

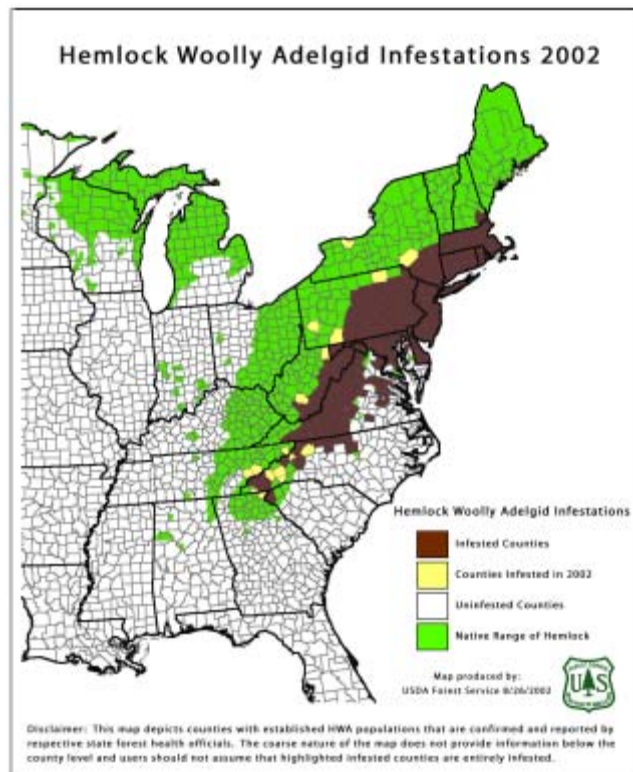


FHTET
Forest Health Technology Enterprise Team

HEMLOCK WOOLLY ADELGID BIOLOGICAL CONTROL

PROVIDING TECHNOLOGY FOR FOREST HEALTH PROTECTION

The hemlock woolly adelgid (HWA) (*Adelges tsugae* Annand) is native to Japan and China (see micrograph of a nymph, and white ovisacs). It was first observed in the eastern United States around 1950 feeding on hemlock in Virginia. In the eastern U.S., HWA attacks two species of hemlock: eastern hemlock, *Tsuga canadensis* (L.) Carr., and Carolina hemlock, *Tsuga caroliniana* Engelm. The geographic range of eastern hemlock extends from the Canadian Maritimes, west to the Lake States, and as far South as northern Georgia and Alabama (see figure below).



Carolina hemlock is a rare species with isolated pockets in Virginia, North Carolina, South Carolina, and Georgia. Hemlock dominated forests encompass approximately 2.3 million acres in the eastern U.S. In the urban environment, hemlocks are one of the most common backyard species planted by homeowners. Currently, HWA occupies a small part of eastern hemlock's natural range (see left figure). However, during the past decade, it has steadily spread north and west at a rate of about 20-30 km each year and its population levels have increased dramatically. It is now a serious threat to survival of hemlock in eastern forests. Wind, birds, deer, and humans help spread HWA throughout the Northeast. Because HWA is adapted to high elevations in Japan where winter temperatures commonly drop below -35°C (-31°F), it should continue to spread in eastern North America until it occupies the entire range of eastern hemlock.

Damage

HWA is a destructive pest of forest and ornamental hemlock trees in the eastern United States. Feeding by HWA causes the needles on infested branches to desiccate, turn a grayish-green color, and then drop from the tree. Little, if any new growth is produced on heavily infested branches, and most buds are also killed. Dieback of major limbs can occur within two years and typically progresses from the bottom of the tree upward. Trees may die within four years, but some survive longer with only a sparse amount of foliage at the very top of the crown.

Key Issues

- Impacts from HWA are expected to intensify and spread throughout the range of eastern and Carolina hemlocks.
- Hemlock is an ecologically important species and, in many habitats, irreplaceable.
- Since all age classes of hemlock are vulnerable, HWA poses a significant threat to hemlock health, including the reestablishment of hemlock stands.
- There are no practical means available to manage HWA in urban and forest situations and long-range management strategies are needed.

Biological Control

In Japan, where HWA is native, it is a common but innocuous inhabitant of forest and ornamental hemlock and spruce. Japanese hemlocks are not significantly injured because of host resistance and natural enemies. In the United States, there are only a few native predators attacking HWA. This complex of native predators has not controlled HWA populations. For this reason, efforts since 1996 have focused primarily on the development of a multi-agency biological control program as a means to lessen the destruction of HWA in the eastern United States. Both Japan and China have been explored for natural enemies. In Japan, a lady beetle, *Pseudoscymnus tsugae*, is the most common and effective predator of HWA. From 1999 through 2002, the Connecticut Agricultural Experiment Station reared and released more than 150,000 *P. tsugae* beetles in Connecticut, while the New Jersey Department of Agriculture reared 350,000 *P. tsugae* beetles, releasing 185,000 at various locations in New Jersey. The remaining beetles were released in Massachusetts, Rhode Island, New York, Pennsylvania, Maryland, West Virginia, North Carolina, and Virginia. In 2000 through 2002, Ecoscientific, Inc. produced approximately 250,000 *P. tsugae* beetles, releasing them at various locations throughout the Northeast. Field releases of *P. tsugae* will continue in 2003.

Three additional species of predaceous beetles from China have been investigated including *Scymnus sinuanodulus*. From 1999 through 2002, *S. sinuanodulus* was evaluated in the field in sleeve cages attached to infested hemlock branches with promising results. Further field cage evaluations are planned for 2003 using *S. ningshanensis*. From British Columbia, *Laricobius nigrinus* beetles were collected and successfully established on HWA infested hemlock branches at the Virginia Polytechnic Institute and State University quarantine facility. This promising predator has recently been released from quarantine and controlled field releases of this predator are planned for 2003.

Outlook

In just a few years, scientists have made good progress in finding and studying potential biological control agents for HWA. *P. tsugae* is the only non-native predator released into the environment, and results in the field have been encouraging thus far.

Additional studies are needed, however, to substantiate that *P. tsugae*, *Scymnus* spp., and *L. nigrinus* will be at least part of the solution to the HWA problem, and to justify the additional effort and cost required to rear enough beetles for release throughout the HWA-infested area. Managers hope that the beetles will reproduce and spread on their own from release sites to other infested areas. Scientists are developing ways to optimize and reduce the cost of establishing this and other predators throughout the HWA-infested area and to discover other good biological control candidates.

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