

# Longitudinal Patterns in Abundance of the Zebra Mussel (*Dreissena polymorpha*) in the Upper Mississippi River

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## ABSTRACT

We assessed the abundance of zebra mussels in the upper Mississippi River during 1995, four years after they were first found in the river. Samplers were deployed from May 30 to October 19, 1995, at 19 lock and dam facilities in the upper Mississippi River from Minneapolis, Minnesota, to Muscatine, Iowa. Zebra mussels were found at every lock and dam except the two sites farthest upstream (Minneapolis). Generally, densities of zebra mussels were greatest at sites 161 km and farther downstream of the Minneapolis area. The greatest mean mussel density was 11,432/m<sup>2</sup> at Fulton, Illinois.

## INTRODUCTION

The invasion of the exotic zebra mussel *Dreissena polymorpha* into the upper Mississippi River was first documented on September 12, 1991, with the discovery of an adult mussel in Pool 8 near La Crosse, Wisconsin. Zebra mussels have since been found throughout the impounded portion of the upper Mississippi River, from Minneapolis, Minnesota, to Alton, Illinois. Certain tributaries of the Mississippi River, including the Illinois and Ohio Rivers, are also heavily infested (Zebra Mussel Information Clearinghouse 1996). The rapid dispersal of the zebra mussel in the Mississippi River and other inland waters can be attributed partly to its high reproductive rate and its planktonic larval stage, the veliger (Griffiths et al. 1991). The spread of zebra mussels has also been facilitated by certain human activities, such as commercial and recreational navigation (Griffiths et al. 1991, Keevin et al. 1992), which distribute adults and veligers to new locations.

Although the zebra mussel is widely distributed in the upper Mississippi River, there are few quantitative data on its longitudinal density distribution in the river. We assessed the density distribution of zebra mussels in the upper Mississippi River during the 1995 growing season, four years after their initial discovery in the river.

## MATERIALS AND METHODS

Samplers were deployed at each lock and dam in the impounded portion of the upper Mississippi River from Upper St. Anthony in Minneapolis, Minnesota, to Lock and Dam 16 in Muscatine, Iowa. The samplers were emplaced from May 30 to October 19, 1995, a 143-day colonization period. This allowed zebra mussels to colonize the samplers throughout their annual reproductive period in the upper Mississippi River (Cope et al. 1995). We assume that all zebra

mussels obtained were produced during the 1995 reproductive season; therefore, final densities on our samplers should reflect the zebra mussel infestation potential. Flooding of the upper Mississippi River during spring 1995 precluded the timely deployment of zebra mussel samplers at lock and dam facilities downstream of Lock and Dam 16.

Concrete blocks (39.5 cm long X 19.0 cm wide X 19.5 cm high, 0.4903 m<sup>2</sup> surface area), which are useful colonization substrates for studying the population dynamics of zebra mussels (Mackie 1991, Cope et al. 1993), were used as samplers. At each site, four concrete blocks were deployed between May 30 and June 1, 1995 in the upper auxiliary lock chamber at each lock and dam. If the deployment of samplers in the upper auxiliary lock chamber was not feasible (Upper St. Anthony, Lower St. Anthony, Lock and Dam 3, Lock and Dam 14, and Lock and Dam 15), suitable areas within the lock structure and having similar flow characteristics were used. The concrete blocks were secured by rope to the lock structure and held suspended in the water about 0.5 m above the bottom.

At the end of the deployment period (October 13-19, 1995), the concrete blocks and attached zebra mussels were placed into polyethylene bags, transported on ice to the laboratory within 24-48 h, and placed in a freezer (-20°C) until further analyses. At the time of processing, a concrete block was removed from the freezer and thawed slightly. All zebra mussels on each block were removed and enumerated.

