

Targeted Sampling for Northern Madtom (*Noturus stigmosus*) in the Lower East Sydenham River, Ontario, 2019

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by

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ABSTRACT

Barnucz, J. and Drake, D.A.R. 2021. Targeted Sampling for Northern Madtom (*Noturus stigmosus*) in the Lower East Sydenham River, Ontario, 2019. Can. Data Rep. Fish. Aquat. Sci. 1317: vi + 15 p.

Northern Madtom (*Noturus stigmosus*), a species listed as 'endangered' under Canada's *Species at Risk Act*, exhibits a limited geographic distribution in southwestern Ontario, with extant populations in the Detroit River, St. Clair River, Thames River, and Lake St. Clair. Northern Madtom was known to occur in the Sydenham River near Florence and Alvinston; however, the species has not been detected since 1975, despite numerous sampling events in the watershed over the past 30 years. In 2019 Fisheries and Oceans Canada conducted targeted sampling for Northern Madtom in the East Sydenham River between Dawn Mills and Dresden, Ontario to determine if Northern Madtom could be detected from poorly sampled river reaches. Targeted sampling utilized a Siamese trawl, with sampling occurring at 40 field sites spanning a gradient of lotic and lentic habitat. A total of 31 species were detected, including two madtom species [Stonecat (*Noturus flavus*), Brindled Madtom (*Noturus miurus*)]. Despite potentially suitable habitat at some sites, Northern Madtom was not detected. The most abundant species were Ghost Shiner (*Notropis buchanaui*), Round Goby (*Neogobius melanostomus*), Blackside Darter (*Percina maculata*), Greenside Darter (*Etheostoma blennioides*), and Logperch (*Percina caprodes*), while the most frequently occurring species were Round Goby (97% of sites), Ghost Shiner (95% of sites), Blackside Darter (82.5% of sites), Logperch (80% of sites) and Trout-perch (*Percopsis omiscomaycus*) (65% of sites). Sixteen Eastern Sand Darter (*Ammocrypta pellucida*) were captured from six locations, seven River Darter (*Percina shumardi*) were captured from five locations, and one Northern Sunfish (*Lepomis peltastes*) was captured from a single location. Brindled Madtom, a species with similar habitat requirements to Northern Madtom, was detected at 14 sites. Much of the lower East Sydenham River, while having suitable depth and substrate, lacked the preferred velocity for Northern Madtom. Round Goby, an invasive fish, is now widespread throughout the lower watershed. Future sampling to detect Northern Madtom will involve targeted sampling in the Sydenham River between Alvinston and Florence. As this reach is considerably shallower than the area targeted in 2019, alternative gears (e.g. seining) may be required.

RÉSUMÉ

Barnucz, J. and Drake, D.A.R. 2021. Targeted Sampling for Northern Madtom (*Noturus stigmosus*) in the Lower East Sydenham River, Ontario, 2019. Can. Data Rep. Fish. Aquat. Sci. 1317: vi + 15 p.

Le chat-fou du nord (*Noturus stigmosus*), inscrit comme espèce en voie de disparition en vertu de la *Loi sur les espèces en péril* (LEP), se caractérise par une répartition géographique limitée dans le sud-ouest de l'Ontario, dont une présence de populations dans les rivières Détroit, St. Clair et Thames ainsi que dans le lac St. Clair. Par le passé, le chat-fou du nord était présent dans la rivière Sydenham, près de Florence et d'Alvinston; l'espèce n'y a cependant pas été observée depuis 1975, et ce, malgré bon nombre d'échantillonnages réalisés dans le bassin versant au cours des 30 dernières années. En 2019, Pêches et Océans Canada a effectué un échantillonnage ciblé du chat-fou du nord dans la rivière Sydenham Est, entre Dawn Mills et Dresden, en Ontario, en vue de déterminer si l'espèce pouvait être observée dans des tronçons peu échantillonnés de la rivière. Un échantillonnage ciblé a été effectué au moyen d'un chalut siamois dans 40 sites couvrant un gradient d'habitats lotiques et lentiques. Au total, 31 espèces ont été observées, y compris deux espèces de chat-fou [barbotte des rapides (*Noturus flavus*) et chat-fou tacheté (*Noturus miurus*)]. Malgré la présence d'habitats potentiellement convenables dans certains sites, le chat-fou du nord n'a pas été observé. Les espèces observées les plus abondantes ont été le méné fantôme (*Notropis buchmanii*), le gobie à taches noires (*Neogobius melanostomus*), le dard noir (*Percina maculata*), le dard vert (*Etheostoma blennioides*) et le fouille-roche zébré (*Percina caprodes*), et les espèces observées les plus fréquentes ont été le gobie à taches noires (97 % des sites), le méné fantôme (95 % des sites), le dard noir (82,5 % des sites), le fouille-roche zébré (80 % des sites) et l'omisco (*Percopsis omiscomaycus*) [65 % des sites]. Seize dards de sable (*Ammocrypta pellucida*) ont été capturés à six endroits différents, sept dards de rivière (*Percina shumardi*) ont été capturés à cinq endroits différents et un crapet du Nord (*Lepomis peltastes*) a été capturé à un endroit. Le chat-fou tacheté, une espèce qui présente des exigences en matière d'habitat semblables à celles du chat-fou du nord, a été observé à 14 endroits différents. Bien que la majeure partie du cours inférieur de la rivière Sydenham Est présente une profondeur et un substrat convenables, la vitesse de ses courants ne convient pas au chat-fou du nord. Le gobie à taches noires, un poisson envahissant, est désormais répandu dans l'ensemble du bassin versant inférieur. Les futurs travaux d'échantillonnage visant à détecter le chat-fou du nord comprendront un échantillonnage ciblé dans la rivière Sydenham entre Alvinston et Florence. Comme les eaux dans ce tronçon sont beaucoup moins profondes que dans le secteur ciblé en 2019, d'autres types d'engins (p. ex. pêche à la senne) pourraient être requis.

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). To inform scientific aspects of the recovery process, DFO regularly conducts field sampling to satisfy research objectives for SARA-listed fishes, such as: evaluating the distribution and abundance of species; determining species-habitat relationships, and 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 sampling SARA-listed fishes and their habitat.

