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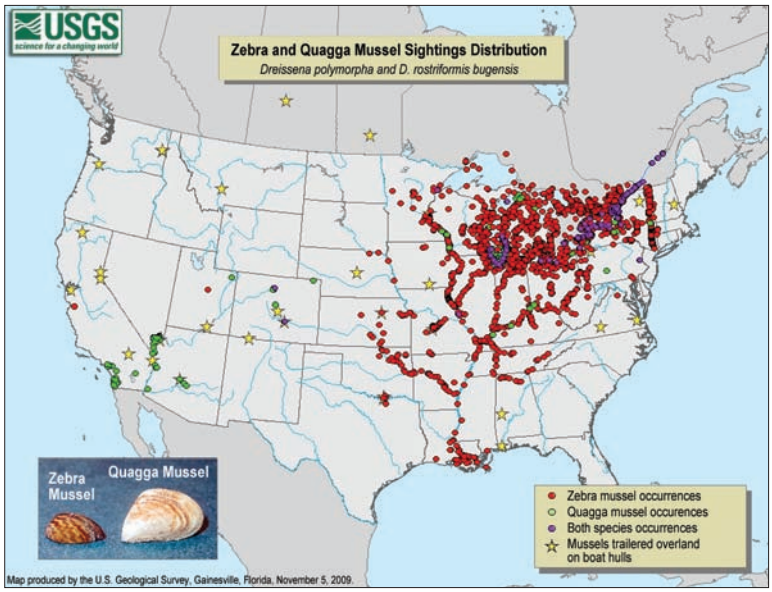
How Will Invasive Zebra Mussels Impact Drinking Water Quality in Kansas Reservoirs?

Invasive species, those species that have been introduced into an area where they did not historically occur, impact virtually every ecosystem in the world. Aquatic ecosystems are particularly vulnerable to invasive species with the establishment of invaders occurring more frequently in recent years. The zebra mussel (*Dreissena polymorpha*) illustrates the significant ecological and economic impacts that can be associated with an aggressive aquatic invader. Since first being reported from the United States in the Great Lakes region in the 1980's, zebra mussels have expanded their range to include water bodies throughout the eastern United States. Kansas and surrounding states are at the current front of the zebra mussel expansion into the southern and western United States.



Current distribution of zebra mussels in the United States as of 2009.
Map obtained from http://nas.er.usgs.gov/taxgroup/mollusks/zebramussel/

Current distribution of zebra mussels in the United States as of 2009.

Numerous studies have been conducted to document the ecological impacts of zebra mussels. Zebra mussels form dense "clumps" that can coat the shores of reservoir (as well as any other objects that are present). It has been estimated that zebra mussels can reach densities of up to 700,000 individuals per square meter in some invaded habitats. As a result, the ecological and economic impacts of zebra mussels can be severe. However, the vast majority of previous research on zebra mussel impacts has been conducted in natural lakes in the north-eastern United States. In contrast, much less is known about how zebra mussel will impact man-made reservoirs, which are the dominate water body type in Kansas. In general, reservoirs are very different than natural lakes. For example, reservoirs are more impacted by their surrounding watershed and they tend to be more turbid (i.e. less clear) and have higher nutrient concentrations than natural lakes. Therefore, the effects of zebra mussels on the ecology of these important ecosystems may be very different than those previously observed for lakes in other regions of the United States.

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One of the most detrimental impacts of zebra mussels has been an increase in the biomass of cyanobacteria. In particular, species of the genus *Microcystis* appear to do well in some systems that have been invaded by zebra mussels. Increases in the biomass of *Microcystis* and other cyanobacteria can have important implications for the quality of drinking water because several taxa produce algal toxins (e.g. Microcystin) that can impact human health and/or taste and odor compounds (e.g. geosmin) that are expensive and difficult to remove. Therefore, it is important to have a better understanding of the relationships between zebra mussels and cyanobacteria in Kansas reservoirs in order to evaluate the potential risks to drinking water quality. Understanding these impacts will allow water treatment plants to plan for future invasions and associated risks as necessary. This information could also be used to help convince the public that it is important to help stop the

Photo: Jason Goeckler, Aquatic Nuisance Species Specialist, Kansas Department of Wildlife and Parks.

