N.C. Department of Agriculture and Consumer Services

N.C. Forest Service

Annual Legislative Report on hemlock restoration

Oct. 1, 2024

Steve Troxler, Commissioner
Greg Hicks, 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 2024.

Contents

***Cover photo: HRI photo from a conservation area illustrating the importance of hemlock to water quality.**

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

The wide range of hemlock trees extend south from New Brunswick and Nova Scotia in Canada to Alabama along the Appalachian Mountains, and as far west as Minnesota, with isolated populations existing east and west of the normal range. In North Carolina, hemlocks are a significant part of the 18.7 million acres of forestland. Hemlocks are present throughout the Appalachian Mountains, descending into the foothills and isolated 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. There are two hemlock species in North Carolina; eastern hemlock (*Tsuga canadensis*) and Carolina hemlock (*Tsuga caroliniana*). Eastern hemlock dominates the range previously mentioned above. In contrast, Carolina hemlock is a Southern Appalachian endemic, restricted to western North Carolina, with smaller populations occurring in Virginia and Georgia. North Carolina is home to roughly 80% of the naturally occurring Carolina hemlock, a unique position for our state.

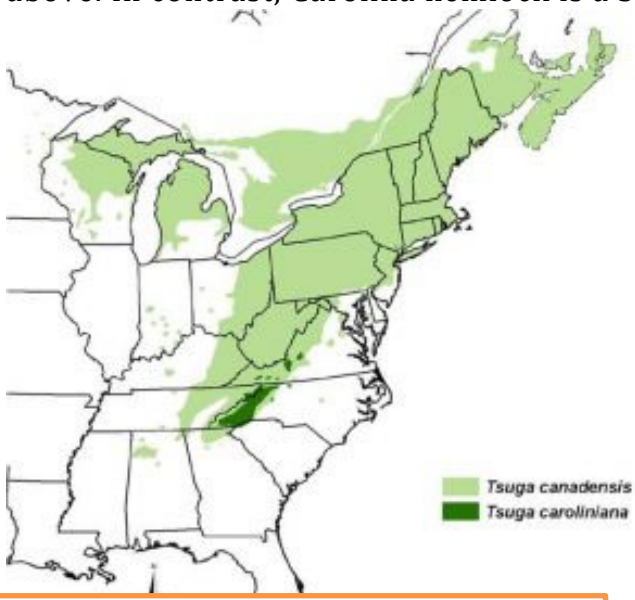

Figure 1: The range of eastern and Carolina hemlock.

Hemlocks are foundational species in the forest ecosystems of our state and beyond. They're a lasting tree species capable of obtaining a large size. It's not unusual for hemlock trees to live for hundreds of years, with the oldest known individuals exceeding 800 years. One of the largest eastern hemlocks on record obtained a diameter of 76 inches and a height of 175 feet. Hemlocks have long

been referred to as "the redwood of the east."

A foundational species is necessary 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 maintaining a microclimate in the understory conducive to the survival of many other plants and animals. In addition, hemlock is shade tolerant and can maintain a full crown, even under the cover of other trees including other hemlocks. These characteristics make it a vital source of winter cover for various wildlife species such as ruffed grouse, white-tailed deer and eastern cottontail rabbit. American black bear commonly use eastern hemlock cavities for winter denning. It also provides critical shading for mountain streams, helping maintain stream temperatures adequate to support many aquatic organisms including several species of salamanders and native brook trout. Hemlock forests are essential to the survival of more than 90 different bird species, 120 vertebrates and numerous plant communities, some of which are listed as threatened or endangered on the state or federal level. Included here are the piratebush, blackpoll warbler and eastern hellbender.

Figure 2 left to right:
Piratebush photo by Will Cook.
Blackpoll warbler photo by Simon Boivin/Maccaulay Library.
Eastern hellbender photo by N.C. Wildlife Resources Commission.

Hemlock forests also have a significant impact on many human activities. Many tend to think of forested areas being used for campsites and recreation areas. The loss of hemlock in these areas create hazard trees that must be removed at a substantial cost or pose a direct threat to public safety as they fall. The visual impact of these dead trees influences the large tourism industry within the hemlock range. Additionally, it has been reported that dead hemlock trees falling into waterways in which they tend

to grow have contributed to destructive flooding events in the mountains in recent years.