This data report summarizes targeted field sampling by DFO in 2019 to better understand the distribution and abundance of Northern Madtom (*Noturus stigmosus*) in the lower East Sydenham River, Ontario. Northern Madtom has a limited distribution in Ontario, with detections of the species known from the Detroit River, St. Clair River, Lake St. Clair, Thames River, and Sydenham River [Committee on the Status of Endangered Wildlife in Canada (COSEWIC) 2012]. Since 2010, Northern Madtom has been collected on multiple occasions in the Detroit River, St. Clair River, and Thames River, while the last known record of Northern Madtom from Lake St. Clair was in 2007 (COSEWIC 2012). In the Sydenham River, a single Northern Madtom was collected near Florence in 1975 (COSEWIC 2012). The specimen was originally identified as a Brindled Madtom (*Noturus miurus*), but was re-examined by the Royal Ontario Museum (ROM) in 1999 and subsequently determined to be a Northern Madtom. A second specimen, originally identified as a Brindled Madtom, was collected near Alvinston in 1929. This specimen was also re-examined by the ROM and subsequently determined to be a Northern Madtom. Between 1989 and 2010 several targeted and community sampling events were conducted within the East Sydenham River, but no additional detections of Northern Madtom occurred (COSEWIC 2012). COSEWIC (2012) concluded that Northern Madtom has likely been extirpated from the Sydenham River given the lack of detections since 1975. However, there has been relatively little targeted sampling in deeper, non-wadeable habitats in the vicinity of historical detections.

Seine nets have conventionally been used for fish community sampling in the Sydenham River due to the abundance of shallow, swift habitats. Seine nets are easily deployed and detect a variety of fishes, including benthic species (Portt et al. 2008). However, seine nets are only effective in shallow waters (<1.5 m in depth). Seine nets are also difficult to operate in habitats with fast current and large substrate (e.g., boulders), which are the habitat features commonly associated with Northern Madtom. Therefore, targeted sampling in 2019 involved the use of small-mesh benthic trawls to sample the habitats (swift, deep waters with large substrates) likely to contain Northern Madtom. The use of trawl nets in lotic systems is a relatively new sampling technique, especially in lotic systems in southern Ontario. Trawls are often large, bulky gears that require large vessels for deployment and retrieval (Guy et al. 2009); however, contemporary design changes have allowed researchers to scale the size of the trawl to the vessel and habitat features of interest. Trawls have proven to be effective tools in lotic systems because of their effectiveness in sampling deep, swift water (Guy et al. 2009; Reid et al. 2016).

The Action Plan for the Sydenham River in Canada (Fisheries and Oceans Canada 2018a) and Report on the Progress of Recovery Strategy Implementation for the Northern Madtom (*Noturus stigmosus*) in Canada for the Period 2012 – 2016 (Fisheries and Oceans Canada 2018b) indicate that targeted sampling for Northern Madtom in areas of historically occupied habitat (i.e., in the vicinity of Florence and Alvinston) are high priority recovery actions needed to determine whether an extant population exists in the watershed. To better understand whether Northern Madtom is extant in the lower East Sydenham River, Fisheries and Oceans Canada

sampled the river in 2019 between Dawn Mills and Dresden using a small benthic trawl. Forty sites were selected based on the habitat features suspected to support Northern Madtom. Sampling was also conducted to evaluate the composition of the fish assemblage in areas potentially inhabited by Northern Madtom and to better understand aquatic habitat features of the drainage. Sampling results will be used to inform assessments of Northern Madtom by COSEWIC and to evaluate the recovery of the species as part of the SARA recovery planning process.

METHODS

STUDY AREA AND SITE SELECTION

The East Sydenham River between Florence and Dresden was the focal area of 2019 sampling (Figure 1). This area was selected due to its proximity to the historical record of Northern Madtom in Florence and because habitat attributes in this section are similar to areas in the Thames River (i.e., deep, swift water with large, irregular substrate) where repeated detections of Northern Madtom have occurred. Therefore, the Dresden to Florence stretch is also conducive to trawling. Prior to sampling, crews travelled the river between Dresden and Dawn Mills to determine the presence of navigation hazards and identify potential sampling sites. The furthest upstream crews could travel by boat was approximately 1 km upstream of Dawn Mills Rd. (County Road 15), which is approximately 20 km downstream of Florence and approximately 12 km upstream of Dresden. Sampling sites were selected if they satisfied at least one of the following inclusion criteria: 1) stream velocities greater than 0.3 m/s; 2) the presence of large substrate (e.g. cobble, boulders); or, 3) river depths >1 m average depth. In addition to these criteria, sites were only sampled if they were mostly free of large physical obstructions (e.g., large woody debris, large boulders near the water's surface) and located at least 100 m away from the nearest selected site. Inclusion criteria (velocity, substrate, depth), and the incidence of potential hazards were evaluated using a Garmin® Echomap™ Plus 95 SV Sonar Unit, equipped with GPS receiver, Garmin® ClearVü™ and SideVü™ technology. In the event that sites were selected for sampling that contained minor navigation or trawl hazards, such obstructions were identified and marked using the Garmin® GPS unit prior to trawling, which allowed the trawl and vessel to be navigated around them. Trawling sites were selected to be approximately 50 m in length.

FISH ASSEMBLAGE SAMPLING

Field sampling was conducted between October 7th and October 17th 2019. A Gerken Siamese trawl equipped with two 3 m tow ropes and two 50 cm x 30 cm otter doors (weighing approximately 6 kg each) was used to sample fishes. The trawl dimensions were 2.4 m wide by 4.3 m long (head rope to cod-end) with a single 2.4 m foot rope. A 2.4 m length of 1/4" link chain was attached to the foot rope to weigh the trawl opening and help maintain bottom contact. The 2.4 m head rope was lined with small plastic floats that opened the trawl vertically. The trawl was constructed of 3 mm polyester square mesh with an 18 mm square mesh separation device sewn into the middle of the trawl. The inner separator mesh served two purposes. First, it provided safe passage of smaller fishes through the trawl and into the 3 mm mesh cod end. Second, it provided separation of captured fishes from potentially harmful objects that were occasionally captured by the trawl (e.g., rocks, large fish, tires). Tow rope length was adjusted at each site based on river depth. Appropriate tow rope length was calculated at 2.1 m of tow rope for each 0.3 m of depth [i.e. water depth (m) x 7 = towline length (m)] (Guy et. al 2009). The trawl was fished from a 5 m jon boat powered with a 40 hp outboard tiller engine. During fishing, the boat was operated backwards and moved in the downstream direction. Site length,

speed, and location were monitored by GPS during trawling, with trawling speed maintained at approximately 2 km/hr. Sampling effort was recorded as distance travelled (50 m was the targeted length) and elapsed time (seconds). Three repeated trawling passes were completed over the same habitat area at a single site. Fishes captured in the trawl were carefully removed and placed into bins of fresh water for counting and identification. Fishes were processed separately by trawling event (e.g., trawl 1, trawl 2, trawl 3). Total length (TL; mm) was measured for captured COSEWIC-assessed and SARA-listed fishes. Both photo and physical vouchers were taken for a subset of captured fishes to confirm species identity. Physical vouchers were preserved in 10% buffered Formalin and species identification was confirmed in the laboratory based on (Holm et al. 2019a,b; Holm and Burrige 2019). Additionally, specimens that could not be identified to species *in situ*, and other sampling mortalities, were retained for laboratory identification.

