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Seasonal Variation in the Composition of Fishes Caught during Trawl-based Surveys of Little Bear Creek, Ontario

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

Little Bear Creek, a tributary of Lake St. Clair, is classified as an agricultural drain and has been identified for maintenance. The creek supports six fish species at risk including Pugnose Shiner, Lake Chubsucker, Grass Pickerel, Blackstripe Topminnow, Spotted Sucker, and Pugnose Minnow. Project staging, fish exclusion methods, and timing windows for in-water works have been proposed as mitigation to minimize drainage work impacts. To assess whether the proposed timing window would minimize the risk of direct mortality to fish species at risk, a trawl-based fish survey was completed over three different time periods (summer, fall and early winter) in 2015. A total of 3,715 individuals representing 32 species were collected from 30 trawling sites. Overall, the most abundant species were Bluegill, Brook Silverside, Ghost Shiner and Gizzard Shad. Of the six fish species at risk known from Little Bear Creek, only the endangered Pugnose Shiner was captured. Two invasive species were also detected, Round Goby and Tubenose Goby. There were large among-season differences in the abundance and composition of Little Bear Creek fishes. The greatest number and diversity of fishes were captured during fall trawling. Ninety percent of all Pugnose Shiner were collected in the fall. The largest fall to winter declines in distribution and abundance were associated with bass, crappie and sunfish species. Compared to the fall, fewer Little Bear Creek fishes are expected to be affected by maintenance activities during the winter. While the timing window is outside spawning and egg incubation periods, it is not likely to avoid the early-rearing period for Pugnose Shiner or direct impacts to young-of-the-year fish species at risk.

Variation saisonnière de la composition des prises de poissons effectuées dans le cadre des relevés au chalut du ruisseau Little Bear, en Ontario

RÉSUMÉ

Le ruisseau Little Bear, un affluent du lac Sainte-Claire, est classé comme drain agricole, et doit faire l'objet d'un entretien. Il abrite six espèces de poisson en péril, soit le méné camus, le sucet de lac, le brochet vermiculé, le fondule rayé, le meunier tacheté et le petit-bec. La préparation du projet par étape, l'utilisation de méthodes d'exclusion de poissons et la réalisation des travaux dans l'eau à des périodes particulières sont les mesures d'atténuation qui ont été proposées pour réduire au minimum les répercussions des travaux de drainage. Afin de vérifier si les périodes particulières proposées permettraient de réduire le risque de mortalité directe des espèces de poisson en péril, un relevé de poissons au chalut a été effectué en 2015, à trois moments différents (été, automne et début de l'hiver). Un total de 3 715 individus représentant 32 espèces ont été recueillis à 30 sites distincts. Dans l'ensemble, les espèces les plus abondantes étaient le crapet arlequin, le crayon d'argent, le méné fantôme et l'alose noyer. Des six espèces de poisson en péril connues dans le ruisseau Little Bear, seul le méné camus, qui est en voie de disparition, a été capturé. Deux espèces envahissantes ont également été détectées, soit le gobie à taches noires et le gobie de la mer Noire. Des différences considérables ont été remarquées, d'une saison à l'autre, en ce qui a trait à l'abondance des poissons du ruisseau Little Bear et à la composition de la population. C'est durant le relevé d'automne qu'ont été capturés le plus grand nombre et la plus grande variété de poissons. Quatre-vingt-dix pour cent (90 %) de tous les ménés camus ont été recueillis à l'automne. Ce sont les achigans, les mariganes et les crapets qui ont connu le plus grand déclin, de l'automne à l'hiver, en termes de répartition et d'abondance. Comparativement à l'automne, des activités d'entretien effectuées durant l'hiver devraient affecter moins de poissons du ruisseau Little Bear. Bien que la période particulière proposée se trouve à l'extérieur des périodes de frai et d'incubation des œufs, il est peu probable qu'elle puisse éviter les premiers stades de croissance du méné camus ou les répercussions directes sur les jeunes de l'année d'espèces de poissons en péril.

INTRODUCTION

Little Bear Creek drains into the St. Clair River via the Chenal Ecarte in the Township of Dover of the Chatham-Kent Region. This small tributary is located approximately 10 km south of the town of Wallaceburg, Ontario. Little Bear Creek is home to several species at risk fishes including Pugnose Shiner, Lake Chubsucker, Grass Pickerel, Blackstripe Topminnow, Spotted Sucker, and Pugnose Minnow (common and scientific names for Little Bear Creek fishes are provided in Table 1). Little Bear Creek, a tributary of Lake St. Clair, is classified as an agricultural drain and has been identified for drain maintenance by the Region of Chatham-Kent. There is increasing pressure to complete a drain clean out of Little Bear Creek with the goal to decrease flooding of land owned by private landowners.

