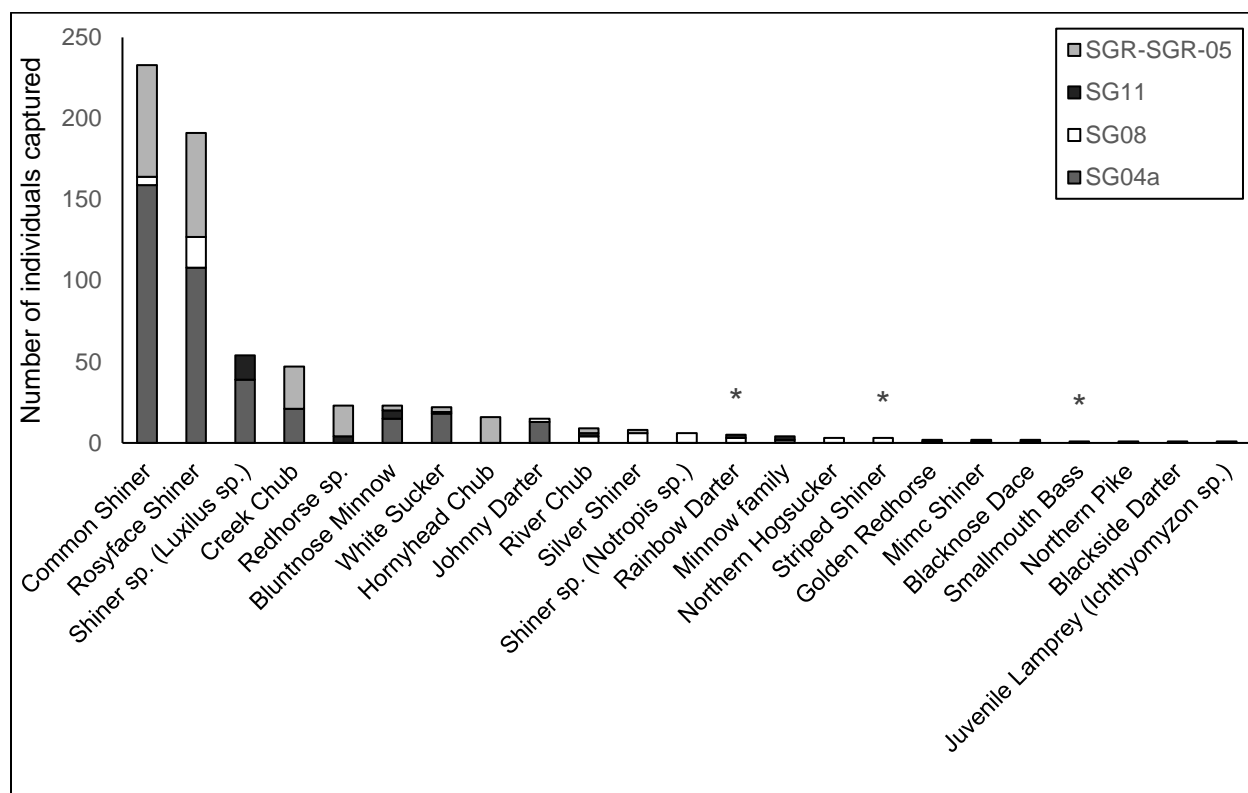
b) Freshwater mussel index site

**Figure 3.** To assess the fish community in the vicinity of freshwater mussel index stations, three seining sites (a) representing distinct habitats were selected from within a sampling reach that contained the index station (b). The length of the reach is 10 x the wetted width (WW) at the index station.





**Figure 4.** Location of three seining sites (4 - riffle, 5 - pool, 6 - run) sampled to assess fish community in relation to location of freshwater mussel index station (SG11) provided as an example to illustrate the proximity of seining sites to mussel station.

