Cantaurus, Vol. 24, 9-12, May 2016 © McPherson College Department of Natural Science

The Effects of Elevated Levels of Calcium and Turbidity on Freshwater Mussel Growth

Levi Fleming

ABSTRACT

Human activity is having an overwhelming effect on the environment and the organisms that depend on it. The construction of dirt roads not only bisects terrestrial environments, but can also dramatically affect aquatic environments through runoff and erosion. Limestone gravel roads are common in Kansas due to the abundance of the mineral, and runoff from these roads may increase water hardness, while at the same time increase turbidity. This study investigated the effect of elevated hardness and turbidity levels on the growth and development of an important indicator of aquatic ecosystem health, freshwater mussels. We used three experimental tanks (control, Hardness and turbidity, and hardness) to look at the effects of calcium and suspended sediment on the shell growth and biomass of freshwater Fat Mucket mussels (*Lampsilis siliquoidea)*. It was found that elevated hardness levels resulted in slightly but not significantly greater shell growth, while mussels in the elevated turbidity groups had a significantly lower biomass production. This data suggests that elevated turbidity levels from limestone road runoff are a detriment to the aquatic mussel community and likely nullify any potential benefit of increased water hardness.

Keywords: *Calcium, Fat mucket, Freshwater Mussels, Lampsilis siliquoidea, Hardness, Turbidity*

INTRODUCTION

There are a variety of ways that humans are impacting and disrupting the ecosystems around the world. These disruptions range from littering on a small scale to pollution on a large scale. Some things that humans do that impact freshwater ecosystems are improper land use and management. One particularly impacted ecosystem is surface freshwater. Surface freshwater is home to a vast ecosystem of interdependent parts, and if one of those parts is altered it could have catastrophic effects on the rest of the system.

One important part of freshwater ecosystems is freshwater mussels. Mussels are considered bio indicators of water quality (Vaughn 2008). Local mussels are declining in numbers in streams (Box 1999), in large part due to the introduction of invasive species. The American Fisheries Department has been doing numerous surveys to see what the effect of invasive species will have on the species that were already here and they found that nearly 55% of the original species have gone extinct because of the new species (Williams 1993). There are a number of reasons that it would be detrimental to the fresh water ecosystems if mussels are removed from the system. Frist, they play a vital part in the food chain. Mussels are a large food source for many fish and other predators (Williams 1993). They also play a large role in shaping and maintaining the ecosystem so that other animals can inhabit the same area. They do this by filtering the water and cleaning it (Vaughn 2008).

One of the biggest ways that humans impact surface freshwater eco-systems is through the construction of paved and gravel roads. One common type of gravel road in the Midwest is limestone. Limestone roads can affect a fresh water ecosystem in many ways; some of those include sedimentation and runoff. Both of these can lead to an imbalance in the water composition and living conditions of the system and could eventually cause it to collapse. The use of limestone for roads increases the amount of extra sediment that runs off into the streams. This sediment causes the water to be harder and there to be more suspended sediments (Ryan 1991), which can have a variety of negative effects on the freshwater stream eco-systems and specifically on mussel populations. For example suspended sediment can accumulate in the gills of mussels causing suffocation or interfering with their ability to feed, since they are filter feeders. Suspended sediment, in high enough quantities, can also reduce the sunlight available in the stream, thus reducing the food available for the mussels (Box 1999).

By conducting this experiment, I hope to broaden our understanding on how human impact in the environment of Kansas is affecting these native species. This research could eventually lead to a better understanding of how we are affecting the aquatic life of our local streams, which may lead to finding ways to better conserve freshwater ecosystems.

MATERIALS AND METHODS

In order to answer my research question I performed a lab experiment to investigate how the effects of turbidity and hardness, from limestone road runoff, affects growth and development of freshwater mussels. The effects on growth and development that I looked at were growth in shell size (length and width) and soft tissue biomass (dry weight, post treatment).

I set up three ten gallon aquariums into separate treatments (control, hardness, hardness + turbidity). The tank supplies that I used included filters, aerators, sand, food for the mussels and limestone. The filters were standard Tetra Whisper filters that can be found in any pet store. These were used because they were cheap and easily accessible. The aerator was one that the school already had on hand. For the sand, I used pool filter sand. I decided to use this sand because it is very fine and made it easy for the mussels to burrow into. The food that was used is from Instant Algae. There were two types of the food that I used in each of the tanks; one was a Shellfish Diet 1800 from Reed Mariculture and the other was Nano 3600 also from Reed Mariculture. Finally, the limestone was collected form a quarry that is used to rock county roads.

