Targeted surveys for Channel Darter and Round Goby along the Trent, Moira, Salmon, and Napanee rivers in 2021

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TABLE OF CONTENTS

ABSTRACT ..... **vi**

RÉSUMÉ ..... **vii**

INTRODUCTION **1**

METHODS **2**

Electrofishing Surveys 2

Angling Surveys 2

RESULTS **3**

Electrofishing Surveys 3

Angling Surveys 4

ACKNOWLEDGEMENTS **6**

REFERENCES **7**

APPENDICES **15**

LIST OF FIGURES

Figure 1. Map of 34 sites sampled in 2021 using a transect-based backpack electrofishing method. Open circle = sample site; grey circle = sample site where American Eel was detected; green dot = sample site where Channel Darter was detected; X = sample site where Round Goby was detected. 9

Figure 2. Schematic diagram of transect-based electrofishing sampling design: 40 transects of 10 x 1 m each were placed in a series along the length of the river running parallel to the shoreline, separated by 2 m widths across the channel. Configuration varied depending on sampleable habitat. Points represent the start of a transect. Image is not to scale. 10

Figure 3. Map of six waterbodies sampled in 2021 using a targeted angling approach to detect Round Goby. 11

Figure 4. Field technicians angling within foam quadrat fixed to the side of a boat. 12

Figure 5. Length distribution of Channel Darter (n = 26) captured from the Trent River during transect-based electrofishing surveys in 2021. 13

Figure 6. Length distribution of Round Goby (n = 166) captured from the Trent River during transect-based electrofishing surveys in 2021. 13

Figure 7. Length distribution of Channel Darter (n = 34) captured from the Salmon River during transect-based electrofishing surveys in 2021. 14

Figure 8. Length distribution of Round Goby (n = 72) captured from the Napanee River during transect-based electrofishing surveys in 2021. 14

LIST OF APPENDICES

Appendix 1. Common and scientific names of fishes captured during electrofishing and angling surveys in 2021. 15

Appendix 2a. Photos of fish species captured during electrofishing surveys for invasive and at-risk fishes in 2021. 16

Appendix 2b. Photos of fish species captured during angling surveys for Round Goby (*Neogobius melanostomus*) in 2021. 17

Appendix 3a. Summary of individuals captured from nine sites along the Trent River during electrofishing surveys in 2021. 18

Appendix 3b. Summary of individuals captured from one site on the Moira River during electrofishing surveys in 2021. 18

Appendix 3c. Summary of individuals captured from 15 sites along the Salmon River during electrofishing surveys in 2021. 19

Appendix 3d. Summary of individuals captured from seven sites along the Napanee River during electrofishing surveys in 2021. 19

Appendix 3e. Summary of individuals captured from two sites along Depot Creek during electrofishing surveys in 2021. 20

Appendix 4a. Site details and sampling effort for nine sites sampled along the Trent River during transect-based electrofishing surveys in 2021. Dash (-) indicates measurement not recorded. 21

Appendix 4b. Site details and sampling effort for one site sampled on the Moira River during transect-based electrofishing surveys in 2021. 21

Appendix 4c. Site details and sampling effort for 15 sites sampled along the Salmon River during transect-based electrofishing surveys 2021. Dash (-) indicates measurement not recorded. 22

Appendix 4d. Site details and sampling effort for seven sites sampled along the Napanee River during transect-based electrofishing surveys in 2021. Dash (-) indicates measurement not recorded. 22

Appendix 4e. Site details and sampling effort for two sites sampled along Depot Creek during transect-based electrofishing surveys in 2021. Dash (-) indicates measurement not recorded..... 23

Appendix 5a. Summary of individuals captured from 25 sites on Crowe Lake during angling surveys in 2021. 24

Appendix 5b. Summary of individuals captured from six sites on the Crowe River during angling surveys in 2021. 24

Appendix 5c. Summary of individuals captured from 10 sites on Rylstone Lake during angling surveys in 2021. 25

Appendix 5d. Summary of individuals captured from 24 sites on Beaver Lake during angling surveys in 2021. 25

Appendix 5e. Summary of individuals captured from 24 sites on Varty Lake during angling surveys in 2021. 26

Appendix 5f. Summary of individuals captured from eight sites on the Trent River at Percy Boom during angling surveys in 2021. 26

Appendix 6a. Site details and sampling effort for 25 sites sampled on Crowe Lake during angling surveys in 2021. 27

Appendix 6b. Site details and sampling effort for six sites sampled on the Crowe River during angling surveys in 2021. 28

Appendix 6c. Site details and sampling effort for ten sites sampled on Rylstone Lake during angling surveys in 2021. Dash (-) indicates measurement not recorded. 28

Appendix 6d. Site details and sampling effort for 24 sites sampled on Beaver Lake during angling surveys in 2021. Dash (-) indicates measurement not recorded. 29

Appendix 6e. Site details and sampling effort for 24 sites sampled on Varty Lake during angling surveys in 2021. Dash (-) indicates measurement not recorded. 30

Appendix 6f. Site details and sampling effort for eight reference sites sampled on the Trent River at Percy Boom during angling surveys in 2021. 31

ABSTRACT

LeBaron, A., and Reid, S.M. 2023. Targeted surveys for Channel Darter and Round Goby along the Trent, Moira, Salmon, and Napanee rivers in 2021 Can. Data Rep. Fish. Aquat. Sci. 1363: vii + 31 p.

The spread of the invasive Round Goby (*Neogobius melanostomus*) was assessed as a significant threat to those populations of Channel Darter (*Percina copelandi*) identified by the Committee on the Status of Endangered Wildlife in Canada as the Lake Ontario designatable unit. However, expert-based threat assessments require validation through field research and monitoring. In 2021, electrofishing surveys to detect and monitor the two species were undertaken along four Lake Ontario tributaries: the Trent River (9 sites), Moira River (1 site), Salmon River (15 sites), and Napanee River (6 sites). Surveys were also undertaken at two sites along Depot Creek, a Napanee River tributary. A total of 60 Channel Darter and 238 Round Goby were electrofished from all sites. Channel Darter was detected at five Trent River sites and six Salmon River sites; Round Goby was detected at nine Trent River sites and one Napanee River site. Round Goby co-occurred with Channel Darter at five sites (Trent River). Angling surveys to detect Round Goby were also undertaken across five waterbodies representing potential baitfish introduction sites within the Trent River, Salmon River, and Napanee River watersheds: Crowe Lake (25 sites), Beaver Lake (24 sites), Varty Lake (24 sites), Rylstone Lake (10 sites), and Crowe River (6 sites), as well as 8 reference sites on the Trent River. Round Goby was only detected at reference sites.

RÉSUMÉ

LeBaron, A., and Reid, S.M. 2023. Targeted surveys for Channel Darter and Round Goby along the Trent, Moira, Salmon, and Napanee rivers in 2021 Can. Data Rep. Fish. Aquat. Sci. 1363: vii + 31 p.

La propagation de l'espèce envahissante gobie à taches noires (Neogobius melanostomus) a été désignée comme une menace importante pour les populations de fouille-roche gris (Percina copelandi) recensées par le Comité sur la situation des espèces en péril au Canada comme l'unité désignable du lac Ontario. Cependant, les évaluations des menaces réalisées par des experts doivent être validées au moyen d'activités de recherche et de surveillance sur le terrain. En 2021, des relevés par pêche à l'électricité visant à détecter et à surveiller les deux espèces ont été menés le long de quatre affluents du lac Ontario : les rivières Trent (9 sites), Moira (1 site), Salmon (15 sites) et Napanee (6 sites). Des relevés ont également été menés à deux emplacements le long du ruisseau Depot, un affluent de la rivière Napanee. Un total de 60 fouille-roche gris et 238 gobies à taches noires ont été pêchés à l'électricité dans l'ensemble des sites. Le fouille-roche gris a été détecté dans cinq sites de la rivière Trent et six sites de la rivière Salmon; le gobie à taches noires a été détecté dans neuf sites de la rivière Trent et un site de la rivière Napanee. On a observé la cohabitation du gobie à taches noires et du fouille-roche gris dans cinq sites (rivière Trent). Des relevés par pêche à la ligne visant à détecter le gobie à taches noires ont également été menés dans cinq plans d'eau représentant des sites éventuels d'introduction de poissons-appâts dans les bassins versants des rivières Trent, Salmon et Napanee : les lacs Crowe (25 sites), Beaver (24 sites), Varty (24 sites), Rylstone (10 sites) et la rivière Crowe (6 sites), ainsi qu'à huit sites de référence sur la rivière Trent. Le gobie à taches noires n'a été détecté qu'aux sites de référence.

INTRODUCTION

The Channel Darter (*Percina copelandi*) is a small, elongate, benthic fish found in both rivers and lakes, typically in areas with moderate water flow and coarse substrate (Committee on the Status of Endangered Wildlife in Canada [COSEWIC] 2016). The species has a widespread but extremely disjunct distribution across North America, occurring west of the Appalachian Mountains from Louisiana north through 15 American states, and into Ontario and Quebec (Fisheries and Oceans Canada [DFO] 2013). In Ontario, populations are split into three designatable units (DU) as defined by COSEWIC (2016): Lake Erie populations (DU1), Lake Ontario populations (DU2), and St. Lawrence populations (DU3). Lake Erie and Lake Ontario populations were assessed by COSEWIC as *Endangered* in 2016; St. Lawrence populations were designated as *Special Concern* in 2016. New populations were discovered in Ontario and Quebec during surveys conducted from 2001 to 2009, but this finding can most likely be attributed to increased sampling effort rather than range expansion (DFO 2013).

In Canada, Channel Darter is threatened by habitat loss and degradation (e.g., shoreline modifications, altered flow regimes, barriers to movement, turbidity and sediment loading, and contaminants and toxic substances), the introduction of invasive species and diseases, and possibly baitfish harvesting (DFO 2013). The most significant threat to Channel Darter is the invasive Round Goby (*Neogobius melanostomus*). This invasive species competes with Channel Darter for space and resources (Phelps and Francis 2002) and may also prey on Channel Darter eggs (Corkum et al. 2004; Committee on the Status of Species at Risk in Ontario [COSSARO] 2017). Since its introduction into the lower Great Lakes, Round Goby has been implicated in the declines of native benthic fishes (Baker 2005; Thomas and Haas 2004). For imperiled darters, the adverse population impacts due to Round Goby have been assessed as high, however; these assessments require validation through field research and monitoring (DFO 2011; COSEWIC 2016).

