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Age 0 fish assemblages in proximate systems: the Detroit River and Cedar Creek

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Age 0 Fishes in Proximate Systems: The Detroit River and Cedar Creek

by

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ABSTRACT

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Age 0 fishes were collected in lower Detroit River, a large, deep channel connecting Lake St. Clair and Lake Erie, and lower Cedar Creek, a low-gradient, turbid tributary to Lake Erie. The two systems drain proximate watersheds differing in environmental characteristics (urban and rural). Weekly and bi-monthly collections were made in the Detroit River from May to November and in Cedar Creek from July to November 1994. Ichthyoplankton nets and beach seines collected 39 taxa in the Detroit River and 18 in Cedar Creek. In both systems, age 0 fish densities were consistently low (generally <30 fishes/100 m^3). Estimates of growth in the first year of life were made for the most-abundant taxa. Yellow perch *Perca flavescens*, alewife *Alosa pseudoharengus*, and emerald shiner *Notropis atherinoides* dominated assemblages in the Detroit River, whereas gizzard shad *Dorosoma cepedianum* dominated fishes in Cedar Creek. Species assemblages were useful indicators of environmental conditions in both systems.

RÉSUMÉ

Leslie, J.K., C.A. Timmins, and A. Pachkevitch. 1999. Age 0 fishes in proximate systems: the Detroit River and Cedar Creek. Can. Tech. Rep. Fish. Aquat. Sci. 2279.

Des poissons d'âge 0 ont été capturés dans le cours inférieur de la rivière Détroit, un canal large et profond qui relie le lac Sainte-Claire au lac Érié, et dans le cours inférieur du crique Cedar, un affluent trouble du lac Érié possédant une faible pente d'écoulement. Ces deux cours d'eau drainent des bassins hydrographiques adjacents qui ont des caractéristiques environnementales différentes (urbaines et rurales). En 1994, des captures hebdomadaires et bimensuelles ont été effectuées dans la rivière Détroit, de mai à novembre, et dans le crique Cedar, de juillet à novembre. Des filets à ichtyoplancton et des sennes de plage ont permis de récolter 39 taxons dans la rivière Détroit et 18 dans le crique Cedar. Dans les deux cours d'eau, la densité des poissons d'âge 0 était constamment faible (généralement <30 poissons/100 m^3). Des estimations de la croissance pendant la première année de la vie ont été produites à partir des taxons les plus abondants. La perchaude (*Perca flavescens*), le gaspareau (*Alosa pseudoharengus*) et le méné émeraude (*Notropis atherinoides*) dominaient les assemblages de la rivière Détroit, tandis que l'alose noyer (*Dorosoma cepedianum*) était le poisson dominant du crique Cedar. Les assemblages d'espèces se sont révélés des indicateurs utiles des conditions environnementales des deux systèmes.

INTRODUCTION

One of the most important fisheries in the Great Lakes and largest concentration of fish species in Canadian freshwaters are located in the St. Clair-Detroit River corridor. Fishes in this ecosystem experience relatively high flux in species composition, a manifestation of intense human activity, or, as Cairns and Pratt (1991) would have it, the consequence of "anthropogenic onslaught". Surprisingly little basic information is available on unexploited native fishes, especially their early life stages, and our understanding of most aspects of fish ecology is primitive. The recent appearance of two exotic fishes, the Ponto-Caspian tubenose goby *Proterorhinus marmoratus* and round goby *Neogobius melanostomus,* in the St. Clair River (Crossman et al. 1992) and south-eastern Lake St. Clair has introduced another dimension to environmental problems in a seriously polluted system (GLWQB 1983). Because occurrence of certain age 0 fishes is a useful indicator of environmental conditions (Schloesser 1982; Copp et al. 1991; Penczak 1994), the Department of Fisheries and Oceans initiated a preliminary survey of fish larvae in 1994 in Cedar Creek and the lower reach of the Detroit River.

Cedar Creek was surveyed for age 0 fishes because of its importance as a sensitive ecological area proximate to the lower Detroit River. The two systems drain adjacent watersheds, but differ greatly in terms of fish habitat attributes. This paper intends to provide some aspects of basic ecological information on age 0 fish assemblages in the Detroit River and Cedar Creek. Due to logistical problems, we investigated the distribution and habitat utilisation of fishes mainly during their nursery period of life history.

Study area

The Detroit River (42° 10'N, 83° 10'W) connects lakes St. Clair and Erie (Fig. 1). It is 1.2 to 6.8 km wide and falls 0.9 m along a length of 51 km. It is essentially a large, deep channel characterised by rapid flow and moderate water clarity. The river and tributaries drain 70% urban and 30% agricultural watershed in the United States and >90% agricultural land in Canada. On the basis of multi-use impairment, the river was designated a Great Lakes "Area of Concern" by the International Joint Commission. With an average daily flow of 5140 m^3, it accounts for >90% of the input to Lake Erie (Herdendorf 1987). Bedrock substrate consists of glacial till sediment and lake and stream deposits. About 90% of the shore of the Detroit River is bulkheaded or reinforced with solid debris. Water velocities in the study area average 0.3-0.9 m/s (1.7 m/s in mid-channel) (Manny and Kenaga 1991). Shoreline in the town of Amherstburg, on the east shore of the lower Detroit River, is almost exclusively retaining wall (DOE 1994a). One shore site was established along a 0.3-km section of narrow sand beach, near the southern boundary of Amherstburg. Sampling also took place on the east shore of Bois Blanc Island (colloquially "Bob-Lo" Island), which is 4 km long and approximately 0.5 km wide (Fig. 1).

Cedar Creek (42° 01'N, 82° 49'W) is a low-gradient turbid stream near the estuary of the Detroit River. A dendritic tributary to Lake Erie, Cedar Creek meanders ~12 km through sensitive terrain of natural and ecological significance (DOE 1994b), draining Carolinian forest and agricultural land in Essex County, Ontario. The substrate of Cedar Creek consists mainly of alluvium. At the sampling site, high turbidity prevents extensive development of rooted submersed plants. Fish collections were taken where stream width was approximately 20 m and maximum depth was 1.5 m. Cattail (*Typha* sp.) marshes are developed in sheltered sections of Cedar Creek, whereas shoreline terrestrial vegetation includes white ash *Fraxinus americana*, white oak *Quercus alba*, aspen *Populus* sp., and willow *Salix* spp.

