

MANAGEMENT OF HEMLOCK WOOLLY ADELGID IN GREAT SMOKY MOUNTAINS NATIONAL PARK

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The following is an excerpt from the annual Forest Insects and Disease briefing provided to National Park Service administration by GRSM Resource Management Staff: Though it does not delve into great detail on any one item of the HWA management program it does provide vital knowledge of “on the ground” operations on a large scale attempt to control this forest pest.

Hemlock woolly adelgid (*Adelges tsugae* (Annand)) was first detected in the park in 2002 and has rapidly spread throughout all areas of the park that contain eastern hemlock (*Tsuga canadensis* (L.) (Carriere)). HWA was considered an unimportant pest on ornamental hemlocks when it was first discovered in Richmond, VA in 1952. It subsequently spread into natural forest stands throughout the Mid-Atlantic States and has become one of the region’s most serious forest insect problems, with infestations extending south into Georgia and north into New England. HWA attacks several species of hemlock, but eastern hemlock is the only hemlock species found in the park. The insect is easily dispersed by birds and wind or infested horticultural material, and all ages of hemlocks from seedlings to old growth are vulnerable to ecological extinction.

HWA feeds at the base of the tree’s needles, reproducing exponentially and sometimes causing tree death in as little as two years. Insecticidal control is possible in landscape set-

tings but is difficult in natural stands. GRSM currently manages HWA with insecticides and release of biological control insects. Biological control holds the best hope for long-term control of HWA at levels that will allow hemlock trees to survive. Early results of biological control with several Asian species of beetles that feed exclusively on HWA show promise. Virgin hemlock stands in the park are particularly vulnerable since they are aging and not vigorous; these stands have been a high priority for treatment with systemic insecticides and biological controls.

Vegetation mapping shows a large hemlock resource in the park. Nearly 1500 acres of old growth hemlock have been documented with some trees in excess of 500 years old, six feet across, and 170 feet tall. The park's total hemlock resource has been mapped at more than 137,000 acres with over 14,000 acres of hemlock-dominated forest. The hemlock forests provide unique habitat for plant and animal species, including stream edge (riparian) species. Hemlock is a key component of many forest types in the park, and stands where hemlock is dominant are not uncommon. No other evergreen species is capable of filling the ecologically critical role of hemlock.

A Finding of No Significant Impact was prepared in December, 2005 in response to the public scoping process and affected agency review of a draft environmental assessment (EA) of Hemlock Woolly Adelgid Control Strategies in GRSM. The EA offered five alternatives: No Treatment, No Action (no change from current level of treatment), Chemical Control Only, Biological Control Only, and Both Chemical and Biological Control. The option of "Both Chemical and Biological Control" was chosen as the "Preferred Alternative." The Hemlock Program in the Park continues to see wide support from the public with over \$30,000 dollars raised in t-shirt sales alone to date.

Work to preserve eastern hemlock trees and forests in FY 2010 progressed successfully despite increased tree health decline and obvious mortality of trees throughout the park. Areas of particular focus have been in the Park's eastern areas near Cosby, Big Creek and Cataloochee. Some untreated higher elevation stands over 4,500 ft. continue to survive, perhaps because of colder winter temperatures and/or rime ice. All front country areas received an annual foliar application of insecticidal soap or oil totaling 600 acres. All trees in the front country campgrounds and heavily visited areas were retreated with systemic insecticides if needed. These were initially treated five years ago when the trees were, for the most part, very healthy and HWA populations were low. Service contracts completed in 2009-2010 used a new systemic treatment (Safari/dinotefuran) that has shown rapid results in controlling HWA on some of the largest old growth trees in poor health.

Work in the Conservation Areas (CAs) consisted of applying a second treatment to the very large trees ($\geq 25"$) based on research, establishing new CAs, and expanding existing areas. Of the 81 existing conservation areas, 50 have received a second treatment. Of the over 132,000 trees systemically treated since the project started over 20,000 of these have been treated in FY 2010 to date. With the returning rains of 2009 many treated trees have shown a positive response to past treatments and untreated trees will presumably respond as well if treated within the next two years.

