

Impact of *Lorencia maackii* on Native Plant Richness, Diversity, and Abundance

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Abstract

Invasive species can negatively impact plant communities and lead to environmental, ecological, and economic losses. But while the introduction of invasive species is almost universally detrimental to native species and communities, the impact of these invasive plants can vary widely between different types of ecosystems. Amur honeysuckle (*Lorencia Maackii*), a wide-spread species of invasive honeysuckle, provides a look into the varying impacts of invasive plants with studies across the Midwest suggesting different levels of threat from *L. maackii*. In this experiment, I examine the impact of *L. maackii* on UNDERC plant systems by comparing abundance, richness, β diversity, and light availability in sites where *L. maackii* is present with sites where *L. maackii* is not present. Although it can be difficult to distill all of the changes in an ecosystem down to the presence of a single invasive like *L. maackii*, the evidence found in this study showed a reduced abundance of important shade-intolerant species where *L. maackii* was present, despite these plots having significantly more light available. This project explores the impact of *L. maackii* in the Upper Peninsula of Michigan and the results imply that the presence of *L. maackii* is having an impact on plant diversity in this ecosystem.

Introduction

The increasing ease of mobility and of the human population in the modern era has hastened the spread of exotic and invasive species. When invasive species are introduced to a region they compete with native populations for resources, and where they outperform the native species they may change the structure of the entire community (Richardson et al, 2000). These species pose a major threat to the native plant composition of ecosystems as well as inflict economic and aesthetic damage. Eurasian species have been the most common and successful invaders, and now account for over 80% of invasive species worldwide, so it is prudent to examine one of this ilk in order to better understand the influence of most invasive species (di Castri, 1989). The Asian shrub *Lonicera Maackii* (Amur Honeysuckle) has proven to be a fierce competitor for native shrubs in the Eastern United States. *L. maackii* was introduced as an ornamental in Ohio around 1850 and has since spread across the Midwest where, in some

ecosystems, the shrub has effectually replaced the native shrubs with a monocrop of *L. maackii* (Trisel, 1997). In Addition, *L. maackii*, despite being a registered invasive can still be purchased at garden shops and planted as an ornamental, continuing the process of invasion throughout the US.

L. maackii poses a serious threat to native herbaceous and shade-intolerant species because of its ability to outcompete native shrubs with its superior resistance to deer browsing, early foliating leading to a longer growing season, and ability to hybridize with native honeysuckle varieties (Swearingen, 2010 and Trisel, 1997). These qualities combined with the light-dependence of *L. maackii* has, in many ecosystems, pushed out native shade-intolerant species of the most desirable habitat on the edges of forests (Hutchinson and Vankat, 1997). The greatest foothold for non-cultivated *L. maackii* is in disturbed areas where the shrub prevents the establishment of other honeysuckle varieties and normal successional patterns of native species (Swearingen, 2010). Like many invasive species, the presence of *L. maackii* in eastern U.S. environments has been linked to decreased survival and fecundity in native annual herbaceous plants, leading to a loss of species richness and even diversity in areas where invasive species are highly successful (Gould and Gorchov, 2000; Collier et al., 2002). However, research in various parts of the US has revealed that the presence of *L. maackii* has more impact on native plants in some ecosystems than others, with the shrub being particularly successful in altered or recently disturbed communities (Hutchinson and Vankat, 1997). While the majority of the UNDERC property has been protected from human disturbance since the turn of the century, the development of roads, buildings, and mowed areas have created perfect foothold habitats for *L. maackii*. Given the reduction of native plant dispersal and fecundity in other areas of the Midwest where *L. maackii* is present, I hypothesize that an examination of the altered habitats on

the UNDERC-East property where *L.maackii* is present will yield less species richness than at similarly-altered locations where invasive *L.maackii* is not present.

