Abundance of honeysuckle along used and unused roads of an eastern deciduous forest

BIOS 35502: Practicum in Environmental Field Biology

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2011

ABSTRACT:

Invasive plants spread into forest ecosystems and outcompete native plants for nutrients and space. One invasive plant, *Lonicera* spp. or honeysuckle, spreads into forests from the outside. In this study, I examined honeysuckle cover at 80 plots along used roads and at 80 plots along unused roads at varying distances from the road. I found a significant interaction between distance and road usage, showing that honeysuckle cover was highest close to the road along used roads and lowest far from the road along unused roads. Though light is often a factor in invasive plant spread, light had no significant effect on honeysuckle cover. These findings support the idea that invasive plants move into a forest along roads, especially those with human traffic.

INTRODUCTION:

Invasive plant species can easily creep into an ecosystem and dominate it. Directly competing with native plants for nutrients as well as light, their hardy fitness can yield a large invasive plant population that degrades the light received by the understory through shading (Allan *et al*., 2010). In the end, invasive species out-compete and therefore exclude native plants from the ecosystem (McKinney and Goodell, 2010). In their nonnative habitats, invasive species are also released from the pressure of adversaries, including competing plants and specialist herbivores. In a study conducted in southern Indiana, native seedlings suffered 82% more herbivory due to insects and small mammals than invasive seedlings, indicating that herbivores in these forests prefer native plants to the invaders (Flory and Clay, 2009). The release from predators and adaptability to the new habitats has led to an increase in invasive plant species. Although most species started as problems along edges of habitats, they are invading the interior as well (Vellend, 2002).

Invasive species spread from the edges of an ecosystem inward (Cadenasso and Pickett, 2000). Many species have fruit-encased seeds that are spread following consumption by herbivores such as birds (Myers *et al*., 2004). Therefore, the invasive plants grow around where these herbivores live. This is especially true in eastern deciduous forests, where invasive shrubs are significantly denser closer to roads; roads fragment an area's forests and create anthropogenic edges through the ecosystem (Flory and Clay, 2006). Often native plants are harmed by fragmentation due to breakup of the habitat, fragment-created barriers for pollinators, and a general disturbance of the ecosystem (Cadenasso and Pickett, 2000). With greater light and potential water availability, invasive shrubs that are initially deposited by animals survive well along the edges, including those that meet with roads. Such edges allow increased herbivory in areas that were once isolated within a forest interior (Cadenasso and Pickett, 2000). As the herbivores move into the forest, the seeds also are deposited into the forest, slowly moving away from the edges.

A very common roadside exotic species in the eastern deciduous forests of North America is *Lonicera* spp. or honeysuckle (McKinney and Goodell, 2010). Several species of honeysuckle have invaded, including *L. maackii* (bush honeysuckle). All species of invasive honeysuckle in forests are bushy, woody shrubs identifiable by thick green foliage and bright red berries. They do not grow tall enough to reach the canopy, but they are tall enough and bushy enough to block light from the understory (Vellend, 2002). Honeysuckle is prevalent along roads due to its method of seed dispersal. Birds eat the bright, attractive berries produced by honeysuckle and distribute them along the edge, where the seeds are easily accessible (Vellend, 2002). Honeysuckle thrives in edge environments, outcompeting other herbaceous plants and even reducing the growth and survival of native tree seedlings (Flory and Clay, 2006).

Flory and Clay (2006) found the density of *L. maackii* invasive shrubs significantly decreased with magnitude by distance to the nearest road. Besides having the highest average stem density in plots nearest to the road, *L. maackii* honeysuckle had the highest average stem density at the road's edge than any of the other six invasive shrubs measured in the study. Flory and Clay (2006) offer three possible mechanisms for the difference in honeysuckle density along roads. One is that birds move evenly along roads and disperse seeds, which survive well in roadside soil. A second is that survival of seedlings is not affected by road distance; density is determined by dispersal alone. A final mechanism is that these invasive shrubs were introduced along the roadside by herbivores or even humans (Flory and Clay, 2006).

