Monitoring of *Alliaria petiolata* in Kleinstuck Preserve

Ben Cooper
Kelsey Hassevoort
Neil Matthews-Pennanen
Zachary Smith

Kalamazoo College, Biology Department

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Introduction

Invasive species are one of the foremost causes of habitat disruption around the globe (Mooney & Cleland, 2001). There have been many studies on invasive species and how they affect native species and the communities they live in (Williamson & Brown 1986, Sala et al. 2000). An invading species can disrupt everything from feeding relationships to soil chemistry to light availability, any of which can cause major habitat disturbances. Biogeographical boundaries are being broken faster than at any point history due to increased trade and travel. Plants are being shipped around the world as decorations or as crops so that people can grow them in similar climates on different continents where they will hopefully flourish and provide an æsthetically pleasing view or a new source of income. This is exactly how Garlic Mustard (*Alliaria petiolata)* came to the United States; a sample was brought from Eurasia originally to be grown for food and possible medicinal use (invasivespeciesinfo.gov). It has now spread through much of the United States as well as into Canada. It has the ability to outcompete its neighbors by stunting the growth of roots in nearby plants, allowing it to effectively muscle its way into new habitats once it has only a small foothold (Roberts & Anderson, 2001). Once said foothold is established, it is notoriously difficult to get rid of. Seeds are able to survive for years in the soil, and the plant itself actually multiplies when burned or improperly pulled from the ground.

With these facts in mind, we had a two-fold objective in our investigation into the local population of *A. petiolata* located in the Kleinstuck Nature Preserve. First, we studied the current condition of the distribution of *A. petiolata* within Kleinstuck in an effort to determine the pattern of its spread and its effect on local native flora. The Stewards of Kleinstuck have put in place a management system that focuses on the containment and eradication of garlic mustard using both physical and chemical means to kill the plant. In order to better make use of these resources, the Stewards need to be directed to where their efforts would be the most effective. By sampling the growth patterns throughout the reserve, we hoped to find the spread pattern of *A. petiolata* to better guide the containment efforts and help protect the native species in the area. Finding and protecting areas that still have high native species richness and abundance increases the chance of their continued survival in comparison to their relatives that are surrounded by *A. petiolata*. We expected to find patterns that showed areas with high levels of *A. petiolata* had lower abundance and diversity of native plants in comparison to areas of low *A. petiolata* abundance.

Our second goal is to develop a methodology that can be followed by any of the community members that happen to be walking through the nature preserve. If data can be collected by anyone and everyone walking through the reserve, the large amount of information that could be provided would be enormously useful to the Stewards' effort. The more data that can be collected, the more refined the patterns of growth in the reserve would be, and the better able the Stewards would be to identify the key areas to protect.

Methods

Study location:

This study was conducted at Kleinstuck Preserve in Kalamazoo, Michigan. This 50-acre preserve is composed of a variety of environments, including upland forest, swamp forest, and marsh. Sampling was conducted in all of these zones, apart from the marsh zone, located at the center of the preserve.

Sampling methods:

GPS posts placed throughout the preserve were used as starting points for sampling. Using a random number generator, we generated a list of GPS posts from which to begin sampling. We also used a random number generator to determine the distance (in paces) from the GPS marker and direction in which we would sample. Distance from the GPS marker ranged from 1 to 20 paces, while the four cardinal directions were assigned numbers in order to randomize them, with 1 corresponding to north, 2 to east, 3 to south, and 4 to west. In the event that the randomly generated direction and number of strides caused the sampling location to fall outside of the Klienstuck property or in a location that was impossible to sample (for example, the marsh within the preserve), the number of strides was retained, but the direction was reversed. Once the predetermined sampling location was reached, a 1 X 1 meter plot was laid down and all first- and second-year *Alliaria petiolata* specimens were counted. Other plants, including native species were also counted and later identified.

Data analysis:

We plotted each of the sample sites on a map of the Kleinstuck Preserve using ArcGIS software. We then examined the relationship between garlic mustard abundance and total species richness by plotting the log of total garlic mustard abundance against the log of total species richness. To determine the strength of the relationship between garlic mustard abundance and total species richness, we performed a linear regression and calculated the appropriate regression equation, r^2 value, and p-value.