Materials and Methods

Twenty plots were sampled on the UNDERC property. These twenty sites included 10 experimental locations where *L. maackii* was present and 10 control sites where it was absent. The sampling area for each plot was 10m by 10m with one side bordering on a disturbed area such as a road, mowed section, or building. This provides both the increased light availability and human disturbance conditions preferred by *L. maackii* (Hutchinson and Vankat, 1997). Each control site was associated with an experimental site that was similar in plant community composition and within a 400m radius of the experimental plot. After a location was selected, the plot location was randomized by placing a flag and flipping a coin to determine in which direction the outward edge of the plot would be placed.

In each of the experimental plots, we calculated the approximate *L.maackii* coverage by first dividing each plot up into 100 one-by-one meter squares and then estimating how many of those square meter plots had either an *L.maackii* plant rooted in them or were dominated by *L.maackii* branches. This approach is more accurate than counting individual *L.maackii* plants of different sizes as one since it gives an estimation of area impacted by the invasive species (Hutchinson and Vankat, 1997). For each plot, both experimental and control, the grid was divided into quadrants and four one-by-one meter squares were randomly selected. Within these squares all herbaceous plants, shrubs, and trees (less than .127m DBH) were recorded with abundances and identified to species. The overall species richness was then taken for each 10m by 10m plot.

Individual species abundance within the randomized quadrant samples were analyzed using a one-way ANOVA to check for significant differences between counts in experimental and control plots. All statistics were calculated using MiniTap Express. Similarity in overall diversity between control and experimental plots was examined using the Modified Morisita-Horn Overlap Index in a hypothesis test (Morisita, 1962; Horn, 1966; Garratt et al., 1976). The diversity of the quadrants was compared using Simpson's Diversity Index and analyzed using a paired t-test.

Light readings were taken with a photometer for each quadrant in all twenty plots. The readings were recorded in the middle of each quadrant at breast height on the same day within a two hour period, making sure to have shadows pointed straight behind the reader while measuring. The readings were then analyzed using a one-way ANOVA to check for significant differences in available light between the experimental and control sites.

Results

All twenty experimental and control plots were recorded before analysis. There was a significant difference in the β -diversity between the control and experimental sites, as measured by the Modified Morisita-Horn Overlap Index (mean \pm SE; $.39557 \pm .08685$; T-value -6.96 ; P-value $>.0001$; Figure 1).

The paired t-test analysis of the Simpson's Diversity Index yielded a significant difference in the diversity between the experimental and control plots (mean \pm SE; paired $.11553 \pm .06335$; T-value 1.82 ; P-value $.1015$; Figure 2).

A one-way ANOVA analysis of the six native light-loving species; wild strawberry (*Fragaria vesca*), swamp dewberry (*Rubus hispidus*), pin cherry (*Prunus pensylvanica*), Orange hawkweed (*Pilosella aurantiaca*), and red raspberry (*Rubus occidentalis*); found significant results for *R.occidentalis*, *F.vesca*, and *P.pensylvanica* (P-values of .0683, .0845, and .0663, respectively; Figures 4, 6 and 7) while *R.hispidus* and *P.aurantiaca* did not yield a significant difference between the two plot types (P-values of .3696, .1506, and .2726, respectively; Figures 5 and 8).

There was a significant difference in the available light between the control and the experimental plots (mean \pm SE; control 15.588 ± 7.483 ; experimental 23.273 ± 16.811 ; F-value 6.98; P-value 0.01; Figure 4).

Discussion

The experimental results support the hypothesis that the presence of *L. maackii* on the UNDERC-East property has altered the native plant composition. The results of the analysis of the control and experimental sites using the Modified Morisita-Horn Overlap Index demonstrates that there is a significant difference between the species composition of the two plot types. The results of the Simpson's Diversity Index point to the cause of the difference being significantly diminished species richness and abundance within the plots where *L. maackii* was present. Past studies have pointed to this being the case in habitats in Ohio and Kentucky, and with similar data have reached the conclusion that the presence of *L. maackii* is linked with less richness and abundance of native plants (Collier et al., 2002). My research suggests that the presence of the

invasive shrub *L. maackii* is at least one factor in the decreasing richness and abundance in forest edge communities at UNDERC-East.

