Round Goby (*Neogobius melanostomus*) Mussel Predation

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ABSRACT

Gut analysis of a recent Great Lakes invader, the round goby (Neogobius melanostomus) *collected from the Cheboygan River, showed that they ate zebra and or quagga mussels* (Dreissena polymorpha *and* Dreissena bugensis) *68% of the time. This study investigated the preference of round gobies to select for different size classes of mussels. There was a significant positive relationship found between the length of round gobies and the size of mussels selected. Although the larger round gobies sampled in this study were able to consume larger mussels, smaller mussels were still preferred. This study suggests that the preference of smaller mussels by round gobies will not alter the population of mussels due to nonselection of the largest mussels as prey and the benthic nature of the round goby.*

INTRODUCTION

"In April 1990, David J. Jude found a round goby in the St. Clair River outside Detroit. A biologist at the University of Michigan in Ann Arbor, he immediately recognized the threat of invasion signaled by the North American debut of this European fish. Almost immediately, as he had feared, the goby began nesting in the adjoining Lakes Huron and Erie. Last week, Canadian officials announced that the fish has reached Lake Ontario."

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The round goby (*Neogobius melanostomus*) is an invasive, benthic fish species that has recently been introduced into the ichthyofauna of the Great Lakes. It was first observed in 1990 in the St. Clair River and has spread significantly throughout the five Great Lakes and many of their tributaries. The means of introduction is thought to be ballast water (Jude *et al*. 1992). Round gobies utilize a broad range of foods, but prefer mussels; consumption of mussels may exceed 100 per day (Fig.1) (Ghedotti, 1995). Research indicates mollusks are the favored prey item over non-mollusks in all age classes in other introduced areas of the world as well (Simonovic *et. al*. 2001). Molariform teeth enable the round goby to crush the shells of bivalves with great efficiency (French 1993, Ghedotti *et al*. 1995, Ray and Corkum 1997). The abundance of the round goby and the lack of information relating to size preference for zebra mussels (*Dreissena polymorpha*) and quagga mussels (*Dreissena bugensis*) make this a practical organism to study. This research investigates the feeding selection of the round goby on mussels (size of fish verses size of mussel). Results of this study may further indicate feeding strategies that the round goby employs under conditions it encounters in the Great Lakes.

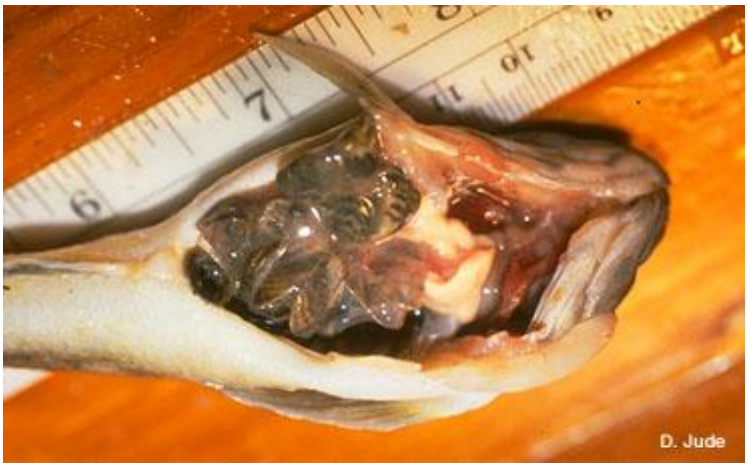

FIG. 1 Gut of round goby showing ingested mussels.

Native to the Black and Caspian seas region, the round goby has been accidentally introduced into several areas of the world other than the Great Lakes. The Gulf of Gdansk (southern inlet of the Baltic Sea), and the Moscow River in Asia (Sokolov *et.al*., 1989) have also been colonized by the round goby. "The proliferation of organisms into aquatic ecosystems beyond their endemic range has been caused, in part, by insufficient control of ballast water carried by marine ships, and historically, the construction of canals interconnecting previously separated watersheds." (Skora and Rzeznik, 2001).

