The Effect of *Dreissena polymorpha* on the Native Mussel Species in the Missisquoi Bay

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Abstract

Zebra mussels (*Dreissena polymorpha*) have become an invasive species in Lake Champlain, and have altered macroinvertebrate habitat significantly. They negatively affect native mussel species by attaching to the mussels and eventually killing them. Missisquoi Bay has more recently been colonized by zebra mussels and represents an opportunity to study the effects of a new invasion. I hypothesized that when the abundance and species richness of the native mussels *Elliptio complanata, Lampsilis radiata, Lampsilis ovata, Pyganodon cataracta, Pyganodon grandis,* and *Pisidiidae* increased, the number of zebra mussels would increase as well. My results showed that there was a significant increase in the number of zebra mussels with higher native mussel richness. There was also an increase in the number of zebra mussels when native mussel abundance was higher but this effect was not statistically significant. There were more native mussels in samples with zebra mussels than in samples lacking zebra mussels, for all native mussels, except *Elliptio complanata*. This could be because *Elliptio complanata* populations overwinter under sediment and may shed zebra mussels when embedded. These results support my hypothesis, and show that the abundance and richness of native mussels are affecting the number of zebra mussels present. This is important because zebra mussels are becoming more invasive and altering the environment that many organisms live in. It is important to see how they are changing the environment, and what effects they will cause in the future.

Introduction

- Zebra mussels (*Dreissena polymorpha*) have become an invasive species in both North America and Europe, causing major changes in both macroinvertebrate abundance and diversity (Ward & Ricciardi, 2007).
- They invaded Lake Champlain in 1993, and have been causing both positive and negative effects on the native species there (Beekey *et al.,* 2004).
- They have positively affected macroinvertebrates by offering them more space between colonized mussel shells, which helps them to avoid predators. They also create a larger surface area for macroinvertebrate colonization (T.W. Stewart *et. al,* 1998).
- Zebra Mussels increase the organic matter available to the macroinvertebrates by depositing both faeces and pseudofaeces onto the benthos (Beekey *et al.,* 2004).
- They have been negatively affecting native unionids by causing competition for food and space by attaching themselves using thin fibers called byssal threads. This attachment eventually leads to mussel death (Ward & Ricciardi, 2007).
- Zebra mussel presence can also cause disease and parasitism in native species, which can lead to community alteration (Schmidlin & Schmera, 2012).
- We tested the hypothesis that when species richness and abundance of native mussels *Elliptio complanata, Lampsilis radiata, Lampsilis ovata, Pyganodon cataracta, Pyganodon grandis,* and *Pisidiidae* increases, the number of zebra mussels will also increase.

Methods

Field

- A grid was created (SedTrend, 2013) that had 370 sample sites, in Missisquoi Bay, laid out 500 meters apart.
- We used boats to collect 334 samples (some sampling points were not boat accessible) from Missisquoi Bay's floor by using a petite ponar sampler.
- We ran each sample through a 0.5mm sieve, and then rinsed the sample twice with water.
- We scooped the sample from the sieve and placed it into a whirl-pack bag filled with 100% EtOH, and a tag with the date, latitude, longitude, and sample number.

Lab

- We ran each sample through a 0.6mm sieve and rinsed the sample with water.
- We picked out the bugs and full mollusc shells from each sample and placed them in glass vials with 70% EtOH, 1% glycerin, and then recorded the number of macroinvertebrates, empty snail shells, and empty mussel shells present.
- We placed the mussels into whirl packs with 70% EtOH, 1% glycerin.
- We went through and identified macroinvertebrates down to the lowest practical taxonomic unit using a dissecting microscope and taxonomic keys.

Data Analysis

- I used a one-way ANOVA to ask if average species richness differed between samples with zebra mussels and without zebra mussels.
- I performed two regression analyses of 1. native mussels abundance and 2. species richness responses to *Dreissena polymorpha* density.
- I performed a rarefaction analysis between samples that contained *Dreissena polymorpha* and that did not, using Ecosim software.
- I performed a *t*-test, and calculated Cohen's D for each of the native mussel species and their response to the presence of zebra mussels, and graphed results (IBM SPSS Statistics, 2013).

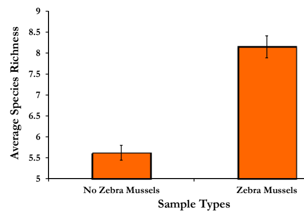

Figure 1. A comparison of the average species richness between 334 samples, taken from Missisquoi Bay, that contained *Dreissena polymorpha* and that did not contain *Dreissena polymorpha (*ANOVA; *p*<.001).

