

# Targeted Surveys for Eastern Sand Darter in the upper Ausable River and Big Otter Creek, Ontario, 2018

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2020

**Canadian Data Report of  
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by

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## ABSTRACT

Barnucz, J., Reid, S.M., and Drake, D. Andrew R. 2020. Targeted Surveys for Eastern Sand Darter in the upper Ausable River and Big Otter Creek, 2018. Can. Data Rep. Fish. Aquat. Sci. 1312 : vi + 26 p.

Targeted sampling for Eastern Sand Darter (*Ammocrypta pellucida*), a species listed as Threatened under Canada's *Species at Risk Act*, was undertaken in Ontario drainages of the Great Lakes that historically supported the species. Drainages sampled in 2018 included the Ausable River, a tributary of Lake Huron (last known detection of Eastern Sand Darter in 1928), and Big Otter Creek, a tributary of Lake Erie (last known detections in 1955). Nine sites (consisting of 27 seine hauls) were sampled in the Ausable River near Exeter, Ontario, while 52 sites (consisting of 156 seine hauls) were sampled in Big Otter Creek, from the confluence with Lake Erie to areas upstream of Tillsonburg, Ontario. Eastern Sand Darter was not detected in either drainage. In the Ausable River, 22 species were detected, with Bluntnose Minnow (*Pimephales notatus*), Johnny Darter (*Etheostoma nigrum*) and Logperch *Percina caprodes* being the most common and widespread species. In Big Otter Creek, 40 species were detected, with Common Shiner (*Luxilus cornutus*), Johnny Darter, Round Goby (*Neogobius melanostomus*) and White Sucker (*Catostomus commersonii*) being the most common and widespread species. Both drainages exhibited sandy substrates, the preferred habitat of Eastern Sand Darter (mean percent sand composition of 61% in both drainages); however, in the Ausable River, sand was always accompanied by silt (at least 15% of total substrate composition), while Big Otter Creek sites were composed entirely of sand, or sites with  $\geq 60\%$  sand composition but lacking silt. Round Goby, an invasive species and perceived threat to Eastern Sand Darter, was detected throughout the main branch of Big Otter Creek as far upstream as Tillsonburg. Fish community and habitat results are presented for both drainages.

## RÉSUMÉ

Barnucz, J., Reid, S.M., and Drake, D. Andrew R. 2020. Targeted Surveys for Eastern Sand Darter in the upper Ausable River and Big Otter Creek, 2018. Can. Data Rep. Fish. Aquat. Sci. 1312 : vi + 26 p.

Un échantillonnage ciblé visant le dard de sable (*Ammocrypta pellucida*), qui est inscrit sur la liste des espèces menacées aux termes de la Loi sur les espèces en péril du Canada, a été effectué dans le bassin de cours d'eau ontariens qui se jettent dans les Grands Lacs et où l'espèce était présente par le passé. Les bassins dans lesquels des échantillons ont été prélevés en 2018 étaient ceux de la rivière Ausable, qui se jette dans le lac Huron (dernière détection connue du dard de sable en 1928), et du ruisseau Big Otter, qui se jette dans le lac Érié (dernières détections connues en 1955). Neuf sites (27 levées de senne) ont été échantillonnés dans la rivière Ausable près d'Exeter, en Ontario, tandis que 52 sites (156 levées de senne) ont été échantillonnés dans le ruisseau Big Otter, de l'endroit où il se jette dans le lac Érié à des zones en amont de Tillsonburg, en Ontario. Le dard de sable n'a été détecté dans aucun des deux bassins. Dans la rivière Ausable, 22 espèces ont été détectées. Les plus communes et les plus répandues étaient le ventre-pourri (*Pimephales notatus*), le raseux-de-terre noir (*Etheostoma nigrum*) et le fouille-roche zébré (*Percina caprodes*). Dans le ruisseau Big Otter, 40 espèces ont été détectées. Les plus communes et les plus répandues étaient le méné à nageoires rouges (*Luxilus cornutus*), le raseux-de-terre noir, le gobie à taches noires (*Neogobius melanostomus*) et le meunier noir (*Catostomus commersonii*). Les deux bassins présentaient des substrats sableux, l'habitat favori du dard de sable (composition moyenne de 61 % de sable dans les deux bassins); cependant, dans la rivière Ausable, le sable était toujours accompagné de limon (au moins 15 % de la composition totale du substrat), tandis que les sites du ruisseau Big Otter étaient entièrement composés de sable ou contenaient > 60 % de sable, sans limon. Le gobie à taches noires, une espèce envahissante perçue comme une menace pour le dard de sable, a été détecté dans tout le bras principal du ruisseau Big Otter, jusqu'à Tillsonburg en amont. Les résultats concernant les communautés de poissons et les habitats sont présentés pour les deux bassins.



## INTRODUCTION

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

This data report summarizes targeted field sampling by DFO and its partners in 2018 to evaluate the distribution of Eastern Sand Darter (*Ammocrypta pellucida*) in two southwestern Ontario watercourses. Eastern Sand Darter is a small benthic species listed as Threatened under SARA since 2003. Within Canada, Eastern Sand Darter is found in the Lake St. Clair, Lake Erie, Lake Ontario, and St. Lawrence River/Lake Champlain drainages, with extant populations in the Grand River (Lake Erie drainage), Thames River (Lake St. Clair drainage), Sydenham River (Lake St. Clair), Big Creek (Lake Erie), West Lake (Lake Ontario), Rondeau Bay (Lake Erie), nearshore areas of Lake St. Clair and the western basin of Lake Erie, and numerous St. Lawrence River (including Lake Champlain) tributaries in Quebec (DFO 2010). Historically, Eastern Sand Darter occurred within Cattfish Creek (Lake Erie), Big Otter Creek (Lake Erie), and the Ausable River (Lake Huron) in southwestern Ontario, but has not been detected in these drainages since 1941, 1955, and 1928, respectively (COSEWIC 2009; Hubbs and Brown 1929). A single adult Eastern Sand Darter was collected west of Ailsa Craig (43° 08' 55" N, 81° 32' 47") in the Ausable River on May 26, 1928 (COSEWIC 2009). A single adult Eastern Sand Darter was collected in Big Otter Creek (formerly referred to as Otter Creek) near Tillsonburg, upstream of Highway 3 (42° 51' N, 80° 44' W) on August 23<sup>rd</sup>, 1923 (Hubbs and Brown 1929). Additionally, Eastern Sand Darter was collected near Calton (42° 42' 36" N, 80° 50' 25" W; Figure 1a,c) and Richmond (42° 45' 20" N, 80° 50' 48" W; Figure 1a,d) in Big Otter Creek in 1955 (COSEWIC 2009).

To understand whether Eastern Sand Darter is extant in the upper Ausable River and Big Otter Creek, targeted field sampling was undertaken in 2018 as part of on-going efforts by DFO and the Ontario Ministry of Natural Resources and Forestry (OMNRF) to evaluate the distribution of Eastern Sand Darter in Ontario. Sampling in the Ausable River and Big Otter Creek was also conducted to evaluate the composition of the fish assemblage and better understand aquatic habitat features of the drainages.

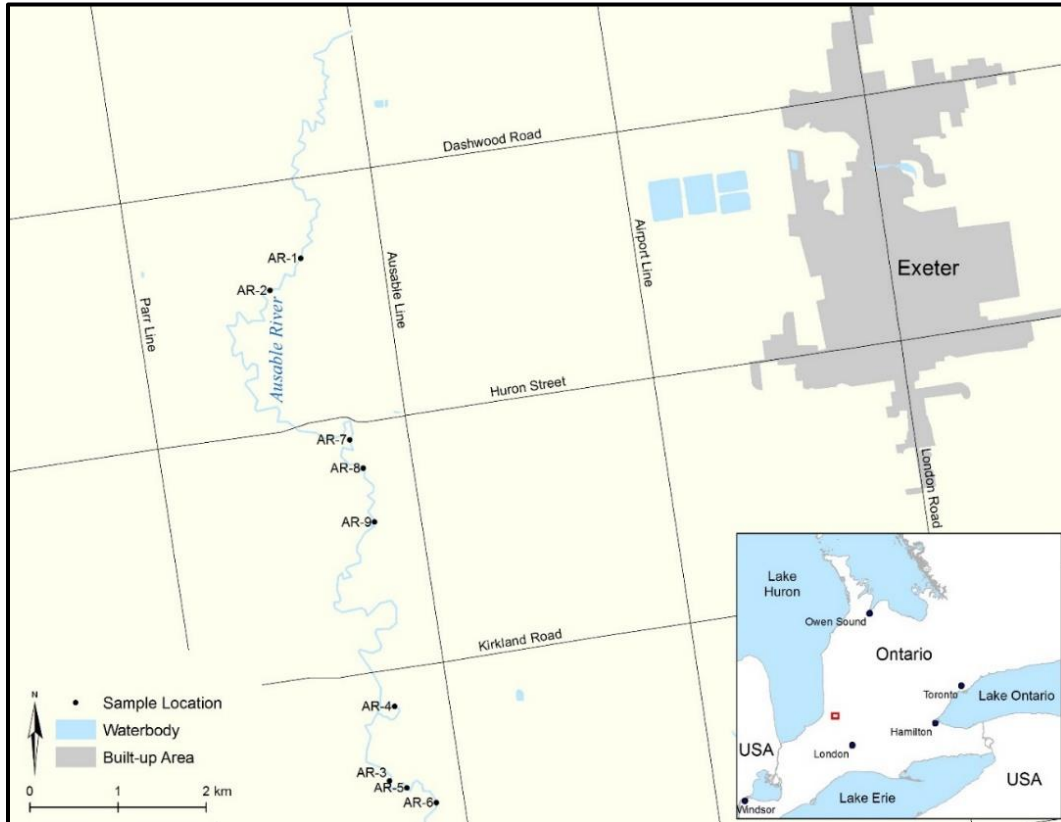
## METHODS

### SITE SELECTION

#### *Ausable River*

Over the last decade, multiple agencies (DFO, Ausable Bayfield Conservation Authority) have sampled fishes near Ailsa Craig where Eastern Sand Darter was collected in 1928. Sampling in 2018 focused on a section of the Ausable River that had not been recently sampled. The area upstream of Crediton Road and downstream of Dashwood Road was targeted (Figure 1). This area was chosen because recent work evaluating habitat features in the Ausable River indicated an abundance of preferred habitat features of Eastern Sand Darter (clean sand

substrates) in the vicinity of Hay Swamp (A. Dextrase, OMNRF, pers. comm., April 2018); however, the fish assemblage in this area has been poorly described (but see Dextrase 2013). Sampling sites were selected by navigating the river between Dashwood Road and Crediton Road via canoe and identifying areas where field crews could wade safely. Much of the river consisted of non-wadeable habitats or large physical obstructions (e.g., large woody debris). When wadeable areas were located, efforts were made to identify depositional zones (sand- or sand-silt dominated habitats), which were the areas targeted for fish sampling and are hereafter referred to as sampling sites. Site locality information is found in Appendix A1.