Results

We found *A. petiolata* in all 13 plots tested. There was much more first-year than second-year garlic mustard in the majority of plots as indicated by Figure 1. There was generally much more *A. petiolata* found in the lower transition and swamp forest habitats than in the upland forest habitat. The plots very close to, or right on the path had lower levels of *A. petiolata* than other plots in similar areas (Figure 1, GPS markers 50 and 72).

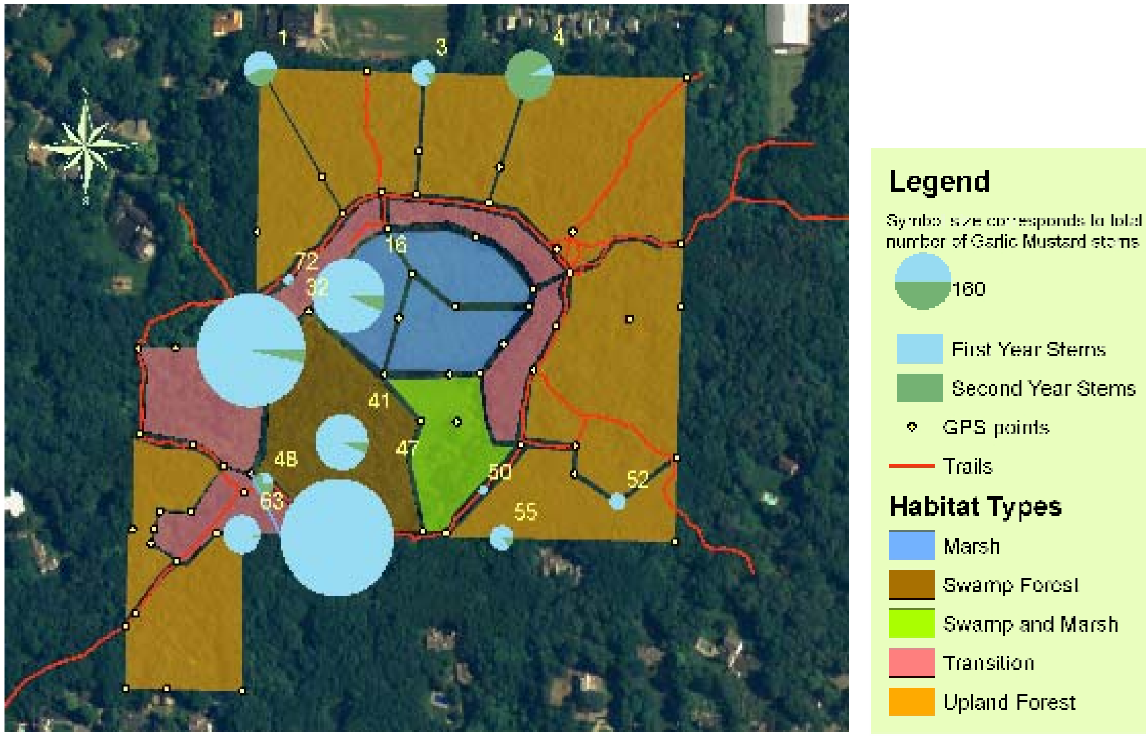

Figure 1. ArcGIS map of garlic mustard plot locations in Kleinstuck Preserve. The size of each dot denotes how much garlic mustard was found in that plot.

In Figure 2, we show there was a positive correlation between log of total *A. petiolata* and log of total species richness ($r = 0.505$). This correlation was not significant at the $\alpha = 0.05$ level ($p = 0.079$). This does show some evidence that there is a positive correlation between amount of garlic mustard and total species richness.

