Invasion in Oliver's Woods:
Japanese Honeysuckle (*Lonicera japonica L.*)

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Abstract

Invasive plant species can cause changes in an ecosystem by affecting the availability of resources to native plants or by out competing the native plants for these resources. Understanding the mechanisms that invasive plants use to alter an ecosystem allows for better management and prevention of their economic harm to susceptible environments.

Introduction

Invasive plants are becoming a more widespread problem since they can cause damage to ecosystems, lower plant biodiversity, and cause economic harm. Non-native or invasive plants are a problem because they can alter ecosystem processes such as nutrient cycling, hydrologic cycles, erosion, and sediment deposition (Center for Invasive Plant Management 2008). Invasion ecologists attempt to study the invasion process and devise ways to control or eliminate invasive plant species (Richardson 2000). They also attempt to devise uniform standards for assessing a non-native plant species' potential to become invasive (Powell 2004) as well as uniform standards in classifying whether a non-native plant species is considered invasive or not (Fox 2004).

A non-native plant invasion can occur in a number of ways. First the plant has to be able to overcome some barrier into a new region and be able to thrive in the new area. The simplest area for a plant to invade is a disturbed area. The non-native plant must be able to overcome many different factors or just be able to out-compete existing native plants for resources when invading undisturbed areas, this usually the more difficult way of invasion. The invasion process can be classified into three stages: introduction, colonization, and naturalization. The introduction stage consists of propagules arriving in an area. Colonization is the stage where the plant species has formed a colony and is self-perpetuating. The naturalization stage is an expansion of the colonization stage and the species becomes part of the native flora (Richardson 2000).

Japanese honeysuckle (*Lonicera japonica*) belongs to the family Caprifoliaceae and is native to eastern Asia but has become naturalized in the United States. It was first introduced in the early 1800s as an ornamental landscape plant, but it escaped cultivation (Regehr 1988). Without many natural enemies, honeysuckle spreads quickly as it out-competes native species. Honeysuckle can kill other trees and shrubs with its vining habit by blocking out light. It can thrive in a variety of environments. Honeysuckle can reproduce sexually as well as vegetatively

(Bravo 2005). Clumps of honeysuckle can be large and dense; this can prevent the germination and growth of native plant species. Its fruits are typically produced September through November (MacDonald 2008). Seeds are often spread by birds. Since honeysuckle is semi-evergreen, it can grow in a forested area while deciduous trees are dormant (Nyboer 1988).

Japanese honeysuckle has varying levels of classification as an invasive species. The Federal and State Noxious Weeds list only lists *L. japonica* as an invasive species in four states; Connecticut, Massachusetts, New Hampshire, and Vermont. Japanese honeysuckle is not listed as invasive species in Oklahoma on the Federal list even though it is considered one of the most commonly occurring invasive plant species in the US (USDA Plants Database 2008). However, on the Oklahoma Non-Native Invasive Plant Species list it is classified as a problem species in Oklahoma (Oklahoma Invasive Plant Council 2008). These discrepancies show that uniform criteria need to be established and fully implemented so that there is no ambiguity even with the release of the NISC's new plan earlier this year.

One area in Norman, OK, that has an extensive population of Japanese honeysuckle is in the area known as Oliver's Woods. Oliver's Woods is located at the southeast corner of Chautauqua and Highway 9 in Cleveland County, OK (35^{o}10'44.56"N 97^{o}26'49.33"). This is south of the city of Norman and north of the Canadian River. This wooded area is 80 acres of virgin bottomland forest and was donated to the University of Oklahoma by the Oliver family in the 1940s (Shannon 2003). This wooded area was chosen to study the invasiveness of Japanese honeysuckle even though how the honeysuckle got there is unknown at this time.

This study aims to answer the following questions. Is Japanese honeysuckle invading the wooded area known as Oliver's Woods? Are there differences between the areas where honeysuckle is growing and where it is not growing? What factors are contributing to the growth of the honeysuckle? Are there differences in soil nutrients, available light, soil moisture, and any plant species associated with the honeysuckle? We propose that Japanese honeysuckle should be classified as an invasive plant species in Oklahoma. We also propose that there are differences in the areas that honeysuckle is growing and the areas where it is not growing. We also propose that soil nutrients and soil moisture are not contributing to the growth of honeysuckle and that light is contributing to its ability to invade this area.

