Hemlock Woolly Adelgid and the Effects on Forest Structure

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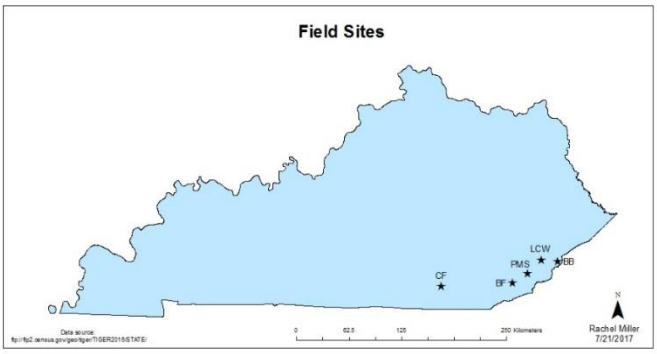
Introduction

The Eastern Hemlock (*Tsuga canadensis*) is a shade tolerant conifer that grows across much of eastern North America, including southeastern Kentucky. Hemlocks play a vital ecological role in which their profuse canopy provides a shaded habitat for numerous birds and small mammals, along with providing diverse forest structure (Brown & Weinkam, 2014). Hemlock Woolly Adelgid (*Adelges tsugae*, HWA) is an invasive pest native to Japan that was introduced into the U.S. through Virginia in the 1950's that reaps havoc on hemlocks of all ages and sizes (Orwig & Foster, 1998). Fortunately, treatment for the hemlocks includes the release of predatory beetles and soil absorption or trunk injection of imidacloprid, a systemic pesticide (Cowles, Montgomery, & Cheah, 2006). Research objectives included analysis on the impact HWA has on forest structure like canopy vigor, canopy gaps and increased understory vegetation. Along with looking for relationships between infestation and site characteristics. This research sought to determine if plots that have been treated will have a higher importance value when compared to untreated plots. Also, research was conducted to establish if untreated hemlocks will rank higher on the canopy vigor scale than treated hemlocks.

Field Sites

Data was collected in Hemlock Forests in the Appalachian Mountain region of southeastern Kentucky. The study areas included Lilley Cornett Woods, Cumberland Falls, Bad Branch Falls, Blanton Forest and Pine Mountain Settlement School. Many hemlock trees within these areas have been previously treated. A total of 32 plots were observed over the 10 week program.



Methods

Data was collected using standard forestry techniques. HWA infestation was ranked on a scale of 0 to 7 based on visible branches; 0 was no infestation, 7 was severe infestation. Topographic features such as elevation and landform were documented to analyze any developing patterns between landform characteristics and infestation. At each plot the diameter at breast height of all trees within the basal area were recorded, along with the canopy vigor of Eastern Hemlocks. Canopy vigor was based on an ocular scale of 1 to 5; 5 being dead. The average importance value was taken of treated and untreated hemlocks. Importance value is the sum of relative density and relative dominance of the species. The dominant vegetation at each strata was also noted.

Results & Discussion

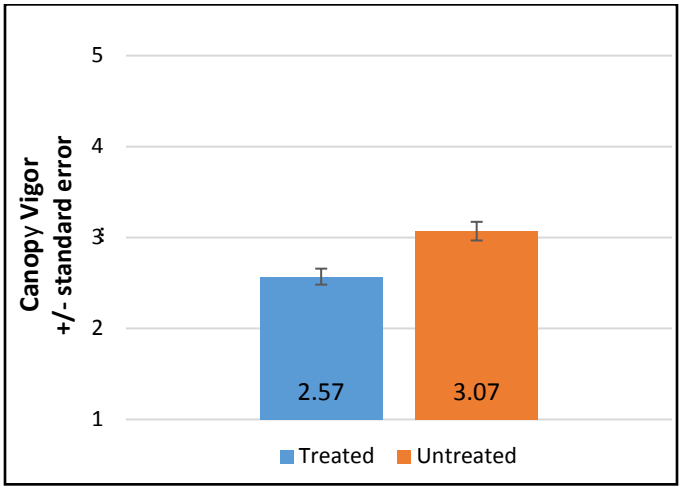


Figure 1. Average canopy vigor of treated vs untreated hemlocks.

