



**NORTH CAROLINA  
DEPARTMENT OF AGRICULTURE  
AND CONSUMER SERVICES**



**NORTH CAROLINA FOREST SERVICE**



**ANNUAL LEGISLATIVE REPORT ON HEMLOCK  
RESTORATION**

Oct. 1, 2022

Steve Troxler, Commissioner  
Scott Bissette, Assistant Commissioner  
David Lane, State Forester

Pursuant to G.S. 106-927, the North Carolina Forest Service, a division of the North Carolina Department of Agriculture and Consumer Services, respectfully submits this annual report on hemlock restoration in North Carolina for fiscal year 2022.

## Contents

STATUTORY REQUIREMENT .....	3
§ 106-927. Annual report on hemlock restoration .....	3
IMPORTANCE OF HEMLOCK FORESTS TO NORTH CAROLINA.....	3
AN OVERVIEW OF HEMLOCK WOOLLY ADELGID INFESTATION AND CONTROL MEASURES IN NORTH CAROLINA .....	4
HEMLOCK RESTORATION INITIATIVE GOALS AND ACCOMPLISHMENTS: 2014 - PRESENT .....	7
HEMLOCK RESTORATION INITIATIVE ACCOMPLISHMENTS: FY 2022.....	9
CONTACT INFORMATION.....	12
Appendix A .....	13
Appendix B.....	14
Appendix C.....	15

## STATUTORY REQUIREMENT

### § 106-927. Annual report on hemlock restoration

Beginning Oct. 1, 2022, and no later than Oct. 1 of each year, the Commissioner shall submit a written report on hemlock restoration in North Carolina to the Joint Legislative Oversight Committee on Agriculture and Natural and Economic Resources and the Fiscal Research Division. The report shall include the following with respect to each hemlock restoration initiative funded during the previous fiscal year:

- (1) Identification of goals and outcomes for the initiative.
- (2) A description of the measures used, or data collected to evaluate the efficiency and effectiveness of the initiative in reaching its desired goals and outcomes.
- (3) The performance of each initiative with respect to the identified goals and outcomes.

## IMPORTANCE OF HEMLOCK FORESTS TO NORTH CAROLINA

Hemlock trees have a large range extending from New Brunswick and Nova Scotia in Canada to Alabama along the Appalachian Mountains. It extends as far west as Minnesota and exists in isolated populations both east and west of the normal range. Hemlock is an important part of North Carolina's 18.8 million acres of forestland. It occurs throughout the Appalachian Mountain region and in the foothills and areas in the piedmont. A disjunct occurrence is present in the Hemlock Bluffs Nature Preserve in Cary (the reason for the preserves formation) approximately 100 miles east of the edge of the normal range. Two species of hemlock occur in North Carolina; the eastern hemlock (*Tsuga canadensis*) and the Carolina Hemlock (*Tsuga caroliniana*). The large range described above encompasses eastern hemlock. Carolina Hemlock

only occurs naturally from Virginia into Georgia. North Carolina is home to approximately 80 percent of the naturally occurring Carolina Hemlock; a unique position for our state.

