The effect of storm disturbance on macroinvertebrate populations in contrasting streams

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Abstract

This study was undertaken to assess the impact of forested and urban landscapes and rainfall on benthic macroinvertebrate communities. Macroinvertebrates were collected at multiple sites before and after rainfall and a two way ANOVA was run to determine the effects of each factor, as well as the interaction between the two factors on 7 benthic community response variables. Forested sites were often found to have a higher abundance of macroinvertebrates than urban sites, but rainfall led to a higher abundance of macroinvertebrates in urban sites and a lower abundance in forested sites. Furthermore, the interaction between landscape and rainfall had many different affects on macroinvertebrate populations, showing how landscape and rainfall work together to influence macroinvertebrate populations, but landscape has a more dominant effect on macroinvertebrate populations than rainfall. This shows how landscape is important in the ecology of streams most likely due to poor water quality in urban streams, which many macroinvertebrates are unable to survive in.

Background

- Macroinvertebrates are essential components of river food webs and serve as links between the stream ecosystem food base and the top predators (Merritt and Cummins, 1996)
- Human impacts can greatly affect macroinvertebrate populations and these populations can be used to assess the overall ecological health of particular rivers
- Excessive paving and building that funnels storm water rapidly to streams increases erosion, sedimentation, and reduces stream water quality
- Because of the excess of water, currents flow faster and carry sediments across rocks, which scrapes away the periphyton layer, an important food source for many macroinvertebrates (McCabe, 2010)
- The objective of this study was to compare macroinvertebrate communities in forested and urban settings, as well as before and after rainfall to determine the effects that both landscape and rainfall had on these communities.

Methods

- Macroinvertebrate samples were collected during the summer of 2015 from 8 Vermont stream. We sampled 4 forested sites and 4 urban sites.
- Sampling was done using kick-sampling methods (Letovsky *et al.* 2012)
- Macroinvertebrates from each site were identified to the lowest practical taxonomic unit.
- We examined rainfall data for Summer 2015 to group samples into before rainfall or after rainfall (within 10 days of rainfall) categories.
- I calculated 7 of the "best candidate benthic metrics" for measuring macroinvertebrate response to their environment (Barbour et al, 1999) for each of the samples.
- A two way ANOVA was then performed to determine effect of landscape, rainfall, and the interaction of the two factors.

Results

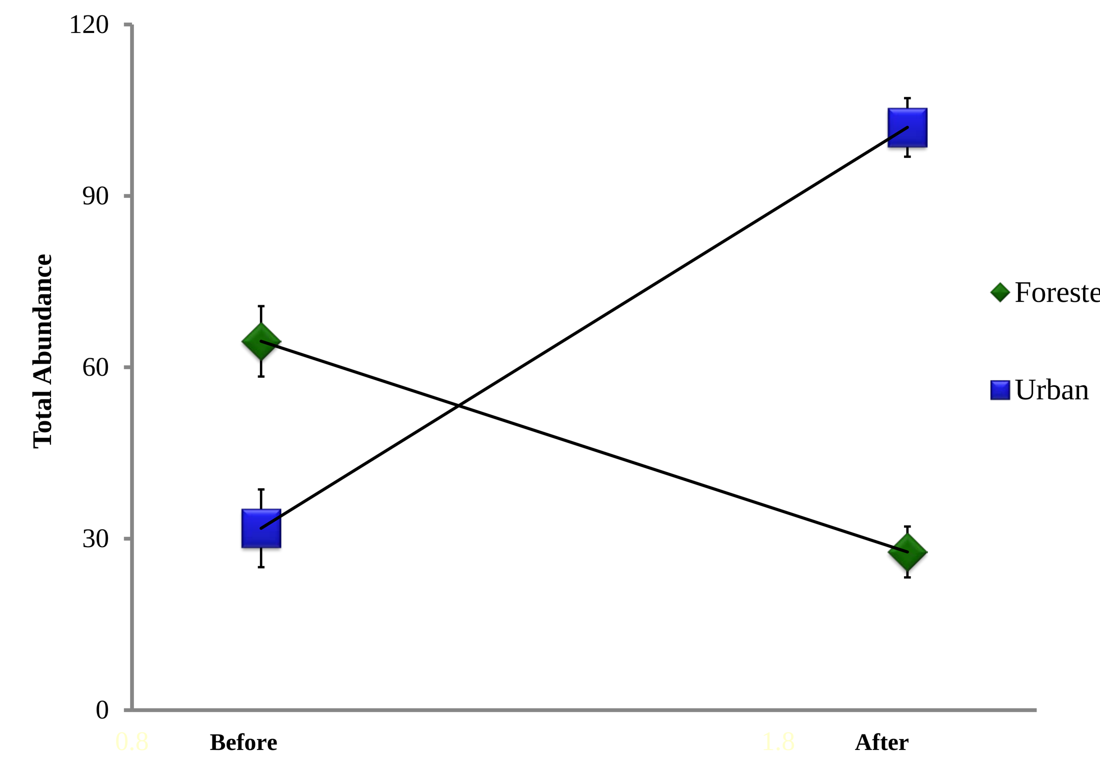

Figure 1. Total abundance for forested and urban sites before and after rainfall.

