Effect of Walking Trails on the Community of Macroinvertebrates in Grassland and Forest Habitats

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Abstract

This study took a look at the effect of walking trails on macroinvertebrate communities in forest and grassland habitats at Pierce Cedar Creek Institute in Hastings, MI. Pitfall traps were placed 1m, 4m, 7m and 10m away from a walking trail to see if distance from the trail had any effect on the species abundance, richness or diversity of the macroinvertebrates. The forest and grassland habits were also compared to see if the type of habitat had any effect on species abundance, richness or diversity. We also looked soil moisture, soil pH and soil temperature to see how these abiotic factors influenced species abundance, richness and diversity. We found that the trail itself did not have any effect on the macroinvertebrate community, and species diversity was not affected by habitat or by any abiotic factor tested. However, species abundance and richness did vary between the grassland and forest habitat. Soil temperature and soil moisture also had significant correlations with total abundance. Soil temperature also had a significant correlation with species richness. These results show that the walking trails at Pierce Cedar Creek have minimal impact on the macroinvertebrate community. More research is needed to determine if factors such as trail substance and width have any effect on the macroinvertebrate community.

Introduction

Fragmentation has been a controversial issue in the field of conservation biology for quite some time. Research has shown that fragmentation can have a devastating effect on a region's biodiversity. Although biodiversity can vary greatly from one habitat to the next, a decline in a region's biodiversity may also reduce a biological community's ability to remain stable during times of environmental stress.

Fragmentation occurs when there is a physical disruption of the habitat (sometimes very narrow), such as the construction of a road. Fragmentation may limit the dispersal capabilities of

many species, thus reducing gene flow between formerly cohesive populations. Even relatively narrow (<3m), unpaved roads have been show to increase mortality (through construction, collision or increased human access), modify animal behavior (foraging, reproduction, and migration), and alter the physical environment (Trombulak and Frissell 2000). Breaks in the habitat may change the community by allowing the establishment of *r*-selected or exotic species to take hold, and may allow increased access of predators to prey.

Conservationists and proponents of ecotourism often promoted walking trails as a low impact way to enjoy the natural environment. Although a walking trail is certainly less destructive than a road, it may have an impact on some of the smaller members of the biological community. To small invertebrates, even a narrow trail could fragment their habitat. A well-walked or maintained hiking trail could serve as a barrier to dispersal to non-flying species. A parking loop was shown to limit the dispersal of ground dwelling beetle species, essentially creating two subpopulations (Mader 1984).

Hiking trails may also increase trampling of vegetation near the path, which may cause changes in microclimate. Increased trampling of montane heath communities in Scotland caused a significant loss in plant structure and an increase in evapotranspiration rates (Scott et al. 2002). The adverse effects of trampling varied seasonally, and were found to be greatest during the summer (Gallet and Roze 2002), the time trails may get the most use from recreational hikers. Understory ground cover, and soil microbial activity was found to be negatively affected by trampling in urban forest communities (Malmivaara-Lamsa and Fritze 2003). Trampling has also been shown to influence invertebrate communities. Species richness and abundance of dragonflies declines with increased human utilization of river banks (Muller et al. 2003).

As hiking trails could lead to changes in soil and plant cover, it is possible that the macroinvertebrate community that inhabits adjacent areas may be affected. For some of the smallest members of the animal community, even narrow hiking trails may fragment grassland and forest habitats.

This study conducted tests on (1) the effect of the distance from a hiking trail on species abundance, richness and diversity of the macroinvertebrate community, (2) whether the effect of the walking trail on species abundance, richness and diversity varied between forest and grassland habitats, and (3) if species abundance, richness or diversity was correlated with the changes in temperature, precipitation and soil moisture.

Methods

Study Area

We studied the effects of walking trails on macroinvertebrate communities at Pierce Cedar Creek Institute in Hastings, Michigan. Forty pitfall traps were placed along the Yellow Trail at PCCI. This location was selected because of its close proximity to the visitor's center and we expected that this trail would get more use than the property's other walking trails. Five transects of four pitfall traps were placed in both the grassland and forest habitat. Traps were set at 1m, 4m, 7m, and 10m from the trail and each transect was placed approximately 10m away from each other (Fig 1).

