Assessing Catostomidae Fishes as potential biocontrols of Zebra Mussels (*Dreissena polymorpha*) in the Ohio River

Hannah Gill[1] and Chris Lorentz, Ph. D[2]

1. Ohio Northern University, 525 S. Main Street, Ada, OH 45810

2. Thomas More University Biology Field Station and The Center for Ohio River Research and Education, 8309 Mary Ingles Highway California, KY 41007

Abstract

Zebra mussels (*Dreissena polymorpha*) are an invasive mollusk species that have established populations in the Ohio River. Invasive species tend to thrive in the habitats they are introduced to and disrupt ecosystems due to a lack of natural predators. Although some North American native fishes have adapted to prey on zebra mussels. Fishes from the Catostomidae family have been hypothesized to be predators of zebra mussels because they have pharyngeal teeth which are used to help process hard foods like mollusk shells. This study uses gut content analysis to identify members of the Catostomidae family that prey on zebra mussels. Additionally, this study will attempt to understand if fish predation of *Dreissena* by these species can help reduce zebra mussel population densities. Twenty-six fish were collected using electrofishing and gill nets. A total of five Smallmouth Buffalo and one River Redhorse had zebra mussels in their gut content. Of those Smallmouth Buffalo, zebra mussels only composed an average of 0.5% of their total gut content. The River Redhorse had the greatest proportion of zebra mussels to total gut content with zebra mussels composing 16% of its total gut content. River Redhorse and Smallmouth Buffalo were confirmed as predators of zebra mussels in the Ohio River, although the rate of predation of zebra mussels by these fish is unlikely to reduce *Dreissena* densities alone.

Introduction

Zebra mussels (*Dreissena polymorpha*) are a species of freshwater mollusk native to Europe that have invaded North America via the Great Lakes and have established populations in waterbodies throughout the country including the Ohio River (Ram and McMahon, 1996). They have been able to successfully invade North America likely due to their high fecundity and their ability survive in a broad range of environmental conditions (Molloy et al., 1997). In addition to their life history traits, an absence of natural predators has helped zebra mussel populations thrive in North America (Molloy et al., 1997). Although, 14 species of fish in North America have been documented to eat zebra mussels (Molloy et al., 1997). When zebra mussels colonize new waterbodies, they can quickly become a large part of diets of mollusk eating fish because they are an abundant, novel prey item (Molloy et al., 1997; Magoulick and Lewis, 2002). The more fish predators of zebra mussels there are, the greater the likelihood that native fish predation could help reduce the density of zebra mussel populations (Magoulick and Lewis, 2002).

The Catostomidae family of fishes are benthic dwelling. This family is referred to as the Sucker family and is characterized by their large fleshy lips **(Figure 1)**. They feed on macroinvertebrates including mollusks along with algae and plant matter. These fish use specialized pharyngeal teeth to process food, which are located in the "throat region" **(Figures 2 and 3)** (Eastman, 1977).

Freshwater Drum (*Aplodinotus grunniens*) are another fish species that have very strong pharyngeal teeth they utilize to crush the shells of zebra mussels **(Figure 4)** (Molloy et al., 1997). This species is the best documented fish predator of zebra mussels in North America (Molloy et al., 1997). In some waterbodies, Freshwater Drum have been documented to greatly reduce the densities of colonizing zebra mussels (Magoulick and Lewis, 2002). Catostomids have been hypothesized to be able to utilize their pharyngeal teeth similarly to Freshwater Drum to consume zebra mussel shells.

Figure 1. Fleshy lips of a Redhorse sucker (*Moxostoma sp.*).

Figure 2. Location of pharyngeal teeth in fishes (Fraser et al. ,2009) .

Figure 3. Pharyngeal teeth of River Redhorse (*Moxostoma carinatum*).

Figure 4 . Pharyngeal teeth of Freshwater Drum (*Aplodinotus grunniens*).

This study will examine the gut contents of fish from the Catostomidae family found in the Ohio River. The goal of this study is to identify members of the Catostomidae family that are predators of zebra mussels in the river to better understand how native fish predation of zebra mussels may decrease the population densities of this invasive species.

Methods

Smallmouth Buffalo (*Ictiobus bubalus*), River Carpsucker (*Carpiodes carpio*), Golden Redhorse (*Moxostoma erythrurum*), Smallmouth Redhorse (*Moxostoma breviceps*) and River Redhorse (*Moxostoma carinatum*) were collected from the Ohio River via electrofishing and gill nets **(Figure 5)**. After collecting, fish were returned to the lab to be frozen until the time of dissection.