The light readings analyzed are significant because they introduce differences in available light between the experimental and control plots as an important variable (Figure 9). This difference in available light between plots with *L. maackii* and plots without has two important implications, the first relating to how increased light contributes to how easily a system can be invaded. Environments with high light availability have been linked to increasing the speed of non-native plant invasion, especially *L. maackii* (Hutchinson and Vankat, 1997). Part of this process is unavoidable even in undisturbed habitats as environments with high light availability occur naturally via events such as wind storms, fire, and the death of large trees. But while natural processes have created footholds for *L. maackii* in Eastern forests, human involvement may have sped up the invasion by creating man-made environments with high light availability. The roads, buildings, and mowed landscapes of UNDERC have all created high-light forest edge communities that give *L. maackii* access to new portions of the forest community. The significantly higher light readings in experimental plots should be cause for concern that any further development may be offering an inroad of invasive *L. maackii* into new landscapes (Figure 9).

Another facet of the comparison of light readings between the control and experimental plots is how high light availability and *L. maackii* pertains to native species (Figure 9). Shade-intolerant species native to the UNDERC habitats such as wild strawberry (*Fragaria vesca*), swamp dewberry (*Rubus hispidus*), pin cherry (*Prunus pensylvanica*), and red raspberry (*Rubus occidentalis*) suffer from having limited access to direct sunlight in the presence of *L. maackii*. In habitat without invasives like *L. maackii*, these species are the natural fillers of high-light

openings in the forest. The presence of these species is important to both plant and animal populations because fruiting bushes like *F.vesca*, *R.hispidus*, *P.pensylvanica*, and *R.occidentalis* provide important food sources and their absence could have a potentially negative impact on animals that prefer them as a food source (di Castri, 1989). Other species like *P.mariana* play important roles for insects as preferred locations for pupating and feeding spots for larvae (CABI, 2018). The abundance of Orange hawkweed (*Pilosella aurantiaca*), another invasive in the region, was examined to see if *L. maackii* was paving the way for the expansion of other invasive plants into the forest. While there was no significant difference in the abundance of *P. aurantiaca* between the two plots, the plant was still able to survive in some locations with *L. maackii*, possibly pointing to an advantage over native wild flowers in the presence of *L. maackii*. The significant reduction of *R.occidentalis*, *F.vesca*, and *P.pensylvanica* within the experimental sites demonstrate that at least some of these light-loving and ecologically important natives may be losing their access to their habitats where *L. maackii* is present (Figures 2, 4, and 5). *R.hispidus* and *P.aurantiaca* did not show a significant reduction between the control and experimental plots, but further research may reveal a downward trend in these species where they intersect with *L. maackii* as well. The impact of *L. maackii* on these few species is clear, and future studies focusing on the impacts of *L. maackii* on individual plant species may reveal a more nuanced effect. Additionally, the role of human development as an aid to the invasion of non-native plants raises some interesting opportunities for mitigation. Further study on how removing human development impacts invasive species or how more cautious development could slow the rate of invasion could yield interesting information on invasive control.

Figures

P-value	T-value	Mean	Standard Deviation	N
>.0001	-6.96	.39557	.27464	10

Figure 1: Morisita Horn Index Results: A hypothesis test with the Morisita Horn Index showing a significant difference in Beta diversity.

