

# Hemlock Hill Management and Research

In 1997, the hemlock woolly adelgid (HWA; *Adelges tsugae*) was discovered on the Arnold Arboretum's Hemlock Hill. This tiny insect, a relative of the aphid, feeds with lethal effect on the hemlock species of eastern North America. Native to eastern Asia, HWA was first detected in Virginia in the early 1950s and has since spread throughout the mid-Atlantic and southern New England. Sadly, researchers studying the insect have observed very high mortality rates among infested forests.



Beginning in 1997, Arboretum staff monitored the condition and rates of decline of roughly 1,900 eastern hemlocks (*Tsuga canadensis*) on Hemlock Hill. Presently, it is believed that 100 percent of the population is infested with HWA. To date, over 500 trees have been lost. As has been observed on other sites, those trees located in more marginal habitat conditions—thin soils or south- and west-facing exposures—have often been the first to succumb.

Because of the absence of host resistance and limited cultural control options, chemical treatments are the only reliable means of protecting hemlocks. Clearly any chemical treatment brings concern for the larger environment. At the same time, Hemlock Hill is an important resource for a large urban population that for over 150 years has enjoyed the singular educational and aesthetic experiences of a majestic hemlock-dominated forest.

Finding balance among stewardship, education, and public service goals, we are presently protecting hemlocks that are of sufficient vigor to recover and that grow in conditions that are favorable for treatment and do not present risk of water contamination. We control HWA on selected trees with applications of horticultural oil and, more recently, soil-injections of Imidacloprid (®Merit), a treatment now provided to over 40,000 trees at Great Smoky Mountains National Park. While using this method, we pay close attention to ongoing research that monitors for non-target effects and persistence in the environment. Ultimately, it is hoped that these treatments will “buy time” until biocontrols or other non-chemical options can offer reliable protection.

Other management measures include:

1. **Removal of hazardous trees.** We continue to remove hemlocks that are in severe decline and present a potential safety hazard.
2. **Native regeneration.** We encourage the growth of native tree species by removing competing invasive plants. We have also planted native hardwood species on the Hill's south-facing slope. In the future, we envision a mixed deciduous and evergreen forest in areas where hemlocks have been lost to HWA.
3. **Research Programs on Hemlock Hill.** The severe consequences of HWA infestation pose compelling questions about the ecological changes associated with the loss of eastern hemlock. Beginning in 2004, the Arboretum collaborated with the Harvard Forest, a research institute, to examine changes on Hemlock Hill. Harvard Forest scientists established six 15 x 15 meter research plots in order to measure the changes that occur when hemlock is removed from the forest system. Measurements established baseline data for soil temperature, available nitrogen, organic soil mass and understory vegetation. Analysis compared nitrogen cycling, decomposition rates and regeneration across the six plots. Completed in summer 2008, the study is part of a longer-term Harvard Forest effort to assess ecosystem impacts of HWA in southern New England.



A second research project determined that Chinese hemlock (*T. chinensis*), a close relative of our native species, is fully resistant to HWA. Ongoing field observations assess the suitability of Chinese hemlock as a landscape replacement for the eastern hemlock.

A summary of Hemlock Hill research aims, methods, and preliminary findings follows. Additional information about hemlock woolly adelgid is available from the [USDA](#) and the [Harvard Forest](#).

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## Ecosystem Responses to Forest Cutting After HWA Infestation: New insights from an urban site

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Our research on Hemlock Hill at the Arnold Arboretum continued into its 4th and final year in 2007. High levels of nitrogen availability and dramatic growth of herbaceous and shrub vegetation as well as increasing importance of black birch saplings are among the interesting highlights of this year.

In 2003, we began to study the effects of post-adelgid logging on ecosystem function at the urban Arnold Arboretum. Hemlock woolly adelgid (HWA) was discovered at the Arboretum on blown down foliage in 1997, and had likely infested trees there for years before. Hemlock Hill is a heavily used portion of the Arboretum and many moribund hemlocks needed to be removed to address safety concerns. At this time collaboration between the Arboretum and Harvard Forest was initiated to study ecosystem responses to removal of adelgid-infested hemlocks in this park setting. During 2004, six 15 x 15 meter plots were fenced off, and baseline data on soil nutrient cycling, microclimate, and vegetation dynamics were collected. Hemlocks were removed from four plots in February of 2005, while two remained untreated, as control plots. Slash was chipped and left on site in two chipped treatment plots, or removed from two logged (only) treatment plots. Minimal impact logging was conducted using a crane. This series of treatments coincided in time with Harvard Forest's Hemlock Removal Experiment at the Simes Tract, where we are collecting analogous data, allowing for an urban vs. rural comparison.

To date we have completed one year of pre-treatment and three years of post-treatment measurements. Nitrogen availability, estimated with the use of resin bags, is very high at the Arboretum in comparison with rural sites, but did not increase significantly with tree removal. Results from winters in 2005 and 2006 trend toward increases in the cut plots, and analyses from the growing season and winter of 2007 may help clarify the nitrogen availability story on the hill (Fig. 1). There continues to be a dramatic vegetation response to hemlock removal in the logged plots. Herbaceous cover in both the logged and logged + chip plots have increased over time to between 50 and 60% cover. The control plot also exhibited a recent increase in herb cover due to declining hemlock health and several treefalls adjacent to the plot (Fig. 2). Similarly, average shrub cover has increased in all plots, but particularly in the cut plots (Fig 2). *Rubus* sp. continues to be the dominant shrub, while *Frangula alnus* averages about 10% cover in the chipped plots. Total seedling densities were highest in the control plots, but many of these were small, 1 or 2 year old hemlocks that are establishing under thinning canopies. In contrast, large *Betula lenta* seedlings with higher cover are driving the changes in both the logged and chipped plots. Understory species richness continues to be largely unchanged.

The last overwinter nitrogen mineralization cores and resins will be pulled at Hemlock Hill in April and May of 2008. These overwinter data will complete our data set and provide 4 years of nutrient and vegetation dynamics for synthesis.

## Additional Research on Hemlock Woolly Adelgid

<http://arboretum.harvard.edu/research/living-collections-research/>

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