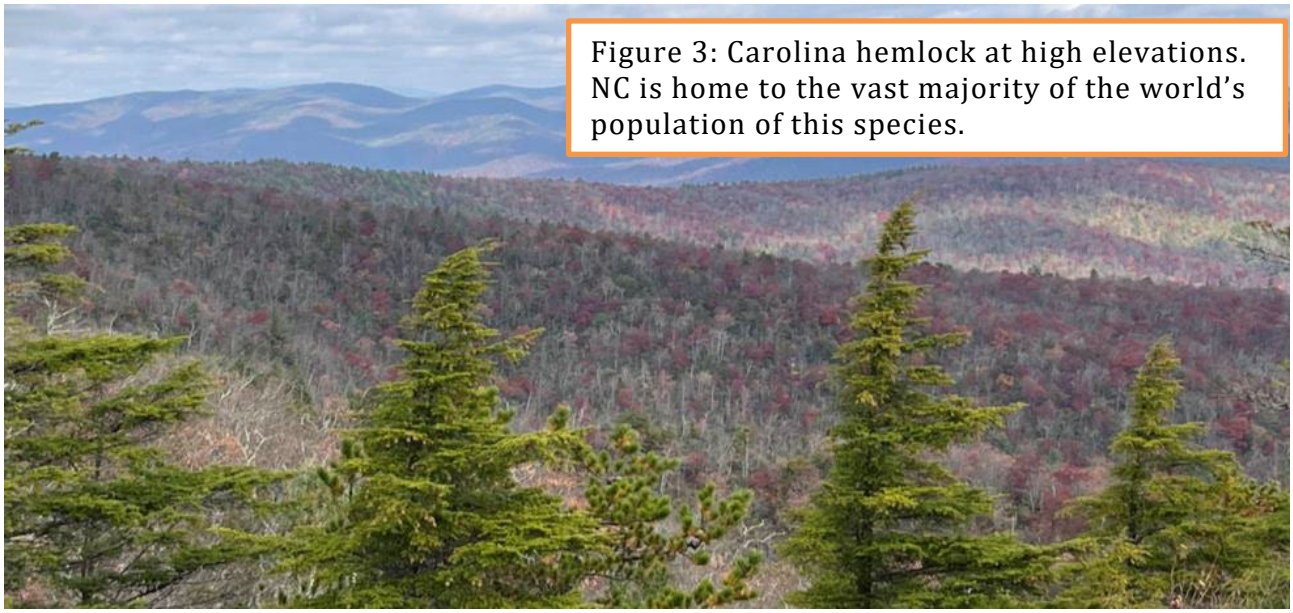

Figure 3: Carolina hemlock at high elevations. NC is home to the vast majority of the world's population of this species.

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's 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 Richmond, VA in the early 1950s. 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 (spring) and sistens (fall/overwinter) generations. The sistens generation is active and feeds during the winter. This is when most pesticide treatments occur. Although HWA has both males and females in its native range, only females exist in eastern North America. In their native range, where sexual reproduction occurs, males feed on tiger-tail spruce. This portion of the life cycle has not been shown to occur in eastern North America as our native red spruce does not seem to support male HWA. In eastern North America, HWA has an abbreviated life cycle where females are parthenogenic, or able to reproduce asexually.

Figure 4: A heavy infestation of hemlock wooly adelgid. Each wool enclosure contains either adelgids or eggs. Inset: A hemlock woolly adelgid showing its feeding tube. Photo by Kelly Oten, NCSU.

