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Use of main channel and two backwater habitats by larval fishes in the Detroit River

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ABSTRACT

Recent investigations in the Detroit River have revealed renewed spawning activity by several important fishes, but little is known about their early life history requirements. We surveyed two main channel and two backwater areas in the lower Detroit River weekly from May to July 2007 to assess habitat use by larval fishes. Backwater areas included a soft-sediment embayment (FI) and a hard-sediment area (HIW). Main channel sites were located adjacent to each backwater area. Water temperature, velocity and clarity measurements and zooplankton samples were collected weekly. A macrophyte assessment was conducted in July. Growth and diet of larval yellow perch (*Perca flavescens*), bluegill (*Lepomis macrochirus*) and round goby (*Neogobius melanostomus*) were used to assess habitat quality. Macrophyte diversity and percent cover were higher and velocity lower at FI than HIW. Although larval fish diversity was highest in the main channel, yellow perch and bluegill larvae only grew beyond the yolk stage at FI, where they preferentially selected copepods, while *Daphnia* were selected in the main channel. Round goby ate harpacticoid copepods and *Daphnia* and grew at similar rates in HIW and the main channel. These data indicate that FI was a valuable nursery area for yellow perch and bluegill, whereas HIW was better suited to round goby. We only assessed two backwater areas, thus a complete census of wetland areas in the Detroit River is needed to identify valuable habitats. Restoration of shallow backwater areas is essential for rehabilitating fish populations and should be a priority in the Detroit River.

Introduction

The Detroit River is part of the Huron–Erie Corridor (HEC) connecting Lake Huron to Lake Erie and serves as an important migration route for many fishes, some of whom use it for spawning and early life stage development. At least 21 species of larval fishes have been documented in the Detroit River; the most abundant included rainbow smelt, alewife and gizzard shad (Hatcher and Nester, 1983). Important sport and commercial fishes that use the river for spawning, nursery, and adult habitat include crappies, lake sturgeon, lake whitefish, largemouth bass, smallmouth bass, and walleye, (Caswell et al., 2004; Goodyear et al., 1982; Hatcher and Nester, 1983; Roseman et al., 2011).

Habitat loss is a major factor affecting fishes in the Detroit River. Most of the historic coastal wetlands on the Michigan side have been lost (Manny, 2003). Pollution from bordering industrial facilities, waste discharge from nearby cities, armored shorelines, dredging, and channel construction have also contributed to the reduction of habitat in the Detroit River (Manny, 2003; Manny et al., 1988). Human activities such as recreation, power generation, and transportation also negatively affect the suitability of the river for fishes (Manny, 2003). Research that quantifies the abundance and functionality of remaining spawning and nursery habitats is needed to provide resource managers with contemporary scientific information necessary to develop strategies that protect and restore the health and productivity of the river.

Contemporary lotic habitats in the Detroit River are diverse and include natural river channels such as the lower Trenton Channel where the river bottom has not been dredged, deep channels that accommodate large ships such as the dredged Amherstburg Channel, and constructed channels that are long, deep, and narrow such as the Livingstone Channel (Derecki, 1984; Edwards et al., 1989). The few remaining littoral habitats are equally diverse in structure and size and include diked wetland complexes, littoral fringes along main channel areas, marinas, and backwater embayments and invaginations (Derecki, 1984; Manny et al., 1988). The diversity of habitat types offers the potential for the Detroit River to meet the life history requirements for numerous native fishes underscoring the ecological importance of this system.

Recent investigations of fish habitat use in the Detroit River have revealed renewed spawning activity by several socially and ecologically important fishes including lake whitefish (Roseman et al., 2007, 2012), walleye (Manny et al., 2007) and lake sturgeon (Caswell et al., 2004; Roseman et al., 2011). In addition, some nearshore areas of the Detroit

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River have been found to support diverse assemblages of native fishes (Hintz, 2001). The improvements to the environmental conditions and aquatic community in the Detroit River have been attributed in part to habitat protection and decreases in water pollution (Hartig et al., 2007).

Although some spawning activity by native fishes has been detected by researchers in the Detroit River, it is unclear whether larval fishes are using the limited remaining wetland and backwater habitats within the river. While diverse in size and type, protected nearshore wetland and backwater areas may serve as nursery habitats because they are highly productive, being routinely replenished with nutrients from the main channels and surrounding landscape (Sheaffer and Nickum, 1986). Macrophytes are an important component of nursery habitats because they provide refuge from predators and attract prey for larval fishes (Lane et al., 1995). They also minimize flows (Madsen et al., 2001) thereby increasing the residence time (retention) of larval fishes. Sufficient nursery habitat is important because it provides newly hatched larvae with the necessary resources and environmental conditions for growth (Houde, 1989; Leslie and Timmins, 1991, 1993).

Hayes et al. (1996) classified fish habitat features based on their effects on fish population dynamics. Similarly, Orth and White (1993) inferred that good habitat is a "place" where life history needs are met including food, refuge from predators and adverse environmental conditions, and connection with migration and dispersal routes. In our study, we used habitat characters such as connectivity, retention, feeding, and growth to make inferences about the level of habitat quality for larval fishes at sites in the Detroit River. High quality nursery habitats would be well connected to the main channel and have high retention of larvae. Food would be abundant and most larvae would be eating and growing larger.

