Aquatic Habitat Assessment for Eastern Sand Darter (*Ammocrypta pellucida*) in Big Otter Creek, Elgin County, Ontario, 2020

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assigned to sieve diameters were as follows: medium gravel or larger (≥ 8 mm), fine gravel (≥ 4 mm to <8 mm), very fine gravel (≥ 2 mm to <4 mm), very coarse sand (≥ 1 mm to <2 mm), coarse sand (≥ 0.5 mm to <1 mm), medium sand (≥ 0.25 mm to <0.5 mm), fine sand (≥ 0.125 mm to <0.25 mm), very fine sand (≥ 0.063 mm to <0.125 mm), and silt (<0.063 mm). Substrate classes adapted from Wentworth (1922).

ABSTRACT

Barnucz, J., Gáspárdy, R.C., Colm, J.E., and Drake, D.A.R. 2022. Aquatic Habitat Assessment for Eastern Sand Darter (*Ammocrypta pellucida*) in Big Otter Creek, Elgin Country, Ontario, 2020. Can. Data Rep. Fish. Aquat. Sci. 1343: vii + 21 p.

The Eastern Sand Darter (Ammocrypta pellucida) is listed as Threatened (Ontario Designatable Unit) under Canada's Species at Risk Act and was last observed in Big Otter Creek, a tributary of Lake Erie, in 1955. In 2020, Fisheries and Oceans Canada sampled Big Otter Creek to determine the suitability of aquatic habitat for a possible Eastern Sand Darter translocation. Habitat sampling focused primarily on sediment composition and sediment oxygen profiles. Twelve sites were sampled (six historical, six targeted) between Tillsonburg and Vienna, Ontario. Each site consisted of ten randomly selected observation points where dissolved oxygen (mg/L) and water temperature (°C) were measured at three depth increments near the substrate surface. Additionally, at a subset of five observation points, substrate was collected to a depth of 10 cm. Substrate samples were dried, sieved, and weighed in the lab. The mean oxygen concentration at the substrate surface was 9.94 mg/L and 10.26 mg/L for historical and targeted sites, respectively, but was much lower 1 cm below the substrate surface (2.5 mg/L and 0.61 mg/L for historical and targeted sites, respectively). The dominant substrate class at historical sites was medium sand (≥0.25 mm to <0.5 mm), while the dominant class at targeted sites was medium sand (four sites) and fine sand (two sites; >0.125 mm to < 0.25 mm). At historical sites, the overall mean composition of sand and fine gravel (> 0.063 mm to < 8 mm) ranged from 73.8 to 98.8% by weight, and was 91.5 to 98% by weight at targeted sites.

RÉSUMÉ

Barnucz, J., Gáspárdy, R.C., Colm, J.E., and Drake, D.A.R. 2022. Aquatic Habitat Assessment for Eastern Sand Darter (*Ammocrypta pellucida*) in Big Otter Creek, Elgin Country, Ontario, 2020. Can. Data Rep. Fish. Aquat. Sci. 1343: vii + 21 p.

Le dard de sable (Ammocrypta pellucida) est inscrit comme espèce menacée (unité désignable de l'Ontario) aux termes de la Loi sur les espèces en péril du Canada et a été observé pour la dernière fois dans le ruisseau Big Otter, un affluent du lac Érié, en 1995. En 2020, Pêches et Océans Canada a effectué un échantillonnage dans le ruisseau Big Otter afin de déterminer la gualité de l'habitat aquatique pour une éventuelle translocation du dard de sable. L'échantillonnage de l'habitat a porté principalement sur la composition des sédiments et les profils d'oxygène des sédiments. On a échantillonné douze sites (six historiques et six ciblés) entre Tilssonburg et Vienna, en Ontario. Chaque site comprenait dix points d'observation choisis au hasard où l'oxygène dissous (mg/L) et la température de l'eau (°C) ont été mesurés à trois incréments de profondeur près de la surface du substrat. De plus, on a recueilli le substrat à une profondeur de 10 cm pour un sous-ensemble de cinq points d'observation. Les échantillons de substrat ont été séchés, tamisés et pesés en laboratoire. La concentration moyenne d'oxygène à la surface du substrat était de 9,94 mg/L et de 10,26 mg/L pour les sites historiques et ciblés, respectivement, mais elle était beaucoup plus faible à 1 cm sous la surface du substrat (2,5 mg/L et 0,61 mg/L pour les sites historiques et ciblés, respectivement). La classe de substrat dominante aux sites historiques était le sable moyen (de ≥0,25 mm à <0,5 mm), tandis que la classe dominante aux sites ciblés était le sable moyen (quatre sites) et le sable fin (deux sites; de >0,125 mm à < 0.25 mm). Dans les sites historiques, la composition moyenne globale de sable et de gravier fin (de > 0.063 mm à < 8 mm) variait de 73.8 à 98,8 % en poids, et était de 91,5 à 98 % en poids dans les sites ciblés.

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) of 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.

Eastern Sand Darter (*Ammocrypta pellucida*; Ontario Designatable Unit) is found in a small number of locations in the Lake St. Clair, Lake Erie, and Lake Ontario drainages. Extant populations in the Lake Erie drainage are found in the Grand River, Big Creek, Rondeau Bay, and nearshore areas of the western basin of Lake Erie. Historically, Eastern Sand Darter occurred within Catfish Creek and Big Otter Creek; however, Eastern Sand Darter has not been detected in Big Otter Creek since 1955 as described by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2009) despite recent targeted sampling in sand-dominated habitats (Barnucz et al. 2020). The last known collections of the species in Big Otter Creek) include a single adult collected near Tillsonburg, upstream of Highway 3 on August 23rd, 1923 (Hubbs and Brown 1929), as well as collections near Calton and Richmond in 1955 (COSEWIC 2009; Barnucz et al. 2020).

Eastern Sand Darter is one of 14 SARA-listed freshwater fishes for which translocations are identified as a potential recovery strategy (Lamothe et al. 2019a). Big Otter Creek has been identified as a potential location for translocation experiments because of improving water quality as a result of changing agricultural practices. Predictive occupancy modelling that evaluated historical locations of Eastern Sand Darter found that Big Otter Creek is likely a suitable location (Dextrase et al. 2014), but before translocations can occur, the habitat must be thoroughly evaluated to ensure the conditions are suitable for the species to survive and reproduce (Lamothe et al. 2019a). In Ontario, Eastern Sand Darter requires a high proportion of sand and fine gravel substrates in high flow, clear water habitats (Drake et al. 2008; Dextrase et al. 2014; Lamothe et al. 2019b). Additionally, as a fossorial species, it is assumed that oxygen at the substrate-water interface is needed to carry out life-history processes (Bouvier and Mandrak 2010). As part of ongoing efforts to evaluate the potential for translocation in Big Otter Creek, this data report summarizes aquatic habitat sampling by DFO in 2020 to evaluate the current habitat conditions for Eastern Sand Darter.

METHODS

STUDY AREA AND SITE SELECTION

The three historical detection locations for Eastern Sand Darter were identified in Big Otter Creek. Habitat sampling sites in 2020 were selected around these historical locations, classified as either historical or targeted sites (Table 1). A buffer extending 1 km upstream and 1 km downstream of the historical locations was created, and two habitat sites (one upstream, one downstream) were sampled within the buffer, referred to as historical sites (n = 6). Two more sites with suitable habitat features were selected beyond the 1 km buffer for each historical detection, referred to as targeted sites (n = 6). These criteria were established to ensure that aquatic habitat could be assessed within and beyond historical locations of the species (Figure 1). The majority of sites were located near private property, with access from landowners granted in advance of field sampling. Most sampling sites were accessed on foot with the

exception of sampling sites 6 and 7, which were accessed by canoe (Figure 1). Sampling was conducted from September 21st to October 7th, 2020.