HABITAT SAMPLING

Habitat sampling occurred at the midpoint of the sampling site after fishes were processed and released. The mid-point of the site was determined by measuring 25 linear m from the starting point of the trawling transect using the Garmin® sonar unit. Wetted stream channel width (m) was measured at the midpoint, perpendicular to the bank, using a Nikon® range finder. 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 60 cm Fieldmaster turbidity tube. Air temperature (°C) was measured using a Kestrel® 3000 wind meter. Substrate composition within the site was assessed using a combination of a petite ponar sampler and the Garmin® sonar unit. The sonar unit allowed the assessment of large substrates like cobble and boulder, which were not easily detected with the ponar sampler. Substrate within the site was assessed based on the following categories and 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 percent coverage of each substrate category was assessed and recorded up to an aggregate total coverage of 100%. River depth was measured at the start, mid-point, and end of each trawling site using the Garmin® sonar unit. River velocity (m/s) was measured at the same locations using a Swiffer® 2100 velocity meter, deployed at approximately 50% of water depth.

SAMPLING PERMITS AND DATA ARCHIVING

Sampling for this project was conducted under the authority of SARA Permit Number 19-PCA-00016. Trawling activities were conducted under Standard Operating Protocol GWACC-113, approved by the Environment and Climate Change Canada and DFO Animal Care Committee (operated under the approval of the Canadian Council on Animal Care). Data associated with these collections is housed under the project code “2019-NMT-SYD” 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. 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

Forty sites, consisting of 120 trawls in total, were sampled along the East Sydenham River (Table 1; Figure 1). A total of 6,623 fishes representing 31 species were detected (Table 2, Figure 2). Northern Madtom was not detected at any sampling sites. Based on pooled catch data the most abundant species were Ghost Shiner (*Notropis buchanani*), Round Goby (*Neogobius melanostomus*), Blackside Darter (*Percina maculata*), Greenside Darter (*Etheostoma blennioides*), and Logperch (*Percina caprodes*) as shown in Figure 2. The most frequently occurring species across sites were Round Goby (97% of sites), Ghost Shiner (95% of sites), Blackside Darter (82.5% of sites), Logperch (80% of sites) and Trout-perch (*Percopsis omiscomaycus*) which was observed at 65% of sites (Table 2). Brindled Madtom, a species with similar habitat requirements to Northern Madtom, was detected at 14 sites with a total of 38 individuals (Table 2). Three imperiled fishes were detected during sampling. A total of 16 Eastern Sand Darter (*Ammocrypta pellucida*) were captured from six locations, ranging from 27 mm to 47 mm TL (Table 3). Seven River Darter (*Percina shumardi*) were captured from six locations, ranging from 42 mm to 66 mm TL (Table 3). A single Northern Sunfish (*Lepomis peltastes*) was captured from one site, which was 93 mm TL (Table 3).

HABITAT SAMPLING

Water temperature of sampling sites in the East Sydenham River ranged from 11.3 °C to 16.4 °C with a mean of 13.1 °C (Table 4). Conductivity ranged from 412.9 µS to 506 µS with a mean 473.51 µS (Table 4). Dissolved oxygen ranged from 8.30 mg/L to 9.77mg/L with a mean of 9.05 mg/L (Table 4). Turbidity ranged from 19.82 NTU to 48.80 NTU with a mean of 31.69 NTU (Table 4). Site depth ranged from 0.65 m to 3.50 m with a grand mean depth of 1.64 m (Table 4). Surface water velocity ranged from 0.00 m/s to 0.57 m/s with a grand mean 0.10 m/s (Table 4). Substrate composition was variable among the sampled reaches (Table 5). Gravel was the most common substrate type that occurred among sites in the East Sydenham River ranging from 10% to 85% with an overall mean of 46% (Table 5). Clay ranged from 0% to 85% with an overall mean of 10% (Table 5). Cobble ranged from 0% to 60% with an overall mean of 15% (Table 5). Boulder ranged from 0% to 50% with an overall mean of 9% (Table 5). Organic ranged from 0% to 20% with a mean of 5% (Table 5). Sand ranged from 0% to 10% with a mean of 1% (Table 5). The dominant substrate across all sites was gravel (25 sites) followed by cobble and silt (6 sites each), clay (2 sites) and boulder (1 site) (Table 5).

Sampling in 2019 has provided new insight into the fish community and habitat features of the Sydenham River watershed. Future sampling to detect Northern Madtom may involve targeted sampling between Alvinston and Florence. As this reach is considerably shallower than the area targeted in 2019, alternative gears (e.g. seining) may be required

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Table 1. Summary of site locations during targeted sampling for Northern Madtom in the East Sydenham River, 2019.

Site Code	Field Number	Date	Latitude	Longitude
SYD-01	2019-NMT-SYD-071019-001A	07-Oct-19	42.58639	-82.12551
SYD-02	2019-NMT-SYD-081019-001A	08-Oct-19	42.5892	-82.12548
SYD-03	2019-NMT-SYD-081019-002A	08-Oct-19	42.58915	-82.12714
SYD-04	2019-NMT-SYD-081019-003A	08-Oct-19	42.58929	-82.1295
SYD-05	2019-NMT-SYD-081019-004A	08-Oct-19	42.58967	-82.13146
SYD-06	2019-NMT-SYD-081019-005A	08-Oct-19	42.59006	-82.13387
SYD-07	2019-NMT-SYD-081019-006A	08-Oct-19	42.58714	-82.13507
SYD-08	2019-NMT-SYD-091019-001A	09-Oct-19	42.58639	-82.13264
SYD-09	2019-NMT-SYD-091019-002A	09-Oct-19	42.58579	-82.13165
SYD-10	2019-NMT-SYD-091019-003A	09-Oct-19	42.58471	-82.13122
SYD-11	2019-NMT-SYD-091019-004A	09-Oct-19	42.58373	-82.13113
SYD-12	2019-NMT-SYD-091019-005A	09-Oct-19	42.58283	-82.13191
SYD-13	2019-NMT-SYD-091019-006A	09-Oct-19	42.58237	-82.13322
SYD-14	2019-NMT-SYD-091019-007A	09-Oct-19	42.58107	-82.13446
SYD-15	2019-NMT-SYD-091019-008A	09-Oct-19	42.58089	-82.13882
SYD-16	2019-NMT-SYD-091019-009A	09-Oct-19	42.58321	-82.13824
SYD-17	2019-NMT-SYD-091019-010A	09-Oct-19	42.58634	-82.14096
SYD-18	2019-NMT-SYD-101019-001A	10-Oct-19	42.5853	-82.13995
SYD-19	2019-NMT-SYD-101019-002A	10-Oct-19	42.58743	-82.14014
SYD-20	2019-NMT-SYD-101019-003A	10-Oct-19	42.59211	-82.14021
SYD-21	2019-NMT-SYD-151019-001A	15-Oct-19	42.59317	-82.14038
SYD-22	2019-NMT-SYD-151019-002A	15-Oct-19	42.59414	-82.14032
SYD-23	2019-NMT-SYD-151019-003A	15-Oct-19	42.59515	-82.14036
SYD-24	2019-NMT-SYD-151019-004A	15-Oct-19	42.59626	-82.14421
SYD-25	2019-NMT-SYD-151019-005A	15-Oct-19	42.59542	-82.14513
SYD-26	2019-NMT-SYD-151019-006A	15-Oct-19	42.59444	-82.14597
SYD-27	2019-NMT-SYD-161019-001A	16-Oct-19	42.5942	-82.1492
SYD-28	2019-NMT-SYD-161019-002A	16-Oct-19	42.59537	-82.14862
SYD-29	2019-NMT-SYD-161019-003A	16-Oct-19	42.59633	-82.15008
SYD-30	2019-NMT-SYD-161019-004A	16-Oct-19	42.59574	-82.15162
SYD-31	2019-NMT-SYD-161019-005A	16-Oct-19	42.59544	-82.15475
SYD-32	2019-NMT-SYD-161019-006A	16-Oct-19	42.59578	-82.1571
SYD-33	2019-NMT-SYD-161019-007A	16-Oct-19	42.59672	-82.15919
SYD-34	2019-NMT-SYD-161019-008A	16-Oct-19	42.59843	-82.16098
SYD-35	2019-NMT-SYD-161019-009A	16-Oct-19	42.59892	-82.16242
SYD-36	2019-NMT-SYD-161019-010A	16-Oct-19	42.59942	-82.16362
SYD-37	2019-NMT-SYD-171019-001A	17-Oct-19	42.59536	-82.16855
SYD-38	2019-NMT-SYD-171019-002A	17-Oct-19	42.59465	-82.16908
SYD-39	2019-NMT-SYD-171019-003A	17-Oct-19	42.59412	-82.16976
SYD-40	2019-NMT-SYD-171019-004A	17-Oct-19	42.59216	-82.17204