The purpose of this study is to extend the previous work by determining the abundance of honeysuckle along road edges in the forest at the University of Notre Dame Environmental Research Center (UNDERC). The location is a typical eastern deciduous forest, surrounded by the Ottawa National Forest and relatively protected from disturbance. There are dirt roads throughout the property, connecting a variety of habitats. I examined the abundance of honeysuckle based on the proximity to roads, differentiating between roads that receive relatively little use, such as small roads at far ends of the property, and roads that receive more usage, such as the roads leading into the property and roads closer to the buildings. I hypothesized that honeysuckle abundance decreases with increasing distance from roads and that this pattern is weaker along unused roads.

MATERIALS AND METHODS:

Study site and experimental design

This study was conducted from May to July 2011 within the forested property of the University of Notre Dame Research Center (UNDERC) along the border of northern Wisconsin and Michigan's Upper Peninsula. The property encompasses 7500 acres and is surrounded by the Ottawa National Forest. The region contains a variety of early and late successional native tree species, representing second-growth forest due to former logging pressures that removed most of the original forest.

Twenty sites were chosen at random by placing a grid on a map of the property. I assigned each space on the grid a number. Grid spaces were sorted based on presence of roads and the relative use of roads: high use, such as the main roads of the property, and low use, such as parts of the back of the property, especially to the north. I personally defined "used" and "unused" after taking a tour of property and assessing the roads' traffic. Then, I chose 40 sites randomly from each set of grid squares. If a grid occurred on an area of the property that does not contain a road or an area that rests on a lake, it was discarded and replaced with another site. The total of 40 sites were marked on a map of the property (Figure 1).

Study design

At each of the sites, I placed two 70m transects perpendicular to the road on opposite sides. Along each transect, I placed two plots each, 1m deep by 5m wide. Plots will be located at randomly chosen distances (0, 10, 20, 30, 40, 50, 60, or 70m) along each transect. I chose each plot distance by assorting the distances in pairs randomly and then randomly assigning each site a pair of plots. Therefore, each transect contained two 1-by-5m plots; each site surveyed contained a total of four plots. I surveyed a total of 160 plots across all 40 sites. All transects and plots were measured with a measuring tape, and the boundaries were marked with flags. I visually estimated the area occupied above ground by honeysuckle bushes, recording an approximate percentage of honeysuckle cover for each plot. Within each plot, I visually estimated the percentage of open canopy as an indicator for light availability.

Statistical analysis

Data was transformed with an arcsine square root transformation to help normalize the data. I used a two-way analysis of variance to assess the effects of the distance from the road and the road use (used and unused) on percentage of honeysuckle abundance, with honeysuckle proportion as the dependent variable and road use and distance as factors. With information on light availability at each plot, I compared honeysuckle cover and percent open canopy using a least squares linear regression. All analyses were conducted using SYSTAT 13 software (Systat Software, Inc., Chicago, Illinois), and significance was determined by using an $\alpha = 0.05$.

RESULTS:

Honeysuckle cover was not significantly affected by distance from the road ($F_{7,144}$=1.235, p=0.2873) or road usage ($F_{1,144}$=3.491, p=0.0634). There was a significant interaction between distance from the road and road usage on honeysuckle cover ($F_{7,144}$=2.137, p=0.0433). Plots closer to the road and along used roads contained the greatest honeysuckle cover (Figure 2). There was not a significant relationship between proportion of open canopy and honeysuckle cover (R^2 = 0.0007, F_1=0.1163, p=0.7335, Figure 3).