Round gobies are easily recognizable; the Great Lakes Science Center (2007) offers this description; "Round gobies can reach up to 10 inches in length as adults but are usually less than 7 inches long in the Great Lakes. Females and immature male round gobies are mottled gray and brown color. Spawning males turn almost solid black. Round gobies have a soft body and a large, rounded head with eyes that protrude near the top. Round gobies look similar to our native sculpins, but the two species can be easily separated by the fused pelvic fins on the underside of round gobies. Sculpins have two distinct pelvic fins, not one large fin." (Fig. 2)

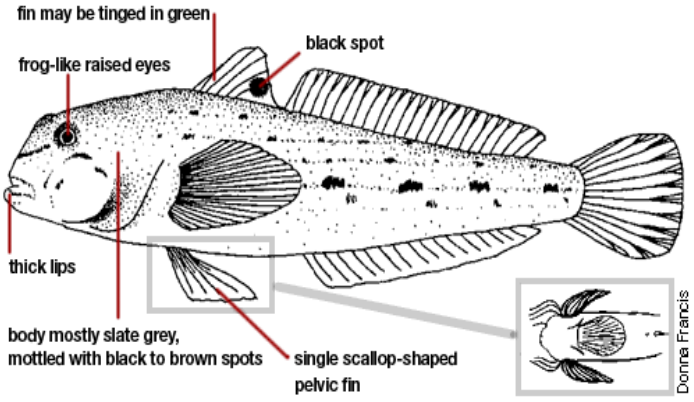

FIG. 2 External anatomy of round goby.

The potential impacts of the round goby invasion are substantial. Innately aggressive, the round goby out-competes native benthic fishes for spawning areas, food, and shelter. They also consume eggs and young of native fish. They are able to spawn multiple times in a season and can survive in water that is poor in quality. These characteristics give the round goby a competitive edge over native benthic species such as the mottled sculpin (*Cottus bairdii*) and the logperch (*Percina caprodes*) (Jude et al., 1995). Recently, round gobies have been observed to disperse to deep water > 30 m in Lakes Michigan and Huron where they might compete with slimy (*C. cognatus*) and deepwater sculpins (*Moxocephalus thompsoni*) for food resources or disrupt spawning (French and Jude, 2001).

The Michigan Department of Natural Resources has recently reported the predation of round gobies by game fish (*Kalish, T. pers. comm.*, Michigan Department of Natural Resources, Traverse City, Michigan). This observation is the basis for another concern. Bioaccumulation is the process through which toxins are concentrated along the food chain. Mussels pick up and store pollutants from the water. These concentrated chemicals are then passed on by way of consumption to round gobies, game fish and, potentially to humans.

The objective of this study was to determine whether there is a correlation between the size of the round goby and the size of the mussels consumed and if there is a preference for selection overall.

MATERIALS AND METHODS

Round gobies were collected during July of 2007 within Cheboygan River, Michigan (Fig. 3), with standard minnow traps and by angling. By far the most successful method of collection was by angling (of the total specimens obtained 95% were by angling, 5% by minnow traps). Rod and reel with six-pound monofilament line and number ten single hook were used; baited with leaf worms. Fish were caught in shallow water (< 3 meters) along break walls and riprap. The substrate was mostly stone-sand with some vegetation. Collection period and number captured were recorded (Table 1).