Table 2. Fish assemblage results from targeted sampling for Northern Madtom in the East Sydenham River (sampling sites SYD-01 to SYD-10) in 2019. Values are aggregate catch (raw abundance) from three consecutive trawls at each site.

Species	SYD-01	SYD-02	SYD-03	SYD-04	SYD-05	SYD-06	SYD-07	SYD-08	SYD-09	SYD-10
<i>Ambloplites rupestris</i>	4	0	4	0	2	0	1	0	0	0
<i>Ameiurus natalis</i>	0	0	0	0	0	1	0	0	0	0
<i>Ammocrypta pellucida</i>	0	0	0	0	0	0	0	0	0	0
<i>Aplodinotus grunniens</i>	1	0	0	0	0	1	0	0	0	0
Cyprinidae	0	0	0	0	0	0	0	0	0	0
<i>Dorosoma cepedianum</i>	0	0	0	0	0	0	0	0	0	0
<i>Etheostoma blennioides</i>	5	19	9	10	5	5	7	3	8	2
<i>Etheostoma flabellare</i>	2	4	0	0	0	0	0	0	0	0
<i>Etheostoma nigrum</i>	0	0	0	0	0	0	0	0	0	0
<i>Ictalurus punctatus</i>	0	0	12	1	9	4	0	0	1	0
<i>Lepomis macrochirus</i>	0	0	0	0	0	0	0	0	0	0
<i>Lepomis peltastes</i>	0	0	0	0	0	0	0	0	0	0
<i>Micropterus salmoides</i>	0	0	0	0	0	0	0	0	0	0
<i>Morone americana</i>	0	0	0	0	0	0	0	0	0	0
<i>Morone chrysops</i>	0	0	0	0	0	0	0	1	0	0
<i>Moxostoma erythrurum</i>	0	0	1	0	2	1	0	1	0	0
<i>Moxostoma macrolepidotum</i>	0	0	2	2	0	0	0	0	0	0
<i>Moxostoma</i> sp.	0	0	0	0	0	0	0	1	0	0
<i>Moxostoma valenciennesi</i>	0	0	0	0	0	0	0	0	0	0
<i>Neogobius melanostomus</i>	0	3	1	5	17	14	2	8	4	15
<i>Notropis atherinoides</i>	0	0	1	0	0	0	0	0	0	0
<i>Notropis buchanani</i>	0	0	2	20	61	19	7	59	5	14
<i>Notropis hudsonius</i>	0	0	0	0	4	0	0	0	0	0
<i>Noturus flavus</i>	1	1	2	0	0	0	0	0	0	0
<i>Noturus miurus</i>	1	3	8	0	14	1	1	1	0	1
<i>Perca flavescens</i>	0	0	1	0	1	0	0	0	0	0
<i>Percina caprodes</i>	3	2	16	0	19	1	1	2	1	0
<i>Percina maculata</i>	0	3	15	3	9	1	1	3	2	4
<i>Percina shumardi</i>	0	0	1	1	0	0	1	0	0	1
<i>Percopsis omiscomaycus</i>	0	0	0	0	3	0	0	0	0	0
<i>Pimephales notatus</i>	0	0	0	0	0	0	0	0	2	0
<i>Pomoxis annularis</i>	0	0	0	0	0	0	0	0	0	0
<i>Pomoxis nigromaculatus</i>	0	0	0	0	0	0	0	0	0	0
Sub Total	17	35	75	42	146	48	21	79	23	37

Table 2. (continued) Fish assemblage results from targeted sampling for Northern Madtom in the East Sydenham River (sampling sites SYD-11 to SYD-20) in 2019. Values are aggregate catch (raw abundance) from three consecutive trawls at each site.