DISCUSSION:

Based upon previous research and invasive plant trends, I hypothesized that honeysuckle abundance would decrease with increasing distance from roads and that pattern would be weaker along unused roads. However, my results indicated honeysuckle cover was not affected significantly by distance from the road. The usual trend is that honeysuckle is very abundant along the edge of the habitat, spreading inward (Allan *et al*., 2010). At the sites I sampled, although the raw honeysuckle cover was higher at plots near the roads, it was not significant. There is a marginally significant trend for honeysuckle cover to be higher in plots along used roads than unused roads (Figure 2). Roads that receive frequent traffic contained slightly more honeysuckle.

The interaction between road usage and plot distance from the road significantly influenced honeysuckle cover. When looking at both factors together, honeysuckle cover was greatest closer to the road along used roads and least at plots with greater distance in from unused roads. Although honeysuckle cover did not differ significantly with distance alone, it did differ with distance and road usage in tandem. Considering the significance of the interaction, I reject my null hypothesis; I found honeysuckle cover was influenced by distance from the road and road usage together.

Although the two factors influence honeysuckle abundance when interacting, I was surprised by the non-significance of distance alone on honeysuckle cover. Many previous studies have found road proximity to be a large contributing factor to honeysuckle spread. Flory and Clay (2006) found that invasive honeysuckle significantly decreased with distance to the nearest road. They noticed that the plots surveyed right along the road were the only plots significantly different from the rest of the plots. The sites surveyed at the UNDERC property showed no such trend. I think this contradiction may be due to a combination of my protocol and the sites surveyed. Since each two plots surveyed at each site were randomly chosen, some plots were 70 meters apart while others were 10 meters apart. Therefore, the stratification measured was not necessarily precise. The sites surveyed may have had heavier invasion that has already penetrated the edge of the forest. Also, many areas of property contained no honeysuckle shrubs.

I solely studied honeysuckle cover in a plot, but I recorded open canopy percent due to light's influence on invasive plant success. Open light regimes, like those created by edges, provide opportune locations for invasive plants such as honeysuckle (Flory and Clay, 2009). Statistically, there was no significant relationship between honeysuckle cover over a plot and the percentage of that plot's open canopy. Once again, the lack of a relationship could be due to the sites surveyed on this property. Most of the open canopy in forests on the UNDERC property is due to snags, and tree cover often begins at the edge where the forest and the roads meet.

Although I focused on honeysuckle cover itself, invasive shrubs often have adverse effects on the native vegetation around them. Mills *et al.* (2008) noted that tree seedling density and species richness were negatively related to honeysuckle cover. The plots I surveyed differed in their honeysuckle dominance. Regardless of statistical analysis, the raw data showed that plots often either contained one or two honeysuckle bushes or contained mostly honeysuckle. I did not measure species richness and tree seedling density within each of my plots, but such data collection could be analyzed for future study. Adding the way that the invasive plant interacts with overall species richness would expand the observational study and perhaps lead to new information about honeysuckle's effects when stratified with distance from the road and split between used roads and unused roads.

In examining honeysuckle cover at 160 plots along used and unused roads at varying distances from the road, I found that both factors (road usage and distance from the road) contribute to the level of invasion. Such an interaction should be applicable to many of the forests recently invaded by honeysuckle. The road seems to be the conduit of honeysuckle, corresponding with the literature about invasive plant spread. At the UNDERC property itself, I believe that human movement is a large contributor to the spread of invasive plants such as honeysuckle. Further study would examine any effects honeysuckle has on native vegetation along the paths of invasion.

ACKNOWLEDGEMENTS:

I would like to thank my UNDERC mentor, Dr. Walt Carson, and my advisor at Saint Mary's College, Dr. Cassie Majetic, for helping me with experimental design. Thank you to Dr. Michael Cramer, Heidi Mahon, and Matt Igleski for general project advice. Thank you Shayna Sura for helping me transform my data, among other statistical magic. A special thanks goes to Maria Correa, Kathleen Lay, Mason Murphy, and Matthew Schirtzinger for driving me around property, holding a meter tape, forging paths through thick brush, and keeping me company. Finally, I would like to thank the Bernard J. Hank family endowment for making this summer possible and funding the program.