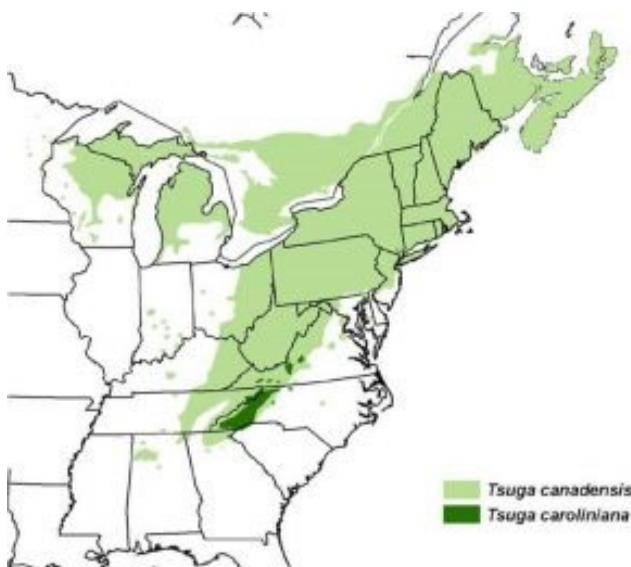


Figure 1: The Range of Eastern and Carolina Hemlock

Hemlocks are foundational species in the forest ecosystems of our state and beyond. It is a long-lived tree species capable of obtaining a large size. Indeed, it has been called “the redwood of the east”. One large eastern hemlock obtained a diameter of 76 inches and a height of 175 feet. It is not unusual for hemlock trees to live for hundreds of years with the oldest known obtaining an age of 800 years.

A foundational species is a requisite to the survival of other plants and animals in these forests. In the case of hemlock, the shade provided by the overstory canopy is responsible for the maintenance conditions in the understory conducive to the survival of many other plants and animals. In addition, hemlock is tolerant of shade and can maintain a full crown, even under the cover of other trees, including other hemlocks. These characteristics help serve as a winter cover for various species of wildlife including ruffed grouse. It also provides critical shading for mountain streams which maintains temperatures adequate to support many aquatic organisms including our native brook trout. Hemlock forests have been tied to the survival of over 90 different bird species and numerous plant communities. Some of these plant and animal communities contain species that have been deemed threatened or endangered at the state or national level. Among these include the Acadian Flycatcher, hellbender and piratebush among others.



Figure 2: An example of shading provided by hemlock trees.

Hemlock forests also have direct impacts on many human activities such as areas used for campsites and recreation. The loss of the hemlock in these areas impacts these activities by creating hazardous trees that either must be removed at a significant cost or pose a direct threat as they fall. The visual impact of these dead trees is crucial to the large tourism industry within the hemlock range. It has also been reported that dead hemlock trees falling into the waterways along which they tend to grow, have contributed to the destructive flooding events that have occurred within the mountains in recent years.

## **AN OVERVIEW OF HEMLOCK WOOLLY ADELGID INFESTATION AND CONTROL MEASURES IN NORTH CAROLINA**

Hemlock woolly adelgid (HWA) is an aphid like insect native to Asia and the west coast of North America where it was first identified in 1928. It is a native pest in its natural range and has an adapted suite of natural predators that keep populations in check under normal conditions. It was first detected in the early 1950's in Richmond, Va., and the original infestation was determined to have originated from Honshu Island, Japan. HWA has a complex life cycle consisting of two phases known as the progrediens in the spring months and sistens generations during the fall and winter months. The sistens generation feeds during the winter which is when most pesticide treatments occur. HWA has both male and female species. Males feed on spruce in

their native range and sexual reproduction occurs in this area. This portion of the life cycle has not been shown to occur in Eastern North America where females reproduce alone (asexual reproduction).



Figure 3: Heavy HWA infestation on eastern hemlock at the Governor's Western Residence.  
Inset: A HWA showing its feeding tube – photo by Kelly Oten, NCSU.

As eggs hatch following the progrediens generation, the early nymphs, known as crawlers, travel to the base of the needles, settle, and become stationary. They then enter a period of dormancy. Around October, they put on their woolly covering to shelter their eggs. They feed, mature, and then lay their eggs in the early spring months. Adults from these eggs begin the same progrediens generation again and the timing within this life cycle is critical for treatment operations (Appendix A).

In 1995, HWA was detected in North Carolina for the first time in Stokes and Surry counties. It gradually expanded to the point that most of the hemlock range in North Carolina was generally infested by 2007. In that same year, widespread mortality was noticed in the earlier infested areas (Appendix B).

Following initial detection, control methods were centered around trees in urban areas heavily traveled by people such as campgrounds. Much of the original response consisted of community outreach, provisions of insecticides and technical advice to those desiring to treat hemlocks. This was conducted by N.C. Forest Service (NCFS) personnel.