It is important to assess the performance of fishes in potential nursery habitats in the Detroit River to understand how these areas function so they can be protected and restored. Larval growth rate and diet analysis can yield information about the quality of the habitat. Higher growth rates are beneficial because large larvae are less likely to be preyed upon by gape-limited predators (Rice et al., 1987). In addition, large larvae can eat a wider size range of prey than small, gape-limited larvae and thus exhibit higher growth rates (Miller et al., 1988). Turbidity, water temperature, zooplankton abundance and larval fish densities have also been shown to affect growth rates (Claramunt and Wahl, 2000; Letcher and Bengtson, 1993; Post et al., 1997).

The characteristics of good quality nursery habitat vary depending on the life history of the species in question. This study focused on the larvae of three recreationally and ecologically important species: yellow perch; bluegill; and round goby. Yellow perch and bluegill are common to the Detroit River and are known to use shallow, slack-water areas for spawning and early life stage development (Jude et al., 1998; Poe and Poe, 1983). These larvae have diverse habitat requirements: newly hatched larvae move to open water portions of the habitat to avoid predation and take advantage of zooplankton resources and move back to vegetated areas after attaining a larger size (Scott and Nielsen, 1989; Werner, 1969; Whiteside et al., 1985). Very little is known about the early life history of round goby. The adults spawn in cavities among rocky or hard surfaces in areas with minimal silt (Moskal'kova, 1996). Larvae remain in the nest using their fused ventral fins to adhere to the hard surface. Once they reach the juvenile stage, round goby migrate a short distance from the nest and establish residence (Moskal'kova, 1996). Although typically considered benthic, recent evidence suggests that larval round goby migrate toward the surface at night and have been collected in neuston samples, possibly as a means of dispersal (Hensler and Jude, 2007).

The purpose of this study was to examine two contrasting backwater and two main channel areas for suitability as nursery habitat for larval fishes in the Detroit River. We measured environmental characteristics and larval fish species composition over time to determine the degree of similarity between backwater and main channel habitats. We also compared the growth rate and diet of larval yellow perch, bluegill, and round goby in backwater and main channel areas to assess relative quality of each habitat.

Materials and methods

Study area

The Detroit River is 51 km long and is an unregulated river with a relatively constant flow (approximately 5300 m^3/s; Derecki, 1984). Approximately 95% of water in the Detroit River comes from Lake Huron (Manny et al., 1988). Flow in the lower river branches into three, deep (6.4–8.8 m) channels (Trenton, Livingstone and Amherstburg) maintained by dredging (Manny et al., 1988). Two shallow vegetated areas in the Detroit River representing contrasting backwater habitats were sampled in 2007 (Fig. 1). The first area (FI) was located along the eastern shore of the river just south of Fighting Island. The second area, Hole-in-the-Wall (HIW), was located southeast of Grosse Ile. We also sampled three river main channel (MC) sites adjacent to each nursery area in 2007 (Fig. 1).

Nursery and main channel assessment

Several physical and biological variables were measured concurrently with larval fish assessment to characterize environmental conditions at each site. Depth (m) and surface water temperature (°C) were measured using the vessel's onboard depth finder with integrated temperature gauge. Water velocity (m/s) was measured in the top 1 m of the water column using a Marsh-McBirney flow meter.

To quantify the structural complexity of backwater areas, aquatic macrophytes were collected on 11 July 2007 using a grapnel hook lined with 1-cm square wire mesh. Four 10-m tows (two towards shore and two away from shore) were made with the grapnel hook at each sampling site (Schloesser and Manny, 1982). All macrophytes were identified using Schloesser (1986). We estimated macrophyte density by measuring the volume of plant material collected in each tow (low ≤ 10 L, medium = 11–30 L, or high > 30 L). Percent cover within an imaginary 7.5 m radius circle was estimated using a diagram for visual estimation of percent cover (Integrated Land Management Bureau, 2007). Relative abundance (percentage by volume) was estimated by dividing wet vegetation into species-specific piles. Three observers estimated the percent contribution of each pile (B. Manny pers. comm.). Mean relative abundance, percent cover, and species richness were compared between HIW and FI using the Mann–Whitney *U*-test (Zar, 1999) since the data were not normally distributed and could not be transformed.

Zooplankton samples were collected weekly using a 0.5-m diameter plankton net fitted with 64 μm mesh netting. One or two 7-m horizontal tows were collected at FI and HIW; one or two vertical tows were taken at MC sites. Samples were preserved with 10% formalin. Copepods (calanoids, cyclopoids and nauplii) and cladocerans were identified using Balcer et al. (1984). Rotifers were identified using Edmondson (1959). Rotifer densities were determined using 1-mL Sedgwick-Rafter cell counts, while planktonic crustaceans were quantified using a 5-mL plankton-counting chamber. Zooplankton density in backwater sites was compared using a randomized block design ANOVA with date and habitat as factors.

Larval fish assessment

Larval fishes were collected from backwaters and MC areas in the Detroit River using light traps and ichthyoplankton nets. Sampling occurred every 7–10 days between 9 May and 2 July 2007. Light traps were constructed of clear acrylic inside a 30.0 cm polycarbonate frame arranged in a cloverleaf pattern with longitudinal gaps between tubes (25 cm diam., 30 cm length). The bottom plate of the frame had a

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