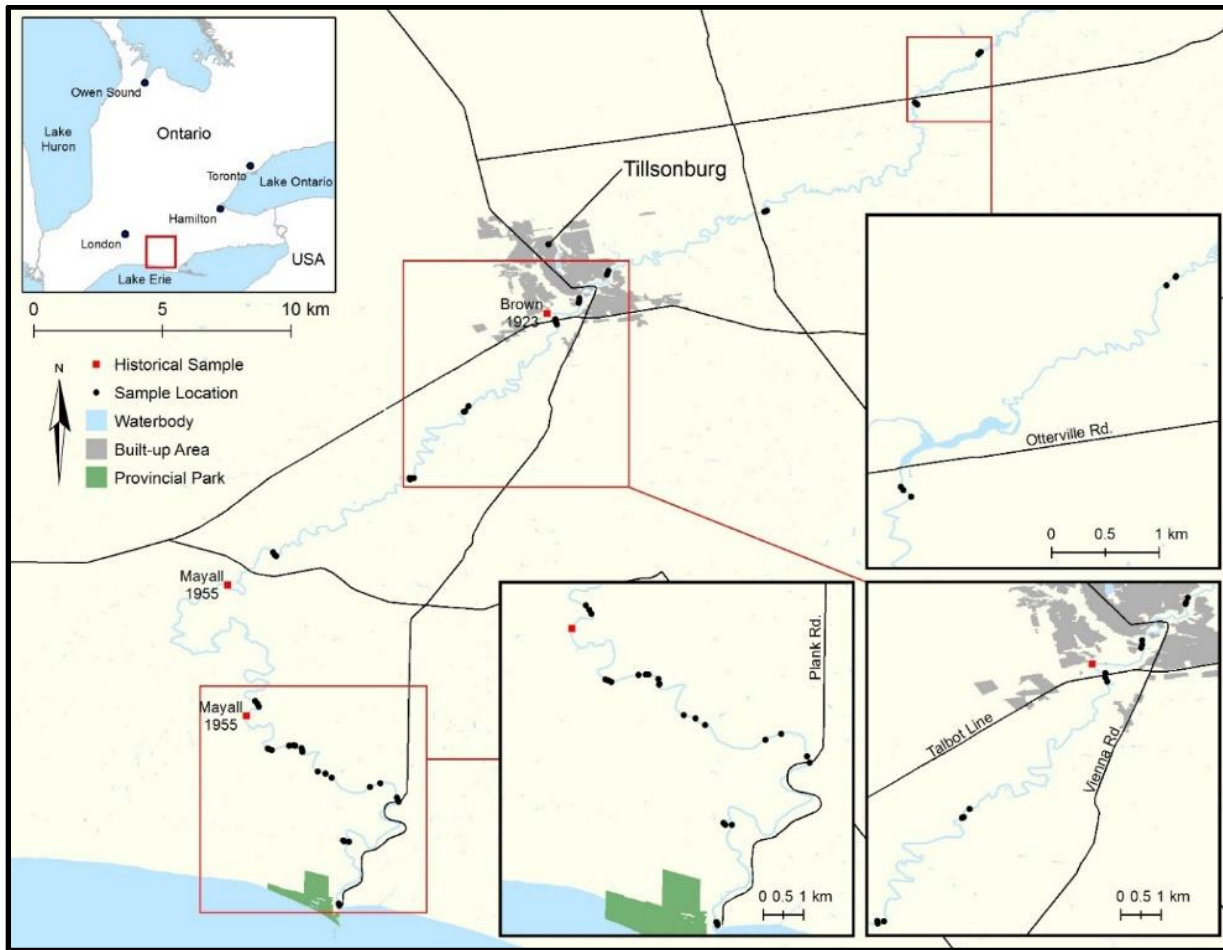


**Figure 1.** Sites sampled by DFO and OMNRF in the upper Ausable River in 2018

### Big Otter Creek

Fish assemblage sampling has been infrequent in Big Otter Creek over the past decade, so site selection focused on sampling: 1) in the vicinity of the 1923 and 1955 Eastern Sand Darter collections (Figure 2, Figure 3, Figure 4, Figure 5), and 2) as many reaches as possible on the main branch of Big Otter Creek between an upstream boundary of Highway 59 and a downstream boundary of the confluence of Big Otter Creek with Lake Erie (Figure 1), while ensuring proportional effort across the four OMNRF Aquatic Ecosystem Classification Segments (ProvSegID S2.3171, S2.3170, S2.3369, S2.4201) covering the main branch. Much of the land adjacent to Big Otter Creek is privately owned. Sites between Vienna and Port Burwell, Ontario were accessed primarily by boat, while sites upstream of Vienna to Highway 59 were chosen based on public access points (e.g., road crossings), or those where landowner permission was

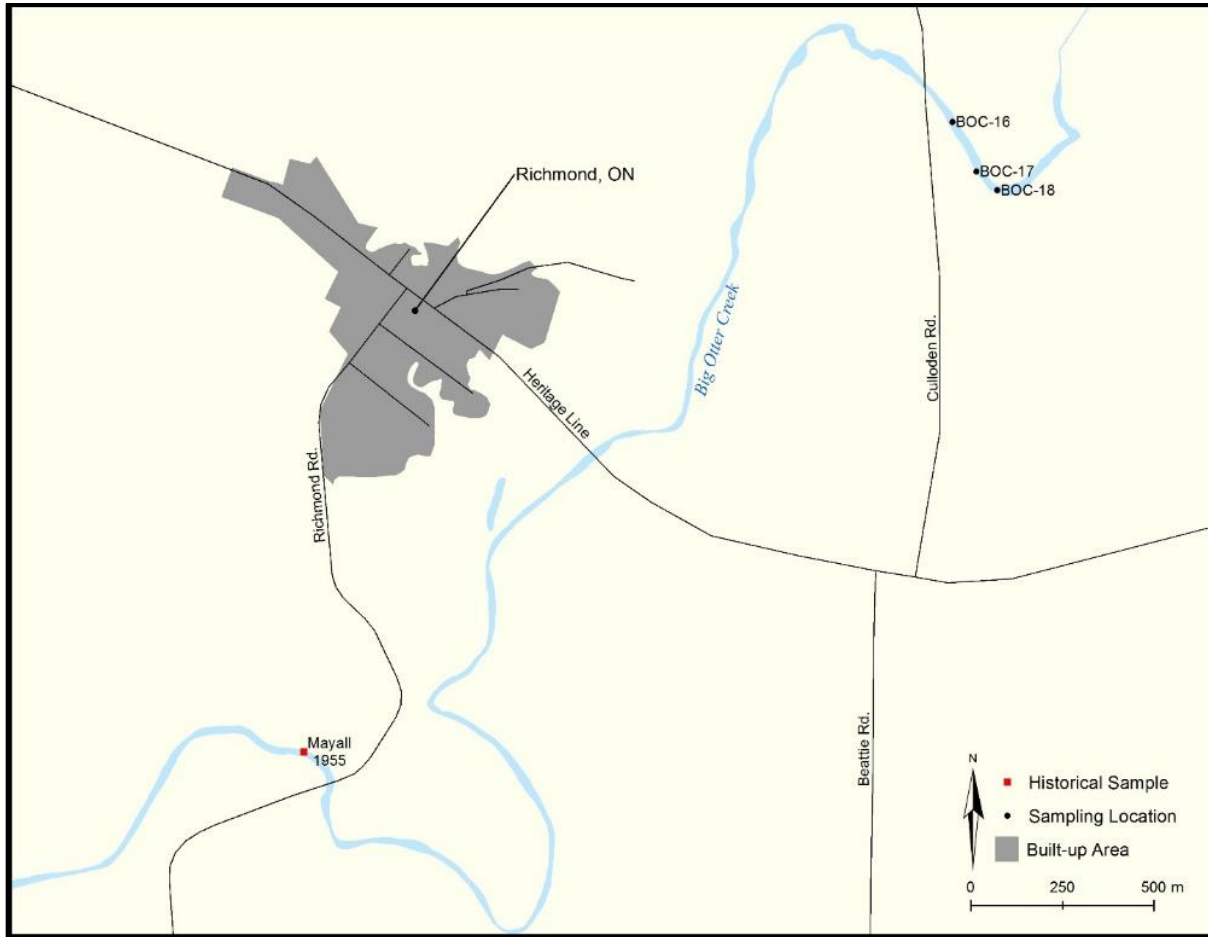
obtained. In the case of road crossings, crews moved at least 100 m upstream or downstream from the bridge crossing before selecting a sampling reach. Unlike the Ausable River, in Big Otter Creek, three discrete habitat types (riffle, run, pool) were visually identified within a single river reach, which was defined as a stream unit that was ten times the wetted channel width and contained at least one crossover (Stanfield 2005). Following Stanfield (2005), crossovers were defined as the location where the bulk of stream flow is in the center of the channel when at bankfull conditions. Each habitat type (riffle, run, pool) is hereafter referred to as a sampling site. Site locality information is found in Appendix A2.



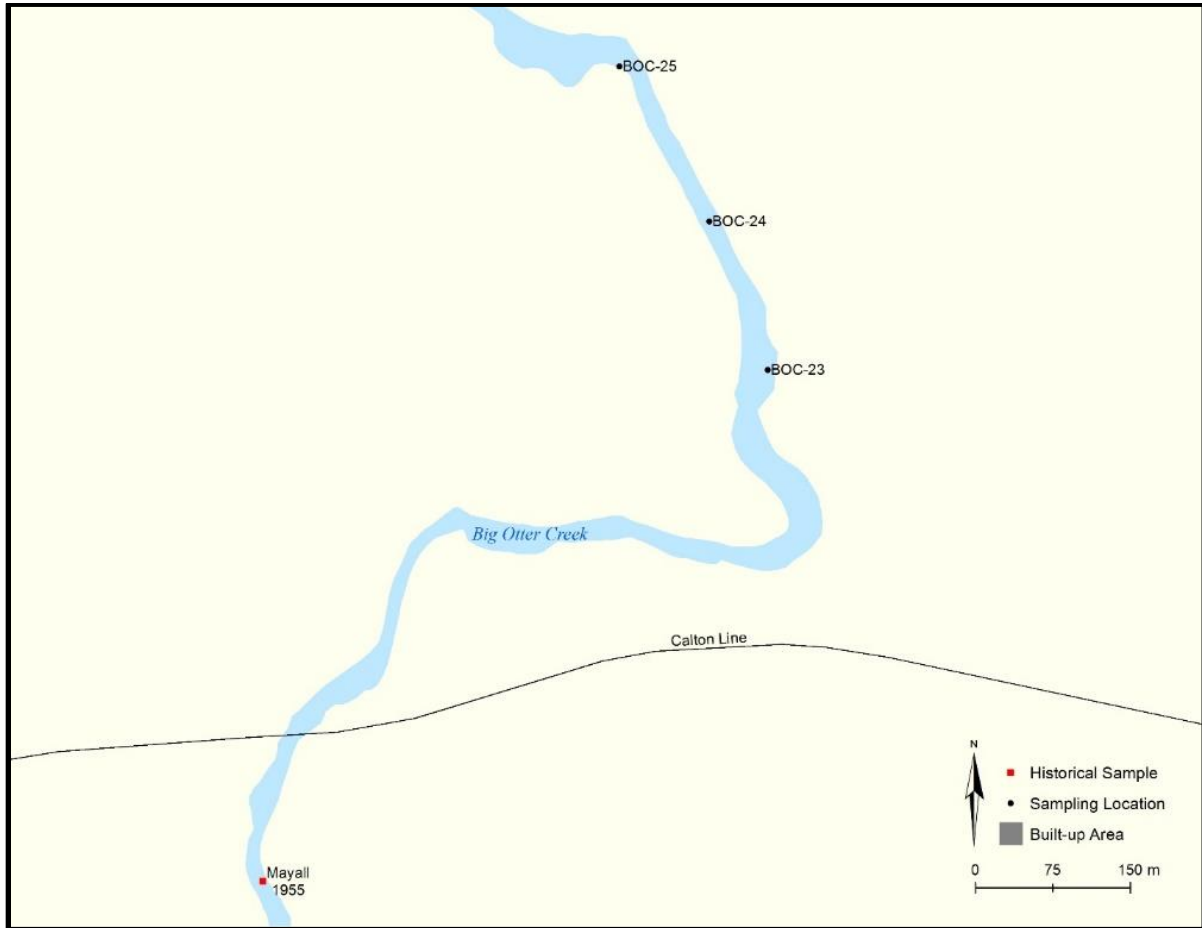
**Figure 2.** Overview of 1923 and 1955 collections of Eastern Sand Darter near Tillsonburg, Richmond, and Calton Line, Ontario (red icons, locality information COSEWIC 2009) and nearest targeted surveys conducted by DFO and OMNRF in 2018 (black icons).



**Figure 3.** Location of 1923 collection of Eastern Sand Darter downstream of Tillsonburg, Ontario (red icon; COSEWIC 2009) and nearest surveys conducted by DFO and OMNRF in 2018.



**Figure 4.** Location of 1955 collection of Eastern Sand Darter downstream of Richmond, Ontario (red icon; COSEWIC 2009) and nearest surveys conducted by DFO and OMNRF in 2018.



**Figure 5.** Location of 1955 collection of Eastern Sand Darter downstream of Calton Line, Ontario (red icon; COSEWIC 2009) and nearest surveys conducted by DFO and OMNRF in 2018.

### FISH ASSEMBLAGE SAMPLING

Sampling in the upper Ausable River occurred between July 24 – 26, 2018, while sampling in Big Otter Creek occurred between July 9 – 19 and September 24 – 26, 2018. Both rivers were sampled using a bag seine (9.2 m length and 1.8 m height; bag dimensions 1.8 m in width, height and depth). The seine was constructed of 3 mm heavy delta mesh and mounted on two wooden poles. Seining was performed in a downstream direction at each sampling site. Each haul was approximately 10 m in length, resulting in a fished area of approximately 80 m<sup>2</sup>, assuming an ~8-m seine opening. Three hauls were conducted in a repeated fashion over the site and approximately 5 minutes elapsed between hauls to allow fish to repopulate the seined area. To reduce site disturbance, survey crews began by sampling the downstream-most sampling unit first, working upstream towards the next unit, which allowed release of captured fishes downstream of the sampling reach to avoid recapture in upstream sites. Fishes captured during each haul were retained in bankside aquaria, identified to the lowest practical level of taxonomic resolution (typically species), and enumerated separately by haul. The minimum and

maximum total length of each species per sampling unit was recorded. A subset of fishes was retained and preserved in a 10% formalin solution for subsequent identification in the laboratory.

## **HABITAT SAMPLING**

Aquatic habitat variables were measured at the midpoint of the sampling site after fishes were processed and released. Habitat measurements were taken after fish processing was completed, which resulted in a minimum lag time of 10 minutes following fish sampling, thereby ensuring that habitat measures were not biased by sampling disturbance at the site. Water temperature (°C), conductivity (µS), turbidity (NTU), and dissolved oxygen (mg/L) were measured approximately 0.1 m beneath the water's surface using a YSI EX02 Multiparameter Sonde, which was deployed and allowed to stabilize for approximately 1 minute before measurements were recorded. Water clarity (cm) was measured using a 120 cm Fieldmaster Turbidity Tube. Air Temperature (°C) was measured using a Kestrel 3000 Wind Meter. Substrate composition within the seined area was analyzed by obtaining a handful of bed material within the center of the site and determining the percent composition of the grab sample based on median particle diameters: clay (0–0.002 mm), silt (0.002–0.02 mm), sand (0.02–2 mm), gravel (2–40 mm), cobble (40–256 mm), and boulder (>256 mm excluding bedrock). The ability of small substrates to remain formed within a hand grab sample was used to differentiate clay (formed) from silt (unformed) samples. Channel depth (m) was measured at three representative locations within the boundaries of the seined area (deep, shallow, and mid-depth) using a metre stick. Stream velocity (m/s) was also measured in three representative locations (fastest, slowest, mid-velocity) using a Swoffer 2100 Current Velocity Meter, which was deployed at approximately 50% of the stream depth. Wetted stream channel width (m) was measured at the midpoint of the seining site (Ausable) or river reach (Big Otter Creek), perpendicular to the bank, using a Nikon Laser 1200S Waterproof Laser Range Finder. Site location (latitude, longitude) was determined using a Garmin Montana 600 handheld GPS unit.