Fish were thawed until they were soft enough to be dissected. Fish mass was weighed using a spring scale and standard length was measured using a meter stick.

Dissections were performed by making a longitudinal cut using scissors on the ventral side of the fish **(Figure 6)**. A cut was made posterior of the pectoral fins to posterior of the anal fins toward the anus. Transverse cuts were made on both ends of the longitudinal cut to access the gut.

Figure 5. Smallmouth Buffalo caught by electrofishing.

Figure 6. Dissection of Smallmouth Buffalo.

The gut was removed by cutting the esophagus inferior of the mouth and cutting the intestine superior of the anus.

After removing the gut from the fish, the gut contents were obtained by making a longitudinal cut with scissors along the intestines **(Figure 7)**.

Figure 7. Dissection of Smallmouth Buffalo intestines.

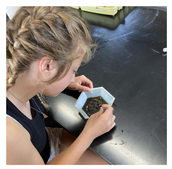

Figure 8. Sorting through gut contents.

The wet weight of the gut contents was measured using an electronic scale. After weighing, a probe was used to sort through the gut contents **(Figure 8)**. Fragments of zebra mussel shells were separated from the remaining gut contents using forceps. Then the zebra mussel shell fragments were weighed, and the mass was recorded.

The zebra mussel shells found in the gut content were confirmed under microscope and preserved in 70% ethanol. After each gut content analysis, the gut content, intestines and fish were disposed of properly.

Results

A total of 26 fish were dissected including 18 Smallmouth Buffalo (SMB), five River Carpsuckers (RCS), one Golden Redhorse (GRH), one Smallmouth Redhorse (SMRH) and one River Redhorse (RRH). Five Smallmouth Buffalo and one River Redhorse had zebra mussels in their gut content **(Table 1 and Figure 9)**. Smallmouth Buffalo and River Redhorse were confirmed as predators of zebra mussels.

Only 27.8% of the Smallmouth Buffalo caught had zebra mussels in their gut content. Of these fish, zebra mussels comprised an average of 0.5% (± 0.4%) of their total gut content. The average mass of a Smallmouth Buffalo that consumed zebra mussels was 1902 grams (± 799 grams).

The River Redhorse had the greatest ratio of zebra mussels to total gut content. Zebra mussels composed 16% of the total gut content in this individual.

Results Continued

Table 1. Fish analytics: gut content and morphometrics.

Fish ID	Fish Mass (g)	Fish Standard Length (cm)	Total Weight of Gut Content (g)	Zebra Mussels Present in Gut Content?	Weight of Zebra Mussels (g)	% of Gut Content that was Zebra Mussels
SMB 7	462.5	25	8.6256	X	X	X
SMB 14	462.5	23	0.902*	X	X	X
SMB 2	550	26	5.18	X	X	X
SMB 8	550	26	6.2056	X	X	X
SMB 13	760	30	14.3911	✓	0.0061	0.0424
SMB 9	775	28	7.7125	X	X	X
SMB 12	1200	35	13.9085*	X	X	X
SMB 15	1500	30	4.5787	✓	0.0035	0.0764
SMB 4	1800	39	32.0025	✓	0.1981	0.6190
SMB 1	2100	42	Empty	X	X	X
SMB 3	2250	42	35.907	X	X	X
SMB 5	2300	41	30.3741	✓	0.3655	1.2033
SMB 11	2800	40	Empty	X	X	X
SMB 6	3150	51	24.125	✓	0.1501	0.6222
SMB 10	3175.2	53	50.0375	X	X	X
SMB 16	4200	45	Empty	X	X	X
SMB 17	4200	41	Empty	X	X	X
SMB 18	4450	47	2.8349	X	X	X
SMRH 1	350	25	3.206*	X	X	X
GRH 1	675	30	2.383	X	X	X
RRH 1	725	31	2.1224	✓	0.3429	16.1562
RCS 1	750	34	5.391	X	X	X
RCS 5	750	29	5.4559	X	X	X
RCS 4	1500	35	2.479	X	X	X
RCS 3	1550	33.5	Empty	X	X	X
RCS 2	925	32	15.8477	X	X	X

* indicates the presence of other mollusk shells in the gut content.

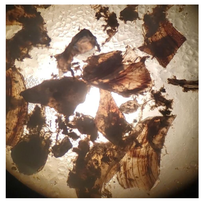

Figure 9. Comparison of unsorted gut content (Left) to zebra mussel remains found in the gut content of a River Redhorse (Right).

