North Carolina Forest Service

Department of Environment and Natural Resources
Division of Forest Resources

Cooperative Hemlock Woolly Adelgid Response Report

2001-2010

Introduction

The hemlock woolly adelgid, a tiny aphid-like insect, originated in Asia and was detected in the eastern United States in the 1950's.

The insect attacks and kills both eastern and Carolina hemlocks, the only two hemlock species native in North Carolina. The hemlocks usually die within a few successive years of infestation.

Since first being observed in Richmond, VA, in the 1950's, the HWA has quickly spread across approximately half of the native range of hemlocks in the eastern United States. These insects can spread in a variety of ways including by wind, animals, or people.

No hemlock is safe from HWA. The insect causes the needles to fall off by feeding at the base of the needles and thereby preventing an adequate flow of nutrients. The tree cannot survive without its needles. Since all HWA are females that reproduce asexually, there are very large numbers of eggs produced in each generation and there are two generations per year in North Carolina.

The HWA has the potential to cause devastation reminiscent of the chestnut blight which decimated the American chestnut in the last century.

Hemlocks are an important species in the mountain counties of North Carolina. They are long lived and provide a multitude of benefits to the forests around them. They provide shade that helps regulate stream and forest floor temperatures. Stream shade from hemlocks provides a favorable habitat for many native fish, amphibians, and aquatic invertebrates. The branches are used by many species of birds as nesting sites, including some birds which nest exclusively in hemlocks.

History of HWA in North Carolina

In 1995, the first detections of HWA in North Carolina were recorded. Initial adelgid infestations were confined to counties along the Virginia state line. From the time of the first detections until 2002, there was no reported hemlock mortality and the adelgid was thought to be spreading very slowly. During this period, the mountain region of North Carolina was also experiencing a devastating outbreak of southern pine beetles and much attention was directed toward controlling this pest.

Because of reports of HWA in other locations in the western one-third of the state, a survey was conducted beginning in 2001. By the end of 2002, adelgid infestation was documented in 19 mountain counties (the presence of the pest in one tree in a county is enough to consider the county infested). Infestations were considered to mostly be light and scattered and no hemlock mortality was recorded.

The Division of Forest Resources continued annual surveys of undocumented counties and by 2007, all mountain counties in the state were infested. While scattered mortality may have been present as early as 2005, widespread mortality was not observed until around 2007 in the counties that were previously infested. Adelgid detections continued to spread throughout the piedmont and by summer, 2010, all counties within the historic range of hemlocks in the state were infested.

History of HWA Control in North Carolina

The HWA is a difficult insect pest to manage. Because it is not native to North Carolina, there are no effective natural enemies to keep HWA in balance. The insect is also difficult to detect until population levels are high. Control of this pest with traditional insecticides is limited to individual tree treatments in readily accessible, non-environmentally sensitive areas.

Application of systemic insecticides has been the primary control method used on state and private lands, and limited release of several species of predatory beetles has occurred on public lands. Most chemical control efforts are limited to urban landscape trees, and trees of high aesthetic, historical, or sentimental value on both public and private lands. There are currently no practical means to chemically control the pest in more remote areas and along sensitive streams.

The release of predatory beetles is in transition from the research only phase to the implementation phase. While there is hope that these beneficial insects will provide some level of control, there is no claim that predatory beetles are the "silver bullet" needed to protect residual and future hemlock forests.

The North Carolina Division of Forest Resources (NC DFR) identified a number of ways to provide proactive detection and management of HWA on state and private lands. In addition to monitoring and surveying pest damage, a major component of the Division's program is to provide technical advice for private lands, homeowners, and municipalities; prepare and distribute information and educational materials; and controlling HWA populations affecting critical select trees in state forests and other state lands.

Private Land. Since the first reports of HWA in the state, DFR personnel have received thousands of calls from landowners and homeowners asking for assistance with controlling this pest on their properties. DFR's Pest Control Branch personnel are tasked with providing up-to-date information on the spread, detection, biology and control of the pest to the agency's field personnel. This was done through trainings, talks at personnel meetings, correspondence, publications, and through individual personal contact. Field personnel used this information to provide technical assistance to concerned property owners in their work areas. Many of these landowners provided control within their means on their own properties.