## RESULTS AND DISCUSSION

The density of zebra mussels continued to increase in the upper Mississippi River during 1995, relative to previous years (e.g., Cope et al. 1995). We found zebra mussels on samplers at every lock and dam except those at Upper and Lower St. Anthony, the two sites farthest upstream. Generally, densities of mussels were greatest at sites 161 km and farther downstream of Minneapolis, Minnesota. Mean densities of zebra mussels ranged from 0/m<sup>2</sup> at Upper and Lower St. Anthony to 11,432/m<sup>2</sup> at Lock and Dam 13 (Table 1).

Based on a logarithmic scale of zebra mussel colonization (0-10, 10-100, 100-1,000, 1,000-10,000, and > 10,000/m<sup>2</sup>), zebra mussel densities can be grouped into four colonization categories in the upper Mississippi River. The area with the least colonization (0-10/m<sup>2</sup>) was the most upstream reach of the river from Minneapolis to Red Wing, Minnesota, which had an average density of 0.8/m<sup>2</sup>. Two facilities, Lock and Dam 4 and Lock and Dam 16, were in the 100-1,000/m<sup>2</sup> colonization category with an average density of 235 zebra mussels/m<sup>2</sup>. The reasons for the low colonization rate at Lock and Dam 16 is unexplained, particularly given the high densities of zebra mussels at sites just upstream (Table 1). All but one of the other 11 lock and dam facilities sampled (Lock and Dam 13), had intermediate colonization (1,000-10,000/m<sup>2</sup>) with a mean zebra mussel density of 3,621/m<sup>2</sup>. Lock and Dam 13, near Fulton, Illinois, had the greatest colonization (> 10,000/m<sup>2</sup>) by zebra mussels, with an average density of 11,432/m<sup>2</sup>.

Some of the sites had densities of zebra mussels that have caused adverse ecological effects on native fauna. Ricciardi et al. (1995), for example, evaluated

the effects of zebra mussel infestation on unionid mussels and found that mortality of unionids occurred when densities reached 6,000/m<sup>2</sup>. Two sites that we sampled (Lock and Dam 12 and Lock and Dam 13) had mean densities of zebra mussels exceeding 6,000/m<sup>2</sup>. Ten of the remaining sites sampled had densities ranging from 1,417 to 4,666/m<sup>2</sup>, abundances approaching the critical level for mortality of unionids. If densities of zebra mussels continue to increase in the upper Mississippi River, adverse effects on the river's rich native mussel fauna and perhaps on water quality (Effler and Siegfried 1994, Effler et al. 1996) and the trophic structure of riverine communities seem probable.

Table 1. Final mean density (standard error in parentheses) of zebra mussels on samplers deployed at lock and dam facilities in the upper Mississippi River during 1995.

Lock and Dam code	Location	River mile	No. of samples	Mean density of zebra mussels (no./m <sup>2</sup> )
AU	Upper St. Anthony Minneapolis, MN	853.7	3	0.0 (--)
AL	Lower St. Anthony, Minneapolis, MN	853.4	3	0.0 (--)
1	St. Paul, MN	847.6	2	1.0 (1.0)
2	Hastings, MN	815.2	4	1.0 (0.6)
3	Red Wing, MN	796.9	3	2.0 (0.0)
4	Alma, WI	752.8	4	211 (46)
5	Whitman, MN	738.1	4	1,417 (79)
5A	Winona, MN	728.5	4	2,831 (496)
6	Trempealeau, WI	714.3	4	1,999 (355)
7	Dresbach, MN	702.5	4	2,342 (343)
8	Genoa, WI	679.2	4	4,478 (498)
9	Lynxville, WI	647.9	4	3,649 (498)
10	Guttenberg, IA	615.1	4	1,919 (228)
11	Dubuque, IA	583.0	4	4,666 (575)
12	Bellevue, IA	556.7	3	8,304 (120)
13	Fulton, IL	522.5	4	11,432 (1,044)
14	Davenport, IA	493.3	4	4,232 (395)
15	Rock Island, IL	482.9	2	3,993 (1,509)
16	Muscatine, IA	457.2	3	258 (45)

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