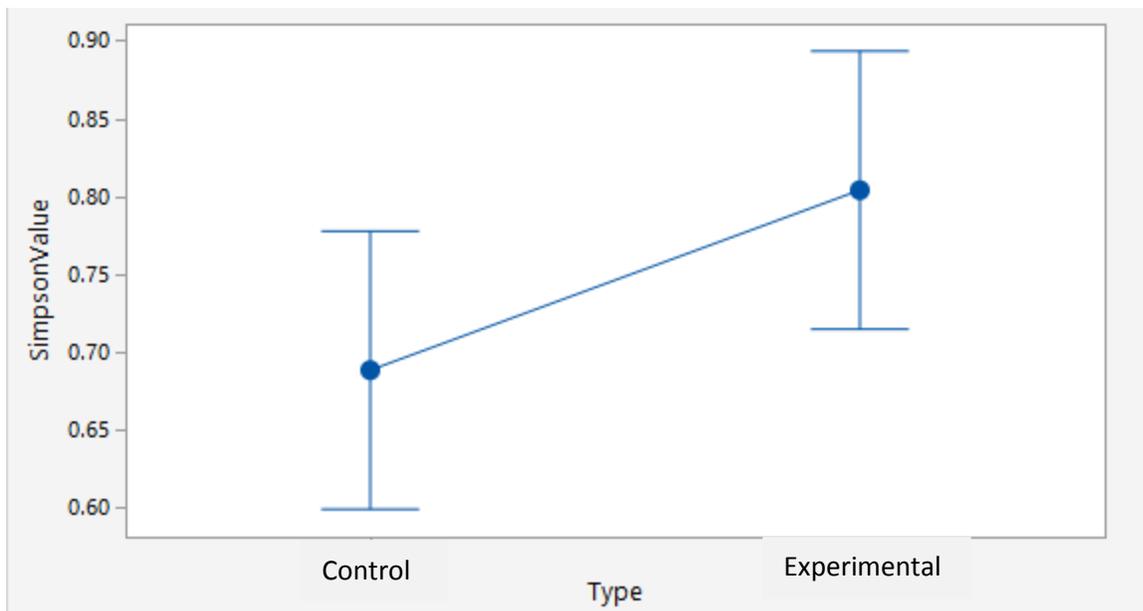


Figure 2: Simpson's Index Results: A paired t-test comparing the control and experimental plots showing a significant difference in diversity.

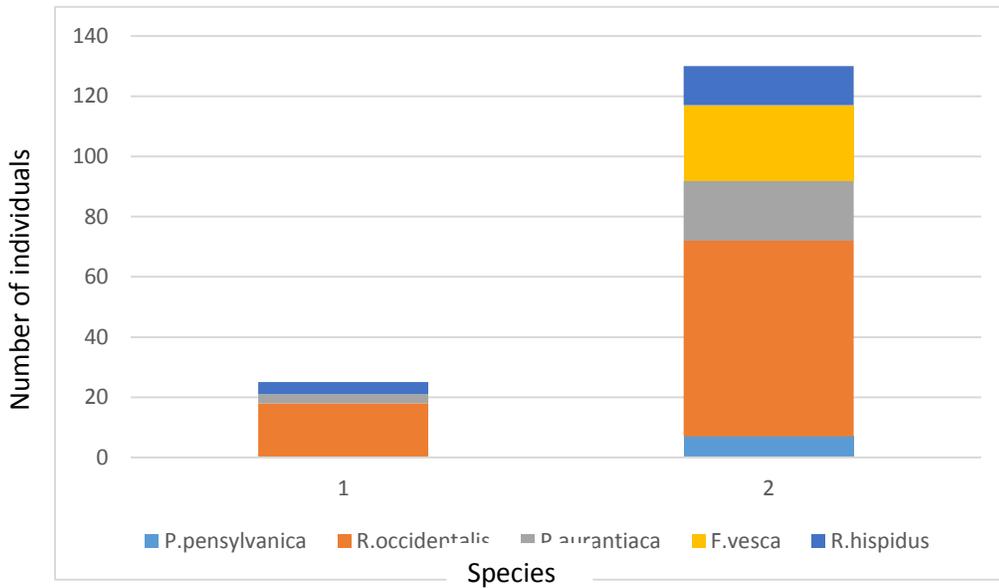


Figure 3: Observed abundance of six light-loving species in the presence and absence *L.maackii*. A stacked bar graph comparing the counts of wild strawberry (*Fragaria vesca*), swamp dewberry (*Rubus hispidus*), pin cherry (*Prunus pensylvanica*), black spruce (*Picea mariana*), Orange hawkweed (*Pilosella aurantiaca*), and red raspberry (*Rubus occidentalis*).