Species	SYD-11	SYD-12	SYD-13	SYD-14	SYD-15	SYD-16	SYD-17	SYD-18	SYD-19	SYD-20
<i>Ambloplites rupestris</i>	0	1	0	1	0	5	1	0	0	2
<i>Ameiurus natalis</i>	0	0	0	0	0	0	0	0	0	1
<i>Ammocrypta pellucida</i>	0	0	4	3	2	0	0	0	1	1
<i>Aplodinotus grunniens</i>	0	0	0	1	3	0	0	0	0	0
Cyprinidae	0	0	0	0	0	0	0	0	0	0
<i>Dorosoma cepedianum</i>	0	0	0	0	0	0	0	0	1	2
<i>Etheostoma blennioides</i>	2	4	1	1	0	2	23	4	4	8
<i>Etheostoma flabellare</i>	0	0	0	0	0	0	2	0	0	0
<i>Etheostoma nigrum</i>	0	1	0	0	0	0	0	0	0	0
<i>Ictalurus punctatus</i>	1	1	1	2	3	0	0	0	0	1
<i>Lepomis macrochirus</i>	0	0	0	0	0	0	0	0	0	0
<i>Lepomis peltastes</i>	0	0	0	0	0	0	0	0	0	0
<i>Micropterus salmoides</i>	0	0	0	1	0	0	0	0	0	2
<i>Morone americana</i>	0	0	0	0	0	0	0	0	0	0
<i>Morone chrysops</i>	0	0	0	0	1	0	0	0	1	0
<i>Moxostoma erythrurum</i>	0	0	2	1	0	1	0	2	0	2
<i>Moxostoma macrolepidotum</i>	0	1	0	0	1	0	0	1	0	0
<i>Moxostoma sp.</i>	0	0	0	0	0	0	0	0	0	0
<i>Moxostoma valenciennesi</i>	0	0	0	1	0	0	0	0	0	0
<i>Neogobius melanostomus</i>	21	5	6	8	34	31	26	25	25	10
<i>Notropis atherinoides</i>	0	0	0	0	0	0	0	0	0	0
<i>Notropis buchanani</i>	22	4	85	59	131	86	7	63	206	222
<i>Notropis hudsonius</i>	0	0	0	1	2	0	0	2	0	4
<i>Noturus flavus</i>	0	0	0	0	0	0	0	0	0	0
<i>Noturus miurus</i>	1	0	0	0	1	0	0	0	1	3
<i>Perca flavescens</i>	0	0	0	0	0	1	0	0	0	0
<i>Percina caprodes</i>	1	0	1	0	1	5	7	3	2	6
<i>Percina maculata</i>	0	4	4	3	7	15	16	10	4	12
<i>Percina shumardi</i>	0	0	2	0	0	0	0	0	0	0
<i>Percopsis omiscomaycus</i>	0	1	2	1	4	2	0	1	1	0
<i>Pimephales notatus</i>	0	0	0	1	0	1	0	0	0	1
<i>Pomoxis annularis</i>	0	0	0	0	0	0	0	0	0	0
<i>Pomoxis nigromaculatus</i>	0	0	0	0	0	0	0	0	0	0
Sub Total	48	22	108	84	190	149	82	111	246	277

Table 2. (continued) Fish assemblage results from targeted sampling for Northern Madtom in the East Sydenham River (sampling sites SYD-21 to SYD-30) in 2019. Values are aggregate catch (raw abundance) from three consecutive trawls at each site.

Species	SYD-21	SYD-22	SYD-23	SYD-24	SYD-25	SYD-26	SYD-27	SYD-28	SYD-29	SYD-30
<i>Ambloplites rupestris</i>	0	1	0	2	0	0	0	1	1	0
<i>Ameiurus natalis</i>	0	0	0	0	0	0	0	0	0	0
<i>Ammocrypta pellucida</i>	0	0	0	0	0	5	0	0	0	0
<i>Aplodinotus grunniens</i>	0	0	0	0	0	0	0	1	0	1
Cyprinidae	0	0	0	0	0	0	0	0	5	1
<i>Dorosoma cepedianum</i>	1	0	0	0	0	0	0	0	0	0
<i>Etheostoma blennioides</i>	3	0	0	0	0	0	0	0	0	0
<i>Etheostoma flabellare</i>	0	0	0	0	0	0	0	0	0	0
<i>Etheostoma nigrum</i>	0	0	0	0	0	0	0	0	0	0
<i>Ictalurus punctatus</i>	0	0	0	1	2	1	2	0	2	2
<i>Lepomis macrochirus</i>	0	0	0	0	0	0	0	0	0	0
<i>Lepomis peltastes</i>	0	0	0	0	0	0	0	0	0	0
<i>Micropterus salmoides</i>	0	0	0	0	0	0	0	0	0	0
<i>Morone americana</i>	0	0	0	0	0	0	0	0	0	0
<i>Morone chrysops</i>	0	0	0	0	0	0	0	0	0	0
<i>Moxostoma erythrurum</i>	0	4	0	0	2	2	0	0	1	0
<i>Moxostoma macrolepidotum</i>	1	2	0	0	2	0	0	0	0	0
<i>Moxostoma sp.</i>	0	0	0	0	0	0	0	0	0	0
<i>Moxostoma valenciennesi</i>	0	0	0	0	0	0	0	0	0	0
<i>Neogobius melanostomus</i>	3	13	11	5	14	18	32	23	16	14
<i>Notropis atherinoides</i>	0	0	0	0	0	0	1	0	0	0
<i>Notropis buchanani</i>	54	150	358	103	400	186	69	93	248	164
<i>Notropis hudsonius</i>	1	0	0	0	1	5	0	0	0	0
<i>Noturus flavus</i>	0	0	0	0	0	0	0	0	0	0
<i>Noturus miurus</i>	0	1	1	0	0	0	0	0	0	0
<i>Perca flavescens</i>	0	5	0	0	0	0	0	0	0	0
<i>Percina caprodes</i>	0	4	1	1	2	3	1	2	0	1
<i>Percina maculata</i>	3	14	5	10	5	5	4	4	4	2
<i>Percina shumardi</i>	0	0	0	0	1	0	0	0	0	0
<i>Percopsis omiscomaycus</i>	3	1	3	0	6	4	1	0	8	2
<i>Pimephales notatus</i>	0	1	0	3	0	0	0	1	0	0
<i>Pomoxis annularis</i>	0	0	0	0	0	0	0	0	0	0
<i>Pomoxis nigromaculatus</i>	0	0	0	0	0	0	0	0	0	0
Sub Total	69	196	379	125	435	229	110	125	285	187

Table 2. (continued) Fish assemblage results from targeted sampling for Northern Madtom in the East Sydenham River (sampling sites SYD-31 to SYD-40) in 2019. Values are aggregate catch (raw abundance) from three consecutive trawls at each site.