Some of the new CAs of interest are located:

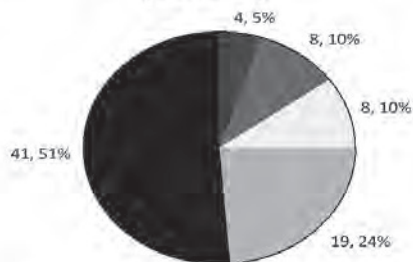
- Adjacent to the Gabes Mtn Trail in Cosby, TN, adding 56 acres
- Adjacent to State Route 284 in Cataloochee, NC, adding 68 acres
- Adjacent to the Enloe Creek trail in NC, adding 249 acres
- To date, 12 new CAs have been created in FY 2010, totaling 700 acres.

In addition to chemical controls, Park resource managers have been releasing biological control insects for HWA control since 2002. *Sasajiscymnus tsugae* (Sasaji and McLure), or St, is a beetle native to Japan. *Laricobius nigrinus* (Fender), or Ln, is native to the Pacific Northwest. *Scymnus sinuanodulus* (Yu and Yao), or Ss, is native to China and has seen limited release for HWA control in the Park. There have been 56 releases of the St predatory beetle totaling 56,669, five Ln releases totaling 1134 beetles, and one Ss release totaling 55 beetles. Although biological controls are expected to take ten years or more to demonstrate effectiveness, positive recovery of beetles has been made in multiple Conservation Areas this year from releases as far back as 2002, though overall success has yet to be determined and will play out over the coming years. Since 2002 the park has released over 500,000 predator beetles as part of the overall control effort.

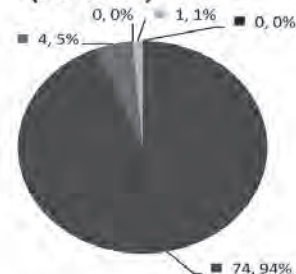
In 2005 nearly 100 monitoring plots were installed throughout the park to determine effectiveness of treatments against control plots receiving no treatment. Data collected from monitoring consists of Crown Health based on U.S. Forest Service FIA Crown Health Analysis. Monitoring has been showing the positive effects of the treatments compared to control areas with no treatments (Figure 1). Review of the plots is scheduled for on a yearly basis.

2009 Hemlock Vigor ratings

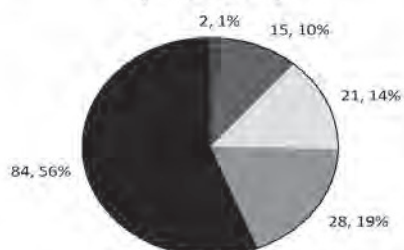
**2009 Hemlock Biocontrol Vigor
(80 total)**



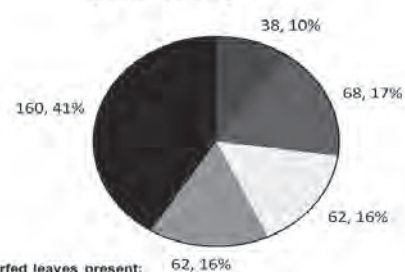
**2009 Hemlock Front Country Vigor
(79 total)**



**2009 Hemlock Control Vigor
(150 total)**



**2009 Hemlock Conservation Area Vigor
(390 total)**



1= (Healthy) - less than 10% branch or twig mortality, discoloration, or dwarfed leaves present;
 2= (Light decline) - 10-25% ...
 3= (Moderate decline) - 26-50% ...
 4= (Severe decline) - > 50% ...
 5= (Dead, standing) - tree is still standing dead; phloem under bark has brown streaks;
 6= (Dead, fallen) - may be result of natural breakage or removal by humans;

Figure 1. Monitoring efficacy based on Vigor Class.