The Municipality of Chatham-Kent has submitted a “Drain Maintenance Request” under the provincial *Drainage Act* to excavate and remove accumulated sediment from the Little Bear Creek drain. In-water works are proposed from the mouth at Chenal Ecarte upstream for 29.5 km to Countryview Line, where the remaining drain portions are buried. Excavation will be a combination of drag-line crane rigging, and long and standard hydraulic excavators. A number of culvert and enclosure works are also proposed in the headwater areas of the drain. Small brush and larger trees are also to be removed from the shoreline along the entire length of the drain.

There is concern that the proposed dredging activity will negatively affect numerous fish species at risk historically and/or currently known to be present in this system. Past research has identified that agriculture drain maintenance can result in direct fish mortality, short-term reductions in aquatic macroinvertebrate abundance, and simplification of instream habitat (Grygoruk et al. 2015). A number of mitigation measures have been proposed to minimize the potential impacts of the proposed drainage work on Little Bear Creek fishes at risk (DFO 2015). These measures include project staging, the application of fish exclusion methods, and timing windows for in-water work.

For timing windows to be effective, dredging should occur outside of the timing of spawning, egg incubation and early-rearing, and during periods when risk of direct mortality to fishes is lowest. A seasonal timing window for in-water work of August 1 to March 15 has been proposed for the Little Bear Creek maintenance. The window is outside the timing of spawning reported in the literature for Little Bear Creek fishes at risk (Table 2). To assess whether the proposed timing window would minimize the risk of direct mortality, a trawl-based fish survey was completed over three different time periods (summer, fall and winter). The primary objective of the study was to characterize among-season differences in the abundance and species composition of Little Bear Creek fishes, with special consideration for fish species at risk.

METHODS

FIELD SAMPLING

Fishes were sampled from 30 sites along a 10 km reach of Little Bear Creek, beginning 125 m upstream of its confluence with the Chenal Ecarte (Figure 1). The locations of sampling sites along Little Bear Creek were randomly selected. The length of each sampling site was 20 m. Mean channel widths at sites were between 31 and 33 m, and mean water depths were between 1.4 and 1.7 m (Table 3). The creek bed was largely comprised of fine sediments (organics, clay and silt). The largest habitat differences among sampling periods were associated with water temperature and vegetation cover. Compared to the summer and fall periods, winter mean water temperature was 15 to 18 °C lower. Vegetation cover varied among

sampling periods, with greatest cover present in the fall (69%) and the least amount of cover in the winter (9.5%).

Little Bear Creek fishes were sampled using two trawls that target different habitats: pelagic or surface, and benthic habitats. The two trawls were the: (1) Mamou surface trawl, and (2) Gerken Siamese benthic trawl. Forward sections of the Mamou trawl are made of 38 mm high-density, polyethylene stretched mesh, from the head rope (float line) to 2 m back into the body of the trawl. The remainder of the trawl is made of 4 mm polyester knotless mesh. The net is opened by a pair of Surface Floating Doors (0.6 m long x 0.3 m wide). The Gerken Siamese trawl has a 19 mm outer-mesh, and a 4 mm inner-mesh separator within the cod end (Guy et al. 2009; Fischer et al. 2012). A 4 m length of stainless steel wire with circular pieces of PVC pipe was attached approximately 0.2 m ahead of the foot rope/chain. This device was used to disturb the sediments and dislodge benthic fishes into the trawl. Both trawls sample approximately a 4 m wide swath of habitat.

Sampling with the Mamou trawl was done over three time periods: summer (July 7 to 15, 2015), early fall (September 15 to 23, 2015) and early winter (November 23 to 25, 2015). The Siamese trawl was only used during the fall and winter. Sampling later into the winter was not undertaken as ice formation would create unsafe and impractical conditions for trawling. Except in July, fishes at each site were sampled by a single pass of the trawl. In the summer, three trawls were completed at each site (only data from the first pass is used for analysis). It is recognized that species detection can be improved with repeated trawls at a site; however, the single-pass sampling design permitted greater replication and coverage along Little Bear Creek.

Upon arrival at the sampling site two floats were deployed to mark the upstream and downstream limits of the sampling transect. Sites were field verified for obstructions using a commercially available side imaging sonar unit. Sampling was performed in a downstream direction travelling from the transect start (upstream) to the transect end (downstream). The boat travelled upstream approximately 30 m past the transect start for trawl deployment. The vessel then idled in reverse towards the transect start deploying the trawl slowly into the water. Once at the transect start the crew would deploy the floating doors and continue in reverse deploying the floating warp lines. Once the lines were fully deployed the trawl would open and the crew would begin to accelerate in reverse. A speed of approximately 2.0 km/h was maintained traveling in reverse. Once the floating doors reached the transect stop the boat idled back upstream. The crew quickly retrieved the two floating warps while the boat moved upstream. Floating boards were pulled from the water and placed on the front deck of the boat. The body of the trawl was then pulled from the water.

