Fish reproduction and distribution in a small tributary of Lake St. Clair

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ABSTRACT

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Duck Creek, a small, low gradient stream in the St. Clair plains of southwestern Ontario, was surveyed in 1994-95 for fish reproductive utilisation and longitudinal distribution. Weekly and bi-monthly collections were taken in lower, middle, and upper reaches of the turbid stream (mean Secchi disc transparency = 0.3 m) from spring to late autumn. Beach seines were used to collect fishes, of which there were 41 taxa (32 age 0), representing 14 families. Age 0 fishes were collected in all reaches, although most were found in the lower reach. The fish assemblage, which was mainly transient, was co-dominated by gizzard shad *Dorosoma cepedianum* and bluegill *Lepomis macrochirus*, whilst spottail shiner *Notropis hudsonius* and common carp *Cyprinus carpio* were moderately abundant resident species. At least six taxa were assumed to have extended their range from adjacent watersheds. Two gobioid species, recent arrivals in North America, were represented by tubenose goby and round goby.

RÉSUMÉ

Leslie, J.K., and C.A. Timmins. 1998. Fish reproduction and distribution in a small tributary of Lake St. Clair. Can. Tech. Rept. Fish. Aquat. Sci. No. 2253.

On a étudié en 1994-1995 l'utilisation du ruisseau Duck par les poissons à des fins de reproduction et la distribution longitudinale de ces derniers dans ce cours d'eau. Le ruisseau Duck est un petit cours d'eau à pente faible qui coule dans les plaines du lac St. Clair, dans le sud-ouest de l'Ontario. On a prélevé des échantillons hebdomadaires et bimensuels dans les tronçons inférieur, moyen et supérieur de ce cours d'eau turbide (transparence moyenne, mesurée avec un disque de Secchi, de 0,3 m) du printemps à la fin de l'automne. On a utilisé des sennes de plage pour recueillir les poissons, dont on a identifié 41 taxons (32 d'âge 0) représentant 14 familles. Les poissons d'âge 0 ont été recueillis dans tous les tronçons, mais surtout dans le tronçon inférieur. L'alose à gésier, *Dorosoma cepedianum*, et le crapet arlequin, *Lepomis macrochirus*, dominaient la communauté de poissons, qui était essentiellement transitoire, tandis que la queue à tache noire, *Notropis hudsonius*, et la carpe, *Cyprinus carpio*, étaient des espèces résidantes modérément abondantes. On pense qu'au moins six taxons provenaient de bassins adjacents, ce qui implique une extension de leur aire de répartition. On a recueilli en outre deux espèces de gobioïdes nouvellement arrivées en Amérique du Nord : le gobie de la mer Noire et le gobie arrondi.

INTRODUCTION

Small, low gradient tributary streams in the lower Great Lakes are invariably turbid, impoverished of rooted vegetation, and lack physical diversity. Their fish communities are dominated by forage, or so-called "coarse" species (Trautman 1981) and the result of changes in the hydrologic regime during 200 years of land use practices. Knowledge of fish ecology in small tributaries is superficial. Nevertheless, these fish communities influence ecosystem health in providing life support for fishes in large systems, such as the Great Lakes. Since fish ecology in streams may be evaluated from a perspective of early ontogeny (Schiemer et al. 1991), a brief qualitative survey of fishes was conducted in a small tributary of Lake St. Clair. The study, which arose from opportunistic sampling complementary to work in larger systems, intended to examine fish reproductive utilisation and age 0 fish occurrence and longitudinal distribution in a first order stream.

Study area

One of numerous low gradient streams in southwestern Ontario, Duck Creek is among the smallest tributaries of Lake St. Clair. It is located at the eastern boundary of the town of Belle River, mid-way between the Thames and Detroit rivers in Essex County (Fig. 1). Duck Creek drains a small area in one of the most highly cultivated and unique regions in Canada. Although the Carolinian life zone is located in this sector of Ontario, it long ago succumbed to human depredation so that natural terrestrial vegetation is now sparse. Soil types are derived from lake plain sediments, mainly consisting of silt size particles (Herdendorf 1986). Gravel-sand predominates as the major bottom type in the littoral zone of Lake St. Clair (Leach 1991). Circulating water masses along the shore of the lake relate to recent wind history. In summer, winds prevail from the southwest.

Duck Creek is approximately 9 km long and 10-15 m wide in the lower reach ("L": see Fig. 1). Station L is located between adjacent bridges servicing a railroad and Regional Highway 2, and about 200 m from Lake St. Clair. Steel piling supports banks between the mouth of the creek and the sampling site, where habitat is relatively diverse (Fig. 2). By happenstance, road, rail, marina, and cottage construction have created a small enclave for fishes. Whereas gravel prevails in mid-creek and at the base of bridges, alluvium and detritus form most of the substrate. In the lower reach, depth in mid-stream ranges from 1.2 to 1.6 m, depending on lake level, season, or occurrence of lake seiches. Stream banks, 1 to 4 m high (Fig. 2), are subject to constant degeneration.

The mid-reach sampling site ("M") encompassed a 30-m stretch of water beneath and on both sides of a bridge servicing County Road 42. Open fields flank the stream banks, which are shrouded by a narrow strip of shrubs and trees (e.g. *Salix, Prunus, Populus, Alnus* spp.). In April 1995, the creek was 4 m wide, 0.3 m deep, and current velocity ~20 cm/s. In late June, stream width had decreased to 3 m and flow was barely perceptible. During late summer and autumn, overhanging trees formed a canopy at the sampling site. Stream vegetation was sparse and dominated by *Myriophyllum spicatum* and *Chara vulgaris*. Clay, sand, scattered rock, and debris formed a varied substrate.

