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Zebra Mussel Research Program

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Potential of North American Molluscivorous Fish to Control Dreissenid Mussels

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Introduction

The zebra mussel has rapidly spread through lake and river systems in eastern North America (Herbert, Muncaster, and Mackie 1989), and more recently, as far south as the Mississippi River at New Orleans. Zebra mussel densities in the Great Lakes region are much higher, with a few exceptions, than in western Europe (Garton and Haag 1990), where populations have been established over the last 130 to 150 years, or in their native range in the former USSR. Differences in density are due to a number of factors including native parasites and diseases, natural enemies such as fish and waterfowl, and differences affecting carrying capacity. Therefore, natural enemies of zebra mussels deserve study, for they may eventually lower or control zebra mussel populations in North America (Molloy 1998).

Long-term reduction of zebra mussels by natural predators has yet to be demonstrated (Molloy et al. 1997; Molloy 1998). However, zebra mussels can have adverse economic and environmental effects (Karatayev, Burlakova, and Padilla 1997; Mackie 1991; Ricciardi, Whoriskey, and Rasmussen 1996), so any level of biocontrol is of interest to resource agencies. This article presents a new study to evaluate the effect of zebra mussels on growth and abundance of molluscivorous fish, and whether selected fish species can provide some level of biocontrol of zebra mussels.

Molluscivorous Fish

At least 17 species of North American fish have been documented to consume attached zebra mussels (*Dreissena polymorpha*) and quagga mussels (*Dreissena bugenis*) (Table 1). Additional species are likely to consume zebra mussels (particularly fish in the sturgeon, sucker, and catfish families), but cases remain undocumented. Although numerous and widespread, the efficacy of molluscivorous fish as a control mechanism for zebra mussels is unclear. However, zebra mussels are more susceptible to fish predation than native unionids or *Corbicula* spp. because *Dreissena* shells are weaker, adults are smaller in size, and most individuals are exposed to predators (Thorp, Delong, and Casper 1998).

Feeding efficiencies of molluscivores on zebra mussels will vary depending on the morphology, behavior, and performance of the fish species (Nagelkerke and Sibbing 1996). True molluscivores have modified pharyngeal teeth for crushing shells, such as freshwater drum, but this group is represented by only 5-6 species (French 1993). Other species without modified teeth may swallow the mussel whole, so mussel predation may only occur when preferred food items are scarce (Molloy et al. 1997). Stanczykowska and Lewandowski (1992) concluded that fish exert little control on zebra mussels in Poland. One study in the former Soviet Union

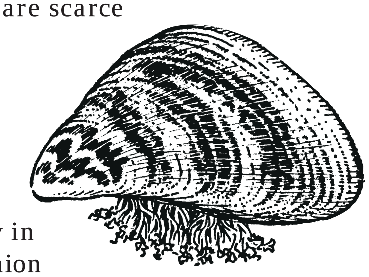

Table 1
Molluscivorous Fish Documented[1] to Consume Zebra Mussels in North America

Common Name	Scientific Name
Shortnose sturgeon	*Acipenser brevirostrum*
Lake sturgeon	*Acipenser fluvescens*
Lake whitefish	*Coregonus clupeaformis*
Trout perch	*Percopsis omiscomaycus*
Common carp[2]	*Cyprinus carpio*
Bull chub	*Nocomis raneyi*
White sucker	*Catostomus commersoni*
Greater redhorse	*Moxostoma valenciennesi*
Brown bullhead	*Ameiurus nebulosus*
White perch	*Morone americana*
White bass	*Morone chrysops*
Redbreast sunfish	*Lepomis auritus*
Pumpkinseed	*Lepomis gibbosus*
Redear sunfish	*Lepomis microlophus*
Yellow perch	*Perca flavescens*
Freshwater drum	*Aplodinotus grunniens*
Round goby[2]	*Neogobius melanostomus*

[1]Documented in Cloe, Garman, and Stranko (1995); French (1993); French and Morgan (1995); French and Bur (1996); Jude, Janssen, and Crawford (1995); Molloy et al. (1997); and Tucker et al. (1996).
[2]Introduced species.

suggested that high densities in the Great Lakes region were the result of a lack of predation by true molluscivores (Karnaukhov and Karnaukov 1993). French and Bur (1996) indicated that freshwater drum in western Lake Erie were not of sufficient size to suppress zebra mussels over a long period. Size-selective predation is supported by Thorp, Delong, and Casper (1998), who also conclude that fish predation is insufficient to regulate zebra mussel densities in the Ohio River because of the large reproductive capacity of remaining individuals. Conversely, there was evidence that molluscivores did reduce zebra mussels in the Hudson River (Boles and Lipcius 1994), and at several locations in eastern Asia (as cited in Molloy et al. (1997)).

The Lake Winnebago Study

The Lake Winnebago system, i.e., Lakes Winnebago, Poygan, and Big Butte des Mortes (Figure 1), was selected as a field site to evaluate the population and bioenergetic relationships between molluscivorous fish and zebra mussels. Zebra mussels have become recently established and the system is populated by a number of potential molluscivores including lake sturgeon, channel catfish, bourbot (*Lota lota*), redear sunfish, common carp, trout perch, and yellow perch. However, the freshwater drum is by far the most abundant molluscivorous fish in the system (Figure 2). Freshwater drum that are greater than 265 mm total length can consume large quantities of zebra mussels (French and Bur 1996), and since this species is widespread and co-occurs with zebra mussel distributions (Figure 3), it represents a potential biocontrol agent applicable to many regions of North America.