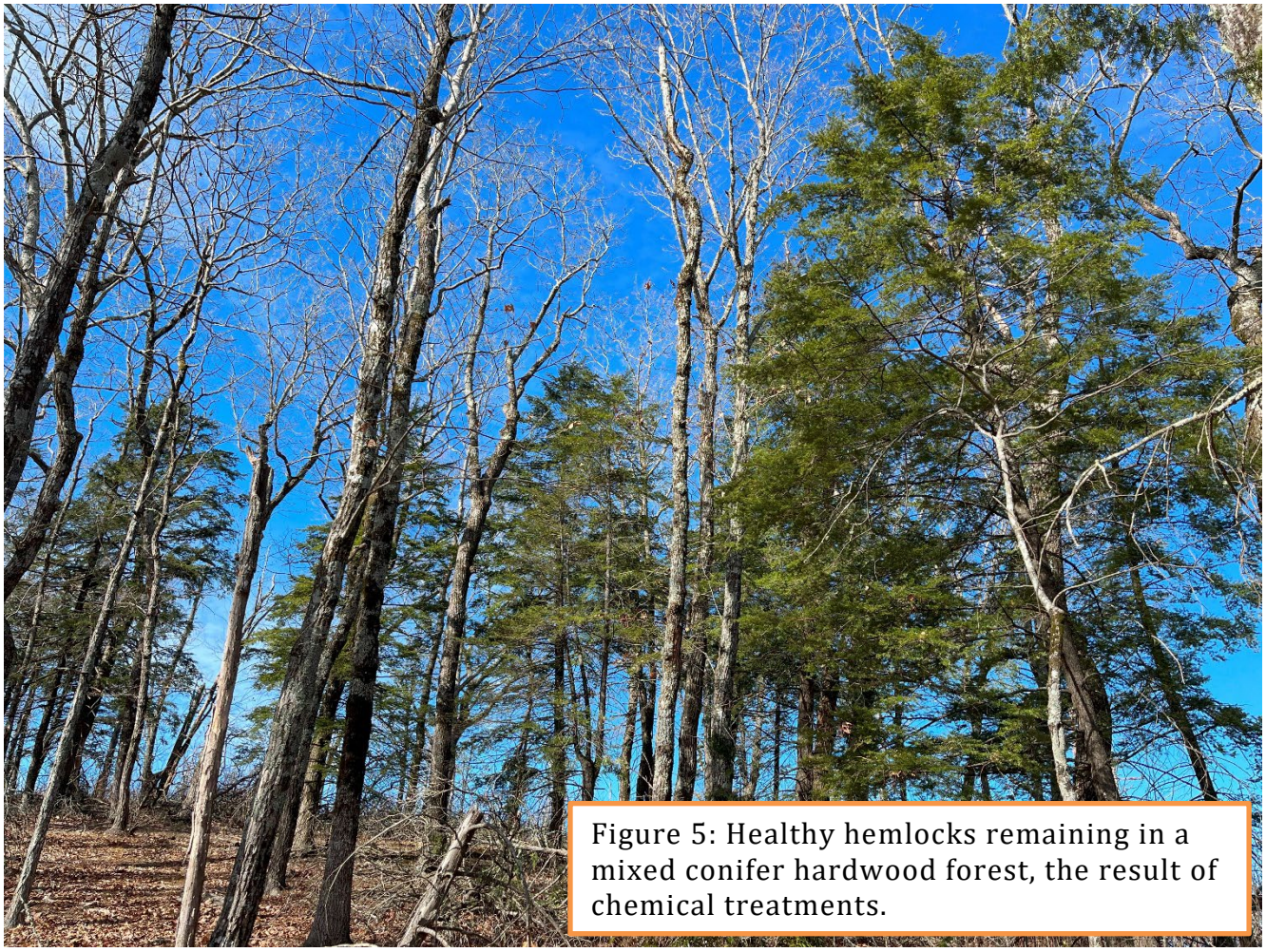

Figure 5: Healthy hemlocks remaining in a mixed conifer hardwood forest, the result of chemical treatments.

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

In 1995, HWA was detected in Stokes and Surry counties. The invasion expanded steadily to the point that most of the hemlock range in North Carolina was infested by 2007. That same year, widespread mortality was noticed in the earlier infested areas (Appendix B).

Following initial detection, control methods centered around trees in urban locations or areas heavily traveled by people such as campgrounds. Much of the original response consisted of outreach and provision of insecticides and technical advice to those desiring to treat hemlocks. This was done by forest health professionals with the N.C. Forest Service (NCFS) and other selected NCFS personnel.

The NCFS began treatments on state lands in 2007, with the first treatments taking place at Dupont State Recreational Forest (DSRF). The following year, NCFS facilitated the treatment of trees 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 NCFS efforts.

In 2011, the NCFS was transferred from the N.C. Department of Environment and Natural Resources 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 objective for Agriculture Commissioner Steve Troxler, culminating in the formation of the Hemlock Restoration Initiative (HRI) as a signature program in 2014. This program is operated under the nonprofit WNC Communities and has been funded through NCDA&CS, federal grants obtained by NCFS and state appropriations. A large portion of the control of HWA and hemlock restoration was transferred to HRI following the formation of the program.

