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Zebra Mussels *(Dreisenna polymorpha)*: A look at its recolonization onto living (unionid) and non-living surfaces

Abstract

The invasion of zebra mussels (*Dreisenna polymorpha)* has had a tremendous impact on lake habitats ever since their arrival in 1986 (O'Neill 1994). They live on the hard surfaces in the lake, which includes native mussels (*unionids)* and rocks. Within this study, we examined surface preferences of zebra mussels by looking at living and dead native mussel shells and rocks. We constructed a plot area on the South Fishtail Bay area of Douglas Lake and counted the number of zebra mussels we found on both living and dead unionids. After the removal of these zebra mussels, we waited seven days for recolonization to occur and recounted the number of zebra mussels that were present upon the unionids shells and a transect of rocks that were placed in the water. After collecting this data, we found there to be no preference between the three surfaces we studied. However, by examining our plot data, we discovered the recolonization rate of zebra mussels, which is approximately 0.074 zebra mussels per native mussel per day. This data shows there is a possibility of creating a refuge for native mussels along the Douglas Lake shoreline by removing the zebra mussels every three months.

Introduction

There have been approximately 50,000 invasive, non-native, species introduced into the United States. Most of these species have caused environmental damage or native species extinctions of the native species (Pimentel 2000). The zebra mussel (*Dreisenna*

polymorpha) has been one of the most wide-spread, invasive species ever since its introduction in 1986 (O'Neill 1994). The zebra mussel was first discovered in the Lake St. Claire in southeastern Michigan, most likely brought as a freshwater ballast stowaway on a commercial vessel from Europe (O'Neill 1994). From this first introduction, zebra mussels have spread throughout and colonized all of the Great Lakes and most inland lakes Michigan, being transferred by commercial and recreational boats since approximately 1991 (Bossenbroek 2001)

One of the inland lakes of Michigan that zebra mussels have colonized and affected is Douglas Lake, located approximately 10 miles south of Mackinac City and home of the University of Michigan Biological Station. Since the colonization of Douglas Lake, zebra mussels have affected native freshwater mussels as larvae settle and attach to native mussels covering them so completely that they can no longer carry out life processes (Benson 1995). These larval zebra mussels can remain in the water column for several weeks before settling onto a solid surface that would support their larger adult life (Ricciardi 1998). They have also reduced the amount of oxygen and food resources available to the native mussels within the water (Strayer and Smith 1996, Benson 1995).

An experiment was previously recorded to show the preference level of zebra mussels on native unionid species compared to inanimate substrate. Within this experiment by Lewandowski in 1976, there was found to be higher colonization rates of unionids compared with inanimate substrate (Hormann 2006).

We decided to create an experiment of our own to follow up on this data and to look further into the recolonization rates. We examined the colonization of these zebra mussels onto the native clam species (unionids) of Douglas Lake. We studied the shells

of both living and dead unionids to see if there is a level of preference between the two. We also took the measurements of both living and dead native unionids to find if there was a correlation between the size of the native unionids and the number of zebra mussels attached to it. We investigated the colonization of hard surfaces by placing rocks into our transect area. Within a weeks time, we saw recolonization of the native unionids by zebra mussels and used this data to calculate a recolonization rate and to show that there was no observable preference between the colonization of the three surfaces studied. We also studied the recolonizational rates of these zebra mussels back onto the unionid shells. From this data, we hope to form a protocol of creating a refuge for native unionid species within S. Fishtail Bay, keeping the zebra mussels from extirpating these native species.

Materials and Methods

In order to examine the recolonization of zebra mussels on the native unionid species we set up five transects on the western side of South Fishtail Bay area of Douglas Lake. Four of these transects were used to look at the native, living and non-living clam species while the fifth transect was used to look at the colonization on rocks. The transects were 10 meters off the shore and they were parallel to each other (perpendicular to the shoreline), for 10 meters. They were spaced approximately 5 meters apart from each other. We placed anchors, buoys and rope to mark each transect. On our rock transect (transect 5), we placed 10 rocks in the water for 10 meters with one meter spacing between each rock.

We first removed zebra mussels from all live and dead native unionids in transects 1-4. We snorkeled along each transect and collected any native clam shells

within a meter on either side of our transect. We removed and counted all zebra mussels found on the unionid. We measured the length and width of each shell, marked the unionids with a waterproof marker or nail polish, and then returned the unionid to its original location. With the live mussels, we took care to keep them relatively wet while we took their data. Both live and dead shells were replaced in their respective transects after the collection of our data.

