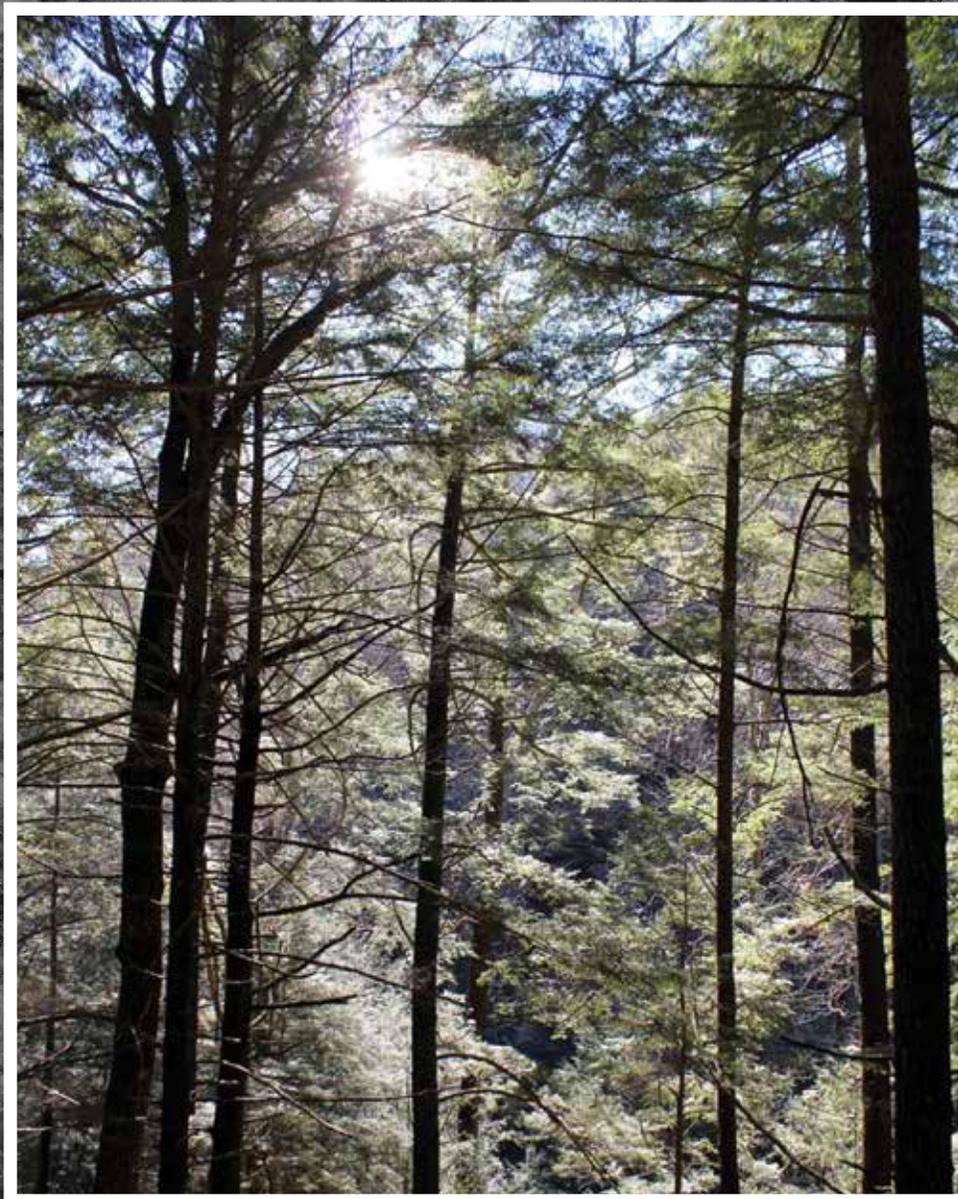


Hemlock Woolly Adelgid: Managing a Nonnative Invasive Pest in Ohio



THE OHIO STATE UNIVERSITY

COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES

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Ohio's Hemlock Forests

Ohio's eastern hemlocks (*Tsuga canadensis*, termed hereafter hemlock) most commonly occur in moist, cool ravines, where they can live hundreds of years. Tree heights can exceed 100 feet, and trunks can measure several feet in diameter. While it is a minor economic species as far as volume and area in the state (approximately 12,000 acres), its ecological, economic, and social values in localized areas can be quite significant. On the Appalachian Plateau in southern and eastern Ohio, hemlock is considered a foundation species