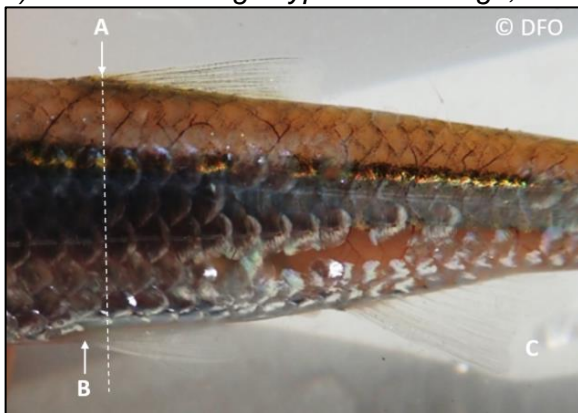


**Figure 5.** Rank abundance of fishes captured (aggregate catch) from three sites in reaches surrounding each of four freshwater mussel index stations in the Saugeen River watershed, 2019. Asterisks (\*) indicate known host fishes for SARA-listed Rainbow mussel.





a) lateral view: large cyprinid with large, silvery scales and dorsal fin set well back

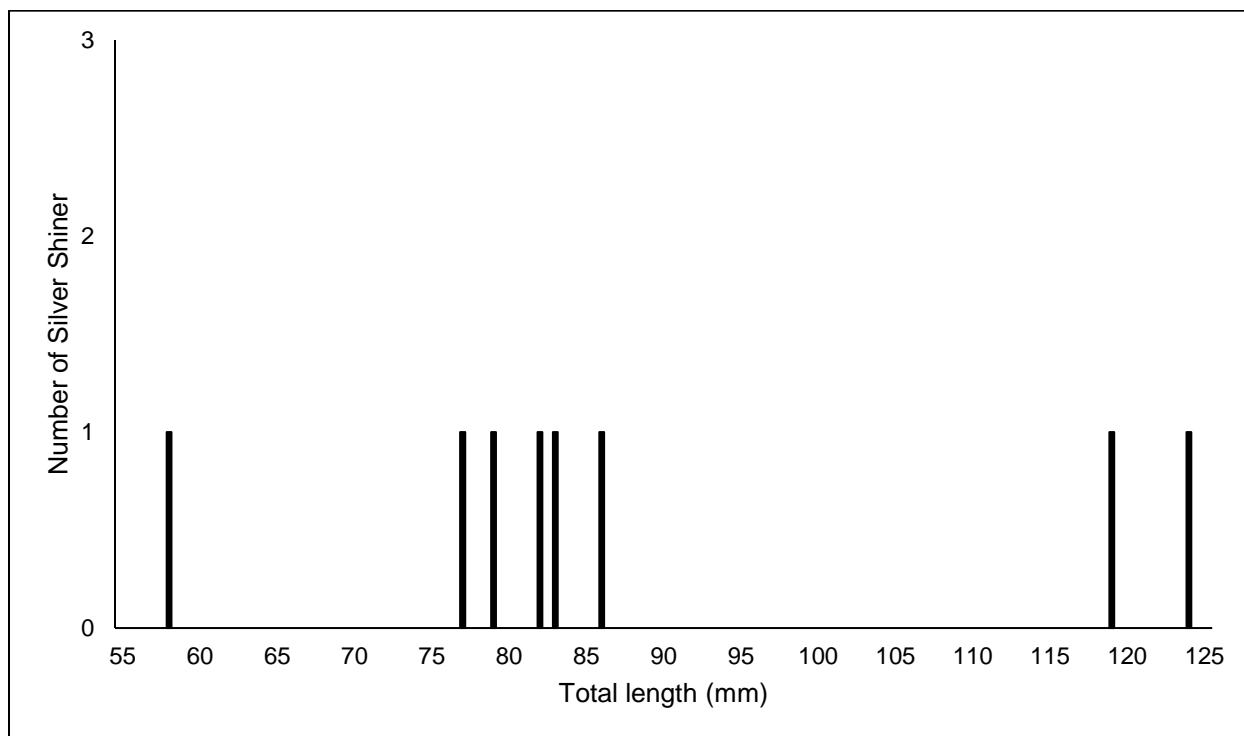


b) dorsal insertion (A) within pelvic fin base (B), and long anal fin with more than eight rays (C)



c) Dorsal view: dark crescents between nostrils and dark mid-dorsal stripe

**Figure 6.** Voucher photos of 124 mm Silver Shiner (*Notropis photogenis*) captured in the run at SGR-SGR-05 mussel index station in the North Saugeen River, 2019, indicating key identification features (Holm et al. 2010).



**Figure 7.** Length-frequency of Silver Shiner captured in the Saugeen River watershed, 2019 ( $n=8$ ).

**Appendix A.** Site details for freshwater mussel index stations (latitude and longitude taken at downstream, left corner of area of mussel quadrat survey). Index stations are presented in downstream to upstream order (top to bottom). Each fish community sampling reach was selected to contain a freshwater mussel index station.

