An Exotic Pest Threat to Eastern Hemlock: An Initiative for Management of Hemlock Woolly Adelgid

USDA Forest Service
National Association of State Foresters
National Plant Board

Overview:

Hemlock woolly adelgid is the single greatest threat to hemlock health and sustainability of this forest resource in the East. The potential ecological impacts of this exotic pest are comparable to that of Dutch elm disease and chestnut blight.

The USDA Forest Service, with the support and cooperation of the National Association of State Foresters and the National Plant Board[1], is proposing an expanded program to develop and implement hemlock woolly adelgid management strategies with a goal of reducing the impact and slowing the spread of this exotic pest. This five-year initiative calls for expanded research and technology development combined with accelerated implementation of available and newly developed management techniques. This document briefly describes this initiative's goals.

Background:

In the early 1950's, a small, aphid-like insect was first observed feeding on hemlock in Virginia. This insect was the hemlock woolly adelgid (HWA), *Adelges tsugae* (Annand), and an exotic pest native to Asia. The HWA has since spread to 15 eastern states where it threatens two species of hemlock--the eastern hemlock, *Tsuga canadensis* (L.) Carr. and Carolina hemlock, *Tsuga caroliniana* Engelm. This pest is responsible for extensive mortality and decline of hemlock trees in the eastern U.S. The insect has steadily spread from its point of introduction and is a serious threat to survival of hemlocks throughout eastern North America.

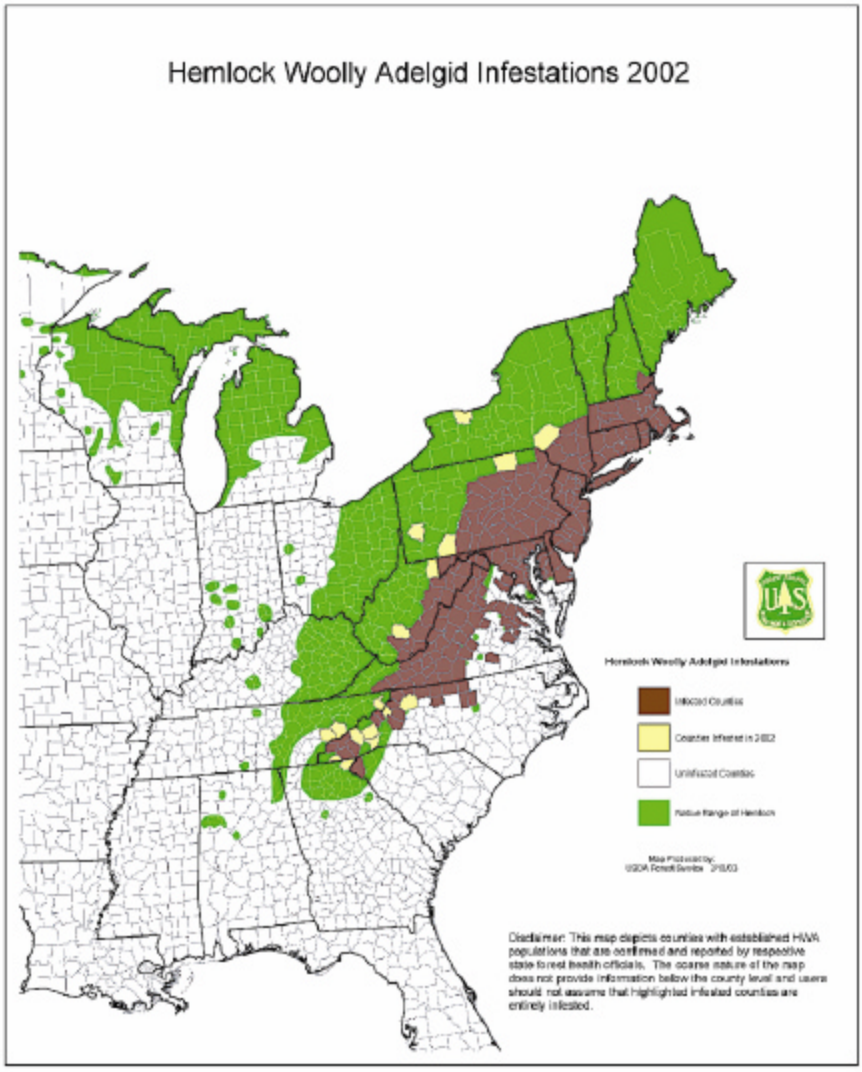
Hemlock stands occur across millions of acres of forested lands in the eastern U.S. (Figure 1). Hemlock can be found in a variety of sites, soil types, and climatic conditions. It is long-lived and extremely tolerant of shade. A visit to a hemlock-dominated forest may bring a vision of an old-growth forest, prior to European settlement. Hemlock is an ecologically important tree species and in many habitats, irreplaceable. Hemlock forests provide unique habitats for many species of wildlife that depend on the tree's dense canopy for food, shelter and breeding sites. Hemlock is commonly associated with riparian areas and has been shown to play an important role in maintaining cool stream water temperatures, preventing erosion on steep banks, and providing shelter to wildlife by moderating temperatures in cold winter months and during hot summer days. As a forest resource, hemlock's value to fish and wildlife and its contribution to the ecology of important riparian areas likely exceed its timber value. Aesthetically, hemlocks are highly valued in recreational areas and urban landscapes. In some urban areas, hemlock is one of the more common species planted by homeowners, and it is an especially important tree for use in shaded areas.