While changes to the composition of Great Lakes fishes have been investigated (e.g., Reid and Mandrak 2008), impacts to native fishes in Great Lakes tributaries are not well documented. In 2019, the Ministry of Northern Development, Mines, Natural Resources and Forestry (NDMNRF) undertook electrofishing surveys targeting Channel Darter and Round Goby along the Trent and Moira rivers to update inventory information on the distribution of Round Goby and Channel Darter (LeBaron and Reid 2021). During the summer of 2021, additional electrofishing surveys were carried out on the Trent River, Moira River, Salmon River, Napanee River, and Depot Creek, as well as angling surveys on five waterbodies representing potential baitfish introduction sites within the Trent River (TR), Salmon River (SR), and Napanee River (NR) watersheds: Crowe Lake (TR), Beaver Lake (SR), Varty Lake (NR), Rylstone Lake (TR), and the Crowe River (TR). This report presents the results of the 2021 surveys. Updated inventory information on the distribution of Round Goby and Channel Darter will inform future invasion risk and species status assessments.

DFO data reports are published to support the Species at Risk Program by providing an overview of field activities and to provide a medium for archiving data associated with the sampling of SARA-listed species and their habitat. This report presents data collected during monitoring-based research undertaken in 2021 in support of the following research and monitoring actions identified in the *Federal Recovery Strategy for the Channel Darter in Canada* (DFO 2013):

- Complete targeted surveys using gear types proven effective at detecting Channel Darter at historical and extant locations, and.
- Investigate potential threats to Channel Darter, such as invasive species (e.g., competition, predation).

METHODS

Sampling locations for this study were informed by recent and historical Channel Darter capture locations and critical habitat descriptions (Reid et al. 2005; DFO 2013; Reid and Haxton 2017; LeBaron and Reid 2021).

ELECTROFISHING SURVEYS

In 2021, transect-based backpack electrofishing surveys (Reid 2011) were undertaken at 34 sites across five watercourses (Figure 1): the Trent River (9 sites), Moira River (1 site), Salmon River (15 sites), Napanee River (7 sites), and Depot Creek (2 sites). Fishes were collected from wadeable sites that were either historical Channel Darter collection sites or assessed as providing potential suitable habitat conditions. Sites sampled were riffles or shoal-type habitats in the tailwaters of dams and/or consisting of coarse bed material (gravel, cobble, boulder, and bedrock) and fast-flowing waters.

Sampling was carried out using a Smith-Root model 12-B backpack electrofishing unit (pulsed DC settings: 300 – 500 V, 50 – 60 Hz, 4 – 6 ms) and one or two netters. At each site, 40 transects (each 10 x 1 m) were sampled. Transects were placed in a series along the length of the river parallel to the shoreline and separated by 2 m widths across the channel. The standard configuration is presented in Figure 2, though variations were used depending on availability of wadeable habitat. Mean sampling effort along each 10 m transect was 60 seconds (standard deviation: 2.0 s). Darter species, American Eel (*Anguilla rostrata*), and Round Goby were targeted for capture by netters. Other species were not netted or were released immediately. The number of each species captured from each transect was recorded. Target fishes were immediately transferred from nets into a bucket of clean water and held until processing. Additional buckets were used if necessary to prevent overcrowding. Buckets were kept in the shade when possible, and water was refreshed periodically. Once sampling was complete, fishes were identified to species, enumerated, measured for total length then released. Channel Darter were processed before other species.

Following fish sampling and processing, water temperature (°C) and conductivity (µS/cm) were measured using a handheld meter.

ANGLING SURVEYS

Angling surveys to detect Round Goby following methods described by Gutowsky et al. (2011) were done at 89 sites across five waterbodies (Figure 3): Crowe Lake (25 sites), Crowe River (6 sites), Rylstone Lake (10 sites), Beaver Lake (24 sites), and Varty Lake (24 sites). Angling was also carried out at 8 reference sites on the Trent River to validate the method. A targeted approach was used to select sites with habitat suitable for Round Goby based on visual observations of cobble, gravel, and sand substrates and lower aquatic macrophyte coverage (Ontario Ministry of Natural Resources [OMNR] 2010).

Angling was done from a 16-foot jon boat or 14-foot v-hull by two individuals using ultra lightweight spinning rods, 0.15 mm zero-stretch fishing line with a single size-4 split-shot sinker, and #20 fly fishing hooks baited with a small portion of scented plastic maggot (white). The boat was anchored from bow and stern to prevent shifting. Angling was done in a 1.5 m^2 area delineated by a foam quadrat fixed to the side of the boat (Figure 4). There was a 5-minute waiting period after anchoring to mitigate disturbance, followed by four consecutive 5-minute periods of angling. Captured fishes were kept in a bucket of water (a separate bucket was used for each 5-minute period) and processed after 20 minutes of angling. Individuals were identified to species and measured for total length before release.

Sampling for this project was conducted under the authority of SARA Permit Number SECT 73 SARA C&A 21-PCAAA-00002 and Parks Canada Agency Research and Collection permit TSW-2021-39058. Collection and handling methods were approved by the NDMNRF Aquatic Research and Monitoring Section, Animal Care Committee (Animal Use Protocol ACC#160).

Water depth, water temperature, substrate, and aquatic macrophyte cover was recorded at each angling site. Water depth and temperature were obtained using a Garmin® Echomap™ Plus 95 SV Sonar Unit. Substrate was sampled using a Wildco® Petite Ponar™ benthic grab (15 cm x 15 cm). 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 (< 0.002 mm), silt (0.002 – 0.05 mm), sand (0.5 – 2 cm), gravel (0.2 – 8 cm), cobble (8 – 25 cm), rubble (25 – 60 cm), and boulder (> 60 mm) (Wentworth 1922). Substrate composition was estimated visually when materials were too large to be effectively sampled by the Ponar (cobble, rubble, boulder). Percent aquatic macrophyte cover (open water, emergent, submergent, and floating vegetation) was visually assessed at each site.

RESULTS

Common and Scientific names for all fish species captured during 2021 electrofishing and angling surveys are provided in Appendix 1. Photos of all species are provided in Appendix 2.

ELECTROFISHING SURVEYS

Species count data are provided in Appendix 3. Site details are provided in Appendix 4.

Trent River

A total of 278 individuals representing four target species were electrofished from the Trent River (Appendix 3a). Channel Darter (n = 26) was captured from five sites (Lock 1 dam, Sonoco dam, Frankford Generating Station, Sills Island, and Glen Ross) with total lengths ranging from 42 to 65 mm (mean: 53 mm) (Figure 5). Round Goby (n = 166) was captured from nine sites (Lock 1 dam, Sonoco dam, Frankford Generating Station, Sills Island, Glen Ross, Meyers Reach, Seymour Conservation Area, Lock 9 dam, and Healey Falls). Total lengths ranged from 28 to 145 mm (mean: 83 mm) (Figure 6). Channel Darter and Round Goby co-occurred at all five sites where Channel Darter was captured. American Eel (n = 26) was captured from three sites (Lock 1 dam, Sonoco dam, and Sills Island), with total lengths ranging from 198 to 520 mm (mean: 276).

Mean water temperature and conductivity were 26.1 °C (standard deviation: 1.2 °C) and 166 µS/cm (standard deviation: 65 µS/cm), respectively (Appendix 4a).

Moira River

A total of 22 individuals were electrofished at the Rapids Rd crossing site, including one target species (Logperch [*Percina caprodes*]) and three additional species: Greater Redhorse (*Moxostoma valenciennesi*), Northern Sunfish (*Lepomis peltastes*), and Pumpkinseed (*Lepomis gibbosus*) (Appendix 3b). Channel Darter, Round Goby, and American Eel were not captured from this site. Total lengths of Northern Sunfish (n = 13) ranged from 53 to 85 mm (mean: 69 mm).

Water temperature and conductivity were 23.5 °C and 285 µS/cm respectively (Appendix 4b).

Salmon River

A total of 1,031 individuals representing five target species were electrofished from the Salmon River (Appendix 3c). Channel Darter (n = 34) was captured from six sites (Milltown, Wyman Rd, Waddingham Rd, Kingsford Conservation Area Site 2, Lonsdale, and Deseronto Rd). Total length of Channel Darter ranged from 32 to 61 mm (mean: 53 mm) (Figure 7). Round Goby was not detected in the Salmon River. American Eel (n = 1) was captured from one site (Teupah Excavating), with a total length of 450 mm. Other species captured include Fantail Darter (*Etheostoma flabellare*; n = 915), Logperch (n = 64), and Johnny Darter (*Etheostoma nigrum*; n = 17).

Mean water temperature and conductivity were 23.5 °C (standard deviation: 1.7 °C) and 255 µS/cm (standard deviation: 50 µS/cm), respectively (Appendix 4c).

Napanee River

A total of 251 individuals representing three target species were electrofished from the Napanee River (Appendix 3d). Round Goby (n = 72) was only captured from one site (Napanee downtown), with total lengths ranging from 32 to 96 mm (mean: 63 mm) (Figure 8). The collection site is located downstream of the first barrier upstream of the Bay of Quinte (Springside Dam). American Eel (n = 34) was captured from all six sites. Total lengths ranged from 290 to 910 mm (mean: 506 mm). Channel Darter was not captured from the Napanee River.

Mean water temperature and conductivity were 22.2 °C (standard deviation: 1.2 °C) and 182 µS/cm (standard deviation: 39 µS/cm), respectively (Appendix 4d).

Depot Creek

A total of six individuals representing two target species were electrofished from one site (First Lake) on Depot Creek (Appendix 3e): American Eel (n = 5) and Logperch (n = 1). Total lengths of American Eel ranged from 440 to 660 mm (mean: 546). Channel Darter and Round Goby were not detected. No fishes were captured from the site at Bellrock Rd.