in the forest ecosystems where it occurs. For instance, in Hocking County, hemlock is found on an estimated 6,100 acres and occupies approximately 3% of the forest area. Where dominant, hemlock stands serve a unique and key role in regulating ecosystem structure and function. These stands also provide habitat for nearly 100 bird species. Dense shade produced by hemlock trees moderates water temperatures. This water provides critical habitats for many aquatic species. Hemlock-dominated ecosystems often create abundant recreational opportunities. Visitors attracted to these areas provide economic support to nearby communities.

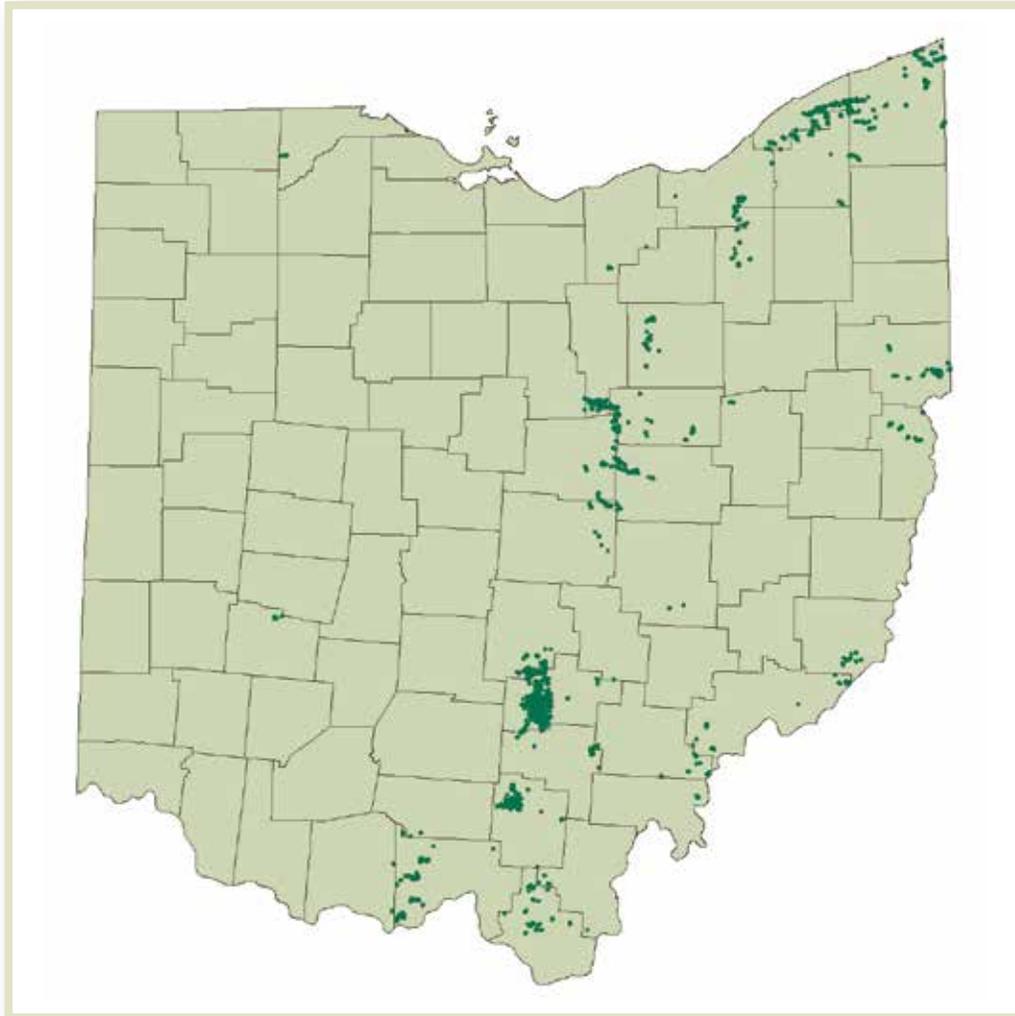


Figure 1. Hemlock stands in Ohio are primarily located in eastern Ohio (map developed by Nicole Stump, formerly of Ohio University).