[1] An organization of state plant regulatory agencies.

Key Issues:

Continued Spread. Currently the HWA infests about one-half of the native range of hemlock in the East. It can be found from New Hampshire to northeastern Georgia and west to central Pennsylvania (Figure 1). The HWA continues to spread. Without intervention the entire range of eastern hemlock may become infested. In the past two years, HWA was found in isolated locations in Maine, New Hampshire, and Michigan and most recently in Ohio. Forestry and agriculture officials have undertaken eradication efforts. To date, Maine, New Hampshire, Vermont, and Michigan have implemented quarantines.

Figure 1. County-Level Distribution of Hemlock Woolly Adelgid



Resource Impacts. Areas of extensive tree mortality and decline are found throughout the infested region, but the impact has been most severe in Virginia, New Jersey, and Connecticut. Repeated heavy infestations in hemlock stands in New Jersey have resulted

in hemlock mortality averaging 42 percent and more than 90 percent in some areas. As of 2001, more than 87 percent of the 157 hemlock stands surveyed in New Jersey have had significant hemlock mortality. Harvesting of hemlock is proceeding at a rapid pace in infested states as landowners attempt to salvage value from threatened trees. Without active programs for gene conservation, some hemlock genotypes could be lost forever. Additional information is needed to quantify potential economic losses associated with widespread mortality of hemlock and potential effects on water quality, wildlife, threatened and endangered species, recreation, and aesthetics. Without intervention, HWA impacts on hemlock forests and ecosystems are expected to spread and intensify; thus the situation is critical.

Lack of Management Tools. The HWA is a difficult insect pest to manage. Because it is not native to North America, there are no effective natural enemies to keep HWA in balance. It is difficult to detect until population levels are high. Survey and monitoring techniques are expensive and inadequate. Control of this pest with traditional insecticides is limited to individual tree treatments in readily accessible, non-environmentally sensitive areas. There are no practical means available to manage HWA in forest environments. Eradication efforts have centered on tree removals and multiple insecticide treatments to individual trees. In short, the tools available to manage this pest are limited and inadequate.

Need for Focused Research & Technology Development and Pest Management. Progress in managing HWA has been made, but additional investments in research and technology development are needed to produce the tools to effectively manage this pest and slow its spread. Additionally, there is a need for a coordinated management effort to implement pest control strategies to slow-the-spread and reduce impacts. Specific areas of focus include biological controls, insecticides, host resistance, improved methods for survey and monitoring, and in support of these efforts, a better understanding of HWA biology.