When we returned after a week's time, we then snorkeled again, finding the clam shells that we had previously marked. We recorded the number of zebra mussels that had colonized the shells and the length and width of each shell that had our markings on them. For our rock transect, we recorded the number of zebra mussels that colonized each and then took the length and width of these to give us the approximate surface area.

We then took this data back to the LaRue computer lab in order to study and draw conclusions. We ran regression lines on our data of length and width of dead and alive unionids vs. the number of zebra mussels upon them. We also ran t-tests on the length and width of live vs. dead unionids to determine if there was a significant difference between the living vs. dead mussels. We ran a t-test on the zebra mussel per millimeter squared of alive vs. dead and a t-test of the average zebra mussels on live vs. dead clams to determine if zebra mussels prefer living or dead unionids. Finally, we found the recolonization rate in order to determine if there was a possibility of creating a refuge for native unionids in S. Fishtail Bay.

Results

The average length of live unionids was 55.3 and for dead unionids was 47.8. The average width for live unionids was 32.3 and for live unionids was 25.6 and both can be

seen in Figure 1. We ran a t-test and found there was no difference between live and dead unionid's length (t-test, 0.41, 5, 0.70). We ran a t-test and found there was no difference between live and dead unionid's width (t-test, -0.33, 5, 0.75). From this length and width data we found that the number of zebra mussels per square millimeter was for both the live and dead unionids, 0.014 and 0.023 respectively (Figure 2). We ran a t-test and found that there was no difference between the number of zebra mussels per millimeter squared on live vs. dead unionids (t-test, 0.40, 21, 0.69).

We used regressions to investigate the relationship between the length and width of the live and dead unionids and the number of zebra mussels found on these unionids. There was no relationship between the length of dead unionids and the number of zebra mussels attached to them (regression, 0.018, 0.11) (Figure 3). There was no relationship between the width of dead unionids and the number of zebra mussels attached to them (regression, 0.018, 0.043) (Figure 4). There was no relationship between the length of live unionids and the number of zebra mussels attached to them (regression, 0.35, 0.22) (Figure 5). There was no relationship between the width of live unionids and the number of zebra mussels attached to them (regression, 0.69, 0.042) (Figure 6).

We ran a t-test to compare the average number of zebra mussels on live versus dead unionids before their removal. From this test, we found that there was significant difference between the means of the live and dead unionid mussels, which were 18.2 and 28.7 zebra mussels respectively (t-test, -3.55, 45, 0.0009).

Once we removed the zebra mussels from native species we waited seven days and then returned to our site to determine the recolonization of the zebra mussels on native mussel species and rocks. We found the mean number of zebra mussels on the

three different surfaces to be 0.63 zebra mussels on dead mussels, 0.57 on live mussels and 0.5 on rocks (Figure 7). We ran a t-test and found that there was no difference in the number of zebra mussels that colonized the live vs. the dead unionids (t-test, 0.04, 14, 0.97).

Finally, we were able to calculate the rate of recolonization by taking the number of zebra mussels per unionid per day. We calculated this rate to be 0.075 zebra mussels per clam per day.

Discussion

We wanted to discover if there was a significant portion of zebra mussels that preferred to colonize live over dead unionids. Previous studies have shown how *Dreissena* can benefit from the relationship of living on native unionid species due the ability of capturing food that was not digested by the native mussel (Hormann 2006). From this study, we could expect that zebra mussels would then prefer to colonize living unionids over dead unionids. Other studies have shown that it is unclear if zebra mussels prefer the unionid shell to other substrata such as rocks (Lewandowski 1976). However, once we collected our data and ran the appropriate t-test on it, we saw that there was no distinct preference for our zebra mussels after a weeks time. Other support to this is Figure 3, which shows the average number of zebra mussels after recolonization on all three surfaces. These are all very similar, showing that there is no distinct preference between all three surfaces after seven days. However, we found that there was a significant difference between the mean number of zebra mussels on the live and dead unionids before the removal of zebra mussels.