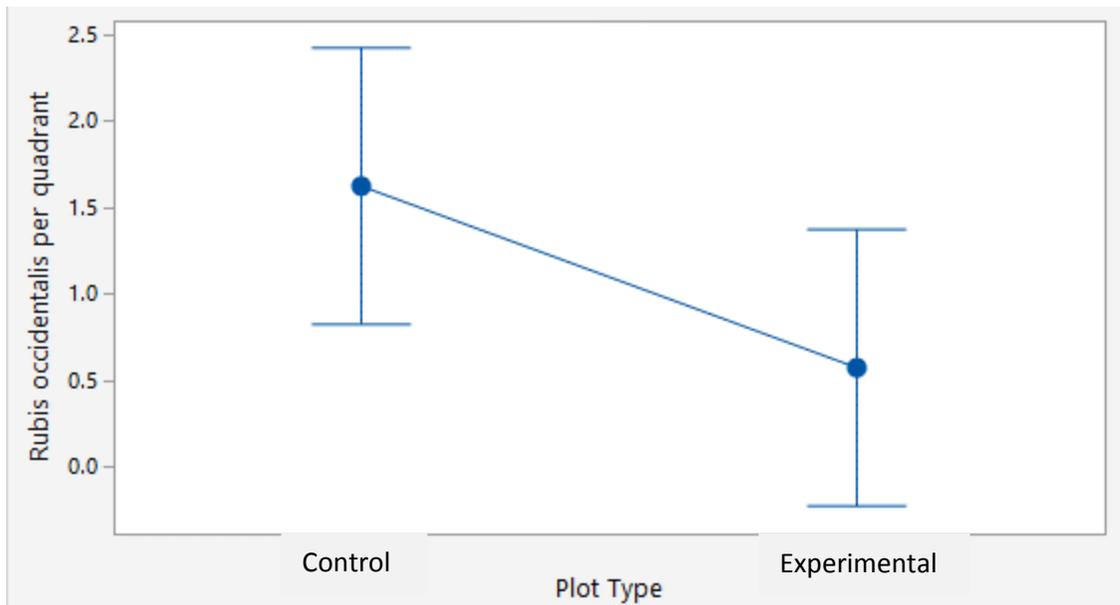


Figure 4: Observed abundance of *Rubis occidentalis* in experimental and control plots. A one-way ANOVA comparing the counts of wild strawberry (*Rubis occidentalis*) found in plots with and without *L.maackii*.