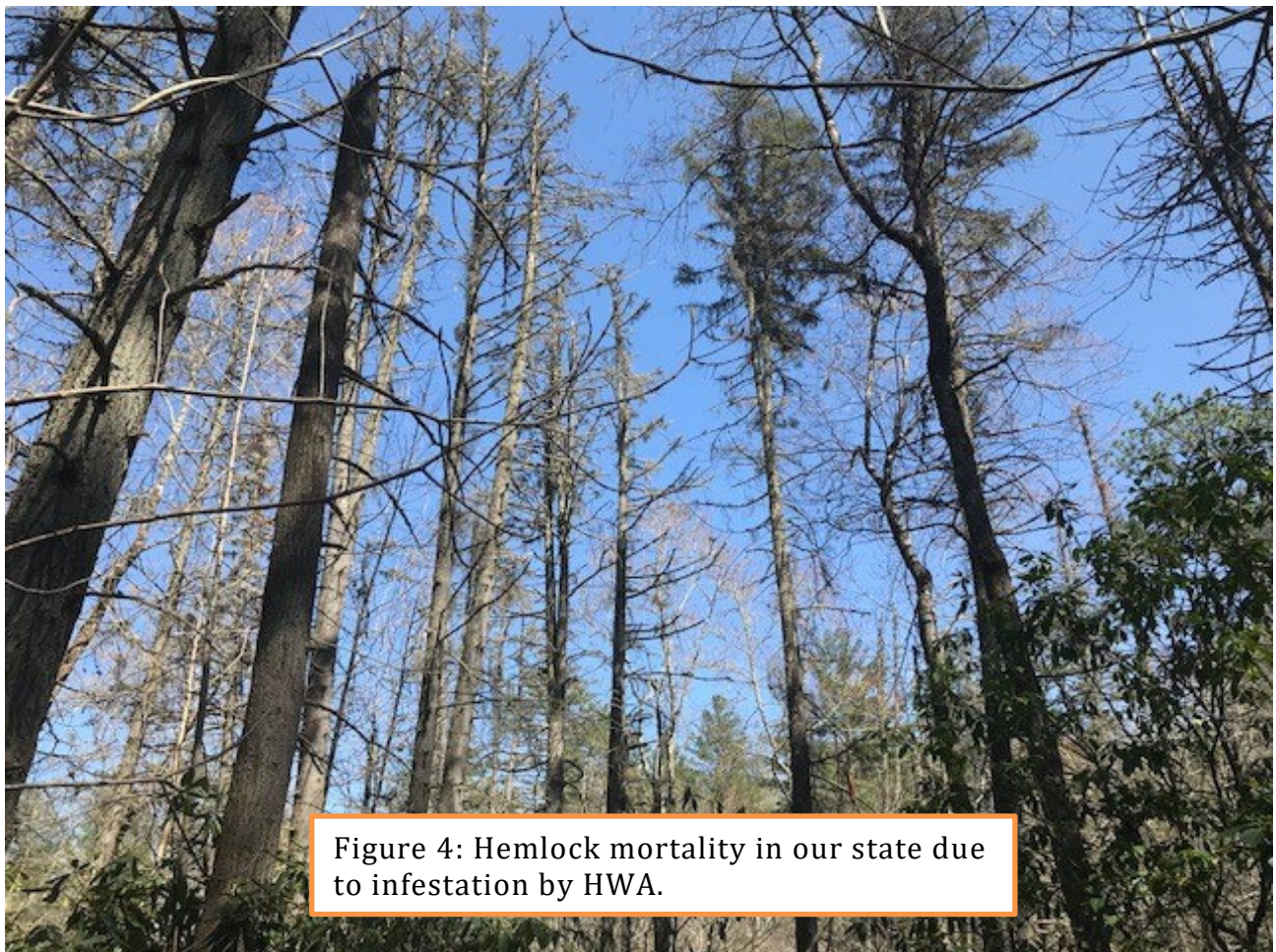


Figure 4: Hemlock mortality in our state due to infestation by HWA.

In 2007, the NCFS began treatments on state lands with the first treatments conducted at Dupont State Recreational Forest. The following year, the NCFS facilitated tree treatments on South Mountains State Park and in 2009, assisted the

N.C. Wildlife Resources Commission (NCWRC) with treatments on several game land properties. These efforts resulted in approximately 5,000 hemlocks being treated directly through efforts by the NCFS.