The upper reach site ("U") is location in flat, open terrain, just south of Highway 401. Although not at the origin of Duck Creek, this site is near the practical limit for sampling. In April, stream width at this locale varied from 1 to 3 m and depth from 0.2 to 0.5 m. In late June, flow decreased so that several sections of the creek bed were exposed, isolating a number of shallow (depth <0.3 m) pools. Low water prevailed until collections were no longer feasible in September. Substrate at this site consisted of clay, sand, and gravel.

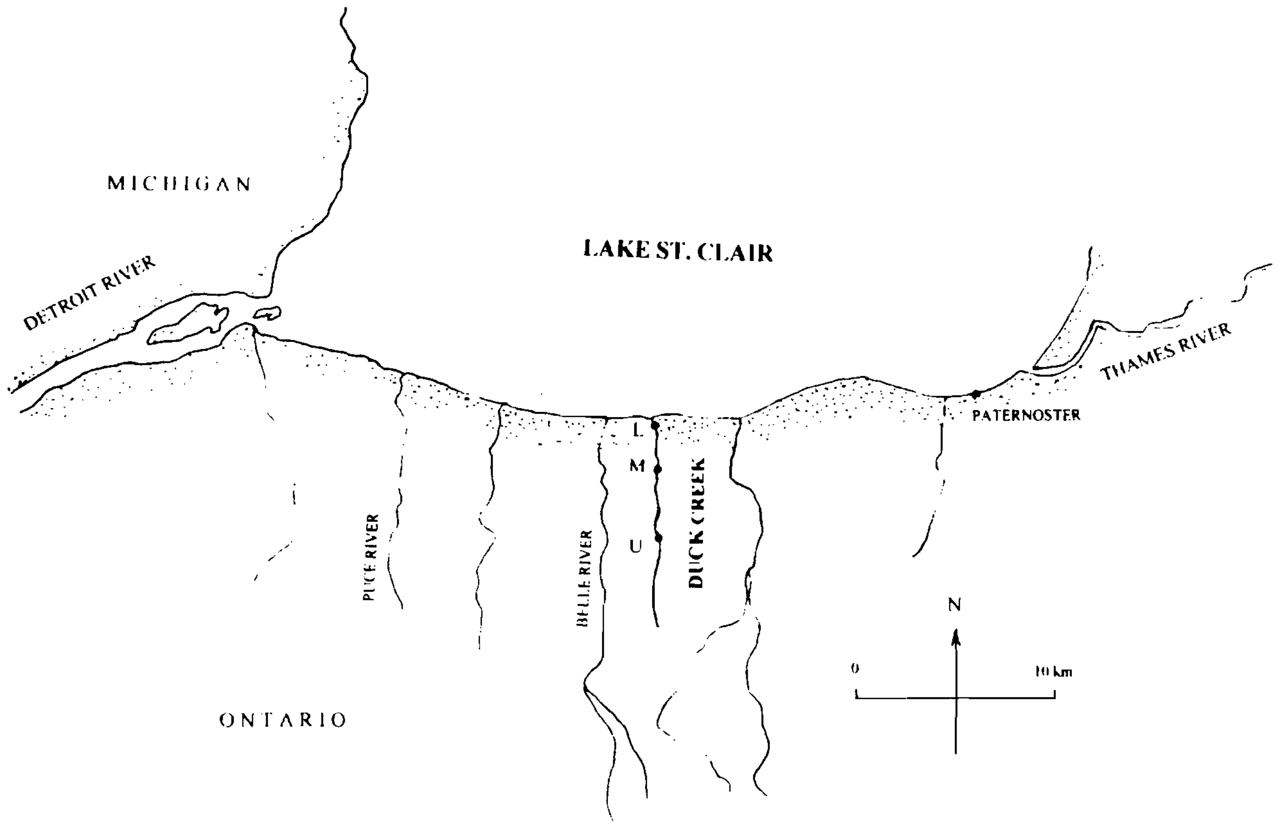

Fig. 1. Generalised map of study area, showing location of sampling sites L (lower), M (middle) and U (upper reach) in Duck Creek.

Rooted vegetation in Duck Creek includes *Potamogeton* spp., *Vallisneria americana*, *Elodea canadensis*, *Myriophyllum spicatum*, *Scirpus* spp., *Typha* spp., *Ceratophyllum crispus*, *Sagittaria* sp., and *Carex* spp. Aquatic vascular plants, which extend to a depth of approximately 0.5 m and about 1 m from the edge of banks, are established by mid-June. Water clarity was usually to bottom (0.2-0.5 m) at M and U, but constantly turbid at L. Water quality is affected by land drainage from cropland and urban areas. No water quality data are available for Duck Creek, but conditions are undoubtedly similar to those in enriched Belle River and Puce River, two nearby tributary streams of Lake St. Clair (Fig. 1). In 1990, pH was 7.3-8.4 in these streams, dissolved organic carbon averaged 10.6 mg/L, and mean dissolved oxygen was 8.5 mg/L (MOEE 1994).