Hemlock Woolly Adelgid Threatens Our Native Hemlocks

Hemlock woolly adelgid (HWA, *Adeleges tsugae*) is an aphid-like insect native to East Asia, where it has caused little damage to Asian hemlock species. In the early 1950s, HWA was inadvertently introduced into the eastern United States from Japan. In the eastern United States, native hemlock species lack resistance to HWA and HWA has few natural enemies. HWA's feeding exclusively on eastern and Carolina (*T. caroliniana*) hemlock in the Appalachians has resulted in significant mortality throughout much of their native ranges.

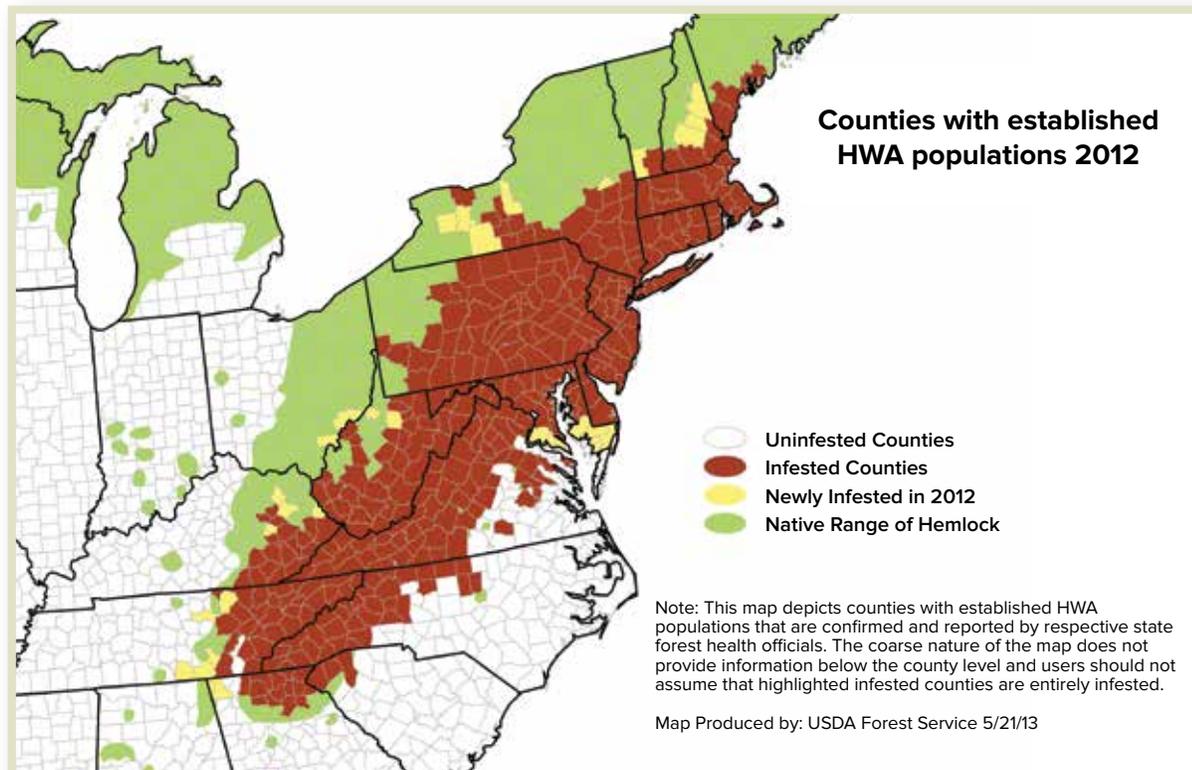


Figure 2. The native ranges of hemlock and the extent of HWA infestation, which as of May 2013 included 19 states (source: U.S. Forest Service).

How Does HWA Inflict Damage?

HWA uses its needle-like stylet to pierce the base of hemlock needles, where it feeds on the energy reserves of its host. HWA population levels climb exponentially because of its ability to reproduce asexually during its two annual generations. At peak levels, up to two or more adelgids can be found on every hemlock needle. A visual cue of HWA infestation is the cotton ball-like ovisac present at needle bases (Figure 4).

