



Above: Hemlock Woolly Adelgid crawler by Kelly Oten, North Carolina Forest Service, Bugwood.org

### Hemlock Woolly Adelgid (HWA)

The biggest concern regarding eastern hemlock is the hemlock woolly adelgid (HWA). Adelgids are soft bodied aphid-like insects that feed by sucking sap from trees. The hemlock woolly adelgid is an introduced pest from Asia, and has few predators in America. Hemlocks and woolly adelgids native to Asia coevolved over thousands of years. This provides the hemlocks in Asia with a biological tolerance to HWA. Hemlocks in eastern North America have not had the opportunity to develop these biological tolerances and therefore succumb to infestation. Hemlock woolly adelgids suck sap from the base of hemlock needles

robbing the trees of the carbohydrates they need to sustain growth. Over a relatively short period of time, an eastern hemlock tree can die from a HWA infestation.



Above: Hemlock Woolly Adelgid, Pennsylvania Department of Conservation and Natural Resources - Forestry Archive, Bugwood.org

Hemlock woolly adelgid can be found in most of the range of eastern hemlock, and it has been extremely destructive to hemlocks in eastern North America. When HWA populations are high enough, entire stands of hemlock can be decimated within four to five years. With the loss of hemlock, these stands will change considerably and become dominated by hardwoods commonly found in the area.

Hocking State Forest and Hocking Hills State Park contain some of the most majestic eastern hemlock stands in the state of Ohio. HWA was first observed in the Cantwell Cliffs area in 2013. Efforts to eradicate it from the state park were undertaken by the Ohio Department of Natural Resources Division of Forestry and Division of Parks and Recreation, the Ohio Department of Agriculture and The Ohio State University Extension personnel in 2013, but HWA was found again in 2014 at the Cantwell Cliffs outside the 2013 treatment area. The 2014 area at Cantwell Cliffs was treated in April 2014. HWA remains the biggest threat to our hemlock stands in the Hocking Hills region.



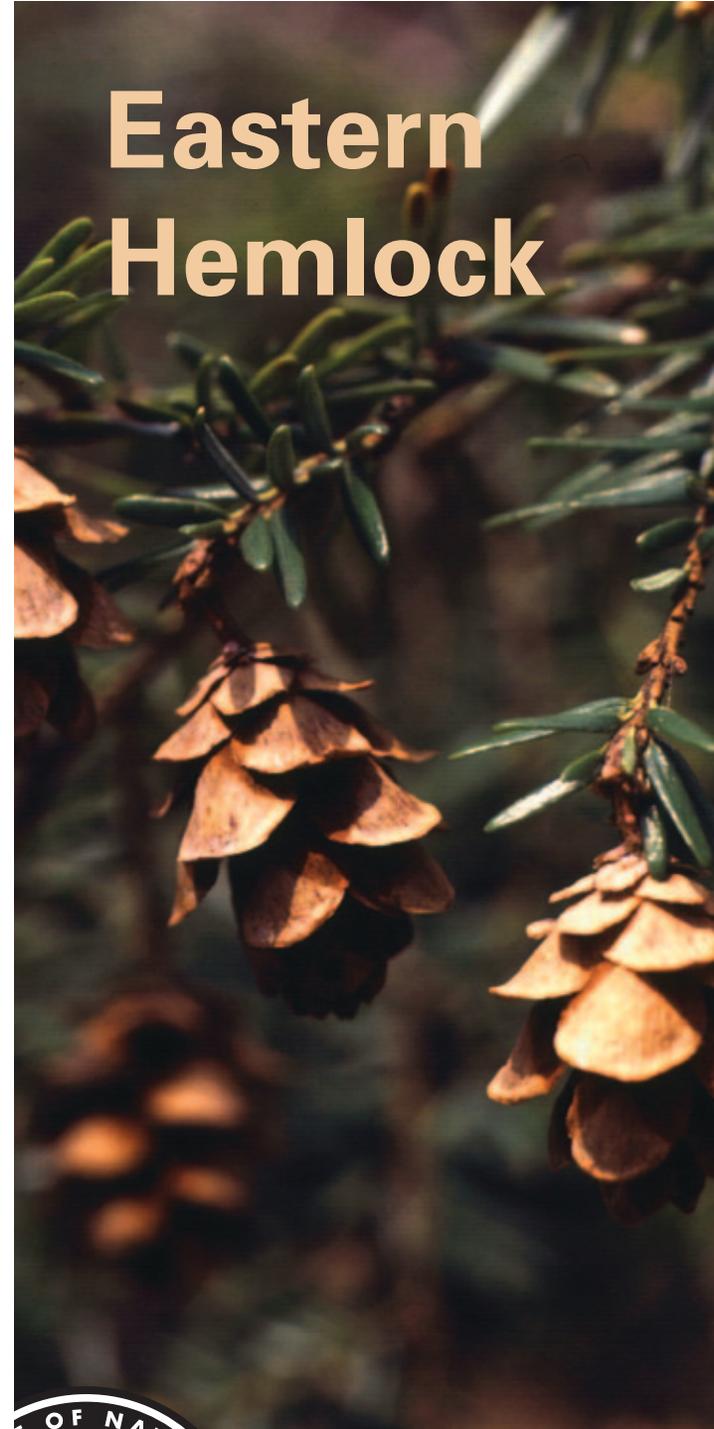
HWA has also been found and treated at Shade River State Forest in 2012 and Zaleski State Forest in 2014. Additionally, in 2014, HWA has been found and will be treated at Dean State Forest.