Index station	Latitude	Longitude	Watershed	Waterbody	Local description
SGR-SGR-05	44.30453	-81.21513	Saugeen	North Saugeen River	County Rd. 11 bridge crossing; East of Paisley
SG11	44.27482	-81.27623	Saugeen	Teeswater River	Concession Rd. 20 bridge crossing
SG08	44.22752	-81.16566	Saugeen	Main Saugeen River	Concession 10 bridge crossing; West of Elmwood
SG04a	44.11671	-80.94362	Saugeen	Beatty Saugeen River	~300 m upstream of Grey Rd. 3 bridge crossing; near Neudstadt

**Appendix B.** Site specific details for fish sampling sites in the Saugeen River watershed in 2019 (latitude and longitude taken at upstream extent of seined area). Three fish sampling sites representing three distinct habitats were sampled within a sampling reach, identified by the mussel index station the reach contains. Sites are presented in downstream to upstream order (top to bottom).

Reach	Site ID	Field number	Latitude	Longitude	Date fishes sampled	Local description	Habitat type	River width (m)	Distance from shore (m)	Site width (m)	Site length (m)	Sampled area (m <sup>2</sup> )
SGR- SGR-05	1	2019-MFCA-170919-004A	44.30420	-81.21539	17-Sep-19	Immediately d/s Bruce Rd 11 bridge (right bank)	Riffle	25	0	8	15	120
SGR- SGR-05	2	2019-MFCA-170919-005A	44.30404	-81.21534	17-Sep-19	Below and immediately d/s Bruce Rd 11 bridge - left bank	Run	25	0	8	15	120
SGR- SGR-05	3	2019-MFCA-170919-006A	44.30400	-81.21546	17-Sep-19	Under Bruce Rd 11 bridge - right bank	Pool	25	0	8	10	80
SG11	4	2019-MFCA-170919-003A	44.27559	-81.27634	17-Sep-19	~75 m u/s Concession 20	Riffle	55	0	8	15	120
SG11	5	2019-MFCA-170919-001A	44.27540	-81.27592	17-Sep-19	~100 m u/s Concession 20 behind island	Pool	9	0	8	10	80
SG11	6	2019-MFCA-170919-002A	44.27525	-81.27619	17-Sep-19	~125 m u/s Concession 20	Run	25	0	8	15	120
SG08	7	2019-MFCA-160919-005A	44.22696	-81.16565	16-Sep-19	~30 m d/s Concession 10	Run	44	15	8	15	120
SG08	8	2019-MFCA-160919-004A	44.22684	-81.16558	16-Sep-19	~20 m d/s Concession 10	Pool	44	0	8	10	80
SG08	9	2019-MFCA-160919-006A	44.22667	-81.16556	16-Sep-19	under Concession 10 bridge	Riffle	58	5	8	12	96
SG04a	10	2019-MFCA-160919-001A	44.11737	-80.94443	16-Sep-19	~40 m d/s of Grey Rd. 3 bridge	Riffle	20	0	8	15	120
SG04a	11	2019-MFCA-160919-002A	44.11721	-80.94373	16-Sep-19	Backwater immediately u/s of Grey Rd. 3 bridge	Pool	22	0	8	15	120
SG04a	12	2019-MFCA-160919-003A	44.11707	-80.94305	16-Sep-19	Mid-channel u/s of Grey Rd. 3 bridge	Run	16	4	8	15	120

**Appendix C.** Fish community sampling results indicating the total number of each species captured at each fish sampling site in four river reaches in the Saugeen River watershed, 2019. Reach is identified by the freshwater mussel index station contained within the reach. Bin number is the first, second, or third consecutive seine haul.