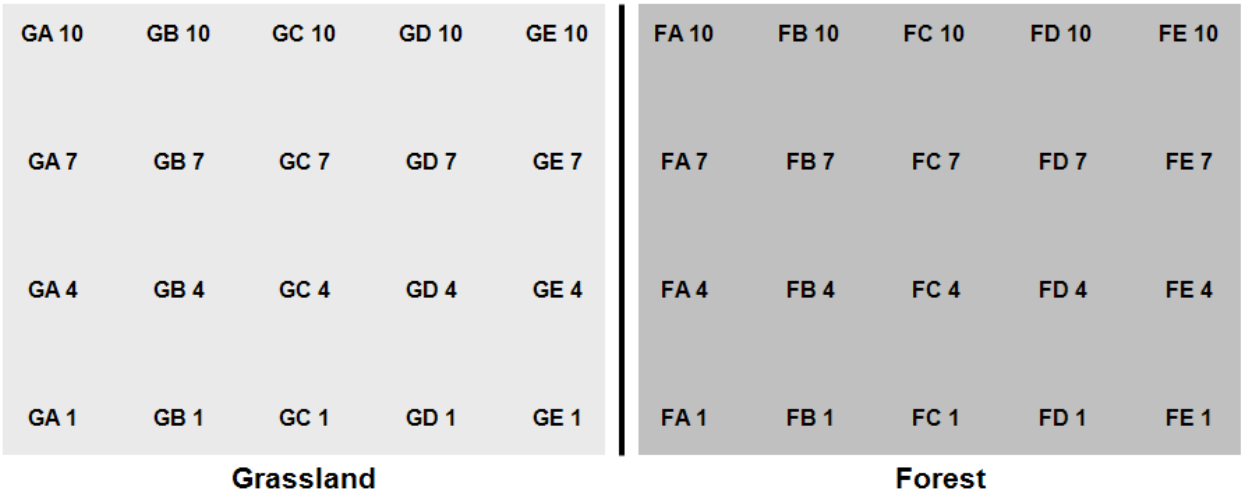

Figure 1. Chart mapping out the locations and setup of our pitfall traps in both the forest and grassland habitats of Pierce Cedar Creek Institute.

Pitfall traps included a collection cup, larger cup and funnel. A golf ball hole cutter was used to dig the holes for the traps. A canopy was placed over the top of each trap by cutting four 5 in. pieces of ¾ in. PVC pipe. We used a rubber mallet to set the pieces of PVC pipe into the ground and placed an 8 in. x 8 in. floor tile over the top, to minimize the amount of rain that would collect in our traps over the two week period. This also helped prevent small mammals from falling into the traps. The collection cup at the bottom of the pitfall trap was filled with approximately 100 ml of propylene glycol, a safer chemical alternative that does not produce odors that attract small mammals.

Collecting Samples

Samples were collected every fourteen days for ten weeks, resulting in five sample sets. The collection cups containing specimens and the propylene glycol were each emptied into a labeled 7oz. WhirlPack bag and taken back to Ferris State University for sorting and identification.

Upon each visit to PCCI, both soil and ambient data were also taken. Soil temperature, moisture, and pH were taken at each trap location. Ambient data including temperature, light, wind and humidity were taken at distances of 1m, 4m, 7m, and 10m from the walking trail in the center of each sampled habitat.

Identification Process

WhirlPack bag and contents were each emptied into a dissection tray and specimens were sorted. Most insects were identified to family, while other macroinvertebrates could only be identified to class. When more than one species per taxonomic family was identified, for

example, having two species of rove beetles, family Staphylinidae, then they were identified as Staphylinidae A and Staphylinidae B.

Data Analysis

Data collected was analyzed with Excel and Statview software packages. The repeated measures 2-factor ANOVA was used to test for the effects of distance (from the trail) and habitat (forest vs. grassland) on the abundance, richness and diversity of macroinvertebrates collected. The Shannon-Wiener Diversity was used to calculated species diversity of each sample. Simple linear regressions were also used to test if species abundance, richness and diversity were correlated with soil temperature, soil pH and soil moisture.