METHODS

All collections were made with a larval fish bulging beach seine (4 m long, 1 m wide, mesh opening 0.4 mm) and two flat adult fish seines. Adult fish seines were 3 m long, 1 m wide (3 mm diamond-shaped mesh), and 6 m long, 1 m wide with 6 mm square mesh opening.

Typically, 3 to 6 successive collections were made for a distance of 10-15 m at the edge of the creek in L, and in the centre of M and U. Deep water and unstable bottom in L prevented use of beach seines in the centre of the creek. Occasionally, at least 10 samples were taken in order to obtain fishes of specific interest. Sampling took place in daylight weekly or bi-monthly from mid-June to early November 1994. In 1995 collections were taken weekly from April to mid-July, then bi-monthly until late October or early November. In 1994, all samples were taken in L, whereas in 1995, mid and upper reach sites were also sampled. Fish larvae identification was aided with descriptions given in Auer (1982) and adults were identified using species descriptions in Scott and Crossman (1973) and Trautman (1981). Where sufficient specimens were available, at least 20 fish (<30 mm) of each species were measured for total length, TL, (±0.2 mm); otherwise, all specimens were measured. Larger fish were measured to an accuracy of 0.5 mm. Age 0 fish are defined here as those hatched in the study year.

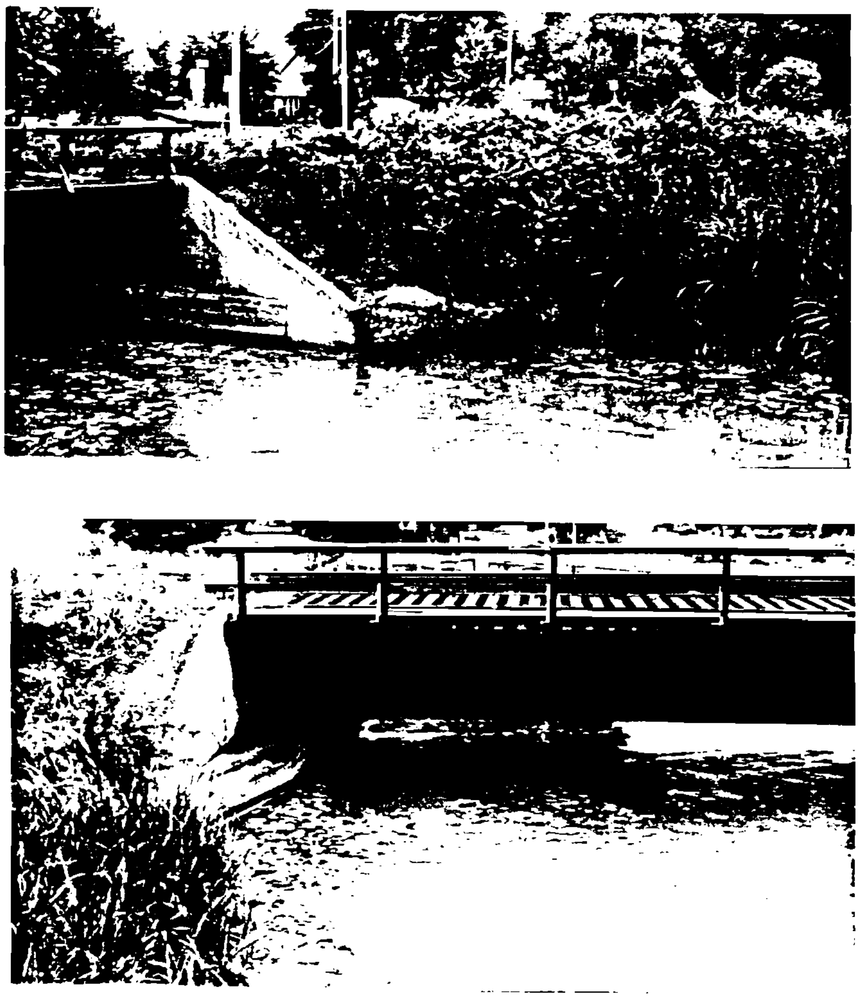

Fig. 2. Specific location of round goby habitat in Duck Creek: adjacent to concrete bridge abutments, near margin of stands of *Typha* sp. (upper and lower photos).

Temperature, pH, and conductivity were measured routinely at a depth of 0.2 m. In addition, weather conditions and temporal and spatial development of macrophytes were noted throughout the seasons. Growth (in total length) was estimated of the most abundant fish taxa.

Jaccard's coefficient of community Cc (Oosting 1956) was used to compare longitudinal occurrence of fishes. This index was compared with a fish turnover index T, which measures assemblage persistence. Persistence, P, is an indicator of stochastic assemblages. $P = 1\text{-}T$, where $T = (C + E)/S1 + S2$, in which C and E are the number of species common to samples S1 and S2 (Przybylski 1994).

RESULTS

Environmental conditions

Water levels in 1994 and 1995 were approximately 0.5 m lower than the recent historical high for the lake (175.83 m) in 1986. During main fish spawning months (May and June), mean water levels were 9-11 cm lower in 1995 than in 1994 (DOE 1994; 1995). Low water levels in the lake decrease reproductive and nursery habitat for fishes utilising the lower reach of small tributary streams, such as Duck Creek. At L (Fig. 2), rooted vascular plants were dominated by *Typha* sp., which extended to a height of ~2.5 m at the margin of the creek, and *Potamogeton* spp., *Vallesneria americana, Myriophyllum spicatum,* and *Nymphaea tuberosa.* These plants were abundant by mid-June. Macrophytes were much less diverse in M than in L and were dominated by *Chara* sp., and *M. spicatum. Najas* sp. was the most common of a small number of species in U. *Najas* is probably more important to small fishes as substrate for food items, e.g., periphyton and invertebrates, than as cover.