## **SAMPLING PERMITS AND DATA ARCHIVE**

Sampling for this project was conducted under the authority of Species at Risk Act Permit, Number 18-PCAA-00017. Data associated with these collections is housed under the project code “2018-ESD-AR” and “2018-ESD-BOC” in the Biodiversity Science Database within the Great Lakes Laboratory for Fisheries and Aquatic Sciences. Every effort has been made to ensure the accuracy of data contained in this report; however, species identities and other sampling results may be revised as part of a long-term data archiving process conducted in partnership with the Royal Ontario Museum. Raw data associated with this data report may be obtained by contacting the Great Lakes Laboratory for Fisheries and Aquatic Sciences.

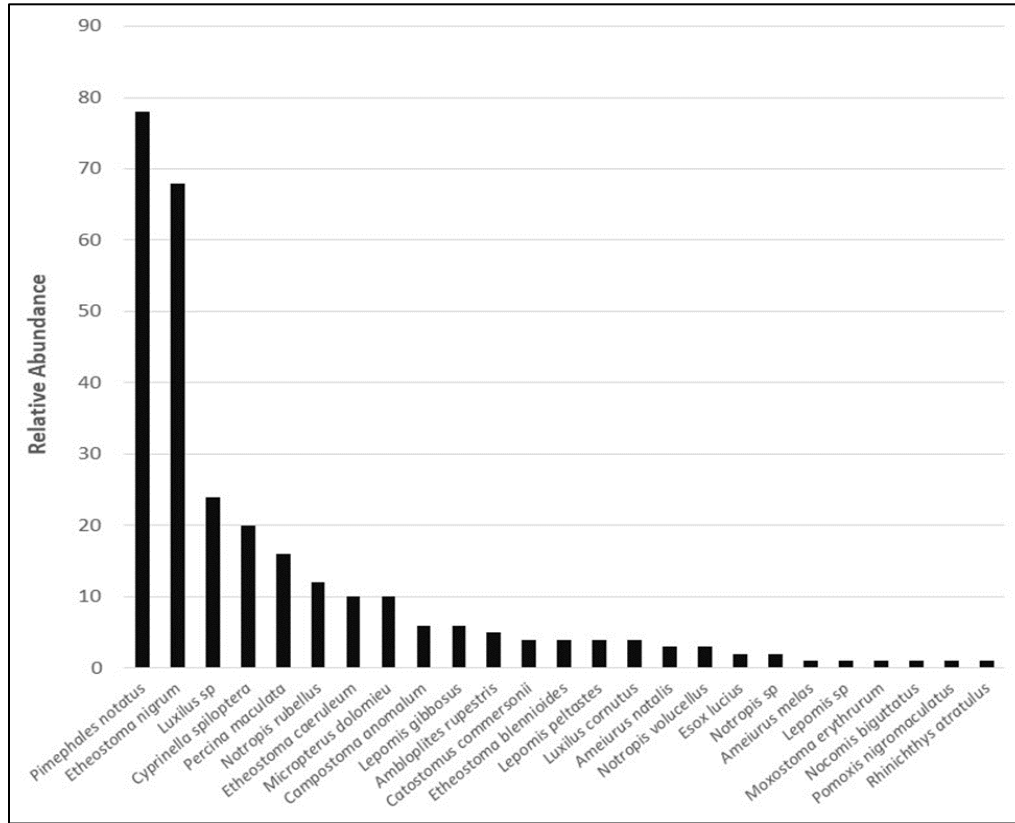
## **RESULTS**

### **FISH ASSEMBLAGE SAMPLING**

#### *Ausable River*

Nine sites, consisting of 27 seine hauls in total, were sampled in the Ausable River (Figure 6, Table 1). A total of 287 fishes representing 22 species were captured (Figure 6, Table 1). Eastern Sand Darter was not detected at any sampling site. Based on pooled catch data, the most abundant species were Bluntnose Minnow (*Pimephales notatus*), Johnny Darter (*Etheostoma nigrum*), *Luxilus* sp., Spottfin Shiner (*Cyprinella spiloptera*), and Blackside Darter

(*Percina maculata*) (Figure 6, Table 1). The most frequently occurring species across sites were Bluntnose Minnow and Johnny Darter (detected at 88% of sites), Smallmouth Bass (*Micropterus dolomieu*) and Blackside Darter (55.5% of sites), and Spotfin Shiner (44.4% of sites). Notably, Northern Sunfish (*Lepomis peltastes*), a species assessed as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2016), was collected at sampling sites AR-2, AR-3 and AR-4 (Table 1, Appendix A1).



**Figure 6.** Rank-abundance of pooled 2018 Ausable River catch data.

**Table 1** Fish assemblage sampling results from all sampling sites in the Ausable River in 2018. Values are aggregate catch from three seine hauls at each site.

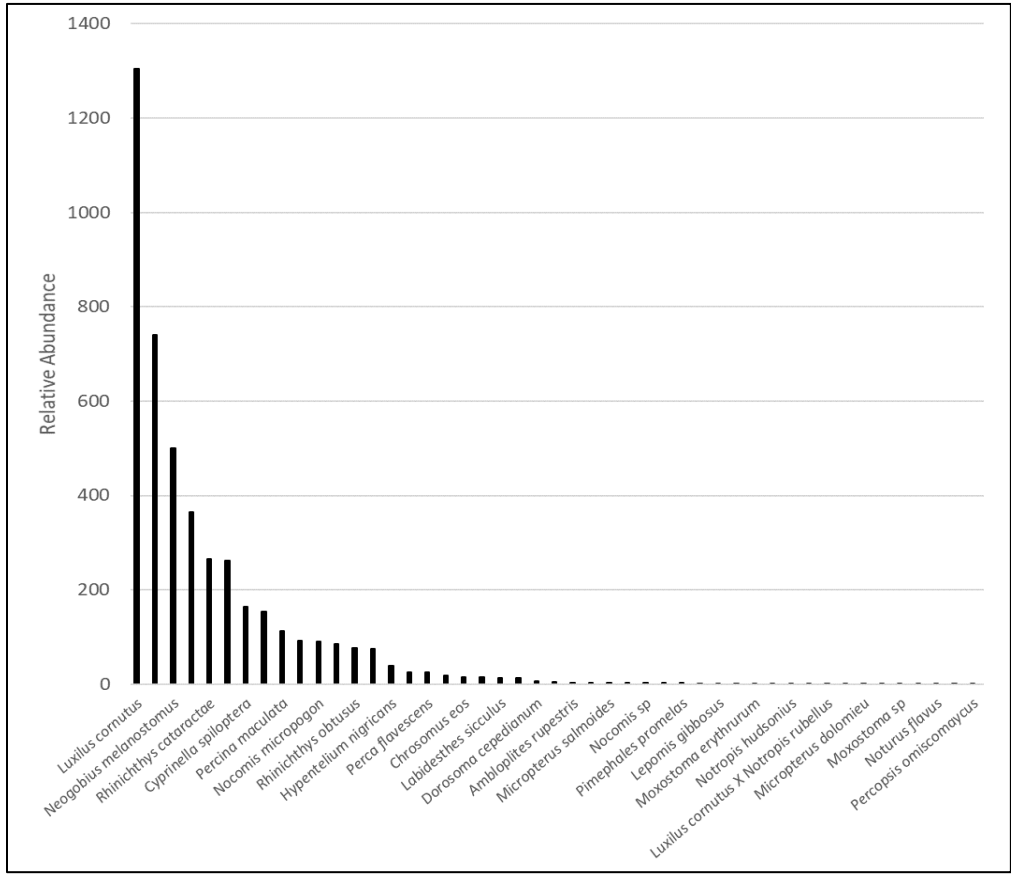
| Species                       | AR-1 | AR-2 | AR-3 | AR-4 | AR-5 | AR-6 | AR-7 | AR-8 | AR-9 | Total |
|-------------------------------|------|------|------|------|------|------|------|------|------|-------|
| <i>Ambloplites rupestris</i>  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 5    | 0    | 5     |
| <i>Ameiurus melas</i>         | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 0    | 1     |
| <i>Ameiurus natalis</i>       | 0    | 1    | 0    | 0    | 1    | 0    | 0    | 1    | 0    | 3     |
| <i>Campostoma anomalum</i>    | 0    | 0    | 3    | 0    | 0    | 1    | 0    | 2    | 0    | 6     |
| <i>Catostomus commersonii</i> | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 3    | 0    | 4     |



| Species                       | AR-1      | AR-2      | AR-3      | AR-4      | AR-5     | AR-6      | AR-7      | AR-8      | AR-9      | Total      |
|-------------------------------|-----------|-----------|-----------|-----------|----------|-----------|-----------|-----------|-----------|------------|
| <i>Cyprinella spiloptera</i>  | 3         | 0         | 0         | 0         | 2        | 0         | 0         | 13        | 2         | 20         |
| <i>Esox lucius</i>            | 0         | 2         | 0         | 0         | 0        | 0         | 0         | 0         | 0         | 2          |
| <i>Etheostoma blennioides</i> | 1         | 0         | 0         | 0         | 1        | 0         | 0         | 2         | 0         | 4          |
| <i>Etheostoma caeruleum</i>   | 0         | 0         | 0         | 0         | 0        | 0         | 2         | 8         | 0         | 10         |
| <i>Etheostoma nigrum</i>      | 5         | 29        | 4         | 2         | 3        | 0         | 2         | 22        | 1         | 68         |
| <i>Lepomis gibbosus</i>       | 0         | 4         | 0         | 0         | 0        | 1         | 0         | 1         | 0         | 6          |
| <i>Lepomis peltastes</i>      | 0         | 2         | 1         | 1         | 0        | 0         | 0         | 0         | 0         | 4          |
| <i>Lepomis sp</i>             | 0         | 0         | 0         | 1         | 0        | 0         | 0         | 0         | 0         | 1          |
| <i>Luxilus cornutus</i>       | 1         | 0         | 0         | 1         | 0        | 0         | 0         | 2         | 0         | 4          |
| <i>Luxilus sp</i>             | 23        | 1         | 0         | 0         | 0        | 0         | 0         | 0         | 0         | 24         |
| <i>Micropterus dolomieu</i>   | 0         | 2         | 3         | 1         | 0        | 0         | 2         | 0         | 2         | 10         |
| <i>Moxostoma erythrurum</i>   | 1         | 0         | 0         | 0         | 0        | 0         | 0         | 0         | 0         | 1          |
| <i>Nocomis biguttatus</i>     | 0         | 0         | 0         | 0         | 0        | 1         | 0         | 0         | 0         | 1          |
| <i>Notropis rubellus</i>      | 2         | 0         | 0         | 8         | 0        | 0         | 0         | 2         | 0         | 12         |
| <i>Notropis sp</i>            | 1         | 1         | 0         | 0         | 0        | 0         | 0         | 0         | 0         | 2          |
| <i>Notropis volucellus</i>    | 3         | 0         | 0         | 0         | 0        | 0         | 0         | 0         | 0         | 3          |
| <i>Percina maculata</i>       | 0         | 0         | 1         | 0         | 0        | 1         | 4         | 6         | 4         | 16         |
| <i>Pimephales notatus</i>     | 16        | 1         | 0         | 1         | 2        | 7         | 29        | 11        | 11        | 78         |
| <i>Pomoxis nigromaculatus</i> | 0         | 1         | 0         | 0         | 0        | 0         | 0         | 0         | 0         | 1          |
| <i>Rhinichthys obtusus</i>    | 0         | 0         | 0         | 0         | 0        | 0         | 0         | 1         | 0         | 1          |
| <b>Total</b>                  | <b>56</b> | <b>44</b> | <b>12</b> | <b>15</b> | <b>9</b> | <b>11</b> | <b>40</b> | <b>80</b> | <b>20</b> | <b>287</b> |

### Big Otter Creek

Fifty two sites, consisting of 156 seine hauls in total, were sampled in Big Otter Creek (Figure 7, Table 2). A total of 4,522 fishes were captured representing 40 species, including one hybrid (*Luxilus cornutus* X *Notropis rubellus*). Eastern Sand Darter was not detected at any of the 2018 sampling sites (Figure 7, Table 2). Based on pooled catch data, the most abundant species were Common Shiner (*Luxilus cornutus*), Johnny Darter, Round Goby (*Neogobius melanostomus*), White Sucker (*Catostomus commersonii*), and Longnose Dace (*Rhinichthys cataractae*). The most frequently occurring species across sites were Common Shiner (detected at 84.62% of sites), Creek Chub (75%), Johnny Darter (67.31%), Round Goby (63.46%), and White Sucker (59.62%). Notably, Round Goby, an invasive fish identified as a perceived threat to Eastern Sand Darter (Raab et al. 2018, DFO 2010), was detected throughout the main branch as far upstream as sampling site BOC-2 near Tillsonburg (Appendix A2). Round Goby was previously known only as far upstream as Richmond based on sampling conducted in 2008 (A. Dextrase, OMNRF, pers. comm. 2019).