Results

Over the ten week period in which traps were set, 22,698 macroinvertebrates were collected and approximately 206 different species were identified (Fig. 2).

Class	Number of Different Species
Insecta	163
Diplopoda	5
Chilopoda	2
Oligochaeta	1
Arachnida	28
Gastropoda	6
Malacostraca	1
Total	206

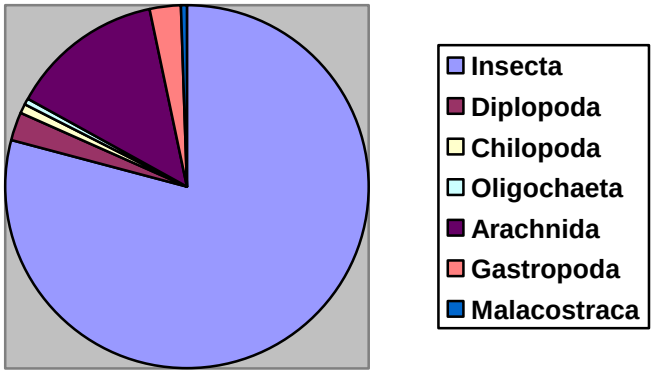

Figure 2. Breakdown of the number of macroinvertebrate species collected in each taxonomic class at Pierce Cedar Creek Institute from May to July 2005.

Distance from the hiking trail did not have an effect on species abundance ($p = 0.7263$), richness ($p = 0.0818$) or diversity ($p = 0.5128$) of the macroinvertebrate community.

Habitat did not have an effect on species diversity ($p = 0.7097$); however, it did have a significant effect on species abundance (0.0001) and richness (0.0014). We found that the grassland habitat generally had more species (a greater species richness) and more specimens (a greater total abundance) collected in the grassland habitat than the forested habitat (Figures 3 & 4).

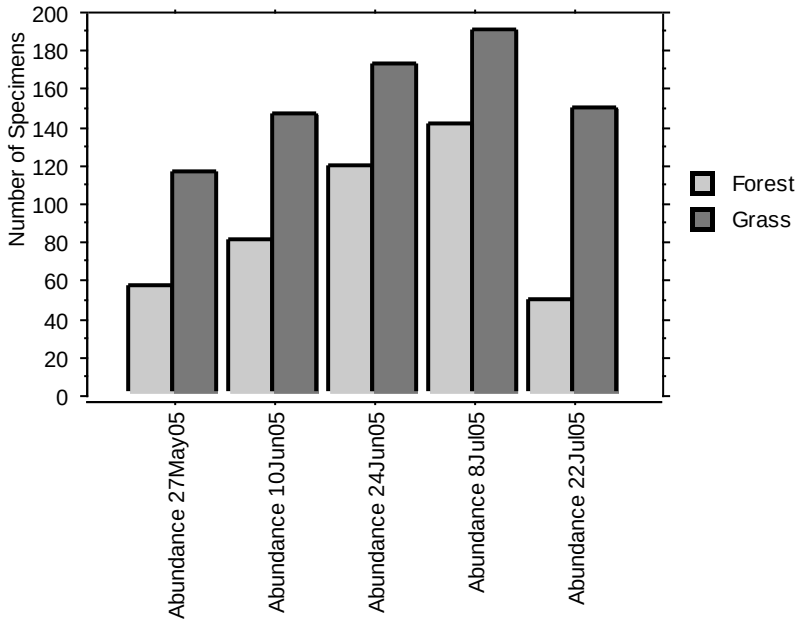

Figure 3. Effect of Habitat on Abundance Over Time.