In 1994, water temperature remained above 15°C from first sampling in mid-June to late September (Fig. 3). Temperature regimes in 1994 and 1995 were similar, but were slightly higher and less variable in 1995. In spring and autumn, respective water temperatures were usually about 2°C lower in M and U than in L. However, as run-off decreased in summer and the upper reach developed a series of isolated pools, water temperature was 2-3°C higher in U than in M and L.

Conductivity varied widely between sampling dates in 1994 and 1995. In L, mean conductivity for respective years was 421 ± 235 and 487 ± 138 μS/cm, whereas mean conductivity in M and U was 829 ± 191 and 888 μS/cm, respectively. Secchi disc transparency varied throughout the sampling period. For example, Secchi disc transparency ranged from an average of 0.08 m in early May 1995 to 0.5 m in late September 1994. In L in both years, mean Secchi disc transparency was 0.3 ± 0.1 m (N = 22), whereas in M and U, transparency usually extended to bottom.

Fish species composition and occurrence

Forty-one fish taxa and an unidentified catostomid (redhorse) species were recorded (Table 1) in the total collection (6272 specimens). A small number (<0.1%) of fishes either was unidentified, unidentifiable due to maceration, or spoiled due to incomplete preservation. Fishes representing most feeding modes: planktivores, benthivores, herbivores, omnivores, and piscivores were collected. On the basis of repeated occurrence, 23 species were considered spring-autumn residents of Duck Creek and the remainder were "transients". All species, except gizzard shad, alewife, logperch, golden redhorse, goldfish, and quillback were represented as age 1+ fishes. Thirty-two age 0 fishes were collected, several of which (e.g., alewife, emerald shiner, and logperch) were undoubtedly transients from Lake St. Clair.

Table 1. Species list and seasonality of fishes collected in Duck Creek, Lake St. Clair in 1994-1995 (o = occurrence as age 0; X = age 1+). Rank = numerical abundance. Occur = occurrence as T = transient, R = resident.

Scientific name	Common name	Ap-Jun	Jly-Sep	Oct-Nov	Occur	Reach L	M	U
Lepisosteus osseus*	Longnose gar	oX	oX		R	oX		
Amia calva	Bowfin	X	X	X	R	X	X	
Dorosoma cepedianum*	Gizzard shad	o	o	o	R	o	o	o
Alosa pseudoharengus	Alewife	o	o	o	T	o	o	
Notropis volucellus	Mimic shiner			X	T	X	X	
Notropis atherinoides*	Emerald shiner	oX	oX	X	T	oX	X	
Notropis hudsonius*	Spottail shiner	oX	oX	X	T	oX	oX	X
Cyprinus carpio*	Common carp	oX	oX	oX	R	oX	oX	oX
Carassius auratus	Goldfish		o		T	o		
Cyprinella spiloptera*	Spotfin shiner	X	X	X	T	X	X	
Pimephales notatus*	Bluntnose minnow	oX	oX	oX	R	oX	oX	o
Pimephales promelas	Fathead minnow	X			T			X
Moxostoma erythrurum	Golden redhorse	o			T	o		
Moxostoma sp.	Redhorse sp.		oX		T	oX		
Catostomus commersoni	White sucker	X			T		X	
Carpiodes cyprinus*	Quillback	o			T	o		
Noturus gyrinus*	Tadpole madtom	oX	oX	oX	R	oX	oX	
Ameiurus natilis*	Yellow bullhead	oX	X	X	R	oX		
Ameiurus nebulosus*	Brown bullhead	X	oX	oX	R	oX	oX	X
Ameiurus melas	Black bullhead	X			T			X
Esox masquinongy	Muskellunge	X			T	X		
Esox lucius*	Northern pike	oX	oX	oX	R	oX	X	o
Umbra limi	Central mudminnow	oX	oX		R	oX		X
Fundulus diaphanus	Banded killifish	oX	oX	oX	R	oX	oX	
Labidesthes sicculus*	Brook silverside	oX	oX	x	T	oX		
Morone chrysops	White bass	X	X		T	X	X	
Lepomis macrochirus*	Bluegill	oX	oX	oX	R	oX	oX	o
Lepomis gibbosus	Pumpkinseed	oX	X	X	R	oX	X	X
Lepomis cyanellus*	Green sunfish	oX	oX	oX	R	oX	X	
Lepomis humilis*	Orangespotted sunfish	oX	oX	oX	R	oX		
Lepomis gulosus	Warmouth			oX	T	oX		
Micropterus salmoides*	Largemouth bass	oX	oX	oX	R	oX	X	X
Micropterus dolomieu	Smallmouth bass		o	oX	T	oX	o	
Pomoxis nigromaculatus*	Black crappie	oX	oX	oX	R	oX	o	
Pomoxis annularis	White crappie	oX	oX		R	oX	o	
Ambloplites rupestris*	Rock bass	oX	oX	oX	R	oX	X	
L. macrochirus x L. gibbosus	Hybrid	X	X	X	T		X	
L. macrochirus x L. humilis	Hybrid		X		T	X		
L. cyanellus x L. humilis	Hybrid			X	T	X		
L. gibbosus x L. gulosus	Hybrid			X	T	X		
Perca flavescens	Yellow perch	oX	X	X	T	oX	oX	X
Percina maculata	Blackside darter	X		X	R	X		X
Percina caprodes*	Logperch	o			T	o		
Etheostoma nigrum	johnny darter			X	R		X	
Neogobius melanostomus*	Round goby	oX	oX	oX	R	oX	X	
Proterorhinus marmoratus*	Tubenose goby	oX	oX	oX	R	oX		