Stress from the depletion of nutrients initially results in needle loss and ultimately leads to tree mortality. Time from infestation to tree death is contingent upon the HWA population growth rate and the initial health of the forest, which in turn are dependent on local site and growing conditions (e.g., soil type, seasonal weather patterns, etc.). Studies have documented a time range of two years to more than six years for mortality to occur.

Research has shown that significant changes occur in forest ecosystems following hemlock mortality. Canopy openings and increases in downed woody debris in streams have resulted in higher water temperatures and altered aquatic habitats. Hemlock-dependent wildlife species, such as the black-throated Green and Blackburnian Warblers, have been adversely affected.



Figure 5. Dead hemlock trees that were killed by HWA in western North Carolina.

Three natural areas in Ohio, the Hocking Hills Region, Mohican-Memorial State Forest and State Park, and Lake Katharine State Nature Preserve, are well known for their hemlock-dominated forests. The many recreational opportunities these areas provide generate considerable economic benefits via the direct activities of visitors along with the multiplier effects produced by indirect and induced spending. The possible loss of tourism dollars resulting from hemlock mortality has the potential to negatively influence hundreds of other sectors in the regional economy (e.g., Hocking Hills Region, Figure 6).

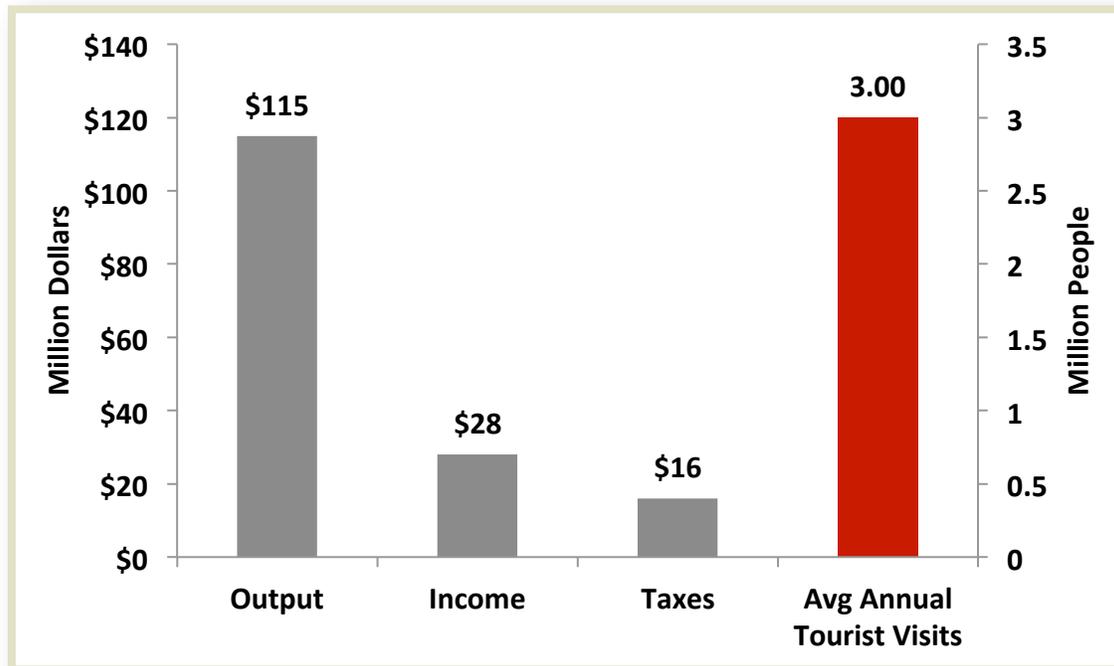


Figure 6. Estimated economic contributions of tourism to the Hocking Hills Region in 2011 (sources: Hocking Hills Tourism Association and Tourism Economics, Inc.).

How Does HWA Expand its Range? What Happens After an HWA Infestation?

In the southern portion of the HWA-impacted region, the insect has spread approximately 15 to 20 miles per year. Other studies indicate a lower rate of dispersal (8 miles per year) as it moves north, since colder temperatures will possibly limit its movement. Wind, birds, animals, and the accidental movement by humans contribute to its spread.