In 2011, the NCFS moved from the N.C. Department of Environment and Natural Resources (NCDENR) to the N.C. Department of Agriculture and Consumer Services (NCDA&CS). Following that transfer, the plight of hemlocks in our state became a focal point of Agriculture Commissioner Steve Troxler, culminating in the formation of the Hemlock Restoration Initiative (HRI) as a signature program in 2014. This program is operated by the WNC Communities, a nonprofit funded through federal grants obtained by the NCFS and state appropriations. A large portion of the HWA and hemlock restoration management was transferred to HRI following the formation of that program.

Hemlock restoration continues to be a cooperative effort between NCDA&CS and WNC Communities. Other main cooperators include the NCFS, the Beneficial Insects Lab, N.C. Division of Parks and Recreation, the NCWRC, the U.S. Forest Service and many others. The remainder of this report will focus on accomplishments related to the HRI culminating in a summary of those accomplishments from the 2022 fiscal year.

## **HEMLOCK RESTORATION INITIATIVE GOALS AND ACCOMPLISHMENTS: 2014 TO PRESENT**

### **GOALS**

The HRI goals and measures of accomplishments are:

- Identifying and establishing hemlock conservation areas (HCA).
- Educating landowners on how to economically treat and manage the hemlocks on their properties.
- Increasing the number of trees being treated on public lands.
- Implementing Integrated Pest Management (IPM) and long-term biological control of HWA.
- Advancing the development of other control strategies and restoration techniques, including the search for HWA-resistant trees and the growing conditions that hemlocks thrive in best.

### **ACCOMPLISHMENTS**

Throughout the life of this initiative, work has been completed related to the objectives mentioned above. A summary of those objectives is as follows:

- 169 Hemlock Conservation Areas established on state, private, and federal lands including 28 separate state properties represented on this list.
- All Hemlock Conservation Areas have received Phase I treatments (chemical).
- Approximately 100,000 hemlocks have been chemically treated.
- 220 educational outreach events conducted.

- 755 individual inquiries from landowners and the public serviced.
- 6,000 trees known treated because of this information sharing.
- 1,826 volunteers have been recruited resulting in 5,175 service hours.
- 21,075 predatory *Laricobius* beetles released for biocontrol across North Carolina.
- More than 7,000 *Laricobius* beetles recovered from 130 locations, many not documented release sites.
- *Laricobius* beetles documented in 17 of the 27 counties within the hemlock range.
- Five *Laricobius* insectary sites established, three of which were on state lands.
- Collection of beetles and support for Beneficial Insects Lab and University of Tennessee's Lindsay Young Beneficial Insect Lab.
- The raising of three separate species of predatory beetles within North Carolina.
- More than 600 pounds of hemlock cones collected and processed for seed.
- Establishment of a Carolina Hemlock Seed Collection Area.
- Successful rearing of both Carolina and Eastern Hemlock seedlings at Linville River Nursery for public sale.
- More than 70,000 hemlock seedlings produced for sale.

## HEMLOCK RESTORATION INITIATIVE ACCOMPLISHMENTS: FY 2022

Throughout the 2022 fiscal year, North Carolina's HRI continued to work toward achieving its goals. The NCFS, Beneficial Insects Lab and WNC Communities HRI worked together and in concert with partners to achieve the following:

- 14,821 hemlocks treated chemically.
  - 269 trees were treated at the Governor's Western Residence.
- 16 Hemlock Conservation Areas established.
- 4 new impact plots established to measure effects of treatments over time.
- 30 educational and outreach programs organized and presented.
- 46 partner/stakeholder meetings organized and/or attended.
- 126 social media posts generated.
- 17,769 social media engagements from the public.
- 155 hemlock inquiries serviced.
- 2,014 additional hemlocks treated by private individuals because of outreach.
- Percival I36-VLC8 growth chamber purchased for the rearing of *Laricobius* and other HWA predators.
- Field cages for study of *Leucotaraxis* (a promising new HWA predator) funded.
- 60 days of assessment for biocontrol program.
- *Laricobius* documented in 29 sites over seven counties.
- 1,625 *Laricobius* released (350 were *ozakensis*, potentially the most effective species).
- Purchased a Strapack strapping machine for Linville River Nursery seedling packaging.
- Funded potting soil, pelletizing of seed and other growing materials for seedling production.
- 70,000 hemlock seedling cells sown (50,000 eastern hemlock/20,000 Carolina Hemlock).