Federal Role:

The hemlock woolly adelgid is a regional pest management issue currently impacting 15 states[2] and a threat to 7 additional states[3] in the eastern United States. This insect ignores ownership boundaries and has long-term impacts on forest resources potentially affecting a broad sector of the public. A management initiative coordinated by the Forest Service and utilizing the expertise of cooperating state agencies and other research institutions will improve efficiency and effectiveness.

Program Components:

Research & Technology Development. Enhanced efforts are needed to continue and accelerate the development of pest management technology. Priorities are to increase effectiveness of biological controls and insecticides, and to furnish new survey technologies and options for restoration of damaged forests. Classical biological control using predators and pathogens seems the most viable management strategy for mitigating HWA impacts on our forests. The search for and introduction of non-native predators of

[2] Massachusetts, Connecticut, Rhode Island, New York, Pennsylvania, New Jersey, Maryland, Delaware, Virginia, West Virginia, North Carolina, New Hampshire, South Carolina, Tennessee and Georgia.
[3] Maine, Vermont, Michigan, Wisconsin, Ohio, Kentucky and Alabama.

HWA began in the 1990's with major emphasis on developing rearing methods and determining the biology and host range of 5 species of predatory beetles. Research and development of biological control strategies needs to be continued and expanded. The development of efficient, effective, and ecologically sound insecticide treatment protocols for both suppression and eradication tactics is needed. Chemical pesticides represent an effective tool to mitigate HWA damage on accessible, individual trees and are a potential tool for eradication of infestations on isolated trees in accessible, but otherwise uninfested areas. A better understanding of HWA biology is essential for the development of effective pest management strategies. Factors believed to be critical include winter mortality, dispersal, and other pest and host interactions. The eastern hemlock species are very susceptible to injury from HWA, while Asian hemlock species (native range of HWA) and western hemlocks show more tolerance to HWA. Research is needed to identify host resistance mechanisms and to develop resistant hemlock hybrids and cultivars. It is important to develop management guidelines for the harvest and restoration of severely damaged forests. Success would be measured by the extent of implementation and use of newly developed tools and techniques.

Management. This component has two priority areas. The first area is accelerating the implementation of available HWA control tactics by increasing emphasis and technical and financial assistance through the use of S&PF cost-share programs. Immediate actions include getting available biological control agents into the field and widely used. Additional biological controls will be released as they become available. A major part of this activity is the mass rearing of predators for release on infested lands. Other actions include improving the effectiveness of eradication tactics, improving survey and monitoring capabilities, and implementing newly developed management tactics and tools to assist forest managers, forest health specialists, and homeowners. In addition, efforts toward conservation of hemlock genotypes must be initiated before the hemlock resource is depleted. Number of acres treated, reduction in hemlock mortality and the rate of HWA spread would measure success.

The second priority area is slowing the spread of HWA to uninfested areas. There is a need to establish cooperative interstate efforts to slow the artificial and natural movement of HWA to uninfested areas. This requires the establishment and maintenance of an accurate database of infested locations, development and implementation of better systems to track movements of hemlock products between states, and establishment and administration of uniform state regulatory policies. More efficient tools for monitoring and detection of HWA must be deployed to meet these objectives. Success would be measured by slowing the rate of spread of HWA to uninfested locales.

Information Transfer. There is an increasing need to make the public aware of HWA and to disseminate newly developed technology to manage this pest. Early detection of HWA infestations before they become generally established is critical to successful eradication and slowing the spread of HWA. A public, educated and informed about HWA enables state regulatory agencies to more effectively respond to isolated infestations. This approach was recently demonstrated in Maine and New Hampshire where media campaigns that followed the discovery of HWA-infested nursery stock in 1999 resulted in additional infestations being identified by the public. Early recognition of HWA can provide landowners with an opportunity to control HWA populations on valued trees

before damage occurs. As new tools, strategies, and treatment options are developed, this information and technology must be transferred and demonstrated to land managers, forest health specialists, and the general public. A measure of success would be interest and demand for information products.