State-Owned Land. Because treatment is labor intensive and expensive (pesticides must be applied to each tree individually) chemical treatment on public lands is limited primarily to trees near visitor centers, campgrounds, scenic road and trails, and near certain streams. There is no

economical or eco-friendly way to treat large areas of land. In anticipation of hemlock mortality on state forests, Pest Control Branch personnel offered both training and insecticides for control of HWA on these state-owned lands as early as 2005. In 2007, DuPont State Forest and Holmes Educational State Forests began treating hemlocks on their properties. In addition, there were also some releases of predatory beetles by the US Forest Service and the Friends of DuPont State Forest. At the same time, training and insecticides were offered to the Division of Parks and Recreation and the Wildlife Resources Commission for treatment of hemlocks on state parks and gamelands. The first chemical treatments with DFR involvement on state parks (South Mountains State Park) began in the fall of 2008, and on gamelands in the spring of 2009.

Treatment Plan/Objectives

The major goals related to treatments for hemlock woolly adelgid on state lands are as follows:

- Minimize damages caused by hemlock wooly adelgid (economic, public safety and aesthetic).
- Reduce negative ecological impacts resulting from hemlock woolly adelgid infestations.
- Minimize potential negative impacts of treatments used to manage hemlock woolly adelgid.
- Minimize the spread of hemlock woolly adelgid within the range of eastern and Carolina hemlocks.
- Increase level of communication and outreach amongst state agencies, researchers, landowners/homeowners, and the public.

Pesticides are available to state agencies for treatment of HWA on their properties. Treatments vary depending on the tree size, tree location, and overall tree health. The primary chemical used for treating and protecting hemlocks from the HWA is imidicloprid. When applied early in the infestation of HWA on a given tree, this chemical has been found to effectively protect the treated hemlock for 2-3 years before retreatment is necessary. Without treatment of these trees, tree mortality is inevitable.

Treatments

Thanks to a grant from the USDA Forest Service, the DFR has been able to provide imidicloprid to state forests and cooperating state agencies for treatment of high value hemlocks. The cooperating agencies, which currently include the N.C. Wildlife Resources Commission and N.C. State Parks, are responsible for determining which trees should be considered for treatment. Trees chosen for treatment may be based on criteria such as proximity to trails, campgrounds, ecologically significant locations, species of hemlock present, or others. While the majority of reported treatments used soil drenching, other methods such as soil injection and Coretect tablets were also utilized where appropriate.

Personnel who treat the hemlocks are provided hands-on training in identification of infestation progression, pesticide application procedures, and proper handling of the pesticides in

accordance with all product labeling. In addition, personnel are asked to record the location, tree species, tree diameter, and ounces of the pesticide solution used for each treated tree. This information is collected on the data sheet shown immediately following this report.

Since 2007, DFR and cooperating agencies have treated 5,000 hemlock trees. Of these treated trees, 3,837 were eastern hemlock, 809 were Carolina hemlock, and 354 trees were not identified by species. The average eastern hemlock treated was 11 inches in diameter at breast height (d.b.h.), while the average Carolina hemlock treated was about 5 inches in diameter. A detailed summary of all treatments, arranged by agency and property, is available following the summary maps at the end of this document.

Multiple releases of predator beetles have also occurred on state-owned lands. The USDA Forest Service has provided the DFR with 10,000 predator beetles since 2007. One site is located at Gorges State Park, where 1,000 beetles were released in 2007. The remaining 9,000 predator beetles were released at DuPont State Forest between 2007 and 2009. A map displaying locations of all DFR-monitored HWA predator release sites can be found following the treatment location map. Additional predatory beetle releases may have been conducted through federal and university research projects. These releases are not included in this report.

Other Efforts

The original intent of this report was to document treatments and responses directly attributed to DFR field personnel and Pest Control Branch. However, it is also important to recognize a variety of other programs and efforts within the state directed towards the conservation of hemlock forests.

Urban and Community Forestry Program (U&CF). As part of a USDA Forest Service U&CF grant, the Division of Forest Resources provided subgrants in 2003-2007 to the Blue Ridge Resource Conservation and Development Council to develop and implement plans for dealing with HWA in their area—Alleghany, Ashe, Avery, Buncombe, Burke, Caldwell, McDowell, Mitchell, Watauga, Wilkes and Yancey Counties. Accomplishments from these U&CF subgrants include: the development of a Highlands Community Strategic Integrated Pest Management Plan; providing awareness to community leaders and citizens through news releases, publications, and trainings and forums; release of 1000's of predatory *Laricobius nigrinus* and *Sasajiscymnus spp.* beetles; conducting research into the collection, release, and activities of predatory beetles and documenting recovery of hemlocks. [Note: since these grants expired, the USDA Forest Service Forest Health Protection Program has continued the HWA collection, release and research objectives listed above through other funding opportunities]