HABITAT SAMPLING

Sampling sites were focused on point bar areas within pools. Pool habitat was identified by measuring the hydraulic head prior to sampling, with pools defined as areas with hydraulic head of 0 – 3 mm [see Stanfield (2005) for the description of hydraulic head]. Once a pool met the hydraulic head criteria, the potential sampling area was identified within the wadeable area (i.e., depth \leq 1 m), and included the point bar feature whenever possible. A flag was placed at the upstream and downstream boundaries of the sampling area for visual reference. Within the site, ten observation points were randomly selected and marked with identifying floats (Figure 2). Water depth (m) and water velocity (m/s) at 50% of the water depth were recorded at each observation point. Water velocity measurements were collected using an OTT MF Pro[™] water flow metre. Oxygen and water temperature were measured at each observation point using a FireStingGO2 pocket oxygen metre with oxygen probe and temperature sensor (Figures 3, 4). Three oxygen and temperature measurements were collected at each observation point, taken at five centimetres above the substrate surface (+5 cm), at the substrate surface (0 cm), and one centimetre below the substrate surface (-1 cm) when the substrate allowed insertion of the probe. Additionally, measurements of water temperature (°C), dissolved oxygen (mg/L), turbidity (NTU), conductivity (µS), and pH were taken immediately upstream of the sampling site at 50% of the channel depth using a YSI™ EX02 multiparameter sonde. Wetted stream width (m; measured at the midpoint of sampling site), site width (m), and site length (m) were measured using a combination of a Nikon® range finder and tape measure.

SUBSTRATE SAMPLE COLLECTION

Substrate was collected using a square-faced shovel with blade dimensions of approximately 21 cm in width x 23 cm in height. The shovel was marked with paint to identify the upper (10 cm) and lower (5 cm) sampling range for each sampling point (Figure 5). The use of the shovel for substrate collection was justified based on Hames et al. (1996), who found that substrate collection with certain shovel designs can produce estimates of percent fines that are consistent with McNiel samplers. At each sampling site, five of the ten observation points were selected for collecting substrate samples based on the representation of different depths, flow, and substrate types within the site. Substrate samples were collected by slowly inserting the shovel vertically into the substrate at an observation point with the open part of the shovel blade facing upstream. Once the shovel blade was inserted into the substrate the sampling depth on the face of the blade was recorded. Substrate samples were collected between 5 cm and 10 cm of depth into the stream bed, never exceeding 10 cm in depth. The maximum depth of the substrate collected at each sampling point was recorded.

The shovel handle was tipped back and down until the blade was parallel with the substrate surface. The blade and substrate sample were then lifted, taking care to move the blade slowly to the surface of the water to retain as much substrate as possible. Substrate from the shovel blade was placed into a resealable plastic bag (Figure 5). The shovel blade was then rinsed to ensure that all substrate from the sampling point, including fines, was collected in the bag. Each bag was given a unique identification number and the corresponding observation point was noted. Substrate samples from each of the five observation points within a sampling site were then placed into a single large resealable bag for storage and transported back to the lab.

SUBSRATE SAMPLE PROCESSING

Once in the lab, substrate samples were removed from their respective bags and placed onto aluminum foil drying trays. The substrate collection bag was rinsed using water spray, which ensured all collected substrate, including fines, was added to the drying tray for processing. Samples in the drying trays were placed on a lab bench to allow fines to settle and to initiate drying of the sediment sample. Samples were allowed to settle for a period of approximately 24 hours on the lab bench. After 24 hours any standing water remaining on the surface of the sample was carefully removed to aid in the drying. Visible clumps of substrate were broken up using a small silicone spatula. Substrate samples were then placed into a Thermo Scientific precision compact oven with mechanical convection for drying. Four to six samples were dried simultaneously depending on the size of the sample. A sample tracking log was used to record the sample identifying number, drying start time, drying end time, and the oven temperature. The drying time of samples was approximately 24 hours at oven temperatures between 50 °C and 60 °C. Once dried, samples were carefully removed from the drying oven and prepared for weighing.

Each sample was weighed in the drying tray with the lid removed using a three kilogram Ohaus[™] lab balance. After being weighed, the sample was transferred from the drying tray into the top sieve of a set of nested brass soil sieves. A tooth brush and silicon spatula were used to ensure all contents of the drying tray were transferred to the top sieve before processing.

The nested sieves were stacked in order with the coarsest mesh at the top of the sieve stack and the finest mesh at the bottom. The stack of sieves consisted of eight different mesh sizes, which were (from coarse to fine): 8 mm, 4 mm (#5 sieve number), 2 mm (#10), 1 mm (#18), 0.5 mm (#35), 0.25 mm (#60), 0.125 mm (#120), and 0.063 mm (#230).

Any particles smaller than 0.063 mm were collected in the bottom pan. Once the sample was transferred into the top sieve, a lid was placed on the top sieve in the stack and the empty drying tray was weighed and the weight was recorded. The nested sieves and substrate sample were placed onto a Humboldt™ motorized sieve shaker. The sieves were secured on the sieve shaker by hand tightening the top cross bar on the shaker. The sieve shaker was operated for ten minutes, after which the empty drying tray was placed on the Ohaus[™] lab balance and the balance was tared to a value of zero kilograms. The contents of the top sieve were transferred into an empty weighing tray on the balance and the weight was recorded in kilograms. Care was taken to remove all material for placement into the weighing trav using a variety of tools including a small wire brush, toothbrush, and a small spatula. This procedure was repeated into separate weighing trays for each subsequent sieve until a weight was recorded for all sieves and the final pan in the sieve stack. All contents of the sieves and the bottom pan were then transferred back to the original drying tray. The lid was replaced and the processed sediment sample was set aside. This process was repeated for all substrate samples. Initially, only 4 mm and smaller sieves were utilized in the stack; however, following initial shaking and weighing, a second stack consisting of an 8 and 4 mm sieve was used to differentiate a larger substrate class. Sample drying, shaking, and weighing was conducted for each individual sample point such that samples were not combined within or among pools during shaking and weighing.

During all shaking and weighing, substrate samples were visually assessed to note the presence of fine sediments that were clumped and had not broken down during the initial sieving process. If clumps were observed, the sample was further processed using a mortar and pestle to break up the small clumps, with the shaking and weighing process repeated.

Substrate classes and particle size ranges were assigned to sieve diameters as follows, based on Wentworth (1922): medium gravel or larger (≥ 8 mm), fine gravel (≥ 4 mm to <8 mm), very fine gravel (≥ 2 mm to <4 mm), very coarse sand (≥ 1 mm to <2 mm), coarse sand (≥ 0.5 mm to

<1 mm), medium sand (\geq 0.25 mm to <0.5 mm), fine sand (\geq 0.125 mm to <0.25 mm), very fine sand (\geq 0.063 mm to <0.125 mm), and silt/clay (<0.063 mm).

Substrate results were reported for each observation point and were also pooled per site. In both cases, the percentage composition of each substrate class calculated as % class by weight (kg). The total percentage of sand and fine gravel (particles ≥ 0.063 mm and < 8mm) was also reported given the importance of this particle size range for Eastern Sand Darter (Dextrase et al. 2014).