There are many different reasons that could possibly create this contradicting information. Primarily, we only have a single week sampling of our data for recolonization. This could mean that we missed a small variable that takes place with more time. Along with this further progression of sampling there is the possibility that there is a threshold level of zebra mussels on a unionid which ultimately kills them. Because we did not reach that threshold, somewhere between 18 and 28 zebra mussels per clam, we could not see this occur within our data of recolonization. This is also supported by Strayer (1999) where it was stated that in some rare cases as few as 10 zebra mussels may kill a unionid but is usually 20 or more (Strayer 1999) Finally, another possibility is that once the unionid dies, the shell opens and lays flat on the lake bed creating more surface area for the zebra mussels to colonize.

We also concluded that the length and width of both live and dead unionids has no effect on the colonization of zebra mussels. Since we also found that there is no preference in the initial recolonization of a unionid species, we can see the true tolerance of the zebra mussel species. No matter how big or small, alive or dead, the zebra mussel will find the hard surface of a unionid mussel and be able to colonize this surface. They could colonize this surface so much that it is a possibility that they past the theoretical threshold level, killing the unionid it has colonized.

We found the rate of recolonization on native unionids to be .075 zebra mussels per clam per day. This is very significant for the creation of a possible refuge site at the University of Michigan Biological Station because it shows that there is a very slow rate of recolonization. Since zebra mussels grow faster in shallow that in deep parts of a waterbody, Douglas Lake may be the perfect area to make a refuge for native clams

(Karatayev 2006). If a handful of researchers and students were to remove zebra mussels from clams in the first few weeks of summer and then were to repeat this removal process after a 90 day period, there would only have been an average of approximately 7 zebra mussels per native mussel, alive and dead. If they were to then remove the zebra mussels from the native mussel species at this point, they would not need to remove the zebra mussels again until the beginning of the following summer because zebra mussel growth tends to slow and even stop in the winter and only resumes again in the spring after water temperatures warms (Karatayev 2006). This is supported by Schlosser (1996) who showed that short-term protection of unionids can occure by the periodic removal of zebra mussels (Schlosser 1996). Karatayev also found that growth of zebra mussels is faster in eutrophic than oligotrophic lakes (Karatayev 2006). This all is significant because Douglas Lake is a meso-oligotrophic lake with deep water that freezes during the winter months creating the perfect refuge for native clams along the shallow shoreline around South Fishtail Bay on Douglas Lake. To help this refuge take place, during the removal process of the unionid shells, all zebra mussels should be removed from surrounding surfaces and taken out of the water. This is because a zebra mussel tends to act like a unionid when removed from their hard surface. They will exhibit creeping behavior until they find a new hard surface to colonize (Toomey 2002).

There are many changes that could be made to the experiment in future trials. First off, a longer period of surveying and collecting data would be able to provide more conclusive data and allow the researcher to provide answers to variables that could not be answered in a week's time. Also, taking a larger plot area to include more living unionids to compare to the dead unionids may help when analyzing the data.

There were some significant findings from this study done on Douglas Lake and it seems as though there is a strong possibility of creating a refuge for native mussels on Douglas Lake. The rate of recolonization is low enough to allow for students and researchers to remove zebra mussels only twice or three times a year, keeping the native mussels alive. Along with this refuge there is hope that zebra mussel populations will exceed their environmental capacity and ultimately decline in population size (Keniry 1995). Zebra mussels will continue to be a problem that persists for a very long time, we just need to discover a way to live with them and protect the many species that they in danger. Hopefully this research and project will be an initial start on this journey.

