A Manipulative Study on the Effects of Sediment on Macroinvertebrate communities

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Abstract

Sediment is a dangerous pollutant in freshwater environments and with the predicted effects climate change, sediment may become even more of a problem for stream health. This study was designed to understand the response of macroinvertebrate communities to fine sediment addition. I hypothesized that a greater proportion of fine sediment present would cause a decrease in macroinvertebrate abundance and taxa richness. I set up three different types of sediment treatments (fine, coarse, control) in the Brown's River in Underhill, Vermont for 12 days, collected and identified the macroinvertebrates within the treatments and also ran sieve analysis on the sediment. I found that although there was a significant difference in sediment smaller 250um in the treatments, there was no significant difference in the abundance and taxa richness in the different treatments. Even though I was unable to support my original hypothesis, this study did not reject the negative relationship between fine sediment and macroinvertebrate communities.

Background

- Sediment is a dangerous freshwater pollutant that can enter freshwater systems by means of rural, agricultural and forested land, urban road sediment, atmospheric deposition, channel banks, construction, large-scale diffuse release, and livestock poaching (Taylor and Owens 2009; Larsen *et al*. 2011).
- Climate change is expected to lead to more precipitation which would mean more runoff and erosion and more sediment in streams (Wilby *et al.* 1997).
- Sediment changes the benthic habitat by filling in the interstitial zone (the space between rocks), increasing turbidity, and changing nutrient and oxygen exchange which can affect macroinvertebrate feeding, lifecycle, and safety from predation and physical disturbances (Larsen *et al*. 2011; Bo *et al*. 2007).
- Macroinvertebrates are bioindicators of overall stream health (Ellis 1936). Specifically, Ephemeroptera, Plecoptera, and Trichoptera are important to focus on (McCabe *et al.* 2012).
- Studies have demonstrated that increased sedimentation can negatively affect macroinvertebrate abundance and taxa richness (Milisa *et al* 2010; Bo *et al* 2007; Angradi 1999).
- My study was designed to understand the effects that different sized sediment treatments (coarse and fine) has on macroinvertebrate communities. I hypothesized that a greater proportion of fine sediment present would cause a decrease in macroinvertebrate abundance and taxa richness.

Methods

Field Protocol

- Sediment samples taken from multiple streams located in urban and forested areas and then sent to UVM for sieve analysis.
- Using sieve analysis results, I created mixtures of sediment that represented urban and forested streams. The urban stream sediment mixtures had a greater proportion of fine sediment, while the forested stream sediment mixture had a greater proportion of coarse sediment.
- Test site: Brown's River in Underhill, Vermont which had forested stream characteristics.
- Sediment mixtures were put into small, transparent, plastic containers. A third treatment, the control treatment, was created at the test site by removing natural substrate from the streambed and putting that into plastic containers. Overall, 12 replicates of each treatment (total of 36 containers).
- Placement of treatment containers determined randomly in a 6x6 array (Figure 1).
- The sediment treatment containers were put into the streambed with their top edges flush with the natural streambed substrate.
- Recovered 24 of the 36 containers after 12 days. The remaining 12 were washed away. Two of the recovered containers were only half-full.

Lab Protocol

- Separated macroinvertebrates from sediment by rinsing the recovered samples numerous times in a bucket and allowing organics to float to the top.
- Macroinvertebrates were identified to genus unless damaged or too small and were stored in 70% EtOh, 5% glycerine.
- Sediment samples, once dried, were run through a sieve shaker for 10 minutes to determine proportionally what sizes of sediment remained in each treatment.
- Used Microsoft Excel to run statistical analysis (ANOVA, t-tests)

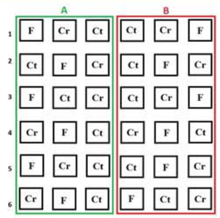

Figure 1. Overhead view drawing of treatment array with Row 1 being the most upstream row. Treatments: F=Fine, Cr=Coarse, Ct=Control. Rows 1m apart, columns 0.5m apart.

Results

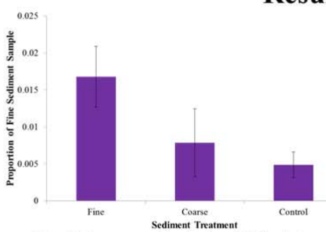

Figure 2. Average proportion of sediment <250um in three sediment treatments; p<0.01.