Species	SYD-31	SYD-32	SYD-33	SYD-34	SYD-35	SYD-36	SYD-37	SYD-38	SYD-39	SYD-40	Total Catch
<i>Ambloplites rupestris</i>	0	0	0	0	0	0	0	0	0	2	28
<i>Ameiurus natalis</i>	0	0	0	0	0	0	0	0	0	0	2
<i>Ammocrypta pellucida</i>	0	0	0	0	0	0	0	0	0	0	16
<i>Aplodinotus grunniens</i>	0	0	1	0	0	0	1	1	0	0	11
Cyprinidae	0	0	0	0	0	0	0	0	0	0	6
<i>Dorosoma cepedianum</i>	0	0	0	0	0	0	0	0	0	0	4
<i>Etheostoma blennioides</i>	0	0	0	0	1	0	0	0	0	0	126
<i>Etheostoma flabellare</i>	0	0	0	0	0	0	0	0	0	0	8
<i>Etheostoma nigrum</i>	0	0	0	0	0	0	0	0	0	0	1
<i>Ictalurus punctatus</i>	3	0	4	2	2	2	2	3	8	1	73
<i>Lepomis macrochirus</i>	0	0	0	0	0	0	0	1	0	4	5
<i>Lepomis peltastes</i>	0	0	0	0	0	0	0	0	0	1	1
<i>Micropterus salmoides</i>	2	1	0	0	1	0	0	0	0	2	9
<i>Morone americana</i>	0	0	0	0	2	0	0	0	0	0	2
<i>Morone chrysops</i>	0	0	0	0	0	0	0	0	0	0	3
<i>Moxostoma erythrurum</i>	0	0	0	0	0	1	2	0	0	0	25
<i>Moxostoma macrolepidotum</i>	0	0	0	0	0	0	0	1	0	0	13
<i>Moxostoma</i> sp.	0	0	0	0	0	0	0	0	0	0	1
<i>Moxostoma valenciennesi</i>	0	0	0	0	0	0	0	0	0	0	1
<i>Neogobius melanostomus</i>	36	10	20	10	10	8	30	32	15	19	599
<i>Notropis atherinoides</i>	0	0	0	0	0	0	0	0	0	0	2
<i>Notropis buchanani</i>	322	328	110	365	340	147	196	201	89	209	5204
<i>Notropis hudsonius</i>	0	3	0	0	0	0	0	0	0	1	24
<i>Noturus flavus</i>	0	0	0	0	0	0	0	0	0	0	4
<i>Noturus miurus</i>	0	0	0	0	0	0	0	0	0	0	38
<i>Perca flavescens</i>	0	0	0	0	0	0	0	0	0	2	10
<i>Percina caprodes</i>	1	1	0	5	6	1	1	1	0	1	103
<i>Percina maculata</i>	0	1	3	1	1	0	0	0	0	4	182
<i>Percina shumardi</i>	0	0	0	0	0	0	0	0	0	0	7
<i>Percopsis omiscomaycus</i>	10	3	3	6	5	2	6	8	13	3	102
<i>Pimephales notatus</i>	0	0	0	0	0	0	0	0	0	0	10
<i>Pomoxis annularis</i>	0	0	1	0	1	0	0	0	0	0	2
<i>Pomoxis nigromaculatus</i>	0	1	0	0	0	0	0	0	0	0	1
Sub Total	374	348	142	389	369	161	238	248	125	249	6623

Table 3. Summary of River Darter (*Percina shumardi*), Eastern Sand Darter (*Ammocrypta pellucida*) and Northern Sunfish (*Lepomis peltastes*) captured during targeted sampling for Northern Madtom in the East Sydenham River, 2019. A value of “-“ indicates no measurement was taken.

Site Code	Species	Date	Total Length (mm)	Latitude	Longitude
SYD-13	<i>Ammocrypta pellucida</i>	09-Oct-19	31	42.58237	-82.13322
SYD-13	<i>Ammocrypta pellucida</i>	09-Oct-19	35	42.58237	-82.13322
SYD-13	<i>Ammocrypta pellucida</i>	09-Oct-19	47	42.58237	-82.13322
SYD-13	<i>Ammocrypta pellucida</i>	09-Oct-19	33	42.58237	-82.13322
SYD-14	<i>Ammocrypta pellucida</i>	09-Oct-19	32	42.58107	-82.13446
SYD-14	<i>Ammocrypta pellucida</i>	09-Oct-19	30	42.58107	-82.13446
SYD-14	<i>Ammocrypta pellucida</i>	09-Oct-19	46	42.58107	-82.13446
SYD-15	<i>Ammocrypta pellucida</i>	09-Oct-19	30	42.58089	-82.13882
SYD-15	<i>Ammocrypta pellucida</i>	09-Oct-19	29	42.58089	-82.13882
SYD-19	<i>Ammocrypta pellucida</i>	10-Oct-19	34	42.58743	-82.14014
SYD-20	<i>Ammocrypta pellucida</i>	10-Oct-19	36	42.59211	-82.14021
SYD-26	<i>Ammocrypta pellucida</i>	15-Oct-19	45	42.59444	-82.14597
SYD-26	<i>Ammocrypta pellucida</i>	15-Oct-19	27	42.59444	-82.14597
SYD-26	<i>Ammocrypta pellucida</i>	15-Oct-19	-	42.59444	-82.14597
SYD-26	<i>Ammocrypta pellucida</i>	15-Oct-19	-	42.59444	-82.14597
SYD-26	<i>Ammocrypta pellucida</i>	15-Oct-19	33	42.59444	-82.14597
SYD-40	<i>Lepomis peltastes</i>	17-Oct-19	93	42.59216	-82.17204
SYD-03	<i>Percina shumardi</i>	08-Oct-19	66	42.58915	-82.12714
SYD-04	<i>Percina shumardi</i>	08-Oct-19	58	42.58929	-82.1295
SYD-07	<i>Percina shumardi</i>	08-Oct-19	60	42.58714	-82.13507
SYD-10	<i>Percina shumardi</i>	09-Oct-19	58	42.58471	-82.13122
SYD-13	<i>Percina shumardi</i>	09-Oct-19	55	42.58237	-82.13322
SYD-13	<i>Percina shumardi</i>	09-Oct-19	54	42.58237	-82.13322
SYD-25	<i>Percina shumardi</i>	15-Oct-19	42	42.59542	-82.14513

Table 4. Habitat results from targeted sampling for Northern Madtom in the East Sydenham River, 2019. Depth and velocity values are presented as the mean values from each of three measurements within a site. A value of “-“ indicates no measurement was taken.