Hemlock restoration continues to be a cooperative effort between NCDA&CS and WNC Communities. Within NCDA&CS, NCFS and the Beneficial Insects Lab under the NCDA&CS Plant Industry Division are the main cooperators. Numerous other state and federal agencies and private partners are involved including the N.C. Division of Parks and Recreation, the NCWRC, the U.S. Department of Agriculture Forest Service (USFS) and many others. The remainder of this report will focus on accomplishments related to the HRI culminating in a summary of accomplishments from the 2023-2024 fiscal year.

Hemlock Restoration Initiative goals and accomplishments: 2014 to present

Hemlock Restoration Initiative goals

The Hemlock Restoration Initiative goals and measures of accomplishment are:

- Identifying and establishing hemlock conservation areas (HCA) – *Number of HCAs established.*
- Educating landowners on how to economically treat and manage the hemlocks on their properties – *Number of outreach programs, social media posts and engagement and additional trees treated on private lands.*
- Increasing the number of trees being treated on public lands – *Number of trees treated and cumulative inches of diameter (breast height) treated.*
- Implementing Integrated Pest Management (IPM) and long-term biological control of HWA – *Number of sites and counties in which HWA predators recovered. Number of release sites for HWA predators.*
- Advancing the development of other control strategies and restoration techniques including the search for HWA resistant trees and the growing conditions that hemlocks like best – *Number of impact plots established or*

revisited. Pounds of hemlock cones collected. Number of hemlock seedlings produced.

Overall accomplishments

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

- 206 hemlock conservation areas established on state, private and federal lands.
    - 31 separate state properties are represented in this list.
- All hemlock conservation areas have received Phase I treatments (chemical). Areas scheduled for return treatments are being evaluated for Phase II treatments.
    - Phase II treatments are based on the presence of beneficial predators of HWA and consist of partial chemical treatments to promote the growth of beneficial insect populations.
- Approximately 138,000 hemlocks have been chemically treated.
- 273 educational outreach events were conducted.
- 1,080 individual inquiries from landowners and the public serviced.
- 7,916 trees have been reported to have been treated because of this information sharing.
- 2,119 volunteers have been recruited, resulting in 7,184 service hours.
- 22,248 predatory *Laricobius* beetles released for biocontrol across North Carolina.
- More than 7,604 *Laricobius* beetles recovered from more than 130 locations, many not documented release sites.
- *Laricobius* beetles documented in 17 of the 27 counties within the hemlock range.
- Seven *Laricobius* insectary sites established, five on state lands.
- Collection of beetles and support for NCDA&CS Plant Industry Division's Beneficial Insects Lab and University of Tennessee's Lindsay Young Beneficial Insect Lab.
- Raising of three separate species of predatory beetles within North Carolina.
- 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 130,000 hemlock seedlings were produced for sale.

Figure 6: NCFS Forest Health Invasive Species Treatment crew members treating Carolina hemlock on South Mountains State Park.

Hemlock Restoration Initiative accomplishments: 2023-2024 Fiscal Year

Throughout the 2023-2024 fiscal year, North Carolina's HRI continued to work toward achieving its goals. The three major entities involved: the NCFS, NCDA&CS Plant Industry Beneficial Insects Lab and WNC Communities HRI, worked together and in concert with partners to achieve the following:

- 28,747 hemlocks treated chemically
- 26 hemlock conservation areas with Phase II treatments.
- 21 new hemlock conservation areas established.
- Eight new impact plots were established to measure the effects of treatments over time.
- 27 educational and outreach programs organized and presented.
- 51 partner/stakeholder meetings organized and/or attended.
- 126 social media posts generated.
- 10,346 social media engagements from the public.
- 167 hemlock inquiries serviced.
- 469 additional hemlocks were treated by private individuals because of outreach activities.
- Establishment of two new insectaries in Wilkes County slated for Laricobius osakensis release.
- 43% emergence of 110 Laricobius ozakensis larve held in cups at the Beneficial Insects Lab this past year.
- Continuation of surveys and collection of Sasajiscymnus tsugae (released 2002-2015) indicating a viable population of this predatory insect. Some at distance from known release sites, 11 sites have yielded recovery to date.
- Laricobius documented in 18 sites over nine counties indicating widespread establishment.
- Currently holding 1,900 Laricobius larvae in soil containers for emergence this fall. Some of these will stock the new Wilkes County insectaries.
- Laricobius egg release study implemented with more than 900 eggs released as part of this study.
- 60,384 hemlock seedling cells sown (48,348 eastern hemlock/12,036 Carolina hemlock).
- Continued work and replanting of eastern and Carolina hemlock for seed production at Morganton Forestry Center.