**Figure 7.** Rank-abundance of pooled 2018 Big Otter Creek catch data.

**Table 2.** Fish assemblage sampling results from Big Otter Creek in 2018. Values are aggregate catch from three seine hauls at each site.

a) Species: *Ambloplites rupestris* – *Moxostoma* sp.

| Species | <i>Ambloplites rupestris</i> | <i>Campostoma anomalum</i> | <i>Catostomidae</i> | <i>Catostomus commersonii</i> | <i>Chrosomus eos</i> | <i>Culaea inconstans</i> | <i>Cyprinella spiloptera</i> | <i>Cyprinidae</i> | <i>Dorosoma cepedianum</i> | <i>Etheostoma nigrum</i> | <i>Hypentelium nigricans</i> | <i>Labidesthes sicculus</i> | <i>Lepomis gibbosus</i> | <i>Lepomis macrochirus</i> | <i>Lepomis</i> sp. | <i>Luxilus cornutus</i> | <i>Luxilus cornutus</i> X <i>Notropis rubellus</i> | <i>Luxilus</i> sp. | <i>Margariscus margarita</i> | <i>Micropterus dolomieu</i> | <i>Micropterus salmoides</i> | <i>Moxostoma erythrurum</i> | <i>Moxostoma macrolepidotum</i> | <i>Moxostoma</i> sp. |
|---------|------------------------------|----------------------------|---------------------|-------------------------------|----------------------|--------------------------|------------------------------|-------------------|----------------------------|--------------------------|------------------------------|-----------------------------|-------------------------|----------------------------|--------------------|-------------------------|--|--------------------|------------------------------|-----------------------------|------------------------------|-----------------------------|---------------------------------|----------------------|
| BOC-1   | 0                            | 0                          | 0                   | 0                             | 0                    | 0                        | 0                            | 0                 | 0                          | 0                        | 0                            | 0                           | 0                       | 0                          | 0                  | 94                      | 0  | 0                  | 0                            | 0                           | 0                            | 0                           | 0                               | 0                    |
| BOC-2   | 0                            | 0                          | 0                   | 4                             | 0                    | 0                        | 0                            | 0                 | 0                          | 25                       | 2                            | 0                           | 0                       | 0                          | 0                  | 23                      | 0  | 0                  | 0                            | 0                           | 0                            | 0                           | 0                               | 0                    |
| BOC-3   | 0                            | 0                          | 0                   | 0                             | 0                    | 0                        | 0                            | 0                 | 0                          | 5                        | 0                            | 0                           | 0                       | 0                          | 0                  | 21                      | 0  | 1                  | 0                            | 0                           | 0                            | 0                           | 0                               | 0                    |
| BOC-4   | 0                            | 0                          | 0                   | 7                             | 0                    | 0                        | 0                            | 0                 | 0                          | 12                       | 3                            | 0                           | 0                       | 0                          | 0                  | 37                      | 0  | 0                  | 0                            | 0                           | 0                            | 1                           | 0                               | 0                    |
| BOC-5   | 0                            | 0                          | 15                  | 33                            | 0                    | 0                        | 0                            | 1                 | 0                          | 62                       | 1                            | 0                           | 0                       | 0                          | 0                  | 61                      | 0  | 25                 | 0                            | 0                           | 0                            | 0                           | 0                               | 0                    |
| BOC-6   | 0                            | 0                          | 0                   | 4                             | 0                    | 0                        | 0                            | 0                 | 0                          | 6                        | 1                            | 0                           | 0                       | 0                          | 0                  | 73                      | 0  | 0                  | 0                            | 0                           | 0                            | 0                           | 0                               | 0                    |
| BOC-7   | 0                            | 0                          | 0                   | 0                             | 0                    | 0                        | 0                            | 0                 | 0                          | 0                        | 0                            | 0                           | 0                       | 0                          | 0                  | 46                      | 0  | 0                  | 0                            | 0                           | 0                            | 0                           | 0                               | 0                    |
| BOC-8   | 0                            | 0                          | 0                   | 0                             | 0                    | 0                        | 1                            | 0                 | 0                          | 7                        | 0                            | 0                           | 0                       | 0                          | 0                  | 18                      | 0  | 0                  | 0                            | 0                           | 0                            | 0                           | 0                               | 0                    |
| BOC-9   | 0                            | 0                          | 0                   | 0                             | 0                    | 0                        | 1                            | 0                 | 0                          | 84                       | 0                            | 0                           | 0                       | 1                          | 0                  | 0                       | 0  | 0                  | 0                            | 0                           | 0                            | 0                           | 0                               | 0                    |
| BOC-10  | 0                            | 0                          | 3                   | 2                             | 0                    | 0                        | 0                            | 0                 | 0                          | 13                       | 0                            | 0                           | 0                       | 0                          | 0                  | 9                       | 0  | 0                  | 0                            | 0                           | 0                            | 0                           | 0                               | 0                    |
| BOC-11  | 0                            | 0                          | 2                   | 0                             | 0                    | 0                        | 0                            | 0                 | 0                          | 5                        | 0                            | 0                           | 0                       | 0                          | 0                  | 10                      | 0  | 0                  | 0                            | 0                           | 0                            | 0                           | 0                               | 0                    |
| BOC-12  | 0                            | 0                          | 0                   | 0                             | 0                    | 0                        | 0                            | 0                 | 0                          | 0                        | 0                            | 0                           | 0                       | 0                          | 0                  | 16                      | 0  | 0                  | 0                            | 0                           | 0                            | 0                           | 0                               | 0                    |
| BOC-13  | 0                            | 0                          | 0                   | 7                             | 0                    | 0                        | 1                            | 0                 | 0                          | 2                        | 0                            | 0                           | 0                       | 0                          | 0                  | 72                      | 1  | 0                  | 0                            | 0                           | 0                            | 0                           | 0                               | 0                    |

| Species | <i>Ambloplites rupestris</i> | <i>Campostoma anomalum</i> | <i>Catostomidae</i> | <i>Catostomus commersonii</i> | <i>Chrosomus eos</i> | <i>Culaea inconstans</i> | <i>Cyprinella spiloptera</i> | <i>Cyprinidae</i> | <i>Dorosoma cepedianum</i> | <i>Etheostoma nigrum</i> | <i>Hypentelium nigricans</i> | <i>Labidesthes sicculus</i> | <i>Lepomis gibbosus</i> | <i>Lepomis macrochirus</i> | <i>Lepomis sp.</i> | <i>Luxilus cornutus</i> | <i>Luxilus cornutus X Notropis rubellus</i> | <i>Luxilus sp.</i> | <i>Margariscus margarita</i> | <i>Micropterus dolomieu</i> | <i>Micropterus salmoides</i> | <i>Moxostoma erythrum</i> | <i>Moxostoma macrolepidotum</i> | <i>Moxostoma sp.</i> |
|---------|------------------------------|----------------------------|---------------------|-------------------------------|----------------------|--------------------------|------------------------------|-------------------|----------------------------|--------------------------|------------------------------|-----------------------------|-------------------------|----------------------------|--------------------|-------------------------|---|--------------------|------------------------------|-----------------------------|------------------------------|---------------------------|---------------------------------|----------------------|
| BOC-14  | 2                            | 0                          | 0                   | 3                             | 0                    | 0                        | 0                            | 0                 | 0                          | 5                        | 0                            | 0                           | 0                       | 0                          | 0                  | 39                      | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-15  | 0                            | 0                          | 0                   | 0                             | 0                    | 0                        | 0                            | 0                 | 0                          | 12                       | 0                            | 0                           | 0                       | 0                          | 0                  | 18                      | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-16  | 0                            | 0                          | 0                   | 7                             | 0                    | 0                        | 3                            | 0                 | 0                          | 7                        | 1                            | 0                           | 0                       | 0                          | 0                  | 44                      | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-17  | 0                            | 0                          | 0                   | 0                             | 0                    | 0                        | 0                            | 0                 | 0                          | 0                        | 0                            | 0                           | 0                       | 0                          | 0                  | 5                       | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-18  | 0                            | 0                          | 0                   | 18                            | 0                    | 0                        | 1                            | 0                 | 0                          | 12                       | 0                            | 0                           | 0                       | 0                          | 0                  | 25                      | 0   | 2                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-19  | 0                            | 0                          | 2                   | 0                             | 0                    | 0                        | 0                            | 0                 | 0                          | 9                        | 0                            | 0                           | 1                       | 0                          | 0                  | 26                      | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-20  | 0                            | 0                          | 1                   | 10                            | 0                    | 0                        | 0                            | 0                 | 0                          | 31                       | 10                           | 0                           | 0                       | 0                          | 0                  | 35                      | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-21  | 0                            | 2                          | 0                   | 76                            | 16                   | 13                       | 0                            | 0                 | 0                          | 45                       | 10                           | 0                           | 0                       | 0                          | 0                  | 80                      | 0   | 3                  | 1                            | 0                           | 0                            | 1                         | 0                               | 0                    |
| BOC-22  | 0                            | 0                          | 0                   | 21                            | 0                    | 0                        | 0                            | 0                 | 0                          | 6                        | 7                            | 0                           | 0                       | 0                          | 0                  | 224                     | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 1                               | 0                    |
| BOC-23  | 0                            | 0                          | 0                   | 2                             | 0                    | 0                        | 0                            | 1                 | 0                          | 0                        | 0                            | 0                           | 0                       | 0                          | 0                  | 9                       | 0   | 17                 | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-24  | 0                            | 0                          | 0                   | 1                             | 0                    | 0                        | 0                            | 0                 | 0                          | 0                        | 0                            | 0                           | 0                       | 0                          | 0                  | 4                       | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-25  | 0                            | 0                          | 0                   | 48                            | 0                    | 0                        | 9                            | 0                 | 0                          | 5                        | 2                            | 0                           | 0                       | 0                          | 0                  | 17                      | 0   | 21                 | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-26  | 0                            | 0                          | 1                   | 4                             | 0                    | 0                        | 0                            | 0                 | 0                          | 0                        | 0                            | 0                           | 0                       | 0                          | 0                  | 22                      | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-27  | 0                            | 0                          | 0                   | 0                             | 0                    | 0                        | 1                            | 0                 | 0                          | 0                        | 0                            | 0                           | 0                       | 0                          | 0                  | 4                       | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-28  | 0                            | 0                          | 1                   | 14                            | 0                    | 0                        | 1                            | 0                 | 0                          | 2                        | 0                            | 0                           | 0                       | 0                          | 0                  | 3                       | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-29  | 0                            | 0                          | 0                   | 0                             | 0                    | 0                        | 1                            | 0                 | 0                          | 0                        | 0                            | 0                           | 0                       | 0                          | 0                  | 3                       | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-30  | 0                            | 0                          | 0                   | 36                            | 0                    | 0                        | 7                            | 0                 | 0                          | 2                        | 2                            | 0                           | 0                       | 0                          | 0                  | 2                       | 0   | 10                 | 0                            | 0                           | 0                            | 0                         | 0                               | 1                    |

| Species | <i>Ambloplites rupestris</i> | <i>Campostoma anomalum</i> | <i>Catostomidae</i> | <i>Catostomus commersonii</i> | <i>Chrosomus eos</i> | <i>Culaea inconstans</i> | <i>Cyprinella spiloptera</i> | <i>Cyprinidae</i> | <i>Dorosoma cepedianum</i> | <i>Etheostoma nigrum</i> | <i>Hypentelium nigricans</i> | <i>Labidesthes sicculus</i> | <i>Lepomis gibbosus</i> | <i>Lepomis macrochirus</i> | <i>Lepomis sp.</i> | <i>Luxilus cornutus</i> | <i>Luxilus cornutus X Notropis rubellus</i> | <i>Luxilus sp.</i> | <i>Margariscus margarita</i> | <i>Micropterus dolomieu</i> | <i>Micropterus salmoides</i> | <i>Moxostoma erythrum</i> | <i>Moxostoma macrolepidotum</i> | <i>Moxostoma sp.</i> |
|---------|------------------------------|----------------------------|---------------------|-------------------------------|----------------------|--------------------------|------------------------------|-------------------|----------------------------|--------------------------|------------------------------|-----------------------------|-------------------------|----------------------------|--------------------|-------------------------|---|--------------------|------------------------------|-----------------------------|------------------------------|---------------------------|---------------------------------|----------------------|
| BOC-31  | 0                            | 0                          | 0                   | 1                             | 0                    | 0                        | 1                            | 0                 | 0                          | 0                        | 1                            | 0                           | 0                       | 0                          | 0                  | 4                       | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-32  | 0                            | 0                          | 0                   | 1                             | 0                    | 0                        | 0                            | 0                 | 0                          | 0                        | 0                            | 0                           | 0                       | 0                          | 0                  | 16                      | 0   | 9                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-33  | 0                            | 0                          | 0                   | 2                             | 0                    | 0                        | 31                           | 0                 | 0                          | 2                        | 0                            | 0                           | 0                       | 0                          | 0                  | 33                      | 0   | 3                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-34  | 0                            | 0                          | 0                   | 1                             | 0                    | 0                        | 2                            | 0                 | 0                          | 1                        | 0                            | 0                           | 0                       | 0                          | 0                  | 2                       | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-35  | 0                            | 0                          | 0                   | 0                             | 0                    | 0                        | 2                            | 0                 | 0                          | 8                        | 0                            | 0                           | 0                       | 0                          | 0                  | 25                      | 0   | 0                  | 0                            | 1                           | 0                            | 0                         | 0                               | 0                    |
| BOC-36  | 0                            | 0                          | 0                   | 8                             | 0                    | 0                        | 1                            | 0                 | 0                          | 45                       | 0                            | 0                           | 0                       | 0                          | 0                  | 10                      | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-37  | 0                            | 0                          | 0                   | 3                             | 0                    | 0                        | 2                            | 0                 | 0                          | 18                       | 0                            | 0                           | 0                       | 0                          | 0                  | 83                      | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-38  | 0                            | 0                          | 0                   | 33                            | 0                    | 0                        | 0                            | 0                 | 0                          | 163                      | 0                            | 0                           | 0                       | 0                          | 0                  | 0                       | 0   | 0                  | 0                            | 0                           | 1                            | 0                         | 0                               | 0                    |
| BOC-39  | 0                            | 0                          | 0                   | 7                             | 0                    | 0                        | 0                            | 0                 | 0                          | 81                       | 0                            | 0                           | 0                       | 0                          | 0                  | 0                       | 0   | 0                  | 0                            | 0                           | 1                            | 0                         | 0                               | 0                    |
| BOC-40  | 0                            | 0                          | 0                   | 0                             | 0                    | 0                        | 0                            | 0                 | 0                          | 54                       | 0                            | 0                           | 0                       | 0                          | 0                  | 0                       | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-41  | 0                            | 0                          | 0                   | 0                             | 0                    | 0                        | 2                            | 0                 | 0                          | 2                        | 0                            | 0                           | 0                       | 0                          | 0                  | 11                      | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-42  | 0                            | 0                          | 0                   | 3                             | 0                    | 0                        | 1                            | 0                 | 0                          | 3                        | 0                            | 0                           | 0                       | 0                          | 0                  | 37                      | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-43  | 0                            | 0                          | 0                   | 4                             | 0                    | 0                        | 34                           | 2                 | 0                          | 3                        | 0                            | 0                           | 0                       | 0                          | 0                  | 10                      | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-44  | 0                            | 0                          | 0                   | 0                             | 0                    | 0                        | 6                            | 0                 | 0                          | 0                        | 0                            | 2                           | 0                       | 0                          | 0                  | 27                      | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-45  | 0                            | 0                          | 0                   | 1                             | 0                    | 0                        | 0                            | 0                 | 0                          | 1                        | 0                            | 1                           | 0                       | 0                          | 0                  | 1                       | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-46  | 0                            | 0                          | 0                   | 1                             | 0                    | 0                        | 1                            | 0                 | 0                          | 1                        | 0                            | 0                           | 0                       | 0                          | 0                  | 1                       | 0   | 0                  | 0                            | 0                           | 0                            | 0                         | 0                               | 0                    |
| BOC-47  | 0                            | 0                          | 0                   | 0                             | 0                    | 0                        | 15                           | 0                 | 0                          | 1                        | 0                            | 4                           | 0                       | 0                          | 0                  | 0                       | 0   | 0                  | 0                            | 0                           | 1                            | 0                         | 0                               | 0                    |