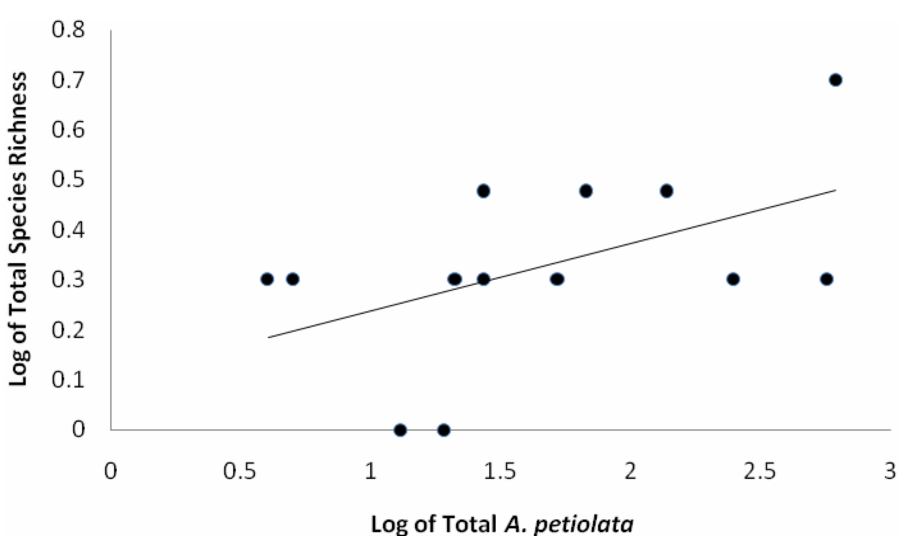

Figure 2. Regression line for the log of total *A. petiolata* abundance vs. the log of total species richness. $y = 0.1348x + 0.1032$, $R^2 = 0.2546$, $R = 0.505$. $p > 0.05$.

Discussion

Garlic mustard abundance was greatest in swamp forest and transition zones (Figure 1). This trend can be attributed largely to three factors. The first factor is that management procedures have largely been conducted in upland forest zones in order to “close in” on the infestation and isolate it to lowland areas. This geographical method was devised on the basis that garlic mustard densities were observed to be lowest in upland forest zones and it was determined that these relatively easier areas to manage should be pursued first in order to isolate the infestation in its greatest observed densities. The high abundance in lowland areas, mainly the swamp forest and transition zones, suggest two other factors: Large amounts of erosion have plagued the Kleinstuck Preserve due to construction of new houses around the upper perimeter and because the fen itself is the runoff basin for the entire surrounding area. Garlic Mustard seeds, which remain viable in the soil for up to 6 years (Dhillion & Anderson 1999), are being brought into the basin in large quantities and thus have populated the basin en masse. The third and perhaps most prominent factor is that the swamp forest and transition zones retain a large amount of moisture in the soil and are also heavily shaded. The ideal habitat for garlic mustard, although it is able to invade a diverse range of habitats, is wet, shady areas. The swamp forest and transition zones provide this ideal habitat and thus the garlic mustard produces maximum fecundity (15,000 – 20,000 seeds/plant) as well as a high survival rate of first year growth to the reproductively viable second year growth. First year rosette mortality rates can largely be attributed to lack of moisture.

Our results showed an abnormally high abundance of garlic mustard, second-year growth in particular, along the northern border of the preserve. While conducting our research, we noticed that garlic mustard was beginning to reinvade the upper forested areas along the northern border from large existing populations untouched in backyards of private property in that area. If this is allowed to continue then all of the progress made in managing upland forest areas will have been for naught. Isolation and elimination of garlic mustard repopulating the northern border of the Preserve from private property is essential to future management efforts.

Our data also showed a consistent trend towards greater abundance of native flowers in the swamp forest and transition zones. Overtly this seems to disprove our hypothesis that garlic mustard excludes native plant growth and thus causing native flower abundance to be lower in those areas of high garlic mustard abundance. We believe that this trend can be explained by the same factor that led to high abundance of garlic mustard. In these same lowland areas, seeds of native flowers are being brought into the basin through erosion and runoff from higher areas. The fact that the lower basin area, including the swamp forest and transition zones, contains a high abundance of native plants suggests that it is a key source of native species abundance as well as dispersal of seeds of native plants. In any case, management of this zone is of particular concern.

The relatively low abundance of garlic mustard in upper forest areas indicates that management effort targeting these areas has largely been successful. These management practices should be continued and expanded extensively into the transition and swamp forest zones. More community members should be educated and encouraged to participate in order to have the same kind of success in quelling the growth of *A. petiolata* in Kleinstuck Preserve.

We believe the methodology we outlined can be a useful tool for tracking the progress of the management effort. Some possible changes to the methodology would include counting garlic mustard at two different points in the season. Ideally they would be done in a short time span, one corresponding to the peak in first-year growth and the other corresponding to peak second-year growth. A simple way to implement this would be to give groups 1 X 1 meter quadrats on the day of the big Garlic Mustard pull and have the members of the group count the first- and second-year plants that they pull in each area. This way the plants are pulled and data is collected at the same time, creating a win-win situation for everyone.

Works Cited

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