RESULTS

HABITAT SAMPLING

Aquatic habitat features were assessed at six historical sites and six targeted sites along Big Otter Creek in 2020 (Table 2). General water chemistry parameters were measured with YSI sonde at one point at the upstream end of the sampling site. The water temperature as measured with YSI at historical sampling sites ranged from 10.57 - 14.83 °C with a mean of 12.64 °C (Table 2). The conductivity ranged from 440.3 – 524 µS with a mean of 476.95 µS (Table 2). The dissolved oxygen ranged from 8.92 - 12.04 mg/L with a mean of 10.65 mg/L (Table 2). The pH ranged from 8.22 to 8.49 with a mean of 8.38 (Table 2). The turbidity ranged from 4.80 - 11.66 NTU with a mean of 8.79 NTU (Table 2). The stream width ranged from 12 -18.5 m with a mean of 14.15 m (Table 2). Site width ranged from 2.5 – 15 m with a mean of 7.82 m (Table 2). Site length ranged from 6 – 21 m with a mean of 12.33 m (Table 2). At targeted sampling sites, the water temperature ranged from 11.69 – 16.02 °C with a mean of 13.04 °C (Table 2). The conductivity ranged from $454.5 - 688.0 \ \mu$ S with a mean of $513.2 \ \mu$ S (Table 2). The dissolved oxygen ranged from 8.97 – 12.20 mg/L with a mean of 10.46 mg/L (Table 2). The pH ranged from 7.88 to 8.46 with a mean of 8.3 (Table 2). The turbidity ranged from 7.03 -11.74 NTU with a mean of 8.95 NTU (Table 2). The stream width ranged from 10.5 – 20 m with a mean of 14.75 m (Table 2). The site width ranged from 3 – 8 m with a mean of 4.67 m (Table 2). The site length ranged from 8 – 12 m with a mean of 10.37 m (Table 2).

The FireStingGO2[™] probe and OTT MF Pro velocity metre were used to assess ten observation points within the six historical sampling sites and six targeted sampling sites along Big Otter Creek in 2020 (Table 3). At historical sampling sites, the mean depth across observation points ranged from 0.31 - 0.63 m with an overall mean depth of 0.43 m (Table 3, Appendix I). The mean water velocity ranged from 0.10 - 0.29 m/s with an overall mean of 0.21 m/s (Table 3, Appendix I). The mean dissolved oxygen at 5 cm above the substrate (+5 cm) ranged from 8.75 – 11.40 mg/L with an overall mean of 10.12 mg/L (Table 3, Appendix I). The mean water temperature at 5 cm above the substrate (+5 cm) ranged from 10.22 – 14.84 °C with an overall mean of 12.25 °C mg/L (Table 3, Appendix I). The mean dissolved oxygen at the substrate surface (0 cm) ranged from 8.76 - 11.46 mg/L with an overall mean of 9.94 mg/L (Table 3, Appendix I). The mean water temperature at the substrate surface (0 cm) ranged from 10.24 - 14.83°C with an overall mean of 12.26°C (Table 3, Appendix I). The mean dissolved oxygen at 1 cm below the substrate surface (-1 cm) ranged from 0.02 - 6.02 mg/L with an overall mean of 2.5 mg/L (Table 3, Appendix I). The mean water temperature at 1 cm below the substrate surface (-1 cm) ranged from 10.51 – 14.93 °C with an overall mean of 12.36 °C (Table 3, Appendix I). At targeted sampling sites, the mean depth across observation points ranged from 0.24 – 0.59 m with an overall mean of 0.36 m (Table 3, Appendix I). The mean water velocity ranged from 0.14 - 0.25 m/s with an overall mean of 0.20 m/s (Table 3, Appendix I). The mean dissolved oxygen at 5 cm above the substrate (+5 cm) ranged from 9.09 – 11.88

mg/L with an overall mean of 10.24 mg/L (Table 3, Appendix I). The mean water temperature at 5 cm above the substrate (+5 cm) ranged from 11.11 - 15.23 °C with an overall mean of 12.71 °C (Table 3, Appendix I). The mean dissolved oxygen at the substrate surface (0 cm) ranged from 9.08 - 11.92 mg/L with an overall mean of 10.26 mg/L (Table 3, Appendix I). The mean water temperature at the substrate surface (0 cm) ranged from 11.12 - 15.12 °C with an overall mean of 12.69 °C (Table 3, Appendix 1). The mean dissolved oxygen 1 cm below the substrate surface (-1 cm) ranged from 0.01 - 2.74 mg/L with an overall mean of 0.61 mg/L (Table 3, Appendix I). The mean water temperature 1 cm below the substrate surface (-1 cm) ranged from 11.19 - 15.10 °C with an overall mean of 12.73 °C (Table 3, Appendix I). The FireStingGO2 probe malfunctioned at targeted site 11 with readings only recorded at six of ten observation points (Table 3, Appendix I). The FireStingGO2 probe was not used at targeted site 12 as the unit was out of service and thus no measurements were recorded (Table 3, Appendix I).

SUBSTRATE COMPOSITION

Substrate samples were processed for all historical and targeted sampling sites. The dominant substrate class at all six historical sites was medium sand, ranging from a mean of 26.0% to 61.2% percent composition at each site (Table 4, Figure 6, Appendix 1). Medium gravel or larger was the second-most common substrate class at the two upstream-most historical sites, 8 and 1, representing 25.3% and 21.5% by weight, respectively. Fine sand was the second-most dominant substrate class at all other historical sampling sites. At four of the targeted sampling sites, sites 4, 7, 9 and 11, the dominant substrate class was medium sand with each having 52%, 51.1%, 57%, and 43% by weight, respectively (Table 4, Figure 7, Appendix 2). Fine sand was the dominant class at the remaining two targeted sites, sites 5 and 12, with 56.9% and 44.2%, respectively (Table 4, Figure 7, Appendix 2).

At historical sites, the percentage composition of sand and fine gravel ranged from 73.8 to 98.8% by weight, with an overall mean of 89.8%. At targeted sites, the percent composition of sand and fine gravel ranged from 91.5 to 98% by weight, with an overall mean of 95.3% (Table 4).

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Table 1. Location of historical and targeted aquatic habitat sampling sites in Big Otter Creek, Ontario. The latitude and longitude coordinates represent approximately the upstream extent of each sampling site.

Site ID	Field number	Sampling date	Category	Upstream latitude	Upstream Iongitude
1	2020-ESDCH-BOC-210920-001A	21-Sep-20	Historical	42.84863	-80.73232
2	2020-ESDCH-BOC-210920-002A	21-Sep-20	Historical	42.75568	-80.84694
3	2020-ESDCH-BOC-220920-001A	22-Sep-20	Historical	42.71319	-80.83600
6	2020-ESDCH-BOC-230920-001A	23-Sep-20	Historical	42.71040	-80.84048
8	2020-ESDCH-BOC-240920-001A	24-Sep-20	Historical	42.85040	-80.73547
10	2020-ESDCH-BOC-300920-001A	30-Sep-20	Historical	42.75246	-80.84193
4	2020-ESDCH-BOC-220920-002A	22-Sep-20	Targeted	42.73268	-80.85098
5	2020-ESDCH-BOC-220920-003A	22-Sep-20	Targeted	42.79256	-80.78461
7	2020-ESDCH-BOC-230920-002A	23-Sep-20	Targeted	42.70647	-80.83675
9	2020-ESDCH-BOC-240920-002A	24-Sep-20	Targeted	42.85456	-80.72408
11	2020-ESDCH-BOC-011020-001A	01-Oct-20	Targeted	42.81637	-80.76392
12	2020-ESDCH-BOC-071020-001A	07-Oct-20	Targeted	42.73815	-80.85104

