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# Fish and Macroinvertebrate Communities in Tributary Streams of Eastern Lake Erie with and without Round Gobies (*Neogobius melanostomus*, Pallas 1814)

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***ABSTRACT***. *Round gobies have had significant impacts on benthic fish and invertebrate communities in nearshore habitats of the Great Lakes. As round gobies have become more abundant in lake habitats, there has been an expansion of their populations into tributary streams and rivers. We compared stream invertebrate and fish communities in New York tributaries to Lake Erie with round gobies present and absent. Four of six benthic invertebrate metrics differed between streams with and without round gobies. Streams with round gobies present had reduced Shannon diversity, EPT richness, and EPT/chironomid ratios, and increased macroinvertebrate density relative to streams without round gobies, but there was no difference in non-Diptera density, or total taxa richness. None of the four fish metrics examined differed between streams with and without round gobies. However, darters occurred in all streams lacking round gobies, but did not occur in any streams with round gobies. Comparisons with historical fish and macroinvertebrate distributional data support our suspicion of goby-induced community changes. In these New York streams, round gobies seem to have had significant impacts on invertebrate communities via their consumptive behavior, whereas the impacts on fish communities are less evident. If round gobies continue to expand their distribution inland, the resultant alterations in macroinvertebrate communities may impact the suitability of tributary streams as spawning and nursery habitat for several sport fish species and for energy dynamics in tributary streams.*

***INDEX WORDS:*** *Non-indigenous species, round goby, stream community ecology.*

## INTRODUCTION

Within a decade of its initial introduction, the round goby (hereafter referred to as goby) has become established in all of the Great Lakes, and in many nearshore habitats it is sometimes the most abundant fish encountered, reaching high population densities (Johnson *et al.* 2005, USGS 2006). Their abundance, in part, has led to significant impacts on nearshore benthic invertebrate and fish communities. Ratti and Barton (2003) reported a decline in the richness of benthic invertebrates in the wave-zone of eastern Lake Erie, finding 122 taxa pre-goby (1974) and 83 taxa post-goby (2001). Some taxa increased in abundance (especially the co-invasive *Dreissena bugensis* and *Echinogammarus ischnus*), but Ephemeroptera, Trichoptera, and other insects decreased in abundance. Kuhns and Berg (1999) documented a similar decline in non-mussel invertebrates with goby presence in southern Lake Michigan. Fish species also have been impacted. Mottled sculpin (*Cottus bairdi*) and Johnny darter (*Etheostoma nigrum*) populations have declined in areas of Lake Michigan since round gobies were first netted in 1998 (Lauer 2004). Chotkowski and Marsden (1999) showed

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that lake trout egg predation by round gobies was substantial and Steinhart *et al*. (2004) documented declines in smallmouth bass embryo survival within minutes after guarding males were angled from nests. These studies highlight field correlations between goby abundance and the decline of native macroinvertebrate and fish species.

Recent distributional studies indicate round gobies are migrating up Great Lake tributary streams. Phillips *et al*. (2003) showed that four of six Pennsylvania tributaries sampled had gobies present. In Elk Creek, gobies comprised almost 20% of the number of fish caught and were found 2.25 km upstream from the mouth of the creek. Similarly, Weimer (2003) showed gobies had invaded up to 1.5 km upstream in Eighteen Mile Creek, New York, and gobies currently are found about 40 km up the New York State Canal (Erie Canal) and continue to spread eastward (M. Goehle, USFWS, pers. comm., 2006). Several streams and rivers in Michigan now have gobies present (D. Jude, pers. comm., U Michigan, 2006). It is unclear whether round gobies will change stream fish and macroinvertebrate communities or disrupt stream ecosystem energy flow to the extent they have in the Great Lakes.

Like their lake counterparts, round gobies in stream habitats have diverse, macroinvertebrate-dominated diets composed mainly of chironomids and mayflies (Phillips *et al*. 2003, Weimer 2003, Carman *et al*. 2006, Lederer *et al*. 2006). As lake-dwelling gobies increase in size, they exhibit an ontogenetic diet shift at about 60 to 70 mm SL, switching to a predominantly mollusc-based diet consisting of *Dreissena* mussels (Jude *et al*. 1995, French and Jude 2001). Most streams draining into the Great Lakes are devoid of *Dreissena* mussels, and thus large stream-dwelling gobies need to consume alternative prey. In Pennsylvania streams, gobies > 75 mm had diets composed primarily of Heptageniidae and Caenidae nymphs whereas those < 75 mm contained mostly chironomid larvae (Phillips *et al*. 2003). In the Flint River, Michigan, Carman *et al*. (2006) demonstrated that goby size was not the only factor affecting diet composition. Prey choice varied depending on the availability of different prey items throughout the day with hydropsychid caddisfly and chironomid larvae predominating during the day, chironomid pupae towards the evening, and heptageniid mayfly larvae at night.

Expansion of goby populations into tributary streams of the Great Lakes has several implications. Egg predation by round gobies poses a threat to many species of game fish that spawn in these streams. Rainbow trout (*Oncorhynchus mykiss*) and smallmouth bass (*Micropterus dolomieui*) are two important sport fish that spawn in tributary streams of Lake Erie, and their populations ultimately may be reduced through egg predation by round gobies. Juveniles of these same species, as well as smaller benthic fish like darters and sculpins, prey upon macroinvertebrates, the primary food source of round gobies in stream communities. It is important that we understand the potential effects of this invasive fish in this new class of habitat, tributary streams, to more fully understand its impact within the Great Lakes watershed.

The goal of this study was to examine the macroinvertebrate and fish communities in tributary streams to Lake Erie with and without round gobies. The abundance, taxa richness, taxa diversity, and occurrence of specific taxa of macroinvertebrates and fish were compared between streams with and without gobies. Because gobies have had significant impacts on benthic communities in lake habitats, we hypothesized that streams with this invasive fish present would also exhibit reduced macroinvertebrate and fish abundance, richness, and diversity relative to streams with gobies absent.

## METHODS

Using 7.5 minute Quad maps, we identified nine potential streams with enough flow to support fish populations (Fig. 1), and which drained directly into Lake Erie between Buffalo, NY and the state line with Pennsylvania. Streams varied in size, substrate, and hydrologic condition, but had similar chemical environments (Table 1). We sampled fish and macroinvertebrate communities in a 50-m stream section within each stream near the stream mouth but upstream enough to avoid lake influence on flow. Sampling continued until we had at least four streams with and four streams without round gobies. We then compared macroinvertebrate and fish community composition among sites differing in goby presence or absence.

Streams were sampled once between 31 May and 13 July, 2005. We assessed fish communities using a Coffelt Electronics BP-6 backpack electroshocker (170 volts, 500 pps, DC-pulse, 150-350 seconds). All macrohabitats (e.g., pools, riffles, runs) were shocked within the 50-m reach working in an upstream direction. All fish, other than round gobies, were identified in the field, measured, weighed, and released. Round gobies were weighed and mea-