Mean water temperature and conductivity were 23.4 °C (standard deviation: 1.8 °C) and 86 µS/cm (standard deviation: 0) respectively (Appendix 4e).

ANGLING SURVEYS

Species count data is provided in Appendix 5. Site details and habitat characteristics are provided in Appendix 6.

Crowe Lake

A total of 18 individuals representing three species were angled from Crowe Lake (Appendix 5a): Bluegill (*Lepomis macrochirus*), Pumpkinseed, and Rock Bass (*Ambloplites rupestris*). No Round Goby were detected.

At sampling sites, mean water depth and water temperature were 0.9 m (standard deviation: 0.3 m) and 24.5 °C (standard deviation: 0.8 °C), respectively. Sites were predominantly open water (mean 95% across all sites) with little submerged macrophytes (5%). Substrates consisted of cobble (mean 37% across all sites), rubble (25%), sand (19%), gravel (13%), boulder (3%), organics (1%), and silt (1%) (Appendix 6a).

Crowe River

Three Pumpkinseed were angled from the Crowe River (Appendix 5b). No Round Goby were detected.

At sampling sites, mean water depth and water temperature were 1.6 m (standard deviation: 0.8 m) and 22.3 °C (standard deviation: 0.5 °C), respectively. Sites were predominantly open water (mean 99% across all sites) with very little submerged macrophytes (1%). Substrates consisted of sand (mean 31% across all sites), cobble (25%), rubble (21%), gravel (18%), bedrock (4%), and organics (1%) (Appendix 6b).

Rylstone Lake

A total of 20 individuals representing two species were angled from Rylstone Lake (Appendix 5c): Bluegill and Pumpkinseed. No Round Goby were detected.

At sampling sites, mean water depth and water temperature were 1.0 m (standard deviation: 0.4 m) and 23.3 °C (standard deviation: 0.7 °C), respectively. Sites were predominantly open water (mean 77% across all sites) with a small amount of submerged macrophytes (14%). Substrates consisted of cobble (mean 32% across all sites), rubble (26%), gravel (24%), silt (6%), organics (5%), sand (4%), boulder (4%), and bedrock (1%) (Appendix 6c).

Beaver Lake

A total of 12 individuals representing three species were angled from Beaver Lake (Appendix 5d): Bluegill, Pumpkinseed, and Rock Bass. No Round Goby were detected.

At sampling sites, mean water depth and water temperature were 1.0 m (standard deviation: 0.5 m) and 20.6 °C (standard deviation: 1.5 °C), respectively. Sites were predominantly open water (mean 78% across all sites) with a small amount of submerged macrophytes (10%). Substrates consisted of sand (mean 31% across all sites), cobble (25%), gravel (16%), rubble (16%), organics (9%), sand (4%), and boulder (4%) (Appendix 6d).

Varty Lake

A total of 20 individuals representing two species were angled from Varty Lake (Appendix 5e): Pumpkinseed and Yellow Perch (*Perca flavescens*). No Round Goby were detected.

At sampling sites, mean water depth and water temperature were 0.8 m (standard deviation: 0.3 m) and 23.5 °C (standard deviation: 1.4 °C), respectively. Sites were largely open water (mean 68% across all sites) with a moderate amount of submerged macrophytes (32 %). Substrates consisting of organics (mean 42% across all sites), cobble (26%), sand (14%), gravel (9%), rubble (6%), and boulder (3%) (Appendix 6e).

Trent River — Reference Sites

A total of 15 individuals representing five species were caught from the Trent River (Appendix 5f): Bluegill, Pumpkinseed, Rock Bass, Round Goby, and Yellow Perch. Seven Round Goby were caught across four of the eight reference sites.

At sampling sites, mean water depth and water temperature were 1.2 m (standard deviation: 0.5 m) and 22.6 °C (standard deviation: 0.5 °C), respectively. Sites had predominantly open water (mean 91% across all sites) with a small amount of submerged macrophytes (9%). Substrates consisting of cobble (mean 36% across all sites), rubble (29%), gravel (25%), sand (9%), and silt (1%) (Appendix 6f).

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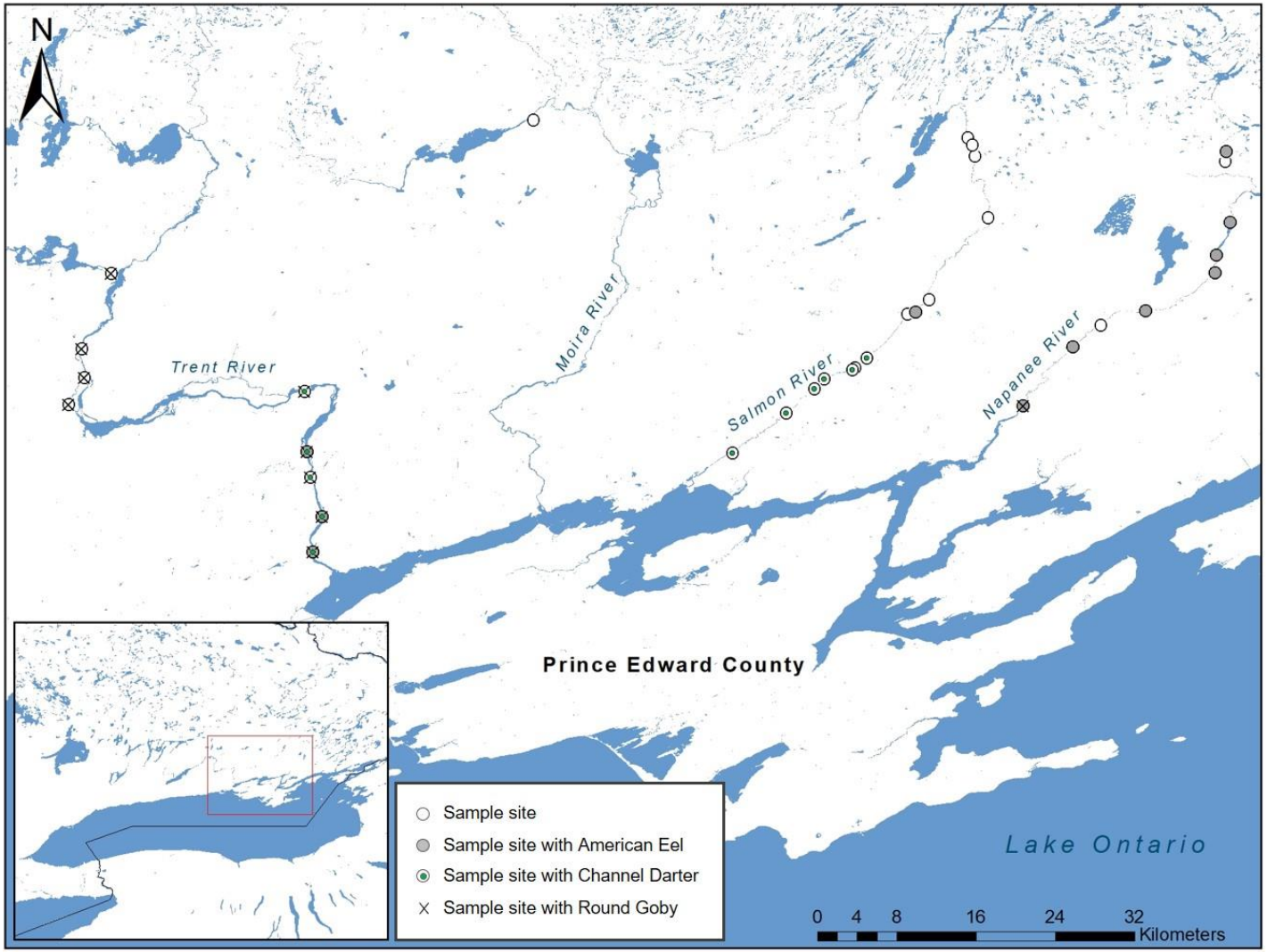


Figure 1. Map of 34 sites sampled in 2021 using a transect-based backpack electrofishing method. Open circle = sample site; grey circle = sample site where American Eel was detected; green dot = sample site where Channel Darter was detected; X = sample site where Round Goby was detected.