Site ID	Category	Water temp. (°C)	Conductivity (µS)	Dissolved oxygen (mg/L)	рН	Turbidity (NTU)	Stream width (m)	Site width (m)	Site length (m)
1	Historical	12.67	524.0	12.04	8.40	4.80	13.0	6.0	8.0
2	Historical	12.29	484.8	11.83	8.48	5.75	12.4	12.4	11.0
3	Historical	10.57	440.3	10.91	8.49	11.35	15.0	15.0	21.0
6	Historical	11.56	448.2	10.53	8.43	11.66	12.0	6.0	16.0
8	Historical	13.90	516.0	9.67	8.28	7.91	18.5	2.5	6.0
10	Historical	14.83	448.4	8.92	8.22	11.28	14.0	5.0	12.0
	Mean	12.64	476.95	10.65	8.38	8.79	14.15	7.82	12.33
	Min	10.57	440.30	8.92	8.22	4.80	12.00	2.50	6.00
	Max	14.83	524.00	12.04	8.49	11.66	18.50	15.00	21.00
4	Targeted	11.69	481.3	11.29	8.39	8.42	14.0	3.0	10.0
5	Targeted	12.58	501.0	12.20	8.46	7.03	14.4	5.0	8.5
7	Targeted	12.39	454.5	10.86	8.45	11.74	13.0	4.0	11.7
9	Targeted	16.02	688.0	9.29	7.88	8.40	20.0	8.0	8.0
11	Targeted	13.33	484.3	8.97	8.23	10.31	10.5	3.0	12.0
12	Targeted	12.22	470.1	10.15	8.36	7.80	16.6	5.0	12.0
	Mean	13.04	513.20	10.46	8.30	8.95	14.75	4.67	10.37
	Min	11.69	454.50	8.97	7.88	7.03	10.50	3.00	8.00
	Max	16.02	688.00	12.20	8.46	11.74	20.00	8.00	12.00

Table 2. Summary of abiotic habitat attributes of historical and targeted sampling sites including water quality and site dimensions from Big Otter Creek, 2020

Table 3. Summary of depth, water velocity, dissolved oxygen (DO), and water temperature measured at each of ten observation points at each field site; values presented are average reading across all ten observation points at the same site. Dissolved oxygen and temperature were measured at three vertical positions at each observation point: 5 cm above bottom (5 cm), at the surface of the substrate (0 cm), and 1 cm into the substrate (-1 cm). Asterisk (*) indicates measurements not taken due to probe malfunction.

					5 c	m	0 c	m	-1 cr	n
Site ID	Category	No. obs. points	Depth (m)	Water velocity (m/s)	DO (mg/L)	Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)	Temp (°C)
1	Historical	10	0.63	0.10	11.38	11.91	11.46	11.92	5.07	11.98
2	Historical	10	0.54	0.29	11.40	11.68	11.41	11.68	6.02	11.64
3	Historical	10	0.45	0.26	10.26	10.22	9.07	10.24	2.77	10.51
6	Historical	10	0.31	0.22	10.02	11.17	10.02	11.16	0.94	11.28
8	Historical	10	0.31	0.15	8.94	13.70	8.91	13.70	0.17	13.81
10	Historical	10	0.36	0.27	8.75	14.84	8.76	14.83	0.02	14.93
		Mean	0.43	0.21	10.12	12.25	9.94	12.26	2.50	12.36
		Min	0.31	0.10	8.75	10.22	8.76	10.24	0.02	10.51
_		Max	0.63	0.29	11.40	14.84	11.46	14.83	6.02	14.93
4	Targeted	10	0.24	0.23	10.66	11.11	10.70	11.12	2.74	11.19
5	Targeted	10	0.59	0.14	11.88	12.20	11.92	12.21	0.01	12.12
7	Targeted	10	0.34	0.25	10.27	11.91	10.30	11.91	0.02	11.86
9	Targeted	10	0.28	0.15	9.09	15.23	9.08	15.12	0.03	15.10
11	Targeted	10	0.41	0.18	9.31	13.10	9.32	13.10	0.24	13.40
12	Targeted	10	0.28	0.25	*	*	*	*	*	*
		Mean	0.36	0.20	10.24	12.71	10.26	12.69	0.61	12.73
		Min	0.24	0.14	9.09	11.11	9.08	11.12	0.01	11.19
		Max	0.59	0.25	11.88	15.23	11.92	15.12	2.74	15.10

Table 4. Summary of substrate particle size class by % of total sample weight for both historical and targeted substrate sites in Big Otter Creek, 2020.

				Medium gravel (or larger)	Fine	Very fine gravel	Very coarse	Coarse	Medium	Fine	Very fine	Silt
·				(or larger)	graver	graver	Sanu	Sanu	Sanu	≥0.125	≥0.063	Sin
									≥0.25	mm	mm	
			Sample		≥4 mm	≥2 mm	≥1 mm	≥0.5 mm	mm	to	to	
SITE		No.	depth		to	to	to	to	to	<0.25	<0.125	<0.063
ID	Category	samples	(cm)	≥8 mm	<8 mm	<4 mm	<2 mm	<1 mm	<0.5 mm	mm	mm	mm
1	Historical	6	7.7	21.5%	7.3%	4.1%	2.8%	7.5%	26.0%	23.0%	5.6%	2.1%
2	Historical	6	10.0	3.0%	1.1%	1.4%	2.7%	10.3%	59.9%	19.0%	1.9%	0.8%
3	Historical	5	10.0	0.0%	0.1%	0.3%	0.7%	3.2%	61.2%	26.6%	5.0%	2.9%
6	Historical	5	10.0	0.2%	0.4%	0.6%	1.1%	4.8%	56.8%	30.7%	4.4%	1.1%
8	Historical	5	5.0	25.3%	6.9%	6.4%	8.3%	13.8%	27.9%	8.8%	1.7%	1.0%
10	Historical	5	8.6	2.2%	3.8%	4.1%	2.1%	2.3%	47.0%	31.9%	5.4%	1.3%
-	-	Mean	8.5	8.7%	3.2%	2.8%	2.9%	7.0%	46.5%	23.3%	4.0%	1.5%
-	-	Min	5.0	0.0%	0.1%	0.3%	0.7%	2.3%	26.0%	8.8%	1.7%	0.8%
-	-	Max	10.0	25.3%	7.3%	6.4%	8.3%	13.8%	61.2%	31.9%	5.6%	2.9%
4	Targeted	5	10.0	0.0%	0.0%	0.0%	0.0%	0.2%	52.0%	41.4%	4.2%	2.1%
5	Targeted	5	10.0	0.0%	0.0%	0.1%	0.3%	0.8%	20.3%	56.9%	14.1%	7.6%
7	Targeted	5	10.0	0.2%	0.6%	2.2%	4.8%	7.3%	51.1%	27.1%	4.9%	1.7%
9	Targeted	5	5.2	7.2%	3.3%	1.7%	1.2%	3.3%	57.0%	22.1%	2.9%	1.2%
11	Targeted	5	8.6	0.3%	0.4%	0.5%	2.5%	17.0%	43.0%	24.9%	8.2%	3.3%
12	Targeted	5	10.0	0.4%	0.3%	0.3%	1.0%	4.1%	37.9%	44.2%	7.8%	3.8%
-	-	Mean	9.0	1.4%	0.8%	0.8%	1.6%	5.5%	43.6%	36.1%	7.0%	3.3%
-	-	Min	5.2	0.0%	0.0%	0.0%	0.0%	0.2%	20.3%	22.1%	2.9%	1.2%
-	-	Max	10.0	7.2%	3.3%	2.2%	4.8%	17.0%	57.0%	56.9%	14.1%	7.6%

Sieve specifications: 8 mm (5/16" sieve), 4 mm (#5 sieve), 2 mm (#10 sieve), 1 mm (#18 sieve), 0.5 mm (#35 sieve), 0.25 mm (#60 sieve), 0.125 mm (#120 sieve), 0.063 mm (#230 sieve), Bottom Tray (< 0.063 mm)



Figure 1. Locations of historical Eastern Sand Darter (Ammocrypta pellucida) detection records (labelled with year), and 2020 historical and targeted habitat sampling sites in lower Big Otter Creek, Ontario.