METHODS

Detroit River

Sampling in open water took place weekly during daylight from mid-May to mid-June, 1994. Three sites were selected for collection of age 0 and older fishes. Ichthyoplankton nets were hauled in mid-channel of the northbound international shipping lane as well as about 10 m from the east shore of Bois Blanc Island and 10 m from the shore at Amherstburg. Duplicate tows, each of 8 min duration, were made at a mean velocity of 1.4 ± 0.1 m/s upstream and 1.8 ± 0.5 m/s downstream. Ichthyoplankton net tow velocity was measured with a hand-held current meter. Stream current velocities were incorporated in calculations for true sampler speed. Two conical nets (2.5-m long, 0.5-m mouth diameter, and 0.4-mm mesh opening) were pushed just below surface at the bow of a Boston whaler. In addition, a single conical net (2.5-m long, 0.4-m mouth diameter, 0.4-mm mesh) was towed from the stern at a depth of 2-3 m. Because depth near each shore was only about 1 m, stern hauls were omitted at these sites. Duplicate beach seine collections (15 m long, parallel to shore) were taken at both shores at a depth of 1.0 m.

Ichthyoplankton net hauls in open water were terminated in mid-June, although shore seining continued until early November. A larval fish beach seine (4-m long, 1-m wide, 0.4-mm mesh opening) was used from early May to early August. Sampling continued at Amherstburg every 5-9 d until July 20, then every 2 or 3 wk until early November. Thereafter, 6.1 m and 3.0 m-long seines (1-m wide, 3-mm or 6-mm opening) were employed to collect age 0 fishes. On both shores, a 61-m long, 3-m wide (6-mm mesh opening) seine was also utilised on 4 dates in late summer and early autumn. Occasionally, unscheduled, qualitative samples of age 0 fishes were taken with a hand held dip-net.

Fishes retained for identification and/or measurement were fixed with 10% formalin, and transferred within 3 mo to a 12:1 mixture of 80% ethanol and glycerol or to Davidson's B solution. Fishes were identified, counted, and, where possible, at least 30 specimens of most-abundant species were measured for total length (TL ± 0.2 mm). Specimens longer than 30 mm were measured with a digital micrometer for TL (± 0.5 mm). On each sampling date, water temperature, conductivity, and pH were taken at a depth of 20 cm, and Secchi disc transparency was measured in open water and at the shore.

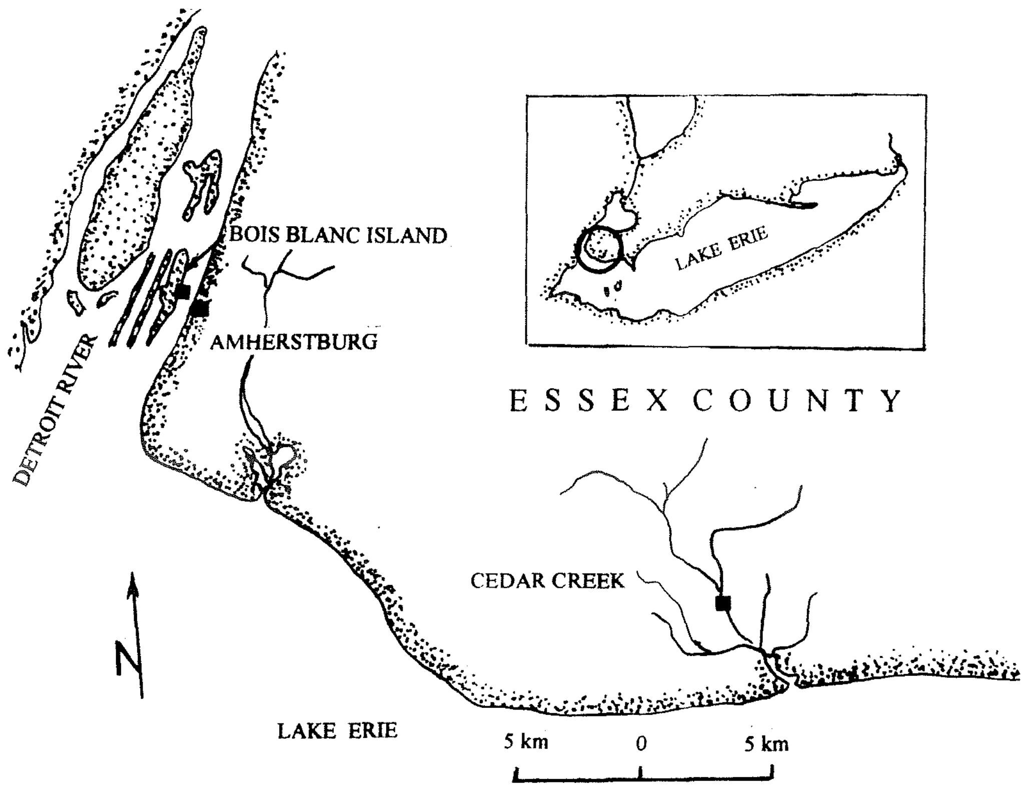

Fig. 1. Map of the study area, showing sampling sites in the Detroit River and Cedar Creek.

Cedar Creek

All collections were made adjacent to a bridge on Regional Road 23 in Essex County, about 3 km from the mouth of the creek. Two or three successive beach seine hauls were made on 8 dates every 2 or 3 wk from mid-July to early November. A larval fish seine (dimensions as above) was used in July and a 6.1 m-long, 1 m-wide (6-mm mesh) seine collected fishes from August to November. All collections were made in water <1.0 m deep, where submerged objects (e.g., garbage, logs, rocks) and soft substrate hampered sampling efficiency. In late summer, low water levels in the creek necessitated sampling at a depth of ~0.5 m. All fishes were processed as described above. On the basis of first appearance of small larvae in the Detroit River, gizzard shad were assumed to have hatched in Cedar Creek around May 20 at a mean total length of 5.0 mm. An equation was developed to indicate approximate growth of gizzard shad from hatch to asymptotic length at "end of season" in October.