Hemlock regeneration is significantly reduced following mortality from HWA, while regeneration of other species, such as oak, maple, and birch, were found to have increased. Moreover, an influx of nonnative invasive species often occurs following severe canopy disturbance, affecting long-term future forest productivity and ecosystem function.

Current Situation in Ohio

HWA was initially found in Shade River State Forest in Meigs County, followed shortly thereafter by finds in the communities of Marietta and Belpre in Washington County in 2012. In 2013, a 60-tree infestation, which covered about one acre, was identified at Cantwell Cliffs within Hocking Hills State Park. Detection of this tiny (1mm) insect is extremely difficult, thus the insect continues to expand its range into additional Ohio counties. As of June 2014, three small infestations had been confirmed. These infestations were located in Vinton County at Zaleski State Forest, followed by Lawrence County at the Dean State Forest, and then Monroe County in a single landscape tree.

What is Being Done to Combat HWA?

Since HWA was confirmed in Ohio, joint efforts among multiple agencies, organizations, and Ohio State University (OSU) Extension have taken place to survey a number of locations throughout the state. OSU Extension's contributions to addressing HWA in the Hocking Hills and Ohio thus far have included:

- Collaborating on an intensive effort to inspect 350 acres of hemlock stands on Ohio State Forest and Park lands near Cantwell Cliffs to delineate the extent of the infestation.
- Assisting with the mapping of infested trees with global positioning systems (GPS) and geographic information systems (GIS). The infested area was determined to encompass approximately 1 acre with 55 HWA-positive trees.
- Co-developing and offering multiple training opportunities, focusing on hemlock inventory and HWA survey methods for property managers, natural resources professionals, camp directors, and Hocking College students.
- Assisting in collecting predator beetles (*Laricobius nigrinus*) in North Carolina and establishing them in infested hemlock landscapes in Washington County. These sites will be utilized to rear beetles for future use in Ohio's hemlock stands. Establishing HWA predators is seen as the sustainable landscape solution to this problem.
- Providing support to the Ohio Department of Natural Resources (ODNR) in the formulation of a plan to address HWA at Cantwell Cliffs.
- Assisting with the chemical treatment of more than 500 hemlock trees in and around the infested area at Cantwell Cliffs.

This is a rapidly emerging issue for the tourism industry and will greatly impact ecosystems unique to Ohio, particularly within the state's Hocking Hills Region. OSU Extension intends to continue its work with ODNR, the Ohio Department of Agriculture, the Hocking Hills Conservation Association, and other partners to:

- Develop educational programs and materials for a variety of audiences, including the general public, the tourism industry, woodland owners, and natural resources managers.
- Enhance early detection and rapid response capabilities.
- Inventory hemlock stands in the region and use the data to formulate future plans of action.
- Seek external funding sources for outreach and research on tourism impacts, biological control, and chemical control treatments.
- Continue to establish HWA predator beetle populations in Ohio for further use in hemlock stands.
- Expand these efforts to other areas of the state with hemlock populations.



Figure 7. Injection of insecticide for HWA control.



Figure 8. Predator beetles (*Laricobius nigrinus*) on HWA-infested needles ready for release.

What Can You Do to Help?

First and foremost, be alert! Examine your hemlock trees regularly for HWA. Remember, early detection is key! If you desire to plant hemlock, ensure your potential nursery stock is not from an Ohio Department of Agriculture regulated area. Also, perform an inspection prior to planting, looking for any unusual characteristics. Be aware of the potential for HWA to be present when visiting recreational areas where hemlock is located, particularly from March to June when HWA crawlers are most active. Travelling from infested areas to other hemlock stands could inadvertently contribute to HWA's spread. Additionally, avoid placing bird feeders on or near hemlock trees.

Should you discover your hemlock trees have HWA, immediately contact the Ohio Department of Agriculture for verification. Treatment options are available for infested trees, but a great deal of research on these choices is still ongoing. **Chemical control is not recommended as a preventative measure.** HWA is a slow killer and can be controlled if detected before trees become heavily infested and begin to decline. Verifying HWA's presence prior to chemical treatment also minimizes the use of pesticides, which could potentially damage unintended targets. You can, though, help to maintain the health of your landscape trees by mulching and watering during periods of drought and/or fertilizing if soil analysis indicates nutrient deficiencies. Infested trees should not be fertilized with nitrogen.

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