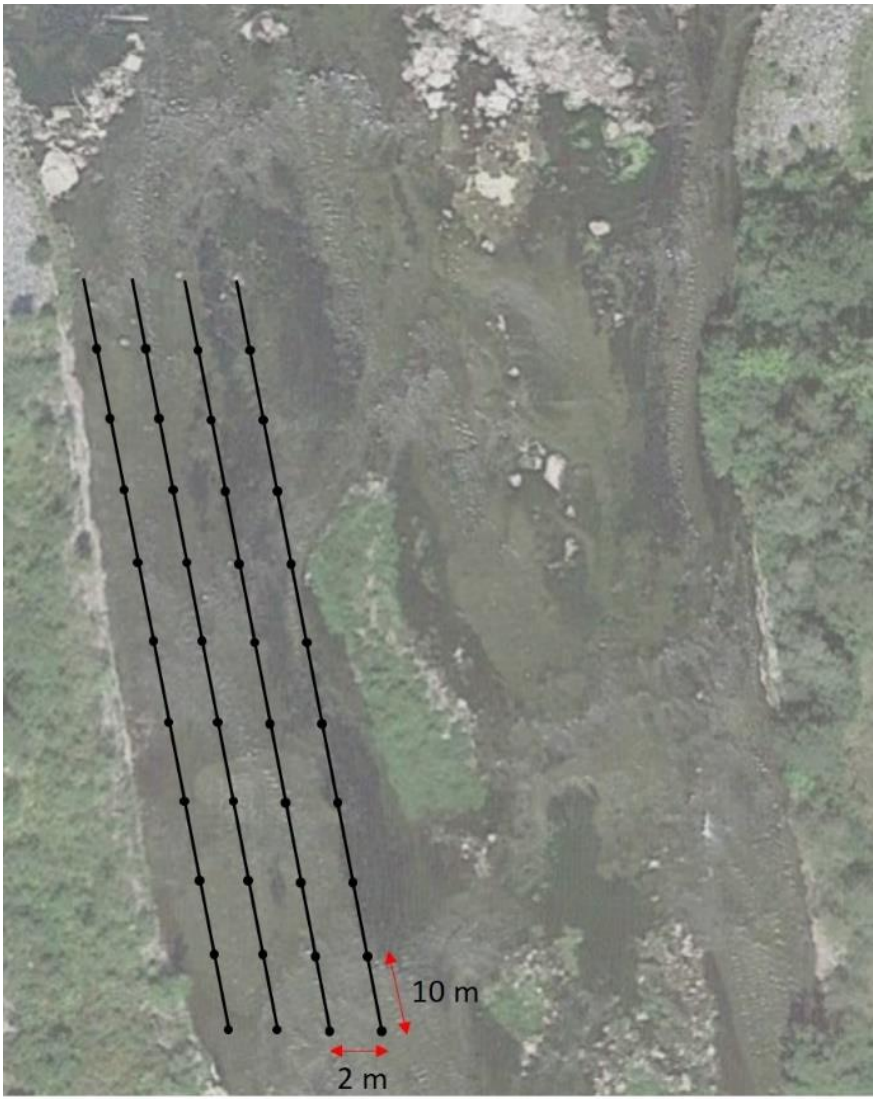


Figure 2. Schematic diagram of transect-based electrofishing sampling design: 40 transects of 10 x 1 m each were placed in a series along the length of the river running parallel to the shoreline, separated by 2 m widths across the channel. Configuration varied depending on sampleable habitat. Points represent the start of a transect. Image is not to scale.

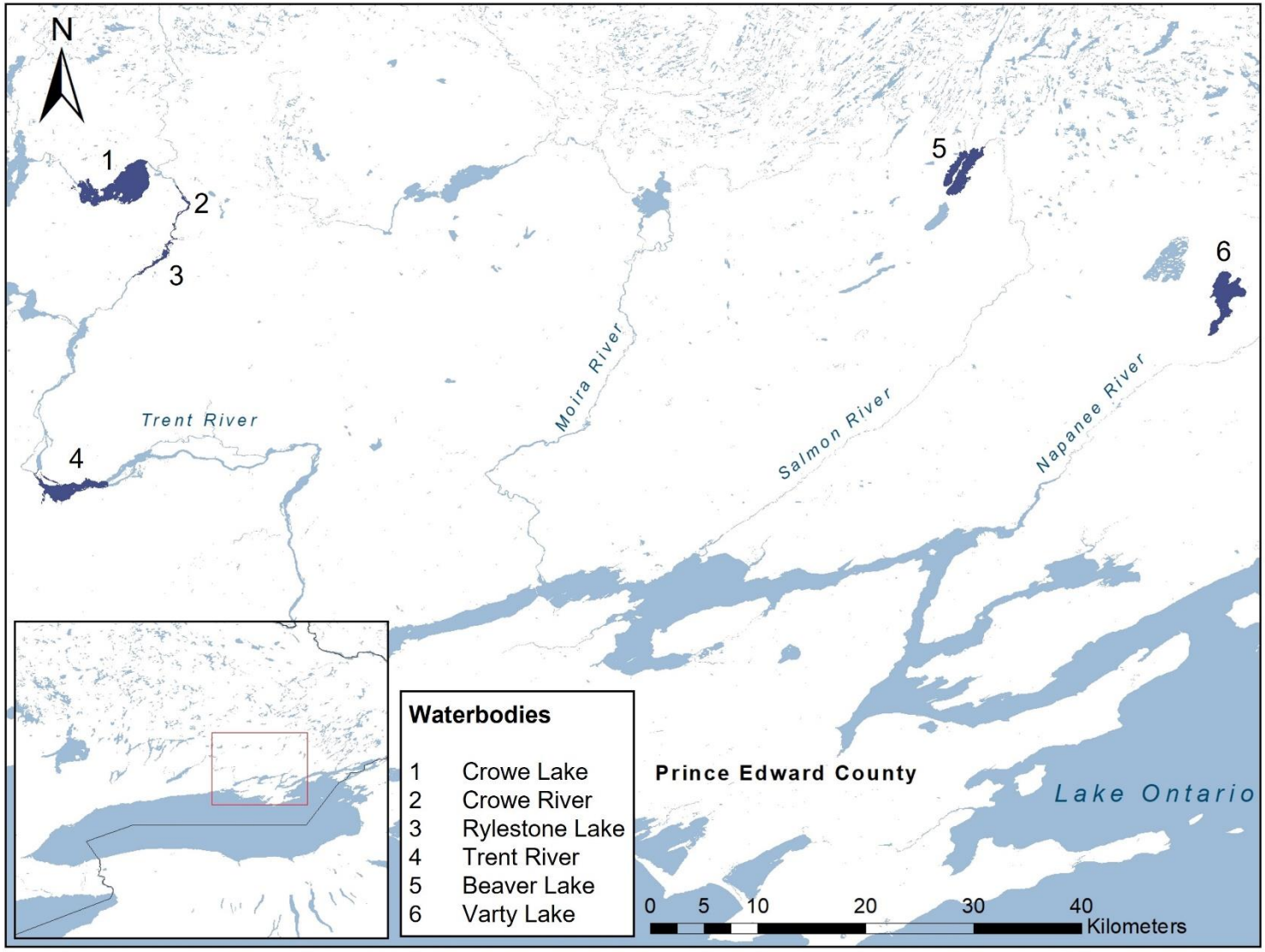


Figure 3. Map of six waterbodies sampled in 2021 using a targeted angling approach to detect Round Goby.

Figure 4. Field technicians angling within foam quadrat fixed to the side of a boat.

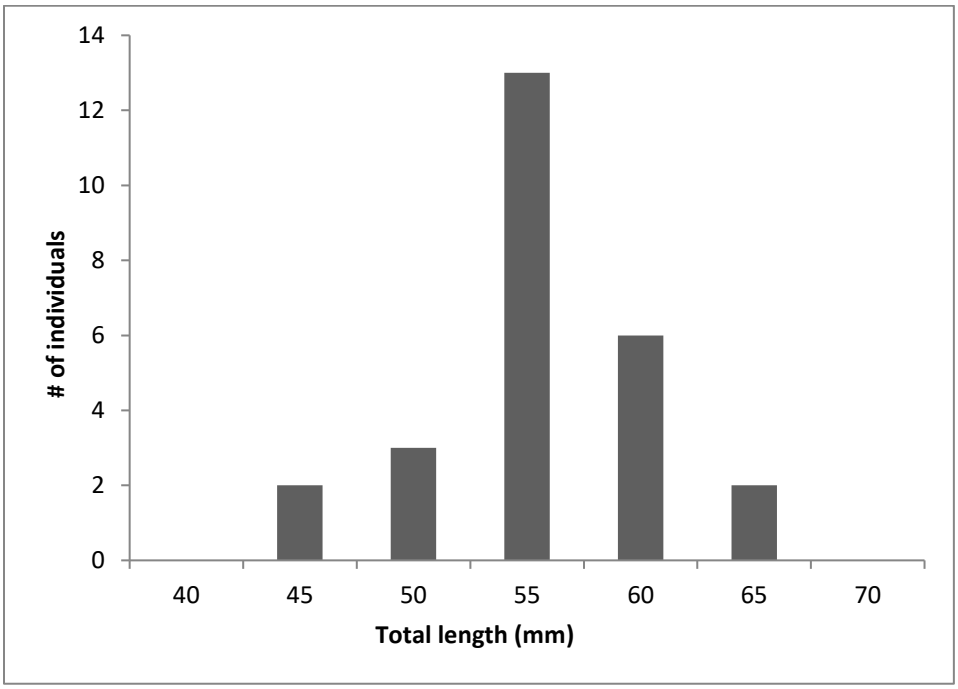


Figure 5. Length distribution of Channel Darter (n = 26) captured from the Trent River during transect-based electrofishing surveys in 2021.

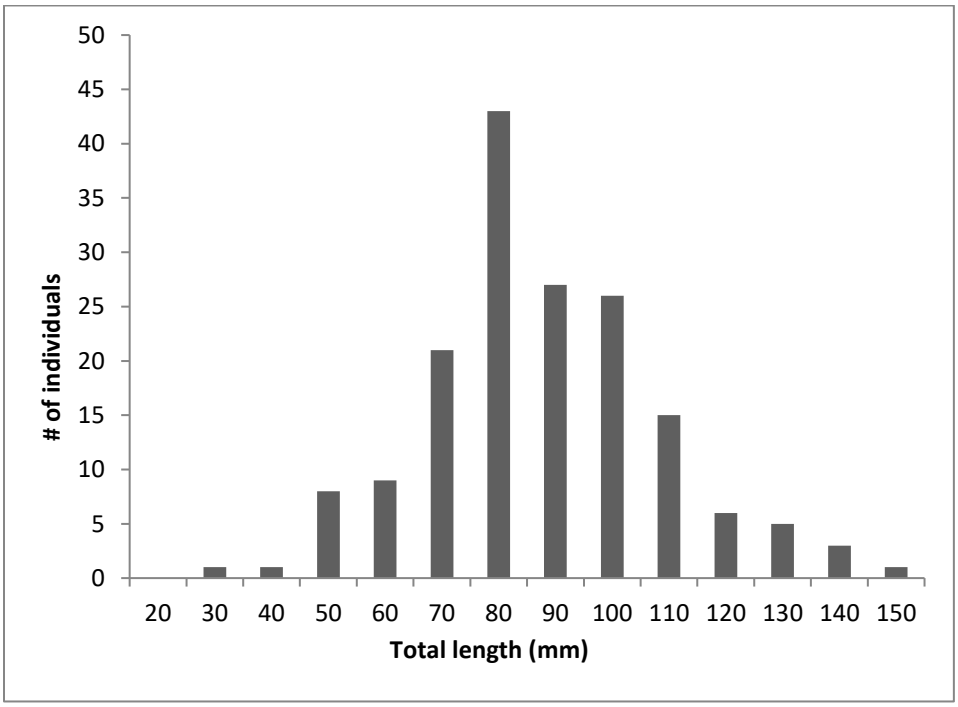


Figure 6. Length distribution of Round Goby (n = 166) captured from the Trent River during transect-based electrofishing surveys in 2021.