Methods and Materials

Twenty 1m^2 plots that contained honeysuckle were identified and marked as honeysuckle plots (H1-H20). Twenty additional 1m^2 plots that did not contain honeysuckle were chosen at random and marked as random plots (R1-R20). GPS coordinates were taken for all 40 plots for future location. Data was collected from each of the 40 plots in an equal manner. Canopy openness for each plot was obtained using a spherical densiometer. All plant species within each plot were identified to species where possible using a floral key. The floral keys used are listed in the appendix. The total area of the plot that each species covered of the total biomass was assigned a value using the Daubenmeyer Scale based on a visual estimation. The scale values and their percent coverage are listed in the appendix.

For the honeysuckle plots, the nearest tree was identified and its distance from the honeysuckle plot was measured in meters. The diameter of the nearest tree was measured using a DBH measurer at 12in above ground. The circumference of each clump of honeysuckle was calculated from the diameter of the clump measured in meters. For the random plots, the nearest tree was also identified, its distance from the plot, and its diameter was measured in meters using a DBH measurer. Honeysuckle clump circumference was not taken for the random plots since honeysuckle was not present.

Two sets of soil samples were taken from each plot. Each plot was broken down into four subplots and soil samples were taken with a soil core. This was repeated once for each plot so that two samples sets were obtained. One set of subplot samples were combined so that there were a total of 40 soil samples to be used for nutrient and pH testing. The other soil subplot soil samples were not combined, resulting in 160 samples. These were weighed in grams and then placed in a drying oven for one week. At the end of the week, each sample was weighed again. The difference in weight was the moisture content in grams. These values were then averaged to give the average soil moisture content for each plot. The second sets of soil samples were each tested for Nitrogen (lb/a), Phosphorous (lb/a), Potassium (lb/a), and pH. These tests were run using a La Motte Soil Macronutrient Kit. The directions accompanying the test kit were followed for each individual test.

Statistical analysis was then run on all data using Nonmetric Multidimensional Scaling Ordination (NMDS). The NMDS was run with 100 starting configurations and Bray-Curtis dissimilarity. This gave a resulting 2D stress value. Vector fitting was done with 10,000 random starts using Bray-Curtis dissimilarity. P values were obtained for the significant vectors of Nitrogen and Soil Moisture. Analysis of similarity was run by grouping honeysuckle and random plots into their respective classes and using 10,000 permutations and Bray-Curtis dissimilarity. This resulted in the respective P and an R values.

Results

All figures and tables for the resulting data are presented in the appendix. The data shows a trend of honeysuckle being in plots with higher soil Nitrogen levels, while honeysuckle was not in plots with higher soil moisture. This trend can be seen in Figure 6, which shows the Nonmetric Multidimensional Scale Ordination. The vector fitting resulted in correlation and P values that indicated soil Nitrogen and soil moisture as significant environmental factors. Analysis of Similarity (ANOSIM) resulted in a P value of <0.001 and an R value of 0.3404.

Discussion

After analysis of the data collected, the honeysuckle appeared to prefer sites with higher soil nitrogen levels and lower soil moisture (Figure 6). There was a significant difference in ANOSIM between the plots with and without honeysuckle. Nitrogen is a significant factor to where honeysuckle grows. None of the honeysuckle plants observed showed any signs of sexual reproduction, the higher nitrogen levels (Figure 4) in the soil could have been keeping the plants in a vegetative state since during the time of this study it should have been producing fruit. Honeysuckle was not associated with the areas that had higher soil moisture content (Table 1). Soil Moisture is a significant factor in where honeysuckle does not grow.

Soil phosphorous levels (Figure 5), soil potassium levels (not shown), and canopy openness (Figure 2) did not have any significant impact on the growth of the honeysuckle. There were no detectable amounts of potassium found during soil nutrient testing. Honeysuckle plants were found growing in both open and shaded areas. There also was not any significant pattern found between where the honeysuckle was growing and other plant species growing in the same areas (Table 4 and Table 5). The honeysuckle could have already displaced some of these species. There was not any significant pattern between what species of tree was growing nearest to the honeysuckle plots (Table 2 and Table 3).