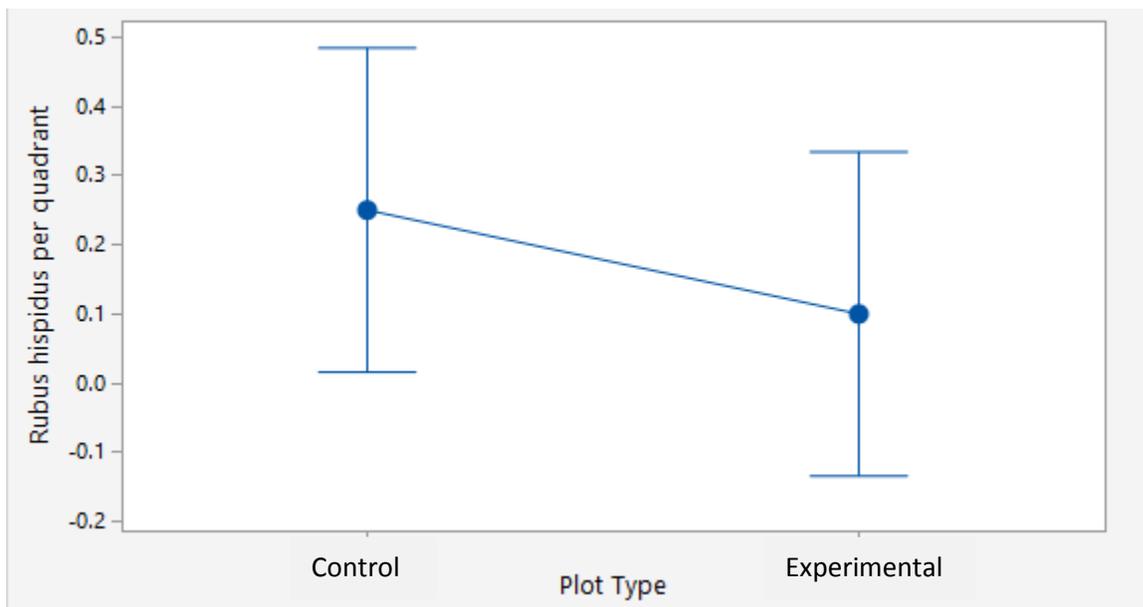


Figure 5: Observed abundance of *Rubus hispidus* in experimental and control plots. A one-way ANOVA comparing the counts of swamp dewberry (*Rubus hispidus*) found in plots with and without *L.maackii*.

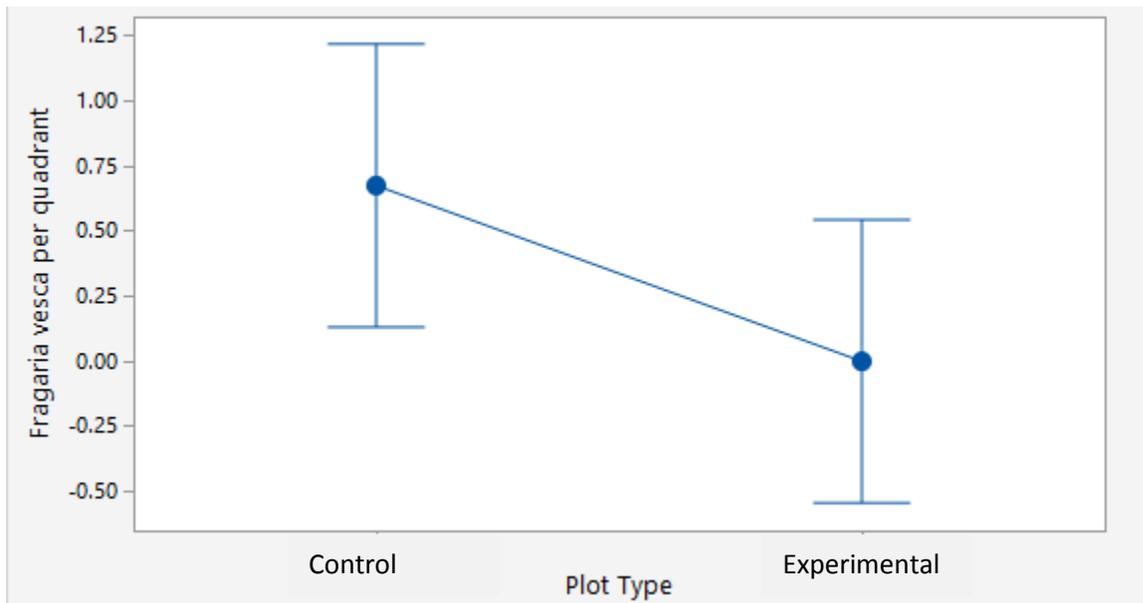


Figure 6: Observed abundance of *Fragaria vesca* in experimental and control plots. A one-way ANOVA comparing the counts of wild strawberry (*Fragaria vesca*) found in plots with and without *L.maackii*.