*species collected in L during 1995

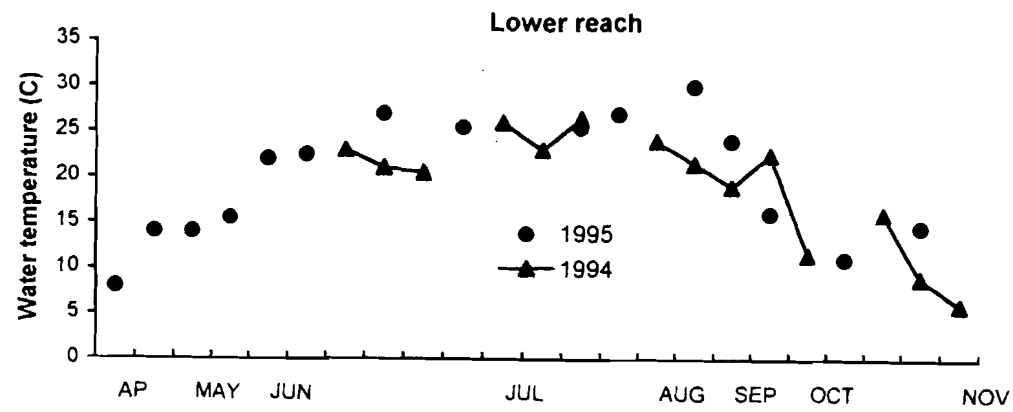

Fig. 3. Water temperature in the lower reach (L) of Duck Creek in 1994-1995.

Duck Creek is dominated numerically by spottail shiner, gizzard shad, bluegill, and common carp. However, only the latter three and bluntnose minnow were collected as age 0 fish in all reaches (Table 1). Reproductive habitat for these taxa is, however, not extensive. Gizzard shad were more abundant as older larvae and age 0 juveniles than as recently hatched fish and dominated all reaches of the creek more than any species. Bluegill, orangespotted sunfish, and spottail shiner were found mainly at the margin of vegetation in the lower reach. Tubenose goby and round goby were rarely collected together and partitioned habitat in the lower reach. Tubenose gobies occupied an area with large boulders and solid debris submersed in clay in the presence of *Vallisneria americana*, *Potamogeton gramineus*, and *Myriophyllum spicatum*. Round gobies, in contrast, were restricted to an unvegetated area at the base of bridge structures in L (Fig. 2).

In May 1995 first fishes collected included logperch, black crappie, golden redhorse, and common carp. They were followed chronologically by pumpkinseed, tubenose goby, gizzard shad (in early June), several centrarchids and cyprinids, brook silverside, and alewife in late June. On November 2, 1994, a collection of round gobies may have been the first reported for the species on the southeastern shore of Lake St. Clair. In June 1995 a small collection of age 1 round gobies (44-47 mm) was followed by capture of age 0 round gobies in August. Age 1+ tubenose gobies were first collected in mid-November 1994, whereas larvae first appeared at 22°C on June 1, 1995. Thereafter, both larvae and adult tubenose gobies were collected each month in L. However, no tubenose gobies were found in U.

Centrarchids were represented by more species and residents (10 and 8, respectively) than any other family (Fig. 4). Cyprinids (8 species) were mainly transients, as were catostomids. Bluegill led all centrarchids numerically (75%), followed by orangespotted sunfish (14%) and black crappie (7%). Most centrachids appeared sporadically. For example, eleven warmouth (33-93 mm) were found in L only in mid-November, 1994 and largemouth bass only in spring and late autumn. Similarly, almost all (N = 291) orangespotted sunfish (12-20 mm) were caught in late June at 22°C, when the suspended sediment load was highest (maximum Secchi disc transparency = 0.2 m).

Eight cyprinids contributed 39% to the collection of age 0 fishes. Spottail shiner and common carp each represented 46-49% of all cyprinids, or 18-19% of total catch. Bluntnose minnow, a "resident" fish, occurred in all reaches of Duck Creek, although it was most often caught in L. Emerald shiner was a transient that appeared sporadically as age 0 fish in late June, 1994 and in early November as age 1+(>40 mm). Although 12 species (5 age 0 and 7 age 1+) co-occurred in L on June 1 1995, no larvae were collected at either upstream site on this date. This absence was undoubtedly due to extreme turbidity (Secchi disc transparency <0.2 m) and oil pollution emanating near the origin of the creek. Similarly, no age 0 fishes were caught in M on August 2, 1995, when blue-green and filamentous green algae prevailed. Schools of gizzard shad (53.7 mm mean TL; range = 41-66 mm) were collected as migrants in M when strong onshore winds caused flow reversal in Duck Creek on September 7, 1995.