Biocontrol beetles that feed on the adelgids have been released at several locations in Southern Ohio. The purpose of this is to build a population of predators for a natural form of control. Any sightings of HWA should be reported to the ODNR Division of Forestry or the Ohio Department of Agriculture.



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# Eastern Hemlock



Ohio Department of  
**NATURAL RESOURCES**  
**DIVISION OF FORESTRY**



Eastern hemlock (*Tsuga canadensis*), also known as spruce hemlock and Canada hemlock, is found extensively in much of the eastern United States and Canada. In Ohio, its natural range is confined to the eastern portion of the state, but it is planted as an ornamental statewide. It is one of the most shade tolerant trees and can survive with as little as five percent sunlight. In Ohio's forests, eastern hemlock can live for more than 300 years suppressed in the understory by overtopping vegetation, and respond to release from this shade with renewed vigor. Hemlock has been known to live in excess of 800 years under ideal conditions, and 300 to 400 year-old stands of hemlock are not uncommon.

Hemlock can survive on a variety of sites and soils. It grows best on moist, well-drained sites with an acidic soil. The conditions under a hemlock forest are cooler than under adjacent stands of hardwoods. The acidic nature of the soil, leaf litter and cooler conditions benefit water quality and a variety of wildlife species, some of which do not occur anywhere else in nature. Many of the organisms living within this unique ecosystem would cease to exist without the deep shade created by the hemlock over story.

Management techniques for the maintenance, perpetuation and regeneration of hemlock should be confined to uneven-aged silvicultural practices. Single tree selection to create small openings would remove inferior, diseased or dying trees allowing for understory hemlock to work its way into the forest canopy and the increased growth

of superior hemlock stems. Excessive release of hemlock trees can contribute to ring shake and should be avoided. Even-aged management such as clear-cutting and large group openings should also be avoided, as they are likely to result in the regeneration of hardwood species that could out-compete the hemlock regeneration.



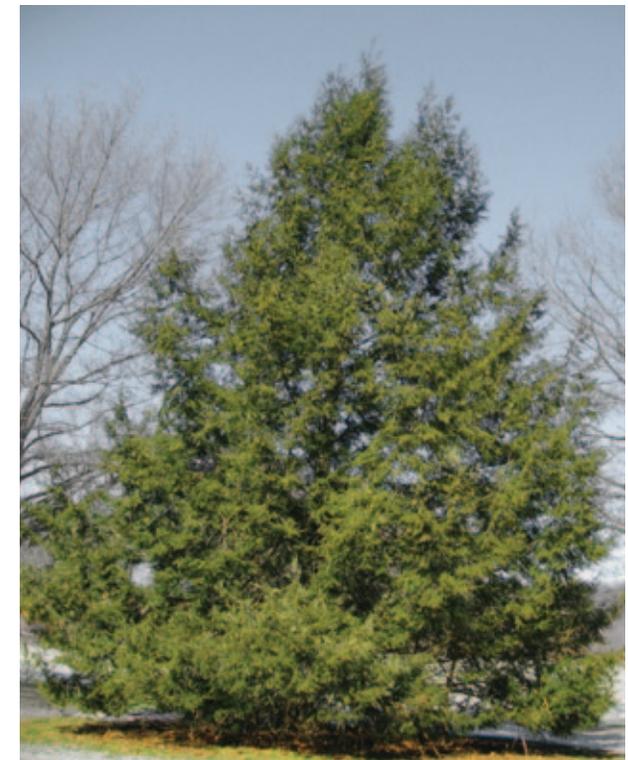
Eastern hemlock wood has been used for construction, framing, crates, pallets, paper pulp and many other uses. The wood is somewhat brittle, but relatively light and strong with good nail-holding ability. Many old barn and covered bridge timbers were made from hemlock in parts of Ohio where hemlock was abundant. Since hemlock has a low resin and oil content, it paints and stains well. At one time it was used to make faux mahogany furniture as it could be stained to look somewhat similar. Historically, the bark was used extensively in the leather tanning industry because of its high tannin content.