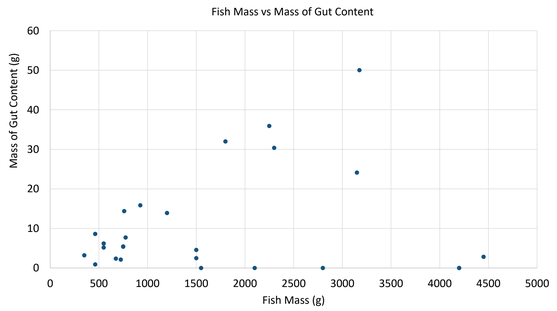

Figure 10 . Comparison of fish mass to the mass of fish gut content.

Five of the fish dissected had empty guts. Majority of fish were collected during daytime hours between 11:00 and 16:00. Four Individuals were collected during night electrofishing after 21:00. All of the empty individuals were collected during the daytime hours.

There appears to be no correlation between the mass of a fish and the mass of the gut content found in that fish **(Figure 10)**. This data speaks to the challenges of performing a gut content analysis. There is uncertainty when catching fish if they have recently consumed a full meal and have contents in their gut to analyze.

Conclusions

A study conducted by Thorp, Delong and Casper (1998) found 55% of the Smallmouth Buffalo sampled in the Ohio River had zebra mussels in their gut and 63% of the Redhorse suckers (*Moxostoma sp.*) sampled in the Mississippi River consumed zebra mussels. The fish used in this study were collected in 1995, only two years after zebra mussels invaded the Ohio and upper Mississippi Rivers. The researchers concluded that fish predation lowered the density and biomass of zebra mussels in their study areas, although the rate of predation was not strong enough to regulate zebra mussel populations. The researchers predicted as the population sizes of zebra mussels increased fish predation for zebra mussels would also increase. This prediction did not hold true for the 26 Catostomids sampled in 2021.

The rate of Smallmouth Buffalo predation on zebra mussels was much smaller in this study with only 27.8% of Smallmouth Buffalo caught having zebra mussels in their gut. Since their introduction in the early 1990's *Dreissena* densities in the Ohio River have fluctuated, yet they remain an ample member of the river's macroinvertebrate community. The decreased predation rate for zebra mussels observed in Smallmouth Buffalo may be caused by a variety of factors, but it is unlikely due to a lack of zebra mussels in the river. The low predation rate observed in the Smallmouth Buffalo is likely not strong enough to regulate zebra mussel populations in the Ohio River.

Carpiodes and *Ictiobus* have smaller, more fragile pharyngeal teeth that are not well adapted for chewing prey unlike Freshwater Drum. *Carpiodes* have especially delicate pharyngeal teeth not suited for crushing hard prey items which is likely why no River Carpsuckers were found to consume *Dreissena*. River redhorses have large, flat pharyngeal teeth adapted to grind food items, which they may use to crush zebra mussel shells such as Freshwater Drum do. Only one River Redhorse was dissected in this study and this individual had the greatest proportion of zebra mussels to total gut content.

This study was unable to conclude much on the predation of zebra mussels by River Redhorses because of the small sample size of this species. Future studies could focus conducting gut content analyses on River Redhorses to understand if this species may help decrease zebra mussel populations in the Ohio River. Additionally, when individuals have empty guts, it can not be concluded what they consumed. This leaves more uncertainty about the predation rates of these fish species on zebra mussels. Further gut content analysis studies could compare the time of capture and to amount of gut content to see if there is any correlation between the two variables to increase the probability of catching fish with full guts.

Literature Cited

1. Eastman J. The pharyngeal bones and teeth of Catostomid fishes. Am. Midl. Nat. 1977; 97:68-88.
2. Magoulick D, Lewis L. Predation on exotic zebra mussels by native fishes: Effects on predator and prey. Freshwater Biol. 2002; 47:1908-1918.
3. Molloy D, Karatayev A, Burlakova L, Kurandina D, Laruelle F. Natural enemies of zebra mussels: Predators, parasites, and ecological competitors. Rev. Fish. Sci. Aquac. 1997; 5:27-97.
4. Ram J, McMahon R. Introduction: The biology, ecology, and physiology of zebra mussels. Am. Zool. 1996; 36:239-243.
5. Thorp J H, Delong M D, Casper A F. In situ experiments on predatory regulation of a bivalve mollusk (Dreissena polymorpha) in the Mississippi and Ohio Rivers. Freshwater Biol. 1998; 39:649-661.

Acknowledgements

We would like to thank the Duke Energy Foundation and the Friends of the Field Station for their financial support. We would also like to thank the 2021 River Crew for assisting in fish collection.

For Further Information

Hannah Gill (h-gill@onu.edu), Ohio Northern University.