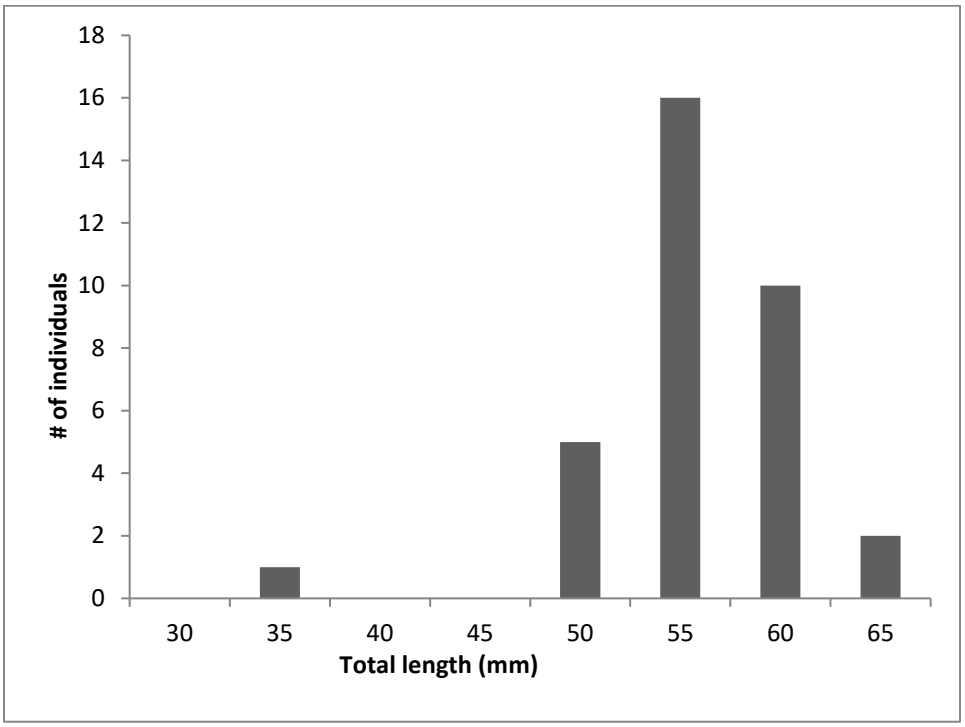


Figure 7. Length distribution of Channel Darter (n = 34) captured from the Salmon River during transect-based electrofishing surveys in 2021.

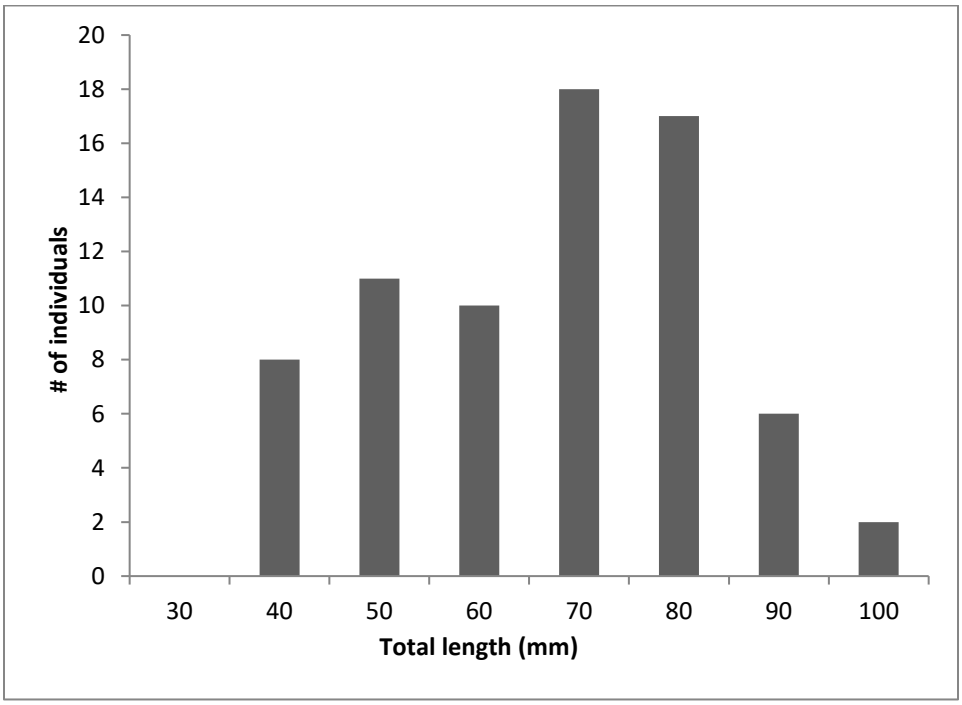


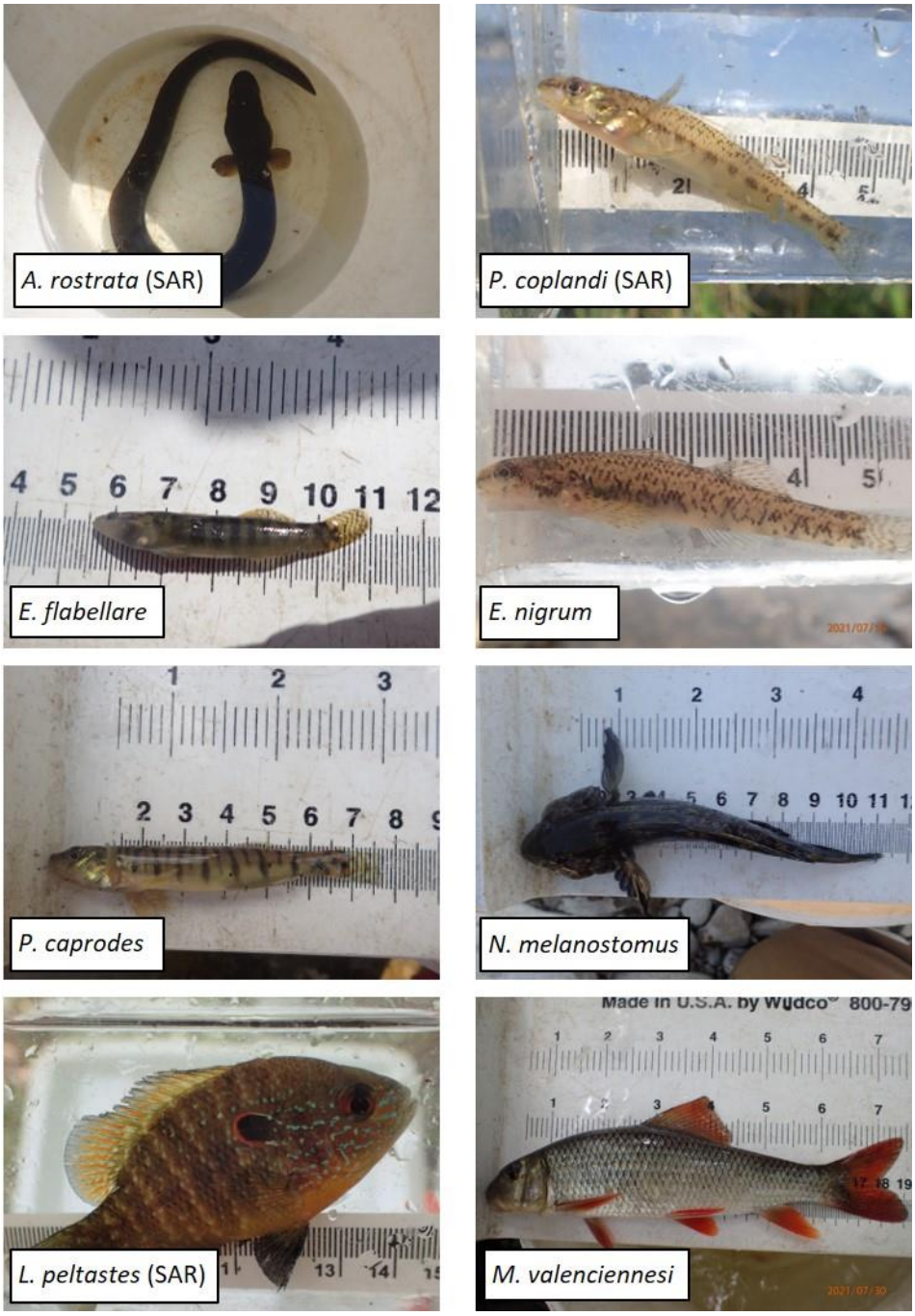
Figure 8. Length distribution of Round Goby (n = 72) captured from the Napanee River during transect-based electrofishing surveys in 2021.

