Results from freshwater mussel brail sampling in non-wadeable habitats of four southwestern Ontario rivers

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2023

Canadian Data Report of
Fisheries and Aquatic Sciences 1377

Fisheries and Oceans Canada | Pêches et Océans Canada

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Canadian Data Report of Fisheries and Aquatic Sciences

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Cat. No. Fs97-13/1377E-PDF ISBN 978-0-660-68188-7 ISSN 1488-5395

Correct citation for this publication:

LeBaron, A., Hassal, E., and Reid, S.M. 2023. Results from freshwater mussel brail sampling in non-wadeable habitats of four southwestern Ontario rivers. Can. Data Rep. Fish. Aquat. Sci. 1377: viii + 74 p.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

LeBaron, A., Hassal, E., and Reid, S.M. 2023. Results from freshwater mussel brail sampling in non-wadeable habitats of four southwestern Ontario rivers. Can. Data Rep. Fish. Aquat. Sci. 1377: viii + 74 p.

Mussel surveys of Ontario rivers have largely been limited to habitats suitable for wading or snorkelling. In 2019 and 2022, surveys of deeper, non-wadeable habitats using a mussel brail were done along four southwestern Ontario rivers. Forty-eight sites along the lower Grand River were sampled. In total, 729 live individuals were collected, representing 15 species. Live individuals of three species at risk were collected: Mapleleaf (*Quadrula quadrula*; n = 83), Round Pigtoe (*Pleurobema sintoxia*; n = 42), and Threehorn Wartyback (*Obliquaria reflexa*; n = 7). Thirty-four sites were sampled along the lower Thames River. Sixty-eight live individuals were collected, representing 13 species. Live individuals of three species at risk were collected: Mapleleaf (n = 15), Threehorn Wartyback (n = 3), and Fawnsfoot (*Truncilla donaciformis*; n = 2). Thirty-seven sites were sampled along the east and north branches of the Sydenham River. In total, 45 live individuals were collected, representing 10 species. Live individuals of two species at risk were collected: Mapleleaf (n = 8) and Kidneyshell (*Ptychobranchus fasciolaris*; n = 1). Twenty-three sites were sampled along the Ausable River. Forty-nine live individuals were collected, representing 4 species. Live individuals of Mapleleaf (n = 3) were collected. Results indicate brail sampling can complement existing river sampling methods.

RÉSUMÉ

LeBaron, A., Hassal, E., and Reid, S.M. 2023. Results from freshwater mussel brail sampling in non-wadeable habitats of four southwestern Ontario rivers. Can. Data Rep. Fish. Aquat. Sci. 1377: viii + 74 p.

De façon générale, les relevés ciblant les moules dans les cours d'eau de l'Ontario n'ont été réalisés que dans des milieux propices à l'échantillonnage à gué ou à la plongée avec tuba. En 2019 et en 2022, on a utilisé une épuisette à moules pour réaliser des relevés dans des milieux plus profonds et non propices à l'échantillonnage à gué situés dans quatre rivières du sud-ouest de l'Ontario. On a échantillonné 48 sites du cours inférieur de la rivière Grand. Au total, on y a recueilli 729 individus vivants de 15 espèces différentes, dont trois espèces en péril, soit la mulette feuille d'érable (*Quadrula quadrula*; n = 83), la pleurobème écarlate (*Pleurobema sintoxia*; n = 42) et l'obliquaire à trois cornes (*Obliquaria reflexa*; n = 7). On a aussi échantillonné 34 sites du cours inférieur de la rivière Thames. On y a recueilli 68 individus vivants de 13 espèces différentes, dont trois espèces en péril, soit la mulette feuille d'érable (n = 15), l'obliquaire à trois cornes (n = 3) et la troncille pied-de-faon (*Truncilla donaciformis*; n = 2). On a échantillonné 37 sites des bras est et nord de la rivière Sydenham. Au total, on y a recueilli 45 individus vivants de 10 espèces différentes, dont deux espèces en péril, soit la mulette feuille d'érable (n = 8) et le ptychobranche réniforme (*Ptychobranchus fasciolaris*; n = 1). On a également échantillonné 23 sites de la rivière Ausable. On y a recueilli 49 individus vivants de quatre espèces différentes, notamment des mulettes feuilles d'érable (n = 3). Les résultats indiquent que l'utilisation d'une épuisette à moules peut compléter les méthodes existantes d'échantillonnage dans les cours d'eau.

INTRODUCTION

In Canada, there are 55 native freshwater mussel species with 41 species occurring in the province of Ontario (Metcalfe-Smith et al. 2005). More than a third of these species in Ontario are listed as Endangered, Threatened, or of Special Concern under the federal Species at Risk Act and the provincial Endangered Species Act (COSEWIC 2016; MNRF 2019). Catastrophic declines to the Ontario mussel fauna occurred after the introduction (and subsequent spread) of non-native dreissenid mussels (Zebra Mussel, *Dreissena polymorpha*; and Quagga Mussel, *D. bugensis*) to the Laurentian Great Lakes (Schloesser and Nalepa 1994). In contrast, most Ontario rivers are not heavily infested by dreissenids and the historical mussel diversity is largely intact (Clarke 1992; Reid and Morris 2017). Recovery strategies have been developed to conserve remnant mussel diversity (DFO 2013a,b, DFO 2019). Actions undertaken include surveys and the establishment of population index monitoring stations in rivers. Data collected through these activities are essential for delineating areas of protected habitat, assessing population status and trends, and evaluating the effectiveness of recovery actions (Cudmore et al. 2006; DFO 2011).

The testing and application of gear to sample non-wadeable riverine habitats are required to delineate areas of protected habitat for mussel species at risk. To date, mussel surveys of river habitats have largely been limited to those suitable for wading or snorkelling (i.e. less than 1 m deep). For these habitat types, sampling protocols (timed-search and quadrat-based) have been developed to survey and monitor mussel species at risk populations (Metcalfe-Smith et al. 2000, Smith et al. 2001, Reid et al. 2014). However, sampling protocols are required for deeper (and more practically challenging) habitats so that critical habitat descriptions (extent and functional attributes) can be refined, and the status of mussel populations associated with deeper habitats can be monitored. Examples of methods used to collect mussels from non-wadeable habitats include the basket dredge, mussel brail (or crowfoot bar), Ponar grab, and sampling by divers (Strayer and Smith 2003). Diving-based sampling collects greater numbers of freshwater mussels (and is considered to be less size-biased) than the mussel brail. However, safety issues and sampling costs can limit its application to detect and monitor freshwater mussel species at risk across large stretches of river. Strong river currents and poor visibility can also limit the effectiveness of divers (Dolson et al. 2023).

The mussel brail was first used in 1897 to commercially harvest freshwater mussels from the upper Mississippi River and its tributaries (Coker 1919). Later, the gear was used by biologists working in large rivers to locate mussel beds and describe mussel assemblages. Such efforts were used to direct more quantitative sampling completed by SCUBA divers (Thiel 1981). The brail is a wooden or metal bar with gangs of multi-pronged hooks attached by either chain or rope (Figure 1). Brails used for inventories are smaller (~ 2.4 to 3.0 m long) than those typically used to commercially harvest (> 6.1 m long) freshwater mussels. The brail is towed behind a boat moving slowly downstream over mussel beds. When the hooks encounter open shells, the mussels close their valves tightly on the prongs and are pulled from the riverbed. Only individuals at the surface of the riverbed with their valves open (i.e. actively siphoning) are vulnerable to capture. The brail can be made more selective for larger individuals by increasing the width of wire used to construct hooks, or by adding a bead of material to the tip of hooks (Sparks and Blodgett 1983). Past brail-sampling of mussel shoals along the upper Mississippi River has resulted in the collection of several species assessed as “at risk” in Ontario (e.g. Hickorynut (*Obovaria olivaria*), Lilliput (*Toxolasma parvum*), Mapleleaf (*Quadrula quadrula*) *and* Purple Wartyback (*Cyclonaias tuberculata*)) (Thiel 1981).

This data report presents the methods and results of brail-based surveys undertaken along the lower reaches of four southwestern Ontario rivers. In 2019, mussel brail sampling was done along the lower Grand River to evaluate the effectiveness of the gear to collect freshwater mussels from non-wadeable habitats, characterize spatial variation in mussel distribution, and test for seasonal differences in mussel collections (early summer vs autumn). Based on the success of Grand River sampling, brail-based sampling was also carried out along the Sydenham, Thames, and Ausable rivers in 2022. Project results support the following research and monitoring objectives:

- Recovery Strategy for Round Hickorynut and Kidneyshell: Prepare a distribution map of areas of suitable habitat (currently occupied and unoccupied) (DFO 2013a).
- Mapleleaf Recovery Strategy: Establish long-term quantitative surveys to monitor changes in the distribution and abundance of extant populations of Mapleleaf (DFO 2018).
- Recovery Strategy for the Wavy-rayed Lampmussel in Ontario: Conduct further surveys to determine the extent and abundance of the Ausable River, Grand River, and Thames River populations (Morris 2011).
- Recovery Strategy and Action Plan for the Fawnsfoot (*Truncilla donaciformis*) and Threehorn Wartyback (*Obliquaria reflexa*) in Canada: Conduct further surveys within the historical distribution to detect remnant populations. Determine extent and abundance of any newly discovered remnant populations (DFO 2022).
- Recovery Strategy for Northern Riffleshell, Snuffbox, Round Pigtoe, Salamander Mussel, and Rayed Bean in Canada: Determine extent, abundance and population demographics of existing populations (DFO 2019).

METHODS

STUDY RIVERS

The Grand River was chosen as the location for initial gear testing due to high mussel diversity and ease of navigation along the lower reaches. Habitat from Brantford to the mouth at Port Maitland is typically too deep to be sampled with widely applied survey methods (e.g. timed-searches, quadrat-based surveys). The Thames, Sydenham (east and north branches), and Ausable rivers were chosen for subsequent surveys in 2022 due to their large size and high diversity of mussel species, including many species at risk. Like the Grand River, the lower reaches of these rivers are too deep to be sampled by other methods, therefore sampling will help fill knowledge gaps related to species distributions and critical habitat. Minimum, maximum and median discharge and water levels for the Grand River over the course of the 2019 sampling periods are provided in Table 1. Minimum, maximum, and median water levels for the Thames, Sydenham, and Ausable rivers over the course of the 2022 sampling periods are provided in Table 2.

SITE SELECTION

In consultation with DFO Science, navigable reaches of each river were identified and targeted for sampling (J. Barnucz, personal communications). Using ArcMap 10.3.1, locations of potential sampling sites were generated (Construct Points using the Edit tool) along the length of the river at 200 m intervals. A random number generator was used to select a subset of these points for sampling (Grand River, n = 48; Thames River, n = 34; Sydenham River, n = 37,

Ausable River, n = 23). Additional random numbers were listed to replace sites that could not be sampled, or to add additional sites. Sites located in reaches with limited access or navigability (J. Barnucz, personal communications) were removed from the list. Additional sites were abandoned if they were too deep (> 5 m) or too shallow (< 1 m) to sample. Site locality information can be found in Appendices 1 – 5.

MUSSEL AND HABITAT SAMPLING

A spatially replicated transect design was adopted to standardize sampling across study sites. Other researchers have used spatial replicates and occupancy-based models to: (1) estimate species-specific detection probabilities; and (2) adjust for the influence of imperfect detection on indices of species distribution (Lamothe et al. 2021).

Sampling was done from a 5.5 m jon boat with a 40 hp motor. Each site was sampled with one to five parallel tows (50 m long) of the brail (1.9 m bar, 0.3 m diameter wheels, 24 x 0.75 m towlines, each with clusters of 6 crowfeet; approximately 1.5 mm in diameter with 2.5 mm-diameter beads on ends) spaced evenly across the width of the channel (Figure 2). The number of transects at each site varied across rivers. The number of transects was dependent upon the amount of sampleable habitat available across the channel, and constrained by the requirement to separate transects by a minimum of 10 m to avoid re-sampling the same habitat. On the Grand River, all sites were wide enough to allow for five transects. However, at sites where mid-channel transects were > 5 m in depth, transects were stacked along the shoreline in varying configurations (see notes in Appendix 1 and 2). Along the Thames, Sydenham, and Ausable rivers, it was rarely possible to fit five transects across the sampleable width of the channel, therefore the number of transects ranged from one to five. At most sites where only one or two transects were sampled, multiple passes were carried out along one transect: if the site had two transects, one was randomly selected and trawling was repeated over the same habitat until two passes in a row yielded no catch, up to a maximum of five passes (see notes in Appendices 3-5). Multiple pass sampling was done to increase the likelihood of detecting species, and to assess the potential of improving species detection by increasing effort at individual transects.

Upon arrival at a site, general water depths were observed and major obstructions identified across the channel using a Garmin® Echomap™ Plus 95 SV Sonar Unit, equipped with GPS receiver, Garmin® ClearVü™ and SideVü™ technology. Floats were used to mark the upstream and downstream limits of each sampling transect. Prior to deploying the brail, water depths and potential hazards along each transect were evaluated using sonar. Transects were moved slightly left or right to avoid obstructions. The length of towlines was adjusted based on transect water depth (towline length = 7 × water depth (m); Bonar et al. 2009).

Sampling was done in a downstream direction travelling from the transect start (upstream) to the transect end (downstream). The boat travelled upstream approximately 30 m past the transect prior to brail deployment. The boat then moved in reverse towards the transect start. At the upstream float, the brail was dropped into the water. Once the lines were tight, a GPS stopwatch was started to track time/distance traveled. A speed of 2-3 km/h was maintained while brailing. Once 50 m was travelled, the boat was put into neutral while two crew members pulled in the brail (Figure 3). The bar was set on the bow, and the towlines secured to the cleats. Live mussels and shells were carefully removed from crowfeet.

Live individuals and shells were identified to species (Metcalfe-Smith et al. 2005) and kept in buckets of water until all transects at a site were complete (one bucket per transect). Shell length (mm) of all live individuals was measured along the longest anteroposterior axis using analog calipers. Shells were classified as single weathered valves (WV), weathered whole

(WW) or fresh whole (FW). Fresh shells typically had tissue remaining and shiny nacre, whereas weathered shells had chalky nacre and weathered periostracum (Morris et al. 2022). Sex was recorded for species exhibiting sexual dimorphism. Shells and digital pictures were kept as vouchers. All live individuals were returned to the river at the same sampling site.

Wetted channel width (m) was measured at each site, perpendicular to the bank, using a Leupold® RX Full Draw 2 rangefinder. Site location (latitude, longitude) was determined using a Garmin® Montana 680 handheld GPS unit.

Riverbed material was sampled using a Wildco® Petite Ponar™ benthic grab (15 cm x 15 cm) (Figure 4) at the midpoint of each transect. The percent composition of each sample was assessed visually (based on size) and by texture (for clay and organics). Bed material size categories were as follows: clay (<0.002mm), silt (0.002-0.05mm), sand (0.5-2mm), gravel (0.2-8cm), cobble (8-25cm), rubble (25-60cm), and boulder (>60cm) (OMNR 2015). One grab sample was assessed for each transect (Barnucz and Drake 2021). While only sampling a small fraction of the sampling site, the method is expected to provide information suitable for characterizing among site variation in habitat condition.

Site-specific habitat characteristics are provided in Appendices 6-10. A field sheet template is provided in Appendix 11.

SAMPLING PERMITS AND DATA ARCHIVING

Sampling for this project was conducted under Species at Risk Act Permit numbers 19-PCAA-00021 and 22-PCAA-00022. Data associated with the collections in this report are housed in the Mussel Brail Trawl database within the Ontario Ministry of Natural Resource and Forestry's Aquatic Endangered Species Lab. Every effort has been made to ensure the accuracy of data contained in this report; however, results may be updated as part of ongoing data verification procedures. Data associated with this report may be obtained by contacting the MNRF's Aquatic Endangered Species Lab.

RESULTS

Common and scientific names for all mussels captured during this study are provided in Appendix 12. Photos of all live mussel species can be found in Appendices 13 and 14.

Grand River

In the summer of 2019 (June 11 to July 19), 48 sites with 5 transects each were sampled along 94 km of the lower Grand River between Cockshutt Bridge in Brantford and the mouth of the river at Port Maitland (Figure 5). The reach between Caledonia and Cayuga (approximately 18 km) was not sampled because it was not navigable. In autumn (September 23 to October 9), 45 sites were resampled. Two sites were not resampled due to issues of access/navigability, and a third site was not resampled as it was in a wetland off the main channel and was deemed to be less comparable to the other sites. Channel widths at sampling sites ranged from 65 to 545 m. Water depths sampled ranged from 0.5 to 5.1 m. The composition of riverbed material varied longitudinally. Gravel and sand riverbed material was more dominant along the upstream reaches, whereas a mix of clay and silt was more prevalent along the lower reaches.

In total, 729 live individuals (representing 15 species) were collected by the brail. Shell lengths of live individuals ranged from to 5 to 166 mm (Figure 6, Table 3). In some cases, juvenile mussels (< 14 mm) were collected along with vegetation or inside shells pulled in by the brail. Overall, the most abundant and widespread species were: Mucket (*Ortmanniana ligamentina*: 35.4 and 19.5% of total catch in summer and autumn, respectively), Threeridge

(*Amblema plicata*: 26.2 and 21.8% of total catch in summer and autumn, respectively), and Mapleleaf (11.4 and 11.3% of total catch in summer and autumn, respectively). Table 4 provides frequency of occurrence and relative abundance of each species by sample season. Species counts per site are provided in Appendix 15.

Compared to autumn, four times more individuals (mean: 12.4 vs 3.0 individuals per site) and twice as many species (mean: 2.8 vs 1.5 species per site) were detected during summer sampling. Live individuals were collected from 94% of sites and 53% of transects in the summer. Live individuals were collected from 64% of sites and 28% of transects in the autumn. Most species were detected (as live individuals) during both seasons, except for: Fragile Papershell (*Potamilus fragilis*: 1 individual) which was detected during summer sampling only, and; Deertoe (*Truncilla truncata*: 2 individuals) which was detected during autumn sampling only.

Three species collected from the Grand River exhibit sexual dimorphism: Black Sandshell (*Ligumia recta*), Fatmucket (*Lampsilis siliquoidea*), and Plain Pocketbook (*Lampsilis cardium*). Black Sandshell collected in summer were 49% male and 45% female (6% unknown); those collected in autumn were 58% male and 42% female. Fatmucket collected in summer were 61% male and 21% female (18% unknown); those collected in autumn were 70% male and 10% female (20% unknown). Plain Pocketbook collected in summer were 63% male and 38% female; of the two collected in autumn, one was male and the other was unknown. Numbers of individuals of each sex by season are presented in Table 5.

Live individuals of three species at risk were collected during sampling. Eighty-three live Mapleleaf and 17 shells were collected from 31 sites distributed along 67 km of the Grand River. Shell lengths ranged from 33 to 119 mm. Forty-two live Round Pigtoe (*Pleurobema sintoxia*) and 4 shells were collected from 12 sites distributed along 42 km of the river. Shell lengths ranged from 57 to 107mm. Seven live Threehorn Wartyback (*Obliquaria reflexa*) and 0 shells were collected from six sites along 30 km of the Grand River. Shell lengths ranged from 37 to 57mm.

A small number of live individuals and shells were collected by the Petite Ponar™. Live individuals were collected from 3% of sites (summer and autumn) and 4% of transects in the summer (autumn transects: 1%). Species detected by riverbed sampling included: Deertoe, Eastern Pondmussel (*Sagittunio nasutus*), Fatmucket, Giant Floater (*Pyganodon grandis*), Lilliput, Mapleleaf, Mucket, Pimpleback (*Cyclonaias pustulosa*), Round Pigtoe, Slippershell (*Alasmidonta viridis*), Spike (*Eurynia dilitata*), Threeridge, and Wabash Pigtoe (*Fusconaia flava*). A summary of the Ponar™ catch is provided in Table 6.

Thames River

In the summer of 2022 (May 24 to July 27), 34 sites (130 transects in total) were sampled along 50 km of the lower Thames River between Thamesville and Jeannette's Creek near the mouth of the river (Figure 7). The river was not navigable (too shallow) beyond the most upstream site. Channel widths at sampling sites ranged from 36 to 132 m. Water depths sampled ranged from 0.6 to 5.5 m. The composition of riverbed material varied longitudinally. Gravel and sand riverbed material was more dominant along the upstream reaches, whereas clays and silts were more dominant along the lower reaches.

In total, 68 live individuals (representing 13 species) were collected by the brail. Live individuals were collected from 59% of sites and 23% of transects. Shell lengths of live individuals ranged from to 14 to 145 mm (Figure 8, Table 7). Overall, the most abundant and widespread species were: Mucket (32.4% of total catch), Mapleleaf (22.1% of total catch), and

Pimpleback (10.3% of total catch). Table 8 provides frequency of occurrence and relative abundance of each species. Species counts per site are provided in Appendix 16.

Black Sandshell was the only species exhibiting sexual dimorphism. Both live individuals were male.

Live individuals of three species at risk were collected during sampling. Fifteen live Mapleleaf were collected from 12 sites distributed along entire sampled length. No Mapleleaf shells were collected. Three live Threehorn Wartyback were collected from three sites distributed along 8 km of the river between Kent Bridge and Vosburg. No shells were collected. Two live Fawnsfoot were collected from two consecutive sites upstream of Communication Road. No shells were collected.

Two transects (within sites THR-29 and 31) were sampled with five successive passes of the brail. After the first pass, three new species (Flutedshell (*Lasmigona costata*), Pink Heelsplitter (*Potamilus alatus*) and White Heelsplitter (*Lasmigona complanata*) were detected at THR-29. Additional sampling did not improve species detection at THR-31.

Live individuals collected by the Ponar™ included: Fawnsfoot (n = 1), Deertoe (n = 1), Mapleleaf (n = 1), and Lilliput (n = 1). Live individuals were collected from 3% of sites and transects. The live Fawnsfoot was collected approximately 8 km upstream of where it was detected by brail. Shells collected by the Ponar™ included Deertoe, Fragile Papershell, Mapleleaf, Pink Heelsplitter, Plain Pocketbook, and Round Pigtoe. A summary of the Petite Ponar™ catch is provided in Table 9.

Sydenham River (East and North Syndenham)

In the summer of 2022 (June 4 to July 28), 37 sites (108 transects in total) were sampled along 27 km of the East Sydenham River between Dawn Mills and Wallaceburg, and 25 km of the North Sydenham River between Wilkesport and Wallaceburg (Figure 9). The river was not navigable beyond the most upstream sites (shallow and narrow, lots of downed trees and woody debris). Channel widths at sampling sites ranged from 21 to 75 m. Water depths sampled ranged from 0.7 to 5.2 m. Spatial variation in the composition of riverbed material was present along the two branches of the Sydenham River; following the general pattern of greater amounts of sand, gravel and cobble at upstream sites while downstream sites were a mix of organics, clay and silts.

In total, 45 live individuals (representing 10 species) were collected by the brail. Live individuals were collected from 27% of sites and 11% of transects. Shell lengths of live individuals ranged from to 59 to 174 mm (Figure 10, Table 10). Overall, the most abundant and widespread species were: Mucket (22.2% of total catch), as well as Mapleleaf and Pimpleback (both 17.8% of total catch). Table 11 provides frequency of occurrence and relative abundance of each species. Species counts per site are provided in Appendix 17.

Black Sandshell was the only species exhibiting sexual dimorphism (one male and one female).

