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Competitive Interactions between Round Gobies and Logperch

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ABSTRACT. *We examined territorial defense and behavioural interactions between two species of fish resident in Hamilton Harbour: non-indigenous round gobies* (Neogobius melanostomus) *and native logperch* (Percina caprodes). *Trials consisted of placing one fish, "the resident" (either a round goby or a logperch), in a tank with a shelter for 24 hours before adding another fish, "the intruder" (either a round goby or a logperch), and recording aggressive incidents. Overall, gobies exhibited more aggressive behavior than logperch, and in general resident status had no effect on amount of aggression displayed. Also, gobies spent more time in shelters than logperch, and overall resident status did not affect the amount of time spent under shelter. We also compared abundance data for gobies and logperch using electrofishing transects in Hamilton Harbour that were conducted in 1995 and 2001 and found a dramatic increase in round goby numbers and a non-significant decrease in logperch numbers. Our data suggest that gobies are superior space competitors and hence the range expansion coupled with an increasing population size of the round gobies in Hamilton Harbour is likely to have deleterious consequences for logperch populations.*

INDEX WORDS: *Interspecies competition, Hamilton Harbour, Lake Ontario, Great Lakes exotic invasive species.*

INTRODUCTION

A number of researchers have suggested that the round goby, *Neogobius melanostomus*, a newly invasive species in the Great Lakes, has had deleterious effects on the populations of native fishes (de Kock and Bowmer 1993, Kuhns and Berg 1999, French and Jude 2001, Janssen and Jude 2001). In this study, we examined competitive interactions between one native species, logperch, and round gobies in the laboratory to determine if the outcome of such interactions might help explain the suggested demise of logperch populations (Jude *et al.* 1995, Chant 2002). We also examined the change in abundance of logperch and gobies in Hamilton Harbour from 1995 to 2001.

European and Asian aquatic species have been invading the Great Lakes since the settlement of North America (Charlebois *et al.* 2001). Some of the greatest ecological disasters in North America have resulted from such biological invaders (Mills *et al.* 1994), which have altered physical habitat, disrupted food webs, and caused local extinction of native species (Ricciardi and MacIsaac 2000). This threat intensified in the 1840s when ocean-going vessels began to traverse the Great Lakes. Transoceanic cargo ships can harbor European fish within their ballast tanks (Charlebois *et al.* 2001), regularly delivering them to new ecosystems. The most recent fish species to immigrate into the Great Lakes by ballast tank transfer is the round goby (Jude 1997).

The round goby, a benthic freshwater fish, is indigenous to the Caspian, Black, and Azov seas. In their first year males grow to 10–13 cm standard length (SL, the distance from the lower lip to the caudal peduncle), whereas females are limited to 8–11 cm SL (Berg 1949). Typically round gobies

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live for 4 years and can reach 25 cm in both native and invaded habitats (Charlebois *et al.* 1997). The round goby was first captured in North America on 28 June 1990, in the St. Clair River (North of Lake St. Clair) at Sarnia, Ontario, Canada (Jude *et al.* 1992). Between 1990 and 1992 only 14 round gobies were collected in the St. Clair River; however, by 1995 they were well established with over 3,000 round gobies collected from Lake Erie (Jude *et al.* 1992). The rate of the round goby's range expansion throughout the Great Lakes is considered to be very rapid relative to other invasive fish, such as the sea lamprey (*Petromyzon marinus*), which took almost 25 years to invade Lake Superior after first invading Lake Erie (Jude and Leach 1993).

At least one native fish species, the mottled sculpin (*Cottus bairdi*), has been negatively affected by round gobies (Janssen and Jude 2001). For a number of reasons, we believe that logperch (*Percina caprodes*), another species native to the Great Lakes, may also be deleteriously affected by competition with round gobies. Both species may inhabit similar habitats including sand, gravel, or rocky shallow beaches, spawn at the same time of year, and both species have benthic diets; juvenile round gobies in particular favor similar food items as logperch (such as chironomid larvae and cladocerans, Greenberg 1991, Jude *et al.* 1995, Charlebois *et al.* 1997, Thomas 1997, Scott and Crossman 1998). Although the size range of gobies and logperch overlap, on average Great Lake gobies are larger (mean round goby SL = 10.3 cm; Berg 1949) than logperch (mean logperch SL = 7.9 cm; Scott and Crossman 1998) providing them with a competitive advantage over logperch in terms of their ability to acquire and secure breeding habitat or shelter. In addition, round gobies are believed to directly prey on the eggs and young of logperch (Jude *et al.* 1992). Finally, three previous studies have documented the decrease of logperch in areas where gobies have increased in number (Lake St. Clair: Jude *et al.* 1995; Lake Ontario: Chant 2002; Christine Brousseau, Canada Centre for Inland Waters, personal communication, 2003). Direct evidence of competition between round gobies and logperch, however, has not yet been documented.

The aims of this study were twofold: 1) to investigate the interactions between round gobies and logperch in a shared space with a single resource (shelter) and 2) to monitor how round goby and logperch numbers had changed over time in Hamilton Harbour. To accomplish the first aim, we conducted four different types of trials, using round gobies and logperch as both residents and intruders. In general, in contests between territory holders (residents) and intruders, residents typically win (Maynard Smith and Parker 1976, Grafen 1987, Rosenberg and Enquist 1991, Tobias 1997). However, in competition experiments between mottled sculpins and round gobies, resident sculpins lost shelters to intruding round gobies (Dubs and Corkum 1996). Thus we predicted that 1) round gobies would display more aggressive behaviors than logperch; and that 2) round gobies would sequester the resource (spending more time in shelters) to the exclusion of logperch regardless of residence status. To tackle our second aim, we used data on the numbers and species of fish caught during 20 electrofishing transects conducted in Hamilton Harbour in 1995 and 2001. Transects compared were matched for location and date.

METHODS

Collection and Stock Tanks

Male round gobies were collected with baited minnow traps on 11 July 2002, from Lake Ontario, on the banks of La Salle Park, in Hamilton, Ontario. Round gobies collected ranged in length from 5.3 to 12.1 cm SL (average 8.7 ± 0.2 cm SL). They were housed in a 490 L stock tank in the Psychology Department of McMaster University, which was equipped with two Fluval 404 units and two air powered foam filters. Male logperch were collected with electrofishing gear on 20 August 2002 from the Royal Botanical Gardens Fishway, Hamilton, Ontario. Logperch ranged in length from 4.4 to 9.4 cm SL (average 6.6 ± 0.2 cm SL) and were housed in two 189 L stock tanks. These tanks were each filtered using two air powered foam filters. All tanks were maintained between 22–24°C. To control for differences in aggression between sexes, only males were used in this study. The fish were sexed by visually examining the urogenital papilla between the anus and the base of the anal fin. In females, the papilla is blunt and broad, shaped like a short cylinder with a slit across its top while in males it is more cone-like with a terminal slit (Miller 1984). Fish were used in experimental trials (see below) after an adjustment period of at least one week.

Opaque dividers were placed in the centre of the stock tanks to separate used and unused fish. This ensured that each fish was used only once in this experiment. Both round gobies and logperch were fed twice daily with Nutrafin Tropical® commercial flake food (morning 0900–1100 h; afternoon