APPENDICES

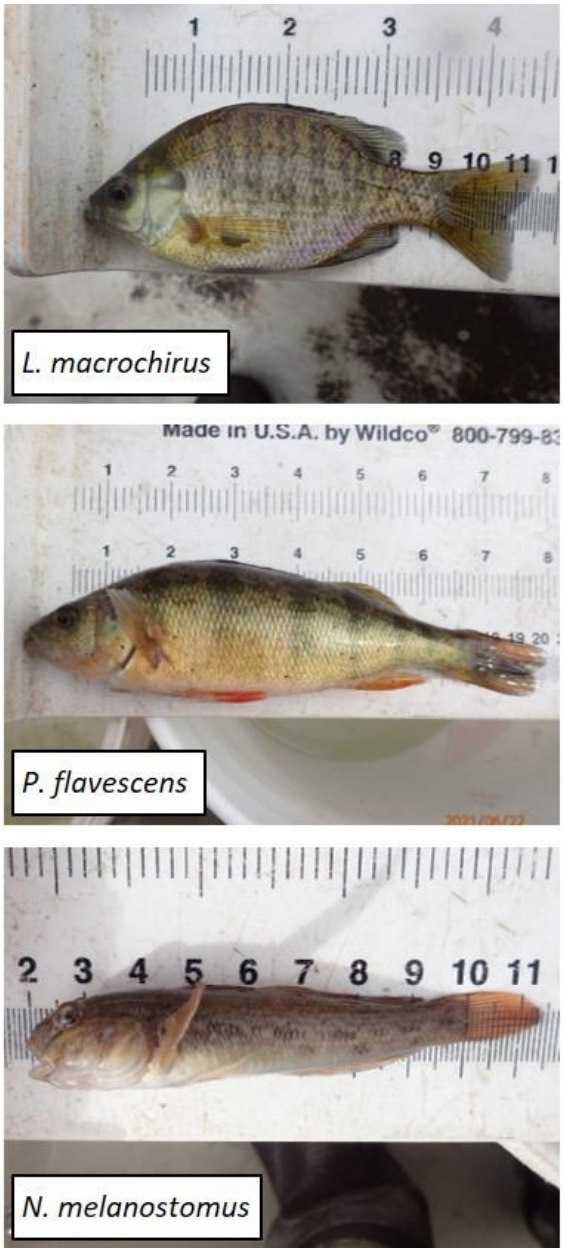
Appendix 1. Common and scientific names of fishes captured during electrofishing and angling surveys in 2021.

Common name	Scientific name
American Eel	*Anguilla rostrata*
Bluegill	*Lepomis macrochirus*
Channel Darter	*Percina copelandi*
Fantail Darter	*Etheostoma flabellare*
Greater Redhorse	*Moxostoma valenciennesi*
Johnny Darter	*Etheostoma nigrum*
Logperch	*Percina caprodes*
Northern Sunfish	*Lepomis peltastes*
Pumpkinseed	*Lepomis gibbosus*
Rock Bass	*Ambloplites rupestris*
Round Goby	*Neogobius melanostomus*
Yellow Perch	*Perca flavescens*

Appendix 2a. Photos of fish species captured during electrofishing surveys for invasive and at-risk fishes in 2021.



Appendix 3b. Photos of fish species captured during angling surveys for Round Goby (Neogobius melanostomus) in 2021.



Appendix 4a. Summary of individuals captured from nine sites along the Trent River during electrofishing surveys in 2021.

Site	American Eel	Channel Darter	Fantail Darter	Greater Redhorse	Johnny Darter	Logperch	Northern Sunfish	Pumpkinseed	Round Goby
Lock 1 dam	1	2	0	0	0	1	0	0	2
Meyers Reach	0	0	0	0	0	20	0	0	3
Sills Island	18	2	0	0	0	0	0	0	22
Seymour Conservation Area	0	0	0	0	0	12	0	0	26
Glen Ross	0	3	0	0	0	2	0	0	6
Sonoco dam	7	18	0	0	0	3	0	0	19
Frankford Generating Station	0	1	0	0	0	4	0	0	14
Lock 9 dam	0	0	0	0	0	0	0	0	23
Healey Falls	0	0	0	0	0	18	0	0	51

Appendix 5b. Summary of individuals captured from one site on the Moira River during electrofishing surveys in 2021.

Site	American Eel	Channel Darter	Fantail Darter	Greater Redhorse	Johnny Darter	Logperch	Northern Sunfish	Pumpkinseed	Round Goby
Rapids Rd	0	0	0	1	0	3	13	5	0

Appendix 6c. Summary of individuals captured from 15 sites along the Salmon River during electrofishing surveys in 2021.

Site	American Eel	Channel Darter	Fantail Darter	Greater Redhorse	Johnny Darter	Logperch	Northern Sunfish	Pumpkinseed	Round Goby
Kingsford Conservation Area Site 1	0	0	17	0	1	3	0	0	0
Kingsford Conservation Area Site 2	0	6	113	0	1	6	0	0	0
Waddingham Rd	0	1	80	0	0	5	0	0	0
Lonsdale	0	6	18	0	1	7	0	0	0
Deseronto Rd	0	1	130	0	4	9	0	0	0
Adair Rd	0	0	185	0	0	0	0	0	0
JonesSt	0	0	11	0	0	0	0	0	0
Tamworth	0	0	72	0	0	0	0	0	0
Croydon	0	0	30	0	0	10	0	0	0
Milltown	0	19	18	0	5	22	0	0	0
Wyman Rd	0	1	12	0	2	1	0	0	0
Buttermilk Falls	0	0	62	0	3	1	0	0	0
Teupah Excavating	1	0	36	0	0	0	0	0	0
Salmon River Rd	0	0	102	0	0	0	0	0	0
Ballantra Dr	0	0	29	0	0	0	0	0	0

Appendix 7d. Summary of individuals captured from seven sites along the Napanee River during electrofishing surveys in 2021.

Site	American Eel	Channel Darter	Fantail Darter	Greater Redhorse	Johnny Darter	Logperch	Northern Sunfish	Pumpkinseed	Round Goby
Colebrook	5	0	0	0	0	22	0	0	0
Petworth	1	0	0	0	0	7	0	0	0
Camden	8	0	0	0	0	2	0	0	0
Strathcona	1	0	0	0	0	13	0	0	0
Napanee downtown	6	0	0	0	0	96	0	0	72
Newburgh	0	0	0	0	0	0	0	0	0
Yarker	13	0	0	0	0	5	0	0	0

Appendix 8e. Summary of individuals captured from two sites along Depot Creek during electrofishing surveys in 2021.

Site	American Eel	Channel Darter	Fantail Darter	Greater Redhorse	Johnny Darter	Logperch	Northern Sunfish	Pumpkinseed	Round Goby
First Lake Rd	5	0	0	0	0	1	0	0	0
Bellrock Rd	0	0	0	0	0	0	0	0	0

Appendix 9a. Site details and sampling effort for nine sites sampled along the Trent River during transect-based electrofishing surveys in 2021. Dash (-) indicates measurement not recorded.

Site	Sample date	Latitude	Longitude	Water temperature (°C)	Conductivity (µS/cm)	Backpack settings	Sampling effort (seconds)
Lock1 1 dam	24-Jun-21	44.11781	-77.59077	-	-	300V	2400
Meyers Reach	24-Jun-21	44.25170	-77.81235	-	-	400V	2400
Sills Island	28-Jun-21	44.20885	-77.59575	24.0	263	-	2416
Seymour Conservation Area	24-Aug-21	44.27599	-77.79799	26.1	111	-	2400
Glen Ross	24-Aug-21	44.26309	-77.59807	27.0	128	G4, 500V	2400
Sonoco dam	25-Aug-21	44.14985	-77.58241	26.9	134	G4, 400V	2400
Frankford Generating Station	26-Aug-21	44.18520	-77.59291	26.3	257	G4, 400V	2400
Lock 9 dam	27-Aug-21	44.30198	-77.80037	25.3	143	H5, 400V	2400
Healey Falls	27-Aug-21	44.37035	-77.77346	27.3	129	-	2400

Appendix 10b. Site details and sampling effort for one site sampled on the Moira River during transect-based electrofishing surveys in 2021.

Site	Sample date	Latitude	Longitude	Water temperature (°C)	Conductivity (µS/cm)	Backpack settings	Sampling effort (seconds)
Rapids Rd	30-Jul-21	44.50975	-77.39077	23.5	285	H5, 300V	2400

Appendix 11c. Site details and sampling effort for 15 sites sampled along the Salmon River during transect-based electrofishing surveys 2021. Dash (-) indicates measurement not recorded.

Site	Sample date	Latitude	Longitude	Water temperature (°C)	Conductivity (µS/cm)	Backpack settings	Sampling effort (seconds)
Kingsford Conservation Area Site 1	14-Jul-21	44.28504	-77.09861	23.2	296	H5, 400V	2400
Kingsford Conservation Area Site 2	14-Jul-21	44.28315	-77.10103	26.3	292	H5, 400V	2400
Waddingham Rd	15-Jul-21	44.26578	-77.13563	25.8	290	G4, 400V	2400
Lonsdale	15-Jul-21	44.27448	-77.12632	-	-	-	2460
Deseronto Rd	16-Jul-21	44.29352	-77.08809	23.4	292	H4, 400V	2400
Adair Rd	19-Jul-21	44.47715	-76.98969	22.7	174	G5, 400V	2400
Jones St	19-Jul-21	44.49383	-76.99639	-	-	G5, 400V	2400
Tamworth	20-Jul-21	44.48729	-76.99199	23.1	161	H5, 400V	2400
Croydon	20-Jul-21	44.42112	-76.97751	25.0	247	H5, 400V	2400
Milltown	22-Jul-21	44.20751	-77.20949	23.7	300	G5, 300V	2400
Wyman Rd	22-Jul-21	44.24386	-77.16124	23.3	284	G4, 500V	2400
Buttermilk Falls	26-Jul-21	44.33329	-77.05071	23.5	271	-	2400
Teupah Excavating	26-Jul-21	44.33526	-77.04309	24.5	272	G4	2400
Salmon River Rd	29-Jul-21	44.34674	-77.03106	20.9	255	H5, 400V	2400
Ballantra Dr	30-Jul-21	44.50975	-77.39077	20.3	181	H5, 400V	2400

Appendix 12d. Site details and sampling effort for seven sites sampled along the Napanee River during transect-based electrofishing surveys in 2021. Dash (-) indicates measurement not recorded.

Site	Sample date	Latitude	Longitude	Water temperature (°C)	Conductivity (µS/cm)	Backpack settings	Sampling effort (seconds)
Colebrook	21-Jul-21	44.38733	-76.77013	24.0	154	-	2400
Petworth	27-Jul-21	44.41702	-76.75781	23.2	152	H5, 500V	2400
Camden	3-Aug-21	44.33631	-76.83416	21.0	174	G5, 400V	2400
Strathcona	3-Aug-21	44.30404	-76.90035	22.6	191	H5, 400V	2400
Napanee downtown	4-Aug-21	44.25022	-76.94562	20.9	264	G5, 400V	2400
Newburgh	4-Aug-21	44.32344	-76.87529	22.2	186	G5, 400V	2400
Yarker	5-Aug-21	44.37125	-76.77120	21.2	156	H5, 400V	2400

Appendix 13e. Site details and sampling effort for two sites sampled along Depot Creek during transect-based electrofishing surveys in 2021. Dash (-) indicates measurement not recorded.