All fishes captured were sorted, counted and identified to species. Minimum and maximum total body lengths of each species were measured. Digital or physical vouchers preserved in formalin (10% formaldehyde solution) were taken of all species captured. Other specimens were identified to species and released.

DATA ANALYSIS

Among season differences in number of individuals captured, and species detected were tested for using the Friedman's Test (Mamou trawl data) and the Wilcoxon Test (Siamese trawl data) (Sokal and Rohlf 2001). For the Mamou trawl data, post-hoc comparisons between seasons were done with pairwise Wilcoxon tests (and Bonferroni-corrected p-values). Non-parametric paired/repeated-measures tests were used as the same sites were sampled each season.

Differences in fish assemblage structure among seasons were tested with the multivariate test, ANOSIM (Analysis of Similarity). ANOSIM was done separately using species

presence/absence data (with the Jaccard distance measure) and species abundance data (Bray-Curtis distance measure).

For both trawls and each season, Spearman Rank correlations were calculated between site distance upstream of the mouth of Little Bear Creek and:

- 1) number of individuals captured; and
- 2) number of species detected.

Statistical analyses were completed using PAST version 1.94 (Hammer et al. 2001).

RESULTS

A total of 3,715 individuals representing 32 species were collected during trawling of benthic and pelagic habitats. During fall and winter, 749 more individuals were captured and six more species detected from benthic habitats than pelagic or surface habitats. Nine species were only collected with the Siamese trawl: Brown Bullhead, Freshwater Drum, Johnny Darter, Logperch, Round Goby, Tadpole Madtom, Tubenose Goby, White Bass, and Yellow Perch. Five species were only collected with the Mamou trawl: Blacknose Shiner, Bluntnose Minnow, Northern Pike, Spottin Shiner and White Perch.

Overall, the most abundant species were Bluegill (43% of total catch), Brook Silverside (17.5%), Ghost Shiner (10.3%) and Gizzard Shad (7.2%). Of the six fish species at risk known from Little Bear Creek, only Pugnose Shiner was captured. Two non-native species were detected: Round Goby (54 individuals from 18 sites) and Tubenose Goby (one individual from site 26; Figure 1).

PELAGIC ZONE TRAWLS

From Mamou trawls, the most abundant species were Brook Silverside (40.9% of total catch), Bluegill (34.0%) and Gizzard Shad (9.2%). The most widespread species were Brook Silverside (detected at 83% of sampling sites), Gizzard Shad (73%), Bluegill (50%), Golden Shiner (47%), and Bluntnose Minnow (37%). Over the three sampling periods, 19 Pugnose Shiner were collected from four sites (sites 26, 34, 39, and 56, Figure 1). Ninety percent of all Pugnose Shiner were collected in the fall. There were significant differences among seasons in the number of individuals collected ($X^2 = 25.5$, $p < 0.001$), and the species detected ($X^2 = 36.0$, $p < 0.001$) (Figure 2). Compared to fall, 49% fewer individuals were captured in winter pelagic trawls and 44% fewer species detected. The least number of fish were collected and species detected during the summer trawling period.

Overall, the assemblage structure of the Little Bear Creek fishes differed among seasons (ANOSIM, Bray-Curtis: $R = 0.17$, $p < 0.0001$; Jaccard: $R = 0.14$, $p < 0.0001$), and between each pair of seasons (Bonferonni corrected p-values < 0.003). Differences largely reflected seasonal variation in the occurrence of Bluegill, Bluntnose Minnow, Brook Silverside, Gizzard Shad, and Golden Shiner, and the relative abundance of Bluegill, Brook Silverside and Gizzard Shad (Table 4). In the winter, centrarchid species were much less widespread and abundant than in the fall.

In the fall, there was a significant negative correlation between distance upstream from Chenal Ecarte and the number of species trawled from a site ($r_s = -0.36$, $p = 0.049$) (Table 5). Other correlations were not statistically significant ($p > 0.75$).

BENTHIC ZONE TRAWLS

From Siamese trawls, the most abundant species were Bluegill (52.5% of total catch) and Ghost Shiner (18.4%). The most widespread species were Bluegill (detected at 90% of sampling sites), Round Goby (60%), Pumpkinseed (47%), and Gizzard Shad (43%). Over the two sampling periods, two Pugnose Shiner were collected from two sites (fall: site 26; winter: site 3; Figure 1). There were significant differences between seasons in the number of individuals collected ($W = 326$, $p = 0.02$), and the species detected ($W = 369.5$, $p < 0.0001$) (Figure 2). Compared to fall, 62% fewer individuals were captured from winter benthic trawls and 16% fewer species detected.