Live individuals of two species at risk were collected during sampling. Eight live Mapleleaf were collected from four sites along a 19 km stretch of the East Sydenham River and four sites along a 17 km stretch of the North Sydenham River. In both the East and North Sydenham, three of the sites where Mapleleaf was detected were concentrated at the upstream end of the study area. One Mapleleaf (WW) shell was collected at the most upstream site on the East Sydenham. One live Kidneyshell (*Ptychobranchus fasciolaris*) was collected on the East Sydenham River downstream of Dawn Mills. No shells were collected. Purple Wartyback has

been assessed by COSEWIC (2021) as Threatened but has not yet been added to Schedule 1. One live Purple Wartyback was collected downstream of Dawn Mills.

Four transects were sampled by two successive passes with the brail, and another four transects were sampled with five successive passes (within sites SYD-31 to 37). No live individuals were collected from transects sampled with two passes. At three of the transects sampled by five passes, an additional two, three and four species were detected after the first pass. Additional sampling effort improved detection of Mapleleaf.

Two live Mapleleaf were collected by the Petite Ponar™: one at the upstream end of the East Sydenham sample area, and one at the upstream end of the North Sydenham sample area. Live individuals were collected from 2% of sites and transects. Shells collected by the Ponar™ included Paper Pondshell, Heelsplitter sp., Black Sandshell, and Mucket (Table 12).

Ausable River

In the summer of 2022 (July 4 to July 25), 23 sites (74 transects in total) were sampled along 10 km of the Ausable River between Kennedy Line and Port Franks at the mouth of the river (Figure 11). Navigation upstream of Kennedy Line was blocked by a downed tree. Channel widths at sampling sites ranged from 30 to 135 m. Water depths sampled at sampling sites ranged from 1.0 to 4.3 m. The composition of riverbed material varied longitudinally. Gravel and sand riverbed material was more dominant along the upstream reaches, whereas clays and silts were more prevalent along the lower reaches.

In total, 49 live individuals (representing 4 species) were collected by the brail. Shell lengths of live individuals ranged from to 40 to 158 mm (Figure 12, Table 13). Overall, the most abundant and widespread species was Threeridge (89.8% of total catch). Table 14 provides frequency of occurrence and relative abundance of each species by sample season. Species counts per site are provided in Appendix 18.

Live individuals of one species at risk were collected during sampling. Three live Mapleleaf were collected from one site near Port Franks. No Mapleleaf shells were collected.

One live Threeridge was collected by the Petite Ponar™. No shells were collected.

CONCLUSION

Sampling efforts presented in this report represent the first extensive surveys of Ontario rivers using the mussel brail. Initial sampling along the lower Grand River demonstrated the potential of the gear to collect mussel species at risk from poorly surveyed, non-wadeable habitats, and to detect the presence of a diversity of mussel species (and sizes). Seasonal differences in the number and diversity of mussel collections were also evident. Lower catches in the autumn are consistent with past studies that report mussels to cease responding to the brail as water temperatures decline; filter-feeding activity is reduced, and more individuals are burrowed (Miller and Nelson 1983). Mean Grand River water temperatures at Glen Morris (upstream of Brantford) were 5.6 degrees cooler during autumn sampling (16.7^{o}C) than summer sampling (22.3^{o}C) (unpublished data, Grand River Conservation Authority). At two autumn-sampled sites, an absence of mussels was associated with aquatic vegetation fouling the brail (noted from 50% of transects sampled). Subsequent brail sampling along the lower reaches of the Thames, Sydenham, and Ausable rivers also detected mussel species at risk and a diversity of species (and sizes); although substantially fewer live individuals were collected. Habitat sampling with the Petite Ponar™ benthic grab provided additional distribution information on four mussel species at risk (Eastern Pondmussel, Lilliput, Mapleleaf and Round Pigtoe).

Among river differences in mussel collections suggest fewer mussels are present along sampled reaches of the Thames, Sydenham, and Ausable rivers than the Grand River. Sampling-related differences may explain some of this variation: 1) the length of navigable habitat on the Thames, Sydenham, and Ausable rivers was significantly less than on the Grand River, and 2) obstacles such as overhanging or downed trees and underwater woody debris were much more prevalent; limiting sample area, causing snags, and potentially impacting the effectiveness of the brail. The effect of differences in riverbed material (e.g. sand/gravel vs. soft substrate or hard clay) on mussel collection efficiency is also unknown.

Given the adverse effects associated with dredge-based harvesting of mussels, concern has been raised regarding effects to mussel species at risk and their habitats as the brail moves over the riverbed and pulls them from the substrate. Minor damage to the edge of the mantle and shell has been attributed to the removal of mussels from crowfeet (Sparks and Blodgett 1983). In another study, Pink Heelsplitter and Mapleleaf collected from the upper Mississippi River with a brail were observed to burrow and re-establish their position in the substrate after being processed (Sparks and Blodgett 1983). Given its poor catch efficiency (<5% of diving-based density estimates: Thiel 1981), the risk of negative population-level effects from brail sampling is interpreted to be very low.

Based on a literature review of different freshwater mussel methods, Dolson et al. (2023) recommend the use of the mussel brail (or the skimmer dredge) for preliminary surveys of deep, turbid habitats. While estimation of mussel densities and other population demographic information requires sampling by divers, our results illustrate that mussel brail sampling of southwestern Ontario rivers can provide useful information for the delineation and description of critical habitat for mussel species-at-risk. Low-intensity sampling approaches such as the brail can also be used to inform the design of two-stage estimates of mussel population densities (i.e. stratification of sampling sites into low, medium and high abundance categories) (Villella and Smith 2005). The spatially replicated design used in this study could be modified to collect temporal replicates along transects (MacKenzie et al. 2018); thereby, providing species detection history data suitable for occupancy model-based monitoring of mussel species at risk populations. Preliminary results from the Sydenham and Thames rivers indicate that species detection can be improved by multiple (5) successive samples of transects.

ACKNOWLEDGEMENTS

Research was supported by Fisheries and Oceans Canada species at risk program funds. We would like to acknowledge the efforts of Victoria Tousaw, Matt Sweeting, Vince Frasca, Katelyn Vardy, Emily Lechner, Elise Millar, and Emma McLennan-Nobrega who participated in sampling. Sampling with the brail would not have been successful without the instruction and guidance provided by Jason Barnucz. Earlier versions of the report were improved by comments from Jason Barnucz, Kelly McNichols-O'Rourke and Todd Morris.

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Table 1. Minimum, maximum, and median water level and water discharge rates for the Grand River throughout the summer and autumn sampling periods of 2019 extracted from the Environment and Climate Change Canada Real-time Hydrometric Data Station website (https://wateroffice.ec.gc.ca/mainmenu/historical_data_index_e.html), station 02GB001 (Grand River at Brantford).

Sample season	Water level			Discharge		
	Min (m)	Max (m)	Median (m)	Min (m^3/s)	Max (m^3/s)	Median (m^3/s)
Summer	0.275	0.591	0.391	26.4	64	38.9
Fall	0.226	0.707	0.265	21.6	78.2	25.4

Table 2. Minimum, maximum, and median water level for the Thames, Sydenham, and Ausable rivers in the summer of 2022 extracted from the Environment and Climate Change Canada Real-time Hydrometric Data Station website (https://wateroffice.ec.gc.ca/mainmenu/historical_data_index_e.html), stations 02GE002 (Thames River at Byron), and 02GG008 (Sydenham River at Wallaceburg), 0FF010 (Ausable River Near Parkhill).

Watercourse	Min (m)	Max (m)	Median (m)
Thames	1.764	2.136	1.859
Sydenham	5.497	5.703	5.59
Ausable	1.876	2.215	2.05

Table 3. Minimum, maximum, and median lengths of species caught by mussel brail trawl from the lower Grand River in the summer and autumn of 2019.

	Summer			Autumn		
Common name	Min (mm)	Max (mm)	Median (mm)	Min (mm)	Max (mm)	Median (mm)
Black Sandshell	110	159	135	120	155	131
Fatmucket	71	115	90	35	41	38
Flutedshell	100	125	110	80	107	87
Fragile Papershell	94	94	94	56	113	106
Giant Floater	107	107	107	111	141	126
Mapleleaf	33	112	81	54	119	91
Mucket	44	166	118	47	146	114.5
Pimpleback	28	75	60	39	76	61
Pink Heelsplitter	42	136	105	76	133	107.5
Plain Pocketbook	77	120	100.5	76	109	92.5
Round Pigtoe	57	107	82	70	96	82.5
Threehorn Wartyback	37	57	48	37	45	41
Threeridge	21	131	84	48	107	78
Unknown Juvenile	12	18	17	5	14	9.5
Wabash Pigtoe	31	64	46.5	43	43	43

Table 4. Frequency of occurrence (FO) and relative abundance (RA) of species caught by mussel brail trawl from the lower Grand River in the summer and autumn of 2019.

	Summer			Autumn		
Common name	Number of individuals	FO (%)	RA (%)	Number of individuals	FO (%)	RA (%)
Black Sandshell	49	25.0	8.2	12	6.7	9.0
Deertoe	0	0.0	0.0	2	4.4	1.5
Fatmucket	28	22.9	4.7	10	15.6	7.5
Flutedshell	11	16.7	1.8	5	11.1	3.8
Fragile Papershell	1	0.0	0.2	0	0.0	0.0
Giant Floater	1	2.1	0.2	2	2.2	1.5
Mapleleaf	68	60.4	11.4	15	22.2	11.3
Mucket	211	35.4	35.4	26	15.6	19.5
Pimpleback	15	25.0	2.5	5	11.1	3.8
Pink Heelsplitter	5	8.3	0.8	4	8.9	3.0
Plain Pocketbook	8	8.3	1.3	2	4.4	1.5
Round Pigtoe	28	16.7	4.7	14	11.1	10.5
Threehorn Wartyback	5	8.3	0.8	2	4.4	1.5
Threeridge	156	37.5	26.2	29	26.7	21.8
Unknown Juvenile	3	4.2	0.5	4	8.9	3.0
Wabash Pigtoe	7	8.3	1.2	1	2.2	0.8

Table 5. Number of male (M), female (F) and unknown Black Sandshell (Ligumia recta), Fatmucket (Lampsilis siliquoidea), and Plain Pocketbook (Lampsilis cardium) individuals collected from the lower Grand River in the summer and autumn of 2019.

	Summer			Autumn		
Common name	M	F	Unknown	M	F	Unknown
Black Sandshell	24	22	3	7	5	0
Fatmucket	17	6	5	7	1	2
Plain Pocketbook	5	3	0	1	0	1

Table 6. Summary of individuals detected by riverbed (Ponar™) sampling in the lower Grand River in the summer and autumn of 2019. Live individuals and single weathered valves (WV) were collected: other shell conditions were not observed.

	Summer		Autumn	
Common name	Live	WV	Live	WV
Deertoe	0	0	0	1
Eastern Pondmussel	0	0	0	1
Fatmucket	0	0	0	2
Giant Floater	0	0	1	0
Lilliput	0	0	0	1
Mapleleaf	0	0	3	1
Mucket	0	0	0	1
Pimpleback	0	0	0	2
Round Pigtoe	1	0	0	0
Slippershell	0	1	0	0
Spike	0	0	0	1
Threeridge	1	0	1	0
Unknown juvenile	0	0	1	0
Wabash Pigtoe	0	0	1	0
Total	2	1	7	10

Table 7. Minimum, maximum, and median lengths of species caught by mussel brail trawl from the Thames River in the summer of 2022.

Common name	Min (mm)	Max (mm)	Median (mm)
Black Sandshell	79	121	100
Deertoe	31	47	39
Fawnsfoot	27	28	27.5
Flutedshell	125	125	125
Fragile Papershell	90	118	109.5
Giant Floater	59	59	59
Mapleleaf	31	119	66
Mucket	58	145	125.5
Pimpleback	54	80	60
Pink Heelsplitter	84	134	99
Threehorn Wartyback	23	41	26
Threeridge	75	75	75
Unknown juvenile	14	14	14
White Heelsplitter	127	139	133

Table 8. Frequency of occurrence (FO) and relative abundance (RA) of species caught by mussel brail trawl from the Thames River in the summer of 2022.

Common name	Number of individuals	FO (%)	RA (%)
Black Sandshell	2	5.9	2.9
Deertoe	2	5.9	2.9
Fawnsfoot	2	5.9	2.9
Flutedshell	1	2.9	1.5
Fragile Papershell	4	11.8	5.9
Giant Floater	1	2.9	1.5
Mapleleaf	15	35.3	22.1
Mucket	22	14.7	32.4
Pimpleback	7	8.8	10.3
Pink Heelsplitter	5	14.7	7.4
Threehorn Wartyback	3	8.8	4.4
Threeridge	1	2.9	1.5
Unknown juvenile	1	2.9	1.5
White Heelsplitter	2	5.9	2.9

Table 9. Summary of individuals detected by riverbed (Ponar™) sampling in the Thames River in the summer of 2022. Live individuals, single weathered valves (WV), fresh whole shell (FW), and weathered whole shell (WW) were collected.

Common name	Live	WV	WW	FW
Deertoe	1	1	0	0
Fawnsfoot	1	0	0	0
Fragile Papershell	0	1	0	1
Lilliput	1	0	0	0
Mapleleaf	1	1	0	0
Pink Heelsplitter	0	2	0	0
Plain Pocketbook	0	1	0	0
Round Pigtoe	0	1	0	0
Unknown	0	1	1	0

Table 10. Minimum, maximum, and median lengths of species caught by mussel brail trawl from the Sydenham River (North and East Sydenham) in the summer of 2022.

Common name	Min (mm)	Max (mm)	Median (mm)
Black Sandshell	155	174	164.5
Flutedshell	102	102	102
Kidneyshell	96	96	96
Mapleleaf	68	96	83
Mucket	96	147	117
Pimpleback	70	101	75
Pink Heelsplitter	103	122	114.5
Purple Wartyback	77	77	77
Threeridge	85	126	102
Wabash Pigtoe	59	59	59

Table 11. Frequency of occurrence (FO) and relative abundance (RA) of species caught by mussel brail trawl from the Sydenham River (North and East Sydenham) in the summer of 2022.

Common name	Number of individuals	FO (%)	RA (%)
Black Sandshell	2	5.4	4.4
Flutedshell	1	2.7	2.2
Kidneyshell	1	2.7	2.2
Mapleleaf	8	21.6	17.8
Mucket	10	10.8	22.2
Pimpleback	8	10.8	17.8
Pink Heelsplitter	6	8.1	13.3
Purple Wartyback	1	2.7	2.2
Threeridge	7	5.4	15.6
Wabash Pigtoe	1	2.7	2.2

Table 12. Summary of individuals detected by riverbed (Ponar™) sampling in the Sydenham River (North and East Sydenham) in the summer of 2022. Live individuals, single weathered valves (WV) and weathered whole shell (WW) were collected.

Common name	Live	WV	WW
Black Sandshell	0	1	0
Heelsplitter sp.	0	1	0
Mapleleaf	2	0	0
Mucket	0	2	0
Paper Pondshell	0	0	1

Table 13. Minimum, maximum, and median lengths of species caught by mussel brail trawl from the Ausable River in the summer of 2022.

Common name	Min (mm)	Max (mm)	Median (mm)
Mapleleaf	84	91	90
Pimpleback	40	40	40
Threeridge	43	158	108
White Heelsplitter	143	143	143

Table 14. Frequency of occurrence (FO) and relative abundance (RA) of species caught by mussel brail trawl from the Ausable River in the summer of 2022.

Common name	Number of individuals	FO (%)	RA (%)
Mapleleaf	3	4.3	6.1
Pimpleback	1	4.3	2.0
Threeridge	44	60.9	89.8
White Heelsplitter	1	4.3	2.0

Figure 1. Samplers holding the brail trawl used to sample mussels in non-wadeable habitats.

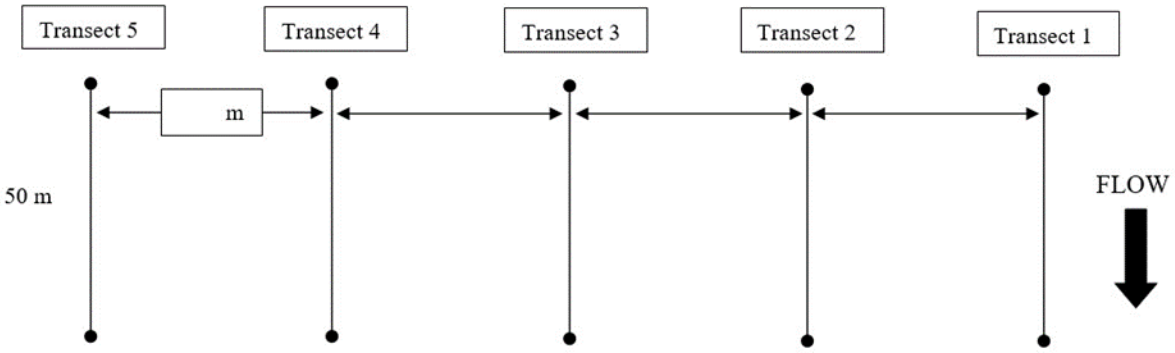


Figure 2. Sampling design at mussel brail sites: 50 m long transects spaced evenly across the width of the channel, with transect 1 closest to the right bank. Number of transects varied depending on channel width up to a maximum of 5 transects.

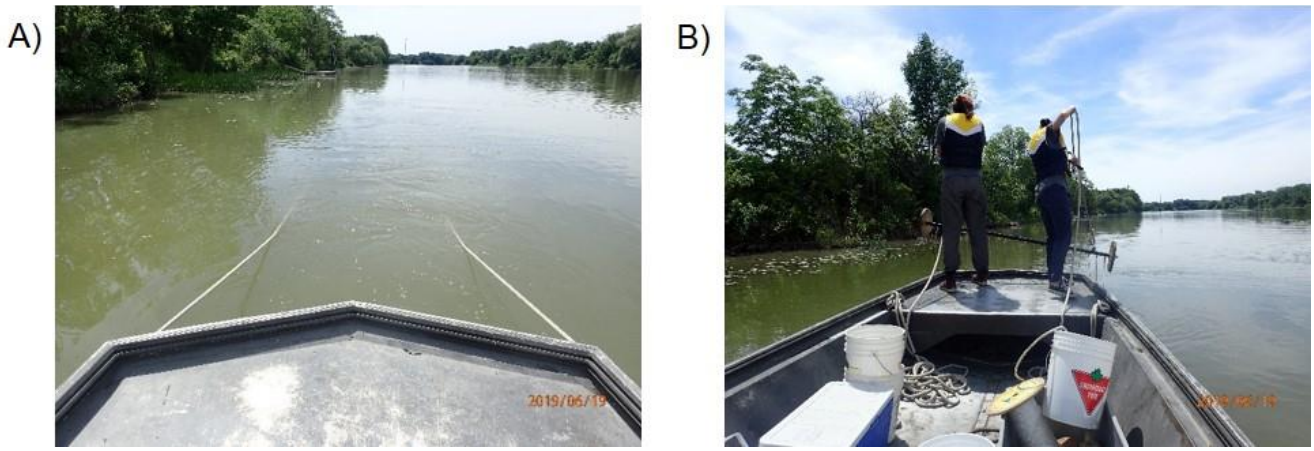


Figure 3. A) Towing the deployed brail along a transect. B) Retrieving the brail after completing a transect.

Figure 4. Deploying the Petite Ponar™ benthic grab to collect riverbed material.

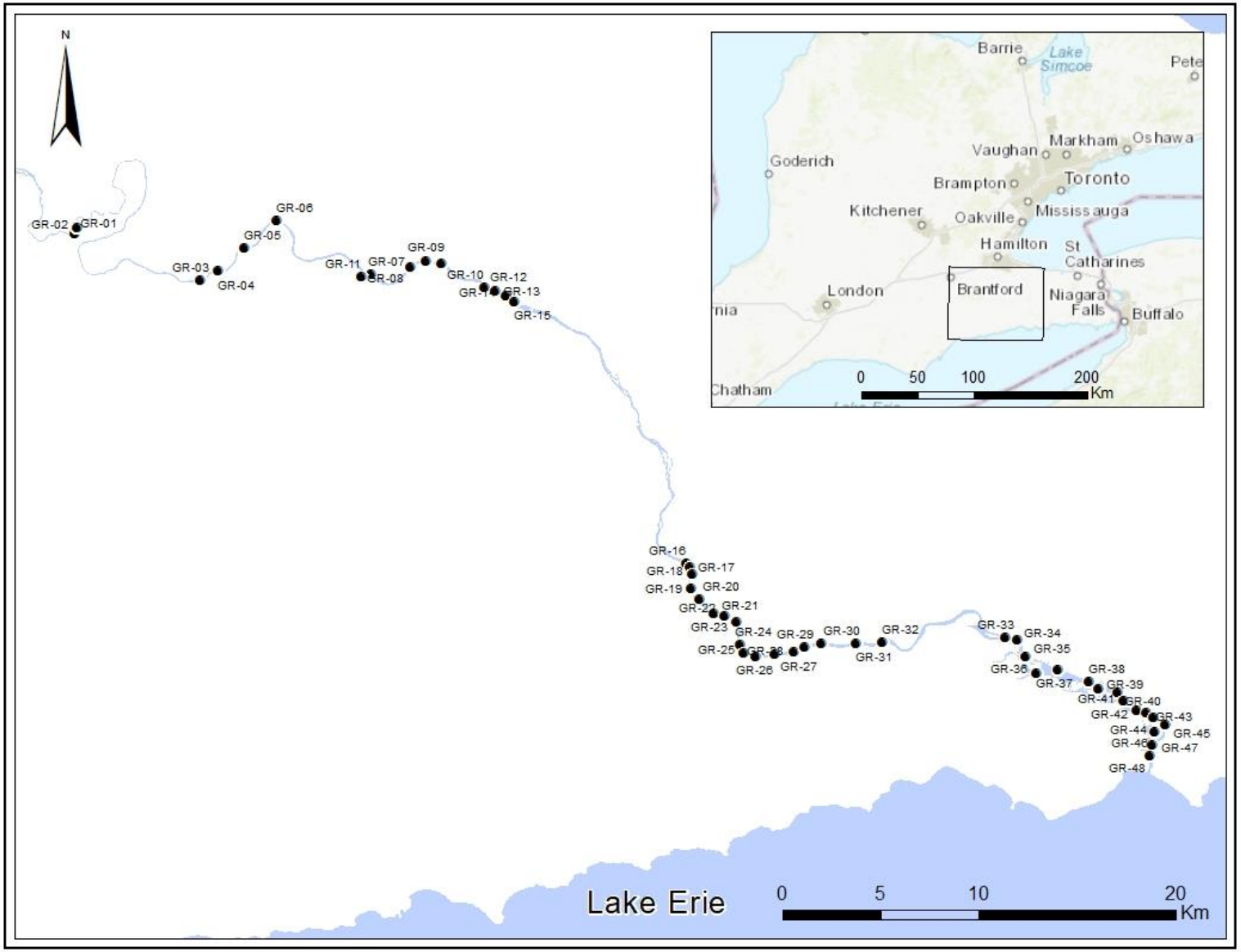


Figure 5. Map of 48 sites on the lower Grand River in Brant and Haldimand counties sampled by mussel brail in 2019, and their location within southern Ontario.