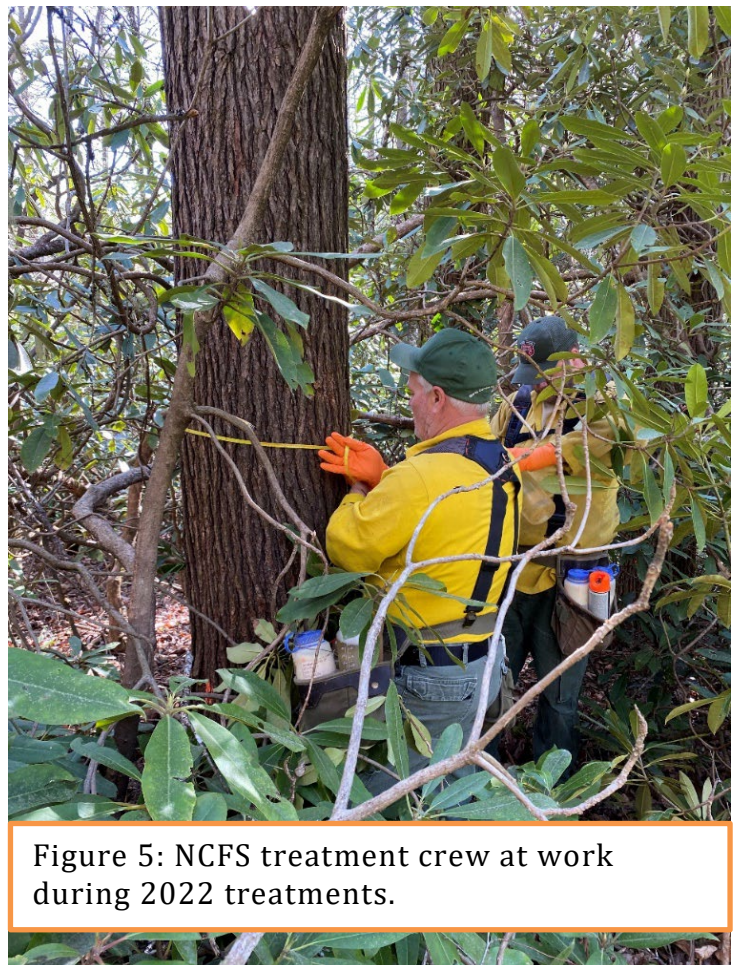


Figure 5: NCFS treatment crew at work during 2022 treatments.



Figure 6: HRI personnel conducting a treatment workshop for private landowners.



Figure 7: HRI Employee sampling for HWA predators.



Figure 8: Hemlock cones drying in the cone shed at the Goldsboro Forestry Center before seed extraction. Inset: Eastern hemlock cones before opening.



Figure 9: A bundle of hemlock seedlings ready for sale through the NCFs Nursery and Tree Improvement Program.



Figure 10: Hemlock seedlings growing at the Linville River Nursery in Crossnore, N.C.