RESULTS

Detroit River

Environmental characteristics

Nearshore water temperature averaged 15.4°C (range = 11.0 to 19.5°C) during the spawning period for many Great Lakes fishes (mid-May to mid-June). Thereafter, water temperature (low 20's) was quite stable until late September. Water transparency (mean depth of Secchi disc = 0.9 ± 0.3 m) was lowest, and mean conductivity highest (237 ± 40 µS/cm), at Amherstburg. Water transparency averaged 2.2 m in centre channel and 0.8 m near Bois Blanc Island, where conductivity was comparatively low (135 ± 23 µS/cm). Values of water transparency and conductivity were highest in mid-August and lowest in early November. Surface water pH averaged 7.4 (range = 7.1 to 8.0) in centre channel and at Amherstburg. Patches of submersed macrophytes had become well established by late June.

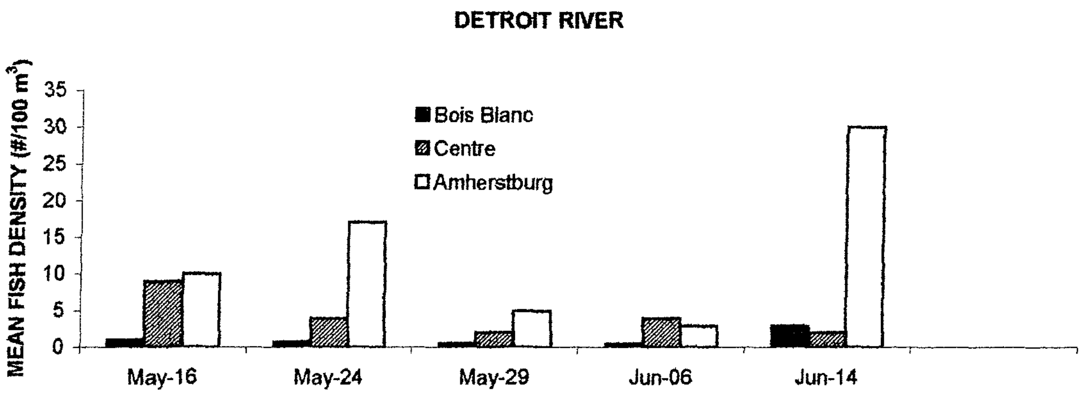

Fig. 2. Mean density of age 0 fishes in three areas of the lower Detroit River, 1994.

Composition and chronology of fishes in open water

Thirty-nine taxa and 15 families were identified in a total catch of 2946 age 0 fishes retained for processing in the laboratory. Of the total collection, <0.01% were unidentified or unidentifiable. Additionally, many juvenile and adult fishes not enumerated were returned to the water after they were identified. Only 6% of the total catch of age 0 fishes was collected near Bois Blanc Island, compared with 33% and 61% in mid-channel and near Amherstburg, respectively. On each sampling date, icthyoplankton nets filtered an average of 924 m^3 (565-1185 m^3) with current aiding, and an average of 642 m^3 (423-828 m^3) with current opposing. Mean velocities upstream and downstream were 1.3 m/s and 1.8 m/s, respectively. Of 469 age 0 fishes caught in open water hauls, 47% were taken with bow-mounted surface nets pushed downstream and 33% were caught in upstream hauls. A single net hauled downstream at a depth of ~2.5 m accounted for 14% of the total catch, compared with 5% upstream.

Plankton nets collected 19 fish species, 14 of which were found in mid-channel, and 12 near Amherstburg. Yellow perch was the dominant fish in the Detroit River, both in centre channel and near Amherstburg. The fish assemblage near Bois Blanc Island consisted of white perch, yellow perch, spottail shiner, burbot, white sucker, common carp, and rainbow smelt. Species found at the 2-3 m depth stratum included yellow perch, logperch, white perch, johnny darter, rainbow smelt, walleye, and mimic shiner. The latter four fishes were found only at 2-3 m. Similarly, common carp, emerald shiner, lake whitefish, quillback, bluntnose shiner, and burbot were found only at the surface. Whereas walleye, mimic shiner, and quillback were caught only in centre channel, deepwater sculpin, gizzard shad, alewife, and pumpkinseed were found only near Amherstburg. Age 0 fishes collected in open water represented seven reproductive guilds. This group, dominated by lithophilous taxa, also included one phytophil (common carp) and one speleophil (johnny darter).

Fish densities were low throughout the sampling period. Mean density (6 sampling dates) was 4 larvae/100 m^3 at the surface in centre channel, compared with 9/100 m^3 in simultaneous hauls at 2-3 m. Maximum mean density (30/100 m^3) occurred near Amherstburg on June 14 (Fig. 2). Densities were higher near Amherstburg than in the centre of the channel or near Bois Blanc Island (usually <10/100 m^3). Yellow perch, lake whitefish, burbot, deepwater sculpin, and walleye appeared first, followed chronologically by white sucker, gizzard shad, several cyprinids, and alewife. Spearmans's rank-order correlation coefficient (-0.287; 15 sampling dates) indicated no relationship between water transparency and total mean density of age 0 fishes.

Fishes collected at the shore

Bois Blanc Island

Fifteen age 0 fish species were recorded at the shore of Bois Blanc Island. Larval yellow perch, white sucker, common carp, and spottail shiner were collected each week in chronological order from mid-May to mid-June. Fish species caught in October included yellow perch, emerald shiner, muskellunge, gizzard shad, alewife, brook silverside, trout-perch, largemouth bass, mimic shiner, common shiner, striped shiner, and white perch. In non-quantitative catches, alewife, yellow perch, brook silverside, and emerald shiner were numerically dominant. Total mean densities of smallest fishes were low (1-4 larvae/100 m^3), as were densities of older age 0 species (63/100 m^3). Mean densities of co-dominants, yellow perch and alewife, were 30/100 m^3.