Conclusion

The original questions this study proposed were partially answered. Are there differences between the areas where honeysuckle is growing and where it is not? Yes and no. The only significant environmental differences were in the soil Nitrogen and soil moisture levels. All other factors that data was taken for were found to not be significantly different between the honeysuckle plots and the random plots. The soil moisture levels in the honeysuckle plots could have been lower than the random plots because honeysuckle plants may be more efficient in taking up water than the plants in the random plots or the maybe the soil simply drains faster/better in those plots. As for the higher levels of Nitrogen in the honeysuckle plots, maybe honeysuckle requires less or the levels are keeping it vegetative since there were no flowers or fruits present. The plants in the random plots could have been depleting the Nitrogen faster than the honeysuckle or simply there was just more Nitrogen available (Davis 2000).

To fully answer the question of whether or not Japanese honeysuckle is invading Oliver's Woods, further study should be conducted. Specifically, a study should be carried out that looks at the same factors as this study but over an extended time period as well as other factors such as level and types of disturbance in the area. An ice storm in December 2007, caused some disturbance in this area by damaging and/or killing many trees. The Japanese honeysuckle present in this area could have been capitalizing on this disturbance or on other factors not covered in this study (Dillenburg 1993). Additional studies should include relative density of honeysuckle clump coverage, evidence and amount of disturbance caused either by weather, humans, or animals, and soil nutrient levels and moisture levels at different times of year. Also, relative biomass of the honeysuckle needs to be estimated and monitored over a longer time period to fully assess the spread of the honeysuckle. Again, during this study no evidence of reproductive parts were observed on any honeysuckle plants. Further analysis of this area should be done to see if plants are able to reproduce sexually or if plants are only spreading vegetatively. Individual plants should also be tested to see if the different clumps of honeysuckle are clones or genetic individuals. Further study of this plant species in this semi-confined area could help develop future management plans for the rest of the state.

Literature Cited

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Appendix

Figure 1. An aerial view of the area of interest, Oliver's Woods, Cleveland County, Norman, OK.

List of Floral Keys Used in This Study:

- Hunter, Carl G. *Trees, shrubs and vines of Arkansas.* (1989). Ozark Society Foundation
- Little, Jr. Elbert L. *Forest Trees of Oklahoma*. (2002). State Dept. of Agriculture
- Smith, Edwin B. *Keys to the Flora of Arkansas.* (1994). The University of Arkansas Press

Daubenmeyer Scale	
Value	% Coverage
0	0
1	0.1-1.0
2	1.0-5.0
3	5.0-25.0
4	25.0-50.0
5	50.0-75.0
6	75.0-90.0
7	90.0-100.0