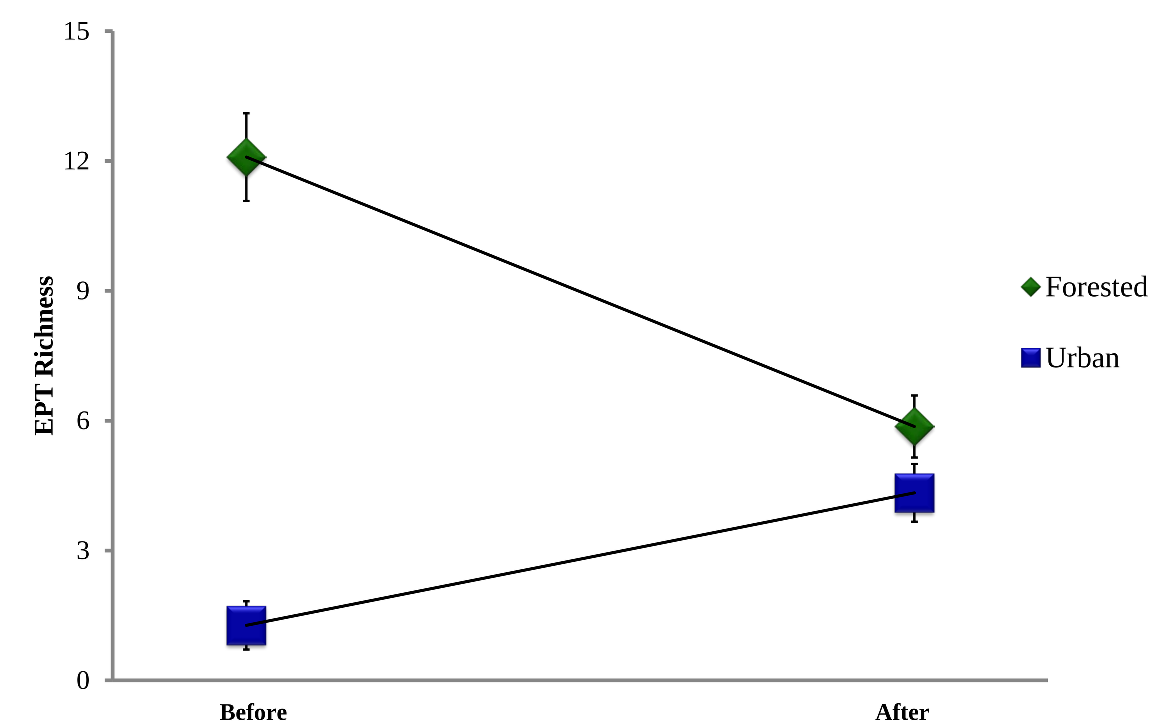

Figure 2. EPT (Ephemeroptera Plecoptera Trichoptera) richness for forested and urban sites before and after rainfall.

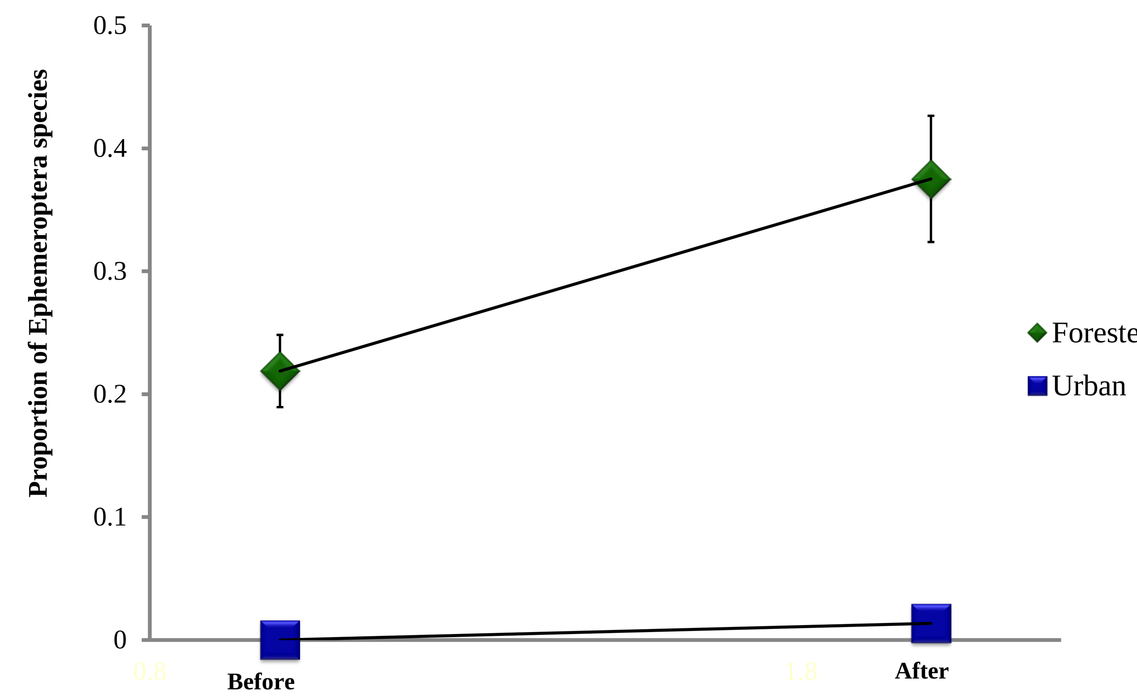

Figure 3. Proportion of Ephemeroptera species in forested and urban environments before and after rainfall.