North Carolina State University's Camcore Program. Camcore through a cooperative agreement with the USDA Forest Service is in the process of conserving hemlock species through seed banking and seed orchard establishment in regions of the world suitable for growing hemlock but where HWA does not occur. Seeds have been collected from a variety of hemlock forests (including one's in state and national forests and parks) throughout western North Carolina and other areas in the eastern United States. According to Camcore's website (www.camcore.org/projects/hemlock.php), "The overall goal of the project is to preserve hemlock

gene pools in perpetuity until a time when effective HWA management strategies are in place and conserved seed resources can be utilized to repopulate depleted hemlock ecosystems. Should adelgid control remain elusive, the seed banks and conservation reserves will serve as a genetic base for breeding HWA resistant stock for reforestation."

The North Carolina Department of Agriculture and Consumer Services, Plant Industry Division (NCDA). NCDA is also active in hemlock conservation. First, NCDA regulates the movement of infested nursery stock and works with nurseries to ensure that infested plants are not moved to uninfested areas. In addition, the agency's Beneficial Insects Rearing Laboratory in Cary, NC, rears predatory *Sasajiscymnus tsugae* beetles for the USDA Forest Service guidelines to release at strategic sites.

Information and Education. Hemlock woolly adelgid related information and education materials, including brochures, bulletin board posters and fair display posters have been developed, printed and made available to appropriate DFR offices, state parks, and NCSU Cooperative Extension offices and online. These were funded by a redesign grant from the USDA Forest Service. In addition, a short online instructional video (podcast) is being developed by DFR staff to show how to safely control HWA through pesticide soil drenching. NC State Extension also provides online recommendations for HWA control in landscapes (www.ces.ncsu.edu/depts/ent/notes/Ornamentals_and_Turf/trees/note119a/note119a.htm).

United States Department of Agriculture, Forest Service, Forest Health Protection Program. Leadership, guidance, coordination, research and funding for hemlock woolly adelgid related activities in the eastern United States is provided to state and federal agencies and to colleges and universities by the USDA Forest Service.

Conclusion

Unfortunately, high rates of mortality are already occurring throughout the hemlock forests of North Carolina and no one knows what the future will hold for the hemlock species across the East Coast. Our hope is that through monitoring and continued treatments, we will be able to save some of the most prized hemlocks on state lands for future generations to enjoy. Without these treatments occurring, it is doubtful that any of our local hemlocks will survive the current attack from this invasive pest.

Property Name & Agency:_____

Contact Person (Name, Address, Phone, and Email):_____

Ounces of water used per packet:_____ oz.