Amherstburg

Fish species diversity (23 taxa) reflected higher habitat diversity on the Amherstburg side of the river than at Bois Blanc Island. Of a total of 2040 age 0 fishes collected at the shore (May-November), approximately 35% were caught during May and early June. Larvae of yellow perch, white sucker, and spottail shiner appeared in May at 11 to 18 °C, whilst quillback, rainbow smelt, and bluntnose minnow were first collected in June. Yellow perch and white sucker were first collected on the same dates as at Bois Blanc Island, and attained peak densities (145 and 643/100 m^3, respectively) in May and June. Mean total densities of all fishes were lowest between late July and late September (Fig. 3), when water temperature exceeded 20°C.

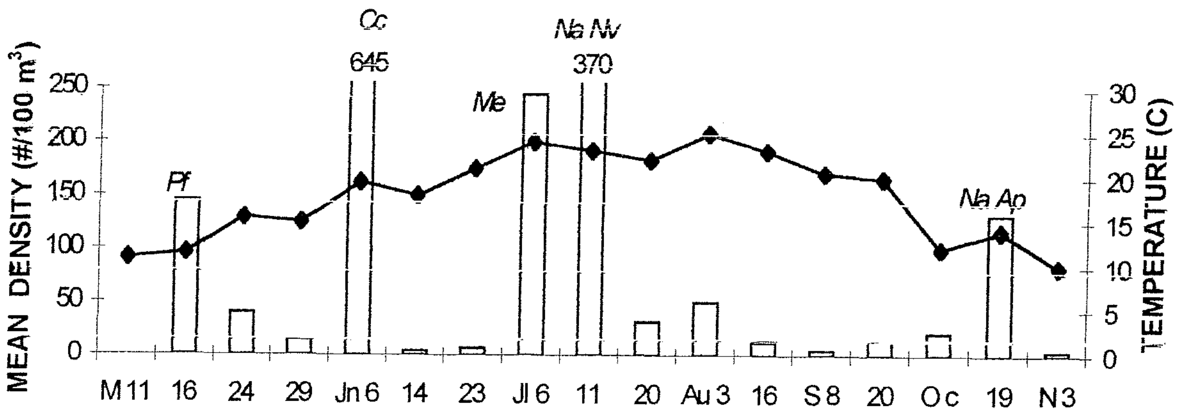

Fig. 3. Mean density (bar) of age 0 fishes, and water temperature (line), at Amherstburg, 1994. Dominant species: *Pf* = *Perca flavescens, Cc* = *Catostomus commersoni, Me* = *Moxostoma erythrurum, Na* = *Notropis atherinoides, Nv* = *Notropis volucellus, Ap* = *Alosa pseudoharengus.*

Yellow perch constituted 12% of the total catch and were collected on 8 sampling dates. After they first appeared in May, yellow perch were not again found until early September. White suckers, 25% of total catch, were caught on 4 occasions, but almost all were found during shoreline migration on June 6. Emerald shiner, which formed 26% of the total catch, were sampled on 10 dates, and alewife (12%) on 11 dates. The following seven taxa were found only as age 1+ fish: spotfin shiner, golden shiner, blackchin shiner, blacknose shiner, trout-perch, sand shiner, and common shiner. None of these species was caught on more than 3 sampling dates. Age 0 longnose gar (20-40 mm) were caught with dip-nets in late June and early July as they drifted near roots of overhanging trees.

Table 1. Fishes collected in the lower Detroit River (DR) and Cedar Creek (CC), Ontario, 1994. Species grouped according to reproductive habitat frequented most commonly. Most reproductive guilds follow Balon (1975). ?? denotes species arbitrarily assigned by the authors.

PHYTOPHILS		PHYTO-LITHOPHILS	
Micropterus salmoides	Largemouth bass DR	*Alosa pseudoharengus*	Alewife DR
Esox masquinongy	Muskellunge DR	*Notropis volucellus*	Mimic shiner DR
Lepisosteus osseus	Longnose gar DR	*Cyprinella spiloptera*	Spotfin shiner DR
Notropis heterodon	Blackchin shiner DR	*Labidesthes sicculus*	Brook silverside DR
Notemigonus crysoleucas	Golden shiner DR	*Morone americana*	White perch DR
Cyprinus carpio	Common carp DR, CC	*Morone chrysops*	White bass DR, CC
Carassius auratus	Goldfish CC	*Perca flavescens*	Yellow perch DR, CC
Ictiobus cyprinellus	Bigmouth buffalo CC		
Pomoxis nigromaculatus	Black crappie CC	PELAGOPHIL	
		Notropis atherinoides	Emerald shiner DR, CC
LITHO-PELAGOPHILS			
Lota lota	Burbot DR	PSAMMOPHILS	
Stizostedion v. vitreum	Walleye DR	*Percina caprodes*	Logperch DR
Dorosoma cepedianum	Gizzard shad DR, CC	*Notropis hudsonius*	Spottail shiner DR
		Notropis heterolepis	Blacknose shiner DR
LITHOPHILS		*Notropis stramineus*	Sand shiner DR
Luxilus cornutus	Common shiner DR	*Carpiodes cyprinus*	Quillback DR, CC
Luxilus chrysocephalus	Striped shiner DR		
Couesius plumbeus	Lake chub DR		
Hypentelium nigricans	Northern hogsucker DR	POLYPHIL	
Moxostoma macrolepidotum	Shorthead redhorse DR	*Lepomis gibbosus*	Pumpkinseed DR
Osmerus mordax	Rainbow smelt DR		
Coregonus clupeaformis	Lake whitefish DR	ARIADNOPHIL	
Percopsis omiscomaycus	Trout-perch DR	*Gasterosteus aculeatus*	Three-spine stickleback DR
Myoxocephalus thompsoni	Deepwater sculpin DR		
Micropterus dolomieu	Smallmouth bass DR	SPELEOPHILS	
Ambloplites rupestris	Rock bass DR	*Etheostoma nigrum*	Johnny darter DR
Catostomus commersoni	White sucker DR, CC	*Pimephales notatus*	Bluntnose minnow DR
Moxostoma erythrurum	Golden redhorse DR, CC	*Pimephales promelas*	Fathead minnow DR. CC
Lepomis gulosus (??)	Warmouth CC	*Ameiurus nebulosus*	Brown bullhead CC
Lepomis humilis (??)	Orangespotted sunfish CC	*Ameiurus natilis*	Yellow bullhead CC
Ameiurus melas	Black bullhead CC		
Lepomis macrochirus	Bluegill CC		