Figure 7: HRI staff conducting a public workshop on hemlock treatment, FY23-24.

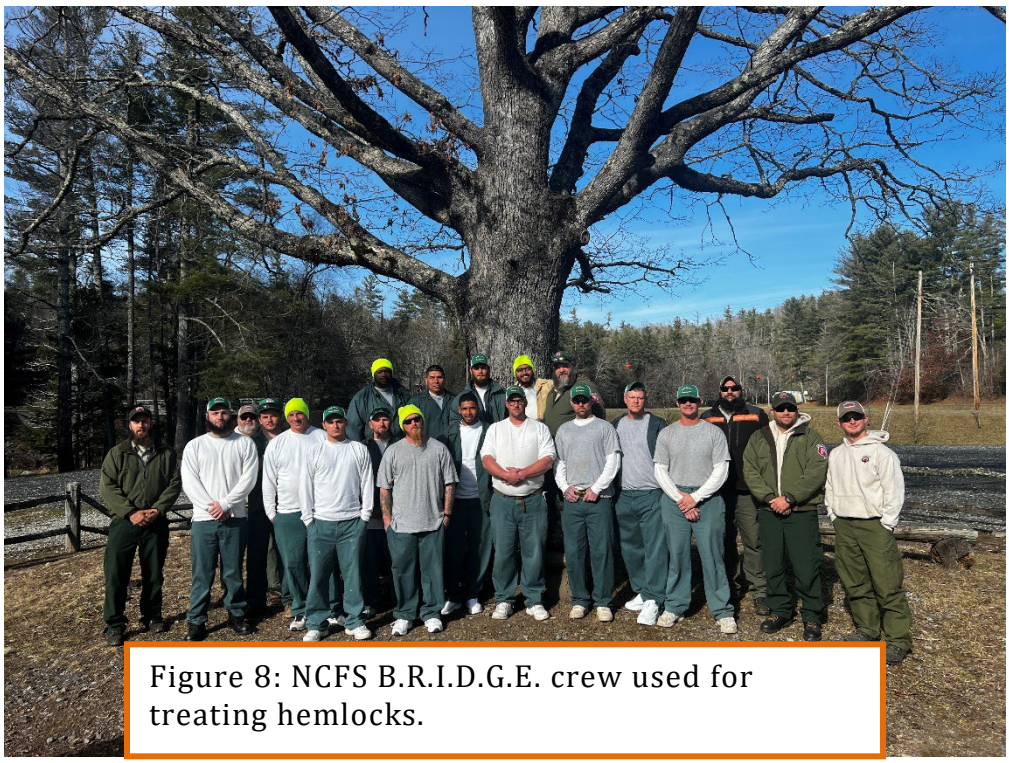

Figure 8: NCFS B.R.I.D.G.E. crew used for treating hemlocks.

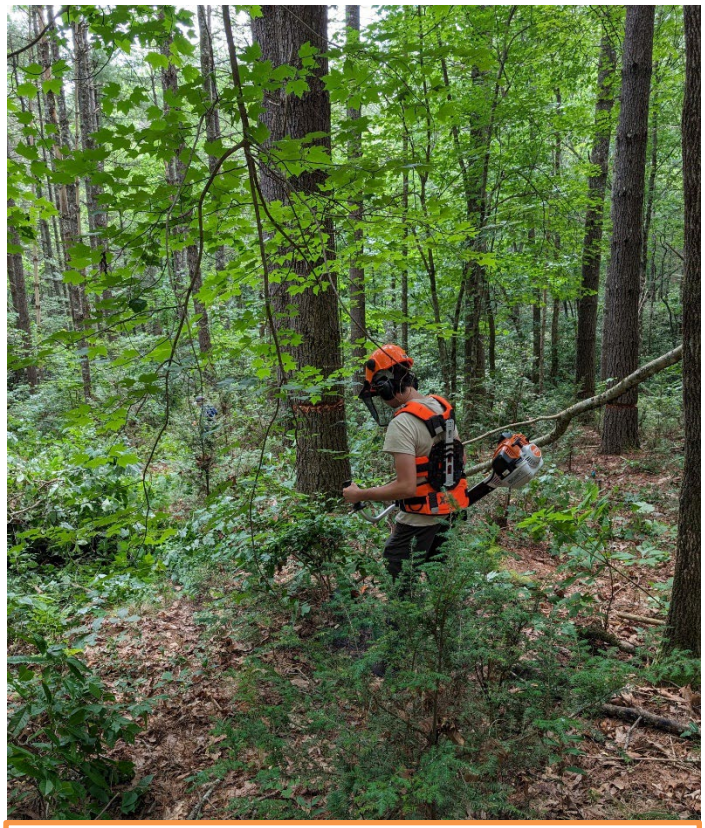

Figure 9: Promotion of hemlock regeneration to establish a field insectary.