Total # of 1.6 oz. packets used:_____

Chemical applcation method:_____

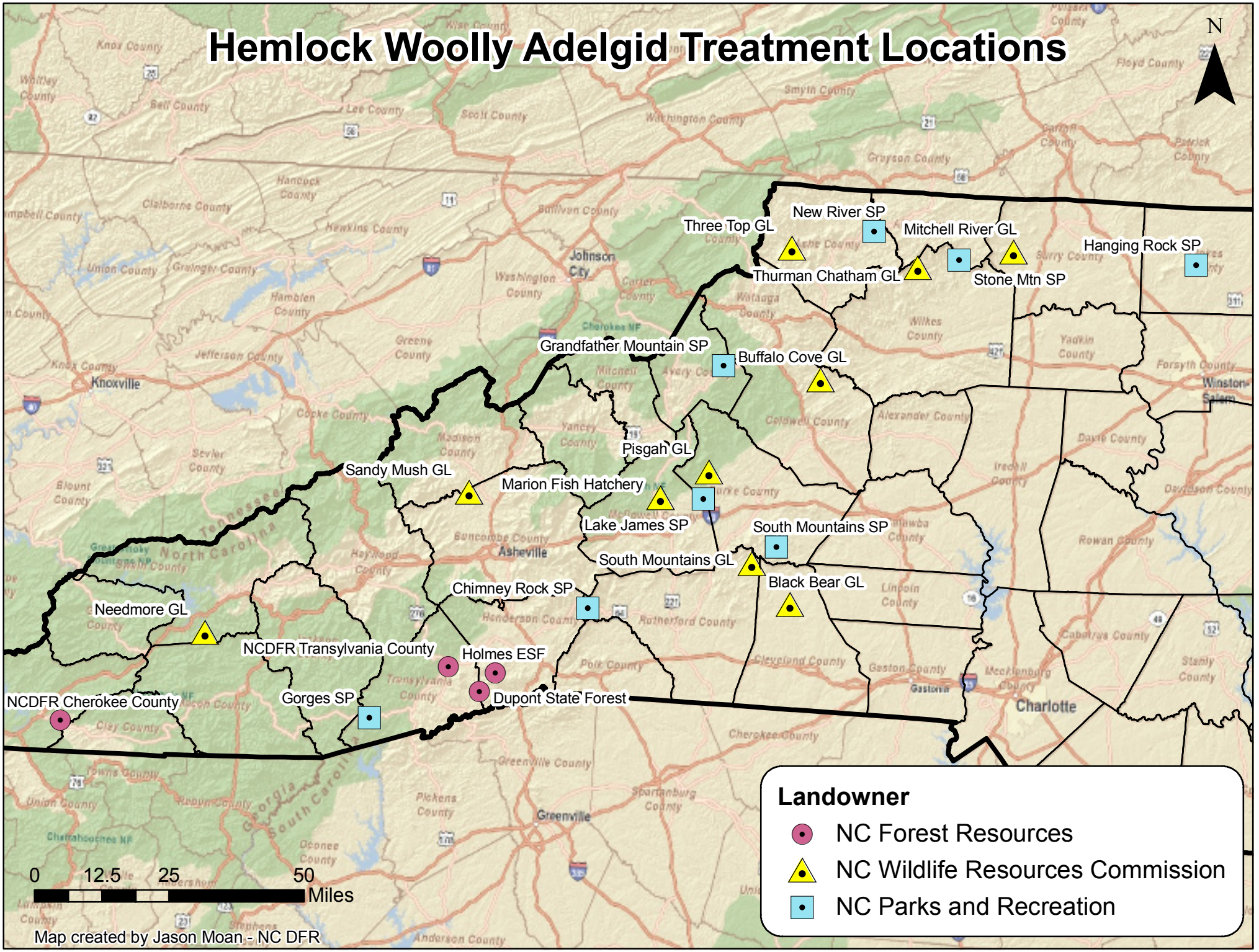
Instructions: Please fill out this worksheet or the accompanying spreadsheet for all trees treated for HWA. Data MUST be returned in a digital format to

Brian Heath, NC DFR Pest Control Forester - West, Morganton Forestry Center, 220 Old Colony Road, Morganton, NC 28655

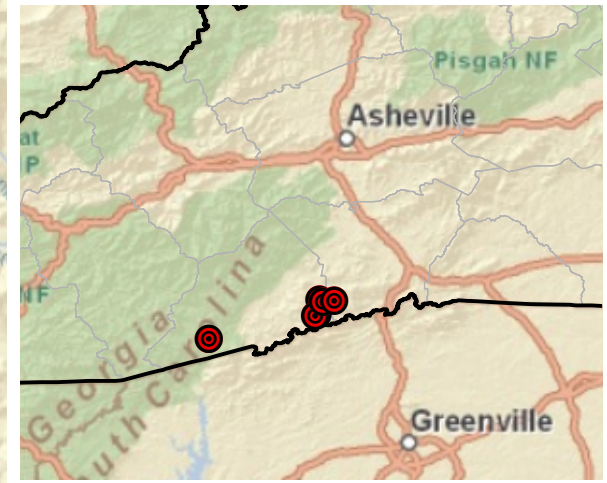
Brian can also be reached at 828-413-2291 or Brian.Heath@ncdenr.gov

Note: Please use the greyed-out example as a reference.

Tree #	Date Treated	Latitude	Longitude	Hemlock Species:		DBH	Chemical Used	Oz of solution used	Initial treatment?		Notes
				Eastern	Carolina				Yes	No	
TT-1	**4/28/2009**	**35.2346**	**-78.2342**	**X**		**12**	**Garrant**	**12**	**X**		


Hemlock Woolly Adelgid Treatment Locations
N
New River SP
Three Top GL
Mitchell River GL
Hanging Rock SP
Thurman Chatham GL
Stone Mtn SP
Grandfather Mountain SP
Buffalo Cove GL
Pisgah GL
Sandy Mush GL
Marion Fish Hatchery
Lake James SP
South Mountains SP
South Mountains GL
Black Bear GL
Chimney Rock SP
Needmore GL
NCDFR Transylvania County
Holmes ESF
Gorges SP
Dupont State Forest
NCDFR Cherokee County
Knoxville
Asheville
Charlotte
Greenville
Johnson City
Landowner
NC Forest Resources
NC Wildlife Resources Commission
NC Parks and Recreation
0 12.5 25 50
Miles
Map created by Jason Moan - NC DFR