The structure of the Little Bear Creek fish assemblage differed between fall and winter (ANOSIM, Bray-Curtis: $R = 0.2$, $p = 0.0001$; Jaccard: $R = 0.15$, $p = 0.0002$). Differences largely reflect seasonal variation in the occurrence of Bluegill, Black Crappie, Largemouth Bass, Mimic Shiner, Pumpkinseed, White Crappie and Yellow Perch, and the abundance of Bluegill, Brook Silverside, Mimic Shiner and Round Goby in benthic trawl samples (Table 6). In the winter, centrarchid species were much less widespread and abundant.

In the fall, there was a significant, negative correlation between distance upstream from Chenal Ecarte and the number of species trawled from a site ($r_s = -0.38$, $p = 0.036$) (Table 7). Other correlations were not statistically significant ($p > 0.08$).

DISCUSSION

As reported for other small watercourses in extreme southwestern Ontario (Leslie and Timmins 1998a, 2005; Mandrak et al. 2006), a high number of fish species was detected during trawling surveys of Little Bear Creek. However, the only fish species at risk collected from Little Bear Creek by single-pass trawling was the endangered Pugnose Shiner. Despite the use of two different trawls that target different habitats, single-pass trawling may not reliably detect fish species at risk in Little Bear Creek. In the summer, two additional passes with the Mamou trawl resulted in the detection of Blackstripe Topminnow at sites 4 and 10. Additional passes also increased the number of sites where 15 other species were detected. Repeat passes with a large bag seine also improved fish species at risk detections from Little Bear Creek habitats during fish exclusion trials (DFO 2015). It is likely that fish species at risk were more widespread along the study reach than indicated by the 2015 trawling data. While the sampling approach was sufficient for demonstrating broad seasonal differences in fish abundance and diversity, a more intensive sampling effort would be required for the study of fish species at risk.

Compared to the fall, substantially fewer individuals and species were collected from Little Bear Creek during summer and early-winter sampling periods. Only a few Pugnose Shiner were collected during winter trawling of Little Bear Creek, with the majority collected in the fall. A similar pattern was observed for Blacknose Shiner. Overall, the largest fall to winter declines in distribution and abundance were associated with bass, crappie and sunfish species. Seasonal variation in the composition of fish assemblages has been related to a variety of factors such as seasonal movements of fishes to spawning or over-wintering habitats, high over-wintering mortality of young-of-the-year (YOY) fishes and seasonal change in habitat local conditions (Vadas 1992; Cunjak 1996; Peterson and Rabeni 2001; Butler and Winfield Fairchild 2005). As compared to the fall, the very low abundance and diversity of fishes captured during summer trawling was unexpected. This pattern may reflect the growth of 1+ fishes into body sizes that are more vulnerable to capture by trawl, and that the greater macrophyte cover in September may attract more fishes into areas sampled.

Based on trawling data, fewer Little Bear Creek fishes are expected to be affected by in-water drain maintenance activities during the winter. Also, the proposed August 1 to March 15 timing window for in-water works is outside the expected timing of fish species at risk spawning and egg incubation (Table 2). No YOY fish species at risk were collected during fall and winter trawling. Collections of YOY were limited to sunfishes, shiners (Emerald Shiner, Ghost Shiner, and Mimic Shiner), and Round Goby. Therefore, a direct assessment of the effectiveness of the timing window to protect early-rearing of fish SAR is not possible with data collected by this study. Past YOY fish sampling efforts in other southwestern Ontario watercourses have identified peak densities occurring in June and July (Leslie and Timmins 1998a, 1998b, 2005). However, YOY fish were often still present in September and October, including fish species at risk such as Grass Pickerel and Pugnose Minnow (Leslie and Timmins 1998a). Along the lower reach of Cedar Creek, Leslie et al. (1999) also found peak YOY densities to occur in late October-early November. Given their late and protracted spawning periods (Table 2), the timing window is not likely to avoid the early-rearing periods for Blackstripe Topminnow and Pugnose Shiner. More temporally intensive sampling in the late summer and fall is recommended to allow for a more direct assessment of the August 1 to March 31 timing window for in-water works, particularly during the early portions of that period.

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Table 1. Scientific and common names of fishes trawled from Little Bear Creek.