| Species      | <i>Ambloplites rupestris</i> | <i>Campostoma anomalum</i> | <i>Catostomidae</i> | <i>Catostomus commersonii</i> | <i>Chrosomus eos</i> | <i>Culaea inconstans</i> | <i>Cyprinella spiloptera</i> | <i>Cyprinidae</i> | <i>Dorosoma cepedianum</i> | <i>Etheostoma nigrum</i> | <i>Hypentelium nigricans</i> | <i>Labidesthes sicculus</i> | <i>Lepomis gibbosus</i> | <i>Lepomis macrochirus</i> | <i>Lepomis sp.</i> | <i>Luxilus cornutus</i> | <i>Luxilus cornutus X Notropis rubellus</i> | <i>Luxilus sp.</i> | <i>Margariscus margarita</i> | <i>Micropterus dolomieu</i> | <i>Micropterus salmoides</i> | <i>Moxostoma erythrurum</i> | <i>Moxostoma macrolepidotum</i> | <i>Moxostoma sp.</i> |
|--------------|------------------------------|----------------------------|---------------------|-------------------------------|----------------------|--------------------------|------------------------------|-------------------|----------------------------|--------------------------|------------------------------|-----------------------------|-------------------------|----------------------------|--------------------|-------------------------|---|--------------------|------------------------------|-----------------------------|------------------------------|-----------------------------|---------------------------------|----------------------|
| BOC-48       | 0                            | 0                          | 0                   | 4                             | 0                    | 0                        | 10                           | 0                 | 0                          | 0                        | 0                            | 0                           | 0                       | 0                          | 0                  | 0                       | 1   | 0                  | 0                            | 1                           | 0                            | 0                           | 0                               |                      |
| BOC-49       | 0                            | 0                          | 0                   | 0                             | 0                    | 0                        | 9                            | 0                 | 1                          | 0                        | 0                            | 2                           | 0                       | 0                          | 0                  | 0                       | 0   | 0                  | 0                            | 0                           | 0                            | 0                           | 0                               | 0                    |
| BOC-50       | 0                            | 0                          | 0                   | 0                             | 0                    | 0                        | 10                           | 0                 | 0                          | 0                        | 0                            | 1                           | 0                       | 0                          | 1                  | 0                       | 0   | 0                  | 0                            | 0                           | 0                            | 0                           | 0                               | 0                    |
| BOC-51       | 2                            | 0                          | 0                   | 0                             | 0                    | 0                        | 10                           | 0                 | 0                          | 0                        | 0                            | 0                           | 1                       | 4                          | 1                  | 3                       | 0   | 0                  | 0                            | 0                           | 0                            | 0                           | 0                               | 0                    |
| BOC-52       | 0                            | 0                          | 0                   | 0                             | 0                    | 0                        | 1                            | 0                 | 6                          | 0                        | 0                            | 4                           | 0                       | 1                          | 0                  | 2                       | 0   | 0                  | 0                            | 0                           | 0                            | 0                           | 0                               | 0                    |
| <b>Total</b> | <b>4</b>                     | <b>2</b>                   | <b>25</b>           | <b>366</b>                    | <b>16</b>            | <b>13</b>                | <b>164</b>                   | <b>4</b>          | <b>7</b>                   | <b>740</b>               | <b>40</b>                    | <b>14</b>                   | <b>2</b>                | <b>6</b>                   | <b>2</b>           | <b>1305</b>             | <b>1</b>                                    | <b>92</b>          | <b>1</b>                     | <b>1</b>                    | <b>4</b>                     | <b>2</b>                    | <b>1</b>                        | <b>1</b>             |

**Table 2.** (continued) Fish assemblage sampling results from Big Otter Creek in 2018. Values are aggregate catch from three seine hauls at each site.

b) Species: *Moxostoma valenciennesi* – *Semotilus atromaculatus*

| Species | <i>Moxostoma valenciennesi</i> | <i>Neogobius melanostomus</i> | <i>Nocomis micropogon</i> | <i>Nocomis sp.</i> | <i>Notemigonus crysoleucas</i> | <i>Notropis atherinoides</i> | <i>Notropis hudsonius</i> | <i>Notropis rubellus</i> | <i>Notropis sp.</i> | <i>Notropis stramineus</i> | <i>Notropis volucellus</i> | <i>Noturus flavus</i> | <i>Noturus gyrinus</i> | <i>Oncorhynchus mykiss</i> | <i>Perca flavescens</i> | <i>Percina caprodes</i> | <i>Percina maculata</i> | <i>Percopsis omiscomaycus</i> | <i>Pimephales notatus</i> | <i>Pimephales promelas</i> | <i>Rhinichthys obtusus</i> | <i>Rhinichthys cataractae</i> | <i>Semotilus atromaculatus</i> | Total |    |
|---------|--------------------------------|-------------------------------|---------------------------|--------------------|--------------------------------|------------------------------|---------------------------|--------------------------|---------------------|----------------------------|----------------------------|-----------------------|------------------------|----------------------------|-------------------------|-------------------------|-------------------------|-------------------------------|---------------------------|----------------------------|----------------------------|-------------------------------|--------------------------------|-------|----|
| BOC-1   | 0                              | 0                             | 0                         | 0                  | 0                              | 0                            | 0                         | 8                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 0                       | 0                             | 1                         | 0                          | 0                          | 22                            | 1                              | 126   |    |
| BOC-2   | 0                              | 2                             | 0                         | 0                  | 0                              | 0                            | 0                         | 2                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 2                       | 0                             | 3                         | 0                          | 0                          | 164                           | 2                              | 229   |    |
| BOC-3   | 0                              | 0                             | 0                         | 0                  | 0                              | 0                            | 0                         | 4                        | 2                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 4                       | 0                             | 2                         | 0                          | 0                          | 1                             | 2                              | 42    |    |
| BOC-4   | 0                              | 0                             | 0                         | 0                  | 0                              | 0                            | 0                         | 1                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 6                       | 0                             | 12                        | 0                          | 0                          | 1                             | 23                             | 103   |    |
| BOC-5   | 0                              | 0                             | 0                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 7                       | 0                             | 15                        | 0                          | 2                          | 22                            | 22                             | 266   |    |
| BOC-6   | 0                              | 0                             | 0                         | 0                  | 0                              | 0                            | 0                         | 6                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 2                       | 0                             | 1                         | 0                          | 0                          | 6                             | 1                              | 100   |    |
| BOC-7   | 0                              | 1                             | 7                         | 0                  | 0                              | 0                            | 0                         | 8                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 0                       | 0                             | 0                         | 0                          | 0                          | 0                             | 0                              | 5     | 67 |
| BOC-8   | 0                              | 0                             | 3                         | 0                  | 0                              | 0                            | 0                         | 1                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 0                       | 0                             | 2                         | 0                          | 0                          | 7                             | 1                              | 40    |    |
| BOC-9   | 0                              | 32                            | 0                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 10                      | 0                             | 1                         | 0                          | 0                          | 0                             | 17                             | 146   |    |
| BOC-10  | 0                              | 1                             | 0                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 1                       | 0                       | 5                       | 0                             | 0                         | 0                          | 0                          | 1                             | 5                              | 40    |    |
| BOC-11  | 0                              | 0                             | 0                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 2                       | 0                             | 0                         | 0                          | 0                          | 4                             | 0                              | 23    |    |
| BOC-12  | 0                              | 4                             | 1                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 0                       | 0                             | 0                         | 0                          | 0                          | 0                             | 1                              | 22    |    |
| BOC-13  | 0                              | 1                             | 1                         | 0                  | 0                              | 0                            | 0                         | 6                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 0                       | 0                             | 0                         | 0                          | 0                          | 0                             | 7                              | 98    |    |
| BOC-14  | 0                              | 2                             | 0                         | 0                  | 0                              | 0                            | 0                         | 15                       | 0                   | 0                          | 0                          | 0                     | 0                      | 1                          | 0                       | 0                       | 1                       | 0                             | 0                         | 0                          | 1                          | 2                             | 9                              | 80    |    |
| BOC-15  | 0                              | 2                             | 0                         | 0                  | 0                              | 0                            | 0                         | 6                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 0                       | 0                             | 0                         | 0                          | 0                          | 0                             | 0                              | 0     | 38 |
| BOC-16  | 0                              | 3                             | 2                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 5                       | 0                             | 0                         | 0                          | 0                          | 0                             | 7                              | 79    |    |