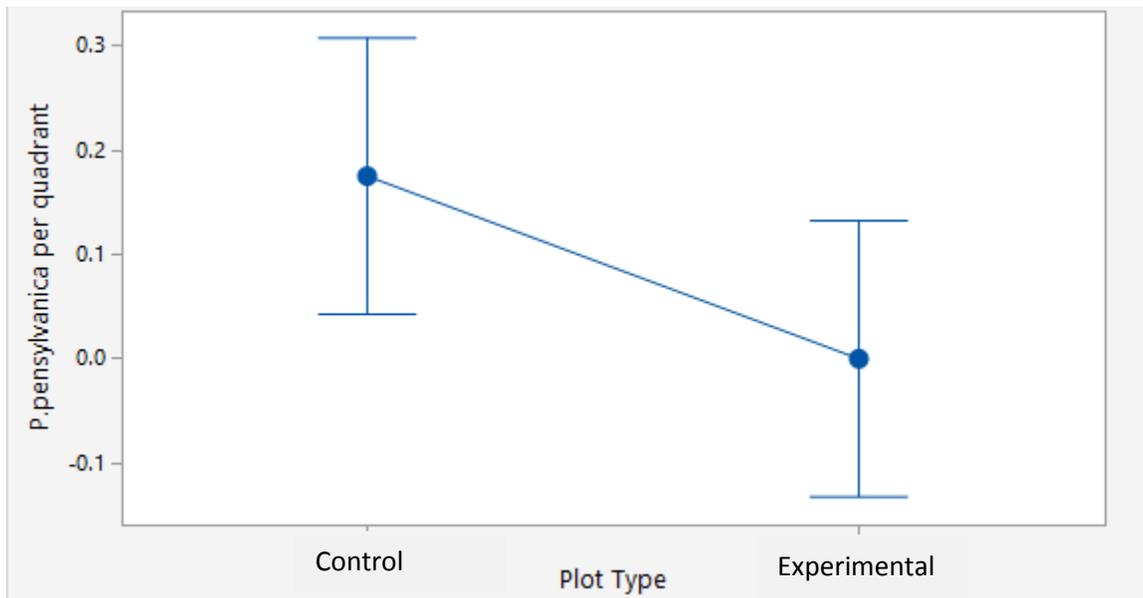


Figure 7: Observed abundance of *Prunus pensylvanica* in experimental and control plots. A one-way ANOVA comparing the counts of pin cherry (*Prunus pensylvanica*) found in plots with and without *L.maackii*.

