Hemlock Woolly Adelgid (*Adelges tsugae)*

Helpline Happenings – October 2024

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Description

- Hemlock woolly adelgid (HWA) is a destructive, non-native pest of forest and ornamental hemlock trees in Eastern North America.
- There are two native hemlock species in Eastern North America: Eastern Hemlock(Tsuga canadensis) and Carolina Hemlock(Tsuga caroliniana). Both species are the only host plants of HWA and are highly susceptible to HWA damage.
- HWA is a tiny, aphid-like insect in the family of Adelgidae, order of Hemiptera. Adult HWA is ~1/32" long.
- From second nymphal stage through adult, HWA secretes a waxy, wool-like material covering over their bodies. The presence of woolly masses 1/16" – 1/8" wide at the base of hemlock needles is the tell-tale sign of this pest.



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Hemlock Tree Identification

- Eastern hemlock is a large, slow growing, shade-tolerant, long-lived Tree.
- Leaves 8 – 15mm long, yellow-green above, two white bands below; those originating from sides and lower surface of the twig spreading in a horizontal plane; those borne on the upper surface of the twig, more or less appressed, 1 - 6mm long, the white stomata bands exposed upwards; each borne on a short peg-like projection(the base).
- Mature seed cones pendant 1.5 – 2cm long, scales ascending in opened cones.
- Carolina hemlock is endemic to drier sites of Southern Appalachian Mountains from western Virginia to northern Georgia, elevation 2300' – 4000' high.
- Leaves 10 – 20 mm long, entire, dark shiny green above, two poorly defined white bands below, leaves spread in all directions of the twig.
- Mature seed cones 2 – 3.5 cm long, scales spreading in opened cones.

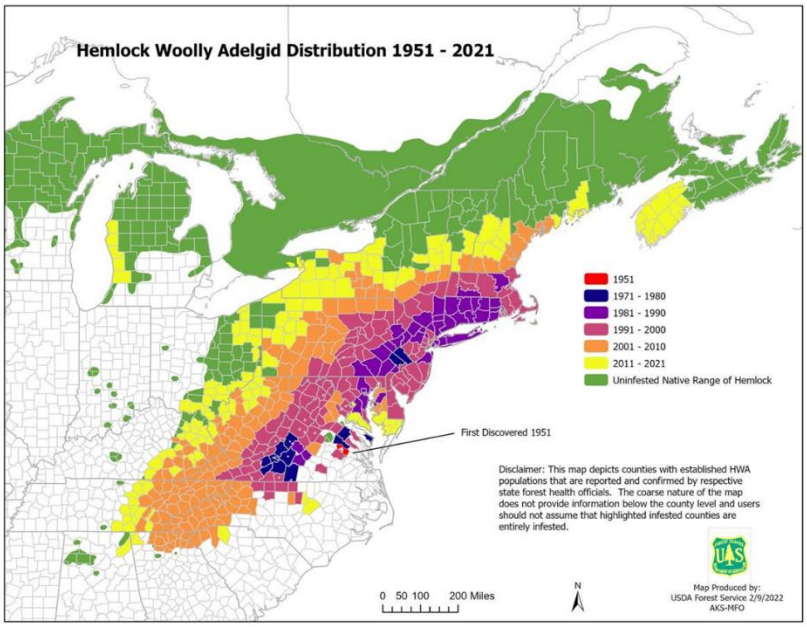


Hemlock Restoration Initiative North Carolina & USDA FS

History

- HWA is native to mainland China, Taiwan, and Japan, where there are several genetic lineages. There is also a distinct lineage of HWA in Pacific Northwest of North America, which was first identified in 1916 in British Columbia, but probably has existed there for much longer.
- All native hemlock species in Asia and the two native Pacific northwest hemlock species, T. heterophylla and T. mertensiana, are highly resistant to HWA, though they serve as host plants of HWA.
- The first record of HWA in the Eastern United States was in 1951 in Richmond, Virginia. Its genotype indicated it was directly from southern Japan, probably from a live plant material, and is different from the HWA of Pacific Northwest.
- HWA has since spread to wide areas in the Eastern North America. In New Jersey, HWA was first identified in Medford, Burlington County in 1978. Without predators, HWA has caused severe mortality of both species of native hemlock trees in Eastern United States.

Native Range of Eastern Hemlock & Spread of Hemlock Wooly Adelgid 1951 - 2021



Biology of Hemlock Woolly Adelgid

- HWA lays eggs in all generations. The ovisac is protected by waxy wool-like material.
- HWA has six life stages: egg, four nymph instars and HWA eggs adult (through incomplete metamorphosis).
- HWA hatches from eggs into crawlers which are minute and highly mobile. Crawlers move around searching for feeding site near the base of needles. Once settled, HWA will stay at the same place for the rest of its life.
- The settled first instar nymph has a fringe of white wool-like material surrounding its body.
- The eggs and crawlers are easily spread by wind, birds, other animals, etc.
- HWA nymphs and adults have gland openings on their back to secrete waxy wool-like material for protection.