Scientific Name	Common Name
<i>Ambloplites rupestris</i>	Rock Bass
<i>Ameiurus natalis</i>	Yellow Bullhead
<i>Ameiurus nebulosus</i>	Brown Bullhead
<i>Amia calva</i>	Bowfin
<i>Aplodinotus grunniens</i>	Freshwater Drum
<i>Cyprinella spiloptera</i>	Spotfin Shiner
<i>Dorosoma cepedianum</i>	Gizzard Shad
<i>Esox lucius</i>	Northern Pike
<i>Etheostoma nigrum</i>	Johnny Darter
<i>Labidesthes sicculus</i>	Brook Silverside
<i>Lepomis cyanellus</i>	Green Sunfish
<i>Lepomis gibbosus</i>	Pumpkinseed
<i>Lepomis macrochirus</i>	Bluegill
<i>Micropterus salmoides</i>	Largemouth Bass
<i>Morone americana</i>	White Perch
<i>Morone chrysops</i>	White Bass
<i>Neogobius melanostomus</i>	Round Goby
<i>Notemigonus crysoleucas</i>	Golden Shiner
<i>Notropis anogenus</i>	Pugnose Shiner
<i>Notropis atherinoides</i>	Emerald Shiner
<i>Notropis buchanani</i>	Ghost Shiner
<i>Notropis heterolepis</i>	Blacknose Shiner
<i>Notropis hudsonius</i>	Spottail Shiner
<i>Notropis volucellus</i>	Mimic Shiner
<i>Noturus gyrinus</i>	Tadpole Madtom
<i>Perca flavescens</i>	Yellow Perch
<i>Percina caprodes</i>	Logperch
<i>Pimephales notatus</i>	Bluntnose Minnow
<i>Pomoxis annularis</i>	White Crappie
<i>Pomoxis nigromaculatus</i>	Black Crappie
<i>Proterorhinus semilunaris</i>	Tubenose Goby
<i>Sander vitreus</i>	Walleye

Table 2. Overview of published observations on the spawning timing of Little Bear Creek fishes-at risk.

Species	Timing	Source
Blackstripe Topminnow	May through August	Carranza and Winn (1954), Becker (1983)
Grass Pickerel	late March to early May water temperatures 8–12 °C	Crossman (1962)
Lake Chubsucker	Late April to June water temperature 20 °C	Mandrak and Crossman (1994), Leslie and Timmins (1997)
Pugnose Minnow	Late May to mid-June	Gilbert and Bailey (1972), Pflieger (1975), Holm et al. (2010)
Pugnose Shiner	Mid May to July water temperatures 21–29 °C	Becker (1983), COSEWIC (2013)
Spotted Sucker	Late April through May	Reid and Mandrak (2006)

Table 3. Comparison of Little Bear Creek habitat characteristics over the three sampling periods.

Characteristic	Summer	Fall	Winter
Water Temperature (°C)	22.5 (0.17)	20.4 (0.14)	3.7 (0.09)
Channel Width (m)	32.7 (1.17)	31.3 (0.87)	31.3 (0.87)
Water Depth (m)	1.7 (0.08)	1.5 (0.07)	1.4 (0.05)
Vegetation Cover (% coverage)	31.3 (7.72)	69.3 (7.31)	9.5 (1.71)
Substrate (% composition)			
Organic	9.1 (1.86)	6.7 (1.45)	6.7 (1.45)
Clay	51.2 (7.2)	19.0 (2.26)	19 (2.26)
Silt	21.2 (4.0)	65.5 (3.0)	65.5 (3.03)
Sand	18.1 (4.6)	6 (0.76)	6 (0.76)
Gravel	0.3 (0.34)	2.8 (1.75)	2.8 (1.75)

Table 4. Frequency of occurrence (FO, percent of all sites sampled) and relative abundance (RA, percent of total catch) of fishes collected from Little Bear Creek with the Mamou trawl.

Species	Summer		Fall		Winter	
	FO (%)	RA (%)	FO (%)	RA (%)	FO (%)	RA (%)
Black Crappie	3.3	1.2	26.7	1.3	0.0	0.0
Blacknose Shiner	0.0	0.0	3.3	0.1	0.0	0.0
Bluegill	6.7	2.4	50.0	52.1	16.7	3.2
Bluntnose Minnow	0.0	0.0	36.7	2.4	0.0	0.0
Bowfin	0.0	0.0	3.3	0.1	0.0	0.0
Brook Silverside	10.0	36.5	70.0	25.2	40.0	70.7
Cyprinid sp.	3.3	1.2	0.0	0.0	0.0	0.0
Emerald Shiner	6.7	2.4	6.7	0.3	13.3	5.5
Ghost Shiner	0.0	0.0	0.0	0.0	3.3	0.2
Gizzard Shad	6.7	4.7	40.0	4.3	50.0	19.2
Golden Shiner	13.3	15.3	40.0	5.6	3.3	0.2
Green Sunfish	0.0	0.0	3.3	0.1	3.3	0.2
Largemouth Bass	16.7	11.8	30.0	3.0	0.0	0.0
Logperch	3.3	1.2	0.0	0.0	0.0	0.0
Mimic Shiner	0.0	0.0	0.0	0.0	3.3	0.2
Northern Pike	3.3	1.2	3.3	0.1	0.0	0.0
Pugnose Shiner	3.3	1.2	10.0	1.8	3.3	0.2
Pumpkinseed	3.3	1.2	23.3	2.3	0.0	0.0
Rock Bass	3.3	2.4	6.7	0.3	0.0	0.0
Spotfin Shiner	3.3	1.2	0.0	0.0	0.0	0.0
Spottail Shiner	3.3	1.2	0.0	0.0	0.0	0.0
Sunfish sp	16.7	11.8	6.7	0.3	6.7	0.4
White Crappie	0.0	0.0	10.0	0.3	0.0	0.0
White Perch	3.3	1.2	0.0	0.0	0.0	0.0
Yellow Bullhead	0.0	0.0	6.7	0.2	0.0	0.0

