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The Effect of Goats as Biological Controls on Soil Seedbanks and Long-Term Habitat Restoration in a Secondary Successional Forest

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Cover Page Footnote

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Abstract

Invasive plant species are a major threat to the biodiversity of a habitat. Biological controls, on the other hand, have been implemented in such areas to eradicate or reverse the effects of invasive plant species. *Capra hircus* (Goat) are being used increasingly as biological controls for eradicating invasive plant species from natural areas. In Fall 2020, we investigated the magnitude to which Goats can alter the dominance of invasive plant species in a secondary successional forest environment near Conesus Lake in Lakeville, NY. To measure this extent, we compared the soil seedbank to the seed rain at our site, along a gradient of browsed to unbrowsed plots along 2 transects (n = 20) that were 18 m apart laterally and 46 m apart longitudinally. We quantified the soil seedbank by identifying the seedlings that emerged from soil samples extracted using a soil auger to a depth of 15 cm at each plot. We also collected the seed rain using 25 cm x 25 cm Astroturf seed traps at each plot. Our preliminary results, such as a higher amount of *Alliaria petiolata* (Garlic Mustard) in the seedbank than in the seed rain, indicate that the use of *Capra hircus* as biological controls is effective, yet the alteration is not as rapid as it might seem because of regeneration from soil seedbanks. Comparing and quantifying plant species results found above and below ground in the presence or absence of biological controls may aid in managing the restoration of an area. Future considerations may include revisiting this area over a longer time frame (in years) to examine if the implementation of biological controls can completely eradicate invasive species in a habitat.

Introduction

Throughout the world, invasive species are an ever-present threat towards native species and the overall biodiversity of an area, often creating harmful ecological impacts. While many solutions have been created to combat invasive species, such as pesticides or other harmful toxins, the use of biological controls would not only

decrease the abundance of invasive species but be non-harmful towards the environment as well. In our research experiment, we are investigating how the implementation of the domesticated goat affects a secondary successional forest's seedbank and seedrain. We predict that there would be more invasive species found in the seedbank than in the seedrain and that over time, the goats will be able to eradicate all invasive species from both the seedrain and seedbank.

To date, there is a slowly growing number of studies that investigate the effect of the domesticated goat on eradicating invasive species. None have focused on a secondary successional forest environment, which is why we created this study to show the effects of goats in a habitat that has yet to be investigated. One study, however, shows the effects of goat grazing on invasive species and their abundances above ground and below ground in an environmental research environment in Kellogg, Iowa. It studied how goats change the abundance of *Lespedeza cuneata* (Sericea Lespedeza) and found that they reduced the abundance of this invasive species above ground, but that the biomass below ground might take several years to decrease significantly (Barnewitz et al, 2012). Our study was modeled closely after this one, investigating the effects of goats as biocontrols on both the seedbank and the seedrain. Additionally, a study by Williams and Prather (2006) showed that goats can control the spread of *Rosa multiflora* (Multiflora Rose), which is a prominent invasive species at our study site. This study helped us to understand and predict what our outcomes might be in our research.

We have already seen the effects of goats as biocontrols through the use of a plant survey. *Lonicera morrowii* (Morrow's Honeysuckle), a once very prominent and invasive plant in the woodlot of our research site, has been almost completely eradicated throughout the one year that the goats have been used as biocontrol agents. Due to this short-term biocontrol treatment, we hypothesized that this was not nearly enough time for the goats to successfully eradicate all invasive species, but that they should have cleared a substantial amount, creating fewer invasive seeds in the seedrain than would be expected in the seedbank. It has been discovered that seeds may be viable in soil for up to 20 years, which would help account for the greater abundance of invasive seeds in the seedbank that we are predicting (Wenning, 2012). Over time, we expect goats to lower aboveground invasive species vegetation, therefore lowering invasive species in the seedrain which will, in turn, lead to lower new invasive species growing and an even lower aboveground vegetation until eventually, all invasives are eradicated.

Methods and Materials

The experiment was conducted in a secondary successional forest located in Lakeville, NY starting in September of 2020 and continued until February of 2021. To begin, we performed a plant survey of the forested land and identified over 20 different herbaceous species (*Figure 1*). Pictures of the mature plant, seeds, and seedlings were documented for future identification.