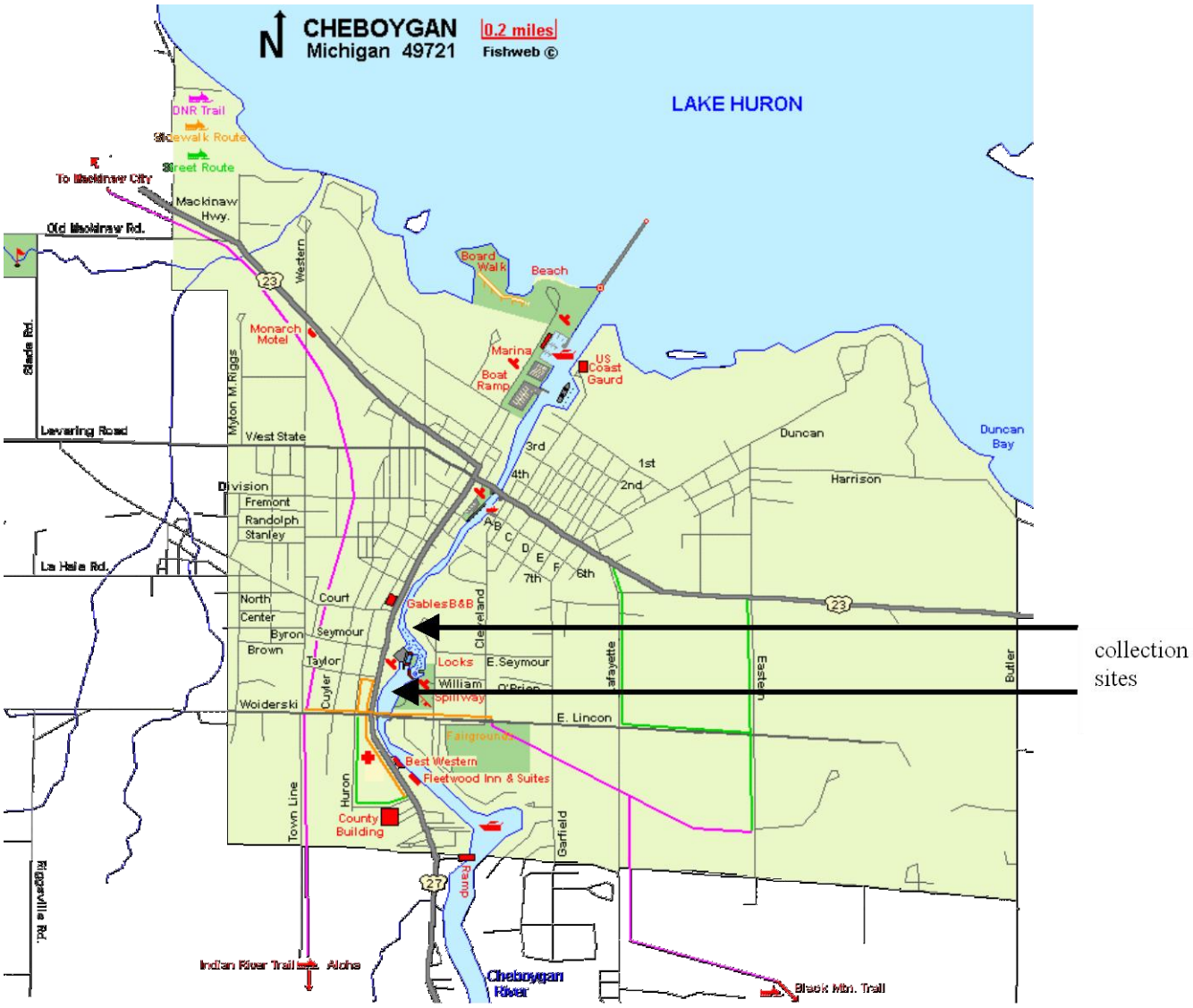

FIG 3. Map of Cheboygan indicating collection sites

Fish were first anesthetized (MS22) and then immediately killed on site (10% formalin). Fish were preserved in alcohol solution. The gobies were measured to total length using a standard ruler (mm) and wet weighed to the nearest 0.5 gram using a Pesola scale (0-30 gram range). The stomach contents were observed. Mussels were totaled from each goby and measured to total length (mm) using a Cen-Tech digital micrometer. Also noted were fish with no mussels in gut. All macroscopic organisms in gut were totaled (Table 1).

TABLE 1.—Summary of gut analysis in round gobies collected in Cheboygan River, Cheboygan, MI during July 2007.

Start date	End date	# of Round Gobies	Prey organism found	Number of prey organisms found	Size Range of prey organisms found
14 July	28 July	37	None: gut empty	0	
		4	Green slime		
		3	Snail	3	
		3	Crayfish	3	Leg Frag., 19.1mm, 20 mm
		85	Mussels	276	2.6mm-18.3mm
Total		132*		282	

* This total is greater than total round gobies dissected (125) because several gobies (7) had more then one prey organism in gut.