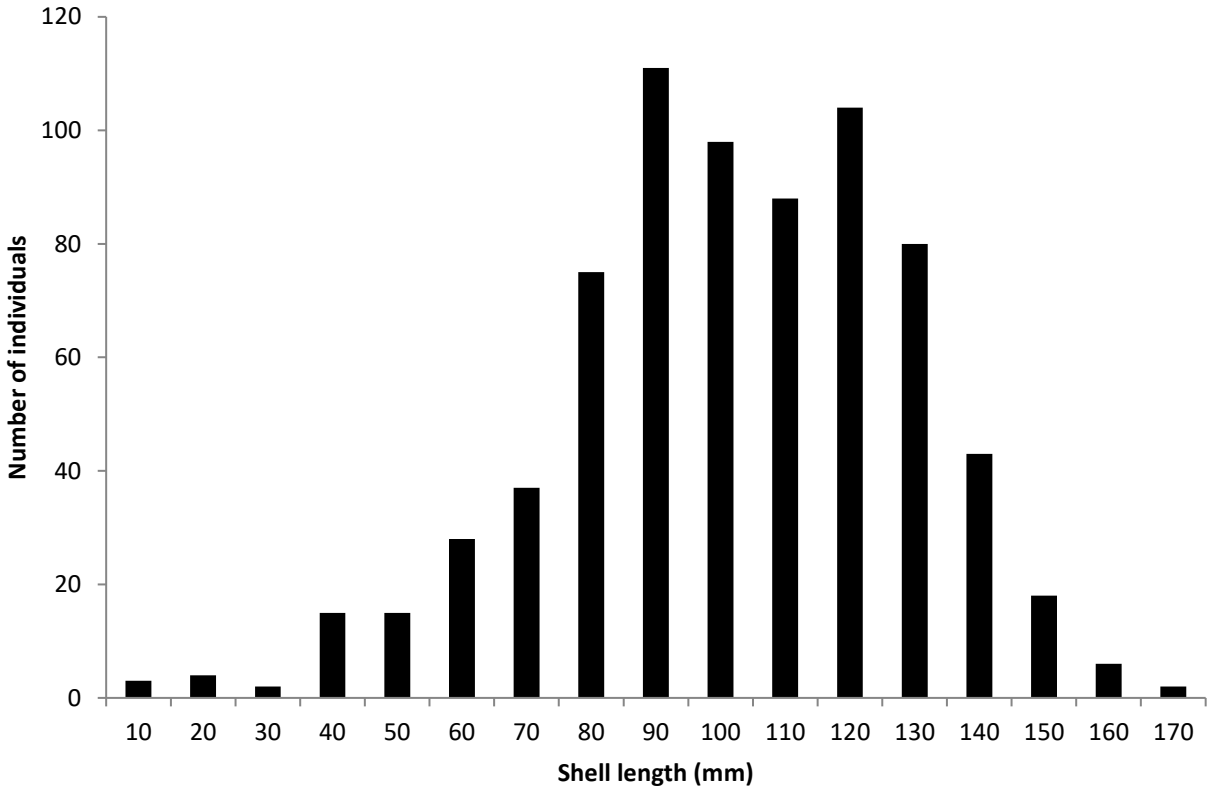


Figure 6. Length frequencies for live mussels (n = 729) caught by mussel brail trawl from the lower Grand River in the summer and autumn of 2019.

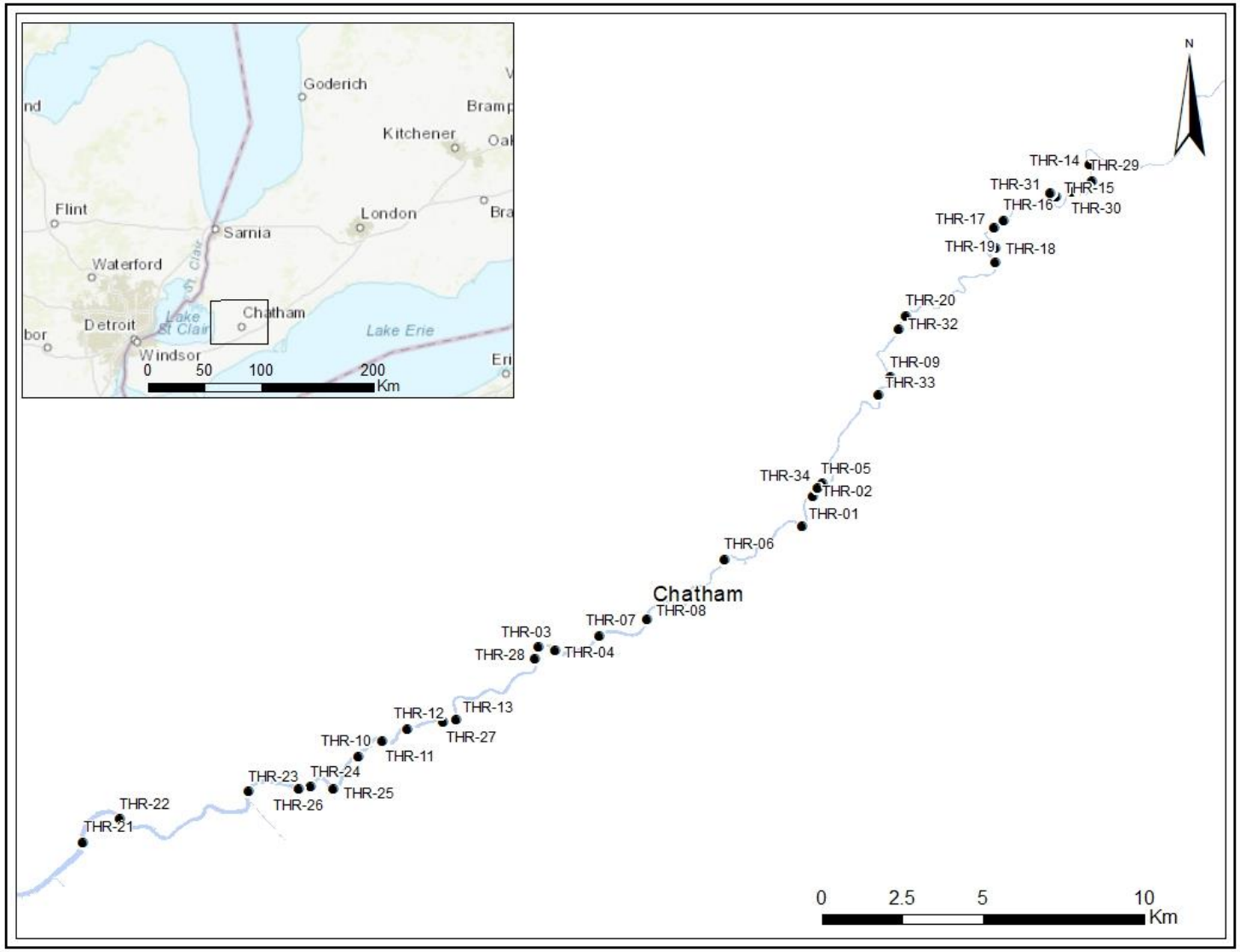


Figure 7. Map of 34 sites on the Thames River in Middlesex County sampled by mussel brail in the summer of 2022, and their location within southern Ontario.

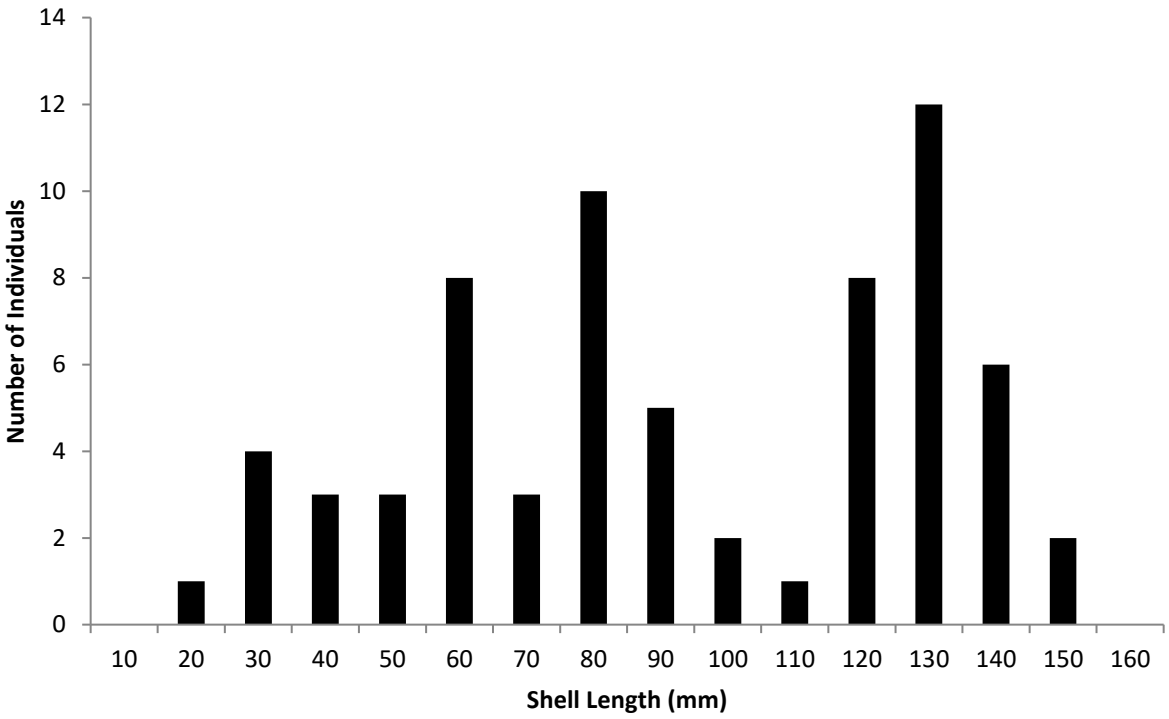


Figure 8. Length frequencies for live mussels (n = 68) caught by mussel brail trawl from the Thames River in the summer of 2022.

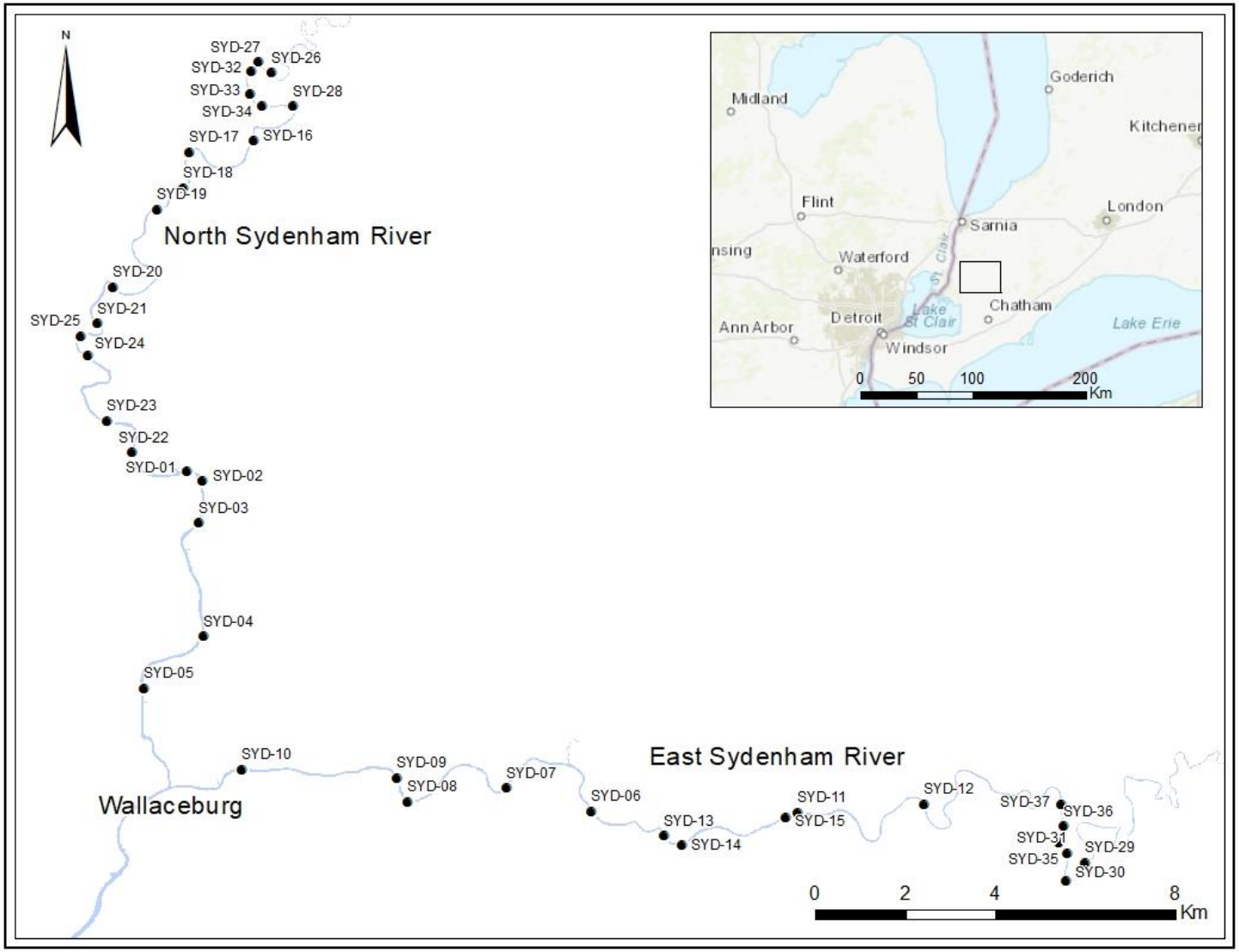


Figure 9. Map of 37 sites on the East Sydenham River in the region of Chatham-Kent and the North Sydenham River in the region of Lambton County and Chatham-Kent sampled by mussel brail in the summer of 2022, and their location within southern Ontario.

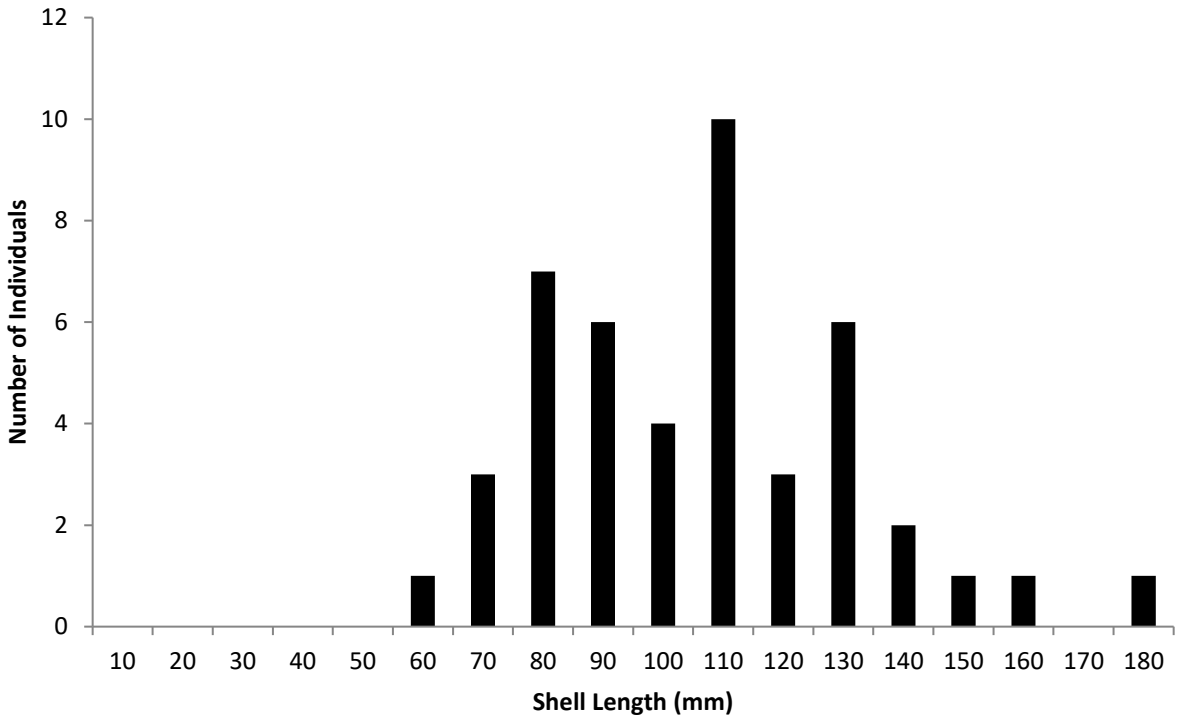


Figure 10. Length frequencies for live mussels (n = 45) caught by mussel brail trawl from the Sydenham River (North and East Sydenham) in the summer of 2022.

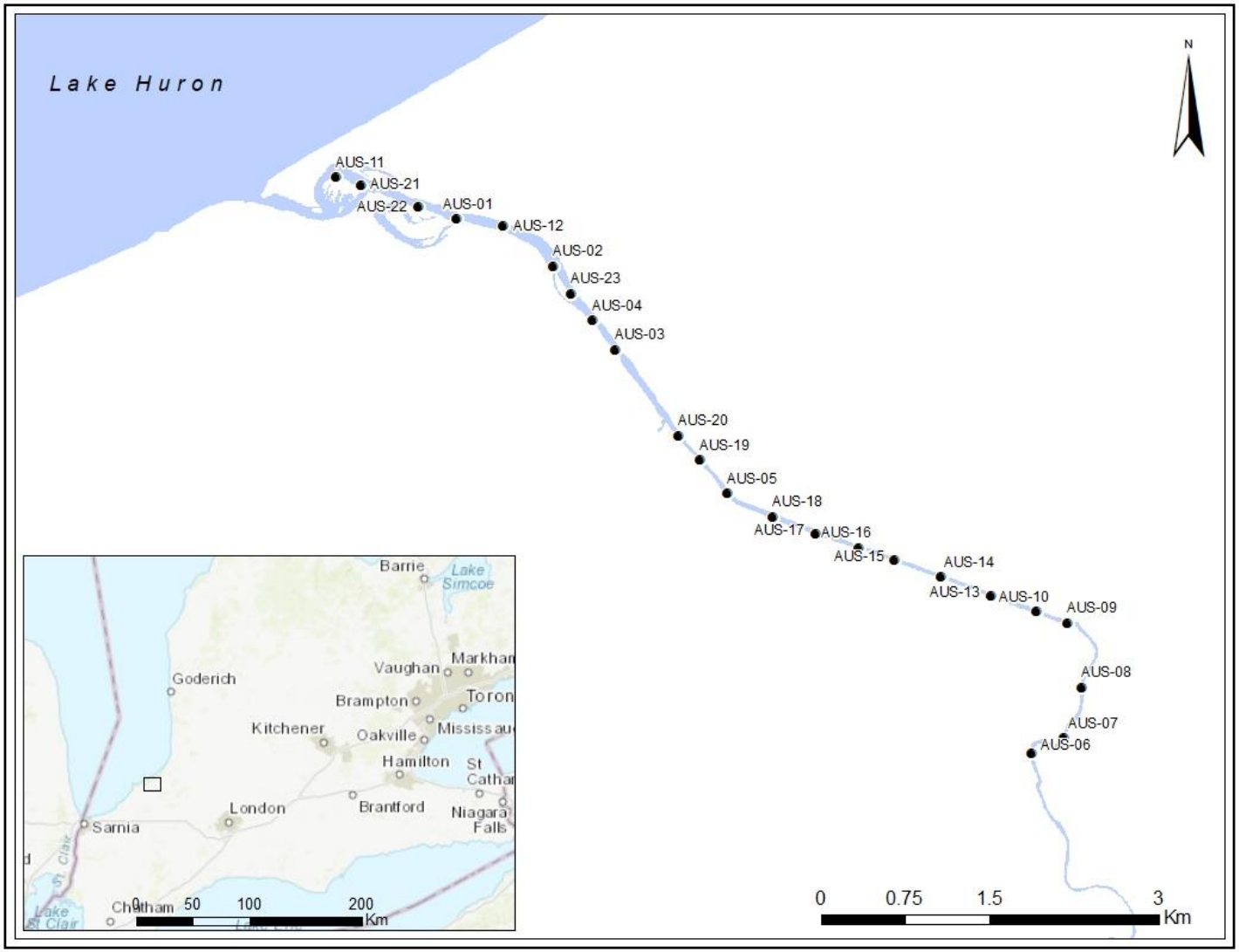


Figure 11. Map of 23 sites on the Ausable River in Lambton County and Middlesex County sampled by mussel brail in the summer of 2022, and their location within southern Ontario.

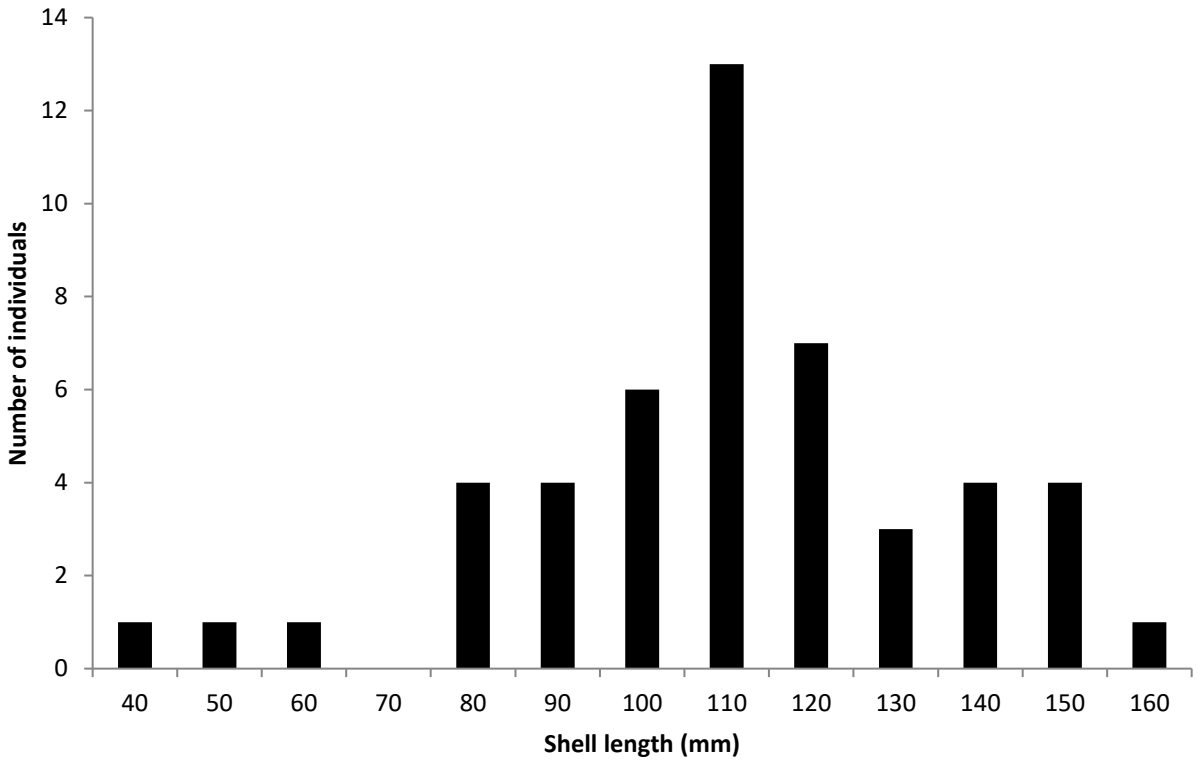


Figure 12. Length frequencies for live mussels (n = 49) caught by mussel brail trawl from the Ausable River in the summer of 2022.

Appendix 1. Locality information for Grand River sites sampled by the mussel brail in the summer of 2019. A dash (-) indicates that no measurement was recorded.