Longitudinal distribution of fishes

According to location in Duck Creek, age 0 and 1+ fishes co-occurred least during mid-summer and autumn. As edge emergent and submersed macrophytes developed in June, the assemblage of age 0 outnumbered age 1+ fishes. Thereafter, age 1+ fishes predominated in L, and also in M, albeit 1-2 wk later. Between late June and late July, numbers of age 0 fishes increased and age 1+ decreased in U. In any case, only gizzard shad, common carp, bluntnose minnow, northern pike, and bluegill were collected as age 0 fish in U. Gizzard shad probably originated in Lake St. Clair, since no recently hatched fish were collected. Adult fishes were seldom found when isolated shallow pools formed in the upper reach. Although sampling in L began in mid-June 1994, a total of 37 species was collected, compared with 22 in 1995, when samples were first taken in mid-April. Between year differences in number of species owes to rare appearances of several incidental fishes collected in low number (<10) in 1994. Whereas centrarchids and cyprinids were represented in roughly the same proportion in U and M, "other" species (Fig. 4) increased in number toward L and varied accordingly. At least one predator, northern pike and/or largemouth bass, appeared on most sampling dates in all reaches.

Distinct differences were observed in longitudinal distribution of many species. For example, 5 age 0 fishes (10 age 1+) were collected in U, 13 (22 age 1+) in M, and 32 each of age 0 and 1+ in L (Table 1). Of the total collection of age 0 fishes, only common carp, bluegill, bluntnose minnow, largemouth bass, and gizzard shad occurred at least once at all sites. The large number of species concentrated in L exploited a small area of diverse habitat. Jaccard's coefficient of community (Cc) for species shared in L and M ranged from 0 on July 5 to 0.38 on November 2. Relatively few fishes were shared by the three sites, but especially at U and M (Fig. 5). A low overall mean Cc of 0.20 indicated weak correspondence between species at these sites. Respective mean Cc for L and U and M and U were 0.09 and 0.21. Fishes occurring in M were not found in L on 6 sampling dates between mid-May and early July. Turnover indices (T) for these sites were very low (0 to 0.29), indicating high persistence. Turnover and consistency indices in three reaches were highly correlated (coefficients = 0.84 to 0.90), which indicates the fish assemblage in Duck Creek was formed by stochastic events.

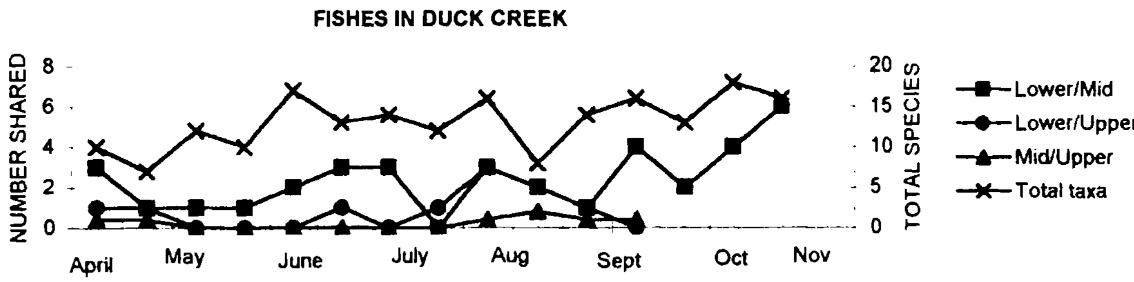

Fig. 4. Seasonal total number and co-occurrence of age 0 and 1+ fishes in three reaches of Duck Creek, 1995.

Two yearling muskellunge (240 mm and 330 mm TL) were found in L in late spring. Similarly, age 0 northern pike (range = 54-141 mm TL; N = 13) appeared in edge vegetation in L and U. Smallmouth bass was the least abundant centrarchid. It was found only in shallow isolated pools in M and L, whereas age 0 largemouth bass and pumpkinseed occurred in L. A seral assemblage in L consisted of at least 23 age 0 and 1+ fishes, whereas much smaller assemblages utilised M and U, usually temporarily. Yellow perch, quillback, and muskellunge emigrated from L, spottail shiner and common carp from M, and spottail shiner and white sucker from U. Conversely, emerald shiner, largemouth bass, gizzard shad, and alewife all migrated upstream.

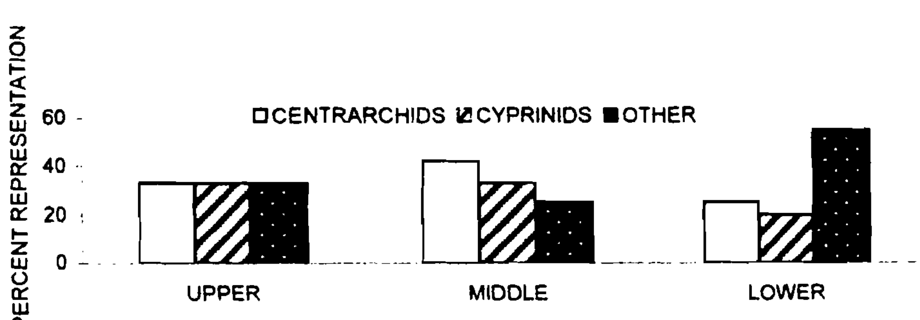

Fig. 5. Percent contribution of main families of fishes in three reaches of Duck Creek, 1995.