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Figures and Tables

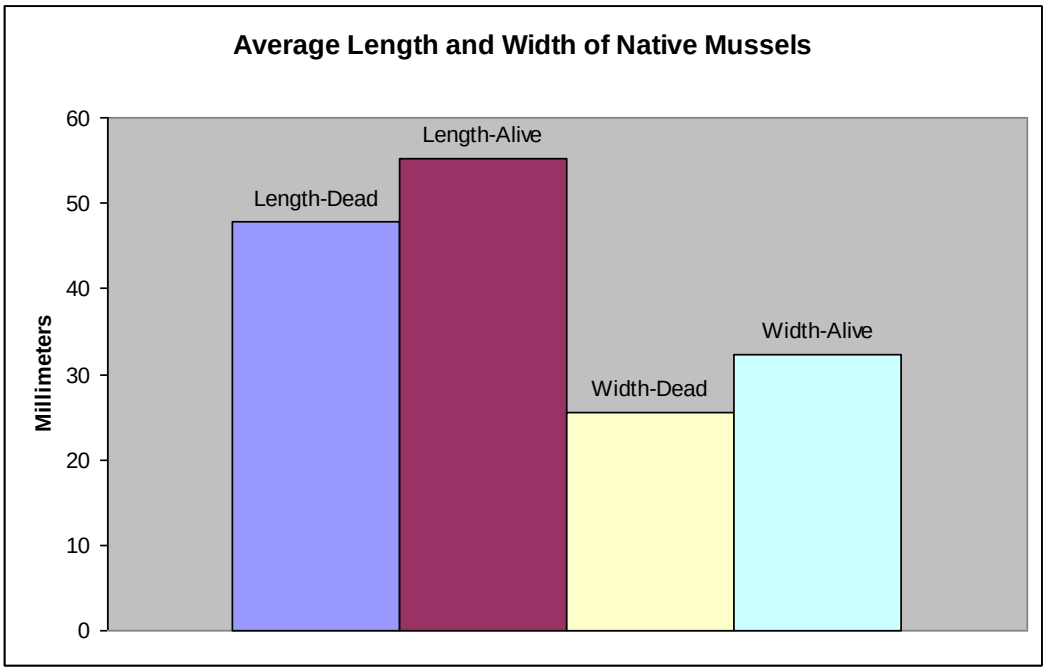

Figure 1. This graph shows the average lengths and widths of the native clams that we collected from Douglas Lake.

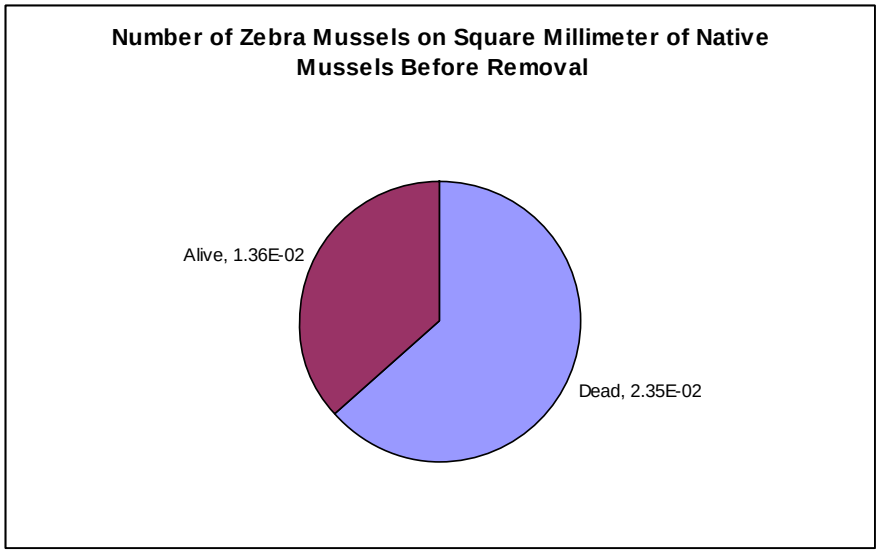

Figure 2. This pie chart shows the average number of zebra mussels on a square millimeter of native mussels of Douglas Lake, before the removal process This could be slightly skewed due to the larger number of dead mussels in comparison to live.