Site Code	Air Temp (°C)	Water Temp (°C)	Conductivity (µS)	Dissolved Oxygen (mg/L)	Secchi Tube (m)	Turbidity (NTU)	Depth (m)	Velocity (m/s)
SYD-01	19.8	16.4	494.0	-	0.14	-	0.80	0.57
SYD-02	14.5	14.2	412.9	8.40	0.15	46.03	0.80	0.38
SYD-03	17.5	14.4	414.1	8.30	0.16	46.65	0.65	0.16
SYD-04	19.1	15.0	422.8	8.57	0.19	44.85	1.17	0.17
SYD-05	19.8	15.2	426.4	8.51	0.20	46.76	0.73	0.14
SYD-06	19.4	15.3	428.7	8.58	0.19	48.35	1.13	0.12
SYD-07	17.8	15.4	430.2	8.58	0.19	44.06	1.10	0.30
SYD-08	11.4	13.8	439.1	8.59	0.17	36.30	1.13	0.13
SYD-09	19.7	13.8	440.2	8.58	0.16	37.52	1.07	0.20
SYD-10	19.7	14.0	443.1	8.51	0.16	48.47	1.00	0.12
SYD-11	18.3	14.2	446.0	8.57	0.19	38.05	1.30	0.13
SYD-12	22.4	14.5	450.2	8.63	0.18	37.83	1.33	0.11
SYD-13	21.6	14.6	451.3	8.75	0.21	38.42	1.37	0.10
SYD-14	24.9	15.1	461.3	8.57	0.15	48.80	1.20	0.07
SYD-15	21.4	14.5	447.9	8.49	0.17	34.00	2.20	0.05
SYD-16	20.9	14.7	448.7	8.37	0.17	48.00	1.30	0.04
SYD-17	18.7	14.7	447.4	8.32	0.16	36.00	1.03	0.09
SYD-18	12.6	13.8	462.9	8.66	0.18	32.30	1.13	0.10
SYD-19	13.8	13.8	461.6	8.62	0.19	31.10	1.53	0.09
SYD-20	18.6	14.4	466.1	8.53	0.19	27.00	1.23	0.05
SYD-21	17.2	11.5	495.5	9.55	0.24	24.30	1.23	0.10
SYD-22	14.4	11.7	498.7	9.54	0.31	23.30	1.30	0.08
SYD-23	14.3	11.4	495.6	9.45	0.27	22.00	1.60	0.04
SYD-24	17.6	11.9	502.0	9.52	0.28	25.30	1.50	0.05
SYD-25	19.7	12.1	504.0	9.57	*	22.90	1.57	0.04
SYD-26	21.6	11.9	502.0	9.52	0.29	23.10	1.60	0.06
SYD-27	11.9	11.8	506.0	9.65	0.24	20.12	1.97	0.09
SYD-28	9.7	11.8	505.0	9.64	0.25	19.82	1.83	0.10
SYD-29	9.2	11.8	505.0	9.57	0.27	21.42	2.00	0.06
SYD-30	10.1	11.8	506.0	9.59	0.15	20.70	2.17	0.01
SYD-31	9.9	11.8	505.0	9.77	0.30	20.89	2.10	0.00
SYD-32	9.5	11.8	505.0	9.63	0.27	20.15	2.27	0.06
SYD-33	9.4	11.7	503.0	9.66	0.23	20.26	2.47	0.02
SYD-34	11.8	11.8	505.0	9.74	0.20	38.74	2.40	0.02
SYD-35	10.5	11.8	506.0	9.64	0.20	32.41	2.13	0.01
SYD-36	10	11.7	504.0	9.58	0.25	22.93	2.50	0.01
SYD-37	6	11.3	499.9	9.21	0.32	21.57	2.47	0.01
SYD-38	6.7	11.2	497.7	9.30	0.30	20.00	2.53	0.01
SYD-39	7.7	11.3	499.2	9.30	0.29	23.57	3.30	0.03
SYD-40	9.6	11.4	501.0	9.20	0.27	22.11	3.50	0.02
Min	6.0	11.3	412.9	8.30	0.14	19.82	0.65	0.00
Mean	15.2	13.1	473.5	9.05	0.22	31.69	1.64	0.10
Max	24.9	16.4	506.0	9.77	0.32	48.80	3.50	0.57

Not measured “*”

Table 5. Substrate results from targeted sampling for Northern Madtom in the East Sydenham River, 2019. Values represent percent composition within the site based on ponar samples of small substrates (organic, clay, silt, sand, gravel, cobble) and sonar assessment of large substrates (large cobble, boulder).

Site Code	Organic	Clay	Silt	Sand	Gravel	Cobble	Boulder	Dominant Substrate
SYD-01	0	0	0	0	20	60	20	Cobble
SYD-02	0	0	0	0	30	50	20	Cobble
SYD-03	5	5	40	0	50	0	0	Gravel
SYD-04	0	0	0	10	60	10	20	Gravel
SYD-05	20	5	10	5	45	5	10	Gravel
SYD-06	10	10	10	5	50	5	10	Gravel
SYD-07	5	0	0	0	40	40	15	Gravel
SYD-08	0	0	0	0	40	50	10	Cobble
SYD-09	0	0	0	0	75	20	5	Gravel
SYD-10	0	0	5	0	85	5	5	Gravel
SYD-11	5	0	5	0	70	10	10	Gravel
SYD-12	5	0	0	0	75	10	10	Gravel
SYD-13	5	0	0	0	80	5	10	Gravel
SYD-14	5	10	10	0	60	10	5	Gravel
SYD-15	0	70	0	0	30	0	0	Clay
SYD-16	0	85	0	0	15	0	0	Clay
SYD-17	0	0	0	0	20	60	20	Cobble
SYD-18	10	30	0	0	60	0	0	Gravel
SYD-19	10	10	0	0	20	10	50	Boulder
SYD-20	10	40	0	0	50	0	0	Gravel
SYD-21	5	5	5	0	10	50	25	Cobble
SYD-22	5	5	30	0	30	20	10	Gravel
SYD-23	5	5	30	0	50	5	5	Gravel
SYD-24	5	5	10	0	10	40	30	Cobble
SYD-25	10	5	20	0	50	10	5	Gravel
SYD-26	5	0	5	0	75	10	5	Gravel
SYD-27	5	0	0	0	55	20	20	Gravel
SYD-28	0	0	0	0	40	30	30	Gravel
SYD-29	5	0	0	0	40	35	20	Gravel
SYD-30	10	10	35	0	35	10	0	Gravel
SYD-31	0	5	45	0	50	0	0	Gravel
SYD-32	10	0	5	0	75	5	5	Gravel
SYD-33	5	0	25	0	65	5	0	Gravel
SYD-34	10	10	50	0	30	0	0	Silt
SYD-35	5	20	45	0	30	0	0	Silt
SYD-36	10	20	40	0	30	0	0	Silt
SYD-37	5	5	45	0	40	5	0	Silt
SYD-38	5	5	50	0	40	0	0	Silt
SYD-39	5	10	10	0	70	5	0	Gravel
SYD-40	10	5	40	5	40	0	0	Silt
Min	0	0	0	0	10	0	0	
Mean	5	10	14	1	46	15	9	
Max	20	85	50	10	85	60	50	