Table 2. Numerical representation (% total catch of N specimens) according to longitudinal distribution of age 0 fishes in Duck Creek, 1994 and 1995.

1994 N = 3721 **Lower reach**	%	1995 N = 2180 **Lower reach**	%	1995 N = 320 **Mid-reach**	%	1995 N = 51 **Upper reach**	%
Bluegill	26	Bluegill	26	Bluegill	21		
Spottail shiner	25	Spottail shiner	8	Spottail shiner	6		
Gizzard shad	22	Gizzard shad	5	Gizzard shad	40	Gizzard shad	49
Common carp	9	Common carp	36	Common carp	18	Common carp	24
Orangespotted sunfish	8			White crappie	6		
Black crappie	3	Yellow bullhead	14			Northern pike	10
						Largemouth bass	10

<u>Age 0 fish growth in total length</u>

Because of temporal gaps in the appearance of many species, estimates of seasonal growth were available only for gizzard shad, bluegill, tubenose goby, and round goby. In mid-October and mid-November 1994, gizzard shad were 88.7 ± 13.7 mm (N = 9) and 95.9 ± 18.1 mm (N = 16), respectively, having grown an average of 0.6 mm/d since mid-June. During the same period in 1995, length increased an average of 0.5 mm/d and gizzard shad attained smaller mean TL (77.4 ± 10.2 mm; N = 45). Only a small number of recently hatched gizzard shad was collected each year, which suggests that in spite of high abundance of older age 0 fish, reproduction in Duck Creek may have been insignificant.

Bluegill utilised the small ecotope available for spawning and rearing at L, and relatively few older larvae of the species eventually migrated upstream. Bluegill larvae, like gizzard shad, were larger in late spring, 1994 than in 1995 but realised faster mean growth during 1995 (e.g., 42.5 ± 4.5 mm; N = 20 in early September, compared with 33.3 ± 7.8 mm; N = 67 in 1994). In both years, average length increased 0.3 mm/d over the total sampling period. Rock bass and black crappie attained similar mean length at the end of first year growth (49.2 mm and 49.5 mm, respectively).

Smallest tubenose goby (7.2 ± 1.4 mm, range = 5.1-9.5 mm; N = 17) were found in turbid conditions in L on June 1, 1995. On July 5, 1995 a small collection of tubenose goby consisted of fish ranging from 7.6 mm to 31.9 mm. "End of first year" growth was difficult to discern, as subsequent collections were mainly of age 1 tubenose goby. Based on lengths of smallest specimens collected in September (35.0 ± 3.7 mm; N = 12), we assume growth was approximately 0.3 mm/d. Although small numbers of age 0 round goby were collected from mid-August to early November 1995, recently-hatched larvae were not collected in Duck Creek. In autumn, fish were 30.8 ± 4.6 mm (N = 13), thus, growth appeared to be similar to that in the tubenose goby.

DISCUSSION

Duck Creek supplies spawning and rearing habitat for a large number of fish taxa that represent a wide range of reproductive strategies. As well, it serves as temporary refuge and forage habitat for fishes of the littoral zone of lakes. In the lower reach the fish assemblage changed with arrival and departure of spawners and seasonally migrating species from Lake St.

Clair or upstream. Percentage of resident taxa was lowest in the upper reach, where, in addition to environmental differences, abiotic stresses compel fishes to emigrate to lower reaches. This is characteristic of fish communities in most stream orders (Schlosser 1982; Zalewski et al. 1990). Highest habitat diversity occurred in a small enclave adjacent to two bridges, where environmental flux is relatively low, but human interference is most direct.

Species were representative of many environmental conditions: standing water, turbid low gradient fluvial, vegetated embayment, moderate-flow riverine, floodplain, mud-bottomed, gravel, and sand substrate, and pelagic. For example, bluegill, a dominant fish, was found at various sizes in all reaches, although mainly in the lower reach. Characteristically, cyprinids were almost exclusively transient. Normally an inhabitant of large systems, spottail shiner usually influx the shore of lakes and the mouth of streams in autumn. Similarly, large numbers of age 0 emerald shiner, a pelagophil, migrate inshore in autumn (Scott and Crossman 1973). However, emerald shiner larvae were not collected in large number in Duck Creek, possibly due to constant high concentrations of suspended sediment. More typical of species tolerant of high concentrations of suspended sediment, gizzard shad dominated the community throughout the summer. It has been found repeatedly in turbid conditions elsewhere in the Great Lakes (see, for example: Leslie and Timmins 1990; 1992; 1998a, b). A highlight of the present study was the collection of two species recently introduced to North America, namely gobies, and their partitioning of microhabitat.

Tubenose goby and round goby, native to the Black and Caspian seas were first found in the St. Clair River in 1990 (Crossman et al. 1992; Jude et al. 1992). Contrary to popular opinion, the distributive vector, thought to be foreign ships, has never been established for these fishes. Tubenose goby is a rheophilic fish in its native waters, but its distribution in the Great Lakes indicates it has adapted to lentic, vegetated habitat. Most Gobiidae reproduce at approximately age 3, although maturity depends on growth rate (Miller 1984). Thus, the tubenose goby probably invaded Duck Creek no later than 1992 or 1993. In June 1995, we collected larvae as small as 5 mm about 1-2 wk after hatching late in May. In 1994 and 1995, collections of larvae and older tubenose goby were made at Paternoster (Fig. 1) from June to August and adult round goby in September (Leslie and Timmins 1998b). Evidence of reproduction in Duck Creek, together with reports of round goby near Windsor (Jude et al. 1995) indicate both species have probably colonised much of the shore of Lake St. Clair.