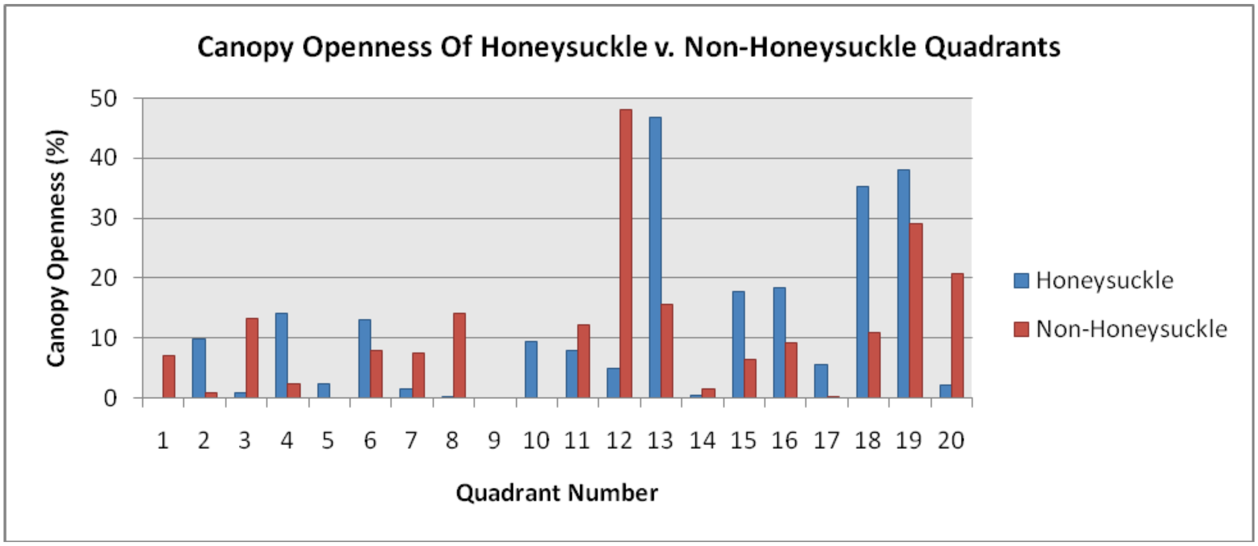

Figure 2. The percentage of canopy openness for plots.

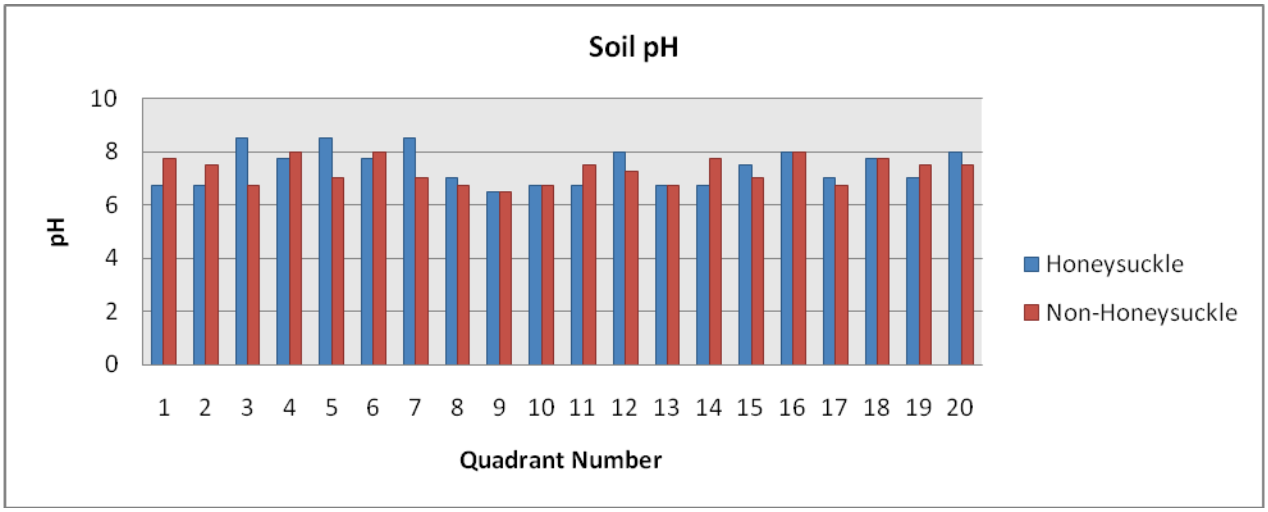

Figure 3. Soil pH for plots.