Table 5. Comparison of the number of fish captured (catch) and species detected (richness) by Mamou trawling at 30 Little Bear Creek sites across three 2015 sampling periods. For each site, the distance upstream from the creek mouth is provided. Sites where fish SAR detected are identified by asterix.

Site Code	Distance (km)	Summer		Fall		Winter	
		Catch	Richness	Catch	Richness	Catch	Richness
3	10.2	6	3	11	3	0	0
4	6.7	5	4	36	6	64	1
7	8.7	6	1	22	1	44	4
9	8.4	1	1	123	6	2	2
10	5.6	2	2	57	4	0	0
13	8.6	1	1	21	3	13	1
15	5.9	0	0	0	9	33	2
16	2.4	0	0	12	5	3	1
18	5.4	0	0	0	1	1	1
19	6.0	0	0	28	3	2	1
20	5.1	0	0	2	6	2	1
21	1.1	0	0	2	5	0	0
22	0.3	0	0	20	7	31	2
23	3.8	0	0	8	5	0	0
24	2.8	0	0	31	1	0	0
26	0.1	2	1	57	10*	113	4
27	5.9	0	0	34	8	11	3
30	1.9	0	0	9	7	5	1
31	3.7	0	0	0	2	115	3
34	4.3	0	0	118	6	14	4*
38	2.0	3	2	32	7	1	1
39	1.3	9	1	55	6*	1	1
42	3.4	4	3	47	3	6	3
44	4.9	2	1	3	4	0	0
45	5.7	11	6	72	7	3	1
48	0.8	9	5	2	7	0	0
53	9.5	0	0	4	3	0	0
54	3.9	0	0	3	1	2	2
55	2.3	22	2	24	4	5	2
56	2.2	2	2*	91	5*	3	2
Total		85	18	924	18	474	10

Table 6. Frequency of occurrence (FO, percent of all sites sampled) and relative abundance (RA, percent of total catch) of fishes collected from Little Bear Creek with the Siamese trawl.

Species	Fall		Winter	
	FO (%)	RA (%)	FO (%)	RA (%)
Black Crappie	26.7	0.7	3.3	0.2
Bluegill	86.7	65.6	50.0	5.9
Bluntnose Minnow	16.7	0.8	13.3	0.8
Bowfin	0.0	0.0	3.3	0.2
Brook Silverside	3.3	0.1	10.0	8.3
Brown Bullhead	10.0	0.2	0.0	0.0
Emerald Shiner	0.0	0.0	3.3	0.5
Freshwater Drum	3.3	0.1	0.0	0.0
Ghost Shiner	16.7	11.7	6.7	31.7
Gizzard Shad	36.7	3.1	30.0	13.7
Golden Shiner	16.7	0.4	0.0	0.2
Green Sunfish	3.3	0.1	0.0	0.0
Johnny Darter	0.0	0.0	3.3	0.2
Largemouth Bass	30.0	0.8	3.3	0.2
Logperch	0.0	0.0	3.3	0.2
Mimic Shiner	6.7	0.2	13.3	27.3
Northern Pike	0.0	0.0	0.0	0.0
Pugnose Shiner	3.3	0.1	3.3	0.2
Pumpkinseed	36.7	2.5	10.0	0.5
Rock Bass	20.0	0.8	0.0	0.0
Round Goby	53.3	3.2	10.0	0.5
Spotfin Shiner	0.0	0.0	0.0	0.0
Spottail Shiner	20.0	0.6	0.0	1.3
Tadpole Madtom	3.3	0.1	33.3	1.1
Tubenose Goby	3.3	0.2	0.0	0.0
Walleye	3.3	0.1	0.0	0.0
White Bass	6.7	0.2	0.0	0.0
White Crappie	30.0	1.1	3.3	0.2
White Perch	0.0	0.0	0.0	0.0
Yellow Bullhead	3.3	0.1	6.7	0.3
Yellow Perch	3.3	0.1	13.3	2.9

Table 7. Comparison of the number of fish captured (catch) and species detected (richness) by Siamese trawling at 30 Little Bear Creek sites across two 2015 sampling periods. For each site, the distance upstream from the creek mouth is provided. Sites where fish SAR detected are identified by asterix.