Figure 2. Float placement for habitat and substrate assessment within targeted sampling Site 12 (2020-ESDCH-BOC-071020-001A), Big Otter Creek, Ontario.



Figure 3. DFO staff measuring oxygen and water temperatures with FireStingGO2™ Oxygen and Temperature Probe at targeted sampling Site 4 (2020-ESDCH-BOC-220920-002A), Big Otter Creek, Ontario.



Figure 4. FireStingGO2™ Oxygen and Temperature Probe mounted on a graduated wading staff, Big Otter Creek, Ontario.



Figure 5: Substrate samples and substrate shovel from targeted sampling Site 4 (2020-ESDCH-BOC-220920-002A), Big Otter Creek, Ontario.



Figure 6. Substrate composition as percentage of total weight of sample of historical sampling sites in Big Otter Creek, Ontario. Sites are in order from upstream (left) to downstream (right).



Figure 7. Substrate composition as percentage of total weight of sample of targeted sampling sites in Big Otter Creek, Ontario. Sites are in order from upstream (left) to downstream (right).

Appendix 1. Habitat data collected at each observation point. Dissolved oxygen (DO) and water temperature were measured using FireStingGO2 optical DO/temp probe at three vertical positions at each observation point: 5 cm above substrate (+5 cm), at the substrate surface (0 cm), and 1 cm submerged beneath the substrate (-1 cm). Asterisk (*) represents missing values where probe malfunctions occurred.

Site ID	Field number	Obs. point	Depth (m)	Water velocity (m/s)	DO (mg/L) +5 cm	Temp (°C) +5 cm	DO (mg/L) 0 cm	Temp (°C) 0 cm	DO (mg/L) -1 cm	Temp (°C) -1 cm	Sediment sample
1	2020-ESDCH-BOC-210920-001A	1	0.69	0.129	11.380	11.7	11.380	11.7	8.503	11.6	N
1	2020-ESDCH-BOC-210920-001A	2	0.83	0.130	11.230	11.7	11.240	11.7	8.555	11.7	Ν
1	2020-ESDCH-BOC-210920-001A	3	0.50	0.144	11.270	11.8	11.380	11.8	8.998	11.9	Ν
1	2020-ESDCH-BOC-210920-001A	4	0.25	0.095	11.310	11.9	11.390	11.9	0.542	11.9	Ν
1	2020-ESDCH-BOC-210920-001A	5	0.88	0.120	11.320	11.8	11.420	11.8	11.200	11.9	Y
1	2020-ESDCH-BOC-210920-001A	6	0.54	0.103	11.430	11.9	11.420	12.0	0.009	12.1	Y
1	2020-ESDCH-BOC-210920-001A	7	0.74	0.112	11.400	12.0	11.500	12.0	2.224	12.0	Y
1	2020-ESDCH-BOC-210920-001A	8	0.64	0.071	11.450	12.0	11.520	12.0	1.489	12.1	Y
1	2020-ESDCH-BOC-210920-001A	9	0.31	0.025	11.440	12.2	11.750	12.2	0.712	12.5	Y
1	2020-ESDCH-BOC-210920-001A	10	0.91	0.064	11.540	12.1	11.630	12.1	8.446	12.1	Y
2	2020-ESDCH-BOC-210920-002A	1	0.43	0.313	11.380	11.5	11.380	11.5	6.995	11.6	Y
2	2020-ESDCH-BOC-210920-002A	2	0.47	0.340	11.370	11.6	11.370	11.6	10.910	11.6	Ν
2	2020-ESDCH-BOC-210920-002A	3	0.57	0.328	11.380	11.6	11.370	11.6	10.850	11.6	Y
2	2020-ESDCH-BOC-210920-002A	4	0.59	0.342	11.380	11.6	11.390	11.6	10.420	11.6	Y
2	2020-ESDCH-BOC-210920-002A	5	0.30	0.191	11.400	11.6	11.400	11.6	0.144	11.6	Y
2	2020-ESDCH-BOC-210920-002A	6	0.58	0.315	11.400	11.7	11.420	11.7	3.020	11.6	Ν
2	2020-ESDCH-BOC-210920-002A	7	0.64	0.303	11.420	11.7	11.430	11.7	8.028	11.7	Y
2	2020-ESDCH-BOC-210920-002A	8	0.69	0.326	11.450	11.8	11.460	11.8	8.779	11.7	N
2	2020-ESDCH-BOC-210920-002A	9	0.39	0.233	11.430	11.8	11.430	11.8	0.991	11.7	Y
2	2020-ESDCH-BOC-210920-002A	10	0.71	0.255	11.420	11.9	11.440	11.9	0.089	11.7	N
3	2020-ESDCH-BOC-220920-001A	1	0.40	0.264	10.180	10.2	0.250	10.3	3.064	10.4	Y
3	2020-ESDCH-BOC-220920-001A	2	0.64	0.347	10.180	10.2	10.110	10.2	9.952	10.3	N
3	2020-ESDCH-BOC-220920-001A	3	0.46	0.426	10.180	10.2	10.180	10.2	4.673	10.4	Ν
3	2020-ESDCH-BOC-220920-001A	4	0.39	0.220	10.240	10.2	9.312	10.3	0.001	10.6	Ν
3	2020-ESDCH-BOC-220920-001A	5	0.62	0.359	10.200	10.2	9.147	10.2	9.618	10.4	Ν
3	2020-ESDCH-BOC-220920-001A	6	0.43	0.398	10.230	10.2	10.190	10.2	0.408	10.5	Y
3	2020-ESDCH-BOC-220920-001A	7	0.35	0.113	10.320	10.2	10.330	10.2	0.000	10.8	Y
3	2020-ESDCH-BOC-220920-001A	8	0.44	0.257	10.260	10.2	10.270	10.2	0.020	10.5	Y
3	2020-ESDCH-BOC-220920-001A	9	0.38	0.143	10.340	10.3	10.520	10.3	0.000	10.6	Y
3	2020-ESDCH-BOC-220920-001A	10	0.35	0.041	10.430	10.3	10.420	10.3	0.000	10.6	N

