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Rooted in Research

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Silvicultural Treatments May Reduce Impact of Hemlock Woolly Adelgid

Eastern hemlock (*Tsuga canadensis*) is a foundational species in forests across the eastern United States. Hemlock trees provide critical ecosystem services, such as shading for streams, regulation of water temperature, and wildlife habitat for many species. Hemlocks are also economically important for the forest products industry, especially for paper and pulpwood.

The invasive insect, hemlock woolly adelgid (HWA, *Adelges tsugae* Annand), has killed millions of hemlocks across the eastern United States and altered forest dynamics since it was first discovered in 1950. In response, forest managers have sought proactive silvicultural strategies to strengthen hemlock resilience before infestation occurs.

Researchers at the U.S. Department of Agriculture, Forest Service, published a new study on improving hemlock resilience. Mary Ann Fajvan (Northern Research Station) and Andrea Hille (Allegheny National Forest) studied how thinning hemlock stands might be used as a proactive strategy against HWA establishment and spread by improving tree vigor and increasing light availability.

Study Overview

The researchers initiated a long-term study in 2005 on the Allegheny National Forest in Pennsylvania to determine whether thinning hemlock forests can improve individual hemlock tree health and growth. Specifically, they studied whether thinning could improve crown health, which they measured through changes in diameter growth, live crown ratio, and crown area.

The study comprised three mixed hemlock-hardwood stands with high hemlock densities. Half of each plot received thinning treatments. The other half served as a control (no thinning). Thinning treatments targeted trees for crown release by removing competing tree species on three to four sides.

Fajvan and Hille measured 96 hemlocks within each thinned plot and 90 hemlock trees in untreated plots. They took measurements of diameter, total height, live crown ratio, and crown area before treatment and at years 5 and 10.

PUBLIC BENEFITS

Silvicultural treatments for hemlock woolly adelgid (HWA, *Adelges tsugae* Annand) improve hemlock growth and vigor, leading to increased economic viability of stands for forest products, such as paper and pulpwood. The ecosystem services associated with healthy hemlock forests support recreational experiences including fishing, hiking, and birdwatching.

Subject tree crown after thinning where crown was released on three sides in the Allegheny National Forest. USDA Forest Service photo by Mary Ann Fajvan.

Thinning Trees for Resilience

The authors reported three primary findings:

- Diameter changes—After 10 years, trees in thinned plots were, on average, about 5 centimeters larger in diameter at breast height (DBH) than those in the control plots. Although the diameter changes were not statistically significant between thinned and control plots, the finding suggests that thinning can enhance hemlock growth rates.
- Live crown ratio—After 5 years, live crown ratio was maintained in thinned stands and decreased significantly in control plots. Higher live crown ratio has been correlated with increased resistance to HWA, suggesting that maintaining live crown ratio through thinning could contribute to hemlock resilience.
- Crown area—Crown area increased significantly in thinned plots and decreased in control plots. A larger crown can improve a tree's ability to tolerate stresses, including insect infestations.

While recognizing more research is needed to fully understand the effects of thinning on HWA populations, the study found that preemptive thinning in hemlock stands may be a viable strategy to enhance hemlock resilience prior to HWA infestation. This information can be part of a strategy for forest managers to prepare for the arrival of HWA.

Subject tree showing where competing trees were removed (stumps) to release the tree's crown. USDA Forest Service photo by Mary Ann Fajvan.

KEY FINDINGS

- Eastern hemlock forests are increasingly threatened by the hemlock woolly adelgid (HWA), an invasive insect that has decimated hemlock stands across the eastern United States.
- Using silvicultural thinning to increase canopy light exposure improved hemlock health, growth, and crown area over 10 years compared to untreated stands.
- In thinned stands, diameter growth averaged 5 cm larger after 10 years, demonstrating silvicultural thinning's potential role in reducing competition for resources like light, water, and nutrients.
- Although HWA was not present in monitored stands, thinning resulted in healthier crowns and improved tree vigor, which may reduce future HWA impacts.

Thinning in study plots allows more light to reach subject tree crowns and enhance growth in the Allegheny National Forest. USDA Forest Service photo by Mary Ann Fajvan.

FURTHER READING

Fajvan, M.A.; Hille, A. 2023. Integrating silviculture with hemlock woolly adelgid mitigation: crown dynamics of *Tsuga canadensis* (L.) Carrière 10 years after thinning. Canadian Journal of Forest Research. 53: 922–930. https://doi.org/10.1139/cjfr-2022-0251.

Ford Miniat, C., Zietlow, D.R., Brantley, S.T., Brown, C.L., Mayfield, A.E., Jetton, R.M., et al. 2020. Physiological responses of eastern hemlock (*Tsuga canadensis*) to light, adelgid infestation, and biological control: implications for hemlock restoration. Forest Ecology and Management. 460: 1–12.

PROJECT LEADS

Mary Ann Fajvan is an emeritus research forester with the USDA Forest Service Northern Research Station.

Forest Service Research and Development works with partners to deliver the knowledge and tools that land managers need to sustain the health, diversity, and productivity of our Nation's forests and grasslands for present and future generations. The Northern Research Station (NRS), one of seven FS R&D units, is rooted in the geography of the Northeast and Midwest. NRS science supports a sustainable future.

For questions on Rooted in Research, please contact Andrea Brandon-Hennig. Technical editing by Carol Hollar-Zwick. Design and layout by Jeremy Siegrist.

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