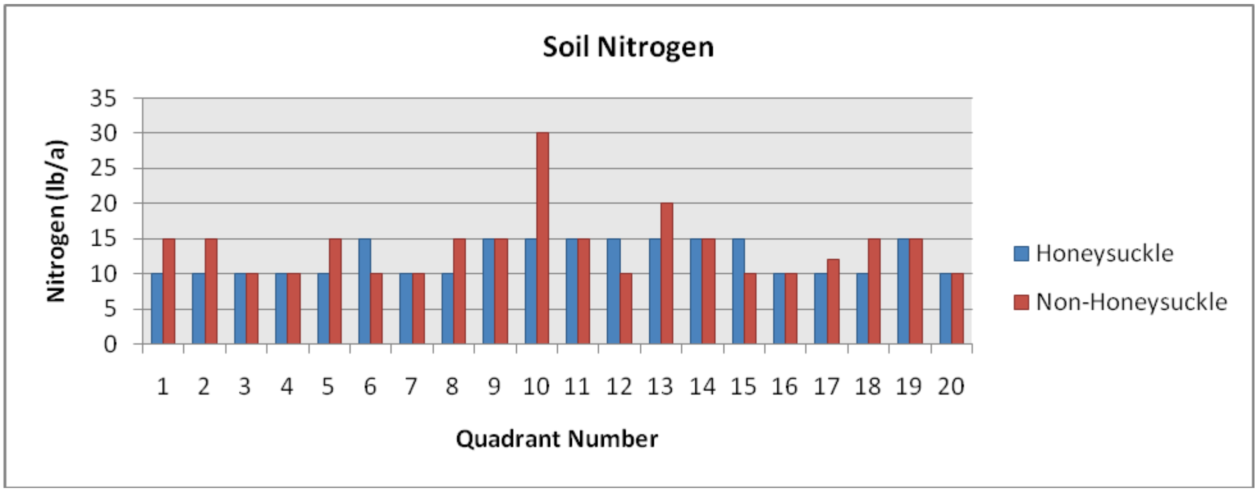

Figure 4. Soil Nitrogen for plots.

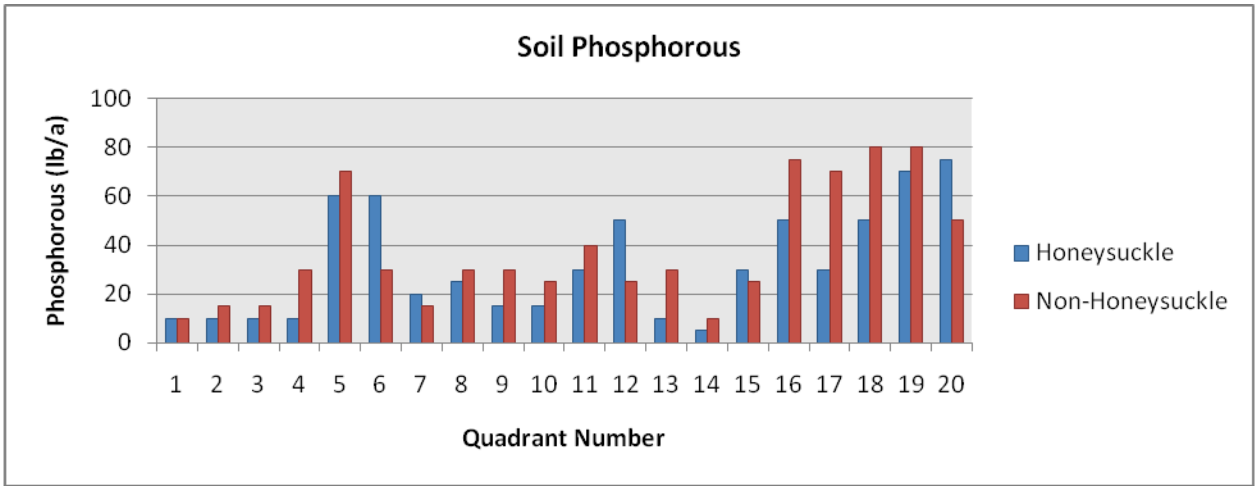

Figure 5. Soil Phosphorous for plots.

Soil Moisture (g)			
H1	0.023	**R1**	0.114
H2	0.059	**R2**	0.113
H3	0.039	**R3**	0.234
H4	0.000	**R4**	0.422
H5	0.009	**R5**	0.129
H6	0.012	**R6**	0.143
H7	0.012	**R7**	0.137
H8	0.000	**R8**	0.168
H9	0.063	**R9**	0.130
H10	0.083	**R10**	0.225
H11	0.019	**R11**	0.113
H12	0.089	**R12**	0.164
H13	0.102	**R13**	0.153
H14	0.104	**R14**	0.152
H15	0.146	**R15**	0.281
H16	0.107	**R16**	0.145
H17	0.024	**R17**	0.278
H18	0.018	**R18**	0.116
H19	0.088	**R19**	0.147
H20	0.084	**R20**	0.202

Table 1. Soil moisture content for plots.