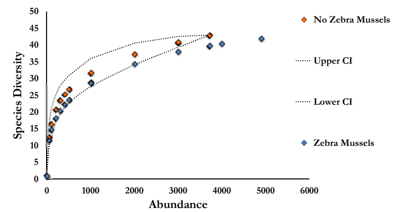

Figure 2. Species richness rarefaction curve comparing 334 samples from Missisquoi Bay. Graph shows predicted abundance and species richness for samples with zebra mussels and without zebra mussels.

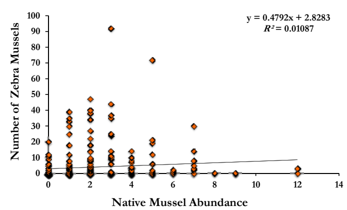

Figure 3. The effect of the abundance of the native mussels *Elliptio complanata, Lampsilis radiata, Pyganodon cataracta, Pyganodon grandis, Lampsilis ovata,* and *Pisidiidae* on the number of *Dreissena polymorpha* in the Missisquoi Bay (linear regression; *p*=.057).

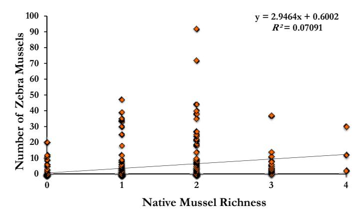

Figure 4. The effect of the species richness of the native mussels *Elliptio complanata, Lampsilis radiata, Pyganodon cataracta, Pyganodon grandis, Lampsilis ovata,* and *Pisidiidae,* on the number of zebra mussels in the Missisquoi Bay (linear regression; *p*<.001).

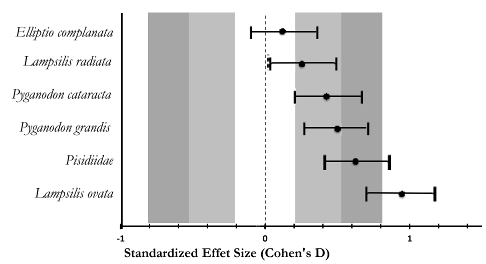

Figure 5. Standardized effect size with 95% confidence intervals showing differences based on the presence or absence of zebra mussels in our 334 samples taken from Missisquoi Bay. Dark gray area shows the range for large effect size (0.8), light gray shows medium effect size (0.5), white area shows small effect size (0.2). When the confidence limit crosses the dotted line, it corresponds to the standard statistical interpretation of *no significant difference* between the number native mussels contained in samples with and without zebra mussels.

Discussion

Zebra Mussels alter habitats by providing macroinvertebrates with extra spaces to hide from predators, and by adding many nutrients from their feces and pseudofeces (T.W. Stewart *et. al,* 1998; Beekey *et al.,* 2004). Our data support this (Fig. 1), by showing there are more species in samples where zebra mussels are present. Our rarefaction graph showed that samples with zebra mussels had a smaller expected abundance and species richness than those without zebra mussels. The difference between these two sample types was not significant over most of the range of the rarefaction graph (Fig 2). The differing results between these two graph types can be explained by recognizing that by gathering more individuals in samples, there will most likely be an increase in species richness. Thus higher density communities will tend to have more species because more individuals are available to be sampled. This model is called 'passive sampling' and often explains richness increase associated with an increased abundance (Yaacobi *et al.,* 2007).

Zebra mussels have had negative effects on the native mussels (Ward & Ricciardi, 2007). Our results show that zebra mussels positively correlated with native mussel abundance (Fig. 3) and species richness (Fig. 4). This correlation could be due to zebra mussels attaching themselves to the live native mussels. It could also be due to them both relying on the same set of resources to survive, and so they would be found in the same places. There were differences between every native mussel species' presence when zebra mussels were present as opposed to when they weren't, except with *Elliptio complanata* (Fig. 5). The majority of the native mussels had medium to large effect sizes, showing there were more mussels present when zebra mussels were in the sample. A reason for *Elliptio complanata* not having a difference could be because this mussel was the second most common mussel we found and is probably present all around the Missisquoi Bay. *Elliptio complanata* is relatively tolerant of zebra mussels, and this mussel suffers much less from zebra mussel attachment than does *Lampsilis radiata* (Hallac & Marsden, 2000).

An interesting future study would be to see how zebra mussel shells are affecting the bottom of Lake Champlain. A study was done in Switzerland that showed zebra mussel shells last longer than native mussel shells after being abandoned, and turn the sandy substrate into partially hard substrate (Schmidlin & Schmera, 2012). Another interesting future study would be to see how zebra mussels are affecting the algae blooms in Lake Champlain, because they increase the number of bacteria in the sediment and increase water clarity (Schmidlin & Schmera 2012; Atalah & Kelly-Quinn, 2010).

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