One of the biggest drawbacks to the use of hemlock for lumber is the tendency to develop ring shake. The causes of ring shake in hemlock are yellow bellied sapsucker damage or other injury, such as root damage from livestock grazing, changes in growth rates such as sudden release from competing vegetation and exposure to wind. These factors combine to create internal stresses and eventual separation of wood along the annual

growth rings. While ring shake is more readily observed in dry lumber, it is not a product of the drying process.

Hemlock can be found in Ohio in pure stands or mixed with white pine or hardwoods. Some of the more common hardwood species found in combination with hemlock in Ohio are black cherry, yellow-poplar, cucumbertree, black birch, basswood, and a variety of maple, oak and ash species as major and minor components. Some of the pure hemlock stands are naturally occurring, and some are a result of the loss of American chestnut in the early 1930s. Where chestnut was a minor component, the hemlock in the understory was able to find its way to the forest canopy creating nearly pure hemlock stands. In situations where hemlock was a minor component and chestnut was a major component, hardwoods likely out-competed the understory hemlock creating mixed stands of oak, hickory and hemlock.

*Below: Eastern Hemlock by Richard Webb, horticulturist, Bugwood.org*



# HEMLOCK TREE COOKIE

This tree cookie was cut from a majestic eastern hemlock that stopped growing in 2006 and died shortly thereafter. The tree was felled in 2011 for safety reasons as it was standing dead along the trail to Cedar Falls in the highly popular Old Man's Cave area of Hocking Hills State Park. Studying the annual growth rings shows that environmental forces altered the growth of the tree and caused a number of injuries. The tree lived at least 288 years, during which time droughts, wars, blights and floods took place.

## 1 1718: Eastern Hemlock is Two Feet Tall

In 1718, this tree was two feet tall and probably took about three years to reach that height. Most likely it germinated in spring 1715. Due to the shade tolerance of eastern hemlock, the year of seed germination may have been earlier.

## 2 1776: American Revolution

English colonists in America declared their independence from England. This declaration precipitated the American Revolution and the birth of a great nation.