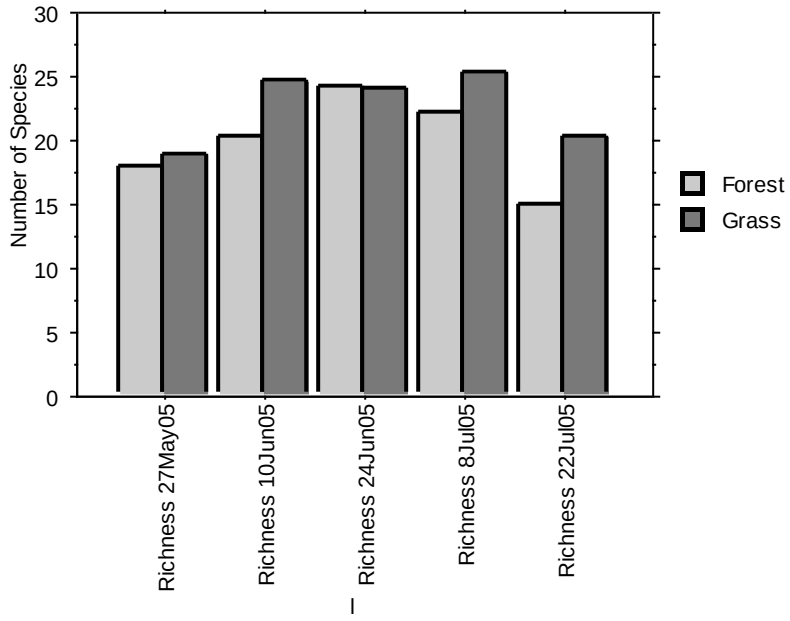

Figure 4. Effect of Habitat on Richness Over Time

Sampling date also had a significant effect on the abundance and richness. Abundance increased steadily from May to July, then dropped slightly (Fig. 3). A similar trend was observed for species richness (Fig. 4).

When we looked at the effect of soil moisture on species abundance, richness and diversity, we found that species abundance and soil moisture were positive correlated (Fig. 5A). An increase in soil moisture seems to indicate an increased number of macroinvertebrates in the area. We did not find any correlations between soil moisture and species richness or diversity.

When we looked at the effect of soil temperature on species abundance, richness and diversity, we found that species abundance (Fig. 5B) and species richness (Fig. 5C) were both positively correlated with soil temperature. An increase in soil temperature seems to indicate an increase in total abundance and species richness. No correlation was found between soil temperature and species diversity.