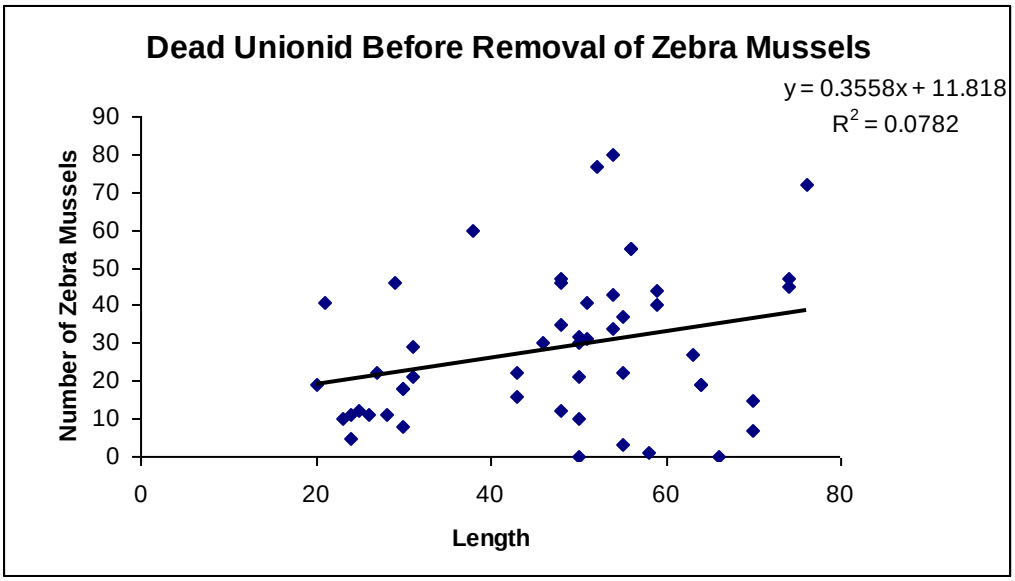

Figure 3. This graph shows the number of zebra mussels according to the length of the dead unionids. There is a regressional trend line with the R^2 value showing us that there is no relationship between the two.

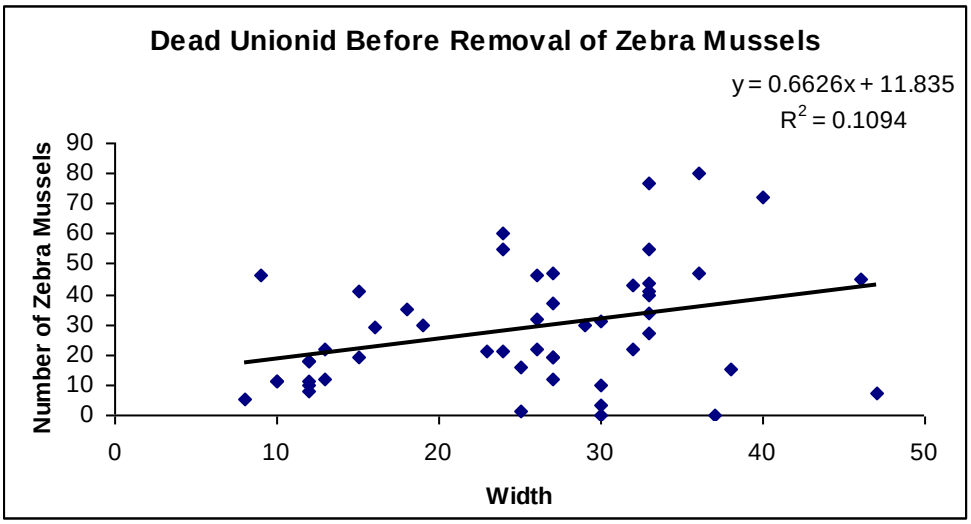

Figure 4. This graph shows the number of zebra mussels according to the width of the dead unionids. There is a regressional trend line with the R^2 value showing us that there is no relationship between the two.

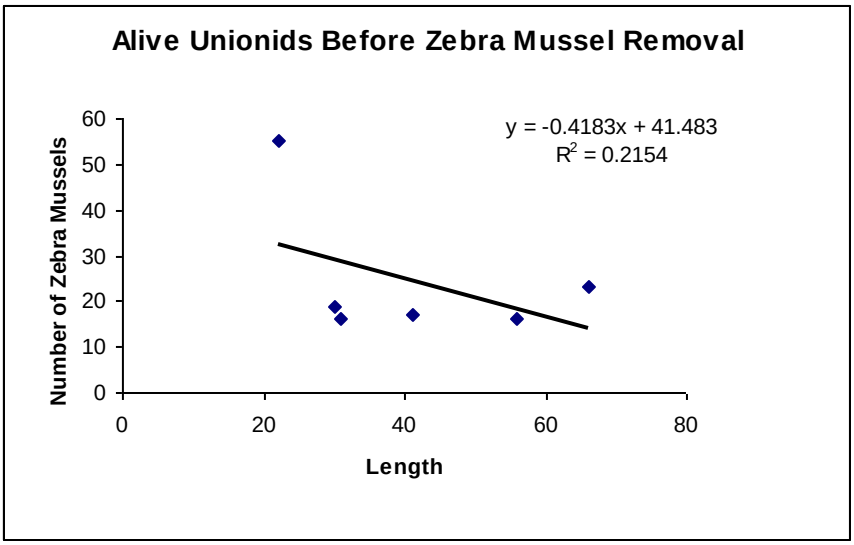

Figure 5. This graph shows the number of zebra mussels according to the length of live unionids. There is a regressional trend line with the R^2 value showing us that there is no relationship between the two.