Collection of a wide size spectrum of species is not possible when samplers target age 0 fishes, although older fishes are often caught with larvae. Numbers of small age 1+ fishes decreased, and age 0 species increased, in concert with higher water temperatures between late May and mid-July. In contrast to ichthyoplankton nets, which seldom collect age 1+ fishes, beach seines are efficient samplers of most-abundant small age 1+ fishes, such as cyprinids, percids, and centrarchids. Beach seines were used to collect emerald shiner and spottail shiner, the only abundant and persistent adult fishes collected in the lower Detroit River.

Age 0 fish growth in the Detroit River

Most species were found in small number, and few were represented by early developmental stages. We were thus unable to determine hatch size and growth rate of yolk sac larvae. Alewife larvae (3.3-5.1 mm) were first collected in mid-June at 18°C. Total length of alewife increased 0.5-0.6 mm/d to mid-October, with the fastest rate of growth occurring from June to August (0.7 mm/d). Mean total length of age 0 alewife was most variable when fish were ~12 mm (CV = 54%) and least variable at >50 mm (CV range = 9 to 17%). The wide range in size of alewife larvae indicated possible mixing of cohorts migrating to Lake Erie.

Yellow perch were 6.7 ± 0.8 mm (range = 4.6-8.3 mm) in early May and about 67-68 mm in October (Table 2). Summer growth of this fish averaged 0.4 mm/d. Growth of emerald shiner was highly variable, as mean length of larvae "decreased" 0.5 mm/d in mid-July, subsequently increased 1.4 mm/d until early August, and then became linear to mid-October. Highest variability was observed in 11-14 mm emerald shiner (CV = 33-40%). Spottail shiner reached asymptotic length in September at a mean length of 62.8 mm.

Table 2. End of year growth (total length, mm), age 0 fishes in the Detroit River, 1994. CI = 95% confidence interval; N = number of fish measured.

Species	Date	Mean TL	CV (%)	Range	CI	N
Gizzard shad	Sept. 21	104.8	12	60-145	4.4	36
	Oct. 3	110.7	17	71-145	10.8	14
Brook silverside	Aug. 16	44.6	11	33-53	2.1	24
	Oct. 19	65.1	7	54-79	1.3	55
White bass	Oct. 19	90.0	22	68-121	11.2	14
White perch	Oct. 19	75.4	8	66-85	5.2	8
Yellow perch	Oct. 3	66.9	7	58-75	1.5	42
	Oct. 19	68.4	10	49-82	1.8	62

Cedar Creek

Environmental conditions

Water temperature (24.5°C) from mid-July to the end of first year fish growth averaged 2°C higher than in the Detroit River (Fig. 4). Secchi disc depth averaged 15 cm (8-25 cm), thus, water clarity in the Detroit River was 4.5 times higher than in Cedar Creek. However, conductivity was much higher in Cedar Creek (average = 443 μS/cm, range = 240-550 μS/cm) than in the Detroit River (120-300 μS/cm).

Species composition and occurrence

Eighteen species of fishes (total catch = 868) were collected. Nine of these fishes did not occur in the Detroit River (Table 1). In addition, a small number of hybrids, (warmouth x green sunfish, and bluegill x orangespotted sunfish) were found. Seven families of fishes represented 7 reproductive guilds, most of which were phytophils and lithophils. Gizzard shad was the dominant or co-dominant fish on all dates, except in late July, when 11 yellow bullhead and 1 bluegill constituted the total catch. Only age 0 fish represented gizzard shad, which formed 38% of the total catch in Cedar Creek. Common carp, emerald shiner, fathead minnow, and black crappie were found at all life stages. Each of these species contributed 8-14% to the total catch of age 0 fishes. Five exotic taxa: warmouth, common carp, goldfish, orangespotted sunfish, and bigmouth buffalo were collected. All, except common carp, occurred in small number. Mean total density of age 0 fishes and number of species followed the same seasonal trend (Fig. 5) (Spearman's $r_s = 0.696$; $\alpha = 0.05$).

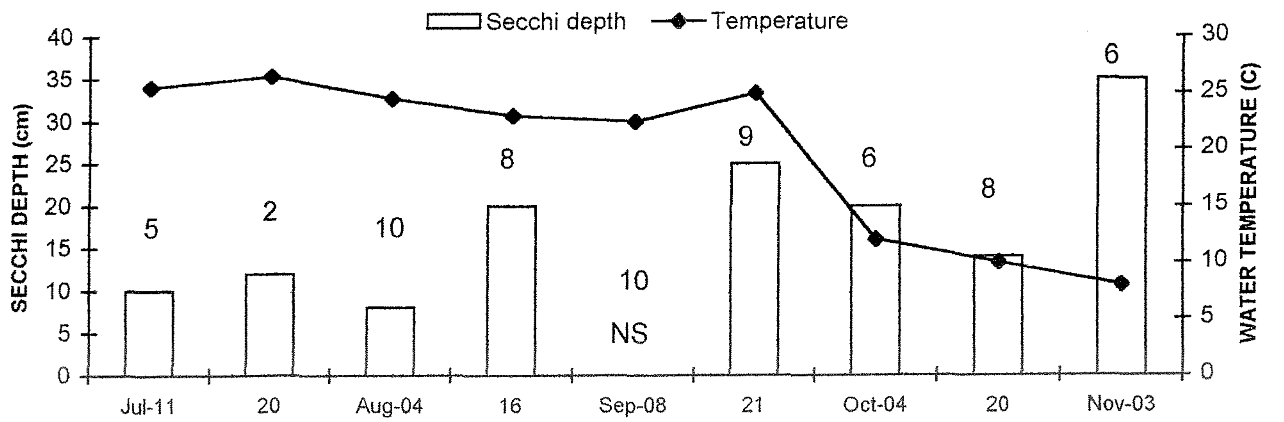

Fig. 4. Water temperature and water transparency (Secchi disc depth) in the lower reach of Cedar Creek, 1994. Water transparency not measured (NS) on Sept. 8. Total number of age 0 fishes found on each sampling date indicated above bars.