CURRENT RESEARCH AND MANAGEMENT FOR FY2011

Sampling of hemlock canopy needles to determine effective length of systemic treatment was the focus of a recent pilot project in the Fall of 09'. In this study, trees that were treated up to seven years ago with a lower label dose rate of the active ingredient imidacloprid were found to be adelgid free with effective control levels of imidacloprid in the lower canopy, and its metabolite olefin (an effective pesticide) at levels in the upper canopy sufficient to control adelgid. This initial study has developed into the creation of a CESU Agreements Research between the Park and The University of Tennessee that will investigate in depth the minimum systemic treatment needed for the maximum control period. This study will give the park and their neighbors a more precise understanding of proper long term management of the tens of thousands of trees that have been successfully.

Management goals for FY2011 will incorporate innovative application techniques with systemic controls using more stem injection and basal application treatments. The focus of the biocontrol program will be to augment past release sites and/or release larger numbers at one site initially. The technique of caging beetles until they establish on certain trees in one area will also be attempted to maximize biocontrol effect.

The park continues to share information and experience acquired during the program with neighbors such as state park managers, private landowners and national forests in a cooperative effort to preserve this unique tree. Even though great loss of hemlock in the forest continues, the HWA program in Great Smoky Mountains National Park will preserve many valuable areas for decades to come.

ACKNOWLEDGMENTS

GRSM has been fortunate to draw on a dedicated funding source for HWA control. The following are some of the other sources that have made this program possible:

US Forest Service, Forest Health Protection

Friends of the Smokies

NRPP-National Resource Preservation Program

The many visitors and friends to the Park who continue to ask what they can do to save this beautiful tree.

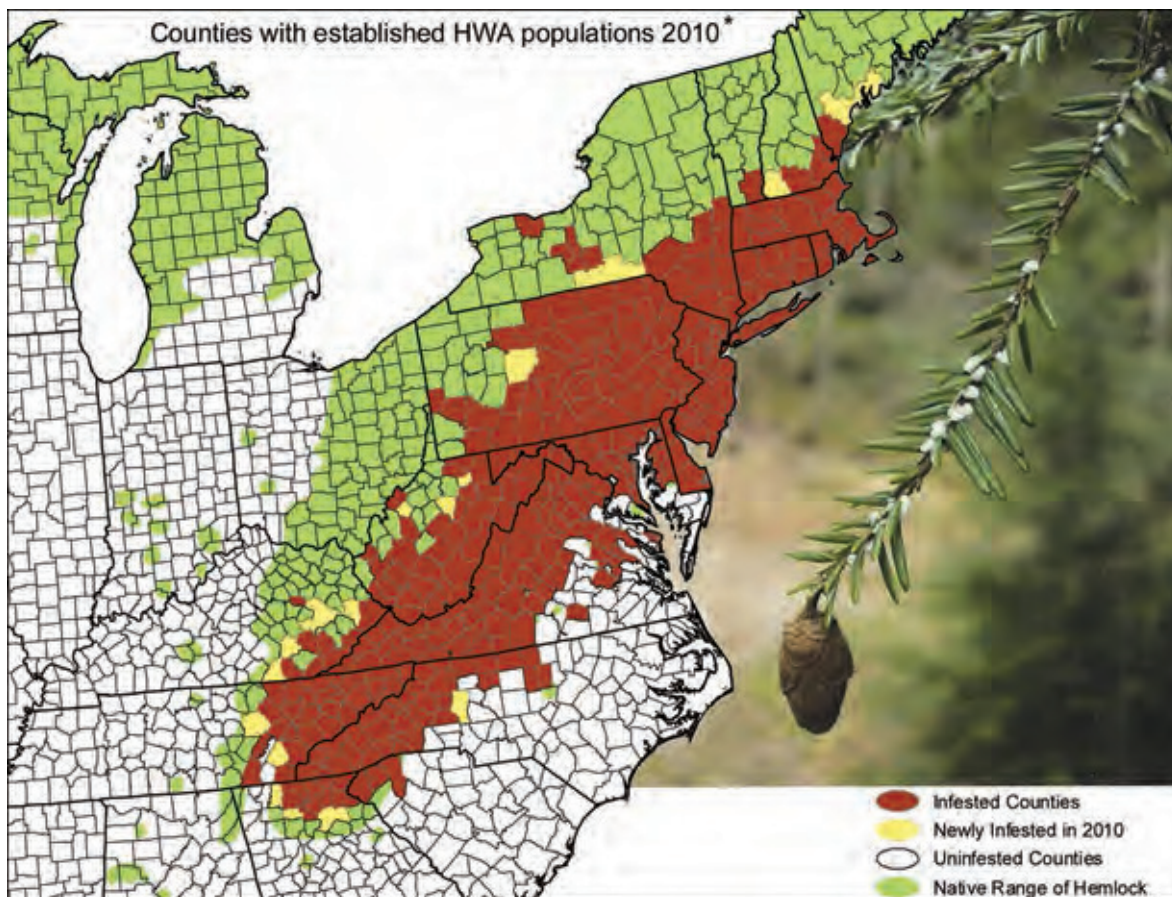
Forest Health Technology Enterprise Team

