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BULLETIN 89

Frontline EXPRESS

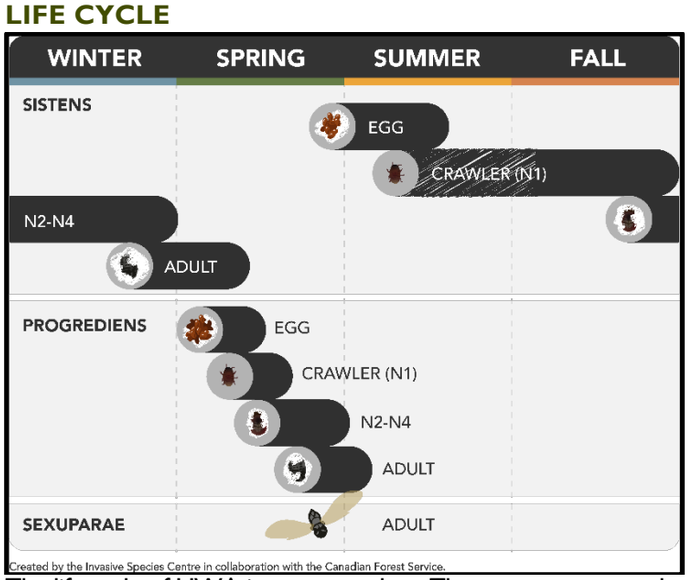
Canadian Forest Service – The Great Lakes Forestry Centre

Hemlock Woolly Adelgid

INTRODUCTION

Hemlock woolly adelgid (HWA), *Adelges tsuga*e, is a non-native, invasive aphid-like insect that is attacking and killing eastern hemlock (*Tsuga canadensis*) trees in eastern Canada. The insect is native to east Asia and northwestern North America and was introduced to eastern North America from Japan likely in the 1920s. Since then, the invaded range of HWA has expanded across the northeastern US and in Michigan and Ohio. HWA was detected in eastern Canada in 2012, though populations were likely present for several years prior to their discovery. HWA is a highly damaging pest in eastern North America: up to 95% of the hemlocks in a stand can be killed by HWA over a 3-15 year period. In western Canada, the insect is not a pest and under normal conditions does not kill western hemlock. Hemlock is often found in riparian forests, where it is considered to be an ecological foundation species. The hemlock canopy moderates air temperatures throughout the year, creating a unique ecosystem that provides critical habitat for many organisms. When planted in urban areas, hemlock provides significant ecosystem services and important aesthetic and economic values to humans. Unfortunately, the abundance of hemlock on the landscape has decreased by 60-80% due to land use changes and harvesting. HWA is a major threat to what remains of eastern Canada's hemlock forest and is regulated by the Canadian Food Inspection Agency (CFIA).

LIFE CYCLE



The life cycle of HWA is very complex. There are two asexual generations annually (sistens, progrediens) on eastern hemlock. There is also a winged form (sexuparae) that develops along with the progrediens generation and then migrates to spruce to initiate a sexual generation. However, the sexual generation does not occur in eastern North America.

The sistens generation develops on hemlock from late fall through spring, whereas the progrediens generation develops during late spring and early summer, which we will refer to as winter and spring generations, respectively. Both generations develop under a protective white wool-like covering, called an ovisac. Adults of the winter generation will deposit up to 300 eggs inside their ovisacs that hatch to become the spring generation. These newly hatched 1st instar nymphs (called crawlers, the only mobile stage of HWA) settle at the base of a needle along the twigs. After settling, the crawlers become sessile for the rest of their lives, developing through the remaining three nymphal instars to reach maturity in about a month and a half. Adults of the spring generation will deposit up to 100 winter generation eggs inside their ovisacs. The biology of the winter and spring generations differ in two ways: first, the crawlers settle on new hemlock shoots rather than 1-yr-old twigs; and then after the crawlers have settled, they aestivate, or become dormant, from summer to mid-fall. Once awake, the nymphs feed on the hemlock tree until they mature in early spring. The timing of each generation is climate dependent. For example, in Nova Scotia and Ontario spring generation eggs are deposited in April and May, whereas eggs are deposited in February and March in the southeastern U.S. Dispersal of eggs and crawlers occurs through wind, birds, and other animals at rates of 9- 20 km per year, but spread over much longer distances occurs during spring bird migration and via the movement of infested materials. Only one egg or crawler is needed to initiate a new outbreak.

APPEARANCE

Due to its small size, HWA is most easily recognizable by the white waxy wool masses (ovisacs) it creates near the base of the needles along the underside of the stem. These ovisacs look like the tip of a cotton swab.

HWA white woolly ovisacs on a hemlock twig.

All life stages of HWA are small (< 1.5 mm) and may require the use of a microscope to identify. Eggs are an amber colour and oval shaped. The newly hatched crawlers are football shaped and brown, but once settled they become black with a woolly fringe. The four nymphal instars are almost identical in appearance among the generations and as the insect grows it sheds its outer skin, which remain in the ovisac.