Site code	Date	Latitude	Longitude	Stream width (m)	Site width (m)	# of transects	Comments
GR-01s	4-Jul-19	43.11026	-80.24420	-	40	5	
GR-02s	4-Jul-19	43.11327	-80.24249	65	40	5	
GR-03s	11-Jun-19	43.08865	-80.16537	97	70	5	
GR-04s	11-Jun-19	43.09262	-80.15409	95	76	5	
GR-05s	27-Jun-19	43.10323	-80.13800	90	70	5	
GR-06s	25-Jun-19	43.11542	-80.11758	110	80	5	
GR-07s	25-Jun-19	43.09025	-80.05850	135	100	5	
GR-08s	12-Jun-19	43.09362	-80.03375	184	140	5	
GR-09s	12-Jun-19	43.09646	-80.02426	142	120	5	
GR-10s	13-Jun-19	43.09510	-80.01478	146	120	5	
GR-11s	12-Jun-19	43.08946	-80.06437	130	120	5	
GR-12s	12-Jun-19	43.08401	-79.98747	150	120	5	
GR-13s	13-Jun-19	43.08238	-79.98130	184	150	5	
GR-14s	27-Jun-19	43.07980	-79.97459	190	160	5	
GR-15s	27-Jun-19	43.07708	-79.96886	182	150	5	
GR-16s	26-Jun-19	42.95599	-79.86340	138	100	5	
GR-17s	26-Jun-19	42.95438	-79.86179	161	120	5	
GR-18s	26-Jun-19	42.95096	-79.86013	200	160	5	
GR-19s	28-Jun-19	42.94474	-79.86095	188	130	5	
GR-20s	26-Jun-19	42.93960	-79.85583	170	140	5	
GR-21s	20-Jun-19	42.93309	-79.84686	156	120	5	
GR-22s	17-Jun-19	42.93167	-79.84023	155	130	5	
GR-23s	17-Jun-19	42.92893	-79.83305	215	160	5	
GR-24s	20-Jun-19	42.91823	-79.83093	144	120	5	
GR-25s	26-Jun-19	42.91454	-79.82827	115	50	5	Too many snags along shore - transects limited to offshore
GR-26s	17-Jun-19	42.91297	-79.82090	139	120	5	
GR-27s	19-Jun-19	42.91361	-79.80901	138	110	5	
GR-28s	19-Jun-19	42.91482	-79.79762	205	160	5	
GR-29s	19-Jun-19	42.91673	-79.79034	163	130	5	
GR-30s	19-Jun-19	42.91868	-79.78029	175	150	5	
GR-31s	18-Jun-19	42.91835	-79.75856	157	130	5	
GR-32s	18-Jun-19	42.91856	-79.74166	186	140	5	
GR-33s	18-Jun-19	42.91997	-79.66505	317	150	5	Large portion of right bank (facing u/s) was not sampled because depth was <1 m
GR-34s	18-Jun-19	42.91845	-79.65791	207	150	5	
GR-35s	3-Jul-19	42.91096	-79.65264	500	220	5	Transects on one side of channel

Appendix 1. *(Continued)*

Site code	Date	Latitude	Longitude	Stream width (m)	Site width (m)	# of transects	Comments
GR-36s	3-Jul-19	42.90321	-79.64608	230	150	5	
GR-37s	3-Jul-19	42.90468	-79.63259	400	380	5	
GR-38s	2-Jul-19	42.89903	-79.61345	245	200	5	
GR-39s	4-Jul-19	42.89580	-79.60756	240	50	5	Transects on one side of channel
GR-40s	2-Jul-19	42.89383	-79.59584	250	90	5	Transects on one side of channel
GR-41s	4-Jul-19	42.88976	-79.59214	280	50	5	Transects on one side of channel
GR-42s	2-Jul-19	42.88573	-79.58399	165	20	5	Transects stacked (3/2) on East side of channel
GR-43s	5-Jul-19	42.88454	-79.57763	200	30	5	Transects stacked (3/2) on East side of channel
GR-44s	5-Jul-19	42.88179	-79.57335	210	40	5	Transects stacked (3/2) on West side of channel
GR-45s	2-Jul-19	42.87877	-79.56611	302	80	5	All transects on one side of channel
GR-46s	5-Jul-19	42.87569	-79.57288	170	150	5	Site is in a wetland off the main channel
GR-47s	3-Jul-19	42.86922	-79.57424	310	30	5	Transects stacked (2/3) on East side of channel
GR-48s	3-Jul-19	42.86480	-79.57612	115	50	5	Transects on one side of channel

Appendix 2. Locality information for Grand River sites sampled by the mussel brail in the autumn of 2019.

Site code	Date	Latitude	Longitude	Stream width (m)	Site width (m)	# of transects	Comments
GR-03f	26-Sep-19	43.08865	-80.16537	100	70	5	
GR-04f	26-Sep-19	43.09262	-80.15409	100	70	5	
GR-05f	30-Sep-19	43.10323	-80.13800	105	80	5	
GR-06f	26-Sep-19	43.11542	-80.11758	110	80	5	
GR-07f	30-Sep-19	43.09025	-80.05850	135	100	5	
GR-08f	30-Sep-19	43.09362	-80.03375	180	110	5	
GR-09f	30-Sep-19	43.09646	-80.02426	140	110	5	
GR-10f	1-Oct-19	43.09510	-80.01478	145	120	5	
GR-11f	30-Sep-19	43.08946	-80.06437	130	120	5	
GR-12f	1-Oct-19	43.08401	-79.98747	150	130	5	
GR-13f	1-Oct-19	43.08238	-79.98130	180	140	5	
GR-14f	1-Oct-19	43.07980	-79.97459	190	150	5	
GR-15f	1-Oct-19	43.07708	-79.96886	180	150	5	
GR-16f	25-Sep-19	42.95599	-79.86340	138	110	5	
GR-17f	25-Sep-19	42.95438	-79.86179	160	120	5	
GR-18f	27-Sep-19	42.95096	-79.86013	200	120	5	
GR-19f	27-Sep-19	42.94474	-79.86095	190	110	5	
GR-20f	27-Sep-19	42.93960	-79.85583	170	110	5	
GR-21f	9-Oct-19	42.93309	-79.84686	150	140	5	
GR-22f	9-Oct-19	42.93167	-79.84023	155	130	5	
GR-23f	9-Oct-19	42.92893	-79.83305	215	150	5	
GR-24f	9-Oct-19	42.91823	-79.83093	140	110	5	
GR-25f	27-Sep-19	42.91454	-79.82827	115	100	5	
GR-26f	9-Oct-19	42.91297	-79.82090	140	110	5	
GR-27f	9-Oct-19	42.91361	-79.80901	140	120	5	
GR-28f	8-Oct-19	42.91482	-79.79762	205	160	5	
GR-29f	25-Sep-19	42.91673	-79.79034	163	130	5	
GR-30f	25-Sep-19	42.91868	-79.78029	170	140	5	
GR-31f	25-Sep-19	42.91835	-79.75856	186	130	5	
GR-32f	25-Sep-19	42.91856	-79.74166	186	140	5	
GR-33f	8-Oct-19	42.91997	-79.66505	317	160	5	Transects on one side of channel
GR-34f	23-Sep-19	42.91845	-79.65791	229	170	5	
GR-35f	23-Sep-19	42.91096	-79.65264	545	230	5	Transects on one side of channel

Appendix 2. *(Continued)*

Site code	Date	Latitude	Longitude	Stream width (m)	Site width (m)	# of transects	Comments
GR-36f	23-Sep-19	42.90321	-79.64608	234	160	5	
GR-37f	23-Sep-19	42.90468	-79.63259	472	360	5	
GR-38f	24-Sep-19	42.89903	-79.61345	245	160	5	Transects on one side of channel
GR-39f	8-Oct-19	42.89580	-79.60756	240	30	5	Transects stacked (3/2) on East side of channel
GR-40f	8-Oct-19	42.89383	-79.59584	250	65	5	All transects are on East side of channel
GR-41f	24-Sep-19	42.88976	-79.59214	280	60	5	Transects on one side of channel
GR-42f	8-Oct-19	42.88573	-79.58399	165	30	5	Transects stacked (3/2) on East side of channel
GR-43f	24-Sep-19	42.88454	-79.57763	188	20	5	Transects stacked (3/2) on East side of channel
GR-44f	8-Oct-19	42.88179	-79.57335	210	30	5	Transects stacked (3/2) on West side of channel
GR-45f	24-Sep-19	42.87877	-79.56611	300	120	5	All transects on one side of channel
GR-47f	24-Sep-19	42.86922	-79.57424	310	30	5	Transects stacked (2/3) on East side of channel
GR-48f	24-Sep-19	42.86480	-79.57612	115	50	5	Transects on one side of channel

Appendix 3. Locality information for Thames River sites sampled by the mussel brail in the summer of 2022.

Site code	Date	Latitude	Longitude	Stream width (m)	Site width (m)	# of transects	Comments
THR-01	24-May-22	42.42322	-82.15060	53	35	4	
THR-02	24-May-22	42.43158	-82.14680	43	35	4	
THR-03	25-May-22	42.38834	-82.24957	98	75	5	
THR-04	25-May-22	42.38736	-82.24320	83	60	5	
THR-05	25-May-22	42.43518	-82.14297	70	60	5	
THR-06	25-May-22	42.41356	-82.17976	55	45	4	
THR-07	26-May-22	42.39183	-82.22642	90	65	5	
THR-08	26-May-22	42.39650	-82.20842	67	50	4	
THR-09	30-May-22	42.46510	-82.11793	65	50	5	
THR-10	31-May-22	42.35706	-82.31680	120	95	5	
THR-11	31-May-22	42.36156	-82.30780	90	70	3	
THR-12	31-May-22	42.36488	-82.29851	100	60	5	
THR-13	31-May-22	42.36775	-82.28010	93	70	4	
THR-14	2-Jun-22	42.52523	-82.04354	50	30	3	
THR-15	2-Jun-22	42.51608	-82.05642	48	30	3	
THR-16	2-Jun-22	42.50932	-82.07599	51	25	3	
THR-17	2-Jun-22	42.50717	-82.07931	48	25	3	
THR-18	2-Jun-22	42.50174	-82.07883	52	30	3	
THR-19	2-Jun-22	42.49769	-82.07873	72	30	3	
THR-20	2-Jun-22	42.48237	-82.11229	51	35	3	
THR-21	3-Jun-22	42.33184	-82.41986	130	100	5	
THR-22	3-Jun-22	42.33854	-82.40644	131	100	4	
THR-23	3-Jun-22	42.34680	-82.35794	115	85	4	
THR-24	3-Jun-22	42.34842	-82.33464	122	80	3	
THR-25	3-Jun-22	42.34785	-82.32578	113	80	4	
THR-26	26-Jul-22	42.34769	-82.33895	132	87	5	
THR-27	26-Jul-22	42.36700	-82.28518	107	77	5	
THR-28	26-Jul-22	42.38513	-82.25062	73	36	4	
THR-29	27-Jul-22	42.52068	-82.04295	36	13	2	5 passes on transect 1
THR-30	27-Jul-22	42.51756	-82.05020	44	26	3	
THR-31	27-Jul-22	42.51708	-82.05834	40	15	2	5 passes on transect 2
THR-32	27-Jul-22	42.47866	-82.11512	56	27	3	
THR-33	27-Jul-22	42.46003	-82.12236	55	30	3	
THR-34	27-Jul-22	42.43382	-82.14499	69	34	4	

Appendix 4. Locality information for Sydenham River sites sampled by the mussel brail in the summer of 2022. A dash (-) indicates that no measurement was recorded.

Site code	Date	Latitude	Longitude	Stream width (m)	Site width (m)	# of transects	Comments
SYD-01	4-Jun-22	42.65758	-82.37846	75	45	4	
SYD-02	4-Jun-22	42.65562	-82.37403	60	40	4	
SYD-03	4-Jun-22	42.64717	-82.37488	60	40	4	
SYD-04	4-Jun-22	42.62463	-82.37318	62	55	5	
SYD-05	4-Jun-22	42.61398	-82.38897	62	50	5	
SYD-06	5-Jun-22	42.59085	-82.26737	49	30	3	
SYD-07	5-Jun-22	42.59522	-82.29032	52	30	3	
SYD-08	5-Jun-22	42.59219	-82.31734	62	45	4	
SYD-09	5-Jun-22	42.59695	-82.32019	58	27	3	
SYD-10	5-Jun-22	42.59812	-82.36202	64	45	4	
SYD-11	6-Jun-22	42.59122	-82.21153	46	30	3	
SYD-12	6-Jun-22	42.59323	-82.17744	42	25	3	
SYD-13	21-Jun-22	42.58619	-82.24777	45	25	3	
SYD-14	21-Jun-22	42.58447	-82.24294	45	25	3	
SYD-15	21-Jun-22	42.59026	-82.21496	50	30	3	
SYD-16	22-Jun-22	42.72371	-82.36174	43	30	3	
SYD-17	22-Jun-22	42.72114	-82.37899	42	25	3	
SYD-18	22-Jun-22	42.71404	-82.38045	37	24	3	
SYD-19	22-Jun-22	42.70968	-82.38770	-	25	3	
SYD-20	22-Jun-22	42.69395	-82.39930	-	30	3	
SYD-21	22-Jun-22	42.68671	-82.40317	52	32	3	
SYD-22	23-Jun-22	42.66112	-82.39331	70	54	5	
SYD-23	23-Jun-22	42.66731	-82.40025	56	40	4	
SYD-24	23-Jun-22	42.68023	-82.40569	51	24	3	
SYD-25	23-Jun-22	42.68417	-82.40774	43	24	3	
SYD-26	23-Jun-22	42.73725	-82.35725	27	-	1	
SYD-27	23-Jun-22	42.73943	-82.36073	30	11	2	
SYD-28	23-Jun-22	42.73074	-82.35124	28	16	2	
SYD-29	24-Jun-22	42.58205	-82.13359	28	10	2	
SYD-30	24-Jun-22	42.57840	-82.13869	21	10	2	
SYD-31	24-Jun-22	42.58388	-82.13854	27	-	1	5 passes on transect 1
SYD-32	26-Jul-22	42.73761	-82.36252	26	10	2	2 passes on transect 1. After collecting a live mussel in transect 2 Ponar, did second pass on transect 2.

Appendix 4. *(Continued)*

Site code	Date	Latitude	Longitude	Stream width (m)	Site width (m)	# of transects	Comments
SYD-33	26-Jul-22	42.73299	-82.36279	32	10	2	2 passes on transect 1
SYD-34	26-Jul-22	42.73064	-82.35953	25	11	2	2 passes on transect 2
SYD-35	28-Jul-22	42.58586	-82.14087	33	-	1	5 passes on transect 1
SYD-36	28-Jul-22	42.58925	-82.13982	32	10	2	5 passes on transect 2
SYD-37	28-Jul-22	42.59348	-82.14040	37	11	2	5 passes on transect 2

Appendix 5. Locality information for Ausable River sites sampled by the mussel brail in the summer of 2022.

Site code	Date	Latitude	Longitude	Stream width (m)	Site width (m)	# of transects	Comments
AUS-01	4-Jul-22	43.23226	-81.88244	71	53	5	
AUS-02	4-Jul-22	43.22857	-81.87178	78	46	4	
AUS-03	4-Jul-22	43.22195	-81.86493	51	43	4	
AUS-04	5-Jul-22	43.22426	-81.86742	70	41	4	
AUS-05	5-Jul-22	43.21056	-81.85246	48	27	3	
AUS-06	5-Jul-22	43.19003	-81.81898	35	20	3	
AUS-07	5-Jul-22	43.19129	-81.81548	36	16	2	3 passes on transect 2
AUS-08	5-Jul-22	43.19533	-81.81356	30	11	2	2 passes on transect 1
AUS-09	5-Jul-22	43.20046	-81.81519	36	18	2	2 passes on transect 2
AUS-10	5-Jul-22	43.20136	-81.81866	36	17	2	2 passes on transect 1
AUS-11	6-Jul-22	43.23547	-81.89567	135	40	4	
AUS-12	6-Jul-22	43.23177	-81.87730	91	43	4	
AUS-13	6-Jul-22	43.20258	-81.82364	40	25	3	
AUS-14	6-Jul-22	43.20408	-81.82915	34	16	2	2 passes on transect 2
AUS-15	6-Jul-22	43.20539	-81.83420	32	14	2	3 passes on transect 2
AUS-16	6-Jul-22	43.20631	-81.83813	44	24	3	
AUS-17	6-Jul-22	43.20742	-81.84285	47	23	3	
AUS-18	7-Jul-22	43.20874	-81.84751	50	31	4	
AUS-19	7-Jul-22	43.21318	-81.85561	38	20	3	
AUS-20	7-Jul-22	43.21511	-81.85789	46	16	2	2 passes on transect 2
AUS-21	25-Jul-22	43.23481	-81.89294	107	36	4	
AUS-22	25-Jul-22	43.23323	-81.88662	83	58	5	
AUS-23	25-Jul-22	43.22636	-81.86987	66	40	4	

Appendix 6. Transect-specific habitat characteristics for Grand River sites sampled by mussel brail trawl in the summer of 2019.

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Boulder	Unknown	
GR-01s	1	1:26	0.7	0.6	0.9	0	0	0	10	80	10	0	0	
	2	1:09	1.0	1.0	1.4	0	0	0	40	60	0	0	0	
	3	1:11	1.5	1.6	2.1	0	0	0	0	0	0	0	100	Cobble present
	4	1:16	2.5	2.7	2.3	0	0	0	0	0	0	0	100	Gravel present
	5	1:19	2.5	3.8	2.8	0	0	0	10	0	90	0	0	
GR-02s	1	1:12	0.9	0.8	0.8	0	0	0	90	0	10	0	0	
	2	1:25	1.3	1.1	1.0	0	0	0	100	0	0	0	0	
	3	1:23	2.0	1.5	1.1	0	0	0	25	75	0	0	0	
	4	1:20	3.1	2.5	1.7	0	0	0	0	100	0	0	0	
	5	1:20	3.0	2.3	2.0	0	0	0	0	50	50	0	0	
GR-03s	1	1:41	2.5	2.1	1.7	0	0	5	95	0	0	0	0	
	2	1:41	2.5	2.3	2.0	0	0	0	85	10	5	0	0	
	3	1:21	2.1	1.7	1.6	0	0	0	20	80	0	0	0	
	4	1:40	1.7	1.3	1.2	0	0	0	0	0	0	0	100	
	5	1:35	1.4	1.3	1.4	0	0	100	0	0	0	0	0	
GR-04s	1	1:17	1.4	1.6	1.5	0	0	85	5	10	0	0	0	
	2	1:32	1.7	1.9	2.1	0	0	0	0	0	0	0	0	
	3	1:19	2.3	2.2	2.0	0	0	5	95	0	0	0	0	
	4	1:24	1.5	1.3	1.6	0	0	5	80	15	0	0	0	
	5	1:26	1.4	1.5	1.5	0	0	5	80	15	0	0	0	
GR-05s	1	1:22	4.1	3.4	3.6	0	0	0	50	50	0	0	0	
	2	1:15	3.9	3.3	3.2	0	0	15	70	15	0	0	0	
	3	1:13	3.0	2.9	2.6	0	0	50	50	0	0	0	0	
	4	1:16	1.8	1.7	2.1	0	0	5	95	0	0	0	0	
	5	1:13	1.5	1.4	1.2	0	0	20	80	0	0	0	0	
GR-06s	1	1:10	4.4	3.8	3.6	0	60	0	30	10	0	0	0	
	2	1:14	3.6	3.6	3.8	0	0	5	95	0	0	0	0	
	3	1:14	2.2	1.9	2.2	0	0	5	95	0	0	0	0	Moved closer to transect 4 because of snags
	4	1:08	1.8	1.9	2.1	0	0	15	80	5	0	0	0	Lost a small Threeridge
	5	1:20	1.1	1.3	1.4	0	0	10	90	0	0	0	0	Coordinates same as transect 3 because squished close together due to snags

Appendix 6. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Boulder	Unknown	
GR-07s	1	1:12	2.4	2.1	2.0	0	0	5	90	5	0	0	0	
	2	1:09	2.5	2.0	1.9	0	0	0	100	0	0	0	0	
	3	1:16	2.5	2.1	2.0	0	0	0	0	100	0	0	0	
	4	1:15	2.1	1.8	2.0	0	0	0	0	0	0	0	100	Unable to get ponar grab, tried 3 times; lost Round Pigtoe
	5	1:22	1.5	1.8	1.8	0	0	5	0	90	5	0	0	
GR-08s	1	1:19	1.5	2.0	1.8	0	0	70	30	0	0	0	0	
	2	1:31	2.8	2.7	2.7	0	0	0	100	0	0	0	0	
	3	1:30	2.1	2.5	2.7	0	0	0	90	10	0	0	0	
	4	1:41	2.0	2.3	2.4	0	0	50	30	20	0	0	0	
	5	1:25	1.9	2.1	2.1	0	0	30	0	10	40	20	0	
GR-09s	1	1:36	2.3	1.9	1.8	0	0	30	10	60	0	0	0	
	2	1:33	4.0	3.7	3.8	0	0	25	5	0	70	0	0	
	3	1:38	3.4	3.8	4.0	0	0	95	5	0	0	0	0	
	4	1:27	2.4	2.5	2.7	0	50	30	20	0	0	0	0	
	5	1:46	1.0	1.4	1.3	0	50	20	30	0	0	0	0	
GR-10s	1	1:35	1.5	1.6	1.5	0	0	15	85	0	0	0	0	
	2	1:31	3.6	3.4	3.3	0	0	80	10	10	0	0	0	
	3	1:07	3.7	3.7	3.7	0	0	0	100	0	0	0	0	
	4	1:14	3.7	3.2	3.2	0	0	80	15	5	0	0	0	
	5	1:01	1.6	1.7	1.6	0	0	45	50	5	0	0	0	
GR-11s	1	1:15	2.2	2.1	2.4	0	0	90	10	0	0	0	0	
	2	1:35	2.6	2.9	2.9	0	0	40	60	0	0	0	0	
	3	1:30	2.5	3.1	2.8	0	0	30	70	0	0	0	0	
	4	1:28	3.0	3.1	2.8	0	0	0	25	25	50	0	0	
	5	1:30	1.2	1.4	1.2	0	0	10	0	30	60	0	0	
GR-12s	1	1:27	2.0	2.0	2.2	0	0	30	10	60	0	0	0	
	2	1:20	2.1	2.2	2.6	0	0	5	95	0	0	0	0	
	3	1:25	2.3	2.6	2.6	0	0	5	95	0	0	0	0	
	4	1:19	2.6	2.5	2.3	0	0	10	90	0	0	0	0	
	5	1:22	2.0	1.8	1.4	0	0	90	10	0	0	0	0	

Appendix 6. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Boulder	Unknown	
GR-13s	1	1:09	2.0	2.2	1.6	0	0	90	5	5	0	0	0	
	2	2:11	2.4	2.6	2.6	0	0	65	30	5	0	0	0	
	3	3:14	2.6	2.6	2.9	0	0	10	80	10	0	0	0	
	4	1:31	3.0	3.4	3.0	0	0	0	95	5	0	0	0	
	5	1:28	3.1	2.6	2.4	0	0	95	5	0	0	0	0	
GR-14s	1	1:22	2.1	2.0	2.5	0	95	0	5	0	0	0	0	
	2	1:28	2.8	2.5	2.6	0	0	5	95	0	0	0	0	
	3	1:12	2.8	2.9	2.8	0	0	0	95	5	0	0	0	
	4	1:18	2.3	2.5	2.6	0	0	40	60	0	0	0	0	
	5	1:10	1.9	1.6	2.2	0	0	100	0	0	0	0	0	
GR-15s	1	1:22	2.7	2.6	3.0	0	0	10	90	0	0	0	0	Ponar grabs pulled up very little - possibly larger substrate
	2	1:22	2.4	2.5	3.5	0	0	0	100	0	0	0	0	Ponar grabs pulled up very little - possibly larger substrate
	3	1:15	2.2	2.2	2.1	0	0	0	100	0	0	0	0	Ponar grabs pulled up very little - possibly larger substrate
	4	1:24	2.2	2.2	2.2	0	0	90	10	0	0	0	0	Ponar grabs pulled up very little - possibly larger substrate
	5	1:18	2.0	2.1	2.2	0	0	95	5	0	0	0	0	Ponar grabs pulled up very little - possibly larger substrate
GR-16s	1	1:13	1.3	0.9	0.7	0	0	0	0	0	0	0	100	Gravel and cobble present
	2	1:28	1.4	0.9	1.0	0	0	0	0	0	0	0	100	Gravel and cobble present
	3	1:10	1.3	0.9	0.9	0	0	0	0	0	0	0	100	Gravel and cobble present
	4	1:21	1.8	1.6	1.5	0	0	0	0	0	0	0	100	Gravel and cobble present
	5	1:21	1.0	1.2	1.2	0	0	0	50	50	0	0	0	
GR-17s	1	1:20	1.1	0.9	1.2	0	0	0	50	50	0	0	0	
	2	1:09	1.5	1.4	1.2	0	0	0	50	50	0	0	0	
	3	1:13	1.4	1.5	1.4	0	0	0	0	0	0	0	100	Gravel and cobble present
	4	1:15	1.8	1.4	1.5	0	0	0	0	0	0	0	100	Cobble present
	5	1:18	1.3	1.2	1.1	0	0	0	0	0	0	0	100	Cobble present