Relative abundance of age 0 fishes

No taxon was abundant in Cedar Creek and mean densities of individual fish were usually <30/100 m^3, while overall total densities averaged 71/100 m^3. Most-abundant fishes persisted at least 67% of sampling events in spite of high concentrations of suspended particulates and lack of vegetative cover. However, data were too meagre to estimate the effect of turbidity on the persistence and abundance of any given species.

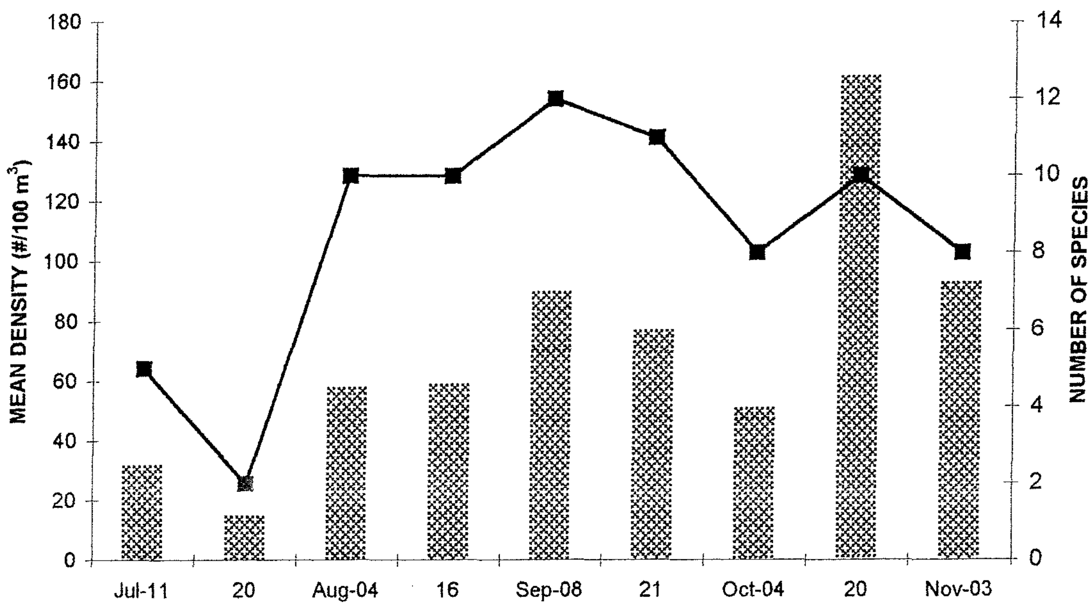

Fig 5. Mean density (bars) and number (line) of age 0 fishes collected in lower reach of Cedar Creek, 1994.

Most fishes in Cedar Creek were found on only 1-4 sampling dates and always in low quantity. Species collected sporadically included immature stages of fishes classified as "vulnerable" in Canada (Mandrak and Crossman 1992): warmouth (61.0 mm), orangespotted sunfish, bigmouth buffalo (45-56 mm in mid-July; 62-70 mm in late September), and quillback (Table 1).

First year growth (common species)

Five species collected in numbers sufficient to allow an estimate of first year growth are listed in Table 3. Hatching period is usually staggered among taxa and development takes place at different rates, exemplified by early spawners and largest fishes, common carp and black crappie. Total length of emerald shiner increased 16.6 mm, and common carp 5 mm, from mid-August to early November, whereas black crappie apparently ceased growth in early September (Table 3).

Table 3. Total length (mm) attained by most-common species in Cedar Creek, 1994. CI = 95% confidence interval; CV = $s \cdot 100/\bar{x}$; N = number of fish measured.

Species	Date	Mean TL	CV (%)	Range	CI	N
Common carp	Aug 4	60.7 ± 10.4	17	41-75	5.8	15
	Aug 16	68.2 ± 9.3	14	51-83	7.2	9
	Sept 8	66.8 ± 11.0	16	46-90	5.6	20
	Oct 20	74.4 ± 13.2	18	56-106	5.3	42
	Nov 3	73.5 ± 10.3	14	60-100	4.7	21
Emerald shiner	Aug 16	34.7 ± 4.1	12	23-46	1.9	43
	Sept 21	41.5 ± 3.6	9	36-49	1.5	26
	Oct 20	50.3 ± 3.6	7	45-56	2.0	15
	Nov 3	51.3 ± 4.9	10	43-62	1.8	31
Black crappie	Aug 16	55.5 ± 3.7	7	50-63	2.3	12
	Sept 8	62.0 ± 7.1	11	50-91	2.2	42
	Sept 21	61.2 ± 4.6	8	52-70	2.4	17
Bluntnose minnow	Aug 4	43.4 ± 5.4	12	34-58	2.8	17
	Aug 16	45.3 ± 5.8	13	40-57	4.8	8
	Sept 8	50.3 ± 6.5	13	45-60	2.7	20
Bluegill	Aug 4	28.6 ± 5.2	18	22-35	5.4	6
	Oct 20	36.0 ± 6.7	19	26-55	2.5	30

Gizzard shad were 51.7 mm TL (range = 20-71 mm) and approximately 7 wk-old on July 11 (age 51d). In October, they were 69-73 mm, and in early November (age 163 d), 77.4 ± 12.6 mm (range = 56-104 mm). Growth during the early phase "decreased" 3.2 mm (mid-July to mid-August). Highest variability in TL occurred in October, when the fish were 50-110 mm. The equation, $TL = 5.19 \pm 1.35 \times age^{0.54 \pm 0.06}$; ($R^2 = 0.998$), is an estimate of age 0 gizzard shad growth in 1994.