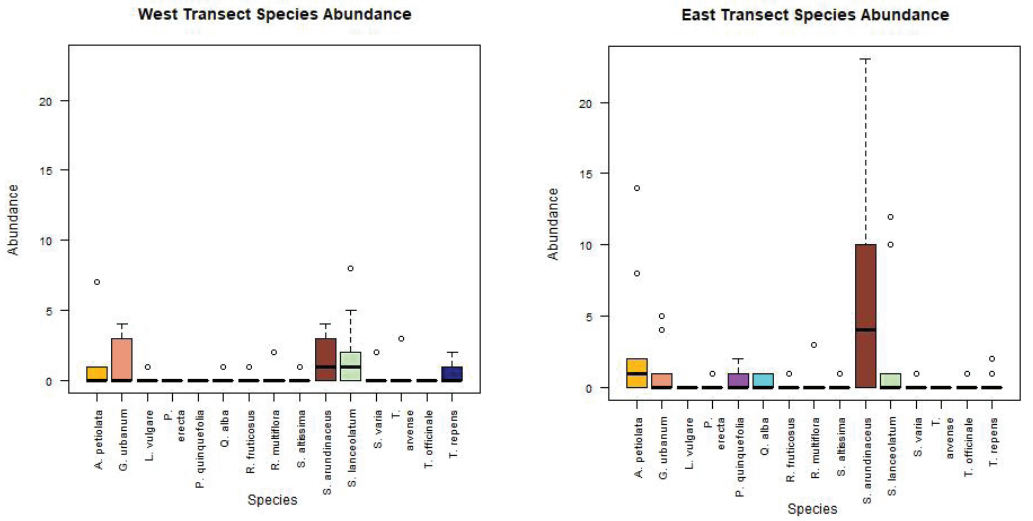


Figure 1. A representation of the plant species' abundances that were identified on the woodlot on the West and East transects

Next, we marked out where the soil was going to be taken from, marking each location with a flag and creating two transects (West and East). Each marker was placed 18 m apart longitudinally while making sure the flags in each transect were latitudinally the same distance apart, 46 m. These locations were labeled as West 1-10 and East 1-10, respectively. After marking out the locations of each spot, the soil was collected using a soil auger. 15 cm of soil was collected, which is classified as a depth that is deep enough to gather all seeds that may be in the ground. The soil that was collected was placed into labeled plastic bags and placed into a freezer at 30 °F for two weeks which was the recommended time to leave seeds in a freezer to mimic an "overwintering" process and to decrease the time before germination. Once the two-week period had been reached, the collected soil was placed into labeled square containers in a greenhouse with a combination of potting mix. The soil was watered once a day by an automated watering system, and was checked on three times a week. When a new seedling emerged, we would label and record it. The seedling was left to continue growing until it could be identified, after which it was then removed from the soil to make room for any other seedlings to emerge. This procedure was repeated from November 2020 through February 2021.

Once the soil seedbank was collected, we then collected the seedrain in October 2020. This was done through the use of 25 cm x 25 cm seedtraps, created out of Astroturf, which were placed at each soil collection location and fastened to the ground by metal garden stakes. This procedure was modeled after a study that used 45 cm x 45 cm Astroturf seedtraps, but showed that the traps were effective at collecting different seeds (Wolters et al., 2005). I collected the contents of the traps once a week for two weeks by emptying everything that was on the traps into labeled brown paper bags that had their contents analyzed and identified.

Results and Statistical Analysis

Based on the experiment data, a box plot revealed that invasive species richness is higher in the seedbank than in the seedrain on both the West and East transects (*Figure 2*). This was further supported by the use of the Kruskal-Wallis test, which gave us a p-value of 0.09 and to which we set the alpha at 0.1 instead of 0.05.