Appendix 6. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Boulder	Unknown	
GR-18s	1	1:22	1.6	1.4	1.1	0	0	0	0	75	25	0	0	
	2	1:16	1.0	1.2	1.4	0	0	0	90	10	0	0	0	
	3	1:15	1.7	1.5	1.6	0	0	0	70	30	0	0	0	
	4	1:15	1.7	1.8	2.0	0	0	0	50	50	0	0	0	
	5	1:23	1.4	1.7	1.3	0	5	0	85	10	0	0	0	
GR-19s	1	1:15	2.1	1.6	1.4	0	0	60	40	0	0	0	0	
	2	1:16	2.5	2.3	2.2	0	0	40	60	0	0	0	0	
	3	1:07	2.2	2.4	2.3	0	0	80	20	0	0	0	0	
	4	1:02	2.1	2.2	2.0	0	0	50	40	10	0	0	0	
	5	1:10	1.8	1.7	1.6	0	0	30	70	0	0	0	0	
GR-20s	1	1:16	1.1	0.9	1.0	0	0	0	100	0	0	0	0	
	2	1:15	1.8	1.7	1.5	0	0	0	100	0	0	0	0	
	3	1:23	1.8	1.8	2.0	0	0	0	50	50	0	0	0	
	4	1:22	2.6	2.5	2.3	0	0	0	100	0	0	0	0	
	5	1:18	2.1	2.3	2.4	0	0	0	20	80	0	0	0	
GR-21s	1	1:16	2.0	1.9	1.8	0	0	25	75	0	0	0	0	
	2	1:17	2.9	2.6	2.4	0	0	45	50	5	0	0	0	
	3	1:17	3.0	2.8	2.6	0	0	5	95	0	0	0	0	
	4	1:22	3.2	3.4	3.7	0	0	10	60	30	0	0	0	
	5	1:15	2.7	2.7	3.1	0	0	20	20	30	30	0	0	
GR-22s	1	1:24	1.1	1.8	1.9	0	0	70	30	0	0	0	0	
	2	1:10	2.4	2.5	2.3	0	0	10	90	0	0	0	0	
	3	1:14	3.0	2.8	2.8	0	0	5	95	0	0	0	0	
	4	1:10	3.1	3.2	3.1	0	0	0	25	75	0	0	0	
	5	1:18	1.7	1.3	2.1	0	0	70	30	0	0	0	0	
GR-23s	1	1:37	1.6	1.6	1.4	0	0	40	60	0	0	0	0	
	2	1:28	3.0	3.1	3.2	0	0	25	75	0	0	0	0	
	3	1:18	1.8	2.1	2.4	0	0	10	90	0	0	0	0	
	4	1:09	2.6	2.1	2.3	0	0	0	25	75	0	0	0	
	5	1:15	1.8	1.8		0	0	60	35	5	0	0	0	
GR-24s	1	1:19	2.3	2.4	2.5	0	0	20	50	30	0	0	0	
	2	1:17	4.4	4.3	4.2	0	0	5	95	0	0	0	0	
	3	1:36	4.4	4.2	4.4	0	0	20	80	0	0	0	0	
	4	1:14	3.1	3.2	3.3	0	0	50	50	0	0	0	0	
	5	1:11	1.2	1.3	1.4	0	0	65	35	0	0	0	0	

Appendix 6. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Boulder	Unknown	
GR-25s	1	1:06	1.3	1.7	1.6	0	30	0	70	0	0	0	0	
	2	1:08	2.4	2.1	2.5	0	5	0	95	0	0	0	0	
	3	1:12	3.2	2.8	3.5	0	0	0	100	0	0	0	0	
	4	1:22	3.7	4.5	4.3	0	0	0	0	100	0	0	0	
	5	1:16	3.8	4.2	4.4	0	0	0	5	95	0	0	0	
GR-26s	1	1:11	1.1	1.1	1.3	0	0	75	25	0	0	0	0	
	2	1:21	3.7	3.4	3.3	0	0	5	95	0	0	0	0	
	3	1:30	4.2	4.2	4.3	0	0	5	65	30	0	0	0	
	4	1:25	4.0	4.3	4.4	0	0	0	0	100	0	0	0	
	5	1:31	2.9	2.7	2.6	0	0	0	5	95	0	0	0	
GR-27s	1	1:32	2.3	2.6	2.7	0	0	40	60	0	0	0	0	
	2	1:25	3.5	3.6	3.6	0	0	20	80	0	0	0	0	
	3	1:25	4.3	4.2	4.1	0	0	40	60	0	0	0	0	
	4	1:40	4.3	4.3	4.3	0	0	10	90	0	0	0	0	
	5	1:33	1.6	1.3	1.5	0	0	30	0	60	10	0	0	
GR-28s	1	1:26	3.4	3.4	3.0	0	0	20	80	0	0	0	0	
	2	1:31	2.8	2.7	2.4	0	0	15	80	5	0	0	0	
	3	1:30	2.6	2.2	2.0	0	0	5	90	5	0	0	0	
	4	1:24	2.6	2.8	2.6	0	0	5	90	5	0	0	0	
	5	1:27	2.6	2.7	2.7	0	20	70	10	0	0	0	0	
GR-29s	1	1:26	2.0	2.0	2.0	0	0	60	40	0	0	0	0	
	2	1:30	3.5	3.2	3.3	0	0	10	90	0	0	0	0	
	3	1:27	4.0	3.6	4.0	0	0	15	85	0	0	0	0	
	4	1:24	4.4	4.5	4.4	0	0	30	30	40	0	0	0	
	5	1:27	1.6	1.8	1.8	0	50	45	0	5	0	0	0	
GR-30s	1	1:39	2.2	2.5	2.6	0	0	30	70	0	0	0	0	
	2	1:22	4.1	4.1	4.0	0	10	40	50	0	0	0	0	
	3	1:28	4.0	3.8	3.9	0	0	10	90	0	0	0	0	
	4	1:24	3.2	3.4	3.5	0	0	20	80	0	0	0	0	
	5	1:27	1.5	1.6	1.8	0	20	60	20	0	0	0	0	
GR-31s	1	1:16	1.9	1.9	1.9	0	0	30	70	0	0	0	0	
	2	1:17	3.5	3.5	3.5	0	0	40	60	0	0	0	0	
	3	1:36	4.5	4.4	4.5	0	0	10	90	0	0	0	0	
	4	1:24	5.1	5.0	4.9	0	0	0	5	95	0	0	0	
	5	1:14	2.4	2.3	1.6	0	10	90	0	0	0	0	0	

Appendix 6. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Boulder	Unknown	
GR-32s	1	1:21	1.4	1.6	1.6	0	0	40	60	0	0	0	0	
	2	1:15	4.1	3.9	3.6	0	0	35	65	0	0	0	0	
	3	1:10	4.6	4.6	4.1	0	0	25	70	5	0	0	0	
	4	1:12	4.2	4.1	4.5	0	0	0	0	0	0	0	100	Likely larger substrate
	5	1:15	1.4	1.5	1.4	0	20	60	20	0	0	0	0	
GR-33s	1	1:18	1.6	2.1	2.4	0	0	50	50	0	0	0	0	
	2	1:25	3.4	3.8	4.0	0	25	50	25	0	0	0	0	
	3	1:18	4.4	4.5	4.7	0	20	60	20	0	0	0	0	
	4	1:16	4.6	4.2	3.9	0	40	60	0	0	0	0	0	
	5	1:14	1.8	1.4	0.9	0	0	60	40	0	0	0	0	
GR-34s	1	1:25	1.6	1.6	1.4	0	60	40	0	0	0	0	0	
	2	1:14	3.7	3.8	3.9	0	60	40	0	0	0	0	0	
	3	1:28	4.4	4.5	4.4	0	50	50	0	0	0	0	0	
	4	1:18	4.5	4.3	4.1	0	0	30	60	10	0	0	0	
	5	1:19	2.1	2.0	1.5	0	0	70	30	0	0	0	0	
GR-35s	1	1:13	1.7	1.5	1.3	0	100	0	0	0	0	0	0	
	2	1:05	1.6	1.8	1.5	20	70	0	0	10	0	0	0	
	3	1:12	3.1	1.6	1.3	40	50	0	0	10	0	0	0	
	4	1:15	3.5	3.7	3.5	0	25	25	50	0	0	0	0	
	5	1:19	1.8	2.6	3.1	0	100	0	0	0	0	0	0	
GR-36s	1	1:08	0.8	0.6	0.6	100	0	0	0	0	0	0	0	
	2	1:10	2.8	2.0	1.6	0	80	20	0	0	0	0	0	
	3	1:05	3.5	3.5	3.4	40	60	0	0	0	0	0	0	
	4	1:18	3.3	3.5	3.5	40	60	0	0	0	0	0	0	
	5	1:18	1.3	1.5	1.7	0	80	20	0	0	0	0	0	
GR-37s	1	1:11	0.9	0.8	0.9	0	100	0	0	0	0	0	0	
	2	1:15	0.9	1.0	0.9	0	100	0	0	0	0	0	0	
	3	1:12	1.2	1.2	1.2	10	90	0	0	0	0	0	0	
	4	1:06	2.7	2.6	2.7	0	100	0	0	0	0	0	0	
	5	1:07	1.5	1.5	1.4	30	70	0	0	0	0	0	0	
GR-38s	1	1:17	1.6	1.5	1.5	0	80	20	0	0	0	0	0	
	2	1:19	4.1	4.2	4.2	0	0	60	40	0	0	0	0	
	3	1:24	4.8	4.6	4.5	0	0	0	100	0	0	0	0	
	4	1:26	4.2	4.3	4.4	0	0	90	0	10	0	0	0	
	5	1:28	1.8	2.2	2.4	0	0	40	60	0	0	0	0	

Appendix 6. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Boulder	Unknown	
GR-39s	1	1:22	4.7	4.5	4.5	60	30	0	10	0	0	0	0	
	2	1:18	4.4	4.4	4.3	10	30	0	60	0	0	0	0	
	3	1:20	4.0	3.9	4.0	60	40	0	0	0	0	0	0	
	4	1:15	3.8	3.9	3.8	80	20	0	0	0	0	0	0	
	5	1:16	1.5	1.4	1.5	80	20	0	0	0	0	0	0	
GR-40s	1	1:18	1.8	2.0	2.1	0	20	80	0	0	0	0	0	
	2	1:14	3.0	3.0	2.8	0	95	0	0	5	0	0	0	
	3	1:14	4.3	4.2	3.7	0	80	20	0	0	0	0	0	
	4	1:18	4.2	4.3	4.1	0	30	30	40	0	0	0	0	
	5	1:14	4.5	4.4	4.3	0	0	30	70	0	0	0	0	
GR-41s	1	1:10	1.7	1.5	1.4	80	20	0	0	0	0	0	0	
	2	1:10	2.1	1.9	1.7	0	50	0	50	0	0	0	0	
	3	1:22	1.9	2.1	2.3	0	90	10	0	0	0	0	0	
	4	1:20	4.2	3.7	2.4	60	40	0	0	0	0	0	0	
	5	1:18	4.5	4.2	2.5	60	40	0	0	0	0	0	0	
GR-42s	1	1:02	1.3	1.3	1.4	30	70	0	0	0	0	0	0	
	2	1:14	1.3	1.4	1.3	0	30	70	0	0	0	0	0	
	3	1:07	1.7	1.6	1.4	0	80	20	0	0	0	0	0	
	4	1:18	1.6	1.8	1.8	0	30	70	0	0	0	0	0	
	5	1:18	3.7	3.2	3.1	0	80	20	0	0	0	0	0	
GR-43s	1	1:17	1.4	1.3	1.3	70	30	0	0	0	0	0	0	
	2	1:23	2.7	2.6	2.2	20	80	0	0	0	0	0	0	
	3	1:16	4.2	4.0	4.1	40	60	0	0	0	0	0	0	
	4	1:15	1.5	1.4	1.3	50	20	30	0	0	0	0	0	
	5	1:17	2.2	2.3	2.1	0	50	50	0	0	0	0	0	
GR-44s	1	1:11	4.5	4.6	4.7	60	40	0	0	0	0	0	0	
	2	1:08	4.3	4.1	4.2	50	50	0	0	0	0	0	0	
	3	1:20	3.0	3.7	4.0	60	40	0	0	0	0	0	0	
	4	1:08	2.0	3.4	3.8	0	80	20	0	0	0	0	0	
	5	1:16	1.3	1.3	1.5	50	40	10	0	0	0	0	0	
GR-45s	1	1:28	1.4	1.4	1.4	70	30	0	0	0	0	0	0	
	2	1:19	1.4	1.5	1.5	60	40	0	0	0	0	0	0	
	3	1:17	1.5	1.6	1.7	10	90	0	0	0	0	0	0	
	4	1:23	1.7	1.8	3.0	0	95	0	5	0	0	0	0	
	5	1:17	2.9	3.3	4.4	0	100	0	0	0	0	0	0	

Appendix 6. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Boulder	Unknown	
GR-46s	1	1:21	1.0	0.9	1.1	100	0	0	0	0	0	0	0	
	2	1:28	1.0	1.2	1.1	100	0	0	0	0	0	0	0	
	3	1:20	1.0	1.2	1.1	100	0	0	0	0	0	0	0	
	4	1:18	1.1	1.2	1.1	100	0	0	0	0	0	0	0	
	5	1:22	1.2	1.2	1.2	100	0	0	0	0	0	0	0	
GR-47s	1	1:10	1.4	1.2	2.5	10	0	0	90	0	0	0	0	
	2	1:19	4.2	2.4	2.0	30	70	0	0	0	0	0	0	
	3	1:19	1.6	1.7	1.4	30	70	0	0	0	0	0	0	
	4	1:10	2.3	2.0	1.6	0	100	0	0	0	0	0	0	
	5	1:13	4.5	3.6	3.0	0	100	0	0	0	0	0	0	
GR-48s	1	1:24	2.6	3.6	4.6	0	50	50	0	0	0	0	0	
	2	1:16	1.7	2.0	3.5	0	80	0	20	0	0	0	0	
	3	1:16	1.5	1.6	1.7	20	60	0	20	0	0	0	0	
	4	1:21	1.4	1.4	1.5	30	50	20	0	0	0	0	0	
	5	1:15	1.4	1.3	1.4	50	50	0	0	0	0	0	0	

Appendix 7. Transect-specific habitat characteristics for Grand River sites sampled by mussel brail trawl in the autumn of 2019.

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Boulder	Unknown	
GR-03f	1	1:20	1.9	2.0	1.7	0	0	5	95	0	0	0	0	
	2	1:01	2.0	2.1	2.1	0	0	0	85	10	5	0	0	
	3	1:18	1.8	1.9	2.1	0	0	0	20	80	0	0	0	
	4	1:16	1.2	1.6	1.8	0	0	0	0	0	0	0	100	Sand, cobble, and gravel present in unknown proportions
	5	1:16	0.7	0.8	0.8	0	0	100	0	0	0	0	0	Heavy macrophytes
GR-04f	1	1:10	1.2	1.2	2.0	0	0	85	5	10	0	0	0	
	2	1:10	1.5	1.6	1.9	0	0	0	0	0	0	0	100	Cobble present
	3	1:07	1.7	1.9	1.5	0	0	5	95	0	0	0	0	
	4	1:18	1.5	1.4	1.3	0	0	5	80	15	0	0	0	
	5	1:12	1.4	1.2	1.2	0	0	5	80	15	0	0	0	
GR-05f	1	1:19	3.4	3.7	3.4	0	0	10	10	80	0	0	0	
	2	1:22	3.5	3.5	3.2	0	0	50	50	0	0	0	0	
	3	1:15	2.8	2.9	2.9	0	0	40	60	0	0	0	0	
	4	1:15	1.9	2.0	2.1	0	0	50	50	0	0	0	0	
	5	1:18	1.1	1.3	1.4	0	0	40	60	0	0	0	0	
GR-06f	1	1:14	2.2	3.3	4.0	0	0	0	0	0	0	0	100	Gravel and clay present
	2	1:06	3.3	3.2	3.5	0	0	0	100	0	0	0	0	
	3	1:06	2.7	2.7	2.7	0	0	10	90	0	0	0	0	
	4	1:14	1.6	1.7	1.9	0	0	0	100	0	0	0	0	
	5	1:08	1.2	1.3	1.1	0	0	0	100	0	0	0	0	
GR-07f	1	1:12	2.0	2.5	2.1	0	0	20	80	0	0	0	0	
	2	1:09	2.7	2.5	2.3	0	0	20	30	50	0	0	0	
	3	1:14	2.7	2.6	2.0	0	0	20	30	40	10	0	0	
	4	1:19	2.5	2.3	2.0	0	0	0	0	0	0	0	100	Cobble and silt present
	5	1:24	1.1	1.0	1.3	0	0	10	10	40	40	0	0	
GR-08f	1	1:13	1.9	2.0	1.8	0	0	10	40	50	0	0	0	
	2	1:16	2.6	2.5	2.6	0	0	10	70	20	0	0	0	
	3	1:12	2.0	2.1	2.5	0	0	10	0	90	0	0	0	
	4	1:18	1.8	2.0	2.4	0	0	0	0	0	0	0	100	Cobble, gravel, sand, and silt present
	5	1:11	1.6	1.7	1.9	0	0	0	50	50	0	0	0	

Appendix 7. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Boulder	Unknown	
GR-09f	1	0:55	1.1	1.4	1.5	0	0	30	30	40	0	0	0	
	2	1:19	3.1	3.4	3.9	0	0	0	0	0	0	0	100	
	3	1:16	4.2	4.1	3.9	0	0	40	40	20	0	0	0	
	4	1:17	3.6	3.1	2.9	5	10	30	50	5	0	0	0	
	5	1:20	1.8	1.8	1.7	0	0	10	50	40	0	0	0	
GR-10f	1	1:08	1.3	1.4	1.5	70	30	0	0	0	0	0	0	
	2	1:11	3.3	3.2	3.3	20	20	20	20	20	0	0	0	
	3	1:16	3.6	3.7	3.6	0	0	30	70	0	0	0	0	
	4	1:14	3.0	3.6	3.8	0	20	70	10	0	0	0	0	
	5	1:18	1.6	1.6	1.6	0	0	40	40	20	0	0	0	
GR-11f	1	1:11	2.3	2.0	2.0	60	20	10	10	0	0	0	0	
	2	1:22	2.6	2.8	2.7	0	0	50	40	10	0	0	0	
	3	1:12	2.7	2.9	2.7	0	0	50	50	0	0	0	0	
	4	1:09	2.5	2.6	2.9	0	0	10	20	10	60	0	0	
	5	1:15	2.0	2.1	2.4	0	0	0	0	0	0	0	100	Sand and gravel present
GR-12f	1	1:15	1.7	1.9	1.9	0	0	0	0	0	0	0	100	Cobble present
	2	1:10	1.9	2.1	2.2	0	0	45	45	10	0	0	0	
	3	1:09	2.2	2.1	2.5	0	0	0	0	0	0	0	100	
	4	1:13	2.6	2.4	2.5	0	0	0	0	0	0	0	100	
	5	1:14	1.8	1.8	1.7	0	30	20	50	0	0	0	0	
GR-13f	1	1:02	2.0	2.0	2.1	40	60	0	0	0	0	0	0	
	2	1:10	2.2	2.0	2.2	0	0	40	35	25	0	0	0	
	3	1:11	2.2	2.5	2.5	0	0	20	60	10	10	0	0	
	4	1:18	2.8	2.9	3.2	0	10	50	40	0	0	0	0	
	5	1:12	2.7	2.5	2.7	0	70	20	10	0	0	0	0	
GR-14f	1	1:14	2.5	2.4	2.3	0	40	40	20	0	0	0	0	
	2	1:10	2.6	2.7	2.5	0	0	40	60	0	0	0	0	
	3	1:13	2.9	2.7	2.8	0	0	20	80	0	0	0	0	
	4	1:22	2.6	2.3	2.4	0	0	50	50	0	0	0	0	
	5	1:11	1.8	1.9	1.5	0	0	80	20	0	0	0	0	
GR-15f	1	1:18	2.7	2.4	2.4	0	0	60	20	20	0	0	0	
	2	1:13	2.4	2.8	2.6	0	0	10	80	10	0	0	0	
	3	1:10	2.2	2.0	2.1	0	0	15	85	0	0	0	0	
	4	1:16	2.1	2.1	2.1	0	0	10	80	10	0	0	0	
	5	1:21	2.0	2.1	2.1	0	0	40	50	10	0	0	0	

Appendix 7. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Boulder	Unknown	
GR-16f	1	1:08	1.0	0.7	0.5	0	0	0	0	0	0	0	100	Heavy vegetation, clogged brail.
	2	1:00	1.1	0.7	0.6	0	0	0	0	0	0	0	100	
	3	1:13	1.0	0.6	0.7	0	0	0	0	0	0	0	100	
	4	1:14	1.5	1.4	1.2	0	0	0	0	0	0	0	100	Cobble, gravel, clay present in unknown proportions
	5	1:21	0.8	0.7	0.5	0	0	20	20	60	0	0	0	Heavy vegetation, clogged brail
GR-17f	1	1:13	0.6	0.5	0.5	0	0	85	10	5	0	0	0	Heavy vegetation, clogged brail
	2	1:13	1.0	1.1	1.0	0	0	10	30	50	10	0	0	
	3	1:10	1.1	1.1	1.0	0	0	0	0	0	0	0	100	Heavy vegetation, clogged brail. Cobble present
	4	1:08	1.4	1.2	1.2	0	0	0	0	0	0	0	100	Clay, gravel and sand present in unknown proportions
	5	1:12	0.9	0.6	0.6	0	0	0	0	0	0	0	100	Heavy vegetation, clogged brail. Sand, silt and clay present in unknown proportions
GR-18f	1	1:14	1.0	1.1	1.0	0	0	0	50	50	0	0	0	
	2	1:15	1.3	1.1	1.0	0	0	20	40	40	0	0	0	
	3	1:16	1.5	1.2	0.9	0	0	0	50	50	0	0	0	
	4	1:14	1.7	1.6	1.8	0	0	0	50	50	0	0	0	
	5	1:17	0.9	0.7	0.5	0	0	80	20	0	0	0	0	
GR-19f	1	1:06	2.0	2.2	2.3	0	20	70	10	0	0	0	0	
	2	1:12	2.1	2.3	2.2	0	10	25	20	15	30	0	0	
	3	1:17	2.2	2.1	2.1	0	0	70	15	15	0	0	0	
	4	1:22	1.8	1.7	1.9	0	5	30	30	25	10	0	0	
	5	1:13	1.0	1.1	1.8	0	0	40	40	20	0	0	0	
GR-20f	1	1:14	0.7	0.7	0.5	5	0	0	95	0	0	0	0	
	2	1:29	1.5	1.4	1.6	40	0	10	50	0	0	0	0	
	3	1:08	1.8	1.7	1.6	0	0	5	80	15	0	0	0	
	4	1:16	2.0	2.1	2.0	45	0	25	25	5	0	0	0	
	5	1:14	2.2	2.2	2.0	0	0	10	50	40	0	0	0	
GR-21f	1	1:10	1.7	1.5	1.8	0	0	70	30	0	0	0	0	
	2	1:19	2.6	2.8	3.0	0	0	0	0	0	0	0	100	Cobble present
	3	1:20	2.8	2.5	2.1	0	0	20	80	0	0	0	0	
	4	1:05	3.0	2.8	2.5	0	0	10	75	15	0	0	0	
	5	1:17	2.8	3.0	2.9	0	0	0	0	0	0	0	100	Sand and gravel present