WORKS CITED:

Allan, B.F., H.P. Dutra, L.S. Goessling, K. Barnett, J.M. Chase, R.J. Marquis, G. Pang, G.A. Storch, R.E. Thach, J.L. Orrock. 2010. Invasive honeysuckle eradication reduces tick-borne disease risk by altering host dynamics. *Proceedings of the National Academy of Sciences of the United States of America* 107: 18523-185272.

Cadenasso, M.L. and S.T.A Pickett. 2000. Linking forest edge structure to edge function: mediation of herbivore damage. *Journal of Ecology* 88: 31-44.

Flory, S.L. and K. Clay. 2009. Effects of roads and forest successional age on experimental plant invasions. *Biological Conservation* 142: 2531-2537.

Flory, S.L. and K. Clay. 2006. Invasive shrub distribution varies with distance to roads and stand age in eastern deciduous forests in Indiana, USA. *Plant Ecology* 184: 131-141.

McKinney, A.M. and K. Goodell. 2010. Shading by invasive shrub reduces seed production and pollinator services in a native herb. *Biological Invasions* 12: 2751-2763.

Mills, J.E., J.A. Reinartz, G.A. Meyer, E.B. Young. 2009. Exotic shrub invasion in an undisturbed wetland has little community-level effect over a 15-year period. *Biological Invasions* 11: 1803-1820.

Myers, J.A., M. Vellend, S. Gardescu, P.L. Marks. 2004. Seed dispersal by white-tailed deer: implications for long-distance seed dispersal, invasion, and migration of plants in eastern North America. *Oecologia* 139: 35-44.

Vellend, M. 2002. A pest and an invader: White-tailed deer (*Odocoileus virginianus Zimm*.) as a seed dispersal agent for honeysuckle shrubs (*Lonicera l*.). *Natural Areas Journal* 22: 230-234.

FIGURES:

