

Status of Gene Conservation for Eastern and Carolina Hemlock in the Eastern United States

Robert M. Jetton¹, W. Andrew Whittier¹, William S. Dvorak¹, and James “Rusty” Rhea²

¹Camcore, Department of Forestry & Environmental Resources
North Carolina State University, 2720 Faucette Drive, Raleigh, NC, 27695

²USDA Forest Service, R-8, Forest Health Protection
200 W.T. Weaver Boulevard, Asheville, NC 28804

ABSTRACT

Since 2003, Camcore (NC State University) and the USDA Forest Service have worked together to conserve the genetic resources of eastern (*Tsuga canadensis* Carrière) and Carolina (*T. caroliniana* Engelm.) hemlocks threatened by the hemlock woolly adelgid (*Adelges tsugae* Annand). The objectives of this 3-phase cooperative effort are to make genetically representative seed collections from populations distributed across the geographic range of each species, establish *ex situ* conservation plantings both inside and outside the United States, and place seeds into long-term cold storage. The overall goal is to maintain viable populations in perpetuity until hemlock restoration is possible. Here we present an update on our progress with seed collections and conservation bank establishment.

KEYWORDS

ex situ gene conservation, germplasm, *Tsuga canadensis*, *Tsuga caroliniana*, *Adelges tsugae*

INTRODUCTION

Camcore (International Tree Conservation and Domestication, NC State University) and the USDA Forest Service Forest Health Protection have been cooperating since 2003 on an east-wide effort to conserve the genetic resources of eastern (*Tsuga canadensis* Carrière) and Carolina (*T. caroliniana* Engelm.) threatened by the hemlock woolly adelgid (HWA, *Adelges tsugae* Annand). The objective of this project is to maintain, in perpetuity, viable *ex situ* populations and seed reserves of both hemlock species for breeding and restoration activities once effective HWA management strategies are in place in the eastern United States. These *ex situ* reserves will also serve as an insurance policy against the “worst-case” scenario where the adelgid completely eliminates hemlock from eastern forest ecosystems.

The strategy and rationale for hemlock gene conservation have been presented in past HWA Symposia proceedings (Tighe et al. 2005; Jetton et al. 2008). Restated briefly, the goals of this 3-phase, 10-year project are to:

- 1) collect seed from up to 10 mother trees in a many Carolina hemlock populations as can be located (Phase 1)
- 2) collect seed from up to 10 mother trees in 60 populations (600 trees) of eastern hemlock in the Southern Region (Phase 2)
- 3) collect seed from up to 10 mother trees in 60 populations (600 trees) of eastern hemlock in the Northern Region (Phase 3)

Some seeds are being used to establish *ex situ* conservation plantings/breeding orchards both inside and outside the United States (Chile and Brazil), while the remaining seed will be catalogued in seed banks at Camcore (NC State University) and the National Tree Seed Laboratory (Dry Branch, GA). This article reports on progress made through the first seven years of the project.

PROGRESS ON SEED COLLECTIONS

Carolina Hemlock: A total of 26 Carolina hemlock populations have been identified in the Southern Appalachian region. Between 2003 and 2009 seed was collected in 18 of these from a total of 126 mother trees (Figure 1; Table 1). The number of mother trees sampled ranges from a few as 1 to as many as 12 trees per population (Table 1). In the fall of 2010, we plan to collect seed from one additional population located on Looking Glass Mountain in the Pisgah National Forest, North Carolina. We will also confirm 5 additional populations that have been reported in North Carolina at Bat Cave, Cloven Cliff, Kelsey Tract, Shope Creek, Big Fork Knob, and Young's Ridge.

[insert Figure 1 here]

[insert Table 1 here]

Eastern Hemlock: Between 2005 and 2009 seed has been collected from 34 populations of Eastern hemlock, 33 that are located in the Southern Region and one in the Northern Region, Cook Forest State Park in Pennsylvania (Figure 2). These represent collections from 232 mother trees ranging from 1 to 24 trees sampled per population (Table 2). Seed collections planned for the Southern Region in the fall of 2010 include Chimney Rock State Park (Poole's Creek area) in North Carolina, Hemlock Falls and Anna Ruby Falls on the Chattahoochee National Forest in Georgia, and Paint Creek Campground on the Cherokee National Forest in Tennessee. In late August 2010 we will also explore populations located at Mammoth Cave National Park in Kentucky and the Bankhead National Forest in Alabama. As of the writing of this article plans for seed collections in the Northern Region for 2010 have not been finalized but will be attempted.

[insert Figure 2 here]

[insert Table 2 here]

PROGRESS ON CONSERVATION BANK ESTABLISHMENT

Carolina hemlock conservation banks have been established in Chile and North Carolina. The Chile planting was established by Camcore Cooperative member Bioforest-Arauco in September 2008 at Predio Cuyimpalihue in the Los Alamos region of the country. A total of 1,400 seedlings were planted representing 9 populations and 56 families (mother trees) from across the Carolina hemlock geographic range. As of June 2010, survival in the planting was 85%, and Bioforest-Arauco is currently preparing to propagate cuttings from the planted seedlings to be used in the establishment of a second conservation bank in Chile.

The North Carolina planting was established by Camcore in 2008 at the NC State University/NC Department of Agriculture Upper Mountain Research Station in Ashe County. Four hundred seedlings representing 9 populations and 53 families from across the Carolina hemlock range were planted, and as of June 2010 survival in the plot was 91%. We plan to establish an additional Carolina hemlock conservation bank in North Carolina with 411 seedlings, representing 8 populations and 31 families, currently being cultivated in pots at the Upper Mountain Research Station.

Camcore Cooperative member Rigesa (MeadWestvaco) will plant conservation banks for both eastern and Carolina hemlock near Três Barras, Santa Catarina State, Brazil in September 2010. The eastern hemlock plot will be planted with 177 seedlings representing 7 populations and 26 families from the southern portion of the species' native range. The Carolina hemlock plot will be planted with 231 seedlings representing 9 populations and 41 families from across the Southern Appalachian Mountains.

SUMMARY

Camcore and the USDA Forest Service continue to make progress on the genetic conservation of eastern and Carolina hemlock. Hemlock seed has been collected from a total of 52 populations and 358 mother trees (eastern and Carolina combined). Carolina hemlock conservation plantings have been established in Chile and the United States (North Carolina), and conservation banks for both species will be planted in Brazil in 2010. Although we continue to make steady progress, this project is not without its challenges. As conservation efforts expand into the Northern Region far removed from our home base in Raleigh seed collections will be challenging without the support and cooperation of resources managers in the region. Difficult to predict seed cycles and cone ripening rates and the severity of HWA related decline confound our ability to locate healthy hemlock stands producing suitable amounts of high quality seed. Fortunately, through research on seed biology and stratification treatments we have been able to improve the germination capacity in some of our seed stocks (Jetton and Whittier, unpublished data). Our overseas conservation banks offer the advantage of being far removed and reasonably secure from HWA infestation, but they also carry the disadvantage of distance and being difficult to monitor on a regular basis. Furthermore, world-wide restrictions on the movement of germplasm are becoming more stringent each year, putting future hemlock seed shipments and conservation bank establishment in doubt. This leaves us to wonder if we should consider establishing more chemically protected plantings within the native range.

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