Appendix 7. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Boulder	Unknown	
GR-22f	1	1:14	1.9	1.8	1.6	0	0	35	65	0	0	0	0	
	2	1:13	2.0	2.2	2.4	0	0	10	80	10	0	0	0	
	3	1:13	2.6	2.7	2.9	0	0	5	80	15	0	0	0	
	4	1:12	3.1	3.2	3.0	0	0	10	50	40	0	0	0	
	5	1:13	2.6	2.6	2.5	0	0	0	0	100	0	0	0	
GR-23f	1	1:12	2.9	2.8	2.6	0	25	40	35	0	0	0	0	
	2	1:10	3.0	3.1	2.4	10	5	20	65	0	0	0	0	
	3	1:08	1.9	1.7	2.0	0	0	10	90	0	0	0	0	
	4	1:07	2.0	2.9	2.0	0	0	10	90	0	0	0	0	
	5	1:10	1.6	1.5	1.6	0	0	10	90	0	0	0	0	
GR-24f	1	1:10	1.4	2.1	1.6	40	50	10	0	0	0	0	0	
	2	1:17	4.3	4.2	4.5	0	5	20	75	0	0	0	0	
	3	1:10	4.2	4.3	4.4	0	0	30	65	5	0	0	0	
	4	1:14	3.3	3.2	3.2	20	70	0	10	0	0	0	0	
	5	1:11	1.3	1.6	1.7	30	70	0	0	0	0	0	0	
GR-25f	1	1:11	1.4	2.0	2.6	0	0	10	90	0	0	0	0	
	2	1:17	3.4	3.6	4.0	0	0	10	90	0	0	0	0	
	3	1:24	4.5	4.3	3.8	0	0	0	0	0	0	0	100	Gravel and silt present in unknown proportions
	4	1:22	4.8	4.2	4.2	0	0	0	0	0	0	0	100	Gravel and silt present in unknown proportions
	5	1:14	2.2	1.9	2.1	0	0	0	0	0	0	0	100	Cobble present
GR-26f	1	1:06	1.7	1.8	1.9	0	5	45	50	0	0	0	0	
	2	1:14	3.5	3.4	3.3	0	0	15	85	0	0	0	0	
	3	1:14	4.5	4.1	4.1	0	0	40	10	50	0	0	0	
	4	1:12	2.5	2.7	2.9	0	10	0	0	40	50	0	0	
	5	1:17	4.1	4.0	3.9	0	0	10	85	5	0	0	0	
GR-27f	1	1:13	1.8	1.4	1.2	0	30	65	5	0	0	0	0	
	2	1:14	3.7	3.6	3.6	0	0	15	85	0	0	0	0	
	3	1:19	4.2	4.1	4.0	0	0	10	90	0	0	0	0	
	4	1:19	4.2	4.3	4.4	0	0	10	90	0	0	0	0	
	5	1:17	1.5	2.0	2.4	0	10	10	0	80	0	0	0	

Appendix 7. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Boulder	Unknown	
GR-28f	1	1:05	2.4	1.9	2.2	20	70	0	10	0	0	0	0	
	2	1:11	3.6	3.5	3.6	0	0	20	80	0	0	0	0	
	3	1:11	2.7	3.0	4.6	0	0	10	90	0	0	0	0	
	4	1:13	3.0	3.2	3.6	0	80	10	0	0	10	0	0	
	5	1:24	1.8	2.2	2.4	0	80	0	20	0	0	0	0	Towline slipped, had to retie - forgot to stop time
GR-29f	1	1:12	1.2	1.3	1.6	15	0	15	70	0	0	0	0	
	2	1:11	2.6	2.6	2.7	0	0	10	90	0	0	0	0	
	3	1:13	3.8	3.8	3.6	0	0	20	80	0	0	0	0	
	4	1:22	4.3	4.2	4.4	0	0	5	95	0	0	0	0	Snagged twice
	5	1:29		1.8	1.6	95	0	0	0	5	0	0	0	Snagged
GR-30f	1	1:10	2.2	2.0	2.0	10	50	30	10	0	0	0	0	
	2	1:09	4.1	4.1	4.0	10	0	80	10	0	0	0	0	
	3	1:10	3.5	3.7	3.6	0	0	80	20	0	0	0	0	
	4	1:14	3.2	3.1	3.1	0	0	90	10	0	0	0	0	
	5	1:15	1.8	1.7	1.5	10	50	40	0	0	0	0	0	
GR-31f	1	1:11	0.8	1.2	1.3	0	0	5	95	0	0	0	0	
	2	1:14	2.6	2.7	2.6	0	80	10	10	0	0	0	0	
	3	1:11	3.9	4.0	4.0	0	0	5	95	0	0	0	0	
	4	1:19	4.3	4.4	4.5	0	10	50	30	10	0	0	0	
	5	1:18	3.5	3.2	3.0	0	0	15	85	0	0	0	0	
GR-32f	1	1:07	0.7	0.8	1.0	0	0	30	70	0	0	0	0	
	2	1:11	3.3	3.1	3.2	0	0	40	60	0	0	0	0	
	3	1:19	4.3	4.1	4.0	0	0	50	50	0	0	0	0	
	4	1:24	4.3	4.1	4.5	0	0	50	30	20	0	0	0	
	5	1:17	1.1	1.2	1.1	20	70	0	10	0	0	0	0	
GR-33f	1	1:10	1.2	1.8	2.7	30	70	0	0	0	0	0	0	
	2	1:06	3.0	3.0	3.1	0	100	0	0	0	0	0	0	
	3	1:08	3.3	4.0	4.3	0	95	0	5	0	0	0	0	
	4	1:18	4.6	4.6	4.5	0	70	20	10	0	0	0	0	
	5	1:14	2.0	1.7	1.8	0	90	0	5	5	0	0	0	

Appendix 7. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Boulder	Unknown	
GR-34f	1	1:10	0.7	0.8	0.8	0	30	70	0	0	0	0	0	
	2	1:10	2.7	2.9	2.8	0	40	60	0	0	0	0	0	
	3	1:26	4.2	4.2	4.2	0	50	50	0	0	0	0	0	
	4	1:14	4.5	4.3	4.2	0	10	80	10	0	0	0	0	
	5	1:24	1.9	1.5	1.4	0	20	70	10	0	0	0	0	
GR-35f	1	1:07	1.7	1.5	1.3	0	70	30	0	0	0	0	0	
	2	1:07	1.6	1.5	1.6	0	100	0	0	0	0	0	0	
	3	1:17	3.4	2.4	1.4	0	100	0	0	0	0	0	0	
	4	1:09	3.5	3.6	3.5	0	0	30	20	50	0	0	0	
	5	1:17	0.9	2.1	3.0	0	60	30	10	0	0	0	0	
GR-36f	1	1:07	0.5	0.6	0.6	0	30	60	10	0	0	0	0	
	2	1:12	2.1	1.8	1.5	0	30	50	20	0	0	0	0	
	3	1:12	3.4	3.2	3.3	0	60	40	0	0	0	0	0	
	4	1:11	3.3	3.5	3.5	0	100	0	0	0	0	0	0	
	5	1:15	1.3	1.4	1.5	0	100	0	0	0	0	0	0	
GR-37f	1	1:05	0.8	0.8	0.8	0	50	50	0	0	0	0	0	
	2	1:07	0.9	0.9	0.9	0	50	50	0	0	0	0	0	
	3	1:11	1.4	1.4	1.5	0	40	50	10	0	0	0	0	
	4	1:13	2.8	2.7	2.8	0	50	50	0	0	0	0	0	
	5	1:11	1.3	1.3	1.2	0	60	40	0	0	0	0	0	
GR-38f	1	1:16	1.0	1.1	1.1	0	20	80	0	0	0	0	0	
	2	1:07	2.4	2.3	2.5	0	25	70	5	0	0	0	0	
	3	1:17	3.7	3.8	3.7	0	0	60	40	0	0	0	0	
	4	1:10	4.4	4.4	4.5	0	0	90	10	0	0	0	0	
	5	1:13	4.2	4.2	4.1	0	0	70	10	20	0	0	0	
GR-39f	1	1:10	0.9	0.9	0.9	0	30	50	20	0	0	0	0	
	2	1:15	2.8	2.8	2.7	20	20	40	10	10	0	0	0	
	3	1:14	4.0	3.7	3.5	0	60	30	10	0	0	0	0	
	4	1:11	0.9	0.9	1.0	0	40	30	30	0	0	0	0	
	5	1:11	2.6	2.3	1.7	20	45	25	10	0	0	0	0	
GR-40f	1	1:15	1.1	1.5	1.8	0	70	0	0	30	0	0	0	
	2	1:15	2.9	3.0	2.6	0	100	0	0	0	0	0	0	
	3	1:19	3.9	3.6	3.4	0	40	55	5	0	0	0	0	
	4	1:18	3.8	3.9	3.6	0	40	30	30	0	0	0	0	
	5	1:12	4.0	3.8	3.8	0	10	70	10	10	0	0	0	

Appendix 7. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Boulder	Unknown	
GR-41f	1	1:13	1.0	1.1	1.1	20	50	25	5	0	0	0	0	
	2	1:15	1.1	1.2	1.3	20	50	25	5	0	0	0	0	
	3	1:03	1.3	1.4	1.7	30	30	30	10	0	0	0	0	
	4	1:09	1.8	1.7	2.2	20	30	40	10	0	0	0	0	
	5	1:18	2.8	3.4	3.8	0	40	50	10	0	0	0	0	
GR-42f	1	1:11	1.0	1.0	0.9	80	0	10	10	0	0	0	0	
	2	1:19	1.8	2.0	2.1	0	70	0	30	0	0	0	0	
	3	1:10	4.2	4.0	4.4	0	80	10	10	0	0	0	0	
	4	1:10	0.9	0.9	1.0	60	20	0	20	0	0	0	0	
	5	1:20	2.4	2.8	3.0	70	15	0	15	0	0	0	0	
GR-43f	1	1:08	0.9	1.1	1.2	50	0	40	10	0	0	0	0	
	2	1:04	2.9	2.7	2.5	20	10	60	10	0	0	0	0	
	3	1:18	4.8	4.4	4.5	0	20	80	0	0	0	0	0	
	4	1:18	1.2	1.0	0.9	10	0	80	10	0	0	0	0	
	5	1:19	4.4	4.2	3.8	0	20	80	0	0	0	0	0	
GR-44f	1	1:18	0.9	1.0	1.1	30	55	0	15	0	0	0	0	
	2	1:15	2.3	2.9	3.4	20	70	0	10	0	0	0	0	
	3	1:20	4.2	4.2	4.3	30	70	0	0	0	0	0	0	
	4	1:13	0.9	0.9	1.0	60	30	0	10	0	0	0	0	
	5	1:16	2.9	2.8	2.7	50	40	0	10	0	0	0	0	
GR-45f	1	1:06	1.0	0.9	1.0	100	0	0	0	0	0	0	0	
	2	1:09	1.1	1.0	1.1	100	0	0	0	0	0	0	0	
	3	1:11	1.3	1.2	1.2	100	0	0	0	0	0	0	0	
	4	1:14	2.5	1.8	1.5	95	0	5	0	0	0	0	0	
	5	1:13	4.0	3.5	3.0	90	0	10	0	0	0	0	0	
GR-47f	1	1:10	0.9	0.9	2.0	20	0	70	10	0	0	0	0	
	2	1:04	3.7	1.6	1.4	10	0	80	10	0	0	0	0	
	3	1:09	0.9	1.1	1.2	0	10	90	0	0	0	0	0	
	4	1:07	1.5	1.4	1.4	0	20	60	20	0	0	0	0	
	5	1:11	3.6	3.4	3.0	0	20	80	0	0	0	0	0	
GR-48f	1	1:17	1.5	3.3	4.7	40	0	40	20	0	0	0	0	
	2	1:07	1.3	2.5	3.3	60	0	20	20	0	0	0	0	
	3	1:14	1.1	1.3	2.1	70	0	30	0	0	0	0	0	
	4	1:14	1.1	1.1	1.1	95	0	5	0	0	0	0	0	
	5	1:16	1.0	0.9	0.9	90	0	10	0	0	0	0	0	

Appendix 8. Transect-specific habitat characteristics for Thames River sites sampled by mussel brail trawl in the summer of 2022. A dash (-) indicates that no measurement was recorded. For transects with multiple passes measurements were only recorded once.

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Rubble	Unknown	
THR-01	1	1:00	4.1	3.6	3.6	0	0	0	0	90	0	10	0	
	2	0:59	4.3	4.4	4.1	0	0	0	0	0	0	0	100	Substrate was very difficult to get samples of, larger substrate could be preventing ponar from grabbing smaller substrate
	3	1:14	4.6	4.4	3.8	0	0	5	0	95	0	0	0	
	4	1:10	3.8	3.1	3.2	0	0	0	100	0	0	0	0	
THR-02	1	1:09	4.2	4.8	5.4	0	95	5	0	0	0	0	0	
	2	1:07	4.4	4.9	5.3	0	0	0	0	0	0	0	100	Could not get sample
	3	1:01	3.9	4.0	4.1	0	0	0	0	0	0	0	100	Teaspoon of sand plus woody debris
	4	1:12	2.6	3.0	3.4	0	0	0	100	0	0	0	0	
THR-03	1	1:19	2.4	2.0	2.1	0	5	25	70	0	0	0	0	
	2	1:28	2.8	2.6	2.3	0	0	15	85	0	0	0	0	
	3	1:18	3.5	3.5	4.0	5	0	15	80	0	0	0	0	
	4	1:28	5.1	5.3	5.1	0	75	25	0	0	0	0	0	
	5	1:16	4.5	5.3	4.8	0	95	5	0	0	0	0	0	
THR-04	1	0:57	4.7	4.6	4.3	0	95	5	0	0	0	0	0	
	2	1:01	5.4	5.3	5.1	0	95	5	0	0	0	0	0	
	3	1:24	4.4	4.3	4.5	5	0	10	85	0	0	0	0	
	4	1:22	3.5	3.8	4.3	0	0	5	95	0	0	0	0	
	5	1:16	2.1	2.8	3.1	5	0	25	70	0	0	0	0	
THR-05	1	1:19	2.0	1.9	1.5	0	5	45	50	0	0	0	0	
	2	1:23	2.8	2.4	1.8	5	10	40	45	0	0	0	0	
	3	1:03	2.9	2.9	3.1	0	0	15	85	0	0	0	0	
	4	1:10	4.0	4.0	3.8	0	90	5	5	0	0	0	0	
	5	1:23	4.1	3.5	3.0	0	85	10	5	0	0	0	0	
THR-06	1	1:39	4.8	4.5	4.2	0	100	0	0	0	0	0	0	
	2	1:20	4.4	5.1	4.5	0	0	0	0	0	0	0	100	Not a good sample
	3	1:12	4.6	4.3	3.9	0	0	10	90	0	0	0	0	
	4	1:01	3.1	3.1	3.4	0	0	15	85	0	0	0	0	
THR-07	1	1:11	2.4	2.3	2.5	20	0	80	0	0	0	0	0	
	2	1:26	3.2	3.4	3.4	0	0	20	80	0	0	0	0	
	3	1:12	4.0	4.0	4.3	0	0	5	95	0	0	0	0	
	4	1:17	5.0	5.0	5.2	0	90	10	0	0	0	0	0	
	5	1:03	4.8	4.4	4.6	0	90	5	0	5	0	0	0	

Appendix 8. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Rubble	Unknown	
THR-08	1	-	2.5	2.8	2.7	5	5	50	40	0	0	0	0	
	2	-	5.0	4.9	4.9	10	0	50	40	0	0	0	0	
	3	-	5.0	5.2	5.2	5	0	80	5	15	0	0	0	
	4	-	4.1	5.1	4.1	0	90	5	5	0	0	0	0	
THR-09	1	1:08	2.7	2.4	2.2	0	5	55	25	15	0	0	0	
	2	0:54	2.5	2.6	2.3	0	0	5	90	5	0	0	0	
	3	1:08	2.8	3.0	3.1	0	0	5	95	0	0	0	0	
	4	0:55	2.9	3.3	3.4	0	0	5	95	0	0	0	0	
	5	1:16	3.3	3.6	3.3	0	5	75	0	15	5	0	0	
THR-10	1	1:28	2.4	2.4	2.4	0	85	15	0	0	0	0	0	
	2	1:08	4.2	4.3	4.0	0	0	95	0	5	0	0	0	
	3	1:11	4.2	4.1	4.1	0	0	10	90	0	0	0	0	
	4	1:20	3.8	3.9	4.1	5	0	20	75	0	0	0	0	
	5	1:26	2.6	2.6	2.3	0	10	90	0	0	0	0	0	
THR-11	1	1:08	4.1	4.4	4.9	5	85	10	0	0	0	0	0	
	2	1:19	5.0	5.1	5.2	5	15	80	0	0	0	0	0	
	3	1:12	1.6	1.8	2.2	0	5	95	0	0	0	0	0	
THR-12	1	1:07	3.8	3.8	4.1	0	0	70	30	0	0	0	0	
	2	1:10	4.3	4.5	4.9	0	30	65	5	0	0	0	0	
	3	1:13	5.0	4.7	4.5	0	0	15	85	0	0	0	0	
	4	1:07	4.3	4.0	4.3	5	0	70	25	0	0	0	0	
	5	1:22	3.5	3.5	3.4	5	10	85	0	0	0	0	0	
THR-13	1	1:03	2.8	2.7	3.5	5	40	50	5	0	0	0	0	
	2	0:57	4.6	4.5	4.3	5	75	20	0	0	0	0	0	
	3	1:17	4.2	4.3	3.2	0	0	5	95	0	0	0	0	
	4	1:24	2.4	2.1	1.9	5	0	5	90	0	0	0	0	
THR-14	1	1:07	1.5	1.2	1.2	0	30	10	45	15	0	0	0	
	2	1:14	1.5	1.5	1.4	0	0	0	0	0	0	0	100	
	3	1:15	0.7	0.6	0.7	0	0	0	80	20	0	0	0	
THR-15	1	1:07	2.4	1.8	1.0	0	0	0	95	5	0	0	0	
	2	1:20	2.3	2.1	2.0	0	0	0	100	0	0	0	0	
	3	1:02	2.3	2.5	3.5	5	5	90	0	0	0	0	0	

Appendix 8. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Rubble	Unknown	
THR-16	1	1:06	3.1	2.1	1.3	5	0	5	90	0	0	0	0	
	2	1:08	2.7	2.4	2.2	0	0	0	100	0	0	0	0	
	3	1:11	2.9	2.8	3.0	0	0	15	85	0	0	0	0	
THR-17	1	1:08	2.0	2.2	2.6	0	0	0	35	65	0	0	0	
	2	1:11	1.6	2.0	2.4	0	0	0	100	0	0	0	0	
	3	1:20	2.0	2.0	2.3	0	0	0	15	85	0	0	0	
THR-18	1	1:11	2.3	2.0	2.5	0	0	0	0	0	0	0	100	No sample
	2	0:57	2.1	1.4	1.2	0	0	0	0	0	0	0	100	Bad sample of gravel and cobble
	3	1:11	1.4	1.1	1.1	0	0	5	80	15	0	0	0	
THR-19	1	1:07	0.7	0.8	1.5	0	0	5	95	0	0	0	0	
	2	1:10	1.5	1.7	1.9	0	0	0	100	0	0	0	0	
	3	0:59	2.6	2.8	2.6	0	0	0	70	30	0	0	0	
THR-20	1	1:10	1.8	2.0	2.4	0	0	0	0	0	0	0	100	No sample
	2	1:00	2.5	2.3	2.4	0	0	0	5	95	0	0	0	
	3	1:13	3.5	3.0	3.3	15	0	40	40	0	0	0	0	
THR-21	1	1:13	0.9	0.9	0.9	5	20	75	0	0	0	0	0	
	2	1:14	3.6	3.8	3.9	0	10	90	0	0	0	0	0	
	3	1:14	4.9	4.9	4.9	0	10	85	5	0	0	0	0	
	4	1:10	5.0	5.1	5.2	5	55	40	0	0	0	0	0	
	5	1:08	4.4	4.6	4.5	5	15	75	5	0	0	0	0	
THR-22	1	1:14	3.6	3.9	4.3	5	35	60	0	0	0	0	0	
	2	1:14	4.5	4.5	4.7	5	75	20	0	0	0	0	0	
	3	1:17	4.3	4.4	4.8	0	15	85	0	0	0	0	0	
	4	1:04	1.1	1.3	1.8	0	15	85	0	0	0	0	0	
THR-23	1	1:22	1.6	1.5	2.2	30	5	65	0	0	0	0	0	
	2	1:21	3.5	4.3	5.0	5	15	80	0	0	0	0	0	
	3	1:33	4.6	5.4	4.8	5	25	70	0	0	0	0	0	
	4	1:17	2.5	2.7	3.0	5	25	70	0	0	0	0	0	
THR-24	1	1:09	2.3	2.5	2.8	10	15	75	0	0	0	0	0	
	2	1:15	5.0	4.2	4.1	30	0	65	5	0	0	0	0	
	3	1:14	3.6	3.2	3.2	15	15	65	5	0	0	0	0	

Appendix 8. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Rubble	Unknown	
THR-25	1	1:21	4.0	3.5	3.7	0	85	15	0	0	0	0	0	
	2	1:07	5.2	5.1	5.4	0	0	5	95	0	0	0	0	
	3	1:04	3.1	2.7	2.7	0	0	15	85	0	0	0	0	
	4	1:04	1.9	1.4	1.7	0	0	20	80	0	0	0	0	
THR-26	1	1:03	2.3	2.3	2.2	15	15	65	0	5	0	0	0	
	2	1:05	3.6	4.3	4.0	0	60	40	0	0	0	0	0	
	3	1:09	5.1	5.1	5.3	5	0	60	35	0	0	0	0	
	4	1:07	4.4	4.3	4.4	5	0	20	70	5	0	0	0	
	5	1:10	3.5	2.9	3.5	10	0	65	10	15	0	0	0	
THR-27	1	1:13	3.2	3.8	3.7	0	85	10	0	5	0	0	0	
	2	1:16	4.3	5.0	5.5	0	65	30	0	0	5	0	0	
	3	1:09	4.4	4.8	5.0	20	0	10	70	0	0	0	0	
	4	1:11	3.9	4.3	4.7	5	5	30	60	0	0	0	0	
	5	1:09	1.8	2.5	2.9	5	80	15	0	0	0	0	0	
THR-28	1	1:10	4.7	4.6	3.6	10	35	55	0	0	0	0	0	
	2	1:19	5.0	4.9	4.8	0	0	50	45	5	0	0	0	
	3	1:06	5.0	5.1	5.3	10	40	10	40	0	0	0	0	
	4	1:13	5.2	5.2	5.0	5	0	70	0	25	0	0	0	
THR-29	1	1:07	1.3	1.4	1.3	0	0	0	0	0	0	0	100	Large rocks, cobble and gravel were found. No complete sample, deployed ponar twice.
	1	1:09	-	-	-	-	-	-	-	-	-	-	-	
	1	1:09	-	-	-	-	-	-	-	-	-	-	-	
	1	1:13	-	-	-	-	-	-	-	-	-	-	-	
	1	1:11	-	-	-	-	-	-	-	-	-	-	-	
	2	1:06	1.0	1.0	1.1	0	0	0	0	0	0	0	100	Large rocks, cobble and gravel were found. No complete sample, deployed ponar twice.
THR-30	1	1:10	0.8	0.8	1.0	0	0	5	95	0	0	0	0	
	2	1:04	2.1	2.5	2.4	0	0	15	85	0	0	0	0	
	3	1:19	2.7	2.5	3.1	0	0	0	0	0	0	0	100	Coarse substrate (gravel and cobble). No sample.