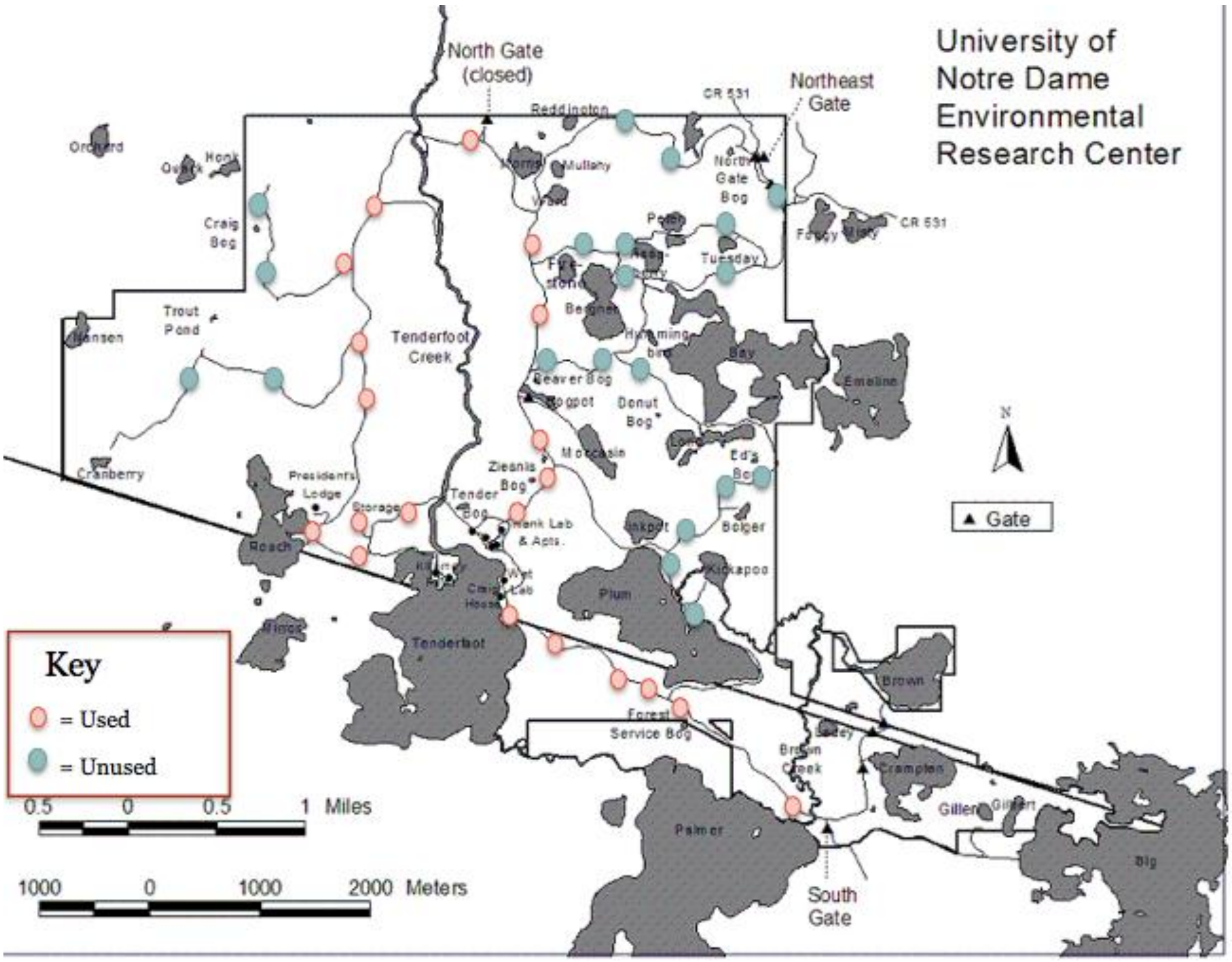

Figure 1. Map of UNDERC property with sites marked as used or unused. At each site, four plots were surveyed at varying distances from the road. All sites and distances were chosen randomly.