Studies are being conducted jointly with the Wisconsin Department of Natural Resources (WDNR). The WDNR has monitored abundance and growth of fishes in the Lake Winnebago system for over 10 years using electrofishing, netting, and trawling. These collections will continue as zebra mussels increase in density. Zebra mussel densities and size distributions are being estimated, and these data will be correlated with demographic variables and bioenergetic requirements of freshwater drum. Although the primary goal of this study is to evaluate the potential of molluscivorous fish as biocontrol agents, the historic databases of WDNR coupled with additional fish sampling will also

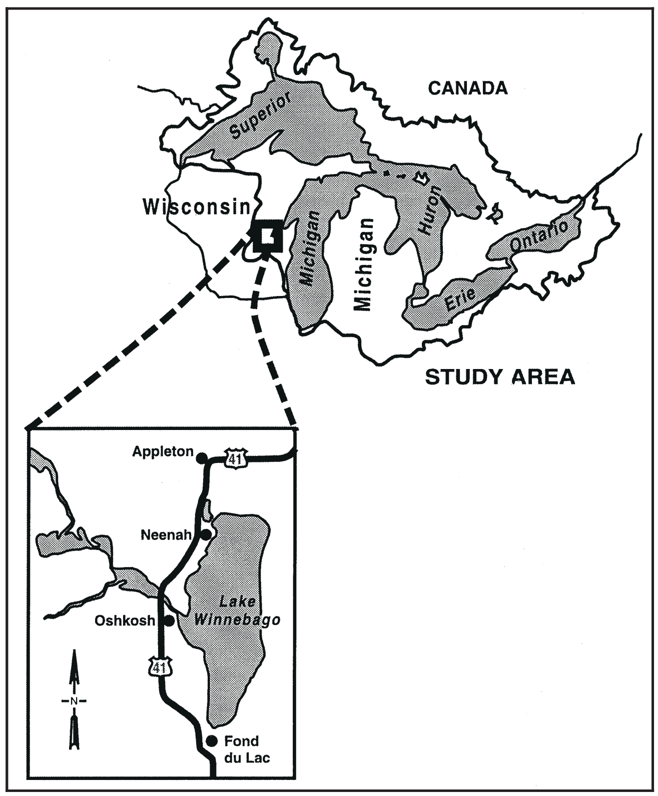

Figure 1. The Lake Winnebago system, Wisconsin, is an ideal study area to evaluate the relationships between freshwater drum and zebra mussels. Zebra mussels are rapidly increasing in density, and the drum is the primary molluscivorous fish that has the potential of controlling or regulating this invasive species

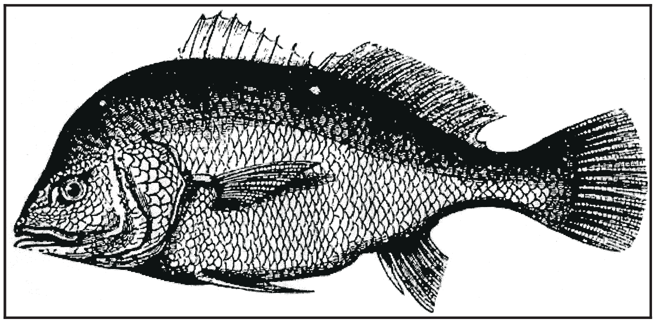

Figure 2. The freshwater drum has strong molariform pharyngeal teeth that can crush the shells of mollusks

provide an opportunity to evaluate the response of native fish assemblages to differing levels of zebra mussel infestation.

Age-structured population models will be developed for freshwater drum. Otoliths (i.e., ear bones) will be collected, sectioned, and aged. Age and length correlations will be calculated and growth equations will be derived. In cooperation with WDNR, stomach contents of freshwater drum will be examined to determine frequency and size of zebra mussels consumed. Taken together, predation rates on zebra mussels and control efficacy will be estimated.

A bioenergetic model, which is an energy balance equation, will be used to examine the effect of temperature, fish body size, and food quality on maximum feeding rates of freshwater drum on zebra mussels. Bioenergetic models use species-specific estimates of consumption or growth, respiration, egestion, and excretion for the energy mass balance equation (Hanson et al. 1997):

Consumption = metabolism + wastes + growth

A previous study indicated that zebra mussels may not benefit drum when comprising a staple diet (French and Bur 1996), but as a biocontrol agent, understanding the bioenergetic costs of zebra mussel consumption will be an important component in predicting the potential of regulating this invasive species.

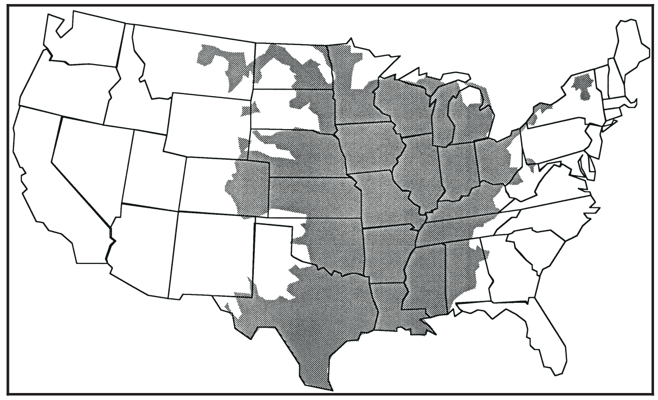

Figure 3. Distribution of the freshwater drum coincides with that of zebra mussels

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