## 3 1803: Ohio Becomes a State

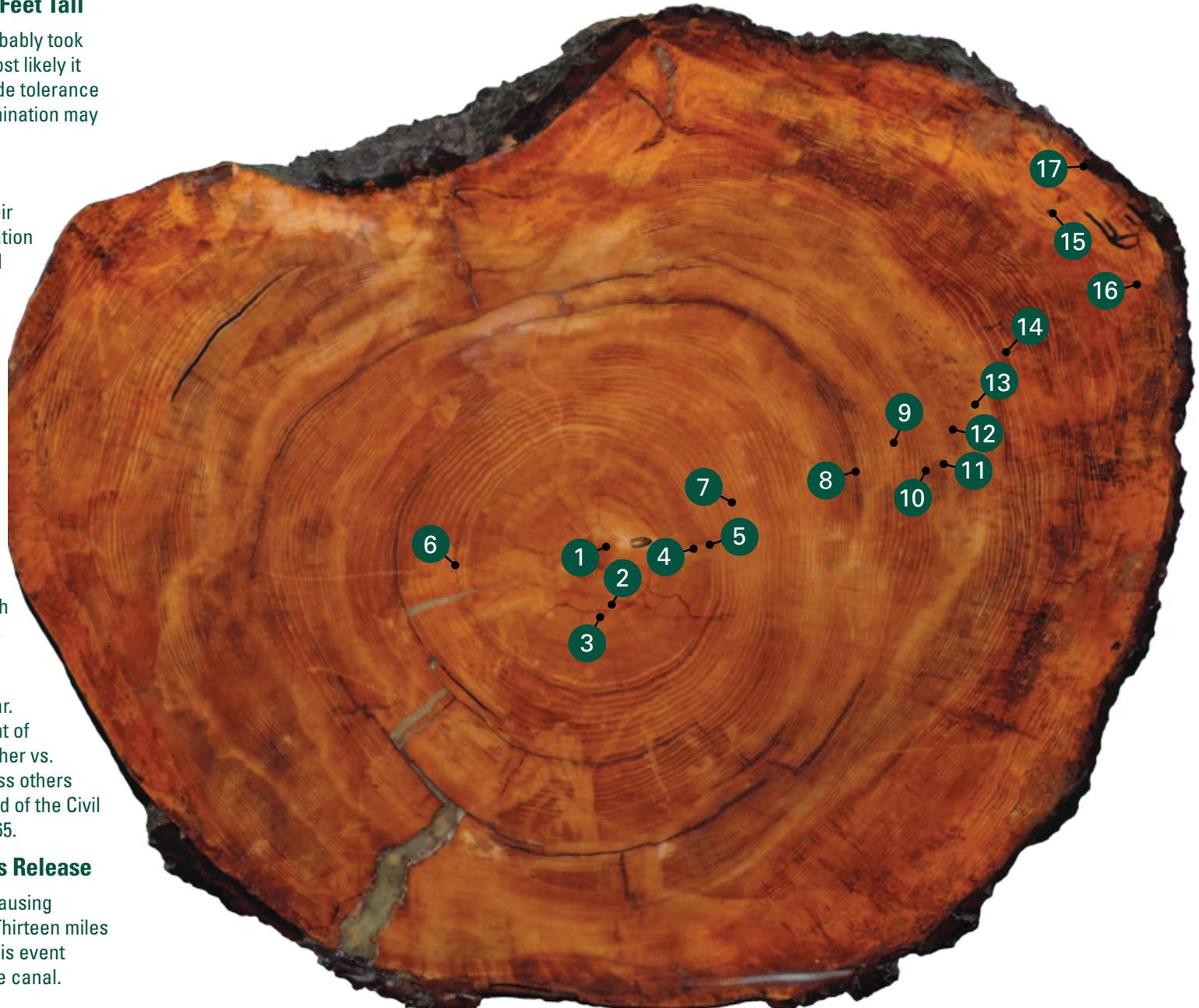
The Iroquois word ohi-yo means "big river." Ohio was originally part of the Northwest Territory and was the first state to be admitted to the United States under the Northwest Ordinance. The official date was March 1, 1803, making Ohio the 17th state in the Union.

## 4 1861: The Civil War Begins

Ohio contributed soldiers to the Union Army, including General William Tecumseh Sherman from Lancaster, Ohio. Sherman's march through Georgia and to the South Carolina coast redefined modern warfare and brought a hasty end to the divisive war. Nearly 700,000 Americans (about 2 percent of the population) lost their lives in the "Brother vs. Brother War of the States," while countless others were wounded and maimed before the end of the Civil War at Appomattox, Virginia in April of 1865.

## 5 1873: Major Storm Event Allows Release

A storm moved through Hocking County causing widespread flooding and storm damage. Thirteen miles of the Hocking Canal were destroyed in this event marking the beginning of the demise of the canal.



(This information supplied by Judy Miniskas, Hocking County Historian.) This storm event likely damaged taller trees around the hemlock, as by 1875, the hemlock was growing at a markedly increased rate. When a tree is “released,” it often takes a year or two to enlarge its crown and root system to efficiently utilize the increased sunlight. (The potential of this effect confirmed by Greg Wiles, PhD, dendrochronologist at the College of Wooster.)

## 6 1877: Ring Shake

A high percentage of eastern hemlock have ring shake. This feature has been studied extensively. (See “Ring Shake in Eastern Hemlock: Frequency and Relationship to Tree Attributes” by Baumgras et al.) Ring shake is caused by internal stresses from damage repair (compartmentalization) and an abrupt change in growth rate. The 1873 storm that released the tree likely caused some damage such as broken limbs. This, combined with the marked change in growth rate, caused the ring shake in the 1877 growth ring.

## 7 1882: First American Forest Congress

Forested lands in America were being developed and converted to agriculture at a rapid pace in the latter part of the 19th century. Ohio forests were heavily cut for charcoal used in the production of iron. John Warder, a medical doctor, and other conservationists, concerned about the demise of the forests of the Midwest, created the American Forestry Association (AFA) in 1875. Seven years later the AFA merged with the American Forest Congress. The first American Forest Congress was held in Cincinnati, Ohio, in April 1882. There was one trained forester in attendance, Prussian-born Bernhard Fernow, who promoted forest management. There were few forest landowners in attendance, but the seed for forest management in the United States was planted at this meeting. Fernow is known as the “father of forestry” in the United States and held various forestry positions including being the third chief of the USDA Division of Forestry (now USDA Forest Service) and dean of the New York College of Forestry at Cornell.