TECHNOLOGY
TRANSFER

*Hemlock Woolly
Adelgid*

Fifth Symposium on Hemlock Woolly Adelgid in the Eastern United States

Asheville, North Carolina
August 17-19, 2010



*See inside cover.

Compiled by Brad Onken and Richard Reardon



FHTET-2010-07
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Most of the abstracts were submitted in an electronic format, and were edited to achieve a uniform format and typeface. Each contributor is responsible for the accuracy and content of his or her own paper. Statements of the contributors from outside of the U.S. Department of Agriculture may not necessarily reflect the policy of the Department. Some participants did not submit abstracts, and so their presentations are not represented here.

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***Cover map:** Produced by USDA Forest Service, 2010. The map depicts counties with established populations of hemlock woolly adelgid (HWA) that have been confirmed by state forest-health officials. The coarse nature (scale) of the map does not provide information below the county level; highlighted counties are not necessarily entirely infested with HWA.

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Fifth Symposium on Hemlock Woolly Adelgid in the Eastern United States

Asheville, North Carolina
August 17-19, 2010

Renaissance Hotel
Asheville, North Carolina

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FOREWARD

This is the 5th HWA symposium; the first meeting was held in Charlottesville, Virginia in 1995. Over the past fifteen years we have seen HWA spread like wildfire in the south, invade six additional states, and cause extensive tree mortality throughout the mid-Atlantic and southern regions. Sounds rather hopeless and yet we remain optimistic, and here's why.

During the first seven years (1995-2002), there were but a handful of scientists, forest health specialists and resource managers working on the HWA research and management issue. Investigations into biological control were limited and in its infancy, there were no chemical control options for protecting hemlocks in a forest environment, no standardized sampling methods, impacts to hemlock forests remained scattered regionally and until the late 1990s, some forest health specialists were even skeptical that HWA was really that big of a threat to hemlocks! Our basic knowledge of HWA biology was limited as was the consistency of funding to support the needed research and methods development. In 2001, a formalized plan, *An Exotic Pest Threat to Eastern Hemlock: An Initiative for Management of Hemlock Woolly Adelgid* was put forward and more stable levels of funding were made available annually by the USDA Forest Service beginning in 2003. This was the beginning of the HWA Initiative and the accelerated effort to research and develop management solutions. An effort that now involves 24 universities, seven institutions in China and Japan, 20 state agencies, four federal agencies and nine private institutions.

In the last eight years we have seen several effective systemic insecticides become labeled for forest applications resulting in tens of thousands of hemlocks treated and protected annually. Standardized survey methods have been developed, and thanks to investigative DNA technology, we now know that all HWA are NOT created equal and that the origin of HWA found in the East is southern Japan. We now have six institutions rearing HWA predators and we are seeing predators becoming established in many areas from Maine to North Carolina. The cold tolerant *Laricobius nigrinus* found in the interior west has been recently released is now becoming established in areas where the coastal strain of this beetle was difficult to establish. With all this, we also have approval to begin rearing and releasing the newly discovered beetle predator from Japan, *Laricobius osakensis* which has proven to be very promising.

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