Photo: Marc Murrell

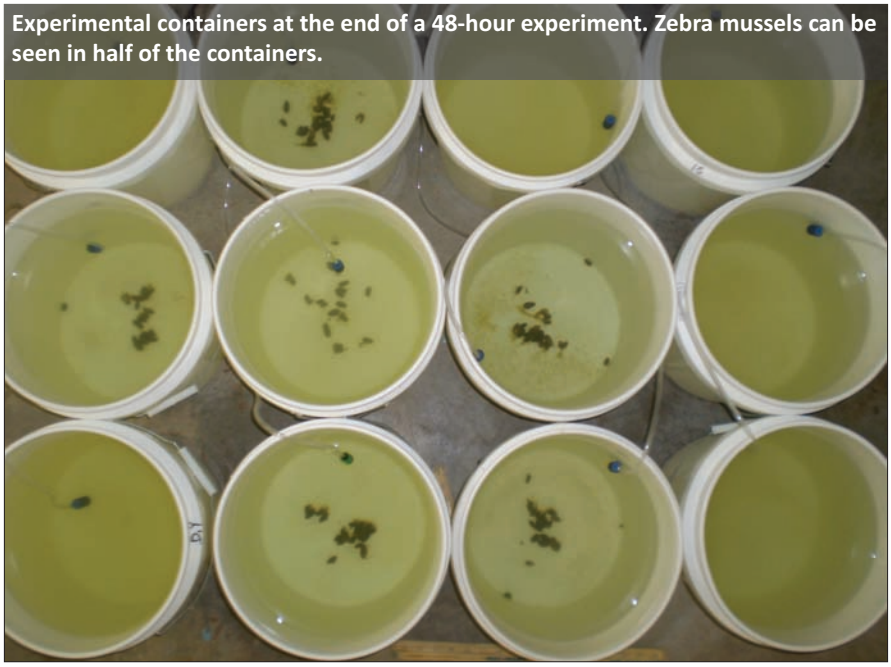
Examples of a zebra mussel infestation from a Kansas reservoir. Zebra mussels form dense "clumps" that can coat the shores of reservoir (as well as any other objects that are present).

spread of this aggressive biological invader (see the websites listed at the end of the article for specific information related to zebra mussel dispersal and control).

Several factors potentially contribute to increases in cyanobacteria following zebra mussel invasions. First, zebra mussels are efficient filter feeders that filter particles out of the water column. While estimates vary, individual adults can filter up to one liter of lake water per day. Zebra mussels can selectively filter algal cells out of the water column. These cells can then be reject and expel as pseudofaeces where they continue to grow and reproduce in the water column. Through this selective filtering, the rejected species can potentially become dominant over other taxa. In addition, several taxa of cyanobacteria form large colonies or filaments that create difficulties for zebra mussels due to their large size. Finally, zebra mussels can alter the concentrations and ratios of important plant nutrients (mainly of nitrogen and phosphorus) in ways that promote dominance by cyanobacteria.

We have recently completed a preliminary study that was funded by the Kansas Department of Wildlife and Parks (KDWP) through the United States Fish and Wildlife Service (USFW) to begin to determine how zebra mussels impact cyanobacteria in Kansas reservoirs. To accomplish this, we collected water from three Kansas reservoirs (Big Hill, Cheney, and Marion) and brought it back to the laboratory where it was placed in replicated eighteen liter containers that either did or did not contain zebra mussels. After forty-eight hours, water was collected from each container and algae were identified and enumerated. Interestingly, we found that zebra mussels were able to effectively graze and reduce the biomass of most of the cyanobacterial taxa that were present in the reservoir water at the time of our experiments. It is important to note, however, that the reservoirs did not contain *Microcystis spp*. during our experiments. It is possible that *Microcystis* may gain a competitive advantage over other cyanobacteria, such as *Anabaena* which were effectively grazed by zebra mussels in our experiments. However, additional research is needed to test this hypothesis in Kansas reservoirs using water that is collected during blooms of *Microcystis spp*.

In addition to reducing the biomass of cyanobacteria, zebra mussels also affected a number of water quality variables in our experiments. For example, they reduced turbidity in the water that was collected from each of the three reservoirs and increased dissolved nutrient (nitrogen and phosphorus) concentrations in the water that was collected from two of the three reservoirs. Combined, the results from this preliminary research suggest that zebra mussels have the potential to impact water quality in several important ways. The next step will be to scale our studies up to the reservoir level and determine if similar patterns are found within actual reservoirs (e.g. compare the water quality conditions in invaded and non-invaded reservoirs).



Experimental containers at the end of a 48-hour experiment. Zebra mussels can be seen in half of the containers.

While our research suggests that zebra mussel may reduce the biomass of some cyanobacterial taxa in Kansas reservoirs, we are in no way advocating for the spread of this invader. In addition to promoting the growth of the toxic cyanobacteria *Microcystis spp*. as discussed above, zebra mussels have been responsible for declines in native mussels, increases in total nutrient (both nitrogen and phosphorus) concentrations, reductions in zooplankton abundance, and reduced growth rates of larval fish. These negative impacts of zebra mussels far outweigh any potential "increases" in water quality that may occur following invasion. Furthermore, the long term impacts of zebra mussels are currently unknown. Some research suggests that while zebra mussels may initially improve water quality, this improvement is only temporary with conditions decreasing after the initial invasion. Finally, the economic impacts of zebra mussels alone outweigh any potential benefits that may be associated with their continued range expansion. For example, it has been estimated that zebra mussels cause hundreds of millions of dollars worth of damage each year in the United States. As can be seen in the Figures throughout this article, zebra mussels form dense clumps that not only coat the shoreline, but also clog or biofoul water intake pipes affecting water use and industry.

To learn more about the zebra mussels in Kansas please visit:
www.kdwp.state.ks.us/news/Fishing/Aquatic-Nuisance-Species/Aquatic-Nuisance-Species-List/Zebra-Mussels.

To learn more about what you can do to help reduce the spread of zebra mussels visit:
www.protectyourwaters.net or www.100thmeridian.org.

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