Plot	Nearest Tree	Distance to Tree (m)	Tree Diameter	Clump Circumference

			(m)	(m)
H1	*Acer negundo*	0.40	1.00	4.09
H2	*Juglans nigra*	0.35	0.73	3.27
H3	*Juglans nigra*	0.85	2.34	8.58
H4	*Celtis occidentalis*	0.94	2.24	6.97
H5	*Juglans nigra*	0.59	1.25	8.19
H6	*Ligustrum vulgare*	0.27	0.99	9.07
H7	*Cercis canadensis*	0.40	0.39	7.08
H8	*Tilia americana*	0.11	1.40	6.11
H9	*Carya illinoensis*	0.63	1.01	6.01
H10	*Carya illinoensis*	0.41	0.79	7.32
H11	*Carya illinoensis*	0.63	0.91	1.50
H12	*Celtis occidentalis*	0.77	2.40	7.39
H13	*Cercis canadensis*	0.53	0.92	5.97
H14	*Juglans nigra*	0.84	1.06	3.16
H15	*Juniperus virginiana*	0.37	1.52	2.61
H16	*Celtis laevigata*	0.34	1.48	11.80
H17	*Quercus macrocarpa*	0.12	0.26	7.95
H18	*Ulmus sp.*	0.21	0.35	10.45
H19	*Celtis occidentalis*	0.20	1.40	9.63
H20	*Quercus macrocarpa*	0.11	1.92	20.00

Table 2. Tree nearest to clump of honeysuckle id, distance from clump, and diameter. Also honeysuckle clump circumference.

Plot	Nearest Tree	Distance to Tree (m)	Tree Diameter (m)
R1	*Juglans nigra*	0.40	1.20
R2	*Juglans nigra*	0.10	1.28
R3	*Cercis canadensis*	0.71	2.00
R4	*Cercis canadensis*	0.55	2.93
R5	*Cercis canadensis*	1.13	2.52
R6	*Juglans nigra*	0.62	2.07
R7	*Fraxinus pennsylvanica*	0.90	1.01
R8	*Fraxinus pennsylvanica*	0.44	0.38
R9	*Carya illinoinensis*	0.92	1.33
R10	*Juniperus virginiana*	0.59	2.09
R11	*Carya illinoensis*	0.22	2.19
R12	*Cercis canadensis*	0.74	1.51
R13	*Celtis occidentalis*	0.36	2.56
R14	*Juglans nigra*	0.23	0.80
R15	*Juniperus virginiana*	0.28	1.53
R16	*Juglans nigra*	1.67	2.23
R17	*Quercus macrocarpa*	2.40	0.46

R18	*Juglans nigra*	0.32	3.45
R19	*Celtis occidentalis*	0.88	2.71
R20	*Morus alba*	0.46	2.53

Table 3. Tree nearest to clump of honeysuckle id, distance from clump, and diameter.

Coverage of Associated Species – Honeysuckle Plots

	H-1	**H-2**	**H-3**	**H-4**	**H-5**	**H-6**	**H-7**	**H-8**	**H-9**	**H-10**	**H-11**	**H-12**	**H-13**	**H-14**	**H-15**	**H-16**	**H-17**	**H-18**	**H-19**	**H-20**
Apiaceae sp.	0	0	0	0	0	1	0	0	2	0	1	3	0	1	3	1	0	1	2	1
Aster sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bidens bipinnata	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Brassicaceae sp.	0	0	0	0	0	0	0	0	0	0	0	3	3	0	3	2	0	1	1	1
Bromus sp.	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
Carex sp.	3	4	0	0	1	0	1	0	2	3	3	0	3	3	3	2	3	3	2	1
Carya illinoensis	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Carya illinoensis seedling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Celtis occidentalis	0	0	0	0	0	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0
Celtis occidentalis seedling	0	0	4	0	0	0	0	0	0	0	0	0	2	4	3	0	0	2	0	2
Cercis canadensis seedling	2	0	0	3	2	3	0	0	0	0	4	3	0	0	1	0	0	1	0	0
Elephantopus carolinianus	0	3	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Eupatorium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Geum canadense	1	0	2	0	0	0	0	0	0	2	3	0	0	1	1	2	1	1	0	2
Gallium sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0
Galium triflorium	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
Ivy cultivar-periwinkle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	4
Ligustrum vulgare	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Lonicera japonica	4	5	3	6	6	3	4	6	6	2	3	3	3	5	3	6	7	3	6	5
Morus rubra	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0