| Species | <i>Moxostoma valenciennesi</i> | <i>Neogobius melanostomus</i> | <i>Nocomis micropogon</i> | <i>Nocomis sp.</i> | <i>Notemigonus crysoleucas</i> | <i>Notropis atherinoides</i> | <i>Notropis hudsonius</i> | <i>Notropis rubellus</i> | <i>Notropis sp.</i> | <i>Notropis stramineus</i> | <i>Notropis volucellus</i> | <i>Noturus flavus</i> | <i>Noturus gyrinus</i> | <i>Oncorhynchus mykiss</i> | <i>Perca flavescens</i> | <i>Percina caprodes</i> | <i>Percina maculata</i> | <i>Percopsis omiscomaycus</i> | <i>Pimephales notatus</i> | <i>Pimephales promelas</i> | <i>Rhinichthys obtusus</i> | <i>Rhinichthys cataractae</i> | <i>Semotilus atromaculatus</i> | Total |
|---------|--------------------------------|-------------------------------|---------------------------|--------------------|--------------------------------|------------------------------|---------------------------|--------------------------|---------------------|----------------------------|----------------------------|-----------------------|------------------------|----------------------------|-------------------------|-------------------------|-------------------------|-------------------------------|---------------------------|----------------------------|----------------------------|-------------------------------|--------------------------------|-------|
| BOC-17  | 0                              | 0                             | 0                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 1                       | 0                             | 0                         | 0                          | 0                          | 0                             | 0                              | 6     |
| BOC-18  | 0                              | 3                             | 2                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 1                          | 0                     | 0                      | 0                          | 0                       | 0                       | 1                       | 0                             | 0                         | 0                          | 0                          | 0                             | 0                              | 65    |
| BOC-19  | 0                              | 13                            | 0                         | 0                  | 0                              | 0                            | 1                         | 0                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 3                       | 0                       | 3                       | 0                             | 0                         | 0                          | 0                          | 0                             | 1                              | 59    |
| BOC-20  | 0                              | 0                             | 0                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 2                       | 0                             | 4                         | 0                          | 1                          | 0                             | 9                              | 103   |
| BOC-21  | 0                              | 0                             | 0                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 1                       | 0                             | 0                         | 2                          | 59                         | 19                            | 74                             | 402   |
| BOC-22  | 0                              | 0                             | 0                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 0                       | 0                             | 0                         | 0                          | 7                          | 1                             | 23                             | 290   |
| BOC-23  | 0                              | 1                             | 2                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 0                       | 0                             | 0                         | 0                          | 0                          | 0                             | 2                              | 34    |
| BOC-24  | 0                              | 4                             | 0                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 1                          | 0                     | 0                      | 0                          | 0                       | 0                       | 3                       | 0                             | 0                         | 0                          | 0                          | 0                             | 2                              | 15    |
| BOC-25  | 0                              | 0                             | 2                         | 0                  | 0                              | 0                            | 0                         | 3                        | 0                   | 0                          | 4                          | 0                     | 0                      | 0                          | 0                       | 0                       | 7                       | 0                             | 0                         | 0                          | 0                          | 0                             | 1                              | 119   |
| BOC-26  | 1                              | 2                             | 5                         | 0                  | 0                              | 0                            | 0                         | 2                        | 0                   | 0                          | 1                          | 0                     | 0                      | 0                          | 0                       | 0                       | 8                       | 0                             | 1                         | 0                          | 0                          | 0                             | 2                              | 49    |
| BOC-27  | 0                              | 0                             | 6                         | 0                  | 1                              | 0                            | 0                         | 0                        | 0                   | 0                          | 1                          | 0                     | 0                      | 0                          | 0                       | 0                       | 0                       | 0                             | 0                         | 0                          | 0                          | 0                             | 2                              | 15    |
| BOC-28  | 0                              | 0                             | 3                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 2                          | 0                     | 0                      | 0                          | 3                       | 0                       | 4                       | 0                             | 0                         | 0                          | 0                          | 0                             | 0                              | 33    |
| BOC-29  | 0                              | 3                             | 2                         | 1                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 1                       | 0                       | 0                       | 0                             | 0                         | 0                          | 0                          | 0                             | 2                              | 13    |
| BOC-30  | 0                              | 2                             | 5                         | 2                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 0                          | 1                     | 0                      | 0                          | 0                       | 1                       | 7                       | 0                             | 2                         | 0                          | 2                          | 0                             | 1                              | 83    |
| BOC-31  | 0                              | 2                             | 8                         | 0                  | 0                              | 0                            | 0                         | 1                        | 0                   | 0                          | 1                          | 0                     | 0                      | 0                          | 0                       | 0                       | 0                       | 0                             | 0                         | 0                          | 0                          | 0                             | 0                              | 19    |
| BOC-32  | 0                              | 2                             | 2                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 2                          | 0                     | 0                      | 0                          | 1                       | 0                       | 1                       | 0                             | 0                         | 0                          | 0                          | 0                             | 2                              | 36    |
| BOC-33  | 0                              | 19                            | 13                        | 0                  | 1                              | 0                            | 0                         | 4                        | 0                   | 0                          | 4                          | 0                     | 0                      | 0                          | 2                       | 0                       | 4                       | 0                             | 3                         | 0                          | 1                          | 0                             | 1                              | 123   |
| BOC-34  | 0                              | 6                             | 8                         | 0                  | 0                              | 0                            | 0                         | 1                        | 0                   | 0                          | 2                          | 0                     | 0                      | 0                          | 0                       | 0                       | 5                       | 0                             | 0                         | 0                          | 0                          | 0                             | 3                              | 31    |
| BOC-35  | 0                              | 0                             | 0                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 1                          | 0                     | 0                      | 0                          | 0                       | 0                       | 0                       | 0                             | 0                         | 0                          | 0                          | 0                             | 3                              | 40    |
| BOC-36  | 0                              | 0                             | 2                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 0                          | 0                     | 2                      | 0                          | 0                       | 0                       | 4                       | 0                             | 0                         | 0                          | 0                          | 15                            | 0                              | 87    |



| Species      | <i>Moxostoma valenciennesi</i> | <i>Neogobius melanostomus</i> | <i>Nocomis micropogon</i> | <i>Nocomis sp.</i> | <i>Notemigonus crysoleucas</i> | <i>Notropis atherinoides</i> | <i>Notropis hudsonius</i> | <i>Notropis rubellus</i> | <i>Notropis sp.</i> | <i>Notropis stramineus</i> | <i>Notropis volucellus</i> | <i>Noturus flavus</i> | <i>Noturus gyrinus</i> | <i>Oncorhynchus mykiss</i> | <i>Perca flavescens</i> | <i>Percina caprodes</i> | <i>Percina maculata</i> | <i>Percopsis omiscomaycus</i> | <i>Pimephales notatus</i> | <i>Pimephales promelas</i> | <i>Rhinichthys obtusus</i> | <i>Rhinichthys cataractae</i> | <i>Semotilus atromaculatus</i> | Total |
|--------------|--------------------------------|-------------------------------|---------------------------|--------------------|--------------------------------|------------------------------|---------------------------|--------------------------|---------------------|----------------------------|----------------------------|-----------------------|------------------------|----------------------------|-------------------------|-------------------------|-------------------------|-------------------------------|---------------------------|----------------------------|----------------------------|-------------------------------|--------------------------------|-------|
| BOC-37       | 0                              | 1                             | 1                         | 0                  | 0                              | 0                            | 0                         | 5                        | 0                   | 0                          | 2                          | 0                     | 0                      | 0                          | 0                       | 0                       | 3                       | 0                             | 5                         | 1                          | 1                          | 1                             | 5                              | 131   |
| BOC-38       | 0                              | 0                             | 0                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 1                       | 0                             | 0                         | 0                          | 0                          | 0                             | 0                              | 198   |
| BOC-39       | 0                              | 0                             | 0                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 5                       | 0                             | 0                         | 0                          | 4                          | 0                             | 1                              | 99    |
| BOC-40       | 0                              | 0                             | 0                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 0                       | 0                             | 0                         | 0                          | 0                          | 0                             | 0                              | 54    |
| BOC-41       | 0                              | 8                             | 4                         | 0                  | 0                              | 3                            | 0                         | 0                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 2                       | 0                             | 4                         | 0                          | 0                          | 0                             | 2                              | 38    |
| BOC-42       | 0                              | 20                            | 3                         | 0                  | 0                              | 1                            | 0                         | 0                        | 1                   | 1                          | 17                         | 0                     | 0                      | 0                          | 0                       | 0                       | 5                       | 0                             | 23                        | 0                          | 0                          | 0                             | 6                              | 121   |
| BOC-43       | 0                              | 8                             | 5                         | 0                  | 0                              | 2                            | 0                         | 0                        | 0                   | 1                          | 11                         | 0                     | 0                      | 0                          | 0                       | 0                       | 0                       | 0                             | 14                        | 0                          | 0                          | 0                             | 7                              | 101   |
| BOC-44       | 0                              | 10                            | 3                         | 0                  | 0                              | 1                            | 0                         | 0                        | 0                   | 0                          | 2                          | 0                     | 0                      | 0                          | 0                       | 0                       | 0                       | 0                             | 7                         | 0                          | 0                          | 0                             | 4                              | 62    |
| BOC-45       | 0                              | 47                            | 0                         | 0                  | 0                              | 2                            | 0                         | 3                        | 0                   | 0                          | 3                          | 0                     | 0                      | 0                          | 0                       | 0                       | 2                       | 1                             | 1                         | 0                          | 0                          | 0                             | 1                              | 64    |
| BOC-46       | 0                              | 35                            | 0                         | 0                  | 0                              | 6                            | 0                         | 0                        | 0                   | 0                          | 4                          | 0                     | 0                      | 0                          | 0                       | 0                       | 1                       | 0                             | 5                         | 0                          | 0                          | 0                             | 2                              | 57    |
| BOC-47       | 0                              | 37                            | 0                         | 0                  | 0                              | 3                            | 0                         | 0                        | 0                   | 10                         | 8                          | 0                     | 0                      | 0                          | 0                       | 1                       | 0                       | 0                             | 5                         | 0                          | 0                          | 0                             | 0                              | 85    |
| BOC-48       | 0                              | 86                            | 0                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 16                         | 0                     | 0                      | 0                          | 1                       | 0                       | 0                       | 0                             | 18                        | 0                          | 0                          | 0                             | 0                              | 137   |
| BOC-49       | 0                              | 5                             | 0                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 1                          | 1                          | 0                     | 0                      | 0                          | 2                       | 0                       | 0                       | 0                             | 11                        | 0                          | 0                          | 0                             | 1                              | 33    |
| BOC-50       | 0                              | 11                            | 0                         | 0                  | 0                              | 1                            | 0                         | 0                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 0                       | 0                       | 0                       | 0                             | 2                         | 0                          | 0                          | 0                             | 0                              | 26    |
| BOC-51       | 0                              | 74                            | 1                         | 0                  | 0                              | 0                            | 0                         | 0                        | 0                   | 0                          | 0                          | 0                     | 0                      | 0                          | 11                      | 0                       | 0                       | 0                             | 5                         | 0                          | 0                          | 0                             | 2                              | 114   |
| BOC-52       | 0                              | 53                            | 0                         | 0                  | 0                              | 0                            | 1                         | 0                        | 0                   | 2                          | 1                          | 0                     | 0                      | 0                          | 0                       | 2                       | 0                       | 0                             | 8                         | 0                          | 0                          | 0                             | 0                              | 81    |
| <b>Total</b> | 1                              | 500                           | 91                        | 3                  | 2                              | 19                           | 2                         | 76                       | 3                   | 15                         | 85                         | 1                     | 2                      | 1                          | 25                      | 4                       | 114                     | 1                             | 155                       | 3                          | 78                         | 266                           | 262                            | 4522  |

## HABITAT SAMPLING

### *Ausable River*

In the Ausable River, water temperatures were generally warm (mean surface temperature 23.16 °C), and turbidity was moderate to low (mean NTU = 9.60) (Table 3). Sampled sites had mean depths of 0.48 m and were generally slow moving, reflecting the site selection procedure (mean measured water velocity 0.14 m/s) (Table 3). Targeted sites had relatively high composition of sand substrates (mean percent composition of 61%); however, silt always accompanied sand, and was at least 15% of total composition when sand was present (Table 4).

**Table 3.** *Habitat sampling results for the upper Ausable River, 2018.*

| Site Code   | Air Temp (°C) | Water Temp (°C) | Cond. (µS)    | D.O. (mg/L) | Turbidity Tube (m) | Turbidity (NTU) | Depth (mean; m) | Velocity (mean; m/s) |
|-------------|---------------|-----------------|---------------|-------------|--------------------|-----------------|-----------------|----------------------|
| AR-1        | 22.9          | 22.7            | 654           | 9.5         | 0.38               | 8.6             | 0.5             | 0.03                 |
| AR-2        | 29.2          | 24.9            | 654           | 9.5         | -                  | 8.6             | 0.58            | 0.01                 |
| AR-3        | 23.8          | 22.88           | 587.3         | 5.94        | 0.52               | 13.1            | 0.41            | 0.29                 |
| AR-4        | 24.6          | 23.89           | 597.5         | 6.09        | 0.58               | 10.31           | 0.87            | 0.22                 |
| AR-5        | 28.1          | 23.4            | 598.4         | 6.49        | -                  | 8.82            | 0.62            | 0.28                 |
| AR-6        | 27.2          | 23.9            | 604.3         | 7.28        | -                  | 9.53            | 0.46            | 0.12                 |
| AR-7        | -             | 22.15           | 550.3         | 4.47        | -                  | 8.67            | 0.36            | 0.05                 |
| AR-8        | 25.1          | 22.56           | 555.3         | 4.79        | 0.42               | 8.99            | 0.34            | 0.19                 |
| AR-9        | 25.9          | 23.09           | 554           | 5.6         | 0.25               | 10.81           | 0.367           | 0.23                 |
| <b>Min</b>  | <b>22.9</b>   | <b>22.15</b>    | <b>550.3</b>  | <b>4.47</b> | <b>0.25</b>        | <b>8.6</b>      | <b>0.34</b>     | <b>0.01</b>          |
| <b>Mean</b> | <b>25.52</b>  | <b>23.16</b>    | <b>590.54</b> | <b>6.41</b> | <b>0.4</b>         | <b>9.6</b>      | <b>0.48</b>     | <b>0.14</b>          |
| <b>Max</b>  | <b>29.2</b>   | <b>24.9</b>     | <b>654</b>    | <b>9.5</b>  | <b>0.58</b>        | <b>13.1</b>     | <b>0.87</b>     | <b>0.29</b>          |

**Table 4.** *Substrate sampling results for the upper Ausable River, 2018.*

| Site Code | Organic (%) | Clay (%) | Silt (%) | Sand (%) | Gravel (%) | Cobble (%) | Boulder (%) |
|-----------|-------------|----------|----------|----------|------------|------------|-------------|
| AR-1      | 0           | 25       | 25       | 50       | 0          | 0          | 0           |
| AR-2      | 0           | 30       | 20       | 50       | 0          | 0          | 0           |
| AR-3      | 0           | 0        | 20       | 80       | 0          | 0          | 0           |
| AR-4      | 20          | 20       | 20       | 40       | 0          | 0          | 0           |
| AR-5      | 0           | 0        | 20       | 80       | 0          | 0          | 0           |
| AR-6      | 10          | 0        | 20       | 60       | 10         | 0          | 0           |
| AR-7      | 0           | 0        | 30       | 70       | 0          | 0          | 0           |
| AR-8      | 10          | 0        | 20       | 70       | 0          | 0          | 0           |

| Site Code   | Organic (%) | Clay (%)   | Silt (%)    | Sand (%)  | Gravel (%) | Cobble (%) | Boulder (%) |
|-------------|-------------|------------|-------------|-----------|------------|------------|-------------|
| AR-9        | 15          | 0          | 15          | 70        | 0          | 0          | 0           |
| <b>Min</b>  | <b>0</b>    | <b>0</b>   | <b>15</b>   | <b>40</b> | <b>0</b>   | <b>0</b>   | <b>0</b>    |
| <b>Mean</b> | <b>5.5</b>  | <b>7.5</b> | <b>20.5</b> | <b>61</b> | <b>1</b>   | <b>0</b>   | <b>0</b>    |
| <b>Max</b>  | <b>20</b>   | <b>30</b>  | <b>30</b>   | <b>80</b> | <b>10</b>  | <b>0</b>   | <b>0</b>    |

### *Big Otter Creek*

In Big Otter Creek, water temperatures were cool-warm (mean 20.07 °C), and turbidity was higher than the Ausable River (mean NTU = 32.7) (Table 5). Sampled sites had average depths of 0.59 m and were composed of higher average velocities (0.20 m/s), reflecting sites selection that included riffles and runs (Table 5). Notably, the composition of sand substrates was similar to the Ausable River (61%); however, Big Otter Creek contained one site that was exclusively sand (BOC-43). Sampling sites BOC-7, BOC-35, BOC-44 were sand dominated ( $\geq 60\%$ ) but lacked silt (Table 6).