Site ID	Field number	Obs. point	Depth (m)	Water velocity (m/s)	DO (mg/L) +5 cm	Temp (°C) +5 cm	DO (mg/L) 0 cm	Temp (°C) 0 cm	DO (mg/L) -1 cm	Temp (°C) -1 cm	Sediment sample
4	2020-ESDCH-BOC-220920-002A	1	0.18	0.223	10.560	11.0	10.600	11.0	0.647	11.1	Y
4	2020-ESDCH-BOC-220920-002A	2	0.37	0.269	10.540	11.0	10.270	11.0	0.310	11.1	Ν
4	2020-ESDCH-BOC-220920-002A	3	0.26	0.283	10.560	11.0	10.760	11.0	0.163	11.1	Y
4	2020-ESDCH-BOC-220920-002A	4	0.18	0.201	10.630	11.0	10.700	11.1	12.800	11.1	Ν
4	2020-ESDCH-BOC-220920-002A	5	0.28	0.267	10.650	11.0	10.660	11.0	12.730	11.1	Y
4	2020-ESDCH-BOC-220920-002A	6	0.28	0.200	10.650	11.1	10.710	11.1	0.002	11.2	Ν
4	2020-ESDCH-BOC-220920-002A	7	0.14	0.116	10.790	11.2	10.820	11.2	0.016	11.2	Y
4	2020-ESDCH-BOC-220920-002A	8	0.29	0.180	10.690	11.2	10.720	11.2	0.656	11.2	Ν
4	2020-ESDCH-BOC-220920-002A	9	0.19	0.273	10.760	11.3	10.990	11.3	0.004	11.4	Y
4	2020-ESDCH-BOC-220920-002A	10	0.26	0.301	10.740	11.3	10.770	11.3	0.058	11.4	Ν
5	2020-ESDCH-BOC-220920-003A	1	0.27	0.218	11.880	12.1	11.900	12.1	0.008	12.1	Y
5	2020-ESDCH-BOC-220920-003A	2	0.68	0.225	11.880	12.1	11.670	12.1	0.018	12.0	Ν
5	2020-ESDCH-BOC-220920-003A	3	0.21	0.176	11.810	12.1	11.870	12.1	0.034	12.1	Ν
5	2020-ESDCH-BOC-220920-003A	4	0.52	0.158	11.880	12.2	11.950	12.2	0.000	12.1	Y
5	2020-ESDCH-BOC-220920-003A	5	0.76	0.203	11.870	12.2	12.270	12.2	0.004	12.1	Ν
5	2020-ESDCH-BOC-220920-003A	6	0.66	0.116	11.910	12.2	12.050	12.2	0.009	12.1	Ν
5	2020-ESDCH-BOC-220920-003A	7	0.46	0.136	11.900	12.2	11.940	12.3	0.000	12.2	Y
5	2020-ESDCH-BOC-220920-003A	8	0.78	0.092	11.920	12.3	12.020	12.3	0.020	12.1	Ν
5	2020-ESDCH-BOC-220920-003A	9	0.68	0.060	11.830	12.3	11.850	12.3	0.002	12.2	Y
5	2020-ESDCH-BOC-220920-003A	10	0.91	-0.009	11.900	12.3	11.640	12.3	0.005	12.2	Y
6	2020-ESDCH-BOC-230920-001A	1	0.13	0.142	10.010	11.1	9.998	11.1	0.001	11.3	Ν
6	2020-ESDCH-BOC-230920-001A	2	0.32	0.238	10.000	11.1	9.993	11.1	0.017	11.2	Y
6	2020-ESDCH-BOC-230920-001A	3	0.57	0.300	10.000	11.1	9.999	11.1	1.922	11.4	Ν
6	2020-ESDCH-BOC-230920-001A	4	0.29	0.168	10.010	11.1	10.020	11.1	0.000	11.2	Y
6	2020-ESDCH-BOC-230920-001A	5	0.20	0.056	10.030	11.2	10.040	11.2	2.138	11.3	Y
6	2020-ESDCH-BOC-230920-001A	6	0.43	0.299	10.030	11.2	10.010	11.2	3.267	11.2	Y
6	2020-ESDCH-BOC-230920-001A	7	0.25	0.218	10.030	11.2	10.040	11.2	0.003	11.2	Ν
6	2020-ESDCH-BOC-230920-001A	8	0.42	0.346	10.020	11.2	10.040	11.2	1.312	11.3	Y
6	2020-ESDCH-BOC-230920-001A	9	0.26	0.219	10.050	11.2	10.050	11.2	0.222	11.3	Ν
6	2020-ESDCH-BOC-230920-001A	10	0.26	0.212	10.050	11.3	10.050	11.2	0.485	11.4	N
7	2020-ESDCH-BOC-230920-002A	1	0.34	0.193	10.220	11.6	10.240	11.6	0.003	11.7	Ν
7	2020-ESDCH-BOC-230920-002A	2	0.59	0.320	10.210	11.6	10.220	11.6	0.002	11.7	Y
7	2020-ESDCH-BOC-230920-002A	3	0.15	0.116	10.310	11.8	10.340	11.8	0.028	11.9	Y
7	2020-ESDCH-BOC-230920-002A	4	0.26	0.219	10.230	11.8	10.240	11.8	0.005	11.8	Ν
7	2020-ESDCH-BOC-230920-002A	5	0.22	0.258	10.230	11.9	10.250	11.9	0.014	11.8	Ν

Site ID	Field number	Obs. point	Depth (m)	Water velocity (m/s)	DO (mg/L) +5 cm	Temp (°C) +5 cm	DO (mg/L) 0 cm	Temp (°C) 0 cm	DO (mg/L) -1 cm	Temp (°C) -1 cm	Sediment sample
7	2020-ESDCH-BOC-230920-002A	6	0.47	0.312	10.230	11.9	10.220	11.9	0.066	11.8	N
7	2020-ESDCH-BOC-230920-002A	7	0.41	0.312	10.260	12.0	10.270	12.0	0.030	11.9	Y
7	2020-ESDCH-BOC-230920-002A	8	0.30	0.244	10.340	12.1	10.360	12.1	0.004	12.0	Y
7	2020-ESDCH-BOC-230920-002A	9	0.45	0.297	10.330	12.1	10.460	12.1	0.006	12.0	Ν
7	2020-ESDCH-BOC-230920-002A	10	0.19	0.205	10.340	12.3	10.360	12.3	0.005	12.0	Y
8	2020-ESDCH-BOC-240920-001A	1	0.15	0.173	8.890	13.7	8.880	13.7	0.093	13.8	N
8	2020-ESDCH-BOC-240920-001A	2	0.35	0.185	8.934	13.7	8.946	13.7	0.128	13.8	Ν
8	2020-ESDCH-BOC-240920-001A	3	0.49	0.174	8.968	13.7	8.985	13.7	0.050	13.8	Ν
8	2020-ESDCH-BOC-240920-001A	4	0.24	0.131	8.914	13.7	8.903	13.7	1.043	13.7	Ν
8	2020-ESDCH-BOC-240920-001A	5	0.38	0.151	8.929	13.7	8.929	13.7	0.011	13.9	Y
8	2020-ESDCH-BOC-240920-001A	6	0.12	0.120	8.904	13.7	8.919	13.7	0.279	13.8	Y
8	2020-ESDCH-BOC-240920-001A	7	0.31	0.136	8.937	13.7	8.961	13.7	0.005	13.8	Y
8	2020-ESDCH-BOC-240920-001A	8	0.50	0.156	9.018	13.7	8.623	13.7	0.004	13.8	Y
8	2020-ESDCH-BOC-240920-001A	9	0.42	0.122	8.971	13.7	8.943	13.7	0.018	13.9	Ν
8	2020-ESDCH-BOC-240920-001A	10	0.18	0.129	8.948	13.7	8.968	13.7	0.050	13.8	Y
9	2020-ESDCH-BOC-240920-002A	1	0.26	0.243	9.048	15.1	8.898	15.3	0.114	15.1	N
9	2020-ESDCH-BOC-240920-002A	2	0.25	0.219	9.032	15.1	9.041	15.1	0.022	14.9	Y
9	2020-ESDCH-BOC-240920-002A	3	0.20	0.171	9.224	14.7	9.312	14.8	0.018	14.6	Y
9	2020-ESDCH-BOC-240920-002A	4	0.22	0.151	8.661	15.8	8.753	14.7	0.003	15.6	Y
9	2020-ESDCH-BOC-240920-002A	5	0.24	0.137	8.994	15.3	9.027	15.3	0.008	15.3	Ν
9	2020-ESDCH-BOC-240920-002A	6	0.26	0.140	9.163	15.1	9.024	15.1	0.007	15.0	Ν
9	2020-ESDCH-BOC-240920-002A	7	0.32	0.126	9.204	15.0	9.246	15.0	0.088	15.0	Ν
9	2020-ESDCH-BOC-240920-002A	8	0.29	0.096	9.053	15.5	9.001	15.5	0.001	15.3	Y
9	2020-ESDCH-BOC-240920-002A	9	0.35	0.097	9.123	15.4	9.010	15.5	0.003	15.3	Y
9	2020-ESDCH-BOC-240920-002A	10	0.37	0.099	9.388	15.3	9.506	14.9	0.003	14.9	Ν
10	2020-ESDCH-BOC-300920-001A	1	0.35	0.179	8.537	15.0	8.591	14.9	0.005	15.0	Ν
10	2020-ESDCH-BOC-300920-001A	2	0.43	0.263	8.560	14.9	8.561	14.9	0.005	14.9	Ν
10	2020-ESDCH-BOC-300920-001A	3	0.27	0.264	8.603	14.9	8.604	14.9	0.040	15.1	Y
10	2020-ESDCH-BOC-300920-001A	4	0.34	0.277	8.625	14.9	8.633	14.9	0.033	15.0	Y
10	2020-ESDCH-BOC-300920-001A	5	0.33	0.288	8.730	14.9	8.760	14.9	0.009	14.8	Ν
10	2020-ESDCH-BOC-300920-001A	6	0.44	0.388	8.788	14.7	8.816	14.7	0.023	14.8	Y
10	2020-ESDCH-BOC-300920-001A	7	0.23	0.181	8.860	14.7	8.879	14.7	0.010	14.9	Y
10	2020-ESDCH-BOC-300920-001A	8	0.40	0.328	8.874	14.8	8.898	14.8	0.065	15.0	Ν
10	2020-ESDCH-BOC-300920-001A	9	0.36	0.265	8.925	14.8	8.924	14.8	0.003	14.9	Y
10	2020-ESDCH-BOC-300920-001A	10	0.41	0.260	8.952	14.8	8.954	14.8	0.007	14.9	N