The purpose of this experiment was to see if the elevated calcium levels and turbidity in the water affects the growth and development of the mussels, so I had to try and make the test have as few variables as possible. To do this, I set up and maintained the aquariums in as similar manner as possible. I started by setting up the tanks before I got the mussels, in so that the tanks would have a stable ecosystem before I introduced the mussels. When I set up the tanks, I had them all with filters and the same amount of sand and water. I did this so that the filters would clean out any outside contaminates that where either in the tanks, sand, or aerators. After I let the tanks sit for a couple days, I started the treatments. For the control tank, I made no changes because this tank was used to stimulate normal growth in the mussels and give me a base line to compare my findings to.

The second tank was elevated turbidity and calcium levels. To simulate the elevated calcium levels in the tank, I made a pouch out of a net and placed limestone in the pouch; I then put the pouch into the tank and suspended it in front of the filter so that the water movement circulated the calcium throughout the tank. I elevated the turbidity in this tank by removing the filter paper from the filter. This meant that the tank had a constant buildup of grime in it. To counter this I continually changed out water every couple days to keep the water somewhat clean.

The third tank was treated with just elevated calcium levels. To simulate this I did the same thing I did in the second tank, except I left the filter paper in so that it cleaned all the turbidity out of the water but left the elevated calcium levels. To keep the test as uniform as possible I changed the same amount of water in all three tanks every couple days.

In order to tell if my treatments were working like they were supposed to I had to continually monitor the water quality. To do this I used a turbidity tester and a calcium level monitor. For the turbidity the levels in the control tank had a mean of 9.263 Nephelometric Turbidity Units (NTu) and a standard deviation of 1.031. The control tank had relatively the same turbidity as the hardness treatment tank which had a mean value of 12.883 NTu and a standard deviation of 5.371. The hardness and turbidity treatment had much higher levels with a mean value of 149.733 NTu and a standard deviation of 30.258. The control tank had calcium levels with a mean of 5 milligrams per liter (mg/L) and a standard deviation if 4.297. The hardness treatment tank had calcium levels with a mean of 56.4 mg/L with a standard deviation of 11.44. Similar to the hardness treatment, the hardness and turbidity had calcium levels of 64.605 mg/L with a standard deviation of 15.262.

One hundred and fifty *Fat mucket (Lampsilis siliquoidea)* mussels were provided by the Genoa Fish Hatchery (U.S Fish & Wildlife). I randomly assigned mussels to each treatment, fifty per tank, and placed them in the appropriate aquarium within 1 day of arrival to McPherson College.

After receiving the mussels in the mail, I put them all into the control tank until I was ready to measure them and separate them out. To separate and measure the mussels, I started by taking all of the mussels out of the tank and putting them in a bowl full of water. I then randomly selected one mussel at a time and measured its length and width with a set of micro-calipers. The mussels were then each assigned to one of the three tank treatments randomly until there were fifty in each tank. I selected the mussels at random, but even if there was any bias in the separation of the mussels this would not affect the results because I focused on a cumulative growth of the three separate groups.

After getting the mussels into the correct tanks I fed them once a day with the shellfish diet and the Nano 3600. I continued this for about two months. In this time I also changed out the water, changed the filters, and monitored the water quality every two weeks.

After two months of maintaining the tanks, I measured the mussels again to see if the treatment had worked. To do this, I scooped the sand out of each tank individually and sifted through the sand and collected the mussels. The mussels were measured in two separate ways. First, each mussel was individually measured for its length and its width to nearest millimeter. This was done by using a micro caliper and measuring the mussel at its widest point and its longest point. The second measurement was of the biomass of the mussels. To perform this measurement, all of the mussels were dried in an oven for 7 days. This allowed me to get an accurate representation of the mussel's biomass when dry. To weigh the biomass, I broke each of the shells open and removed the biomass and weighed each one individually and recorded the measurements. I was able to conclude that the mussels were alive through the duration of the experiment, because they were tightly sealed, and if they were dead they would have deteriorated and opened with little resistance.

RESULTS

Prior to our experiment, the sizes of the mussels placed in the different treatments were not different in width (Test Statistic, df= 2, P= 0.438, Figure 1) or length (Test Statistic, df= 2, P= 0.246).

Our experimental treatments did not have any significant effect on shell growth over a short time period. Shell width was not significantly different across our treatments (Test Statistic, df= 2, P= 0.433, Figure 2). Likewise, shell length was not significantly different across the treatments (Test Statistic, df= 2, P= 0.246, Figure 2).

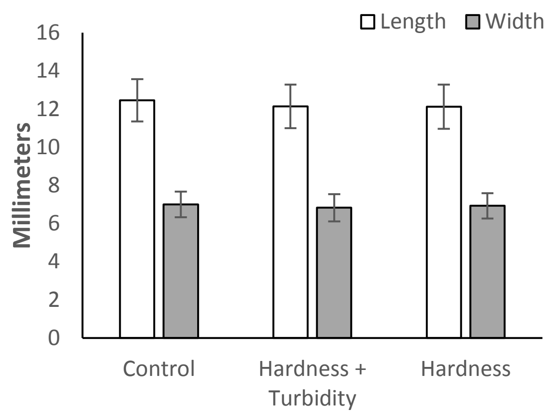

Figure 1. Pre lengths and widths of mussels. Pre length has a P-value of 0.246 and pre width has a P value of 0.438.

