The Threatened Hemlock: Managing Ecosystem Changes

The nonnative invasive insect hemlock woolly adelgid (HWA) is taking its toll on eastern hemlock trees. Once infested with HWA hemlock, trees usually die within 3 to 10 years. This evergreen tree has been important across the forest landscape in the eastern United States, and is especially important in riparian areas in the southern Appalachians. Current scientific and technological advances are allowing land managers to aggressively respond to HWA, to understand the impacts of hemlock mortality, and to eventually implement restoration. Scientists with the U.S. Forest Service Southern Research Station will soon release an important research article, "Hemlock Woolly Adelgid in the Southern Appalachians: Control Strategies, Ecological and Socioeconomic Impacts, and Potential Management Response," that addresses land managers' questions.

The Hemlock Woolly Adelgid, seen here on a Hemlock tree (RIGHT) is less than 1/16-inch (1.5-mm) long (LEFT INSET), and varies from dark reddish-brown to purplish-black in color. All photos courtesy of Bugwood.org.

Why should land managers care?

An eastern hemlock tree with visible HWA infestation.

A mature eastern hemlock can reach a height of 175 feet and 6 feet in diameter and can live more than 800 years. The tree's dense, evergreen canopy creates a unique environment that serves as critical habitat for many animal species. In addition, hemlock is an iconic tree that adds economic and social values to the southern Appalachian region. Since HWA was first inadvertently released into the U.S. in the 1950s, the insect has spread into 18 states and has been particularly destructive in Southern Appalachians. HWA is an "all-lands" problem that requires coordinated efforts among land management agencies -- sixty-percent of eastern hemlock trees occur on private lands in the Southern Appalachian region.

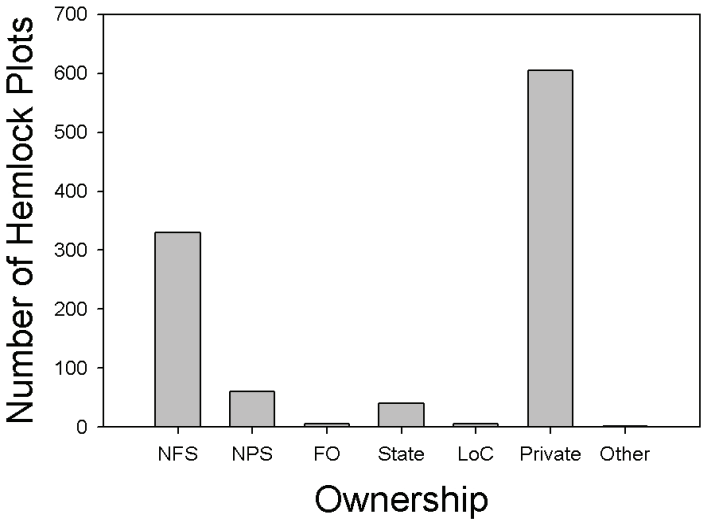
What are the Impacts of Hemlock Mortality?

Despite aggressive HWA control efforts, large numbers of hemlock trees in the Southern Appalachian region are dead or in poor health. This loss has important implications. In addition to providing year-round cover for wildlife, hemlock has a strong influence on riparian habitat conditions and stream health. For example, hemlock needles and wood decompose slowly, providing unique habitat for important forest floor organisms such as salamanders. The shade cast by these majestic trees cools the water where brook trout and other stream organisms live.

Because of hemlock mortality, many of these important functions are changing. Hemlock mortality is adding large quantities of litter to the forest floor and streams and even greater quantities will be added as standing dead trees continue to decompose. Hemlock mortality is also changing basic ecological processes, such as the cycling of carbon, nutrients and water. Some studies predict as much as 30 percent increase in streamflow during the winter months. Many of these short-term changes are localized and small; however, much more significant changes are expected in the coming decades as other species replace hemlock. For example, in areas where Rhododendron is absent, red maple, sweet birch, and yellow poplar are likely replacement species. Where Rhododendron is present, it could limit recruitment of overstory species. These new species may change habitats and ecological processes required by terrestrial and aquatic species. The good news is that land managers have an opportunity to implement restoration activities now to prevent many of these undesirable long-term impacts.