ANALYSIS

The following data was compiled from the dissection of one hundred twenty-five round gobies over a two-week period. The stomach contents were documented and mussels measured and counted. Of the total fish counted, 68% (N = 85) contained one or more mussels. 32% (N = 40) had no mussels. In addition to mussels, only three other prey items were found (green mush N = 4, small crayfish N = 3 and snails N = 3). A mean of 3.3 mussels per fish was calculated for round gobies containing mussels. A linear regression using SPSS demonstrated the significant (d.f. = 83, R = 0.685, $p < 0.0005$) relationship between length of the gobies and the length of the mussels they were ingesting (fig. 6).

DISCUSSION

The data collected indicates a correlation between the length of the round goby and the size of the mussel the goby prey upon. The group of shortest fish collected (70-89 mm) contained few small or no mussels (mean 6.40 mm). Fish of medium length (90-109 mm) selected larger sized mussels (mean 9.79 mm). Selection of mussels by the longest fish sampled (110-129 mm) also consumed large mussels (mean 9.74 mm). These results demonstrate a trend; larger round gobies select larger mussels (Table 2, Fig. 4). Interestingly, another correlation was revealed ($\chi^2 > 3.84$) when the "in gut" range of mussel size is compared to that of a substrate sample (wild) of mussel size range from the same collection site (Fig. 5).

TABLE 2. —Summary of gut analysis in round gobies collected in Cheboygan River, Cheboygan, MI during July 2007 showing mean size of mussels.

Size of goby	**60-69**	**70-79**	**80-89**	**90-99**	**100-109**	**110-119**	**120-129**

(mm)							
Mean	**4.5**	**6.24**	**6.56**	**9.46**	**10.11**	**10.01**	**9.47**
N=total number counted	**N=1**	**N=46**	**N=45**	**N=107**	**N=48**	**N=19**	**N=7**

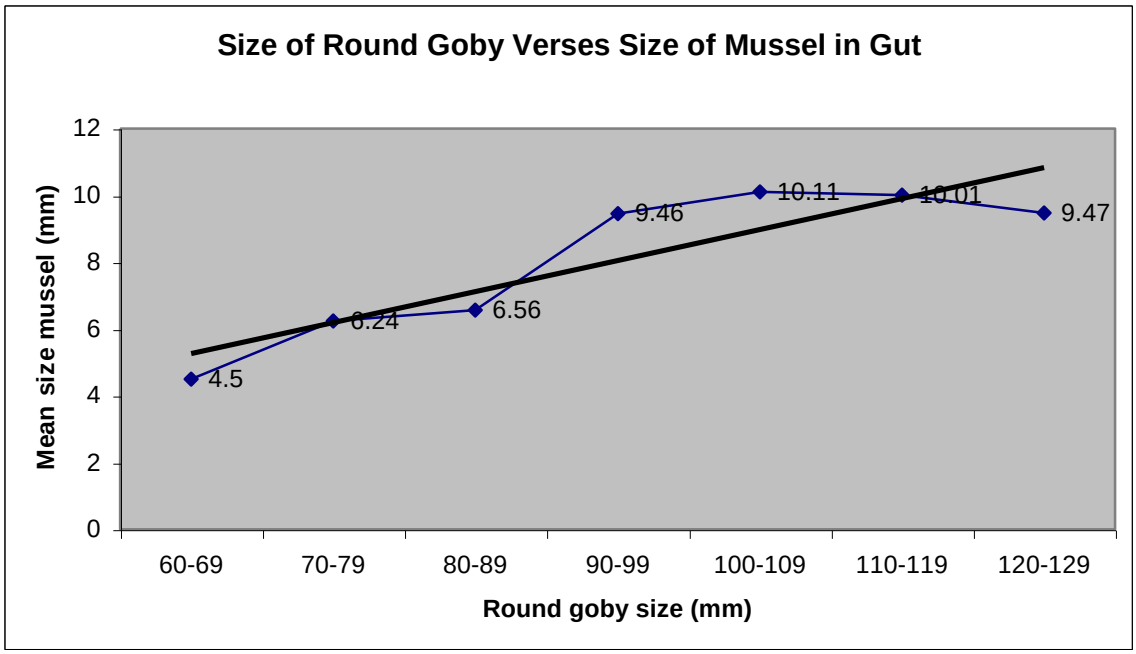

FIG. 4. Size range of mussels found in varying sizes of round gobies in the Cheboygan River.