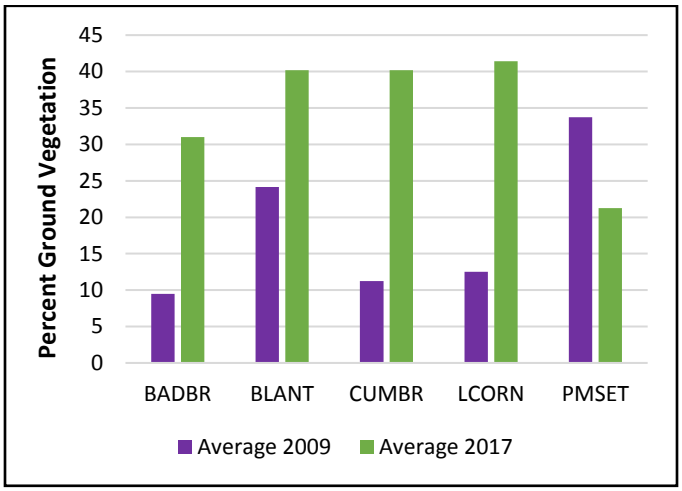


Figure 2. Average percent ground vegetation. PMSET experienced fire damage causing a decrease in ground vegetation.

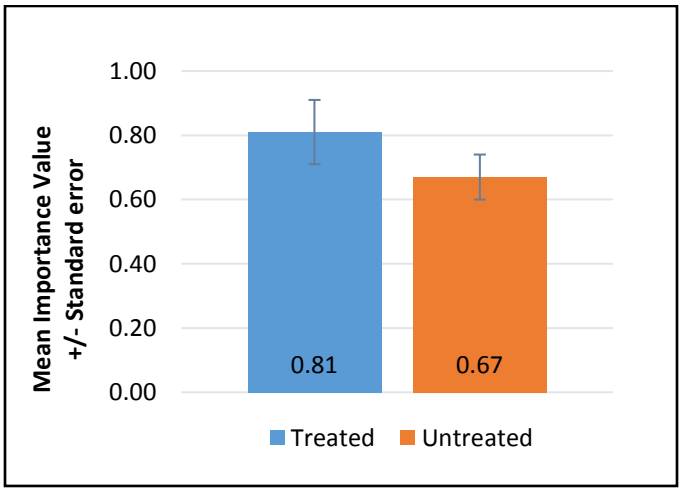


Figure 3. Average Importance value of Eastern Hemlocks.

The average canopy vigor of treated hemlock was lower than that of untreated hemlock ($t = 3.77$, $df = 255$, $p < 0.001$, **Figure 1**) confirming that the treated trees were healthier than the untreated, giving reason to believe that treatments have been successful. Other studies have shown that treatments control HWA and increase canopy health, in some cases up to seven years (Benton, et al., 2016). This pattern was consistent across each individual natural area observed. We found that the average ground cover vegetation percentage has increased compared to in previous years (**Figure 2**). This pattern has been found in previous studies along with suggesting that long term impacts may include change in stream habitat (Vose, Wear, Mayfield, & Nelson, 2013). This likely being caused by the increased light availability from increased light gaps in the over story canopy. In treated plots hemlocks appear to have a higher average importance value ($t = 1.20$, $df = 30$, $p = 0.12$, **Figure 3**), which agrees with our hypothesis. However, it is not a statistically significant difference. Previous studies have revealed that sites with more severe infestation had lower importance value compared to the other sites. With further observations and the expected continued decline of untreated hemlocks, this pattern should strengthen.

Conclusions

Overall, Hemlock Woolly Adelgid is threatening the health of hemlock forests in eastern North America. Previous literature has shown systemic pesticides to be the most effective method of treatment. Results suggest that treatment of imidacloprid should be continued however more research is needed to understand frequency and level of treatments to be most effective.

References

Benton, E. P., Grant, J., Webster, R. J., Cowles, R. S., Lagalante, A. F., Saxton, A. M., . . . Coots, C. I. (2016). *J. Econ. Entomol., 109*, 2125-2136.

Brown, D. R., & Weinkam, T. (2014). *Southeast Nat, 13*, 104-116.

Cowles, R. S., Montgomery, M. E., & Cheah, C. A.-J. (2006). *J Econ Entomol, 99*, 1258-1267.

Orwig, D. A., & Foster, D. R. (1998). *J Torrey Bot Soc, 125*, 60-73.

Vose, J. M., Wear, D. N., Mayfield, A. E., & Nelson, C. D. (2013). *Forest Ecol Manag*, 209-219.

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