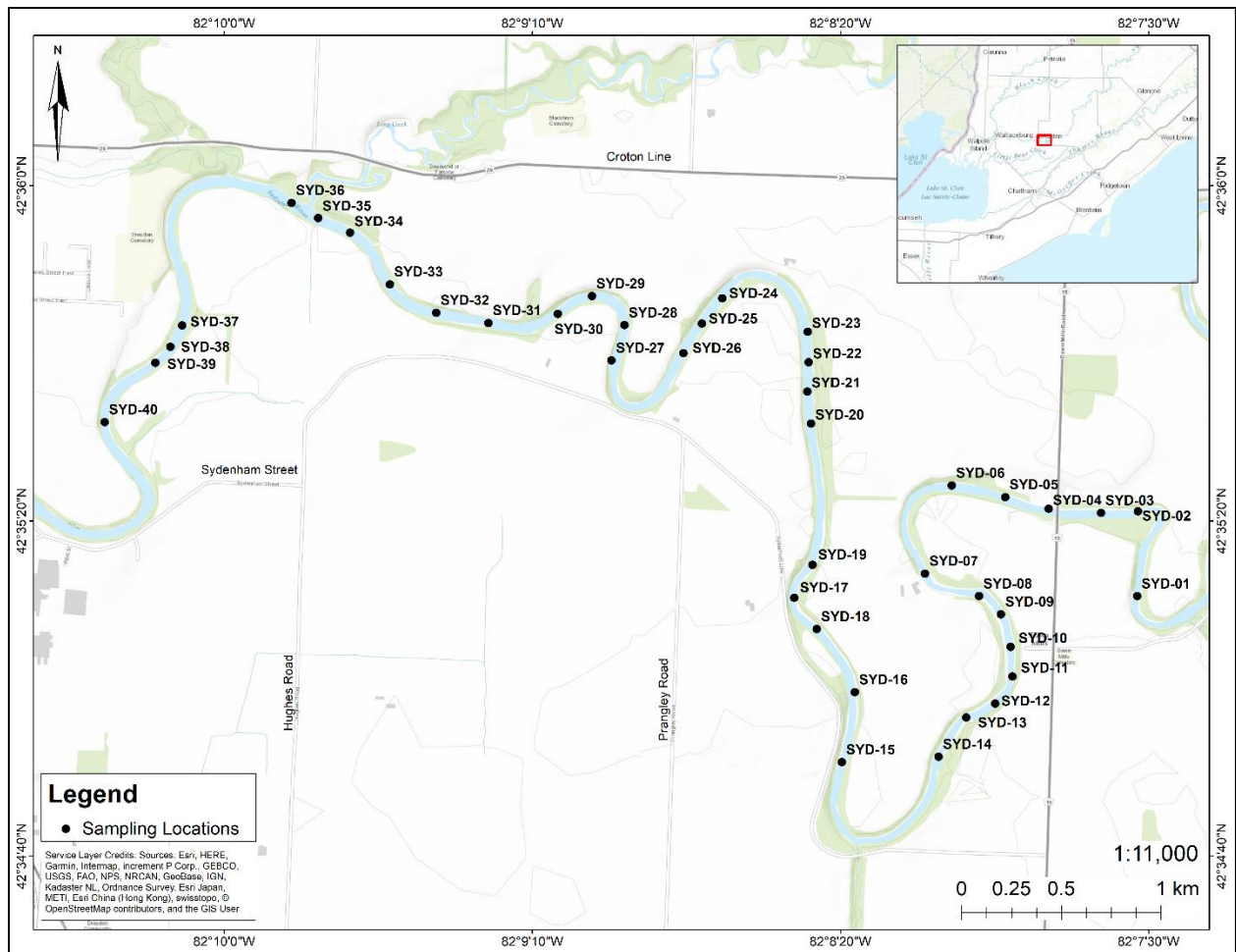


Figure 1. Targeted sampling locations for Northern Madtom in the East Sydenham River, 2019.

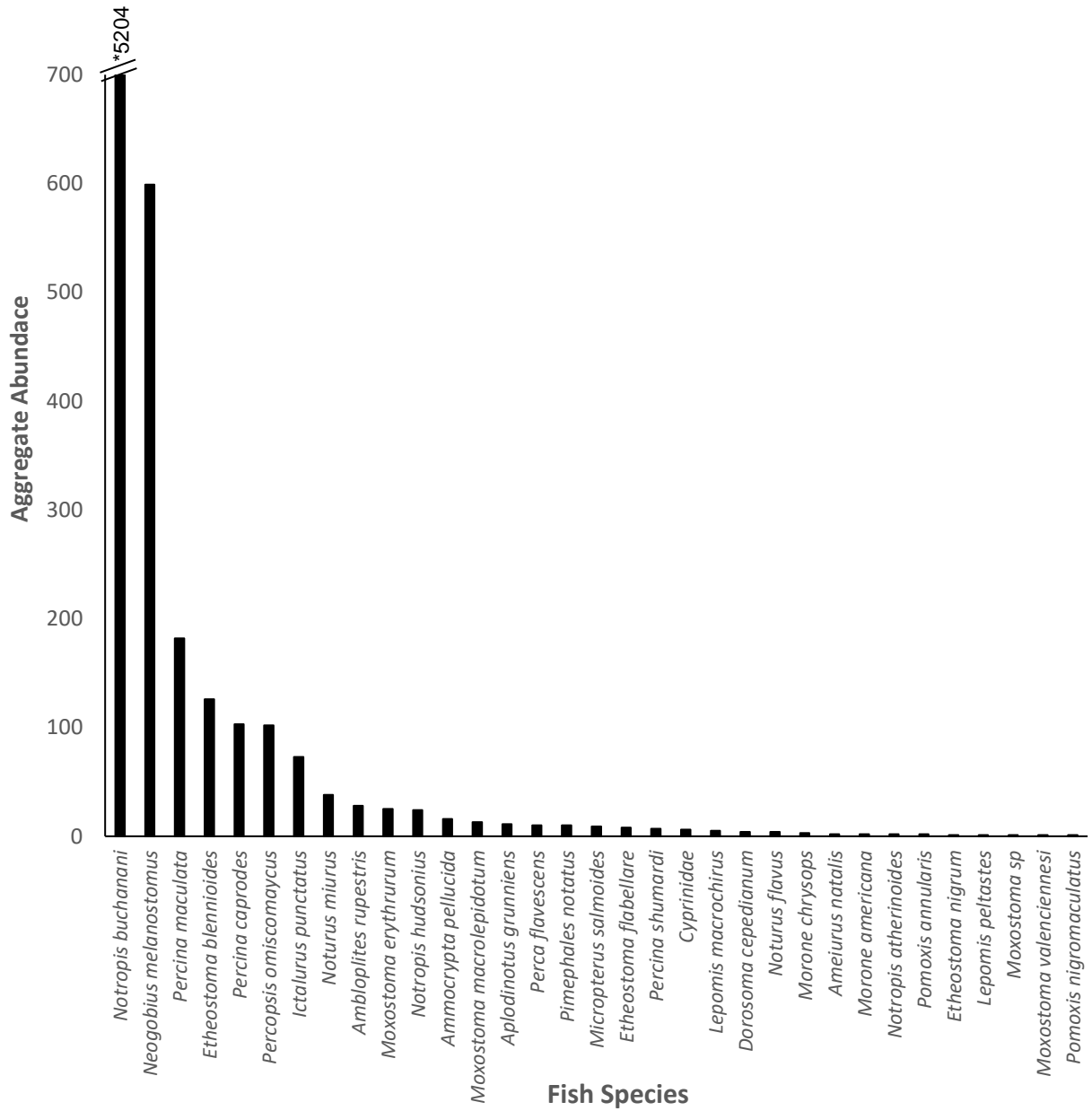


Figure 2. Rank-abundance of catch data (raw abundance) of all species detected during targeted sampling for Northern Madtom in the East Sydenham River, 2019.