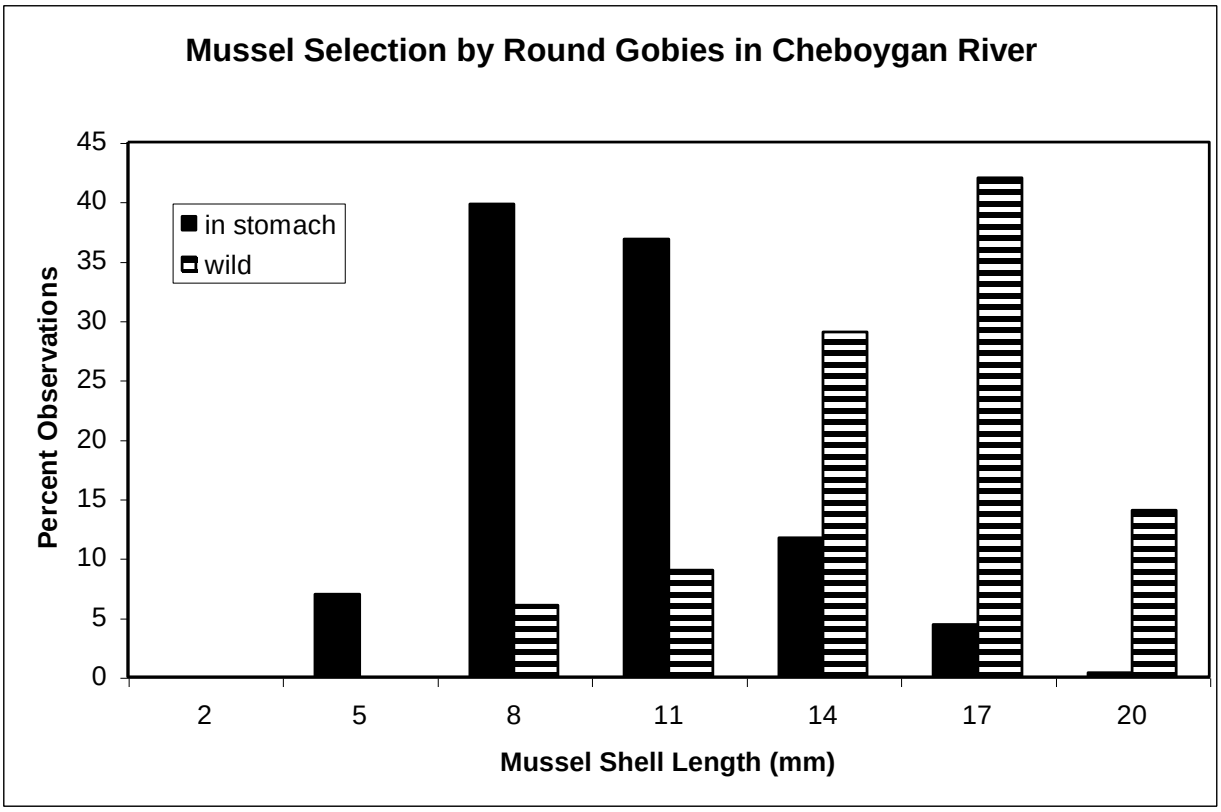

FIG. 5. Size range of mussels found in gut compared to size range sampled on the substrate