## CONTACT INFORMATION

For further information, please contact:

Jim Slye  
North Carolina Forest Service – Forest Health Branch Head  
N.C. Department of Agriculture and Consumer Services  
[james.slye@ncagr.gov](mailto:james.slye@ncagr.gov)  
919-857-4858  
1616 Mail Service Center, Raleigh, NC 27699-1600

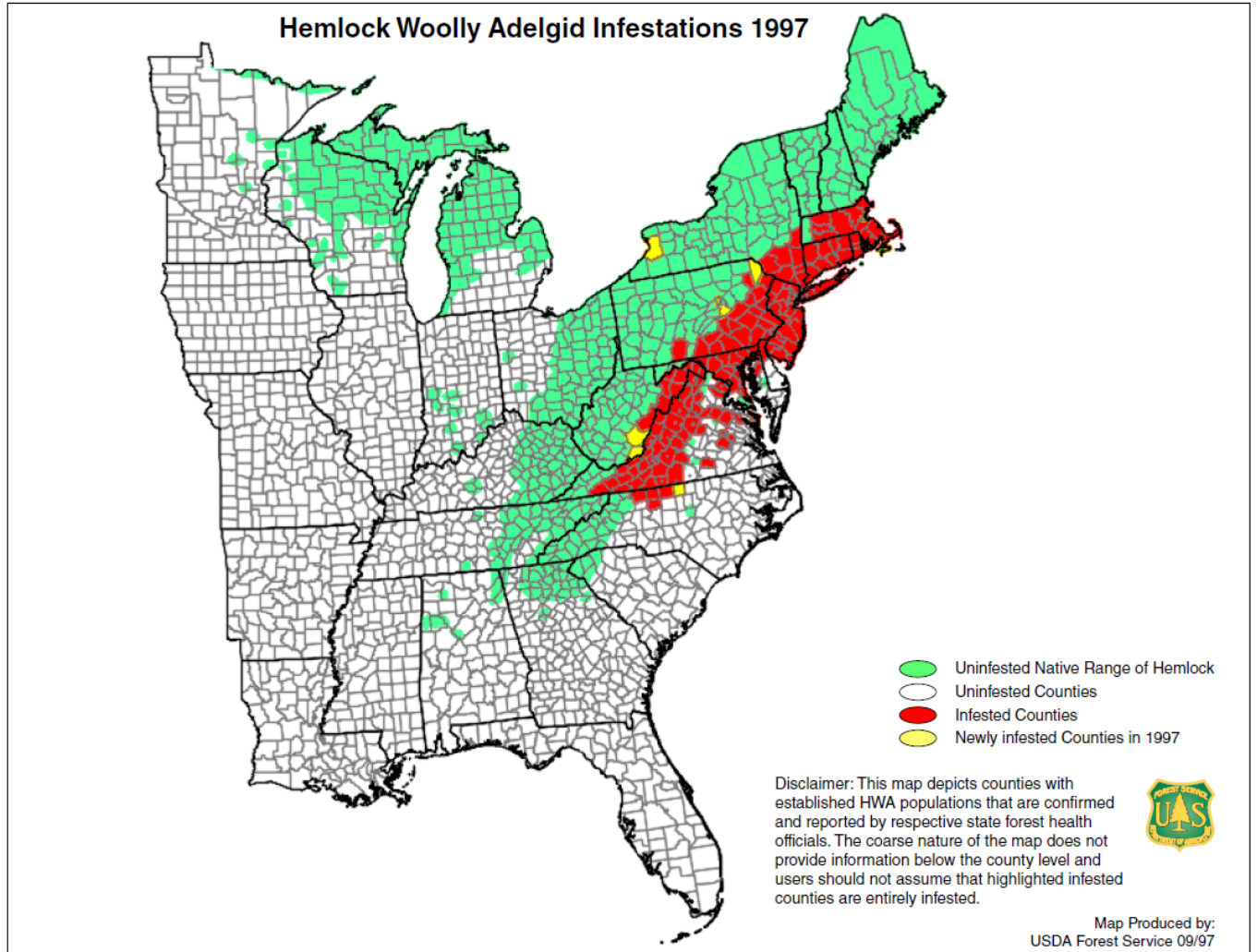
Amanda Poole  
North Carolina Forest Service – Administrative Services Division Director  
N.C. Department of Agriculture and Consumer Services  
[amanda.poole@ncagr.gov](mailto:amanda.poole@ncagr.gov)  
919-857-4853  
1616 Mail Service Center, Raleigh, NC 27699-1600

## Appendix A

# Hemlock Woolly Adelgid (*Adelges tsugae*) Life Cycle



## Appendix B



## Appendix C

