Early Detection of the Hemlock Woolly Adelgid (*Adelges tsugae*) in Small Northeastern Hemlock (*Tsuga canadensis*) Woodlots

Forest Connect Fact Sheet Series

Cornell University Cooperative Extension,
Department of Natural Resources, Ithaca, NY
www.ForestConnect.info

The hemlock woolly adelgid (*Adelges tsugae* Annand) is a serious non-native pest of hemlocks (*Tsuga canadensis* and *T. caroliniana*) in the Eastern United States. Originally from Japan and China, the hemlock woolly adelgid (HWA) was first detected in the East in the early 1950's in Richmond, VA. It has since spread on eastern hemlocks throughout the Eastern U. S. from the southern Appalachian Mountains to New York and New England. (Figure 1).

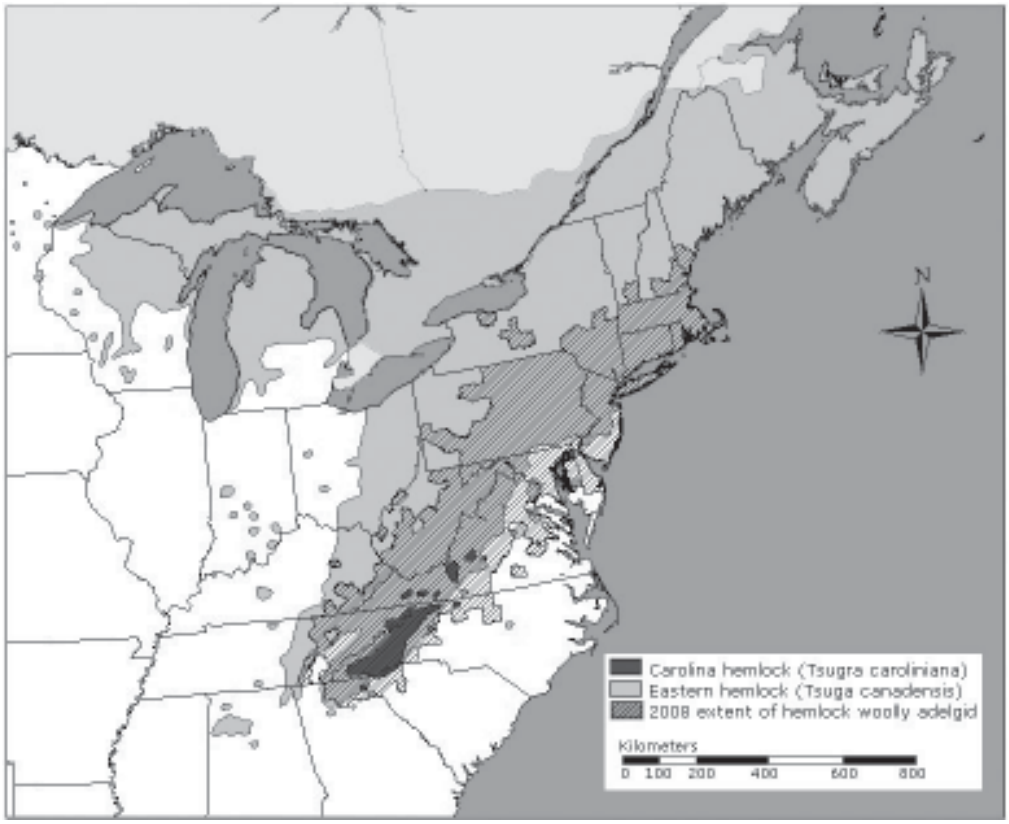

Figure 1. Hemlock Woolly Adelgid distribution in the eastern United States as of 2008. Map courtesy of the USFS Northern Research Station.

The HWA's impact is quite dramatic in the southern forests where hemlocks exhibit little resistance and die a few years after becoming infested. In the north, the situation is quite different where some infested trees survive for ten years or more. Mortality in the Northeast has occurred primarily in the more southerly regions of New York's Hudson River Valley, Connecticut, and Rhode Island. It's still too early to tell if mortality will be severe in the upstate regions of New York and in northern New England.

The HWA currently occurs over nearly half the native range of eastern hemlocks in the U.S. and spreads about 10 miles per year. HWA has nearly reached the southern-most distribution of hemlocks, but its range continues expanding to the west and north.

Detecting new HWA infestations at the leading edge of its range is important so land managers and woodlot owners can slow its spread and take steps to manage it. Early detection and notification of forest health specialist is an important first step to control this and other invasive pests. Many hemlock patches are small, may be confined to gullies or gorges along waterways, or occur mixed with hardwoods. These areas can be quickly surveyed by a few people. Once HWA is found, or when patches (known as stands) are larger than 10 acres, the infestation can best be monitored using the method developed by Costa and Onken (2006).