HWA eggs photo by C. Leppanen



HWA Crawler photo by J. Foley



1st instar nymph photo U.Mass Amherst

Signs of HWA Infestation



adult & eggs by M. Montgomery



ovisacs & a crawler Kelly Oten



nymph by Kelly Oten



an adult, Harvard Forest



Ovisacs on underside of twigs by M. Montgomery



ovisacs seen from both sides of twigs by L. Graney



SEM photo of an adult by Kelly Oten

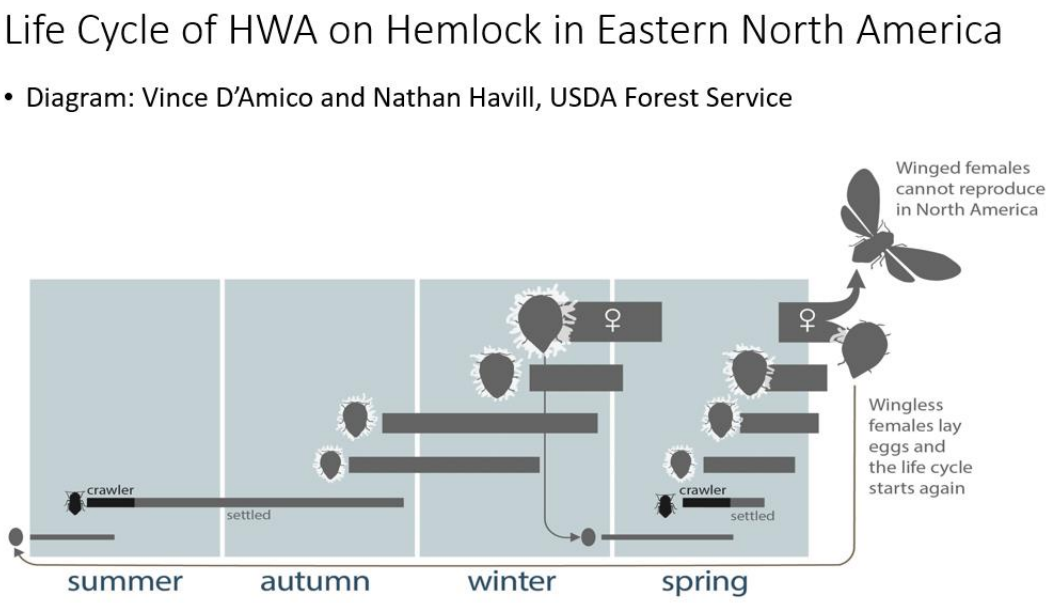
Life Cycle of HWA in the Native Range

- Hemlock woolly adelgid has a complex life cycle.
- In Japan, HWA can alternate between a hemlock Tsuga sieboldii, and a spruce Picea torano in areas where both species coexist.
- Spruce is the primary host plant which supports sexual as well as asexual reproduction.
- Hemlock is the secondary host plant which supports only the asexual generations.
- The winged females produced on hemlock, fly to spruce host plant where they lay eggs for both males and females. Each mated female then lays a single, relatively large egg which develops into an asexual female. This female settles near a spruce bud to overwinter. The following spring, it begins feeding and laying eggs. The feeding by the adult female and the nymphs transform the bud into a gall which houses many her offsprings. When the gall matures in early summer, it releases many winged offsprings which then fly back to hemlock host.
- HWA in the native range has two generations on the secondary host.

Life cycle of HWA in Eastern North America

- In Eastern North America, there are two generations per year on hemlock. All adults on hemlock are wingless females which lay eggs by asexual reproduction or parthenogenesis.
- Overwinter generation: In summer, after the hatched crawlers settle near the base of new-growth needles, the first instar nymphs enter a summer diapause till October when they resume feeding and develop under the cover of white woolly material through winter months. From late winter to early spring, the adults lay eggs to begin the spring generation.
- Spring generation: This generation of HWA on hemlock is relatively short. The hatched crawlers settle near the base of needles of previous year's growth. In late spring to early summer, the wingless adults lay eggs to begin the overwinter generation of next life cycle.

- A portion of adults of the spring generation are winged females which fly away to find suitable spruce host. Since there is no suitable spruce trees as primary host in North America, all winged females die without reproducing.



Feeding

- HWA has long piercing-sucking mouth parts, the stylet bundle which fits together to form two canals. One injects saliva into the stem and the other sucks stored nutrients from the xylem ray parenchyma cells.
- The xylem ray cells are the feeding site for all stages of HWA. HWA does not extract nutrients directly from sap, but removes food reserves from host tree's storage cells.
- The toxin in saliva induces hypersensitive response to form false growth rings in infested stems that restrict water transport.
- Depletion of reserved carbohydrates and restricted water transport result in initial symptom of needles changing color from dark green to grayish green. The infested plant produces little or no new growth.
- Subsequent infestation results in immature needle drop, branch death, canopy thinning and eventual death of Hemlock trees that could occur within four years in the south, eight or more years in the north, especially if hemlock trees are under environmental stresses.
- The cold temperatures in the north decrease the population of HWA in winter. Hemlock trees there could survive longer from HWA infestation.