Although unable to persist and successfully reproduce, the winged adults can be used for identifying or surveying HWA. The winged form is distinct from the winter and spring generations due to its wings, longer 5-segmented antennae, and compound eyes.

DAMAGE

HWA feeds on the contents of hemlock's nutrient storing cells and may inject saliva to help digest the nutrient-containing compounds before consumption. To do this it uses its mouthparts, which are more than three times the length of its body, to reach deep in the tree's twigs. This feeding initiates a tree-wide defensive response that can cause a reduction in photosynthesis and causes the tree to show signs associated with water stress (e.g., reduced water movement, and exchange of carbon dioxide and water with the air). Initially, buds die and needles turn yellow. From a distance, heavily

infested trees appear greyish- or yellowish-green. The crown will thin as needles are lost and eventually the tree will likely die, causing stands to look grey. The damaging effects of HWA to eastern hemlock in Canada can be visible 2-4 years after the tree becomes infested, with death occurring in 5-15 years. Eastern hemlocks may die more quickly if they are also affected by drought conditions.

CONTROL

It may be possible to eradicate small infestations or newly-established populations by cutting and burning all infested trees, however, detecting and delimiting small HWA populations is extremely difficult so eradication is rarely a viable management tactic. Thinning of hemlock stands, which increases exposure of HWA to abiotic stress (e.g., increased light, extreme temperatures), can reduce the survival of populations. Even if HWA populations suffer high mortality due to extreme winter temperatures, scientists suspect that the winter generation may actually damage the new shoots when inserting their mouthparts into the vascular tissues, reducing their ability to grow and regenerate.

Horticultural oils and insecticidal soaps can be used to manage HWA infestations on nursery trees. Some systemic insecticides are registered for use in Canada or are being considered for registration.

There are a number of predators and fungi that attack HWA. Extreme fluctuations in winter temperatures can also slow the rate of growth or reduce populations of HWA. Biological control is one tactic that can be used to manage invasive forest pests. Eight species of predatory insects have been introduced to the eastern US from Japan, China, and the northwestern US since 1995, of which 3 species have established populations. The effectiveness of these biological control agents continue to be monitored in the US. No biological control agents have been introduced to eastern Canada, however, scientists believe that predators from western Canada could be promising control agents in the east.

WHAT CAN I DO?

In eastern Canada property owners, forest managers, and commercial nurseries should report all suspected HWA infestations to CFIA and the provincial agency responsible for forest health.

Homeowners can inspect individual trees for signs and symptoms of HWA infestations during spring and early summer when the wool is most apparent. Woolly ovisacs may be present on the bark of the tree's trunk, on twigs, and on branch tips. The ground around hemlock trees can also be checked for fallen twigs and branches with evidence of HWA. Homeowners can minimize the exacerbating effect of drought by making sure trees are well watered. In infested areas, an arborist can be consulted to advise on appropriate management. It is important to remember that when chemical controls are recommended they must be applied by a licenced pest control applicator in accordance with provincial and federal regulations.

Woodlot owners and forest managers can also survey for HWA in the spring and summer. If after visual inspection no wool is found, a recently developed slingshot technique, called ball sampling, is effective at detecting infestations in the upper hemlock canopy. Another detection tool involves the use of sticky traps, but this technique requires a microscope to inspect the traps. In the US, crown dieback of hemlock stands is directly correlated to HWA and can be detected remotely through aerial or satellite imagery. Management tactics for HWA for forest stands are limited, though thinning is one option that may increase HWA mortality.

Commercial nurseries can limit the risk of spreading HWA by only sourcing hemlock from HWA-free areas or purchasing uninfested material. Nursery owners can manage local infestations of HWA by having a licenced applicator apply horticultural oils and insecticidal soaps according to label instructions.

Hyperdog™ ball launcher and Velcro® - covered racquet balls.

SAMPLING TECHNIQUE INSTRUCTIONAL VIDEOS AND FURTHER RESOURCES

Ball Sampling:
https://www.youtube.com/watch?v=0uurPleLOlY&t=2s

Sticky Trapping:
https://www.youtube.com/watch?v=0uurPleLOlY&t=2s

Hemlock Woolly Adelgid - Survey Protocol (CFIA):
https://www.invasivespeciescentre.ca/wp-content/uploads/2021/03/CFIA_ACIA-10300082-v6-adestu_E_External.pdf

Hemlock Woolly Adelgid Management Plan for Canada (NRCan):
https://cfs.nrcan.gc.ca/pubwarehouse/pdfs/39158.pdf

CONTACT INFORMATION

Great Lakes Forestry Centre
1219 Queen Street East
Sault Ste. Marie, ON P6A 2E5 Canada
Tel: 705-949-9461
E-mail: GLFCWeb@nrcan-rncan.gc.ca
Web site: nrcan.gc.ca/forests/research-centres/glfc/13459

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