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Biology

The HWA is a small aphid-like insect. The adults are tiny, only about 1/32 of an inch, and covered with dry, white, waxy wool that makes them look like the tip of a small cotton swab (Figure 2). In North America, only females that reproduce asexually exist and each one lays 50 to 300 eggs beneath the woolly mass (Figure 3). There are two generations per year and each generation has six stages of development: an egg, four nymphal instars, and an adult. The adults of the overwintering generation produce eggs in April and May. These eggs hatch into the first instar nymph, or crawler, the only life stage that successfully disperses in North America. The crawlers settle on hemlock twigs near the base of a needle and insert its long sucking mouthparts, or stylets, into the twig. Once the crawler settles, it turns a dark color and will not move for the rest of its life (Figure 4). The spring generation develops into adults that begin producing eggs in June. The crawlers that hatch in early summer from these eggs settle and enter a non-feeding resting stage that lasts through the summer. The HWA are difficult to detect during this resting stage because they are small and have not produced much of the characteristic waxy wool. Feeding resumes in October and this generation continues to develop through the winter months with the adults producing eggs the following spring. For a more thorough review of the HWA and its biology please refer to McClure, et al. (2001).

Figure 2. Heavy infestation of the HWA. Mark Whitmore.

Figure 3. Adult HWA with eggs. Michael Montgomery, USDA Forest Service, Bugwood.org.

Figure 4. Newly settled first instar HWA nymphs (indicated by arrow). PA Dept. of Conservation and Natural Resources - Forestry Archives, Bugwood.org

Dispersal

The tiny first instar crawler disperses from tree to tree primarily by wind, on the feet of birds, or in the fur of small mammals (McClure 1990). A widely held view by researchers is that casual human contact with the HWA during surveys is not responsible for dispersal. The crawlers can become established anywhere within a tree crown but after a few generations will invariably be found on the lower branches as the crawlers fall downwards through the canopy.

Signs and Symptoms

The HWA can be difficult to detect at low population levels. The first signs of the HWA are the presence of a few white woolly masses (ovisacs) on the underside of twigs, most often on the most recent growth (Figure 5). As populations build the HWA will also occur on older twigs (Figure 2). With time the needles will lose color, drop from the twigs, and terminal buds will die causing shoot growth to cease (Figure 6).

Figure 5. Light infestation of the HWA. Mark Whitmore.

Figure 6. Needle loss due to HWA infestation. Chris Evans, River to River CWMA, Bugwood.org

Detecting the Hemlock Wooly Adelgid

Time of Year

The HWA is most visible from January through June when the white, waxy wool is new and abundant. The summer months are not good for detection because the small HWA resting stage is difficult to see with the naked eye, although there may be some residual wax on the twigs from earlier generations. Winter is also optimal because it is easier to locate hemlock trees in a stand when there are no leaves on the deciduous trees. This can be particularly important in areas where the hemlocks have a patchy distribution.

HWA Look-Alikes

To the untrained observer and from a distance there are a number of potential HWA look-alikes. The most common are small spider sacs and spittlebugs. Spider sacs are made of much stronger fiber than the wool of the HWA and are usually not closely appressed to the twigs. Spittlebugs are found on twigs but make watery, white foam and are not found in winter (Figure 7). Scale insects are also common but are found on the needles, not on the twigs (Figure 8). Other common potential look-alikes are bird droppings and pine pitch.

Figure 7. HWA (left) and a spittlebug (right) on hemlock. Mark Whitmore

Figure 8. Elongate hemlock scale on needles. Eric R. Day, Virginia Polytechnic Institute and State University, Bugwood.org

Tree Examination

Light infestations of the HWA will be patchy within the tree's crown so examine as many branches and trees as time allows. The first step is to examine the underside of the lowest branches, paying close attention to the most recent year's growth. If the lowest branches cannot be reached, examine the lowest branches with close-focus binoculars. Close-focus binoculars can also be used to look at trees in inaccessible locations like gorges, but be careful about the lighting. The arrangement of hemlock needles on the twigs will reflect light in a manner that mimics HWA ovisacs from a distance. Try to look upwards at the underside of the branches rather than from the side or top.

Surveying the Stand

It's important to know where the hemlocks and waterways are in a stand. Aerial imagery works best for providing a landscape view of a property. Develop a plan of movement within a stand to maximize the trees/branches examined. If more than one person is surveying, move together in a systematic way and communicate regularly. When surveying small stands, examine as many trees as possible because infestations can begin on just one or a few trees. Even when several trees are infested, the distribution of the HWA can be patchy.

The best place to look in a stand is along streams or other waterways. Birds are important vectors of HWA and their behavior within a stand brings them to water. Often the HWA can be found on branches closest to water and absent on the other side of a tree. With limited time in a stand, walk along the streams and examine the trees closest to the water.

Once the HWA has been detected in a stand, examine adjacent trees moving outwards in concentric circles to determine the number of infested trees and where the most heavily infested trees are. Accurate mapping of infested trees and stands will help when monitoring future spread and evaluating management options.

Management options

There are currently two ways to manage HWA insects and the impacts they cause: 1) chemical insecticides; or 2) the use of natural enemies as biological control agents. Infested hemlock trees can be protected individually with chemical insecticides. Systemic insecticides applied as soil drenches or injections into the organic layer can provide multiple years of protection from a single treatment.

Biological control agents from Asia and the Pacific Northwest have been evaluated for over a decade and some promising candidates have been identified. However, we still cannot say with certainty that these agents will be effective.

Cultural practices are available, with options depending on the character of the woodland, the objectives of the owner, and the extent of infestation. These management options are described by Orwig and Kittredge (2005) and by Ward et al. (2004).

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Authored by Mark C. Whitmore, Department of Natural Resources, Cornell University, Ithaca, NY. Comments and advice were provided by Dennis Souto, US Forest Service, and Jerry Carlson, NYS Department of Environmental Conservation. Layout and design by Diana Bryant.

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