Hemlock Woolly Adelgid Predator Releases



Name:	Buck Forest Road
Lat/Long:	35.1959, -82.6078
Date of Release:	3/14/2007, 4/1/2009
Species:	S. tsugae
Number Released:	1000, 1000

Name:	Wintergreen Falls
Lat/Long:	35.1978, -82.5837
Date of Release:	4/1/2009
Species:	S. tsugae
Number Released:	1000

Name:	Hooker Falls
Lat/Long:	35.2016, -82.6204
Date of Release:	3/14/2007
Species:	S. tsugae
Number Released:	2000

Name:	High Falls
Lat/Long:	35.1951, -82.6114
Date of Release:	4/1/2009
Species:	S. tsugae
Number Released:	1000

Name:	Gorges State Park
Lat/Long:	35.1026, -82.8941
Date of Release:	3/14/2007
Species:	S. tsugae
Number Released:	1000

Name:	Reasonover #1
Lat/Long:	35.1610, -82.6307
Date of Release:	5/7/2008
Species:	S. tsugae
Number Released:	1500

Name:	Reasonover #2
Lat/Long:	35.1636, -82.6251
Date of Release:	5/7/2008
Species:	S. tsugae
Number Released:	1500

N

0 2.5 5 Miles

Predator Release Locations

Map created by Jason Moan - NC DFR

Total HWA Pesticide Treatments on State Lands

Data cover the period between January 1, 2007 and December 31, 2010

NCDFR

Total # trees: **698**

Total DBH: **8,172**

Dupont SF

	Number of Trees	DBH
T. canadensis	395	5,894
T. caroliniana	69	680
Total:	***464***	***6,574***

Holmes ESF

	Number of Trees	DBH
Not Specified	184	1,335
Total:	***184***	***1,335***

NCDFR County

	Number of Trees	DBH
T. canadensis	50	263
Total:	***50***	***263***

NCDPR

Total # trees: **3,291**

Total DBH: **29,559**

Chimney Rock SP

	Number of Trees	DBH
T. canadensis	452	5,193
T. caroliniana	86	800

	Total:	***538***	***5,993***

Gorges SP		**Number of Trees**	**DBH**
	T. canadensis	285	3,044
	Total:	***285***	***3,044***

Grandfather Mountain SP		**Number of Trees**	**DBH**
	T. canadensis	166	2,551
	Total:	***166***	***2,551***

Hanging Rock SP		**Number of Trees**	**DBH**
	T. canadensis	7	13
	T. caroliniana	618	2,120
	Total:	***625***	***2,133***

Lake James SP		**Number of Trees**	**DBH**
	T. canadensis	199	1,975
	T. caroliniana	26	209
	Total:	***225***	***2,184***

Mount Jefferson SP		**Number of Trees**	**DBH**
	T. canadensis	2	24
	Total:	***2***	***24***

New River SP		**Number of Trees**	**DBH**
	T. canadensis	139	1,318

	Total:	***139***	***1,318***

South Mountains SP

	Number of Trees	DBH
T. canadensis	1,302	12,209
T. caroliniana	9	103
Total:	***1,311***	***12,312***

NCWRC

Total # trees: **1,011**

Total DBH: **11,816**

Black Bear GL

	Number of Trees	DBH
T. canadensis	52	597
Total:	***52***	***597***

Buffalo Cove GL

	Number of Trees	DBH
T. canadensis	104	1,171
Total:	***104***	***1,171***

Marion Fish Hatchery

	Number of Trees	DBH
T. canadensis	26	279
Total:	***26***	***279***

Mitchell River GL

	Number of Trees	DBH
T. canadensis	68	532
Total:	***68***	***532***

Needmore GL		Number of Trees	DBH
	Not Specified	50	888
	T. canadensis	147	2,389
	Total:	***197***	***3,277***

Pisgah GL		Number of Trees	DBH
	Not Specified	120	1,040
	Total:	***120***	***1,040***

Pond Mountain GL		Number of Trees	DBH
	T. canadensis	1	18
	Total:	***1***	***18***

Sandy Mush GL		Number of Trees	DBH
	T. canadensis	63	943
	Total:	***63***	***943***

South Mountains GL		Number of Trees	DBH
	T. canadensis	70	846
	Total:	***70***	***846***

Three Top GL		Number of Trees	DBH
	T. canadensis	79	766
	T. caroliniana	1	13
	Total:	***80***	***779***

	Number of Trees	DBH
T. canadensis	230	2,334
Total:	***230***	***2,334***

Grand Total:	
Total # Trees:	**5,000**
Total Inches DBH:	**49,546**