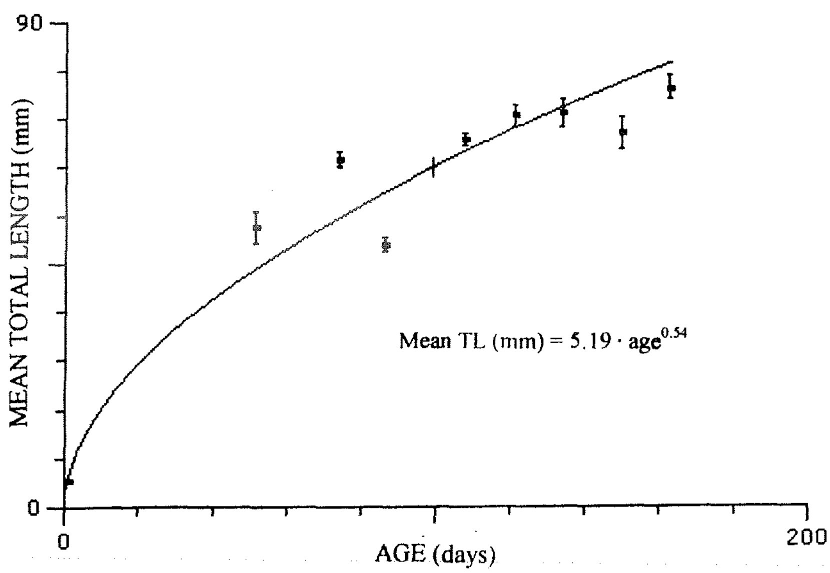

Fig. 6. Growth in total length (±SE) of age 0 gizzard shad in Cedar Creek, 1994.

DISCUSSION

Distinct differences in fish assemblages reflect striking differences in environmental characteristics of the Detroit River and Cedar Creek. Whereas the Detroit River is a large, deep channel that connects two large lakes and drains an urban watershed, Cedar Creek is a shallow, low-gradient stream meandering through an agricultural and woodland watershed. The physical environment in the Detroit River is relatively diverse, and vegetated areas, although patchy (Manny et al. 1988), enhance spawning, refuge, and forage opportunities for many fishes. Emergent plants fringing the banks of Cedar Creek provide little cover for small fishes; indeed, refuge is provided mainly in the form of turbidity. More than twice as many species and families were found in the Detroit River, where yellow perch, alewife, and emerald shiner predominate, as in Cedar Creek, strongly dominated by gizzard shad. However, both in the Detroit River and Cedar Creek, no species was collected in large quantity and fish densities were consistently lower than in bays and shore areas of Lake St. Clair and western Lake Erie (Leslie and Timmins 1993; Leslie and Timmins 1998b; 1998c).

In the present study, density estimates of age 0 fishes are consistent with the reality that a high degree of accuracy is rarely attainable. Selection of appropriate numbers and types of habitat for collections influences species composition, rank, and abundance of age 0 fishes (Scott and Nielsen 1989; Bayley and Dowling 1993; Leslie and Timmins 1994b). Often, many fish habitats are inaccessible or logistically prohibitive to sampling strategies. While a single sample may sufficiently represent species richness, rank, and size distribution (Allen et al. 1992), credible estimates of fish abundance in rivers are not possible when a single biotope or collection method is employed (Penczak et al. 1997). In the Detroit River, tow direction, sampler velocity, and tow depth affected the number of fishes collected. Mean densities of fishes at 2-3 m were usually higher than at the surface, which suggests possible photonegative behaviour by several taxa, including walleye (Leslie and Timmins 1997). Ichthyoplankton net tows with current aiding resulted in larger catches of small, weakly swimming larvae than tows made against the current. Low fish densities in open water, whether in mid-channel or near shore (generally <30 fish/100 m^3), may be due to larvae avoidance of high currents and predators and low food resource. At the shore, low current velocity, greater habitat structural diversity, and the role of turbidity in fish distribution are probably instrumental in higher species diversity and greater densities of fishes.

Fish species richness and rank in the Detroit River have not changed radically during the past 20 years. Hatcher and Nester (1983) determined that common carp contributed only 0.6 to 2.0% of total density of all larvae in 1977-78. In 1977-78, rainbow smelt contributed 30-34%, and alewife 10-35%, to total density of fishes in transect hauls between opposite shores of the Detroit River (Hatcher and Nester 1983). In 1994, we surveyed a much smaller volume of open water and used different sampling methods than Hatcher and Nester and found rainbow smelt and alewife represented a smaller proportion of the total catch and their numerical rank was reversed, i.e., <0.1% and 12% of the total, respectively. However, these data are inconclusive because fish species rank shifts annually and only intensive, long-term sampling allows detection of significant changes in abundance (Leslie 1989).

Rate of growth of age 0 fishes influences recruitment, which is governed by abiotic and biotic factors (Schloesser and Angermeier 1990). These factors (e.g., spring water temperatures, food abundance, changes in water level, type and abundance of riparian vegetation) change annually (Michaletz 1997). In the Detroit River, they apparently favoured rapid growth in most abundant fishes, since length achieved during summer was generally greater than in south-eastern Lake Huron and bays and harbours in the lower Great Lakes. For example, mean length (65 mm) of age 0 brook silverside in the Detroit River was about the same as in south-western Lake St. Clair (Leslie and Timmins 1998a), but larger than fish (47 mm) in Mitchell Bay, a weedy embayment in north-eastern Lake St. Clair (Leslie and Timmins 1993). However, in autumn, they were about 20 mm smaller than fish in eutrophic Penetang Harbour, Lake Huron (Leslie and Timmins 1997).