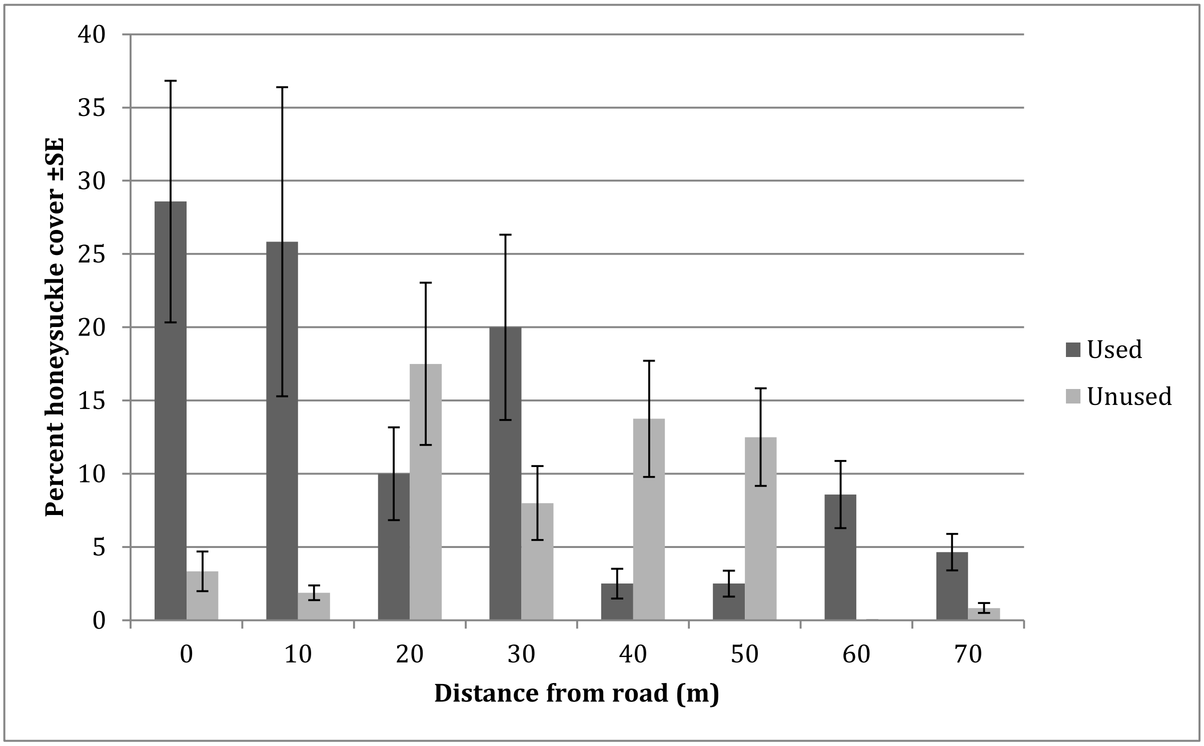

Figure 2. Mean percent honeysuckle cover ±SE across eight distances from the road for both used and unused roads (n=160). The interaction between distance from road and road usage was significant (p=0.0433).

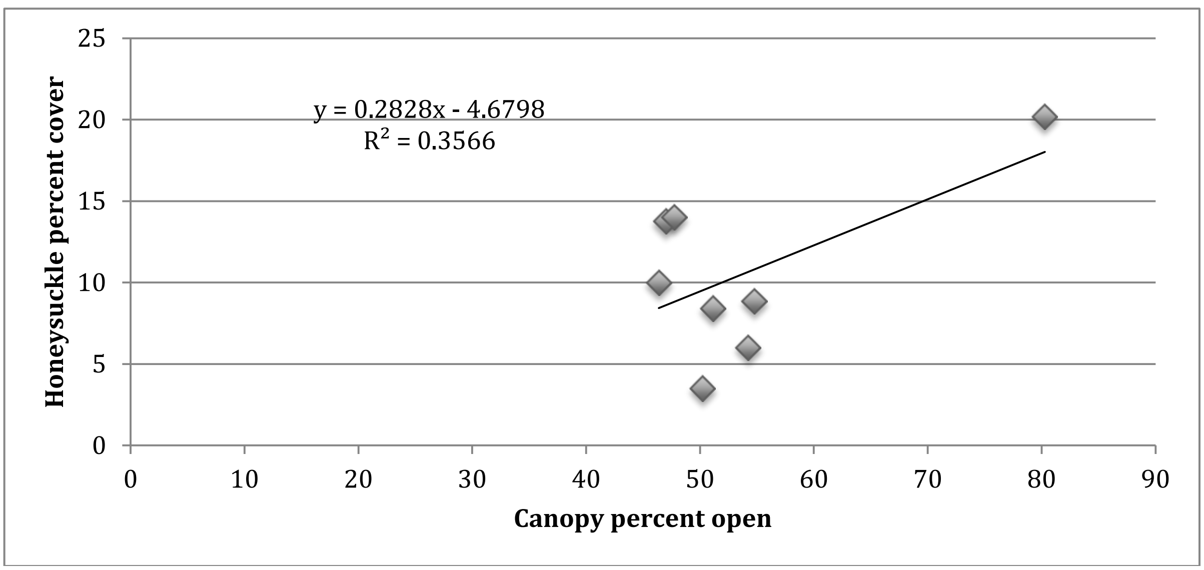

Figure 3. Mean honeysuckle cover as a function of mean canopy percent open (n=8 distances) There is no significant difference between honeysuckle cover and open canopy at each of the distances from the road (p=0.7334). Most of the plots had an average open canopy between 40 and 60 percent.