Site	Sample date	Latitude	Longitude	Water temperature (°C)	Conductivity (µS/cm)	Backpack settings	Sampling effort (seconds)
First Lake Rd	6-Aug-21	44.48080	-76.76096	22.1	86	-	1800
Bellrock Rd	6-Aug-21	44.47200	-76.76248	24.6	86	H5, 400V	1080

Appendix 14a. Summary of individuals captured from 25 sites on Crowe Lake during angling surveys in 2021.

Site code	Bluegill	Pumpkinseed	Rock Bass	Round Goby	Yellow Perch
CL01	0	1	0	0	0
CL02	2	5	0	0	0
CL03	0	3	1	0	0
CL04	0	1	0	0	0
CL05	0	5	0	0	0
CL06	0	0	0	0	0
CL07	0	0	0	0	0
CL08	0	0	0	0	0
CL09	0	0	0	0	0
CL10	0	0	0	0	0
CL11	0	0	0	0	0
CL12	0	0	0	0	0
CL13	0	0	0	0	0
CL14	0	0	0	0	0
CL15	0	0	0	0	0
CL16	0	0	0	0	0
CL17	0	0	0	0	0
CL18	0	0	0	0	0
CL19	0	0	0	0	0
CL20	0	0	0	0	0
CL21	0	0	0	0	0
CL22	0	0	0	0	0
CL23	0	0	0	0	0
CL24	0	0	0	0	0
CL25	0	0	0	0	0

Appendix 15b. Summary of individuals captured from six sites on the Crowe River during angling surveys in 2021.

Site code	Bluegill	Pumpkinseed	Rock Bass	Round Goby	Yellow Perch
CR01	0	0	0	0	0
CR02	0	1	0	0	0
CR03	0	0	0	0	0
CR04	0	1	0	0	0
CR05	0	0	0	0	0
CR06	0	1	0	0	0

Appendix 16c. Summary of individuals captured from ten sites on Rylstone Lake during angling surveys in 2021.

Site code	Bluegill	Pumpkinseed	Rock Bass	Round Goby	Yellow Perch
RL01	1	0	0	0	0
RL02	0	1	0	0	0
RL03	0	0	0	0	0
RL04	1	1	0	0	0
RL05	0	0	0	0	0
RL06	0	0	0	0	0
RL07	1	0	0	0	0
RL08	0	0	0	0	0
RL09	3	3	0	0	0
RL10	6	3	0	0	0

Appendix 17d. Summary of individuals captured from 24 sites on Beaver Lake during angling surveys in 2021.

Site code	Bluegill	Pumpkinseed	Rock Bass	Round Goby	Yellow Perch
BL01	0	0	0	0	0
BL02	0	0	0	0	0
BL03	0	0	0	0	0
BL04	0	0	0	0	0
BL05	0	0	0	0	0
BL06	1	4	0	0	0
BL07	0	0	0	0	0
BL08	1	0	0	0	0
BL09	0	0	1	0	0
BL10	0	0	0	0	0
BL11	0	0	1	0	0
BL12	0	0	0	0	0
BL13	0	0	0	0	0
BL14	0	0	1	0	0
BL15	0	0	0	0	0
BL16	0	0	1	0	0
BL17	0	0	0	0	0
BL18	0	0	0	0	0
BL19	0	0	0	0	0
BL20	0	1	0	0	0
BL21	0	0	0	0	0
BL22	0	0	0	0	0
BL23	0	1	0	0	0
BL24	0	0	0	0	0

Appendix 18e. Summary of individuals captured from 24 sites on Varty Lake during angling surveys in 2021.

Site code	Bluegill	Pumpkinseed	Rock Bass	Round Goby	Yellow Perch
VL01	0	0	0	0	0
VL02	0	0	0	0	0
VL03	0	0	0	0	0
VL04	0	0	0	0	0
VL05	0	2	0	0	1
VL06	0	11	0	0	0
VL07	0	5	0	0	0
VL08	0	0	0	0	0
VL09	0	0	0	0	0
VL10	0	0	0	0	0
VL11	0	0	0	0	0
VL12	0	0	0	0	0
VL13	0	0	0	0	0
VL14	0	0	0	0	0
VL15	0	0	0	0	0
VL16	0	0	0	0	0
VL17	0	0	0	0	0
VL18	0	0	0	0	0
VL19	0	0	0	0	0
VL20	0	0	0	0	0
VL21	0	0	0	0	0
VL22	0	0	0	0	0
VL23	0	0	0	0	0
VL24	0	1	0	0	0

Appendix 19f. Summary of individuals captured from eight sites on the Trent River at Percy Boom during angling surveys in 2021.

Site code	Bluegill	Pumpkinseed	Rock Bass	Round Goby	Yellow Perch
TRPB01	0	0	0	4	0
TRPB02	1	3	0	1	1
TRPB03	1	0	0	1	0
TRPB04	0	0	0	0	0
TRPB05	1	0	1	0	0
TRPB06	0	0	0	1	0
TRPB07	0	0	0	0	0
TRPB08	0	0	0	0	0

Appendix 20a. Site details and sampling effort for 25 sites sampled on Crowe Lake during angling surveys in 2021.

					Macrophyte coverage (%)				Substrate composition (%)									
Site code	Latitude	Longitude	Water temperature (°C)	Water depth (m)	Open water	Emergent	Submerged	Floating	Organic	Clay	Silt	Sand	Gravel	Cobble	Rubble	Boulder	Bedrock	Unknown
CL01	44.47331	-77.76483	24.0	0.30	95	0	5	0	5	0	5	15	25	50	0	0	0	0
CL02	44.47754	-77.76484	24.7	0.75	100	0	0	0	0	0	0	0	0	50	50	0	0	0
CL03	44.48650	-77.76922	25.8	0.90	90	0	10	0	10	0	0	5	10	30	45	0	0	0
CL04	44.48293	-77.76034	26.2	0.80	95	0	5	0	0	0	0	5	25	20	50	0	0	0
CL05	44.47165	-77.75822	24.2	0.95	95	0	5	0	0	0	0	10	5	15	70	0	0	0
CL06	44.47265	-77.74619	24.1	0.80	100	0	0	0	0	0	0	0	0	85	15	0	0	0
CL07	44.47553	-77.73257	23.8	0.55	70	0	30	0	0	0	0	55	40	5	0	0	0	0
CL08	44.47447	-77.71809	23.6	1.30	100	0	0	0	0	0	0	10	20	55	15	0	0	0
CL09	44.48163	-77.71364	23.7	1.00	100	0	0	0	0	0	0	0	0	70	30	0	0	0
CL10	44.48711	-77.73845	23.5	1.40	100	0	0	0	0	0	0	40	15	30	15	0	0	0
CL11	44.49266	-77.73595	24.5	1.60	100	0	0	0	0	0	0	10	0	80	10	0	0	0
CL12	44.49758	-77.72965	24.2	0.90	100	0	0	0	0	0	0	15	5	0	20	60	0	0
CL13	44.47829	-77.74806	25.4	0.70	100	0	0	0	0	0	0	25	15	50	10	0	0	0
CL14	44.48549	-77.71007	23.9	1.00	100	0	0	0	0	0	5	50	20	20	5	0	0	0
CL15	44.49231	-77.71025	23.8	1.00	100	0	0	0	0	0	0	30	20	35	15	0	0	0
CL16	44.50218	-77.71346	24.0	1.20	95	0	5	0	0	0	0	45	30	25	0	0	0	0
CL17	44.50515	-77.72115	24.1	0.60	100	0	0	0	0	0	0	10	10	75	5	0	0	0
CL18	44.49508	-77.73209	24.2	0.60	80	0	20	0	0	0	0	20	15	25	40	0	0	0
CL19	44.49091	-77.73743	23.8	0.85	95	0	5	0	0	0	0	0	10	20	70	0	0	0
CL20	44.47303	-77.72532	24.2	1.70	95	0	5	0	0	0	0	30	15	40	15	0	0	0
CL21	44.50429	-77.71047	25.9	0.90	100	0	0	0	5	0	10	20	25	25	15	0	0	0
CL22	44.47978	-77.73864	24.3	0.95	100	0	0	0	0	0	0	35	15	30	20	0	0	0
CL23	44.48378	-77.74528	24.4	1.20	90	0	10	0	0	0	0	45	10	40	5	0	0	0
CL24	44.47644	-77.75630	25.3	0.60	90	0	10	0	5	0	5	5	0	30	40	15	0	0
CL25	44.48694	-77.76427	26.3	0.60	80	0	20	0	5	0	0	5	0	20	70	0	0	0

Appendix 21b. Site details and sampling effort for six sites sampled on the Crowe River during angling surveys in 2021.

					Macrophyte coverage (%)				Substrate composition (%)									
Site code	Latitude	Longitude	Water temperature (°C)	Water depth (m)	Open water	Emergent	Submerged	Floating	Organic	Clay	Silt	Sand	Gravel	Cobble	Rubble	Boulder	Bedrock	Unknown
CR01	44.47414	-77.68073	21.4	2.20	100	0	0	0	5	0	0	90	5	0	0	0	0	0
CR02	44.48056	-77.68463	22.2	1.50	95	0	5	0	0	0	0	45	5	15	5	0	25	0
CR03	44.48168	-77.68535	22.4	2.00	100	0	0	0	0	0	0	0	0	10	90	0	0	0
CR04	44.48146	-77.68499	22.5	0.70	100	0	0	0	0	0	0	5	15	80	0	0	0	0
CR05	44.48123	-77.68498	22.6	2.40	100	0	0	0	0	0	0	20	10	40	30	0	0	0
CR06	44.48071	-77.68407	22.7	0.60	100	0	0	0	0	0	0	25	70	5	0	0	0	0

Appendix 22c. Site details and sampling effort for ten sites sampled on Rylstone Lake during angling surveys in 2021. Dash (-) indicates measurement not recorded.