Appendix 8. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Rubble	Unknown	
THR-31	1	1:09	1.2	1.1	0.8	0	0	0	0	0	0	0	100	Coarse substrate. Small amount of sand and gravel, no sample.
	2	1:15	1.0	1.0	0.9	0	0	0	0	0	0	0	100	Coarse substrate, no sample.
	2	1:00	-	-	-	-	-	-	-	-	-	-	-	
	2	1:17	-	-	-	-	-	-	-	-	-	-	-	
	2	1:13	-	-	-	-	-	-	-	-	-	-	-	
	2	1:10	-	-	-	-	-	-	-	-	-	-	-	
THR-32	1	1:07	2.7	2.6	2.9	0	0	15	85	0	0	0	0	
	2	1:13	2.8	3.0	3.2	0	0	10	90	0	0	0	0	
	3	1:14	3.2	3.3	3.3	0	0	20	70	10	0	0	0	
THR-33	1	1:08	3.3	2.5	3.0	5	0	60	35	0	0	0	0	
	2	1:16	3.8	3.5	3.2	0	0	40	60	0	0	0	0	
	3	1:05	4.9	4.5	4.0	5	0	35	0	60	0	0	0	
THR-34	1	1:07	3.3	3.1	3.0	5	0	50	45	0	0	0	0	
	2	1:07	4.0	3.7	3.4	0	10	35	55	0	0	0	0	
	3	1:09	4.6	4.7	4.3	20	0	65	0	15	0	0	0	
	4	1:11	5.0	5.1	4.5	0	10	20	60	10	0	0	0	

Appendix 9. Transect-specific habitat characteristics for Sydenham River sites sampled by mussel brail trawl in the summer of 2022. A dash (-) indicates that no measurement was recorded. For transects with multiple passes measurements were only recorded once.

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Rubble	Unknown	
SYD-01	1	1:12	1.4	1.6	1.3	10	10	80	0	0	0	0	0	
	2	1:19	3.0	2.9	2.6	0	10	90	0	0	0	0	0	
	3	1:12	2.5	2.5	2.7	0	10	90	0	0	0	0	0	
	4	1:22	1.3	1.2	1.3	5	5	90	0	0	0	0	0	
SYD-02	1	1:14	2.7	2.8	2.5	15	10	65	0	10	0	0	0	
	2	1:19	3.2	3.2	3.2	10	0	90	0	0	0	0	0	
	3	1:18	2.9	2.8	2.4	5	0	95	0	0	0	0	0	
	4	1:11	1.0	0.8	0.7	10	10	80	0	0	0	0	0	
SYD-03	1	1:15	2.8	3.0	2.8	5	25	70	0	0	0	0	0	
	2	1:08	3.1	3.2	3.2	10	20	70	0	0	0	0	0	
	3	1:25	2.5	2.6	2.9	10	40	50	0	0	0	0	0	
	4	1:08	1.2	1.5	1.3	15	15	70	0	0	0	0	0	
SYD-04	1	1:27	2.2	2.6	2.6	40	0	60	0	0	0	0	0	
	2	1:04	3.2	3.3	3.2	30	10	60	0	0	0	0	0	
	3	1:09	3.3	3.3	3.2	25	0	75	0	0	0	0	0	
	4	1:11	3.2	2.8	2.8	25	5	70	0	0	0	0	0	
	5	1:15	0.8	0.7	0.9	15	5	80	0	0	0	0	0	Dreissenid mussel shells pulled up with Ponar Catch (multiple WVs).
SYD-05	1	1:04	1.2	1.8	1.2	60	5	45	0	0	0	0	0	
	2	2:00	3.1	3.2	3.3	30	0	70	0	0	0	0	0	
	3	1:11	3.6	3.7	3.7	20	0	80	0	0	0	0	0	
	4	2:38	2.7	2.9	3.4	45	5	50	0	0	0	0	0	
	5	1:11	1.0	1.1	1.4	50	0	35	5	10	0	0	0	
SYD-06	1	1:13	3.1	3.2	3.0	5	90	5	0	0	0	0	0	
	2	1:19	4.0	3.9	3.5	10	5	85	0	0	0	0	0	
	3	1:15	2.2	3.1	3.1	5	15	75	5	0	0	0	0	
SYD-07	1	1:02	4.0	3.5	3.6	45	5	50	0	0	0	0	0	
	2	1:08	4.1	4.6	4.7	15	0	45	40	0	0	0	0	
	3	1:05	2.7	2.5	2.0	20	70	10	0	0	0	0	0	
SYD-08	1	1:17	1.9	2.6	2.7	10	80	0	5	5	0	0	0	
	2	1:18	4.5	4.1	3.6	35	5	60	0	0	0	0	0	
	3	1:10	4.7	4.7	4.6	35	5	55	5	0	0	0	0	
	4	1:13	1.7	1.3	1.8	30	10	60	0	0	0	0	0	

Appendix 9. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Rubble	Unknown	
SYD-09	1	1:04	3.2	3.9	3.8	65	5	15	15	0	0	0	0	
	2	1:20	4.8	5.1	5.2	5	45	50	0	0	0	0	0	
	3	1:15	2.1	2.7	3.8	20	10	70	0	0	0	0	0	
SYD-10	1	1:09	1.9	1.8	2.4	30	0	60	5	5		0	0	
	2	1:09	4.6	4.9	4.8	15	0	85	0	0	0	0	0	
	3	1:06	4.7	4.8	4.4	15	0	85	0	0	0	0	0	
	4	1:30	2.1	1.8	1.3	25	30	30	5	0	0	0	0	
SYD-11	1	1:04	1.7	1.8	1.9	10	75	15	0	0	0	0	0	
	2	1:03	3.9	3.9	3.9	5	10	85	0	0	0	0	0	
	3	1:25	1.3	2.6	2.1	10	80	10	0	0	0	0	0	
SYD-12	1	1:17	1.5	2.2	2.1	25	10	35	30	0	0	0	0	
	2	1:07	3.2	2.8	2.8	5	0	15	0	70	10	0	0	3 samples were taken, however, not a great sample because of larger substrate
	3	1:14	2.8	3.4	3.3	15	75	5	5	0	0	0	0	
SYD-13	1	1:15	3.7	3.4	3.8	5	80	5	0	10	0	0	0	
	2	1:20	4.1	4.3	4.2	0	10	15	5	70	0	0	0	
	3	1:15	2.4	2.2	2.3	20	20	60	0	0	0	0	0	
SYD-14	1	1:18	3.6	4.0	3.9	15	10	75	0	0	0	0	0	
	2	1:26	3.6	3.8	4.1	10	0	10	0	80	0	0	0	
	3	1:08	2.9	2.8	2.8	0	90	10	0	0	0	0	0	
SYD-15	1	1:20	3.0	3.4	3.8	10	25	60	5	0	0	0	0	
	2	1:03	3.2	3.7	3.8	5	5	15	75	0	0	0	0	
	3	1:12	2.9	2.6	2.3	0	85	10	0	5	0	0	0	
SYD-16	1	1:25	1.2	1.2	1.1	20	55	25	0	0	0	0	0	
	2	1:00	2.1	2.1	2.1	20	65	15	0	0	0	0	0	
	3	1:24	1.1	1.3	1.4	30	0	70	0	0	0	0	0	
SYD-17	1	1:04	1.3	1.6	1.5	35	15	45	5	0	0	0	0	
	2	1:05	2.2	2.3	2.3	10	60	20	0	10	0	0	0	
	3	1:18	1.7	1.9	1.8	20	20	5	0	25	30	0	0	Tried 3 times, may not be a representative sample
SYD-18	1	1:16	2.5	2.3	2.0	20	0	10	0	70	0	0	0	Tried 3 times, may not be a representative sample
	2	1:23	2.5	2.8	2.7	25	35	25	0	15	0	0	0	
	3	1:20	1.6	1.5	1.2	45	30	25	0	0	0	0	0	

Appendix 9. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Rubble	Unknown	
SYD-19	1	1:18	1.5	1.9	2.0	5	55	40	0	0	0	0	0	
	2	1:15	2.5	2.6	2.5	15	55	30	0	0	0	0	0	
	3	1:25	1.7	1.7	1.1	15	60	25	0	0	0	0	0	
SYD-20	1	1:25	1.9	2.1	2.2	20	35	40	5	0	0	0	0	
	2	1:03	2.4	2.6	2.6	25	45	25	5	0	0	0	0	
	3	1:17	1.5	1.1	0.8	15	65	20	0	0	0	0	0	
SYD-21	1	1:08	2.0	1.6	1.4	60	25	15	0	0	0	0	0	
	2	0:54	2.4	2.4	2.5	25	45	30	0	0	0	0	0	
	3	1:12	2.3	1.8	1.8	20	50	25	0	5	0	0	0	
SYD-22	1	1:04	1.4	1.4	1.5	75	0	25	0	0	0	0	0	
	2	1:16	2.8	2.8	2.7	20	5	75	0	0	0	0	0	
	3	1:05	2.8	2.9	3.1	5	85	10	0	0	0	0	0	
	4	1:05	2.0	2.5	2.6	10	30	60	0	0	0	0	0	
	5	1:15	0.8	0.8	1.0	15	50	35	0	0	0	0	0	
SYD-23	1	1:08	1.5	1.6	1.5	5	20	75	0	0	0	0	0	
	2	1:12	2.7	2.5	2.6	15	65	20	0	0	0	0	0	
	3	1:10	3.0	2.9	3.0	5	65	30	0	0	0	0	0	
	4	1:27	2.8	2.9	2.8	25	20	55	0	0	0	0	0	
SYD-24	1	1:26	2.3	2.7	2.3	35	20	45	0	0	0	0	0	
	2	1:11	2.8	2.8	2.9	10	75	15	0	0	0	0	0	
	3	1:19	2.6	2.6	2.0	20	50	15	0	15	0	0	0	
SYD-25	1	1:03	2.1	2.3	2.6	0	20	70	0	10	0	0	0	
	2	1:06	3.0	2.9	3.0	5	60	25	0	0	0	0	0	
	3	1:05	2.6	2.6	2.7	5	20	65	0	10	0	0	0	
SYD-26	1	1:06	1.1	1.1	1.0	10	0	5	10	75	0	0	0	
SYD-27	1	1:21	0.9	1.1	1.6	10	60	30	0	0	0	0	0	
	2	1:16	1.2	1.3	1.4	10	0	35	15	40	0	0	0	
SYD-28	1	1:10	1.2	1.4	1.6	10	65	25	0	0	0	0	0	
	2	1:16	1.4	1.3	1.6	10	0	55	20	15	0	0	0	
SYD-29	1	1:18	0.8	1.0	0.9	0	0	0	0	0	0	0	100	Could not get a sample as there were shells and large rocks
	2	1:24	0.7	1.2	1.7	0	0	0	30	70	0	0	0	
SYD-30	1	1:30	2.6	2.7	3.0	0	95	0	0	5	0	0	0	
	2	1:10	2.8	2.4	2.0	0	0	0	0	100	0	0	0	

Appendix 9. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Rubble	Unknown	
SYD-31	1	1:03	1.9	1.7	1.5	0	0	0	0	0	0	0	100	Not a good sample. Some cobble and clay was grabbed.
	1	1:10	-	-	-	-	-	-	-	-	-	-	-	
	1	1:01	-	-	-	-	-	-	-	-	-	-	-	
	1	1:01	-	-	-	-	-	-	-	-	-	-	-	
	1	1:05	-	-	-	-	-	-	-	-	-	-	-	
SYD-32	1	1:14	1.0	1.1	1.1	10	55	35	0	0	0	0	0	
	1	1:16	-	-	-	-	-	-	-	-	-	-	-	
	2	1:12	1.4	1.3	1.1	30	0	55	0	15	0	0	0	
	2	1:19	-	-	-	-	-	-	-	-	-	-	-	
SYD-33	1	1:15	1.2	1.0	1.3	0	20	55	0	25	0	0	0	
	1	1:12	-	-	-	-	-	-	-	-	-	-	-	
	2	1:21	1.1	0.7	1.0	10	0	20	70	0	0	0	0	Hit a bad snag approximately 1/2 way though, this lead to us pulling brail in and redeploying after snag
SYD-34	1	1:20	1.2	1.0	1.2	10	35	55	0	0	0	0	0	
	2	1:07	1.6	1.6	1.5	15	15	55	0	15	0	0	0	
	2	1:11	-	-	-	-	-	-	-	-	-	-	-	
SYD-35	1	1:16	1.3	1.3	1.1	0	0	0	0	0	0	0	100	Coarse substrate, could not get a proper sample.
	1	1:21	-	-	-	-	-	-	-	-	-	-	-	
	1	1:20	-	-	-	-	-	-	-	-	-	-	-	
	1	1:25	-	-	-	-	-	-	-	-	-	-	-	
	1	1:20	-	-	-	-	-	-	-	-	-	-	-	
SYD-36	1	1:17	1.1	1.2	1.2	0	0	0	0	0	0	0	100	Coarse substrate (some gravel, cobble and sand). No sample
	2	1:09	1.3	1.2	1.4	0	0	0	0	0	0	0	100	Coarse substrate, no sample.
	2	1:04	-	-	-	-	-	-	-	-	-	-	-	
	2	1:10	-	-	-	-	-	-	-	-	-	-	-	
	2	1:10	-	-	-	-	-	-	-	-	-	-	-	
	2	1:08	-	-	-	-	-	-	-	-	-	-	-	

Appendix 9. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Rubble	Unknown	
SYD-37	1	1:15	0.9	1.2	1.1	0	0	5	75	20	0	0	0	
	2	1:14	0.9	1.0	0.9	0	0	20	0	80	0	0	0	
	2	1:09	-	-	-	-	-	-	-	-	-	-	-	
	2	1:16	-	-	-	-	-	-	-	-	-	-	-	
	2	1:12	-	-	-	-	-	-	-	-	-	-	-	
	2	1:16	-	-	-	-	-	-	-	-	-	-	-	

Appendix 10. Transect-specific habitat characteristics for Ausable River sites sampled by mussel brail trawl in the summer of 2022. A dash (-) indicates that no measurement was recorded. For transects with multiple passes measurements were only recorded once.

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Rubble	Unknown	
AUS-01	1	1:14	1.6	1.8	1.9	10	70	20	0	0	0	0	0	
	2	1:20	2.4	2.2	2.2	10	5	20	60	5	0	0	0	
	3	1:20	2.5	2.5	2.5	0	0	30	70	0	0	0	0	
	4	1:13	2.6	2.5	2.4	5	5	30	60	0	0	0	0	
	5	1:23	2.4	2.2	1.8	5	35	50	10	0	0	0	0	
AUS-02	1	1:06	1.8	1.8	1.9	0	0	10	25	65	0	0	0	
	2	1:10	2.0	2.1	1.7	5	0	10	80	5	0	0	0	
	3	1:14	1.5	1.0	1.2	0	5	65	0	20	10	0	0	Lost a Threeridge off brail, length approximately 110mm
	4	1:25	1.2	1.2	1.2	0	0	10	40	50	0	0	0	
AUS-03	1	1:07	2.4	2.4	2.3	5	80	15	0	0	0	0	0	
	2	1:15	3.1	2.6	2.3	15	10	30	45	0	0	0	0	
	3	1:09	3.0	2.6	2.3	10	0	45	45	0	0	0	0	
	4	1:11	2.7	2.5	2.6	0	25	20	55	0	0	0	0	
AUS-04	1	1:06	1.5	1.7	1.1	25	40	35	0	0	0	0	0	
	2	1:14	2.1	2.2	2.2	5	0	75	5	15	0	0	0	
	3	1:27	2.4	2.3	2.3	5	5	15	35	5	0	0	0	
	4	1:02	2.5	2.5	2.4	5	70	25	0	0	0	0	0	
AUS-05	1	1:01	4.0	3.5	3.2	5	75	15	5	0	0	0	0	
	2	1:15	3.0	2.4	2.4	0	5	20	75	0	0	0	0	
	3	1:15	1.8	1.4	2.2	10	0	25	65	0	0	0	0	
AUS-06	1	1:14	2.2	1.9	2.1	5	0	50	0	45	0	0	0	
	2	0:58	2.0	1.8	1.6	0	0	10	20	70	0	0	0	
	3	1:17	1.6	1.7	1.3	20	0	20	60	0	0	0	0	
AUS-07	1	1:13	1.8	1.7	1.6	0	0	0	100	0	0	0	0	
	2	1:07	3.1	2.6	2.2	5	0	20	0	75	0	0	0	
	2	1:14	-	-	-	-	-	-	-	-	-	-	-	
	2	1:12	-	-	-	-	-	-	-	-	-	-	-	
AUS-08	1	1:07	3.0	3.0	3.6	10	0	15	75	0	0	0	0	
	1	1:20	-	-	-	-	-	-	-	-	-	-	-	
	2	1:21	3.4	3.1	2.9	5	50	45	0	0	0	0	0	
AUS-09	1	1:11	2.8	2.5	2.2	5	70	15	10	0	0	0	0	
	2	1:08	2.7	2.7	2.5	5	5	15	5	70	0	0	0	
	2	1:20	-	-	-	-	-	-	-	-	-	-	-	

Appendix 10. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)							Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Rubble	Unknown	
AUS-10	1	1:08	2.7	2.8	2.6	0	70	30	0	0	0	0	0	
	1	1:00	-	-	-	-	-	-	-	-	-	-	-	
	2	1:15	2.9	2.5	2.7	5	55	10	0	30	0	0	0	
AUS-11	1	1:18	1.5	1.1	1.0	5	70	25	0	0	0	0	0	
	2	1:22	1.7	1.6	1.6	10	80	10	0	0	0	0	0	
	3	1:05	1.8	1.8	1.6	10	20	65	5	0	0	0	0	
	4	1:09	1.6	1.8	1.8	5	65	30	0	0	0	0	0	
AUS-12	1	0:57	1.8	1.8	2.1	15	0	45	40	0	0	0	0	
	2	1:11	2.2	2.1	2.2	10	0	45	45	0	0	0	0	
	3	1:04	2.6	2.6	2.6	10	0	60	30	0	0	0	0	
	4	0:56	2.6	2.8	2.7	5	60	25	5	5	0	0	0	
AUS-13	1	1:15	2.4	2.4	2.5	5	5	40	50	0	0	0	0	
	2	1:30	2.6	2.6	2.6	0	0	0	95	5	0	0	0	
	3	1:20	2.4	2.5	2.2	5	80	15	0	0	0	0	0	
AUS-14	1	1:09	3.0	3.4	3.3	0	5	20	5	70	0	0	0	
	2	1:07	1.8	2.6	2.0	0	0	0	0	0	0	0	100	Could not get a sample. Some clay, sand and gravel was pulled up in the PONAR.
	2	1:16	-	-	-	-	-	-	-	-	-	-	-	
AUS-15	1	1:16	3.5	3.9	3.8	5	20	60	5	10	0	0	0	
	2	1:10	2.3	3.5	2.7	0	50	15	15	20	0	0	0	
	2	0:59	-	-	-	-	-	-	-	-	-	-	-	
	2	0:59	-	-	-	-	-	-	-	-	-	-	-	
AUS-16	1	1:25	2.8	2.6	2.6	10	80	10	0	0	0	0	0	
	2	1:21	2.7	2.7	2.6	0	0	10	85	5	0	0	0	
	3	1:15	3.0	2.8	2.8	0	5	35	20	45	0	0	0	
AUS-17	1	1:03	2.3	2.7	2.5	0	80	20	0	0	0	0	0	
	2	1:11	2.5	2.6	2.7	5	0	15	80	0	0	0	0	
	3	1:03	2.5	2.3	2.3	5	15	70	10	0	0	0	0	
AUS-18	1	1:16	2.7	1.9	1.8	0	0	80	20	0	0	0	0	
	2	1:13	2.5	2.2	2.1	0	0	5	95	0	0	0	0	
	3	1:10	2.2	2.5	2.6	0	0	50	50	0	0	0	0	
	4	1:10	2.0	2.2	2.5	10	75	15	0	0	0	0	0	

Appendix 10. *(Continued)*

Site code	Transect	Trawl time (min:sec)	Water depth 1 (m)	Water depth 2 (m)	Water depth 3 (m)	Substrate composition (%)								Comments
						Organic	Clay	Silt	Sand	Gravel	Cobble	Rubble	Unknown	
AUS-19	1	1:03	2.4	2.5	1.8	10	80	10	0	0	0	0	0	
	2	1:05	4.2	4.3	4.2	30	0	55	15	0	0	0	0	
	3	1:21	4.1	3.8	4.0	10	60	25	5	0	0	0	0	
AUS-20	1	1:20	3.6	3.7	3.3	5	60	35	0	0	0	0	0	
	2	1:05	4.0	3.8	3.9	5	10	30	55	0	0	0	0	
	2	1:11	-	-	-	-	-	-	-	-	-	-	-	
AUS-21	1	1:13	1.6	2.5	2.5	10	60	25	5	0	0	0	0	
	2	1:14	1.8	2.0	2.2	10	45	45	0	0	0	0	0	
	3	1:13	1.9	2.1	2.1	5	60	35	0	0	0	0	0	
	4	1:11	2.1	1.9	1.5	5	45	50	0	0	0	0	0	
AUS-22	1	1:10	2.4	2.4	2.3	10	20	60	10	0	0	0	0	
	2	1:15	2.7	2.8	2.7	20	0	40	40	0	0	0	0	
	3	1:13	2.7	2.7	2.7	30	0	50	20	0	0	0	0	
	4	1:17	2.5	2.7	2.8	10	20	70	0	0	0	0	0	
	5	1:14	2.3	2.4	2.3	5	0	55	40	0	0	0	0	
AUS-23	1	1:12	1.9	2.0	1.7	0	0	20	0	65	15	0	0	
	2	1:08	2.6	2.8	2.7	0	0	70	5	25	0	0	0	
	3	1:11	2.3	2.2	2.2	5	0	25	50	15	5	0	0	
	4	1:09	1.8	1.7	1.9	10	60	30	0	0	0	0	0	

Appendix 11. Field sheet template for transect-based mussel brail trawl surveys.