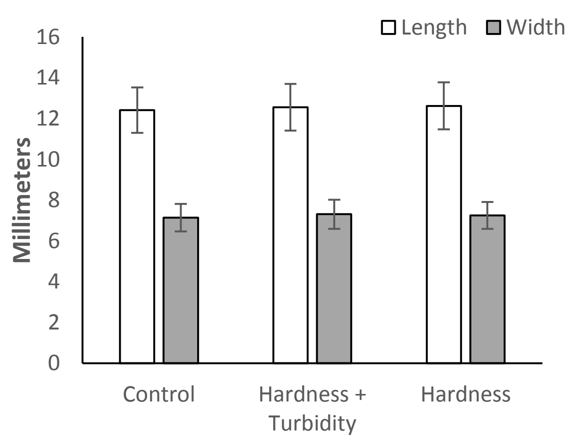

Figure 2. Post lengths and widths. Post lengths have a P value of 0.649 and the post widths have a P value of 0.433.

Elevated turbidity levels were found to have a significant effect on the biomass production (Test Statistic, df= 2, P= 0.038, Figure 3). The data shows that the biomass weights in the hardness treatment group was significantly higher than that of the hardness and turbidity treatment group, suggesting that the turbidity had an effect on the biomass production.

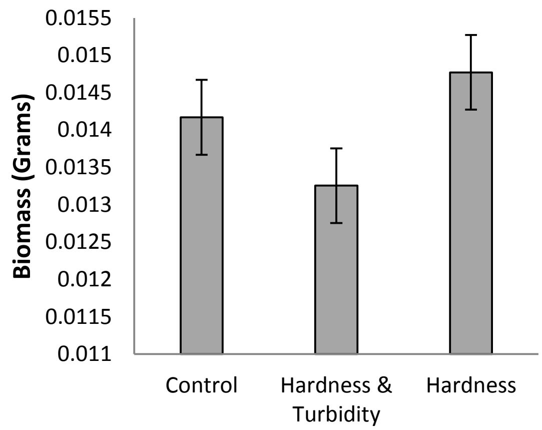

Figure 3. Biomass has a P value of 0.038

DISCUSSION

From the results found in this study, I am able to answer my research question. From the data, I am able to say that elevated calcium levels do not affect the growth of freshwater mussel shells in a short period of time. There was some positive correlation but not enough to be significant. To get a more definitive answer to this question, another study should be performed with a longer test duration.

My results also pointed to a negative correlation between elevated turbidity and biomass production. This was something that was expected, because current literature suggests that extra suspended sediment can inhibit filter feeding, causing the mussels to not get enough nutrients to sustain stable growth.

This was interesting because in respect to limestone roads runoff into streams there will be both elevated hardness and turbidity. This study shows that while the extra hardness could in the long term have a positive effect on shell growth, it has no significant effect in the short term. Extra turbidity on the other hand has a significant effect on the short term production of biomass. This means that the tradeoffs between the positives and negatives would be overall negative, even in the long run.

One thing that was assumed in this study that could not be measured is the pretreatment biomass since it would have been impossible to measure without killing the mussels. The biomasses were assumed to be equal since the mussels were randomly separated into the three treatment groups.

This data could be used as a baseline for future experiments. Another study could be done to test how long it would take for elevated harness levels to have a significant effect on shell growth, or a study could be done to look at what levels of turbidity are tolerable for mussels.

Further studies could also be done to look at what can be done to reduce the impact of extra calcium from roads in freshwater streams. This might include things such as nets to catch falling rocks from the road so that they do not make it to the water and thus dissolve into suspended sediments, or perhaps some sort of better drainage system so that the runoff from the road does not make it to the stream right away, thus reducing the amount of rock that makes it to the stream during rainfall events.

ACKNOWLEDGEMENTS

This study would not have been possible without the help of Dr. Dustin Wilgers and the Natural Science faculty at McPherson College. I would also like to extend my thanks to those who volunteered their time to help with feeding and maintaining the treatment tanks when needed.

LITERATURE CITED

Box, J. B. and Mossa. J. 1999. Sediment, land use, and freshwater mussels: prospects and problems. Journal of the North American Benthological Society, 99-117.

Ryan, Paddy A. 1991 Environmental effects of sediment on New Zealand streams: a review. New Zealand journal of marine and freshwater research. 25.2: 207-221.

Williams, James D., et al. 1993.Conservation status of freshwater mussels of the United States and Canada. Fisheries 18.9: 6-22.

Vaughn, C. C., Nichols, S. J., & Spooner, D. E. 2008. Community and foodweb ecology of freshwater mussels. Journal of the North American Benthological Society, 27(2), 409-423.