HWA Damage on Eastern Hemlock

Eastern hemlock is considered foundation species in the hemlock forest. Loss of eastern hemlock due to HWA infestation has led to great changes in forest ecosystems.

Hemlocks are popular in ornamental landscapes. Defoliation and mortality cause decrease in aesthetic value as well as economic value of the property.

- Symptoms



Photo by Chris Evans



photo by James Johnson



photo by Jason Van Driesche

Management of HWA in Landscapes

- The best time to effectively manage this pest is late September through October. Registered insecticides applied according to label directions during this period target overwintering females. A mid- to late June spray may help reduce the number of developing nymphs.
- HWA Eggs and crawlers are easily spread by wind, birds, other animals, etc.
- Spreading of other life stages require the movement of infested live hemlock material, such as nursery stock, seedlings, for infestation to become established.
- Contaminated tools, clothing, footwears, etc. could also be sources for HWA infestation.
- Keep ornamental hemlock healthy by providing good growing conditions.
- Frequent regular inspection for signs and symptoms of HWA on hemlock for early detection and taking early control treatments to prevent or minimize HWA damage in the landscapes.
- Do not hang bird feeders on HWA infested trees to limit spreading by birds.
- Do not fertilize infested hemlock trees. Nitrogen fertilizer will improve the vigor of hemlock, but will also enhance the population of HWA.
- Efforts for HWA resistant hybrid hemlock has been ongoing by scientists at the National Arboretum. T. chinensis x T. caroliniana ‘Traveler’ and Tsuga caroliniana x Tsuga chinensis ‘Crossroad’ were the first two released for improved resistance, outstanding growth characteristics. Planting HWA resistant hemlock trees in ornamental landscape will become a choice when they are more available.

Biological Control with Predaceous *Laricobius* Beetles

- No known parasitoids are associated with Adegidae. Biological control program for HWA has focused on prey-specific predator species.
- Laricobius beetles in the family of Derodontidae are specialist predators of adelgids
- A predator native to western North America, Laricobius nigrinus was found consistently feed only on HWA in the lab and its life cycle was shown to be synchronous with HWA of the Eastern North America. Females oviposit within HWA ovisacs. This predaceous beetle has established in nature in the east.
- A new native species, Laricobius osakensis was discovered in southern Japan. L. osakensis has host preferences like L. nigrinus, greater fecundity, and a higher predation rate than L. nigrinus. In its native range, L. osakensis is the key natural predator of HWA and has a synchronous life cycle with HWA. It was first released in the east in 2012. Continued efforts toward large scale rearing and monitoring this are ongoing.



Laricobius nigrinus adult photo by J.D. Simmons

Biological Control with Lady Beetles

- Sasajiscymnus tsugae, a small, black lady beetle, 1.7mm L x 1.1mm W, was collected in Japan from HWA infested hemlock trees in 1992. It was imported into U.S.
- Studies have shown that all life stages could be recovered from HWA infested eastern hemlock. Both larvae and adults feed on all life stages of HWA.
- Life cycle of this lady beetle is well synchronized with that of its prey. While its prey is in summer diapause, the beetles feed on the dormant first instar HWA nymphs.
- This lady beetle has been released in sixteen states, including New Jersey. Study results have shown it has excellent potential for further biological control of HWA.
- This lady beetle is the only adelgid predator species available commercially.
- Three new species of lady beetles in genus Scymnus have been collected in China as potential biological control HWA predators.



S. tsugae adult photo by C. Cheah

Chemical Control and Integrated Pest Management

- Contact insecticides, such as horticultural oil and insecticidal soap for foliar spray, require complete coverage of foliage and possible multiple applications.
- Systemic insecticides, such as imidacloprid and dinotefuran, need to be absorbed into vascular tissue to become effective. Application methods include soil drench, soil injection, using pesticide slow-release tablets(imidacloprid), base trunk spray or bark injection.
- Always follow the local and State laws concerning chemical applications. And follow the label instructions fully for each insecticide application.
- Biological control offers larger range and longer-term protection, but takes a long time to establish.
- Numerous biological controls have been released in New Jersey starting in 1998 with predacious insects including Sasajiscymnus tsugae, Scymnus sinuanodulus, and Laricobius nigrinus.
- Chemical control is effective and less expensive, but it covers smaller range, offers shorter term protection, kills non-target insects, and could have serious environmental impact.
- Using IPM for HWA infestation, before HWA predators could be more established, insecticide application will be necessary under certain situations. Foliar spray and basal trunk spray may offer the options of less toxic and less environmental impact.
- Efforts for all HWA management strategies are ongoing.

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