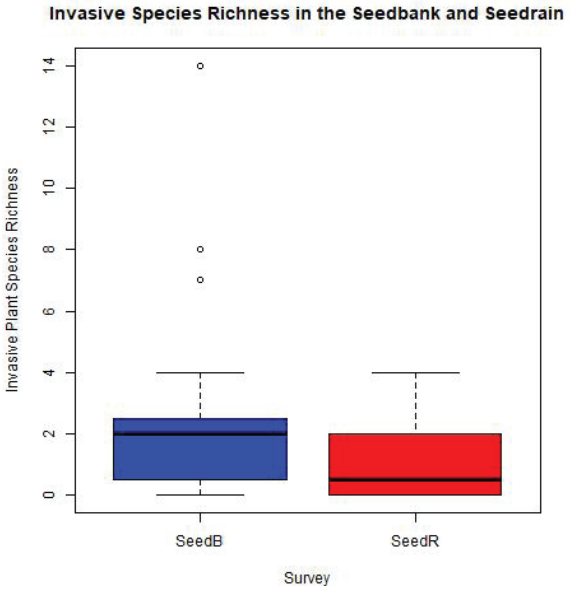
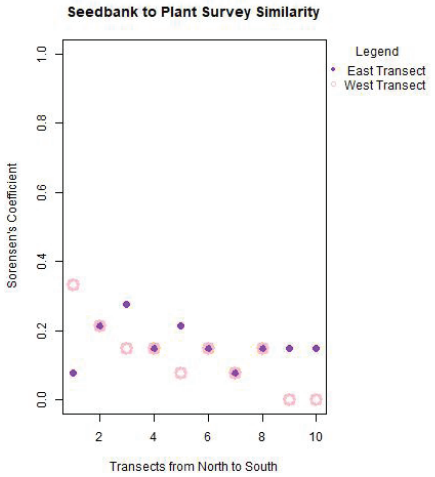


Figure 2. Greater invasive species richness is found in the seedbank than in the seedrain.

Sorensen's Coefficient compares the seedrain, seedbank, and total plant similarity on both the East and West transects. We found that the seedrain is the least similar to the seedbank on both transects (*Figure 3)*. This supports our hypothesis that the seedrain has been altered by the biocontrols. It is important to keep in mind, however, that these are high values of similarity because of the low species richness and the coincidence of there being the same one or two species.



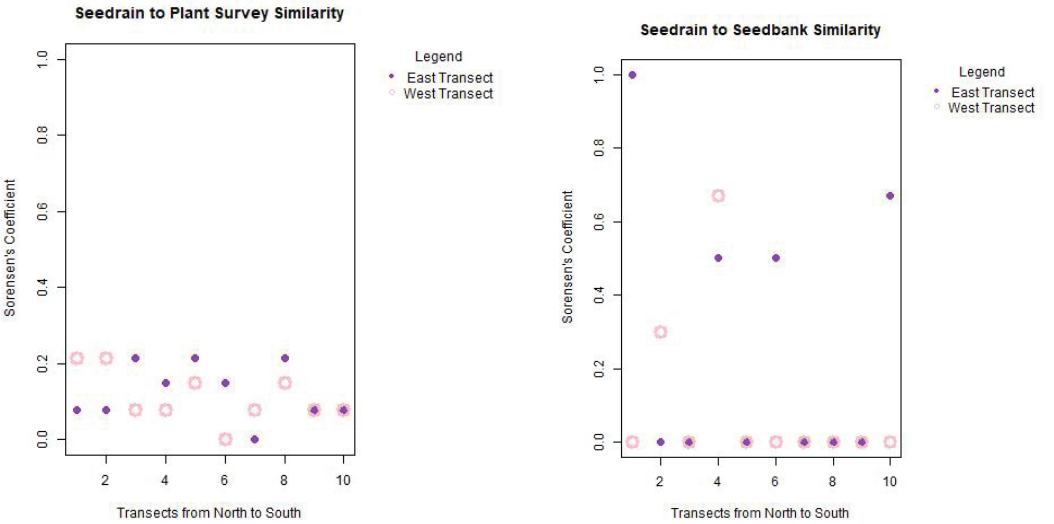


Figure 3. Sorensen's coefficient of similarity; the seedrain is least similar to the seedbank.

The Shannon Diversity Index characterizes the diversity of plant species in both the seedrain and seedbank, using species richness and abundance. Results from this test show that there was no significant trend in differentiating abundances between seedrain and seedbank (*Figure 4)*. This is because multiple sites have a low species richness of only one species, which would result in a zero on the Shannon Diversity Index. This may be a result of various factors, including the time the goats have spent grazing each side of the habitat and a lower overall seed collection.