Reach	Site ID	Bin number	<i>Catostomus commersonii</i>	Cyprinidae	<i>Esox lucius</i>	<i>Etheostoma caeruleum</i>	<i>Etheostoma nigrum</i>	<i>Hypentelium nigricans</i>	<i>Ichthyomyzon</i> sp.	<i>Luxilus chrysocephalus</i>	<i>Luxilus cornutus</i>	<i>Luxilus</i> sp.	<i>Micropterus dolomieu</i>	<i>Moxostoma erythrurum</i>	<i>Moxostoma</i> sp.	<i>Nocomis biguttatus</i>	<i>Nocomis micropogon</i>	<i>Notropis photogenis</i>	<i>Notropis rubellus</i>	<i>Notropis</i> sp.	<i>Notropis volucellus</i>	<i>Percina maculata</i>	<i>Pimephales notatus</i>	<i>Rhinichthys cataractae</i>	<i>Semotilus atromaculatus</i>
SGR-SGR-05	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0
SGR-SGR-05	1	2	0	0	0	0	0	0	0	0	8	0	0	0	0	2	1	0	2	0	0	0	0	0	0
SGR-SGR-05	1	3	0	0	0	0	0	0	0	0	4	0	0	0	0	0	1	0	2	0	0	0	0	0	0
SGR-SGR-05	2	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	11	0	0	0	0	0	1
SGR-SGR-05	2	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	9	0	0	0	0	0	0
SGR-SGR-05	2	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SGR-SGR-05	3	1	1	0	0	0	0	0	0	0	43	0	0	1	10	13	0	0	28	0	0	0	3	0	24
SGR-SGR-05	3	2	1	0	0	0	0	0	0	0	5	0	0	0	2	1	0	0	1	0	0	0	0	0	0
SGR-SGR-05	3	3	1	0	0	0	0	0	0	0	5	0	0	0	7	0	0	0	2	0	0	0	0	0	1
SG11	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SG11	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SG11	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SG11	5	1	1	0	0	0	0	0	0	0	0	8	0	1	4	0	0	0	0	0	0	0	3	0	0
SG11	5	2	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	2	0	0
SG11	5	3	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SG11	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SG11	6	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SG11	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SG08	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
SG08	7	2	0	0	0	1	0	0	0	1	2	0	0	0	0	0	0	2	4	0	0	0	0	0	0
SG08	7	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	3	0	0	0	0	0	0
SG08	8	1	0	0	0	0	2	2	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0

Reach	Site ID	Bin number	<i>Catostomus commersonii</i>	<i>Cyprinidae</i>	<i>Esox lucius</i>	<i>Etheostoma caeruleum</i>	<i>Etheostoma nigrum</i>	<i>Hypentelium nigricans</i>	<i>Ichthyomyzon</i> sp.	<i>Luxilus chrysocephalus</i>	<i>Luxilus cornutus</i>	<i>Luxilus</i> sp.	<i>Micropterus dolomieu</i>	<i>Moxostoma erythrurum</i>	<i>Moxostoma</i> sp.	<i>Nocomis biguttatus</i>	<i>Nocomis micropogon</i>	<i>Notropis photogenis</i>	<i>Notropis rubellus</i>	<i>Notropis</i> sp.	<i>Notropis volucellus</i>	<i>Percina maculata</i>	<i>Pimephales notatus</i>	<i>Rhinichthys cataractae</i>	<i>Semotilus atromaculatus</i>
SG08	8	2	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	
SG08	8	3	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	
SG08	9	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	8	0	0	0	1	0	
SG08	9	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
SG08	9	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	6	1	0	0	0	
SG04a	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
SG04a	10	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
SG04a	10	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
SG04a	11	1	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	19	0	0	1	0	0	
SG04a	11	2	4	0	0	0	0	0	0	0	73	6	0	0	0	0	0	0	32	0	1	0	6	0	
SG04a	11	3	14	0	0	0	12	0	0	0	33	28	0	0	0	0	0	0	27	0	0	0	9	14	
SG04a	12	1	0	2	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	
SG04a	12	2	0	0	0	0	0	0	0	0	53	0	0	0	0	0	0	0	28	0	0	0	0	0	
SG04a	12	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	

**Appendix D.** Total length (TL, mm) of all Silver Shiner (*Notropis photogenis*), a SARA-listed Threatened species, captured in the Saugeen River watershed, 2019.

Site ID	Field number	Bin number	Silver Shiner TL (mm)
2	2019-MFCA-170919-005A	2	83
2	2019-MFCA-170919-005A	2	124
7	2019-MFCA-160919-005A	2	82
7	2019-MFCA-160919-005A	2	119
8	2019-MFCA-160919-004A	3	58
8	2019-MFCA-160919-004A	3	86
9	2019-MFCA-160919-006A	1	79
9	2019-MFCA-160919-006A	3	77

**Appendix E.** Physical characteristics of habitat at each site (n=12) sampled for fishes within four river reaches in the Saugeen River watershed, 2019. Reach is identified by the freshwater mussel index station contained within the reach.