Figure 10: HRI treatment crew in action.

Figure 11: Carolina hemlock seedling protected with a tree shelter at Morganton Forestry Center.

Figure 12: Sampling for beneficial insects at the Bald Knob Hemlock Conservation Area.

Contact information

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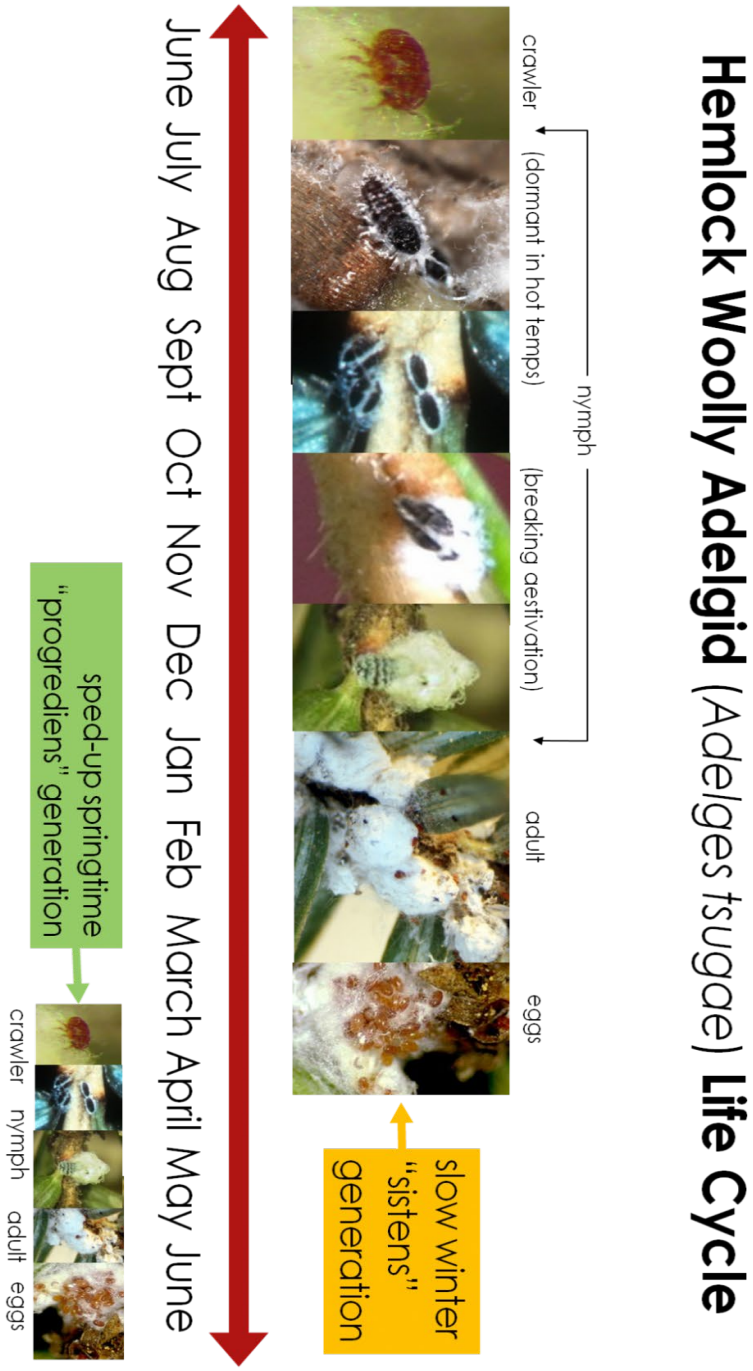
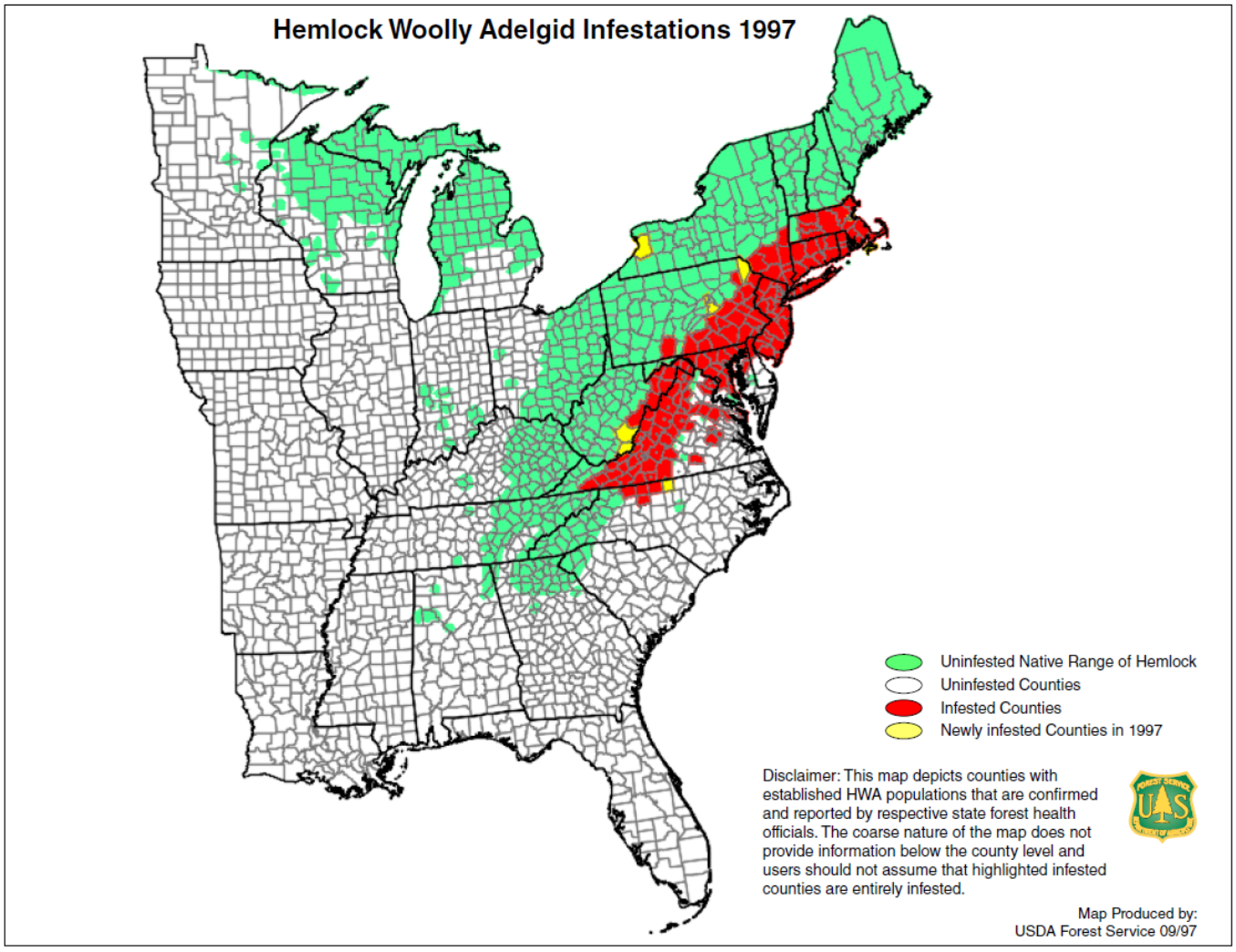
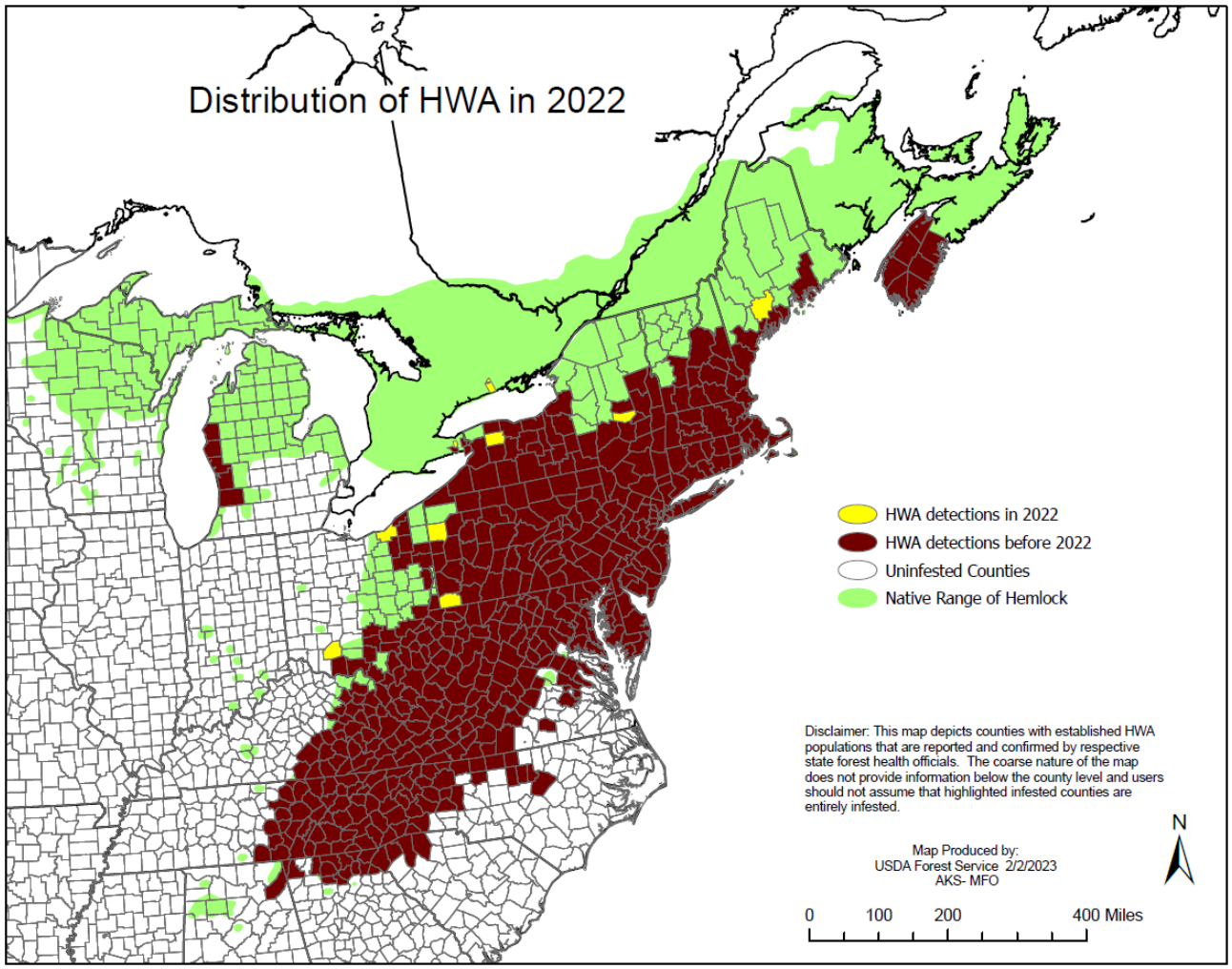
Appendix A


Hemlock Woolly Adelgid (Adelges tsugae) Life Cycle
crawler
(dormant in hot temps)
nymph
(breaking aestivation)
adult
eggs
slow winter "sistens" generation
June July Aug Sept Oct Nov Dec Jan Feb March April May June
sped-up springtime "progrediens" generation
crawler
nymph
adult
eggs

Appendix B


Hemlock Woolly Adelgid Infestations 1997
Uninfested Native Range of Hemlock
Uninfested Counties
Infested Counties
Newly infested Counties in 1997
Disclaimer: This map depicts counties with established HWA populations that are confirmed and reported by respective state forest health officials. The coarse nature of the map does not provide information below the county level and users should not assume that highlighted infested counties are entirely infested.
Map Produced by:
USDA Forest Service 09/97

Appendix C


Distribution of HWA in 2022
HWA detections in 2022
HWA detections before 2022
Uninfested Counties
Native Range of Hemlock
Disclaimer: This map depicts counties with established HWA populations that are reported and confirmed by respective state forest health officials. The coarse nature of the map does not provide information below the county level and users should not assume that highlighted infested counties are entirely infested.
Map Produced by:
USDA Forest Service 2/2/2023
AKS- MFO
N
0 100 200 400 Miles