USDA Forest Service Focus:

The USDA Forest Service is actively involved in addressing the HWA problem. State and Private Forestry (S&PF) through both the Cooperative and Federal Forest Health Management programs provides technical and financial support for HWA eradication, suppression, and technology development efforts. S&PF is well positioned to serve as an information clearinghouse and to coordinate multi-state operations through cooperating state forestry and state agriculture organizations. Forest Service Research, through the Northeastern Research Station, has since 1995 been investigating research problems related to management of HWA.

Link to Current Programs: The USDA Forest Service has made significant investments in research and development of technology to mitigate HWA impacts. State & Private Forestry has supported projects through existing forest health management and technology development programs. The Northeastern Research Station has supported HWA research activities conducted by staff scientists. In addition to the Northeastern Research Station, eight universities and state experiment stations have, with the support of the Forest Service, initiated research to provide improved management of HWA. These projects are limited in scope, but have already produced significant information on biological controls, cold-hardiness, and remote sensing for HWA. Much more information is needed.

Leadership & Oversight: With the support of the National Association of State Foresters and the National Plant Board, the USDA Forest Service has formed a HWA Steering Committee to provide direction and guidance for future activities and projects addressing the HWA problem. The Steering Committee is comprised of senior managers from the Forest Service's State & Private Forestry and Research Branches, APHIS- PPQ, and representatives from the Northeastern Association of State Foresters and the National Plant Board. The Forest Service has assigned technical specialists from both Research and State & Private Forestry to coordinate this initiative. This assignment includes developing detailed action plans and preparing periodic reports on activities and accomplishments for interested constituents.

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Explanatory Notes for Technology Development and Research Needs

Research & Development

- *Biological Control:* Develop biological controls (invertebrate predators and pathogens) that are effective and environmentally safe. Includes: foreign exploration for new, potential biocontrols; pre-release evaluation of biology, host range, and possible effects on non-target organisms; development of release protocols; and field trials to verify effectiveness.
- *Insecticides:* Develop more effective and ecologically sound insecticide treatments, with a focus on systemic insecticides by evaluating efficacy, non-target effects, and environmental residues of available products.
- *Survey Technology:* Develop survey technologies to effectively monitor adelgid populations and their impacts on hemlock stands; develop ground survey methods and remote sensing technologies for use at stand, landscape, and regional levels.
- *Silvicultural Options:* Develop best management practices for forest managers by collecting and analyzing data from infested areas that have utilized various harvest and management strategies.
- *Host Resistance/Vulnerability:* Develop methods to recognize and predict tree and stand vulnerability; initiate development of HWA-resistant hybrids or cultivars. Includes cross-breeding tests, analysis of influence of site factors and host plant chemistry on tree vulnerability.
- *Biology & Interactions:* Acquire knowledge of HWA biology and interactions with other pests that is necessary to develop appropriate management options. Includes information on HWA survival factors, phenology, genetics, and impacts on hemlock health, including interactions with other pests.

Management

- *Biological Control:* Mass rear and release available predators including technology development of mass rearing and release techniques. Evaluate the effectiveness of predator release and impacts on HWA populations.
- *Chemical Control:* Refine and update application technology; pilot test new methods; update recommendations to users; where appropriate, provide technical and financial assistance in control programs.
- *Survey & Monitoring:* Enhance detection and delineation of new and current infestations; implement and evaluate improved sampling techniques and methods to predict rate of spread; identify areas at high risk.
- *Impacts/Economics:* Conduct an assessment of potential economic and ecological impacts. At a regional level, quantify impacts to the hemlock resource and assess potential effects on associated fauna and flora, threatened and endangered species, and water quality.
- *Silvicultural Management:* Identify, demonstrate, and disseminate information on silvicultural alternatives for landowners.
- *Slowing Spread:* Facilitate the establishment of compatible state regulatory policies; develop a program to enhance detection of new infestations; provide financial and technical support for eradication of new infestations.

Information Transfer

- *Education/Awareness:* Develop and implement programs to increase awareness in uninfested and newly infested areas; provide programs to transfer latest management techniques.
- *Publications/Website:* publish new and updated information on HWA; upgrade and maintain a dedicated website.