Round gobies are apparently more abundant than tubenose gobies in the St. Clair River system (Jude et al. 1992). Although both fishes were collected at the Belle River Power Plant, Michigan in autumn and winter of 1990-91, they were not among 20 species collected in shoreline rock and rubble at Lambton Generating Station (GS), Ontario in October, 1990 (Leslie and Timmins 1991). However, subsequent sampling in 1993-1998 revealed Lambton GS a reliable source of round goby specimens of all developmental stages. On the other hand, tubenose gobies, which we first collected at Lambton GS as larvae in early July 1996, were much less abundant and occurred only sporadically (Timmins, unpubl. data 1997). The occurrence of gobies in environments contrasting in water clarity (high at Lambton GS, low in Duck Creek) indicates that in the Great Lakes, as in southern Europe and Asia minor, they adapt to widely differing habitats. It is apparent that the round goby favours firm substrate, whilst the tubenose goby is associated more with submersed vegetation. More extensive field studies are required in order to determine distribution and range of habitat utilisation for both species. This would necessitate several sampling strategies to accommodate various depth strata, substrates, and types of rooted aquatic vegetation.

In addition to gobies, range extension may have been recorded for at least four taxa. For example, year-old muskellunge were found in spring amongst *Vallisneria americana*. Although this apparently extends its contemporary range (Mandrak and Crossman 1992), the muskellunge was formerly more ubiquitous in southwestern Ontario. Similarly, orangespotted sunfish and warmouth have not been reported in southeastern Lake St. Clair, although they were recently found in Canada in drainage of western Lake Erie (Crossman and Simpson 1984; Noltie and Beletz 1984). Both species are endemic to the United States. Orangespotted sunfish, "vulnerable" in Canada, tends to occupy silt-laden waters, such as Duck Creek. This fish was collected mostly as larvae in the lower reach but apparently avoided mid and upper reaches, where water clarity is generally high and depth shallow. Warmouth is less common than orangespotted sunfish, although both taxa are now established in numerous turbid streams in southwestern Ontario, such as the Canard River and Cedar Creek (Timmins unpubl. data 1998). Blackside darter was one of a small group collected in low quantity during the low flow regime in late summer. According to Mandrak and Crossman (1992), blackside darter is restricted in Canadian waters to southwestern Ontario but has not previously been reported in southeastern Lake St. Clair. This may reflect lack of intensive or extensive field surveys in the past, rather than range extension.

Many details of fish early life history are strongly dependent on habitat selection and sampling methods (Schlosser 1982; Floyd et al. 1984; Bayley and Dowling 1993; Leslie and Timmins 1994; 1995). Tubenose and round goby probably would have been overlooked in Duck Creek, were plankton nets deployed solely as drift or active samplers. Sampling confined to the centre of L would underrepresent many fishes in Duck Creek (Chubb and Liston 1986). Moreover, larger numbers of nocturnally active species such as tadpole madtom and bullheads were probably missed during day sampling. Finally, habitat use does not necessarily indicate preference, since difficult habitats are less likely to be sampled (Aadland 1993), or are invariably sampled inefficiently. Our collections in mid and upper reaches were doubtless much more quantitative than in the lower reach, where soft substrate and submerged objects interfered with seining. Consequently, estimates of fish density were unattainable in this, a preliminary survey. Nevertheless, approximations of growth to end of summer were possible for several fishes.

Co-dominants in Duck Creek, gizzard shad and bluegill, increased total length at rates comparable to those in other ecosystems in southern Ontario. Gizzard shad were 77-96 mm in late autumn, compared with 61 mm in nearby Paternoster, and 72-74 mm in mid-September in an agricultural ditch (Leslie and Timmins 1998a). These values exceed those for Lake Erie surf zone fish in 1994 (i.e., 58-63 mm in late September and early October) (Leslie and Timmins 1998b). High temperature and abundant plankton likely promoted rapid growth of fish larvae in Duck Creek, although we have no data to support this assumption. Age 0 bluegill were 33-43 mm in September 1994 and 1995 in Duck Creek and 37-40 mm in Whitebread canal and Paternoster in November, 1994 (Leslie and Timmins 1998a). In Lake Opinicon, an eutrophic lake in eastern Ontario, bluegill averaged 31 mm in October (Keast and Eadie 1984). Thus, in spite of human influences, e.g., loss of natural habitat, land drainage of pesticides, herbicides, and fertilizers, Duck Creek supports a large number of fishes that reproduce successfully and their young at year-end attain a size comparable to species elsewhere in eutrophic waters in southern Ontario.

Whereas Duck Creek is presently utilised by a large number of fishes during at least part of their life cycle, the assemblage undoubtedly contrasts with that of the pre-settlement era. Higher priority on land use is needed in the context of conservation of biological diversity, because urbanisation and intensified land cultivation are increasing throughout watersheds in southwestern Ontario. Nevertheless, the Department of Fisheries and Oceans' policy of no net loss in productive fish habitat applies to waters large and small (DFO 1983). Therefore. sustainability of the fish community as a whole should take precedence over individual commercial or recreational species in adjoining larger systems, because, in the words of John Donne, no fish is "entire of itself."

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