Site Code	Distance (km)	Fall		Winter	
		Catch	Richness	Catch	Richness
3	10.2	16	3	32	5*
4	6.7	132	6	0	0
7	8.7	1	1	20	2
9	8.4	59	6	4	2
10	5.6	62	4	0	0
13	8.6	18	3	22	6
15	5.9	30	9	5	3
16	2.4	19	5	75	4
18	5.4	1	1	6	2
19	6.0	83	3	2	1
20	5.1	30	6	124	5
21	1.1	104	6	22	3
22	0.3	46	8	2	2
23	3.8	13	5	17	3
24	2.8	1	1	1	1
26	0.1	117	10*	0	0
27	5.9	69	8	3	3
30	1.9	14	7	31	4
31	3.7	3	2	157	5
34	4.3	98	6	4	2
38	2.0	124	7	0	0
39	1.3	131	6	11	4
42	3.4	7	3	4	1
44	4.9	17	4	2	1
45	5.7	93	7	4	3
48	0.8	86	7	16	5
53	9.5	5	3	44	5
54	3.9	5	1	0	0
55	2.3	71	4	5	5
56	2.2	162	5	2	3
Total		1617	25	615	21

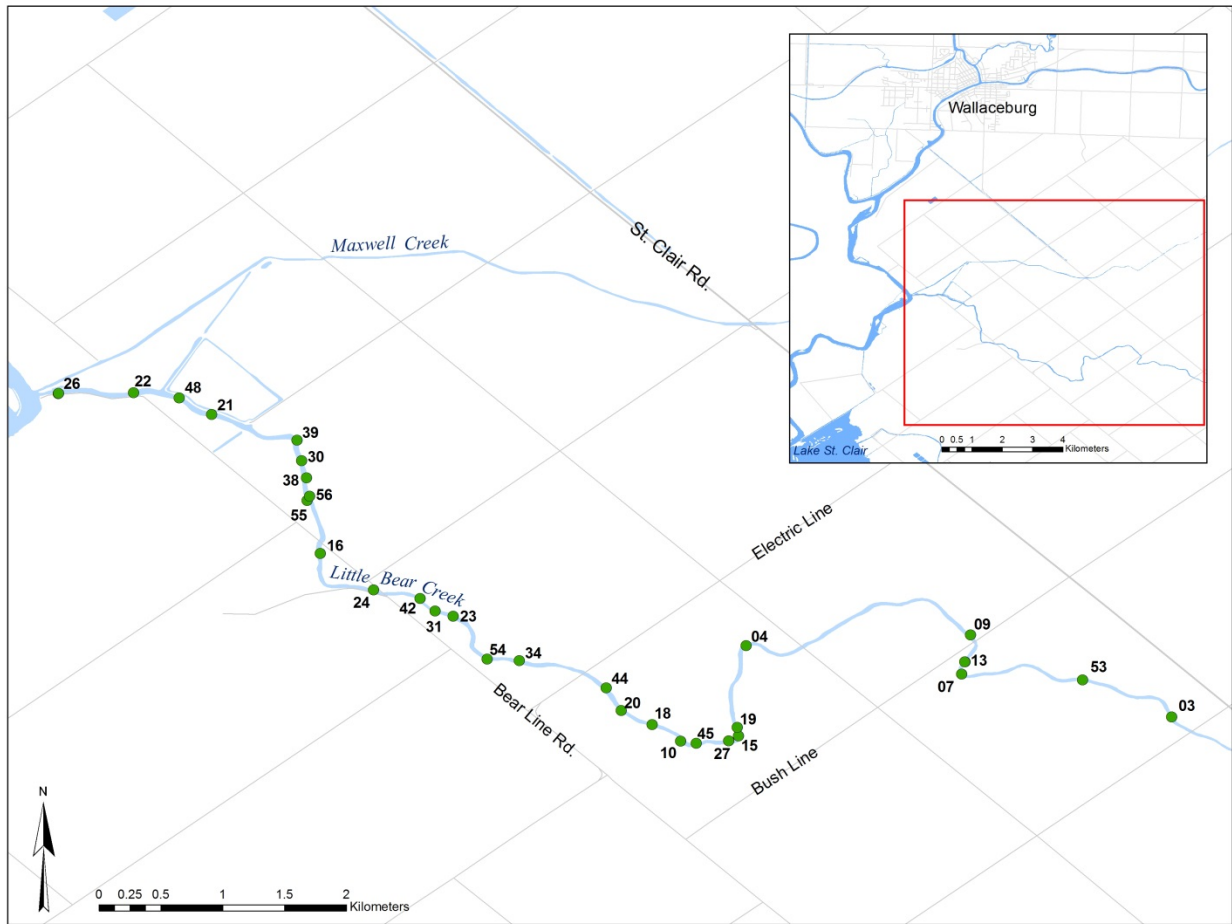


Figure 1. Distribution of sites along Little Bear Creek sampled in 2015 by Mamou and Siamese trawls. Site numbers are provided for reference. Pugnose Shiner was collected from sites 3, 26, 34, 39, and 56.