Site ID	Field number	Obs. point	Depth (m)	Water velocity (m/s)	DO (mg/L) +5 cm	Temp (°C) +5 cm	DO (mg/L) 0 cm	Temp (°C) 0 cm	DO (mg/L) -1 cm	Temp (°C) -1 cm	Sediment sample
11	2020-ESDCH-BOC-011020-001A	1	0.35	0.176	8.917	13.1	8.904	13.1	0.033	13.5	Y
11	2020-ESDCH-BOC-011020-001A	2	0.55	0.195	8.863	13.1	8.960	13.1	0.182	13.4	Ν
11	2020-ESDCH-BOC-011020-001A	3	0.28	0.231	9.360	13.1	9.361	13.1	0.148	13.5	Y
11	2020-ESDCH-BOC-011020-001A	4	0.50	0.236	9.012	13.1	9.034	13.1	0.132	13.2	Y
11	2020-ESDCH-BOC-011020-001A	5	0.29	0.154	9.232	13.1	9.197	13.1	0.242	13.4	Y
11	2020-ESDCH-BOC-011020-001A	6	0.48	0.107	9.989	13.1	9.869	13.1	0.710	13.4	Y
11	2020-ESDCH-BOC-011020-001A	7	*	*	9.789	13.1	9.902	13.1	*	*	Ν
11	2020-ESDCH-BOC-011020-001A	8	*	*	*	*	*	*	*	*	Ν
11	2020-ESDCH-BOC-011020-001A	9	*	*	*	*	*	*	*	*	Ν
11	2020-ESDCH-BOC-011020-001A	10	*	*	*	*	*	*	*	*	Ν
12	2020-ESDCH-BOC-071020-001A	1	0.21	0.267	*	*	*	*	*	*	Y
12	2020-ESDCH-BOC-071020-001A	2	0.35	0.256	*	*	*	*	*	*	Ν
12	2020-ESDCH-BOC-071020-001A	3	0.46	0.315	*	*	*	*	*	*	Y
12	2020-ESDCH-BOC-071020-001A	4	0.20	0.249	*	*	*	*	*	*	Y
12	2020-ESDCH-BOC-071020-001A	5	0.18	0.176	*	*	*	*	*	*	Ν
12	2020-ESDCH-BOC-071020-001A	6	0.26	0.290	*	*	*	*	*	*	Ν
12	2020-ESDCH-BOC-071020-001A	7	0.41	0.301	*	*	*	*	*	*	Ν
12	2020-ESDCH-BOC-071020-001A	8	0.20	0.097	*	*	*	*	*	*	Y
12	2020-ESDCH-BOC-071020-001A	9	0.24	0.309	*	*	*	*	*	*	Y
12	2020-ESDCH-BOC-071020-001A	10	0.28	0.252	*	*	*	*	*	*	Ν

Appendix 2. Weight (kg) of substrate components by particle size in each sample. Sample depth indicates the depth of the substrate shovel into the substrate to collect a sample. Substrate samples were randomly collected at five of ten observation points at each site. Six substrate points were sampled at sites 1 and 2 as part of sampling gear trials. Substrate classes and particle size ranges assigned to sieve diameters were as follows: medium gravel or larger (≥ 8 mm), fine gravel (≥ 4 mm to <8 mm), very fine gravel (≥ 2 mm to <4 mm), very coarse sand (≥ 1 mm to <2 mm), coarse sand (≥ 0.5 mm to <1 mm), medium sand (≥ 0.25 mm to <0.5 mm), fine sand (≥ 0.125 mm to <0.25 mm), very fine sand (≥ 0.063 mm to <0.125 mm), and silt (<0.063 mm). Substrate classes adapted from Wentworth (1922).