## 8 1909: Ring Shake

Ring shake is generally associated with damage to the tree and a change in the growth rate. The damage was likely caused by a yellow bellied sapsucker. Dr. Alex

Shigo, former chief scientist of the USFS, found ring shake in all 25 hemlock trees he studied that showed sapsucker scars. (Shigo, A. L., 1963, “Ring Shake Associated with Sapsucker Injury.”) The moderate increase in the growth rate was likely caused by the loss of a somewhat nearby tree that was a weak competitor. This is part of the natural process of stand dynamics. This release was not as radical as the release associated with the 1877 ring shake.

## 9 1917: United States Enters World War I

To help prepare soldiers for the battlefield, the U.S. Army established Camp Sherman in Chillicothe. Named after the famous Civil War general from Lancaster, Camp Sherman turned out fighting men for the war effort. One of the heavy artillery grounds used by the soldiers was in the hills to the south of Camp Sherman in what is now Scioto Trail State Forest, where hemlock stands can be found.

## 10 1925: Department of Forestry Land Purchase

The land on which the hemlock tree grew changed hands several times. James R. Glass bought the land in 1866 from a man named John Oaks, and Glass was the owner of record during the 1873 flood. Glass subsequently sold the property to Elmer and Blanche Pettit. The Department of Forestry, which was part of The Ohio State University at the Agricultural Experiment Station in Wooster, bought the land from H. O. Pettit, heir to Elmer and Blanche, in 1925.

## 11 1930: Drought Years

The 1936 drought ring is also observable, but not marked. Drought years are easy to locate on a tree cookie, and are used to validate other chronological information. (Drought year information was supplied by dendrochronologists Todd Hutchinson, PhD, and Tim Fox of the USDA Forest Service.)

## 12 1933: Chestnut Blight Release

Introduced to the United States around 1900, the chestnut blight (*Cryphonectria parasitica*) moved across Hocking County during 1932 and 1933. (Information supplied by Brian McCarthy, PhD, Ohio University.) By the end of 1933, American chestnut (*Castanea dentata*) was wiped out in Hocking County. Although it took a while for the hemlock to recover from the droughts of 1930 and 1936, a noticeable increase in growth a few years later is likely the result of the death of a nearby American chestnut tree. The chestnut blight significantly changed forest stand dynamics. Shade intolerant oaks became

established when large openings were created from the death of multiple chestnut trees that allowed adequate sunlight to reach the forest floor. When a single chestnut tree died, shade tolerant trees, like maple and eastern hemlock, became established because smaller openings allow less sunlight to reach the forest floor.

## 13 1941: United States Enters World War II

Approximately 839,000 Ohioans, or 12 percent of the state’s entire population in 1940, served in the armed forces during the war. Of these men and women, 23,000 of them died or were missing in action by the war’s conclusion. Ohio civilians also actively participated in the war effort, joining in scrap drives and growing victory gardens. Tens of thousands of people moved to Ohio seeking jobs in defense industries.

## 14 1955: American Involvement in Vietnam Begins

American involvement in the Vietnam conflict began on November 1, 1955, and ended on April 30, 1975.

## 15 1994: Wood Boring Insect Damage

A wood boring insect bored into the hemlock tree all the way to the 1994 annual ring. It appears that this wood borer attacked the tree in 2006 or later, after the tree was dead. The tunnels can be seen and followed from its entry and/or exit points in this cross section. It is uncertain which boring insect this is - as many feed on dead trees. It is not likely to be a hemlock borer, which feeds in the inner bark area (cambium) and does not bore this deeply.

## 16 1999: Drought Year

The 1988 and 1984 drought years are also observable, but not marked. Drought years are commonly used by dendrochronologists as confidence markers. (Drought year information supplied by Hutchinson and Fox.)

## 17 2006: The End

This eastern hemlock ceased growing in 2006 and died shortly thereafter. Trees can continue to live for a short while without producing noticeable annual growth rings so the exact year of death is possibly a year or two later. (The potential for this was verified by Greg Wiles, PhD, College of Wooster.) By 2011, the tree was dead and deteriorating, creating a potential hazard to trail users near Cedar Falls.