SAR Mussel Brail Data Sheet

Project Name: **2022 Brail Trawl Survey**		Date (dd/mm/yyyy):
Collectors:		
Site Number: **2022-BRSR-**	Waterbody Name:	Waterbody Type:
Gear Description: **Brail Trawl**	Sampling Method: **Transect**	
Weather Conditions: **Sunny / Mixed Sun and Cloud / Cloudy / Rain**		Weather Notes:
Arrival Time:	Departure Time:	Site Photo Numbers:
Stream Width (m):	Site Width (m):	Distance between transects (m):

Site Map

Sample start time:			Sample end time:		
	Transect 1	Transect 2	Transect 3	Transect 4	Transect 5
Start Lat/Long	+ ___._____ - ___._____	+ ___._____ - ___._____	+ ___._____ - ___._____	+ ___._____ - ___._____	+ ___._____ - ___._____
Stop Lat/Long	+ ___._____ - ___._____	+ ___._____ - ___._____	+ ___._____ - ___._____	+ ___._____ - ___._____	+ ___._____ - ___._____
Time (min:sec)					
Depths (m)					
Habitat sample start time:			Habitat sample end time:		
Substrate (≥5% Σ 100%)					
Water temperature (°C):			Conductivity (µS/cm):		
Notes:					

Appendix 11. *(Continued)*

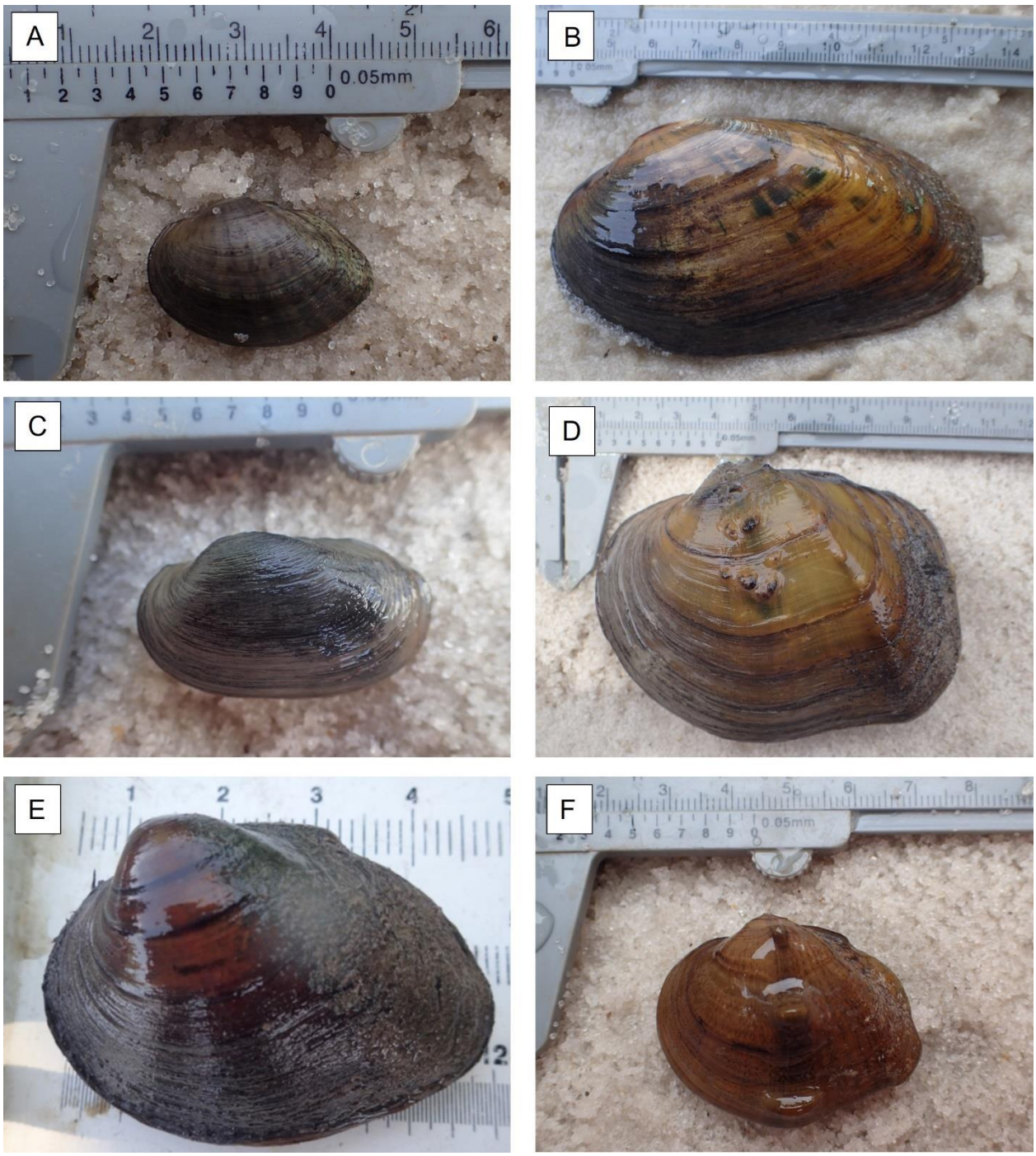
Site Number: **2022-BRSR-**		
Processing start time:	Processing end time:	
Brail Transect: **No. ____ of __**		
Species	Lengths (mm) and Photo Numbers [ex. 101(23-27)]	Notes
Notes:		

Brail Transect: **No. ____ of __**		
Species	Lengths (mm) and Photo Numbers [ex. 101(23-27)]	Notes
Notes:		

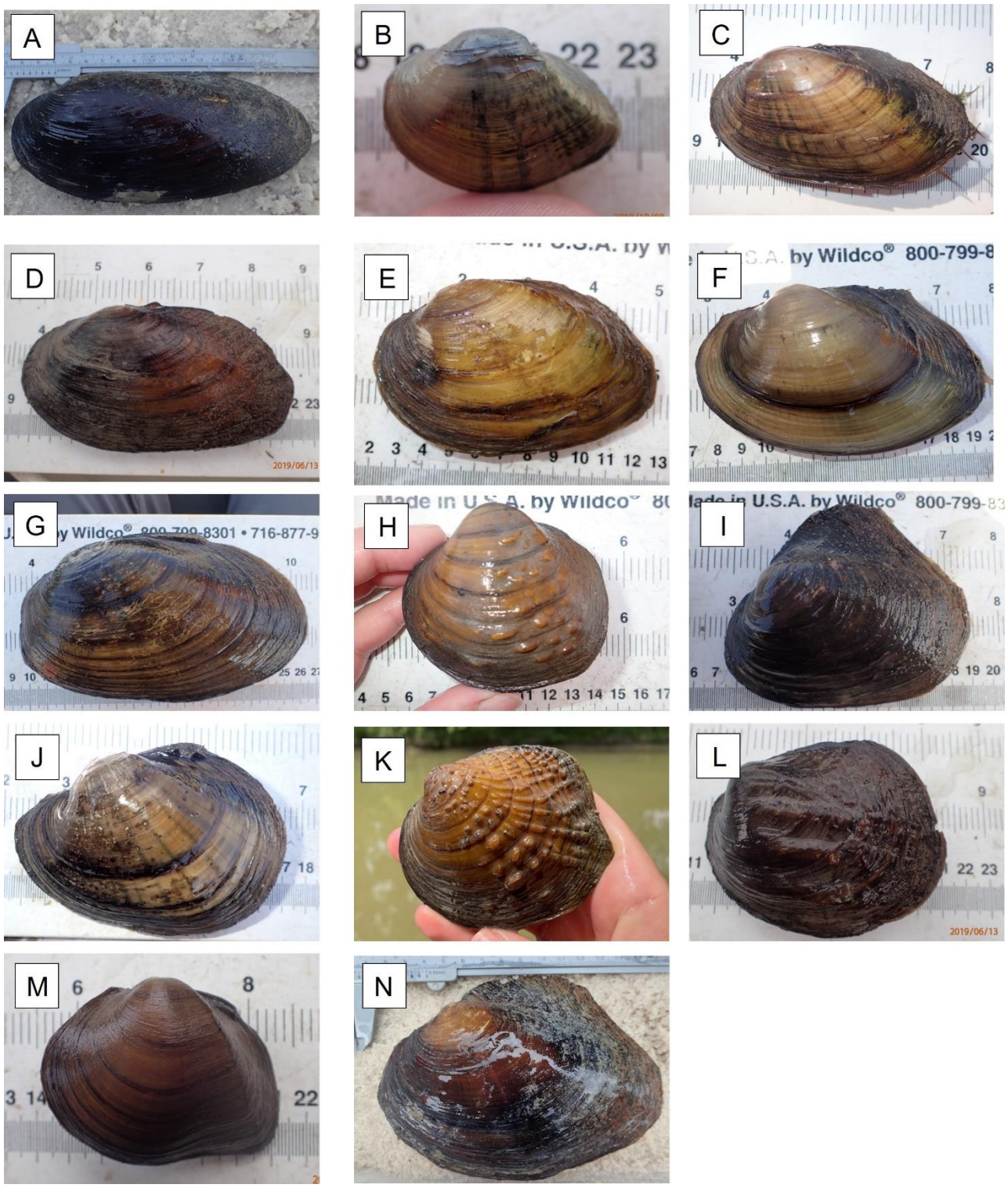
Appendix 12. Common and scientific names for mussel species (https://www.molluscabase.org/) detected during brail trawl surveys on the Grand River in 2019 and the Thames, Sydenham and Ausable rivers in 2022. Species in bold were detected only as shell.

Common name	Scientific name
Black Sandshell	*Ligumia recta*
Deertoe	*Truncilla truncata*
Eastern Pondmussel	***Sagittunio nasutus***
Fatmucket	*Lampsilis siliquoidea*
Fawnsfoot	*Truncilla donaciformis*
Flutedshell	*Lasmigona costata*
Fragile Papershell	*Potamilus fragilis*
Giant Floater	*Pyganodon grandis*
Kidneyshell	*Ptychobranchus fasciolaris*
Lilliput	*Toxolasma parvum*
Mapleleaf	*Quadrula quadrula*
Mucket	*Ortmanniana ligamentina*
Paper Pondshell	***Utterbackia imbecillis***
Pimpleback	*Cyclonaias pustulosa*
Pink Heelsplitter	*Potamilus alatus*
Plain Pocketbook	*Lampsilis cardium*
Purple Wartyback	*Cyclonaias tuberculata*
Round Pigtoe	*Pleuroblema sintoxia*
Slippershell	***Alasmidonta viridus***
Spike	***Eurynia dilitata***
Threehorn Wartyback	*Obliquaria reflexa*
Threeridge	*Amblema plicata*
Wabash Pigtoe	*Fusconaia flava*
White Heelsplitter	*Lasmigona complanata*

Appendix 13. Photos of live mussel species at risk detected during brail trawl surveys (including those collected by Ponar) on the Grand River in 2019 and the Thames, Sydenham and Ausable rivers in 2022. Species are shown in alphabetical order by common name: A) Fawnsfoot (*Truncilla donaciformis*), B) Kidneyshell (*Ptychobranchus facsciolaris*), C) Lilliput (*Toxolasma parvum*), Mapleleaf (*Quadrula quadrula*), E) Round Pigtoe (*Pleurobema sintoxia*), and F) Threehorn Wartyback (*Obliquaria reflexa*).



Appendix 14. Photos of live mussel species (except species at risk) detected during brail trawl surveys (including those collected by Ponar) on the Grand River in 2019 and the Thames, Sydenham and Ausable rivers in 2022. Species are shown in alphabetical order by common name: A) Black Sandshell (*Ligumia recta*), B) Deertoe (*Truncilla truncata*), C) Fatmucket (*Lampsilis siliquoidea*), D) Flutedshell (*Lasmigona costata*), E) Fragile Papershell (*Potamilus fragilis*), F) Giant Floater (*Pyganodon grandis*), Mucket (*Ortmanniana ligamentina*), H) Pimpleback (*Cyclonaias pustulosa*), I) Pink Heelsplitter (*Potamilus alatus*), J) Plain Pocketbook (*Lampsilis cardium*), K) Purple Wartyback (*Cyclonaias tuberculata*), L), Threeridge (*Amblema plicata*), M) Wabash Pigtoe (*Fusconaia flava*), and N) White Heelsplitter (*Lasmigona complanata*).



Appendix 15. Summary of individuals collected by brail trawl from 48 sites along the lower Grand River in the summer of 2019.

Site	Black Sandshell	Fatmucket	Flutedshell	Fragile Papershell	Giant Floater	Mapleleaf	Mucket	Pimpleback	Pink Heelsplitter	Plain Pocketbook	Round Pigtoe	Threehorn Wartyback	Threeridge	Unknown Juvenile	Wabash Pigtoe	**Total # Individuals**
GR-01s	2	0	0	0	0	0	6	0	0	1	0	0	0	0	0	**9**
GR-02s	3	2	0	0	0	0	10	0	0	1	1	0	5	0	0	**22**
GR-03s	10	0	0	0	0	0	49	0	0	2	6	0	27	0	0	**94**
GR-04s	11	1	2	0	0	0	46	0	0	4	12	0	24	2	0	**102**
GR-05s	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	**2**
GR-06s	1	0	0	0	0	1	1	0	0	0	0	0	3	0	0	**6**
GR-07s	6	7	1	1	0	1	37	0	0	0	1	0	10	0	0	**64**
GR-08s	0	7	0	0	0	0	15	0	0	0	3	0	23	0	0	**48**
GR-09s	3	2	1	0	0	0	9	0	0	0	1	0	15	0	0	**31**
GR-10s	1	2	2	0	0	0	5	0	0	0	0	0	2	0	0	**12**
GR-11s	2	1	2	0	0	0	11	0	0	0	3	0	13	0	0	**32**
GR-12s	4	1	1	0	0	0	8	0	0	0	0	0	13	0	0	**27**
GR-13s	0	1	0	0	0	0	2	0	0	0	0	0	2	0	0	**5**
GR-14s	0	1	0	0	0	1	2	0	0	0	0	0	6	0	0	**10**
GR-15s	5	3	0	0	0	0	7	0	0	0	1	0	5	0	0	**21**
GR-16s	1	0	1	0	0	0	1	1	1	0	0	0	1	0	0	**6**
GR-17s	0	0	0	0	0	1	1	1	0	0	0	0	1	0	0	**4**
GR-18s	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	**3**
GR-19s	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**1**
GR-20s	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	**3**
GR-21s	0	0	0	0	0	5	0	1	0	0	0	0	3	0	1	**10**
GR-22s	0	0	0	0	0	4	0	2	1	0	0	1	1	0	0	**9**
GR-23s	0	0	0	0	0	2	0	2	0	0	0	0	0	0	1	**5**
GR-24s	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	**3**
GR-25s	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	**3**
GR-26s	0	0	0	0	0	3	0	2	0	0	0	0	0	0	0	**5**
GR-27s	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	**2**
GR-28s	0	0	0	0	0	5	0	1	0	0	0	0	0	0	3	**9**
GR-29s	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	**6**
GR-30s	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	**3**
GR-31s	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	**3**
GR-32s	0	0	0	0	0	3	0	1	0	0	0	1	0	0	2	**7**
GR-33s	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	**2**
GR-34s	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**1**
GR-35s	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**1**
GR-36s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
GR-37s	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**1**
GR-38s	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	**2**
GR-39s	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**1**

Appendix 15. *(Continued)*

Site	Black Sandshell	Fatmucket	Flutedshell	Fragile Papershell	Giant Floater	Mapleleaf	Mucket	Pimpleback	Pink Heelsplitter	Plain Pocketbook	Round Pigtoe	Threehorn Wartyback	Threeridge	Unknown Juvenile	Wabash Pigtoe	**Total # Individuals**
GR-40s	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	**3**
GR-41s	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	**2**
GR-42s	0	0	0	0	0	5	0	0	0	0	0	1	0	0	0	**6**
GR-43s	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**1**
GR-44s	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	**2**
GR-45s	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	**3**
GR-46s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
GR-47s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
GR-48s	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	**4**

Appendix 16. Summary of individuals collected by brail trawl from 48 sites along the lower Grand River in the autumn of 2019.

Site	Black Sandshell	Deertoe	Fatmucket	Flutedshell	Fragile Papershell	Giant Floater	Mapleleaf	Mucket	Pimpleback	Pink Heelsplitter	Plain Pocketbook	Round Pigtoe	Threehorn Wartyback	Threeridge	Unknown Juvenile	Wabash Pigtoe	**Total # Individuals**
GR-03f	0	0	2	0	0	0	0	4	0	0	0	5	0	7	1	0	**19**
GR-04f	0	0	1	1	0	0	0	11	0	0	0	5	0	4	0	0	**22**
GR-05f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
GR-06f	0	0	1	0	0	0	0	2	0	0	1	0	0	5	0	0	**9**
GR-07f	10	0	3	1	0	0	1	4	0	1	0	1	0	1	0	0	**22**
GR-08f	0	0	1	0	0	0	0	2	0	0	0	1	0	3	0	0	**7**
GR-09f	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	**3**
GR-10f	0	0	0	1	0	0	0	1	0	0	0	2	0	2	1	0	**7**
GR-11f	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	**3**
GR-12f	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	**1**
GR-13f	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	**2**
GR-14f	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	**3**
GR-15f	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	**2**
GR-16f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**1**
GR-17f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
GR-18f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
GR-19f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
GR-20f	0	1	0	0	0	0	2	0	1	1	0	0	0	0	0	0	**5**
GR-21f	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	**2**
GR-22f	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**
GR-23f	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**1**
GR-24f	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	**3**
GR-25f	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	**2**
GR-26f	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	**2**
GR-27f	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**1**
GR-28f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
GR-29f	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**1**
GR-30f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
GR-31f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
GR-32f	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**1**
GR-33f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
GR-34f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
GR-35f	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	**3**
GR-36f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
GR-37f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
GR-38f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
GR-39f	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	**3**

Appendix 16. *(Continued)*

Site	Black Sandshell	Deertoe	Fatmucket	Flutedshell	Fragile Papershell	Giant Floater	Mapleleaf	Mucket	Pimpleback	Pink Heelsplitter	Plain Pocketbook	Round Pigtoe	Threehorn Wartyback	Threeridge	Unknown Juvenile	Wabash Pigtoe	**Total # Individuals**
GR-40f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
GR-41f	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	**2**
GR-42f	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	**2**
GR-43f	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**1**
GR-44f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
GR-45f	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	**2**
GR-47f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
GR-48f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**

Appendix 17. Summary of individuals collected by brail trawl from 34 sites on the Thames River in the summer of 2022.

Site Code	Black Sandshell	Deertoe	Fawnsfoot	Flutedshell	Fragile Papershell	Giant Floater	Mapleleaf	Mucket	Pimpleback	Pink Heelsplitter	Threehorn Wartyback	Threeridge	Unknown Juvenile	White Heelsplitter	**Total # individuals**
THR-01	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**1**
THR-02	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**1**
THR-03	1	0	0	0	0	0	0	0	0	0	0	1	0	0	**2**
THR-04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
THR-05	1	0	1	0	0	1	0	0	0	1	0	0	0	0	**4**
THR-06	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**1**
THR-07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
THR-08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
THR-09	0	0	0	0	0	0	1	1	0	0	1	0	0	0	**3**
THR-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
THR-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
THR-12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
THR-13	0	0	0	0	0	0	1	0	0	0	0	0	0	1	**2**
THR-14	0	0	0	0	0	0	2	4	1	0	0	0	0	0	**7**
THR-15	0	0	0	0	1	0	0	1	1	0	0	0	0	0	**3**
THR-16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
THR-17	0	0	0	0	0	0	1	0	0	0	1	0	0	0	**2**
THR-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
THR-19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
THR-20	0	0	0	0	1	0	1	0	0	1	1	0	0	0	**4**
THR-21	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**
THR-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
THR-23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
THR-24	0	0	0	0	0	0	3	0	0	0	0	0	0	0	**3**
THR-25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
THR-26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
THR-27	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**1**
THR-28	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**
THR-29	0	0	0	1	0	0	1	6	5	1	0	0	0	1	**15**
THR-30	0	0	0	0	0	0	0	0	0	1	0	0	0	0	**1**
THR-31	0	0	0	0	0	0	1	10	0	1	0	0	0	0	**12**
THR-32	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**
THR-33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
THR-34	0	1	1	0	0	0	1	0	0	0	0	0	0	0	**3**

Appendix 18. Summary of individuals collected by brail trawl from 37 sites in the Sydenham River (North and East Sydenham) in the summer of 2022.

Site Code	Black Sandshell	Flutedshell	Kidneyshell	Mapleleaf	Mucket	Pimpleback	Pink Heelsplitter	Purple Wartyback	Threeridge	Wabash Pigtoe	**Total # individuals**
SYD-01	0	0	0	0	0	0	0	0	0	0	**0**
SYD-02	0	0	0	0	0	0	0	0	0	0	**0**
SYD-03	0	0	0	0	0	0	0	0	0	0	**0**
SYD-04	0	0	0	0	0	0	0	0	0	0	**0**
SYD-05	0	0	0	0	0	0	0	0	0	0	**0**
SYD-06	0	0	0	0	0	0	0	0	0	0	**0**
SYD-07	0	0	0	1	0	0	0	0	0	0	**1**
SYD-08	0	0	0	0	0	0	0	0	0	0	**0**
SYD-09	0	0	0	0	0	0	0	0	0	0	**0**
SYD-10	0	0	0	0	0	0	0	0	0	0	**0**
SYD-11	0	0	0	0	0	0	0	0	0	0	**0**
SYD-12	0	0	0	0	0	0	0	0	0	0	**0**
SYD-13	0	0	0	0	0	0	0	0	0	0	**0**
SYD-14	0	0	0	0	0	0	0	0	0	0	**0**
SYD-15	0	0	0	0	0	0	0	0	0	0	**0**
SYD-16	0	0	0	0	0	0	0	0	0	0	**0**
SYD-17	0	0	0	0	0	0	0	0	0	0	**0**
SYD-18	0	0	0	0	0	0	0	0	0	0	**0**
SYD-19	0	0	0	0	0	0	0	0	0	0	**0**
SYD-20	0	0	0	0	0	0	0	0	0	0	**0**
SYD-21	0	0	0	0	0	0	0	0	0	0	**0**
SYD-22	0	0	0	1	0	0	0	0	0	0	**1**
SYD-23	0	0	0	0	0	0	0	0	0	0	**0**
SYD-24	0	0	0	0	0	0	0	0	0	0	**0**
SYD-25	0	0	0	0	0	0	0	0	0	0	**0**
SYD-26	0	0	0	1	0	0	0	0	0	0	**1**
SYD-27	0	0	0	1	0	0	0	0	0	0	**1**
SYD-28	0	0	0	1	0	0	0	0	0	0	**1**
SYD-29	0	0	0	0	1	0	0	0	0	0	**1**
SYD-30	0	0	0	0	0	0	0	0	0	0	**0**
SYD-31	0	1	0	1	0	2	1	0	0	0	**5**
SYD-32	0	0	0	0	0	0	0	0	0	0	**0**
SYD-33	0	0	0	0	0	0	0	0	0	0	**0**
SYD-34	0	0	0	0	0	0	0	0	0	0	**0**
SYD-35	0	0	0	0	4	2	4	0	1	0	**11**
SYD-36	1	0	1	1	3	2	0	0	0	0	**8**
SYD-37	1	0	0	1	2	2	1	1	6	1	**15**

Appendix 19. Summary of individuals captured by brail trawl from 23 sites in the Ausable River in the summer of 2022.

Site Code	Mapleleaf	Pimpleback	Threeridge	White Heelsplitter	**Total # individuals**
AUS-01	0	0	4	0	**4**
AUS-02	3	1	11	0	**15**
AUS-03	0	0	1	0	**1**
AUS-04	0	0	2	0	**2**
AUS-05	0	0	1	0	**1**
AUS-06	0	0	0	0	**0**
AUS-07	0	0	1	0	**1**
AUS-08	0	0	0	0	**0**
AUS-09	0	0	0	0	**0**
AUS-10	0	0	0	0	**0**
AUS-11	0	0	1	0	**1**
AUS-12	0	0	3	0	**3**
AUS-13	0	0	0	0	**0**
AUS-14	0	0	0	0	**0**
AUS-15	0	0	1	0	**1**
AUS-16	0	0	2	0	**2**
AUS-17	0	0	1	0	**1**
AUS-18	0	0	2	0	**2**
AUS-19	0	0	0	0	**0**
AUS-20	0	0	0	0	**0**
AUS-21	0	0	0	0	**0**
AUS-22	0	0	3	1	**4**
AUS-23	0	0	11	0	**11**