					Macrophyte coverage (%)				Substrate composition (%)									
Site code	Latitude	Longitude	Water temperature (°C)	Water depth (m)	Open water	Emergent	Submerged	Floating	Organic	Clay	Silt	Sand	Gravel	Cobble	Rubble	Boulder	Bedrock	Unknown
RL01	44.41327	-77.71459	21.9	1.40	80	0	20	0	0	0	0	5	30	55	10	0	0	0
RL02	44.41526	-77.71455	22.5	0.80	95	0	5	0	15	0	15	0	0	30	40	0	0	0
RL03	44.41760	-77.70764	23.2	0.70	90	0	10	0	5	0	0	0	25	30	40	0	0	0
RL04	44.42369	-77.69810	23.2	1.20	90	0	10	0	10	0	0	5	15	20	40	10	0	0
RL05	44.42650	-77.69838	22.9	0.60	45	0	50	5	5	0	25	0	15	20	0	25	10	0
RL06	44.43120	-77.69484	23.7	1.80	0	0	5	0	10	0	10	0	35	15	30	0	0	0
RL07	44.41065	-77.72039	23.8	-	95	0	5	0	0	0	0	0	5	35	60	0	0	0
RL08	44.40937	-77.72308	23.9	0.70	80	0	20	0	0	0	0	5	15	60	20	0	0	0
RL09	44.40863	-77.72297	23.9	0.80	100	0	0	0	5	0	5	10	25	40	15	0	0	0
RL10	44.40957	-77.72205	24.0	1.20	90	0	10	0	0	0	0	10	75	10	5	0	0	0

Appendix 23d. Site details and sampling effort for 24 sites sampled on Beaver Lake during angling surveys in 2021. Dash (-) indicates measurement not recorded.

					Macrophyte coverage (%)				Substrate composition (%)									
Site code	Latitude	Longitude	Water temperature (°C)	Water depth (m)	Open water	Emergent	Submerged	Floating	Organic	Clay	Silt	Sand	Gravel	Cobble	Rubble	Boulder	Bedrock	Unknown
BL01	44.47917	-77.04536	20.0	1.20	75	0	25	0	5	0	0	95	0	0	0	0	0	0
BL02	44.48315	-77.04333	21.3	1.20	75	0	25	0	5	0	0	95	0	0	0	0	0	0
BL03	44.48820	-77.03974	21.9	0.70	95	0	5	0	5	0	0	30	0	20	45	0	0	0
BL04	44.49820	-77.03321	22.0	0.70	95	0	5	0	0	0	0	80	0	5	15	0	0	0
BL05	44.50767	-77.02981	22.2	1.00	95	0	5	0	10	0	0	85	0	0	5	0	0	0
BL06	44.47821	-77.03869	17.7	0.70	95	0	5	0	5	0	0	15	20	60	0	0	0	0
BL07	44.47910	-77.03543	18.1	0.80	25	0	75	0	0	0	0	55	35	5	0	0	0	0
BL08	44.48148	-77.03250	18.1	1.50	100	0	0	0	0	0	0	30	40	30	0	0	0	0
BL09	44.48577	-77.03130	19.5	0.60	100	0	0	0	0	0	0	5	15	75	5	0	0	0
BL10	44.49489	-77.02865	21.0	0.90	50	0	50	0	45	0	0	30	15	10	0	0	0	0
BL11	44.50159	-77.02419	20.7	0.60	100	0	0	0	5	0	0	25	40	30	0	0	0	0
BL12	44.50621	-77.02065	20.4	1.20	100	0	0	0	0	0	0	15	35	40	10	0	0	0
BL13	44.51076	-77.01427	21.0	0.40	100	0	0	0	0	0	0	20	30	50	0	0	0	0
BL14	44.51765	-77.01354	21.1	1.80	95	0	5	0	10	0	0	0	0	60	30	0	0	0
BL15	44.51426	-77.01749	21.6	0.40	80	0	20	0	90	0	0	10	0	0	0	0	0	0
BL16	44.51344	-77.01999	21.9	1.80	95	0	5	0	5	0	0	5	0	0	90	0	0	0
BL17	44.51149	-77.02651	22.5	1.20	95	0	5	0	10	0	0	85	5	0	0	0	0	0
BL18	44.51265	-77.03235	-	1.10	95	0	5	0	0	0	0	10	0	0	90	0	0	0
BL19	44.50886	-77.03460	-	0.80	100	0	0	0	0	0	0	0	5	90	5	0	0	0
BL20	44.50231	-77.04115	-	0.80	95	0	0	5	0	0	0	20	55	15	10	0	0	0
BL21	44.49477	-77.04409	-	0.70	100	0	0	0	0	0	0	10	15	75	0	0	0	0
BL22	44.48747	-77.04778	-	0.80	100	0	0	0	5	0	0	25	60	10	0	0	0	0
BL23	44.48843	-77.04065	-	1.60	85	0	15	0	5	0	0	5	5	15	65	5	0	0
BL24	44.49797	-77.03603	-	2.50	100	0	0	0	0	0	0	0	0	0	20	80	0	0

Appendix 24e. Site details and sampling effort for 24 sites sampled on Varty Lake during angling surveys in 2021. Dash (-) indicates measurement not recorded.

					Macrophyte coverage (%)				Substrate composition (%)									
Site code	Latitude	Longitude	Water temperature (°C)	Water depth (m)	Open water	Emergent	Submerged	Floating	Organic	Clay	Silt	Sand	Gravel	Cobble	Rubble	Boulder	Bedrock	Unknown
VL01	44.37494	-76.81796	23.9	0.90	25	0	75	0	70	0	0	0	0	10	20	0	0	0
VL02	44.36906	-76.81963	24.7	0.80	95	0	5	0	80	0	0	10	0	5	5	0	0	0
VL03	44.37380	-76.81416	25.1	0.60	0	0	100	0	90	0	0	5	5	0	0	0	0	0
VL04	44.38236	-76.81349	25.7	0.50	55	0	45	0	70	0	0	10	5	10	5	0	0	0
VL05	44.38706	-76.82047	24.4	0.50	75	0	25	0	5	0	0	20	35	40	0	0	0	0
VL06	44.39137	-76.82032	25.1	1.20	100	0	0	0	95	0	0	0	5	0	0	0	0	0
VL07	44.39619	-76.82310	25.2	0.75	25	0	70	5	70	0	0	5	10	15	0	0	0	0
VL08	44.40679	-76.82068	25.2	0.50	0	0	100	0	100	0	0	0	0	0	0	0	0	0
VL09	44.40910	-76.81908	25.2	-	70	0	30	0	40	0	0	5	15	40	0	0	0	0
VL10	44.40624	-76.81042	21.8	2.00	100	0	0	0	0	0	0	0	0	0	20	70	0	10
VL11	44.40298	-76.81010	23.0	0.90	100	0	0	0	50	0	0	0	5	40	5	0	0	0
VL12	44.40470	-76.80678	22.8	1.00	95	0	5	0	25	0	0	0	5	50	20	0	0	0
VL13	44.40654	-76.79968	22.1	0.60	95	5	0	0	5	0	0	10	25	60	0	0	0	0
VL14	44.40174	-76.80199	22.2	1.00	90	0	10	0	10	0	0	35	20	30	5	0	0	0
VL15	44.39902	-76.80105	22.6	0.50	95	0	5	0	0	0	0	20	5	65	10	0	0	0
VL16	44.39270	-76.80318	22.2	0.60	85	0	15	0	15	0	0	15	25	45	0	0	0	0
VL17	44.38911	-76.80874	23.0	1.10	85	0	15	0	35	0	0	0	0	55	10	0	0	0
VL18	44.38262	-76.80962	23.8	1.00	30	0	70	0	70	0	0	0	0	0	30	0	0	0
VL19	44.39957	-76.79864	21.4	1.00	100	0	0	0	10	0	0	55	35	0	0	0	0	0
VL20	44.39775	-76.79607	21.9	0.40	50	0	50	0	0	0	0	100	0	0	0	0	0	0
VL21	44.39278	-76.80127	21.8	1.00	100	0	0	0	5	0	0	30	5	60	0	0	0	0
VL22	44.37862	-76.81702	22.4	0.80	65	0	35	0	35	0	0	0	0	60	5	0	0	0
VL23	44.38188	-76.81519	22.5	0.60	70	0	30	0	25	0	0	10	5	45	15	0	0	0
VL24	44.40398	-76.82201	24.8	1.10	15	0	85	0	100	0	0	0	0	0	0	0	0	0

Appendix 25f. Site details and sampling effort for eight reference sites sampled on the Trent River at Percy Boom during angling surveys in 2021.

					Macrophyte coverage (%)				Substrate composition (%)									
Site code	Latitude	Longitude	Water temperature (°C)	Water depth (m)	Open water	Emergent	Submerged	Floating	Organic	Clay	Silt	Sand	Gravel	Cobble	Rubble	Boulder	Bedrock	Unknown
TRPB01	44.23528	-77.79697	22.5	1.60	100	0	0	0	0	0	0	0	60	10	30	0	0	0
TRPB02	44.23480	-77.78946	22.2	0.90	70	0	30	0	0	0	0	5	20	40	35	0	0	0
TRPB03	44.23476	-77.78932	22.5	0.75	90	0	10	0	0	0	0	5	20	65	10	0	0	0
TRPB04	44.23536	-77.78561	22.0	0.25	95	0	5	0	0	0	0	25	40	35	0	0	0	0
TRPB05	44.23489	-77.78353	22.2	1.50	95	0	5	0	0	0	0	5	5	5	85	0	0	0
TRPB06	44.23497	-77.79598	23.2	1.10	85	0	15	0	0	0	5	15	20	60	0	0	0	0
TRPB07	44.23298	-77.79787	23.1	1.30	95	0	5	0	0	0	0	5	5	20	70	0	0	0
TRPB08	44.23606	-77.79784	23.0	2.00	100	0	0	0	0	0	0	10	30	55	5	0	0	0