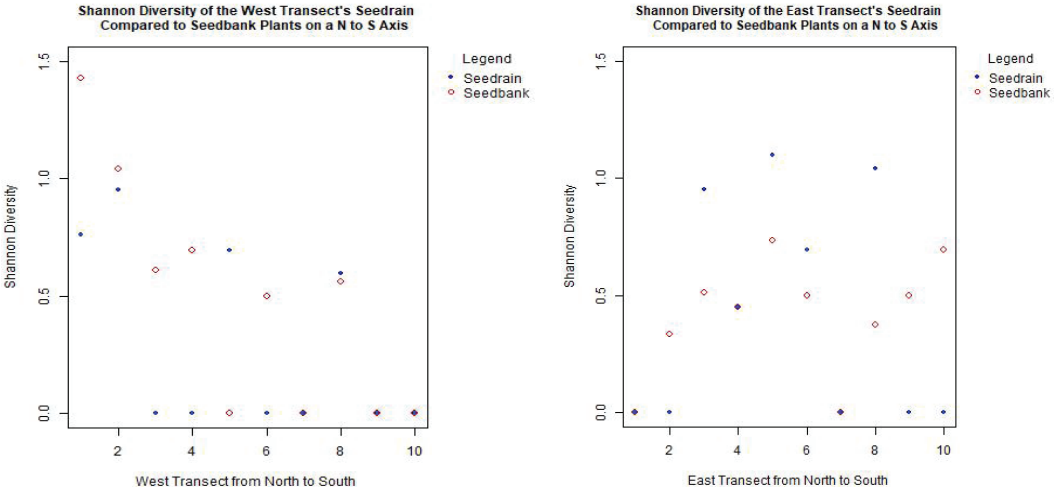


Figure 4. Shannon Diversity Indexes for West and East Transect; no significant trend.

Discussion and Ecological Implications

In our experiment, we were able to support our hypothesis that goats would be effective biological controls and alter the aboveground vegetation, therefore changing the

amount of invasive species found in the seedrain. The box plot (*Figure 2*) and Sorensen's Coefficient (*Figure 3*) both show that there is a lower abundance of invasive species in the seedrain than in the seedbank. Although goats are seen as effective, the alteration of above ground species is not as rapid as it might seem due to regeneration from soil seedbanks. In other words, there are still many seeds of invasive species in the seedbank that will grow and may produce more seeds before goats are able to mow them down.

Future research may help look at this problem such as revisiting this area over a longer time frame or gathering larger sample sizes. Coming back to this site each year, as well as comparing aboveground vegetation at the time of the study to the plant survey data from Fall 2020 (*Figure 1*) will additionally help to reveal if goats are effective biocontrols and can successfully eradicate all invasives from a habitat. This information will help future ecologists understand if they will be able to use the implementation of goats into an area with certain invasive species to successfully get rid of such invasives without further harming the environment. Finally, it is important to consider a few alternative explanations to how we reached our conclusions. The first is the time of year. This study had seeds being collected from September through November, a time when summer-produced seeds had already fallen. This, in turn, may lead to a lower seed abundance and richness, which is what we saw in our study. A small sample size may have also led to Shannon Diversity Index producing no significant results (*Figure 4*).

References

Barnewitz, E., Klinkenborg, A., & Scheibel, J. (2012). Effects of goat grazing and mowing on seed density and seed mass of Lespedeza cuneata. *Tillers*, *6*, 21-25.

Wenning, B. (2012, July 16). Multiflora rose: An exotic invasive plant fact sheet. *Ecological Landscape Alliance*. https://www.ecolandscaping.org/07/landscape-challenges/invasive-plants/multiflora-rose-an-exotic-invasive-plant-fact-sheet/

Williams, S. & Prather, T. (2006). Goats: A tool for controlling spotted knapweed. *Journal of Extension*. *44*(5).

Wolters, M., Garbutt, A., & Bakker, J. P. (2005). Plant colonization after managed realignment: The relative importance of diaspore dispersal. *British Ecological Society*, *42*(4), 770-777, https://doi.org/10.1111/j.1365-2664.2005.01051.x