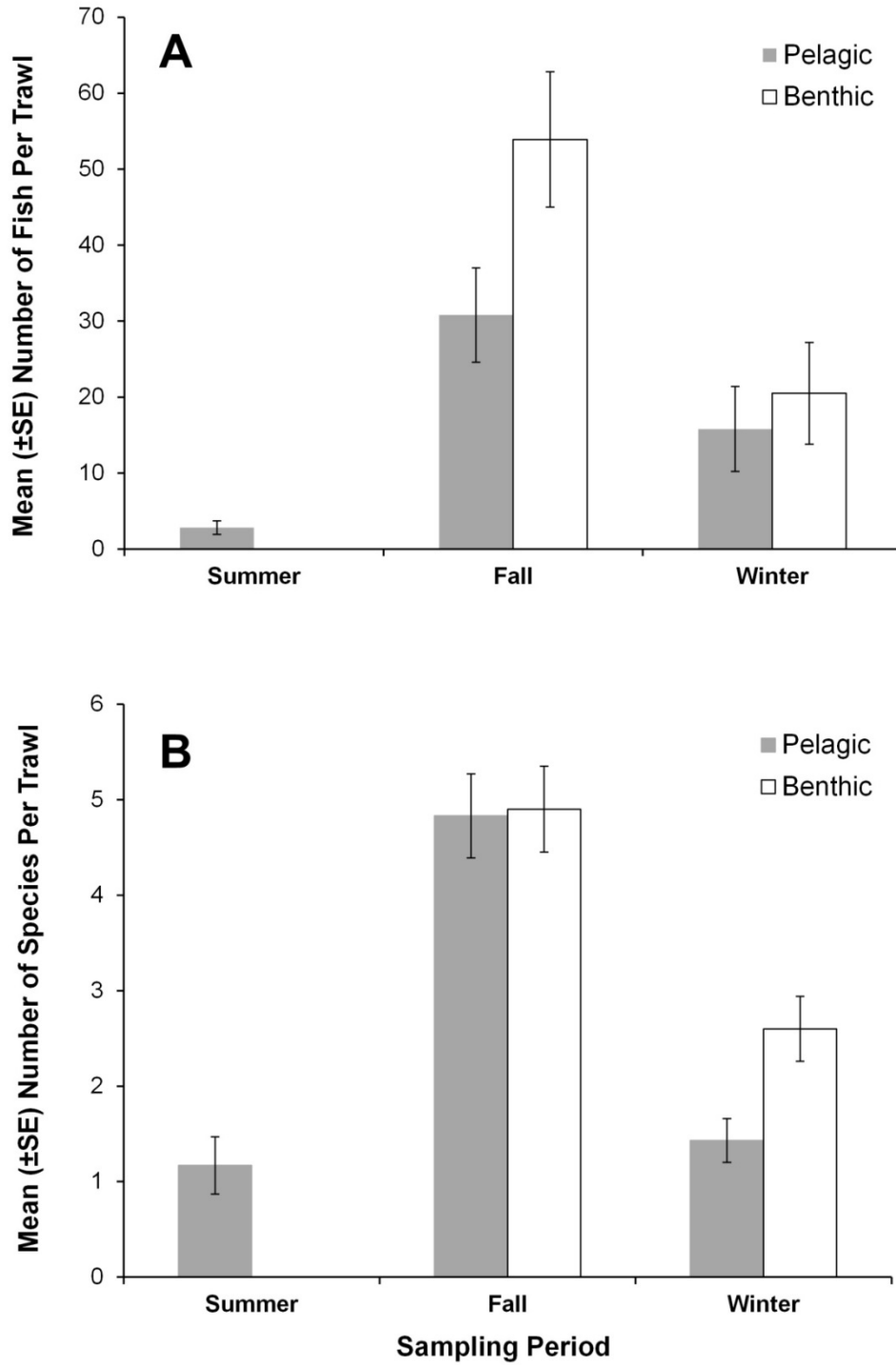


Figure 2. Comparison of the number of fish captured (A) and species detected (B) from Little Bear Creek over three sampling periods in 2015, using two different trawls. Note: benthic habitats were not sampled in the summer.