sapling																				
Opuntia humifusa	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Panicum sp.	0	3	0	0	0	0	0	0	0	1	0	0	3	0	1	0	0	3	0	0
Parthenocissus quinquefolia	0	0	0	0	1	2	0	0	0	0	0	0	0	0	2	0	0	0	1	0
Poaceae sp.	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polygonum sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Rhus copallina	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0
Rosa multiflora	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Smilax bona-nox	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	0	0
Smilax tamnoides var. hispida	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	3	0	2	0	0
Symphoricarpos orbiculatus	0	0	0	0	0	0	0	2	0	3	3	6	2	0	0	5	0	3	3	3
Tilia americana	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toxicodendron radicans	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Ulmus sp.	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vitis sp.	0	0	0	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0

Table 4. Associated species list for honeysuckle plots with Dobben Meyer Scale values.

Coverage of Associated Species – Random Plots																				
	R-1	**R-2**	**R-3**	**R-4**	**R-5**	**R-6**	**R-7**	**R-8**	**R-9**	**R-10**	**R-11**	**R-12**	**R-13**	**R-14**	**R-15**	**R-16**	**R-17**	**R-18**	**R-19**	**R-20**
Apiaceae sp.	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	2	0	2	1	2
Asplenium platyneuron	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Aster sp.	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Brassicaceae sp.	0	0	0	0	0	0	0	0	0	0	3	0	3	1	1	2	1	1	1	2
Bromus pubescense	0	0	4	0	5	0	0	0	0	0	0	0	0	3	3	3	0	0	0	0
Carex sp.	0	1	3	6	0	0	5	2	4	0	2	0	2	2	0	3	1	2	0	2
Carya illinoensis	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0
Celtis occidentalis	0	0	0	0	0	0	0	0	1	0	0	3	2	3	3	2	3	2	1	3
Celtis occidentalis	0	2	3	3	0	0	2	3	0	2	3	0	0	0	0	0	0	0	0	0

seedling																				
Cercis canadensis	0	0	0	0	1	3	2	0	0	0	0	0	0	0	0	3	0	3	0	2
Cercis canadensis seedling	1	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cirsium altissimum	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cornus foemila	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
Elephantopus carolinianus	0	2	3	3	0	0	0	2	0	0	0	0	0	0	0	3	0	0	2	1
Eupatorium sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	3	0	0	0
Geum canadense	4	3	1	1	0	0	2	0	0	0	3	1	0	3	0	4	0	0	0	2
Opuntia humifusa	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Panicum sp.	0	2	2	1	3	4	1	0	0	1	0	0	0	0	0	0	0	7	0	0
Parthenocissus quinquefolia	0	0	3	0	2	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0
Poa sp.	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	7	0
Polygonium virginianum	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	3	0	0	0	0
Smilax bona-nox	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
Smilax tamnoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Symphoricarpos orbiculatus	0	0	0	0	0	0	0	2	0	0	6	2	5	0	0	0	6	3	3	4
Ulmus sp. sapling	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
unknown w/ green fruit	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Vitis sp.	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0

Table 5. Associated species list for random plots with Dobben Meyer Scale values.