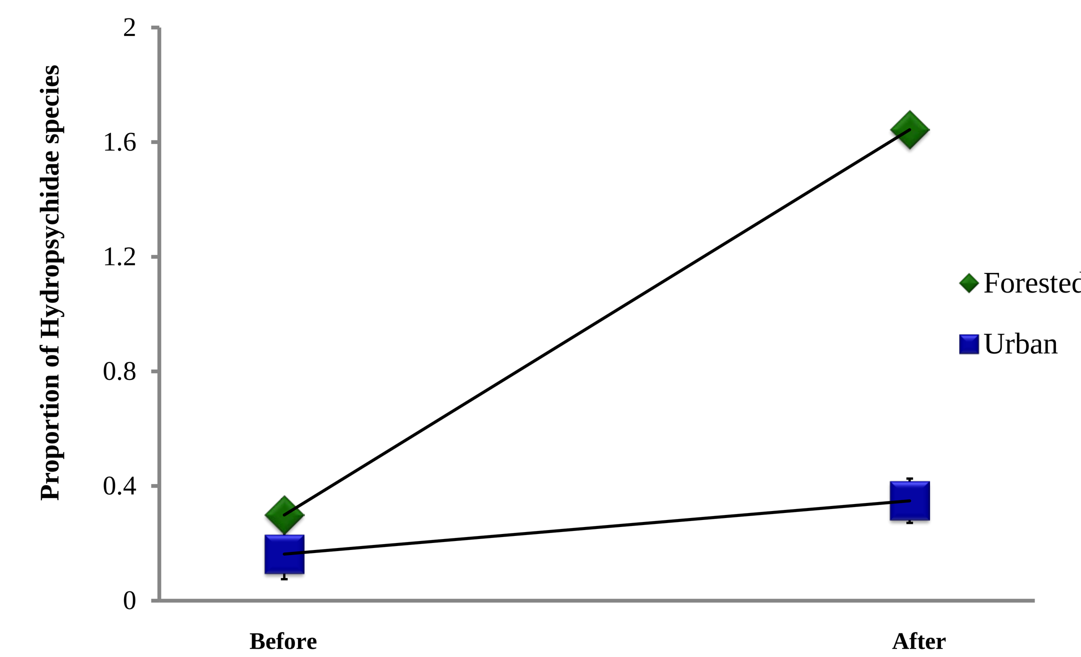

Figure 4. Proportion of Hydropsychidae species in forested and urban environments before and after rainfall.

Missisquoi River

Field Work

Discussion

Landscape was found to have a significant effect on macroinverebrate response variables, which is in line with other studies (Muelbauer & Doyle, 2012), as landscape was found to impact all response variables except for the proportion of Hydropsychidae. Rainfall was found to have a lesser effect on macroinvertebrates than landscape did, as the only response variable that rainfall had a significant effect on was total abundance. This is similar to other studies (Robertson et al, 2015; Fritz and Dodds, 2004), which also found mixed macroinvertebrate responses to rainfall, but often significant rainfall effects on total abundance. However, the interaction of landscape and rainfall did significantly affect every response variable measured except for the proportion of Ephemeroptera.

Forested sites originally yielded a higher total abundance than urban sites, with rainfall causing the total abundance in forest sites to decrease and the total abundance of urban sites to increase (Figure 1). This trend was also seen in richness for both sites, but dominance actually had the opposite trend, with urban sites having higher dominance before rainfall and then decreasing, whereas forested sites increased in dominance after rainfall. The differential dominance response is consistent with greater disturbance at urban sites removing dominant competitors. EPT richness also began with a higher value in the forested sites than urban sites, but rainfall led to an increase in EPT richness in urban sites and a decrease in forested sites leading to values after rainfall that were relatively close to one another (Figure 2). A similar trend was also seen in evenness for both sites. Forested sites had a higher proportion of Ephemeroptera species before rainfall and an even higher proportion after rainfall, whereas urban sites had zero Ephemeroptera species present before rainfall and a very minor increase after rainfall (Figure 3). The proportion of Hydropsychidae species had very similar values in both forested and urban sites before rainfall and both increased after rainfall, but the increase in forested sites was much greater (Figure 4). Net-spinning caddisflies in the family Hydropsychidae build structures in streams that resist storm impacts and this may explain the pattern observed.

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