Similarly, yellow perch (67 mm) were 10 mm longer than in eutrophic Bay of Quinte, Lake Ontario (Leslie and Moore 1985), and white perch and white bass were slightly longer than in Lake Erie (Leslie and Timmins 1998b). Gizzard shad were 22-50 mm longer than in turbid Duck Creek, at the south shore of Lake St. Clair (Leslie and Timmins 1998a), in Whitebread agricultural ditch, east of the St. Clair River delta, and in the surf zone of western Lake Erie (Leslie and Timmins 1998b). In Cedar Creek, fishes grew at rates similar to those in the lower Great Lakes, although in October and November, gizzard shad were much smaller than fish in the Detroit River and Duck Creek (Leslie and Timmins 1998a). Slower growth of gizzard shad may reflect low primary production due to high sediment loading of Cedar Creek, and thus low zooplankton biomass specific to the needs of developing fish. Other most-abundant species in

Cedar Creek, e.g., age 0 black crappies, were about 12 mm longer than in Duck Creek, while age 0 bluegill were about the same length in both systems.

We assume that by virtue of their occurrence 3-km from Lake Erie, all age 0 fishes were spawned in Cedar Creek, rather than in (or near) the Detroit River estuary. However, our species list (Table 1) is wanting, because various taxa that inhabit main stream tributaries or backwaters of turbid streams in southern Ontario were not encountered in our survey. As well, lake-hatched fishes may frequent the mouth of the creek, where we did not sample. In Duck Creek, for example, Leslie and Timmins (1998a) found much higher species representation near its mouth than in mid or upper reaches.

Typically, fish species composition in the lower reach of Cedar Creek accords with environmental conditions, in that large piscivores and rheophilic fishes, such as darters, sculpins, and several cyprinids, were absent. On the other hand, warmouth, orangespotted sunfish, bigmouth buffalo, and gizzard shad were appropriate members of a fish community adapted to high concentrations of suspended sediments and a prolonged regime of relatively high water temperature. High constancy of occurrence of age 0 gizzard shad in turbid conditions affirms findings in lakes Huron, St. Clair, Erie, and Ontario. For example, no gizzard shad larvae were found in relatively clear waters of the St. Clair River from its origin to the St. Clair River Delta (Leslie and Timmins 1991), nor in Severn Sound (Leslie and Timmins 1994a). Few gizzard shad were collected in densely vegetated Mitchell Bay, Lake St. Clair (Leslie and Timmins 1993), although they were abundant in eutrophic Hamilton Harbour (Leslie and Timmins 1992). In conclusion, gizzard shad in the lower Great Lakes apparently select turbid streams, harbours, and canals for spawning and rearing, but not as adult residence habitat.

According to accounts of fish distributions in the Great Lakes basin (Scott and Crossman 1973; Trautman 1981; Jude and Pappas 1992; Mandrak and Crossman 1992), the occurrence of several age 0 fishes in Cedar Creek was unexpected. For example, emerald shiner is a pelagic fish commonly found in large rivers and lakes. In Cedar Creek, it was the second most-abundant fish, and a consistent member of the assemblage. White bass, similarly, tend to avoid turbid waters in low-gradient streams (Trautman 1981), and common carp, third most-abundant fish, and goldfish require rooted vegetation for reproduction, cover, and associated food during early development. Evidently, these taxa were not constrained by lack of vegetation, or the prevalence of suspended sediments, so their occurrence in degraded environments suggests we have much more to learn about them. Such findings encumber models that classify individual fish species according to a narrow set of habitat requirements (Rounsefell 1975; Weaver and Garman 1994).

In Cedar Creek, high representation of introduced species (one-third of all fishes) is indicative of environmental degradation. Our capture of only one warmouth during the day may be related more to its nocturnal activity (Werner et al. 1977) than to lack of preferred habitat of dense vegetation in Cedar Creek. Warmouth is a relatively new member of the Canadian fish community (Crossman and Simpson 1984), as is orangespotted sunfish, a species more suited to environmental conditions in Cedar Creek. The occurrence of bigmouth buffalo may represent a first report of this planktivore in the watersheds of southern Essex County. This fish, recently reported from the St. Clair and Thames rivers (Goodchild 1990), is usually found in turbid, highly eutrophic waters.

Fish species compositions were comparable in two Essex County streams, Cedar Creek (18 fishes, 7 families) and Duck Creek (32 age 0 fishes, 14 families), despite the difference in total species. In both systems, assemblages were strongly dominated by gizzard shad, and with the exception of bigmouth buffalo, all taxa found in Cedar Creek also occur in Duck Creek. The most pronounced difference in assemblages was in respect of numbers of piscivores. Although warmouth, bullheads, white bass, and yellow perch predate other species, no large piscivores were among the Cedar Creek assemblage. In contrast, muskellunge *Esox masquinongy*, northern pike *Esox lucius*, bowfin *Amia calva*, longnose gar, and three *Lepomis* species represent piscivores in Duck Creek (Leslie and Timmins 1998a). An assemblage strongly dominated by a single species, with few predators and a large number of exotic fishes, is clearly unbalanced. Fish species composition in Cedar Creek therefore indicated degraded environmental conditions.

Decreased stability in fish assemblages succeeds human activities. Indeed, in both the Detroit River and Cedar Creek, humans have elaborated new ecosystems. Unless the gap between fish species richness and the number of endemic taxa can be reduced or maintained, paranthropophytia in Essex County will increase the flux of fishes in its rivers and creeks. However, rehabilitation of aquatic systems is possible, in spite of inevitable effects on the environment of a growing human population. Improved water quality, and consequently, more diverse fish assemblages, has been achieved recently in lotic systems with much longer histories of human abuse in, for example, Sweden (Eklov et al. 1998), Switzerland (Muller et al. 1993), and Great Britain (Harper et al. 1994). In these countries, streams have been rejuvenated in response to lowered sediment and nutrient inputs from agricultural and urban non-point loading, lower levels of influent toxic materials, and more stable hydrologic regimes.

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