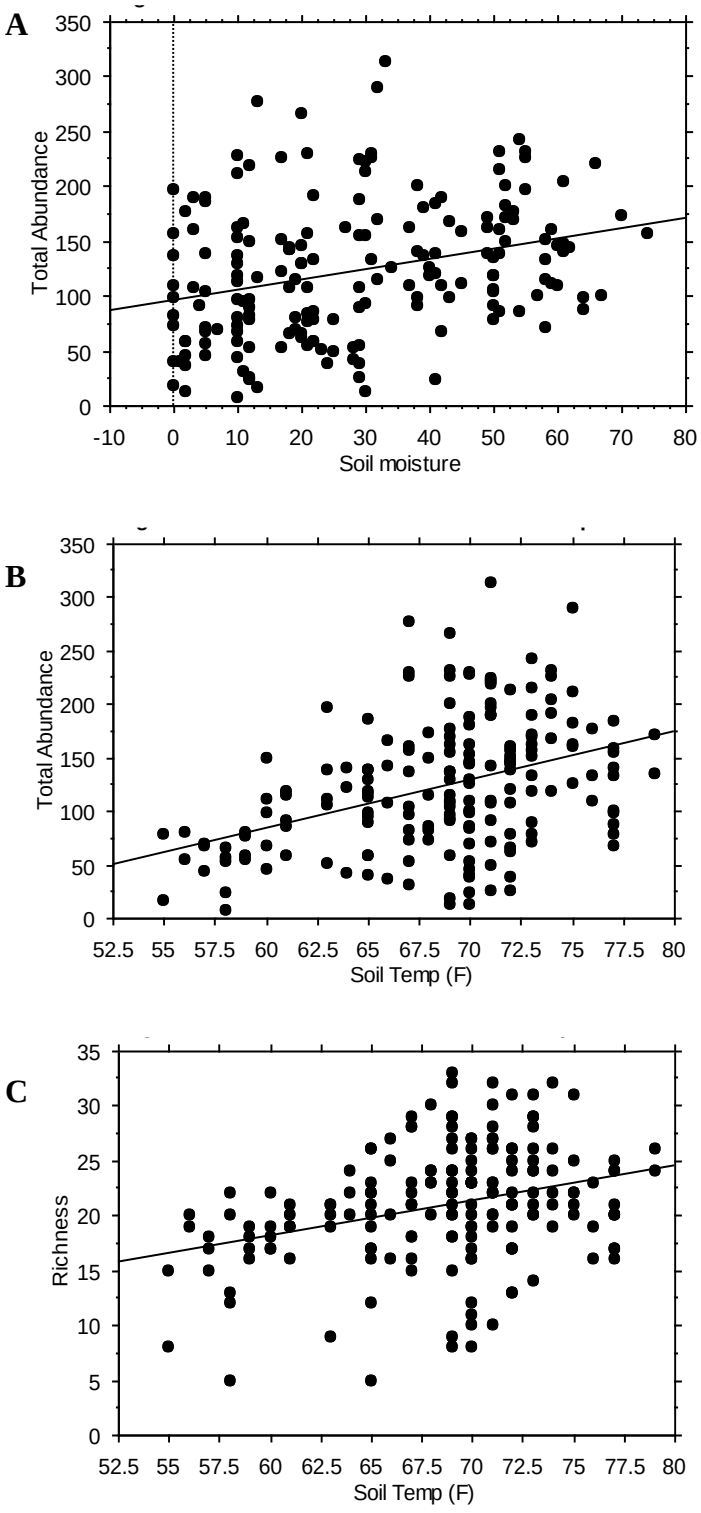

Figure 5. Effect of abiotic factors. A. Regression plot for Total Abundance vs. Soil Moisture. B. Regression plot for Total Abundance vs. Soil Temperature C. Regression Plot for Richness vs. Soil Temperature

Discussion

We can make several conclusions regarding the macroinvertebrate communities at Pierce Cedar Creek Institute. First, it appears that the grassland habitats at PCCI can support larger populations of macroinvertebrate species as well as a more diverse selection of species (higher species richness) than the forested habitats. Perhaps this is due in fact to the positive correlations between soil moisture and soil temperature. The grassland tended to have the higher soil temperatures and higher soil moisture readings, as well as having a significantly larger abundance and species richness of macroinvertebrates.

The forested habitats on the other hand, had fewer species and fewer macroinvertebrates. This, perhaps, is because the habitat had lower soil moisture and temperature readings. Habitat seemed to be the only influential factor in determining any significant differences between species richness and abundance.

Time also had a significant effect in both habitats on species abundance and richness. Abundance and richness increased from May to early July and then dropped slightly. This is likely to due to the increases in both ambient and soil temperature over the summer. Diversity was never significant in any of our calculations.

The trail itself was not shown to affect the species abundance, richness or diversity of the macroinvertebrate community of either habitat. One possible explanation for these results it that the trail was not fragmented enough. Because the trail was formed by mowing, the trail was never very wide and the vegetation was never completely removed to fully separate the habitat. Perhaps if the grass were cut lower to the ground and more frequently, different effects would have been seen. Another possibility is that the trail did not receive enough traffic. We may have obtained different results if we were to complete this study at a different location, such as off of the Rails to Trails system.

One conclusion that we can make from this study is that the walking trails on Pierce Cedar Creek property seem to have little to no effect on the macroinvertebrate community. This could be interpreted as that having trails that are just trimmed and mowed are more environmentally friendly than using concrete, gravel, woodchips, etc. as the trail base. Further testing would need to be completed to understand the effects of what the trail is composed of may have on the macroinvertebrate community.

We still have a lot of data that can be analyzed, and we are now focusing our attention to looking at species composition within the Pierce Cedar Creek property that was sampled. Perhaps there are effects on different taxonomic families, or even on a particular species that do not show up on a community level.

This is just one attempt at studying the fragmentation effects on macroinvertebrates, further testing in different locations and of trails of varying sizes and compositions need to be examined before large-scale conclusions are drawn.

Acknowledgment

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