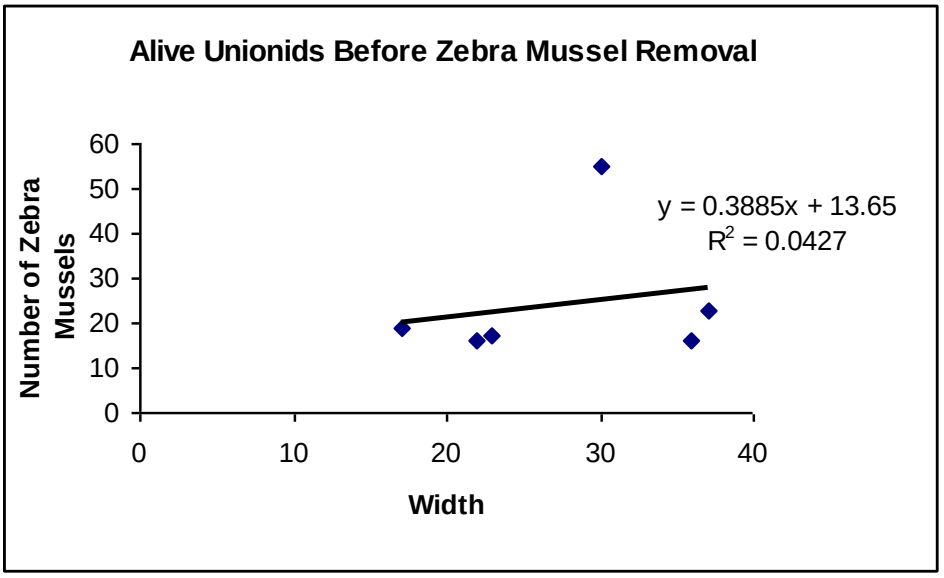

Figure 6. This graph shows the number of zebra mussels according to the width of live unionids. There is a regressional trend line with the R^2 value showing us that there is no relationship between the two.

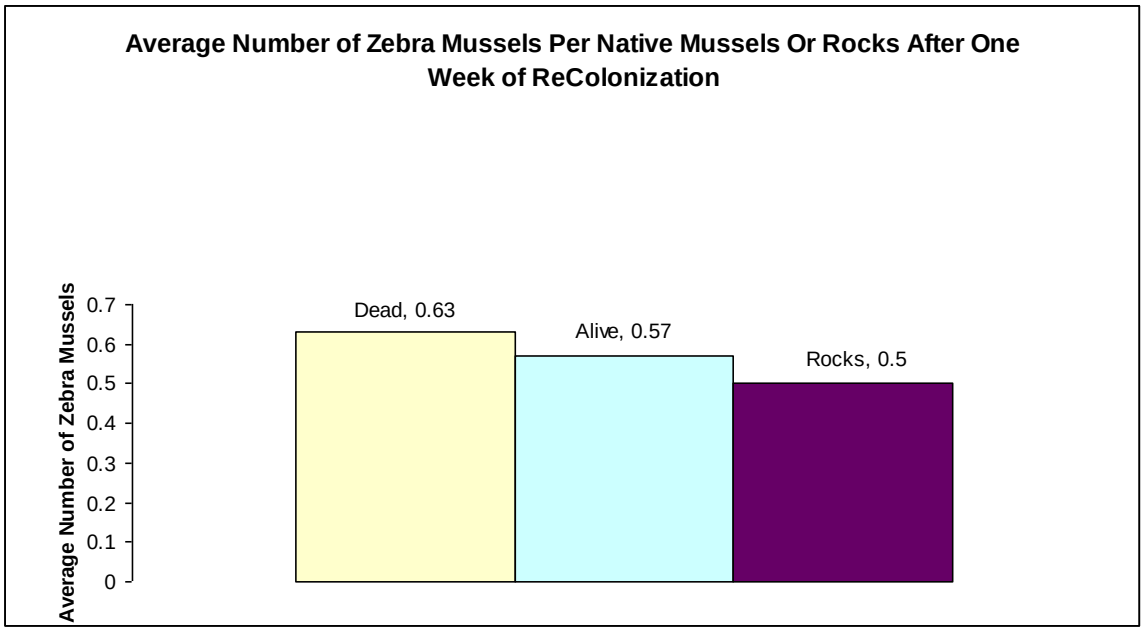

Figure 7. This chart describes the average number of zebra mussel that recolonize the native unionids (alive and dead) and rocks in our transect.