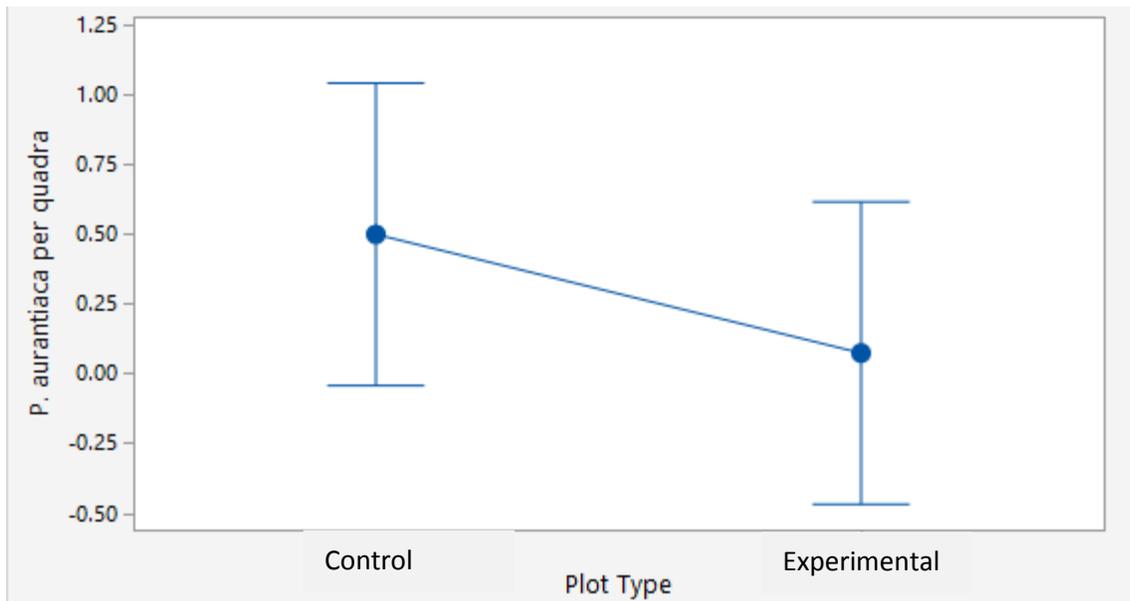


Figure 8: Observed abundance of *Pilosella aurantiaca* in experimental and control plots. A one-way ANOVA comparing the counts of orange hawkweed (*Pilosella aurantiaca*) found in plots with and without *L.maackii*.

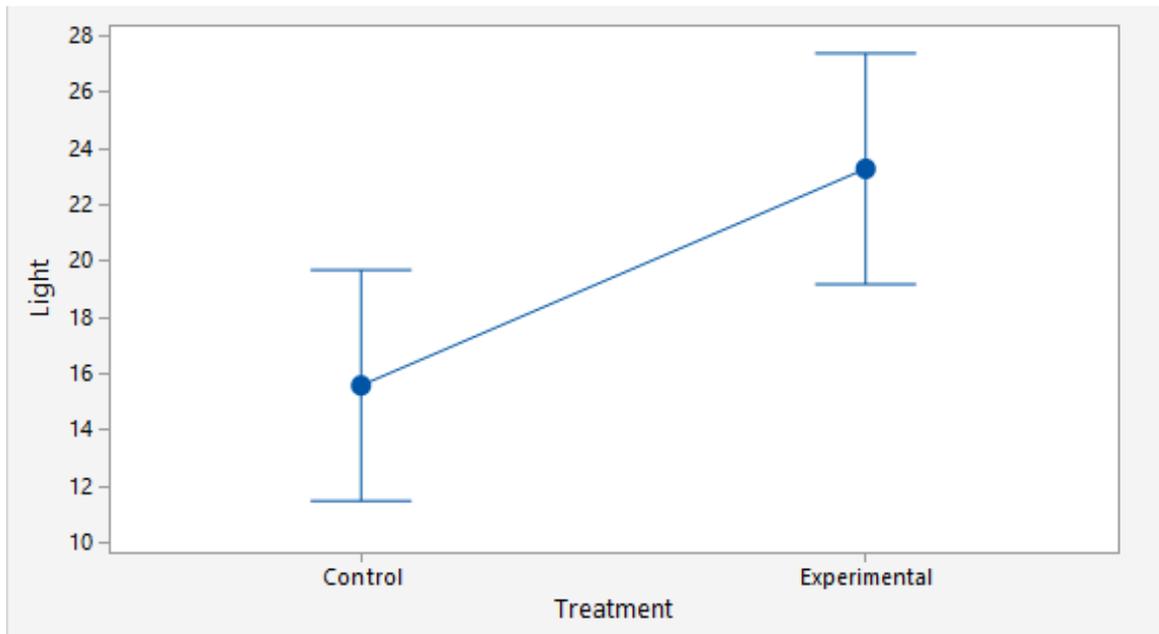


Figure 9: Light availability in both experimental and control plots. A one-way ANOVA comparing the amount of light (measured in BTUs) at control plots to the amount of light at experimental plots, yielding a P-value of 0.01 and an F-value of 6.98.

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