**Table 5.** Habitat sampling results for Big Otter Creek, 2018.

| Site Code | Air Temp (°C) | Water Temp (°C) | Cond. (µS) | D.O. (mg/L) | Turbidity Tube (m) | Turbidity (NTU) | Depth (mean; m) | Velocity (mean; m/s) |
|-----------|---------------|-----------------|------------|-------------|--------------------|-----------------|-----------------|----------------------|
| BOC-1     | 27            | 20.96           | 607.5      | 9.21        | -                  | 12.73           | 0.46            | 0.18                 |
| BOC-2     | 27.2          | 22.29           | 594        | 9.59        | 0.28               | 13.24           | 0.39            | 0.25                 |
| BOC-3     | 27.5          | 22.69           | 595.9      | 9.7         | 0.36               | 37.55           | 0.94            | 0.07                 |
| BOC-4     | 22.7          | 20.28           | 552.9      | 8.79        | 0.46               | 12.03           | 0.53            | 0.16                 |
| BOC-5     | 25.7          | 21.25           | 559.1      | 10.52       | 0.25               | 9.56            | 0.45            | 0.34                 |
| BOC-6     | 27.8          | 22.02           | 563.5      | 11.68       | 0.58               | 8.56            | 0.92            | 0.18                 |
| BOC-7     | 29.1          | 23.4            | 673.4      | 10.55       | 0.44               | 9.99            | 0.72            | 0.16                 |
| BOC-8     | 29.5          | 23.89           | 675.3      | 10.83       | 0.47               | 9.97            | 0.39            | 0.35                 |
| BOC-9     | 26.8          | 24.25           | 682.5      | 10.69       | 0.51               | 11.25           | 0.85            | 0.07                 |
| BOC-10    | 19.7          | 20.37           | 608.8      | 7.87        | 0.11               | 23.54           | 0.86            | 0.06                 |
| BOC-11    | 20.1          | 20.31           | 608.9      | 7.94        | 0.32               | 16.97           | 0.51            | 0.34                 |
| BOC-12    | 19.4          | 20.31           | 609        | 7.94        | 0.31               | 15.88           | 0.56            | 0.32                 |
| BOC-13    | 27.6          | 22.5            | 552.1      | 9.2         | 0.29               | 21.4            | 0.66            | 0.04                 |
| BOC-14    | 27.2          | 22.73           | 552.6      | 9.42        | 0.26               | 14.4            | 0.97            | 0.25                 |
| BOC-15    | 27.7          | 22.8            | 552.1      | 9.6         | 0.31               | 14.95           | 0.57            | 0.37                 |
| BOC-16    | 19.7          | 19.11           | 583.6      | 8.46        | 0.4                | 12.45           | 0.73            | 0.19                 |
| BOC-17    | 20.2          | 19.34           | 584.9      | 8.5         | 0.34               | 12.44           | 0.51            | 0.35                 |
| BOC-18    | 21.5          | 19.77           | 588.3      | 8.78        | 0.35               | 11.99           | 0.75            | 0.21                 |
| BOC-19    | 24.6          | 21.14           | 577.5      | 8.45        | 0.12               | 90.31           | 0.74            | 0.04                 |
| BOC-20    | 28.4          | 21.18           | 525        | 9.38        | -                  | 7.69            | 0.39            | 0.14                 |

| Site Code   | Air Temp (°C) | Water Temp (°C) | Cond. (µS)    | D.O. (mg/L)  | Turbidity Tube (m) | Turbidity (NTU) | Depth (mean; m) | Velocity (mean; m/s) |
|-------------|---------------|-----------------|---------------|--------------|--------------------|-----------------|-----------------|----------------------|
| BOC-21      | 33.5          | 23.31           | 534.8         | 9.75         | 0.45               | 13.35           | 0.21            | 0.28                 |
| BOC-22      | 34.7          | 24.31           | 536.3         | 9.72         | 0.51               | 7.6             | 0.37            | 0.27                 |
| BOC-23      | 21.7          | 21.99           | 563.9         | 7.63         | 0.38               | 18.91           | 0.65            | 0.36                 |
| BOC-24      | 23.2          | 21.99           | 563           | 7.87         | 0.31               | 19.29           | 0.6             | 0.27                 |
| BOC-25      | 26.2          | 22.24           | 564.3         | 8.38         | 0.22               | 15.79           | 0.36            | 0.28                 |
| BOC-26      | 27.5          | 23.21           | 573.5         | 9.69         | 0.35               | 25.45           | 0.92            | 0.19                 |
| BOC-27      | 27.1          | 23.54           | 575.3         | 10.17        | 0.32               | 15.36           | 0.68            | 0.4                  |
| BOC-28      | 30.6          | 29.04           | 578.6         | 10.57        | 0.33               | 14.36           | 0.55            | 0.22                 |
| BOC-29      | 17.7          | 20.52           | 553           | 8.01         | 0.25               | 27.76           | 0.52            | 0.35                 |
| BOC-30      | 19.9          | 20.54           | 553.8         | 8.23         | 0.24               | 41.51           | 0.47            | 0.19                 |
| BOC-31      | 22.1          | 20.56           | 554.7         | 8.48         | 0.27               | 24.12           | 0.72            | 0.39                 |
| BOC-32      | -             | 21.07           | 558.4         | 9.76         | 0.36               | 18.26           | 0.64            | 0.26                 |
| BOC-33      | 28.5          | 21.55           | 560.1         | 10.33        | 0.38               | 21.98           | 0.58            | 0.43                 |
| BOC-34      | 25.2          | 21.77           | 560.4         | 10.71        | 0.4                | 15.06           | 0.59            | 0.29                 |
| BOC-35      | 20.7          | 18.75           | 598.8         | 8.13         | 0.43               | 10.34           | 0.68            | 0.2                  |
| BOC-36      | 19.5          | 18.82           | 599.3         | 8.43         | 0.46               | 9.69            | 0.46            | 0.26                 |
| BOC-37      | 21.2          | 19.19           | 605.3         | 9.16         | 0.44               | 9.02            | 0.34            | 0.35                 |
| BOC-38      | 19.6          | 13.77           | 428.4         | 13.54        | 1.13               | 1.18            | 0.71            | 0.07                 |
| BOC-39      | -             | 13.87           | 422.6         | 13.62        | -                  | 1.15            | 0.41            | 0.09                 |
| BOC-40      | 20.6          | 14.62           | 422.7         | 13.34        | -                  | 1.34            | 0.77            | 0.04                 |
| BOC-41      | 19.1          | 15.66           | 495.8         | 8.92         | 0.28               | 28.28           | 0.66            | 0.18                 |
| BOC-42      | 19.1          | 15.69           | 495.7         | 8.92         | 0.3                | 26.11           | 0.48            | 0.23                 |
| BOC-43      | -             | 15.78           | 493           | 8.93         | 0.23               | 33.38           | 0.4             | 0.2                  |
| BOC-44      | 22            | 16              | 496           | 9.01         | -                  | 27.99           | 0.76            | 0.09                 |
| BOC-45      | 23.5          | 16              | 496           | 9            | 0.28               | 27.99           | 0.63            | 0.15                 |
| BOC-46      | 21.7          | 16              | 496           | 9.11         | 0.28               | 27.99           | 0.79            | 0.15                 |
| BOC-47      | 20.6          | 17.14           | 480           | 6.59         | 0.17               | 246.8           | 0.35            | 0.03                 |
| BOC-48      | 20.1          | 17.14           | 480           | 6.59         | 0.17               | 246.8           | 0.44            | 0                    |
| BOC-49      | 20.1          | 17              | 480           | 6.59         | 0.16               | 246.8           | 0.65            | 0                    |
| BOC-50      | 17.7          | 17.17           | 506           | 8.58         | 0.16               | 32.78           | 0.45            | 0                    |
| BOC-51      | 20.2          | 17.43           | 510           | 8.72         | 0.16               | 40.45           | 0.59            | 0                    |
| BOC-52      | 18.8          | 17.43           | 510           | 8.72         | 0.14               | 40.45           | 0.44            | 0                    |
| <b>Min</b>  | <b>17.7</b>   | <b>13.77</b>    | <b>422.6</b>  | <b>6.59</b>  | <b>0.11</b>        | <b>1.15</b>     | <b>0.21</b>     | <b>0</b>             |
| <b>Mean</b> | <b>23.71</b>  | <b>20.07</b>    | <b>551.78</b> | <b>9.28</b>  | <b>0.33</b>        | <b>32.77</b>    | <b>0.59</b>     | <b>0.2</b>           |
| <b>Max</b>  | <b>34.7</b>   | <b>29.04</b>    | <b>682.5</b>  | <b>13.62</b> | <b>1.13</b>        | <b>246.8</b>    | <b>0.97</b>     | <b>0.43</b>          |

**Table 6.** Substrate sampling results for the upper Big Otter Creek, 2018.

| Site Code | Organic (%) | Clay (%) | Silt (%) | Sand (%) | Gravel (%) | Cobble (%) | Boulder (%) | Bedrock (%) |
|-----------|-------------|----------|----------|----------|------------|------------|-------------|-------------|
| BOC-1     | 0           | 0        | 0        | 15       | 70         | 15         | 0           | 0           |
| BOC-2     | 0           | 0        | 0        | 30       | 60         | 10         | 0           | 0           |
| BOC-3     | 0           | 0        | 15       | 85       | 0          | 0          | 0           | 0           |
| BOC-4     | 0           | 10       | 20       | 70       | 0          | 0          | 0           | 0           |
| BOC-5     | 0           | 0        | 10       | 60       | 30         | 0          | 0           | 0           |
| BOC-6     | 0           | 0        | 0        | 20       | 70         | 10         | 0           | 0           |
| BOC-7     | 0           | 0        | 0        | 60       | 20         | 20         | 0           | 0           |
| BOC-8     | 0           | 0        | 15       | 70       | 15         | 0          | 0           | 0           |
| BOC-9     | 0           | 0        | 25       | 75       | 0          | 0          | 0           | 0           |
| BOC-10    | 0           | 0        | 20       | 80       | 0          | 0          | 0           | 0           |
| BOC-11    | 0           | 0        | 20       | 70       | 10         | 0          | 0           | 0           |
| BOC-12    | 0           | 0        | 20       | 80       | 0          | 0          | 0           | 0           |
| BOC-13    | 0           | 0        | 0        | 10       | 10         | 70         | 10          | 0           |
| BOC-14    | 0           | 0        | 0        | 0        | 0          | 60         | 0           | 40          |
| BOC-15    | 0           | 0        | 0        | 10       | 10         | 30         | 0           | 50          |
| BOC-16    | 0           | 0        | 20       | 80       | 0          | 0          | 0           | 0           |
| BOC-17    | 0           | 0        | 20       | 80       | 0          | 0          | 0           | 0           |
| BOC-18    | 0           | 0        | 20       | 80       | 0          | 0          | 0           | 0           |
| BOC-19    | 20          | 0        | 30       | 30       | 20         | 0          | 0           | 0           |
| BOC-20    | 0           | 0        | 30       | 50       | 10         | 10         | 0           | 0           |
| BOC-21    | 10          | 0        | 10       | 10       | 70         | 0          | 0           | 0           |
| BOC-22    | 0           | 0        | 0        | 30       | 30         | 40         | 0           | 0           |
| BOC-23    | 0           | 0        | 20       | 80       | 0          | 0          | 0           | 0           |
| BOC-24    | 0           | 0        | 20       | 80       | 0          | 0          | 0           | 0           |
| BOC-25    | 0           | 0        | 20       | 80       | 0          | 0          | 0           | 0           |
| BOC-26    | 0           | 0        | 30       | 70       | 0          | 0          | 0           | 0           |
| BOC-27    | 0           | 0        | 20       | 80       | 0          | 0          | 0           | 0           |
| BOC-28    | 0           | 0        | 20       | 80       | 0          | 0          | 0           | 0           |
| BOC-29    | 0           | 0        | 20       | 80       | 0          | 0          | 0           | 0           |
| BOC-30    | 0           | 0        | 30       | 70       | 0          | 0          | 0           | 0           |
| BOC-31    | 0           | 0        | 20       | 80       | 0          | 0          | 0           | 0           |
| BOC-32    | 0           | 0        | 10       | 80       | 10         | 0          | 0           | 0           |
| BOC-33    | 0           | 0        | 0        | 10       | 40         | 40         | 10          | 0           |
| BOC-34    | 0           | 0        | 30       | 70       | 0          | 0          | 0           | 0           |
| BOC-35    | 0           | 0        | 0        | 80       | 20         | 0          | 0           | 0           |
| BOC-36    | 0           | 0        | 10       | 80       | 10         | 0          | 0           | 0           |
| BOC-37    | 0           | 0        | 30       | 10       | 60         | 0          | 0           | 0           |