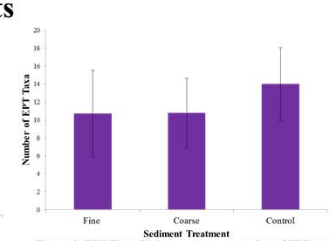

Figure 3. EPT Taxa Richness. Average number of EPT taxa (Ephemeroptera, Plecoptera, Trichoptera) in three treatments; p=0.2997.

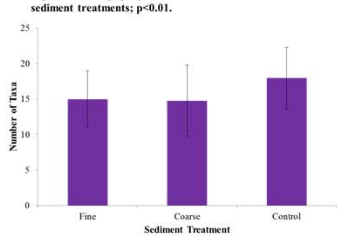

Figure 4. Overall Taxa Richness. Average number of taxa in three treatments; p=0.3767.

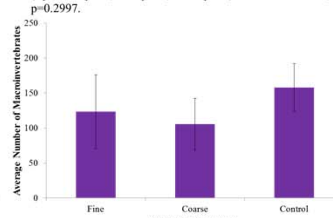

Figure 5. Overall Macroinvertebrate Abundance. Average number of macroinvertebrate individuals in three treatments; p=0.0847

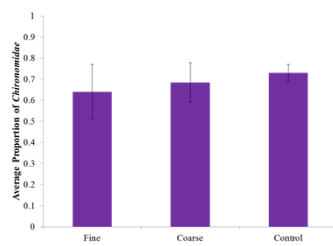

Figure 6. Chironomidae Dominance. Average *Chironomidae* proportion out of total macroinvertebrate individuals in three treatments; p= 0.2786.

Discussion

The significant difference between sediment <250um in each of the three treatments demonstrates that I was successful in establishing three different sediment environments (Figure 2). I expected to find the greatest proportion of <250um-sized sediment in the fine treatments, followed by the coarse treatment and control (Figure 2). Although the stream water added to and subtracted from the original sediment mixtures, the proportion of sediment smaller than 250um remained different and therefore can be used in the comparison of macroinvertebrates in the three treatments.

EPT taxa richness was greatest in the control treatment and virtually identical in the fine and coarse treatments although there was no significant difference (Figure 3). These findings conflict with results from studies done by Larsen *et al*. (2011), Angradi (1999) and Lenat (1983) that showed a significant negative decrease in EPT richness after addition of fine sediment. I expected to find a much greater response to fine sediment from EPT taxa because of how sensitive these taxa tend to be.

My analysis of overall taxa richness and abundance showed no significant difference between treatments, although the control treatment had the greatest average number of taxa and greatest abundance (Figure 4,5). My overall taxa richness results, although not significant, do follow in the same pattern as Larsen et al.'s (2011) results which show that macroinvertebrate taxa richness decreases with fine sediment addition. The difference in overall abundance was nearly significant and can only suggest that the coarse sediment treatment deterred macroinvertebrates from occupying the container. This goes against my hypothesis because more fine sediment would decrease habitable interstitial zone area. These results also conflict with results from Bo *et al*.'s (2007) study, which had very similar methods to my own study, but instead found that abundance decreased with the addition of sand.

Chironomidae were found to be the dominant taxa in all 22 samples recovered but there was no significant difference in their dominance across the three treatments. Although I predicted the tolerant *Chironomidae* would dominate the fine sediment treatments, my results showed the opposite, though they were not significantly different (Figure 6). Angradi *et al.* (1999) also found that *Chironominae*, abundance, a *Chironomidae* subfamily, decreased with an increase in fine sediments.

Additional replicates could have strengthened any patterns that were obscured in my study. A longer period of time for the treatments in the river also would have allowed for more colonization to occur. Future studies could look more at specific taxa to look for any characteristics shared by the macroinvertebrates in each the treatment.

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Acknowledgements

I would like to thank Vermont EPSCoR for providing the funding, research materials and other resource that allowed me to complete this study, Saint Michael's College for providing laboratory space and transportation to travel to field sites. Thank you to Professor Declan McCabe (St. Michael's College) for teaching me the necessary lab and field skills, for his guidance in designing the experiment and his assistance in statistical analysis. Miranda Lescaze for her work in organizing the Streams Project. Finally, thank you to all of the undergraduate interns who assisted me in experimental design and data collection during the 2012 summer.