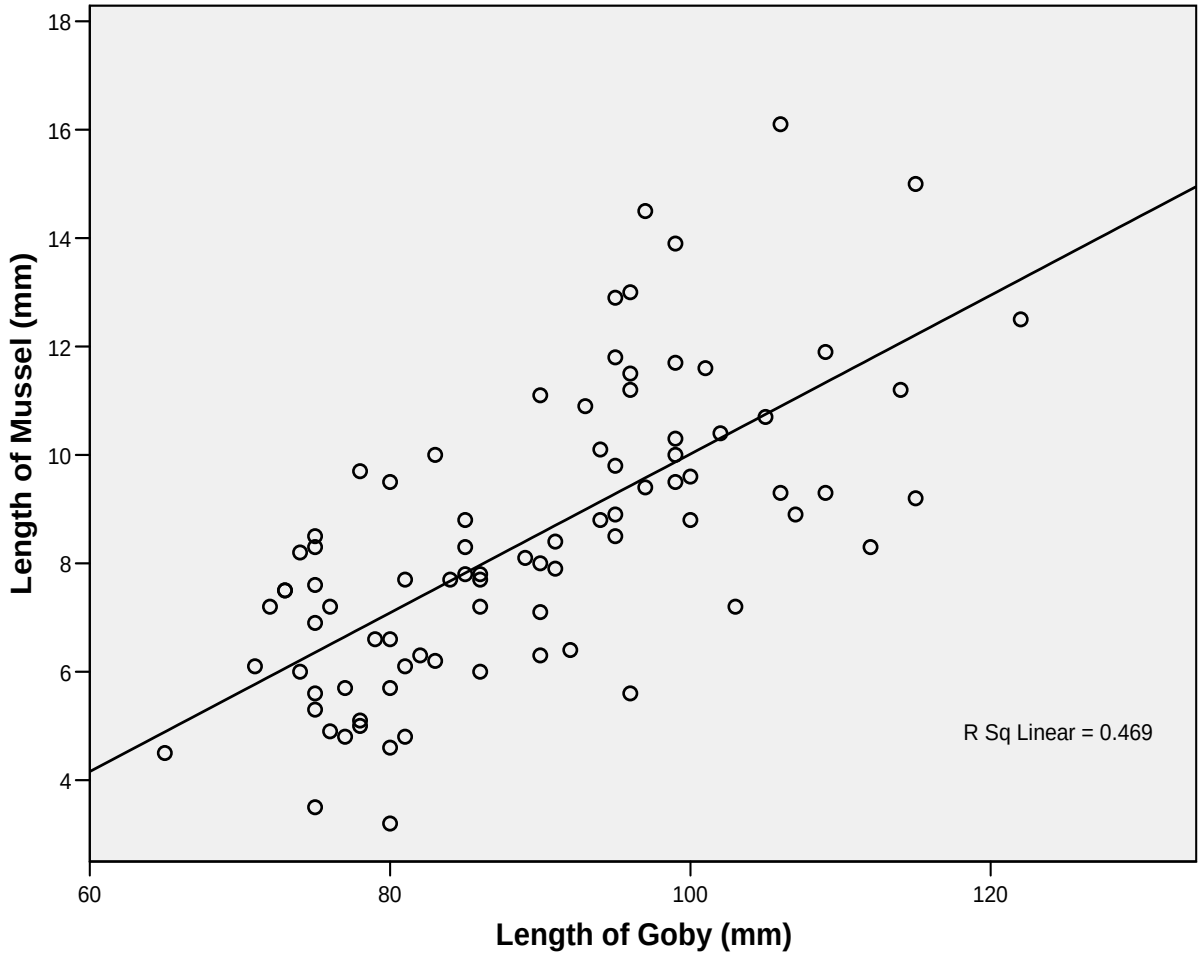

FIG. 6. SPSS linear regression length of gobies verses mussel length.

The round gobies sampled in this survey were selecting for mussels in the size range of 6-11 mm. The number of mussels in that range, sampled from the substrate, was by far less than the number of larger mussels. This is likely due to the predation of the round gobies on the mussel population at this site.

The impact of round goby predation on the mussel population is thought to be minimal. Large mature mussels continue to reproduce and round gobies only prey upon bottom dwelling mussels due to the gobies benthic nature. Zebra and quagga mussels not only occupy benthic zones but are also found throughout the vertical water column. The immediate concern is for the effect that the toxins will have on the food web. The data collected suggests that the diet of the fish sampled in the Cheboygan River consists almost entirely of mussels. This information coupled with observations in the field by DNR personnel and in literature sources suggest that game fish such as smallmouth bass (*Micropterus dolomieui*), rock bass (*Ambloplites rupestris*), and walleye (*Stizostedion vitreum*) are taking advantage of this new food source (*Kalish, T. pers. comm*., Jude *et al*.

1995). This trend may compromise game fish as a food source for humans and harm other predators that harvest these fish.

ACKNOWLEDGMENTS

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