				Medium									
			Sample	gravel		Very	Very				Very		Total
Site	Obs.	Sample	depth	(or	Fine	fine	coarse	Coarse	Medium	Fine	fine		weight
ID	point	ID	(cm)	larger)	gravel	gravel	sand	sand	sand	sand	sand	Silt	(kg)
1	5	63568	5	0.0435	0.0075	0.0030	0.0020	0.0095	0.0310	0.0320	0.0090	0.0055	0.1430
1	6	63569	6	0.2390	0.0420	0.0325	0.0205	0.0310	0.1170	0.1115	0.0315	0.0085	0.6335
1	7	63546	10	0.0775	0.0785	0.0425	0.0250	0.0800	0.1890	0.1890	0.0425	0.0155	0.7395
1	8	63567	10	0.2180	0.1220	0.0720	0.0545	0.0830	0.2245	0.2150	0.0505	0.0205	1.0600
1	9	63566	10	0.4355	0.1440	0.0690	0.0540	0.1190	0.4505	0.1350	0.0320	0.0160	1.4550
1	10	63565	5	0.0000	0.0000	0.0000	0.0000	0.0045	0.0255	0.0285	0.0065	0.0015	0.0665
2	1	63545	10	0.2165	0.0730	0.0630	0.0360	0.0585	0.4500	0.2825	0.0370	0.0170	1.2335
2	3	63547	10	0.0000	0.0000	0.0070	0.0540	0.3175	0.9120	0.1205	0.0080	0.0030	1.4220
2	4	63548	10	0.0000	0.0020	0.0145	0.0720	0.2680	0.8270	0.3960	0.0305	0.0115	1.6215
2	5	63549	10	0.0000	0.0000	0.0000	0.0000	0.0075	1.0975	0.2635	0.0290	0.0205	1.4180
2	7	63550	10	0.0015	0.0035	0.0165	0.0300	0.1210	0.8350	0.2335	0.0175	0.0020	1.2605
2	9	63564	10	0.0010	0.0010	0.0100	0.0390	0.1215	0.9705	0.3225	0.0355	0.0110	1.5120
3	1	63559	10	0.0010	0.0040	0.0045	0.0035	0.0105	0.6675	0.3775	0.0325	0.0015	1.1025
3	6	63560	10	0.0000	0.0001	0.0020	0.0131	0.0731	0.9220	0.3045	0.0215	0.0015	1.3378
3	7	63561	10	0.0010	0.0000	0.0005	0.0015	0.0095	0.4545	0.3785	0.0645	0.0735	0.9835
3	8	63562	10	0.0005	0.0015	0.0055	0.0085	0.0365	1.4870	0.3870	0.0515	0.0125	1.9905
3	9	63563	10	0.0000	0.0010	0.0055	0.0225	0.0840	0.7090	0.2285	0.1420	0.0775	1.2700
4	1	63551	10	0.0000	0.0000	0.0000	0.0000	0.0010	0.2730	1.1505	0.0925	0.0320	1.5490
4	3	63552	10	0.0000	0.0000	0.0000	0.0000	0.0020	1.2055	0.5910	0.0640	0.0055	1.8680
4	5	63553	10	0.0000	0.0005	0.0005	0.0010	0.0055	1.3170	0.5220	0.0550	0.0060	1.9075
4	7	63554	10	0.0000	0.0005	0.0000	0.0005	0.0085	1.1235	1.2360	0.0535	0.0470	2.4695
4	9	63555	10	0.0000	0.0000	0.0005	0.0005	0.0060	1.1810	0.4435	0.1185	0.1115	1.8615
5	1	63556	10	0.0000	0.0000	0.0025	0.0135	0.0265	0.4510	0.6585	0.1240	0.0635	1.3395
5	4	63557	10	0.0000	0.0000	0.0000	0.0000	0.0025	0.1240	0.3585	0.1050	0.0495	0.6395
5	7	63558	10	0.0000	0.0000	0.0010	0.0015	0.0050	0.2225	0.6745	0.1610	0.0925	1.1580
5	9	63521	10	0.0000	0.0005	0.0005	0.0010	0.0060	0.1260	0.5155	0.1070	0.0700	0.8265
5	10	63520	10	0.0000	0.0005	0.0000	0.0005	0.0045	0.1160	0.4805	0.1465	0.0735	0.8220
6	2	63526	10	0.0000	0.0000	0.0000	0.0000	0.0200	0.9465	0.8210	0.1180	0.0365	1.9420
6	4	63522	10	0.0000	0.0000	0.0005	0.0110	0.1310	1.5650	0.3085	0.0740	0.0255	2.1155
6	5	63523	10	0.0000	0.0000	0.0000	0.0010	0.0500	1.0685	0.3330	0.0670	0.0225	1.5420
6	6	63524	10	0.0010	0.0060	0.0070	0.0215	0.0960	0.8600	0.6815	0.0750	0.0090	1.7570
6	8	63525	10	0.0090	0.0170	0.0270	0.0405	0.0940	0.4940	0.4195	0.0435	0.0055	1.1500

				Medium									
			Sample	gravel		Very	Very				Very		Total
Site	Obs.	Sample	depth	(or	Fine	fine	coarse	Coarse	Medium	Fine	fine		weight
ID	point	ID	(cm)	larger)	gravel	gravel	sand	sand	sand	sand	sand	Silt	(kg)
7	2	63527	10	0.0040	0.0220	0.0775	0.1330	0.1435	1.0335	0.3800	0.0440	0.0155	1.8530
7	3	63528	10	0.0140	0.0295	0.1120	0.2385	0.3605	0.4530	0.6975	0.1370	0.0520	2.0940
7	7	63529	10	0.0020	0.0055	0.0240	0.0720	0.1380	0.9095	0.3745	0.0550	0.0070	1.5875
7	8	63530	10	0.0005	0.0005	0.0005	0.0010	0.0055	0.9340	0.5125	0.1295	0.0495	1.6335
7	10	63531	10	0.0005	0.0005	0.0010	0.0195	0.0470	1.1790	0.4980	0.0770	0.0325	1.8550
8	5	63536	5	0.0035	0.0085	0.0085	0.0120	0.0400	0.1395	0.0355	0.0080	0.0050	0.2605
8	6	63533	5	0.1885	0.0350	0.0305	0.0440	0.0390	0.0530	0.0175	0.0035	0.0020	0.4130
8	7	63534	5	0.2265	0.0355	0.0345	0.0320	0.0375	0.1015	0.0365	0.0065	0.0035	0.5140
8	8	63535	5	0.0050	0.0100	0.0215	0.0440	0.0735	0.0880	0.0320	0.0040	0.0020	0.2800
8	10	63532	5	0.0775	0.0280	0.0160	0.0100	0.0240	0.0500	0.0170	0.0045	0.0030	0.2300
9	2	63537	3	0.0040	0.0055	0.0025	0.0025	0.0050	0.0465	0.0155	0.0030	0.0025	0.0870
9	3	63538	3	0.0580	0.0120	0.0075	0.0035	0.0105	0.0865	0.0175	0.0020	0.0015	0.1990
9	4	63539	10	0.0005	0.0015	0.0010	0.0005	0.0025	0.9205	0.2715	0.0435	0.0100	1.2515
9	8	63540	5	0.0010	0.0025	0.0005	0.0005	0.0025	0.0670	0.0560	0.0065	0.0015	0.1380
9	9	63541	5	0.0050	0.0070	0.0040	0.0030	0.0105	0.1905	0.0630	0.0050	0.0010	0.2890
10	3	63513	3	0.0020	0.0025	0.0075	0.0070	0.0050	0.0750	0.1125	0.0175	0.0025	0.2315
10	4	63514	10	0.0995	0.1545	0.1170	0.0395	0.0365	0.8465	0.3290	0.0300	0.0085	1.6610
10	6	63542	10	0.0140	0.0195	0.0285	0.0145	0.0270	0.4445	0.2530	0.0270	0.0070	0.8350
10	7	63543	10	0.0100	0.0355	0.0450	0.0225	0.0205	0.2170	0.3395	0.0910	0.0190	0.8000
10	9	63544	10	0.0210	0.0280	0.0190	0.0055	0.0225	1.1745	0.3050	0.0500	0.0250	1.6505
11	1	63515	10	0.0000	0.0015	0.0030	0.0335	0.2175	0.7790	0.2485	0.0555	0.0260	1.3645
11	3	63516	10	0.0010	0.0055	0.0000	0.0125	0.2150	0.5370	0.1595	0.0730	0.0405	1.0440
11	4	63517	3	0.0010	0.0005	0.0010	0.0015	0.0080	0.0210	0.0245	0.0065	0.0020	0.0660
11	5	63518	10	0.0000	0.0010	0.0010	0.0045	0.0395	0.1050	0.0765	0.0300	0.0110	0.2685
11	6	63519	10	0.0005	0.0015	0.0035	0.0485	0.2235	0.3700	0.2620	0.0930	0.0355	1.0380
12	1	63495	10	0.0025	0.0020	0.0045	0.0120	0.0285	0.3525	0.6790	0.0995	0.0435	1.2240
12	3	63496	10	0.0085	0.0035	0.0030	0.0055	0.0120	0.1170	0.5475	0.0535	0.0125	0.7630
12	4	63497	10	0.0010	0.0005	0.0005	0.0005	0.0290	0.7785	0.5160	0.1110	0.0640	1.5010
12	8	63499	10	0.0040	0.0060	0.0055	0.0215	0.0815	0.2695	0.2010	0.0780	0.0515	0.7185
12	9	63498	10	0.0045	0.0030	0.0020	0.0065	0.0560	0.9275	0.5200	0.0940	0.0355	1.6490