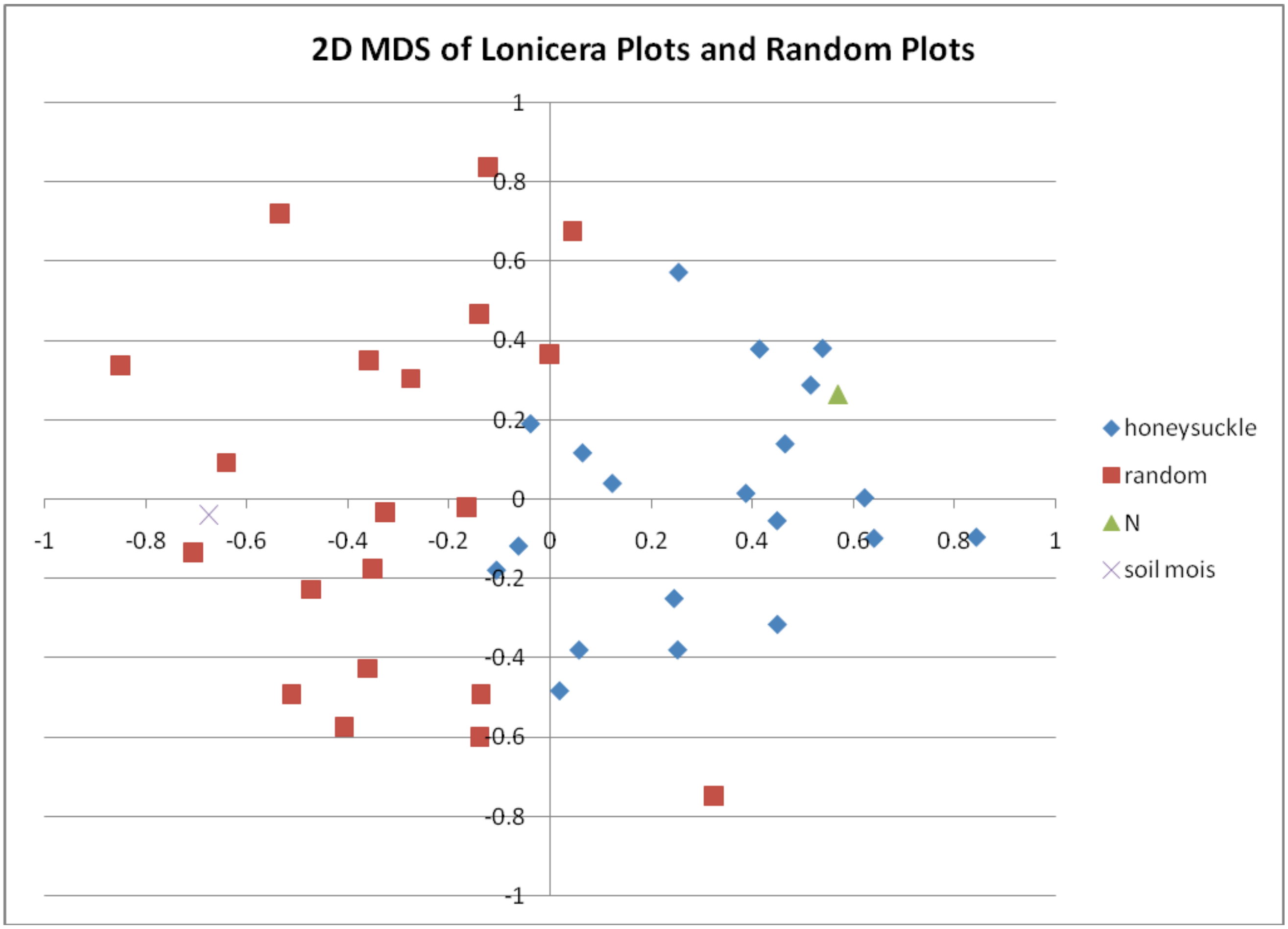

Figure 6. Nonmetric Multidimensional Scale Ordination graph.

NMDS	
2D Stress Value	0.264082
3D Stress Value	0.178669

Table 6. NMDS Stress Values.

Vector Fitting		
Variable	Correlation #	P Value
Tree Distance	0.2566	0.7536
Tree Diameter	0.4377	0.1821
Canopy Openness	0.2456	0.8058
pH	0.2141	0.8967
Nitrogen	0.6802	0.0109
Phosphorous	0.2786	0.7280
Soil Moisture	0.6058	0.0122
Clump Circumference	0.5995	0.2421

Table 7. Vector Fitting Correlation and P Values.