<u>Reach:</u>		<u>SGR-SGR-05</u>			<u>SG11</u>			<u>SG08</u>			<u>SG04a</u>		
<b>Fish sampling site:</b>		<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>
Habitat Type		<i>Riffle</i>	<i>Run</i>	<i>Pool</i>	<i>Riffle</i>	<i>Pool</i>	<i>Run</i>	<i>Run</i>	<i>Pool</i>	<i>Riffle</i>	<i>Riffle</i>	<i>Pool</i>	<i>Run</i>
Air temperature (°C)		23.70	26.00	28.80	20.90	17.40	20.30	21.20	21.20	21.20	18.90	20.40	18.90
Water temperature (°C)		19.30	19.35	19.34	18.21	18.14	18.21	17.77	17.78	17.78	15.13	15.18	15.19
Conductivity (µS)		371.20	371.50	372.00	463.00	456.50	461.00	558.00	558.00	558.00	431.60	433.00	433.40
Dissolved oxygen (mg/L)		10.55	10.69	10.49	9.59	9.90	9.35	9.83	9.83	9.83	10.17	10.26	10.28
pH		11.20	10.38	12.80	9.05	9.17	9.07	9.09	9.11	9.43	9.25	9.08	8.99
Turbidity (NTU)		10.80	10.97	13.00	11.45	8.40	10.77	5.26	5.64	5.11	1.37	1.37	1.47
Secchi tube (m)		0.38	0.38	0.38	0.37	0.37	0.37	0.86	0.86	0.86	> 1.20	> 1.20	> 1.20
Depth (m) 1		0.14	0.36	0.21	0.25	0.24	0.42	1.10	0.58	0.52	0.18	0.34	0.78
Depth (m) 2		0.17	0.37	0.16	0.22	0.29	0.40	0.91	1.12	0.21	0.27	0.30	0.99
Depth (m) 3		0.16	0.33	0.32	0.27	0.27	0.57	0.80	0.36	0.23	0.23	0.27	0.83
Water velocity (m/s) 1		0.23	0.45	0.18	0.79	0.00	0.29	0.14	0.01	0.26	0.43	0.00	0.12
Water velocity (m/s) 2		0.33	0.46	0.11	0.50	0.04	0.19	0.12	0.03	0.71	0.40	0.01	0.06
Water velocity (m/s) 3		0.27	0.36	0.11	0.46	0.00	0.24	0.23	0.07	0.44	0.67	0.00	0.05
Substrate	Organic (%)	0	0	5	0	0	0	0	5	0	0	0	0
	Clay (%)	0	0	0	0	0	0	0	5	0	0	0	0
	Silt (%)	5	10	20	0	20	0	0	5	0	5	50	5
	Sand (%)	15	10	35	0	20	10	5	70	5	0	5	0
	Gravel (%)	20	15	20	10	20	20	10	10	30	10	20	10
	Cobble (%)	55	15	10	80	40	30	35	5	45	80	20	75
	Boulder (%)	5	10	5	10	0	40	50	0	20	5	5	10
	Bedrock (%)	0	0	0	0	0	0	0	0	0	0	0	0
	Hardpan (%)	0	0	0	0	0	0	0	0	0	0	0	0
	Rubble (%)	0	0	0	0	0	0	0	0	0	0	0	0
	Concrete (%)	0	40*	5*	0	0	0	0	0	0	0	0	0



<b>Reach:</b>		<b><u>SGR-SGR-05</u></b>			<b><u>SG11</u></b>			<b><u>SG08</u></b>			<b><u>SG04a</u></b>		
<b>Fish sampling site:</b>		<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>
Aquatic vegetation	Emergent (%)	0	0	0	0	0	0	0	0	0	0	5	0
	Floating (%)	0	0	0	0	0	0	0	0	0	0	0	0
	Submerged (%)	0	0	0	0	0	0	0	0	0	0	0	0
	Open Water (%)	100	100	100	100	100	100	100	100	100	100	95	100
Riparian vegetation	Deciduous (%)	0	5	0	0	0	0	0	0	0	0	0	0
	Coniferous (%)	0	0	0	0	0	0	0	0	0	0	0	0
	Herbaceous (%)	100	5	5	95	100	95	100	100	95	100	95	85
	Shrubs (%)	0	0	0	0	0	0	0	0	0	0	0	10
	None (%)	0	90	95	5	0	5	0	0	5	0	5	5

\*Box culvert