| Site Code   | Organic (%) | Clay (%)    | Silt (%)     | Sand (%)     | Gravel (%)   | Cobble (%)  | Boulder (%) | Bedrock (%) |
|-------------|-------------|-------------|--------------|--------------|--------------|-------------|-------------|-------------|
| BOC-38      | 0           | 0           | 20           | 60           | 20           | 0           | 0           | 0           |
| BOC-39      | 0           | 10          | 50           | 40           | 0            | 0           | 0           | 0           |
| BOC-40      | 0           | 10          | 50           | 40           | 0            | 0           | 0           | 0           |
| BOC-41      | 0           | 0           | 20           | 60           | 20           | 0           | 0           | 0           |
| BOC-42      | 0           | 0           | 10           | 90           | 0            | 0           | 0           | 0           |
| BOC-43      | 0           | 0           | 0            | 100          | 0            | 0           | 0           | 0           |
| BOC-44      | 0           | 0           | 0            | 70           | 30           | 0           | 0           | 0           |
| BOC-45      | 0           | 0           | 10           | 90           | 0            | 0           | 0           | 0           |
| BOC-46      | 0           | 10          | 30           | 60           | 0            | 0           | 0           | 0           |
| BOC-47      | 0           | 0           | 10           | 90           | 0            | 0           | 0           | 0           |
| BOC-48      | 0           | 0           | 10           | 90           | 0            | 0           | 0           | 0           |
| BOC-49      | 0           | 0           | 10           | 90           | 0            | 0           | 0           | 0           |
| BOC-50      | 0           | 0           | 20           | 80           | 0            | 0           | 0           | 0           |
| BOC-51      | 0           | 0           | 10           | 90           | 0            | 0           | 0           | 0           |
| BOC-52      | 0           | 0           | 20           | 40           | 40           | 0           | 0           | 0           |
| <b>Min</b>  | <b>0</b>    | <b>0</b>    | <b>0</b>     | <b>0</b>     | <b>0</b>     | <b>0</b>    | <b>0</b>    | <b>0</b>    |
| <b>Mean</b> | <b>0.58</b> | <b>0.77</b> | <b>15.87</b> | <b>61.83</b> | <b>12.98</b> | <b>5.87</b> | <b>0.38</b> | <b>1.73</b> |
| <b>Max</b>  | <b>20</b>   | <b>10</b>   | <b>50</b>    | <b>100</b>   | <b>70</b>    | <b>70</b>   | <b>10</b>   | <b>50</b>   |

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## APPENDIX

**Appendix A1.** Site locality information for Ausable River sites sampled by DFO in 2018.

| Site Code | Biodiversity Science Field Number | Start Latitude | Start Longitude | Sampling Date | Narrative Locality Description            |
|-----------|-----------------------------------|----------------|-----------------|---------------|---|
| AR-1      | 2018-ESD-AR-240718-001A           | 43.34965       | -81.54099       | 24/07/2018    | ~1km downstream of Highway 83             |
| AR-2      | 2018-ESD-AR-240718-002A           | 43.34726       | -81.54413       | 24/07/2018    | ~2km downstream of highway 83             |
| AR-3      | 2018-ESD-AR-250718-001A           | 43.31092       | -81.53193       | 25/07/2018    | downstream from Kirkton Rd.<br>~1.5km     |
| AR-4      | 2018-ESD-AR-250718-002A           | 43.31644       | -81.53139       | 25/07/2018    | ~1.5km downstream Kirkton Rd.             |
| AR-5      | 2018-ESD-AR-250718-003A           | 43.3104        | -81.53017       | 25/07/2018    | ~2km downstream from Kirkton Rd.          |
| AR-6      | 2018-ESD-AR-250718-004A           | 43.3093        | -81.52715       | 25/07/2018    | ~50m downstream of Culvert / Right of way |
| AR-7      | 2018-ESD-AR-260718-001A           | 43.33619       | -81.53597       | 26/07/2018    | downstream of huron street, ~800m         |
| AR-8      | 2018-ESD-AR-260718-002A           | 43.33409       | -81.53461       | 26/07/2018    | ~2km downstream Huron St                  |
| AR-9      | 2018-ESD-AR-260718-003A           | 43.3301        | -81.53347       | 26/07/2018    | ~2.5km downstream Huron St                |



**Appendix A2. Site locality information for sites sampled in Big Otter Creek by DFO and OMNRF in 2018.**

| Site Code | Biodiversity Science Field Number | Start Latitude | Start Longitude | Sampling Date | Narrative Locality Description                               |
|-----------|-----------------------------------|----------------|-----------------|---------------|--|
| BOC-1     | 2018-ESD-BOC-090718-001A          | 42.85431       | -80.72425       | 09/07/2018    | 175m d/s of Otter Valley trail bridge; at Stoney Creek       |
| BOC-2     | 2018-ESD-BOC-090718-002A          | 42.8553        | -81.7243        | 09/07/2018    | Coronation Park, Tillsongburg; 85m u/s to otter trail bridge |
| BOC-3     | 2018-ESD-BOC-090718-003A          | 42.85599       | -81.72419       | 09/07/2018    | 10m DS otter valley trail                                    |
| BOC-4     | 2018-ESD-BOC-100718-001A          | 42.88618       | -80.65929       | 10/07/2018    | Big Otter Creek, below Rock Mills Dam                        |
| BOC-5     | 2018-ESD-BOC-100718-002A          | 42.88643       | -80.65863       | 10/07/2018    | US Rock mills road, ~150m                                    |
| BOC-6     | 2018-ESD-BOC-100718-003A          | 42.88658       | -80.65835       | 10/07/2018    | Rock mills, below old dam                                    |
| BOC-7     | 2018-ESD-BOC-100718-004A          | 42.84678       | -80.73183       | 10/07/2018    | Big Otter Creek, DS of Hwy 3 ~160m                           |
| BOC-8     | 2018-ESD-BOC-100718-005A          | 42.84769       | -80.73222       | 10/07/2018    | ~60m DS hwy 3 Bridge   |
| BOC-9     | 2018-ESD-BOC-100718-006A          | 42.84864       | -80.73228       | 10/07/2018    | US of Hwy 3 ~60m   |
| BOC-10    | 2018-ESD-BOC-110718-001A          | 42.79321       | -80.78329       | 11/07/2018    | Big Otter Creek, DS of Eden Line ~700m                       |
| BOC-11    | 2018-ESD-BOC-110718-002A          | 42.7927        | -80.78317       | 11/07/2018    | Big Otter Creek, DS of Eden Line ~650m                       |
| BOC-12    | 2018-ESD-BOC-110718-003A          | 42.79315       | -80.78181       | 11/07/2018    | Big Otter Creek, DS of Eden Line ~500m                       |
| BOC-13    | 2018-ESD-BOC-110718-004A          | 42.86414       | -80.71432       | 11/07/2018    | Big Otter Creek, @ Tillsongburg conservation area            |
| BOC-14    | 2018-ESD-BOC-110718-005A          | 42.86449       | -80.71421       | 11/07/2018    | US Hwy 19 ; @Tillsongburg Conservation Area                  |
| BOC-15    | 2018-ESD-BOC-110718-006A          | 42.86551       | -80.71382       | 11/07/2018    | Big Otter Creek, @ Tillsongburg conservation area            |
| BOC-16    | 2018-ESD-BOC-120718-001A          | 42.76713       | -80.83105       | 12/07/2018    | Big Otter Creek, ~100m US of Calloden Rd                     |
| BOC-17    | 2018-ESD-BOC-120718-002A          | 42.76624       | -80.83046       | 12/07/2018    | Big Otter Creek, ~180m US of Calloden Rd                     |
| BOC-18    | 2018-ESD-BOC-120718-003A          | 42.7659        | -80.82995       | 12/07/2018    | Big Otter Creek, ~230 US of Calloden Rd                      |
| BOC-19    | 2018-ESD-BOC-120718-004A          | 42.68006       | -80.78719       | 12/07/2018    | Big otter creek @ lions Park, Vienna                         |
| BOC-20    | 2018-ESD-BOC-160718-001A          | 42.92359       | -80.60578       | 16/07/2018    | Otterville Mill; ~300m DS Otterville St.                     |
| BOC-21    | 2018-ESD-BOC-160718-002A          | 42.92414       | -80.60641       | 16/07/2018    | ~200m DS of Main Street Bridge                               |
| BOC-22    | 2018-ESD-BOC-160718-003A          | 42.9244        | -80.60664       | 16/07/2018    | ~150m DS pf Main Street Bridge                               |
| BOC-23    | 2018-ESD-BOC-170718-001A          | 42.71329       | -80.83601       | 17/07/2018    | Mc Quiggin Farm; Calton Rd; ~400m US Calton Line             |
| BOC-24    | 2018-ESD-BOC-170718-002A          | 42.71424       | -80.83652       | 17/07/2018    | ~500m US Calton Libne; McQuiggin Farm                        |
| BOC-25    | 2018-ESD-BOC-170718-003A          | 42.71523       | -80.8373        | 17/07/2018    | ~650m US Calton Line   |
| BOC-26    | 2018-ESD-BOC-170718-004A          | 42.69807       | -80.83158       | 17/07/2018    | ~200m US of Denis Road                                       |

| Site Code | Biodiversity Science Field Number | Start Latitude | Start Longitude | Sampling Date | Narrative Locality Description        |
|-----------|-----------------------------------|----------------|-----------------|---------------|---------------------------------------|
| BOC-27    | 2018-ESD-BOC-170718-005A          | 42.69841       | -80.83225       | 17/07/2018    | ~350m US Dennis Road                  |
| BOC-28    | 2018-ESD-BOC-170718-006A          | 42.69867       | -80.83288       | 17/07/2018    | ~450m US Dennis Line                  |
| BOC-29    | 2018-ESD-BOC-180718-001A          | 42.69751       | -80.82088       | 18/07/2018    | ~4.5km US of Vienna                   |
| BOC-30    | 2018-ESD-BOC-180718-002A          | 42.6977        | -80.82085       | 18/07/2018    | ~4.5km US of Vienna                   |
| BOC-31    | 2018-ESD-BOC-180718-003A          | 42.6987        | -80.82108       | 18/07/2018    | ~5 km US of Vienna                    |
| BOC-32    | 2018-ESD-BOC-180718-004A          | 42.6997        | -80.8233        | 18/07/2018    | ~500m downstream Dennis Line          |
| BOC-33    | 2018-ESD-BOC-180718-005A          | 42.69973       | -80.8239        | 18/07/2018    | ~450m DS of Dennis Road               |
| BOC-34    | 2018-ESD-BOC-180718-006A          | 42.69965       | -80.82549       | 18/07/2018    | DS ~350m from Dennis Road             |
| BOC-35    | 2018-ESD-BOC-190718-001A          | 42.81629       | -80.75437       | 19/07/2018    | Big Otter Creek; US Carson Line ~350m |
| BOC-36    | 2018-ESD-BOC-190718-002A          | 42.81645       | -80.75391       | 19/07/2018    | ~400m US Carson Line                  |
| BOC-37    | 2018-ESD-BOC-190718-003A          | 42.8183        | -80.76265       | 19/07/2018    | ~750m US of Carson Line               |
| BOC-38    | 2018-ESD-BOC-240918-001A          | 42.94126       | -80.5844        | 24/09/2018    | u/s Hwy 59, ~25m                      |
| BOC-39    | 2018-ESD-BOC-240918-002A          | 42.94196       | -80.58363       | 24/09/2018    | u/s Hwy 59 ~150m                      |
| BOC-40    | 2018-ESD-BOC-240918-003A          | 42.94203       | -80.58361       | 24/09/2018    | ~200m u/s Hwy 59                      |
| BOC-41    | 2018-ESD-BOC-250918-001A          | 42.69066       | -80.81541       | 25/09/2018    | Upstream Port Burwell ~10km           |
| BOC-42    | 2018-ESD-BOC-250918-002A          | 42.68991       | -80.81274       | 25/09/2018    | ~3km upstream of Vienna, ON           |
| BOC-43    | 2018-ESD-BOC-250918-003A          | 42.68844       | -80.8106        | 25/09/2018    | u/s Vienna 2.5km                      |
| BOC-44    | 2018-ESD-BOC-250918-004A          | 42.68518       | -80.79711       | 25/09/2018    | u/s ~2km from Vienna                  |
| BOC-45    | 2018-ESD-BOC-250918-005A          | 42.68647       | -80.79356       | 25/09/2018    | u/s Edison Road ~100m                 |
| BOC-46    | 2018-ESD-BOC-250918-006A          | 42.68146       | -80.7878        | 25/09/2018    | u/s Vienna ~200m                      |
| BOC-47    | 2018-ESD-BOC-260918-001A          | 42.66654       | -80.8065        | 26/09/2018    | u/s Lake Erie ~3km                    |
| BOC-48    | 2018-ESD-BOC-260918-002A          | 42.66613       | -80.80611       | 26/09/2018    | ~2km u/s Port Burwell Bridge          |
| BOC-49    | 2018-ESD-BOC-260918-003A          | 42.66611       | -80.80456       | 26/09/2018    | ~2km u/s of Port Burwell Bridge       |
| BOC-50    | 2018-ESD-BOC-260918-004A          | 42.64437       | -80.80788       | 26/09/2018    | @ Port Burwell Harbour                |
| BOC-51    | 2018-ESD-BOC-260918-005A          | 42.64412       | -80.80788       | 26/09/2018    | Port Burwell Harbour                  |
| BOC-52    | 2018-ESD-BOC-260918-006A          | 42.64379       | -80.80771       | 26/09/2018    | Port Burwell Harbour                  |