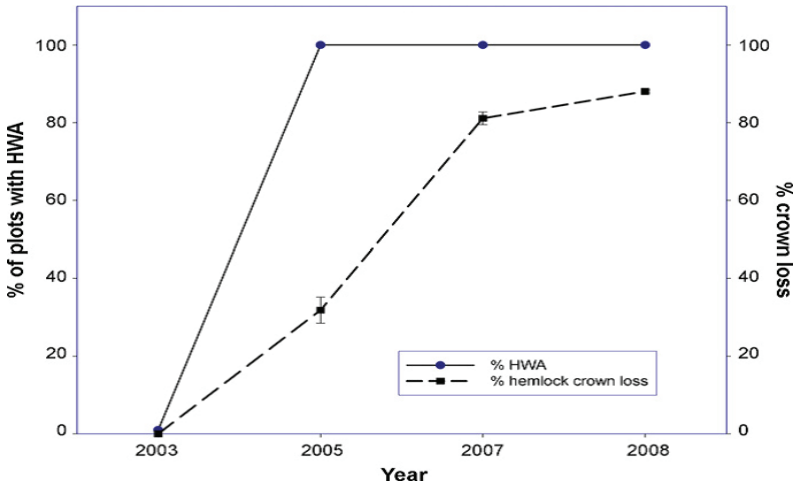
A closer look at the hemlock woolly adelgid.

Ownership patterns across the Southern Appalachian region based on U.S. Forest Service Forest Inventory and Analysis plots containing eastern hemlock



Note: NFS = National Forest; NPS = National Park Service; FO = Federal "other;" State = State owned land; LoC = Local or County; Private = uncategorized private; ONF = other non-Federal

Progression of HWA infestation and crown loss within a 1600 ha watershed in the Southern Appalachians



What can be done to slow the spread of HWA?

Controlling the spread and impacts of HWA involves the integrated use of multiple approaches including chemical control, biological control, cultural treatments, host resistance, and host gene conservation. Chemical control has been extremely effective at small scales, but biological control is the only viable option for controlling HWA across the landscape. Research is continuing on effective control methods that may someday effectively stop the spread of HWA.

Adelgid infestations are easily recognizable by the appearance of tiny "cotton balls" at the base of hemlock needles (ABOVE and LEFT).

What can land managers do now to minimize future impacts?

Controlling the spread and virulence of HWA is the best way to minimize future impacts; however, where those efforts fail, dead and weakened tress will continue to degrade and land managers should anticipate the need to manage for this impact. For example, in near-stream recreation areas, directional felling may be required to minimize hazards, and stream crossings should be carefully monitored to ensure that culverts remain clear. In order to maintain or restore the benefits provided by hemlock trees, restoration efforts may require novel approaches such as the introduction of non-native or hybridized hemlock species, facilitated movement of native species to new habitats, and aggressive management of existing undesirable species to benefit desirable species. In all cases, monitoring will be required to evaluate efforts and guide adaptive approaches.

A beautiful Eastern Hemlock Tree.

Guiding Decision Making

Decision makers are now faced with making decisions about how to invest resources into the critical components of the HWA problem: control, detection monitoring, understanding effects of hemlock mortality, and restoration. The following table outlines the decision options for managing HWA-Hemlock in the Southern Appalachians and the possible outcomes and implications of these decisions:

Decisions	Outcomes	Implications
1a.Intensify detection and monitoring	Increased probability of early detection	Enhanced control opportunities
2b.Monitor casually	Lowered probability of early detection	Reduced monitoring costs
2a. Apply control treatments	Reduced probability of mortality	Chemical: Must be ongoing to avoid mortality; per year costs remained relatively fixed; efficacy on individual trees is very good (e.g., 95%) when applied appropriately; costly to treat large numbers of trees. Biological: Treatment is not ongoing once agents establish and become self-perpetuating; high initial costs incurred in development/delivery but per year costs decrease over time after establishment; efficacy is less certain but some agents showing promise; more practical than chemical on landscape scale. Defers restoration activities and allows for development of new knowledge.
2b. Forego control treatments	Rapid mortality (3-10 years following infestation)	Sets time table of trajectory of ecological changes. May impose constraints on other management choices.
3a. Alter species composition using native species	Some ecosystem services replaced (e.g., shading)	Silvicultural options are not well defined. Efficacy is challenged by competition with Rhododendron and other species.
3b. Alter species composition using nonnative or resistant hemlocks	Broader range of ecosystem services replaced	Public acceptance on introducing nonnative species in public lands uncertain
3c. Forego species management	Species composition determined by site conditions	May result in new forest compositions that may have long-term undesirable implications for structural and functional attributes
4a. Post-mortality sanitation	Short run impacts on aquatic systems reduced. Protects recreationists and aesthetic impacts.	Reduces uncertainty about long-term impacts of standing dead hemlock, but may initiate a trajectory of change.
4b. Forego sanitation treatments	Increased short run (5-15 years) impacts on aquatic systems and recreation values.	Increases uncertainty about long-term impacts of standing dead hemlock, but allows for a “wait and see” approach.

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