



# Current status and mortality rate of hemlock in the Southeastern U.S.



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## Introduction

Eastern hemlock (*Tsuga canadensis* [L] Carr.) and Carolina hemlock (*T. caroliniana* Engelm.) are susceptible to numerous pests and pathogens. Of particular concern, currently, is the hemlock woolly adelgid (*Adelges tsugae* Annand), first reported in Virginia in the 1950's.

Most counties where hemlock occurs in Virginia were infested by 1993. A few counties in North Carolina had adelgid infestations by 1996 (fig. 1) (USDA Forest Service 2000).

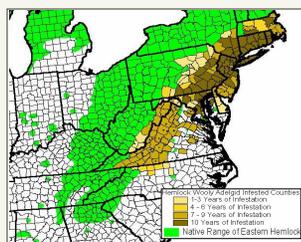


Figure 1. Hemlock woolly adelgid infestation, 2000

By 2006 hemlock woolly adelgid infestations were noted in nearly all counties where hemlock occurs in North Carolina. Infestations had also moved into Tennessee, South Carolina, Georgia, and Kentucky (fig. 2) (USDA Forest Service 2006).

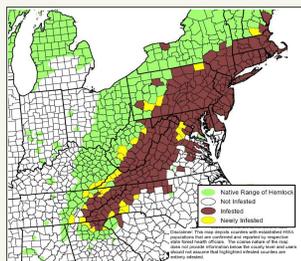


Figure 2. Hemlock woolly adelgid infestation, 2006

## Methods

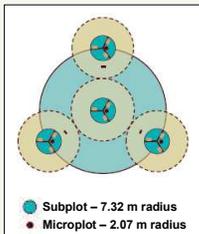


Figure 3. FIA plot design

The current status and mortality rates of hemlock were derived from data collected by the Forest Service's Forest Inventory and Analysis program (FIA)

FIA uses a fixed-radius plot consisting of 4 subplots 37 m apart (fig. 3) (USDA Forest Service 2004)

Trees  $\geq 12.7$  cm d.b.h. sampled on each subplot

Saplings (2.5 cm – 12.6 cm d.b.h.) measured on microplots

Plot sample area = 0.07 ha

Microplot sample area = 0.005 ha

Table 1. Details of mortality data on re-measured hemlock trees

	number		
	Counties	Plots	Trees
Alabama	3	6	51
Georgia	9	28	97
Kentucky	19	40	223
North Carolina	23	186	661
South Carolina	3	12	37
Tennessee	26	170	733
Virginia	32	101	440
All	115	543	2242

Mortality rate calculated as:

$$\left( \frac{\# \text{ that died} / \# \text{ alive at T1}}{\text{re-measurement period}} \right) \times 100$$

## Results

As of 2005, hemlock (*Tsuga* spp.) was tallied in 129 counties of 7 southeastern States (AL, GA, KY, NC, SC, TN, VA). Counties varied widely in density of hemlocks, however the highest concentration was in the Southern Appalachians (fig. 4).

The density of live overstory hemlock trees averaged 9.3 trees/ha for the 129 counties where hemlock was tallied (table 2). North Carolina had the highest density of live trees (15.4 trees/ha) and saplings (39.4 saplings/ha).

Table 2. Density of hemlocks by State.

	Saplings <sup>a</sup>	Trees <sup>b</sup>
	trees ha <sup>-1</sup>	
Alabama	6.9	3.9
Georgia	15.6	6.5
Kentucky	32.1	9.4
North Carolina	39.4	15.4
South Carolina	7.0	5.8
Tennessee	31.8	12.4
Virginia	11.7	5.2
All	24.6	9.3

<sup>a</sup> dbh < 12.7 cm

<sup>b</sup> dbh  $\geq 12.7$  cm

Most counties (68%) had 0% mortality per year (fig. 5). Hemlock mortality was > 2.0% per year in 20 counties, 1/2 of which were in Virginia.

Overall, mortality rates averaged 0.6% per year for trees and 1.2% per year for saplings. Virginia had the highest mortality rate for both saplings (3.6% per year) and trees (1.9% per year), and Kentucky had the 2nd highest rate for trees (1.0% per year) (table 3).

Table 3. Mortality rate of hemlock by State

	Saplings <sup>a</sup>	Trees <sup>b</sup>
	percent year <sup>-1</sup>	
Alabama	0.0	0.5
Georgia	3.5	0.0
Kentucky	0.0	1.0
North Carolina	1.3	0.7
South Carolina	0.0	0.0
Tennessee	0.1	0.3
Virginia	3.6	1.9
All	1.2	0.6

<sup>a</sup> dbh < 12.7 cm

<sup>b</sup> dbh  $\geq 12.7$  cm

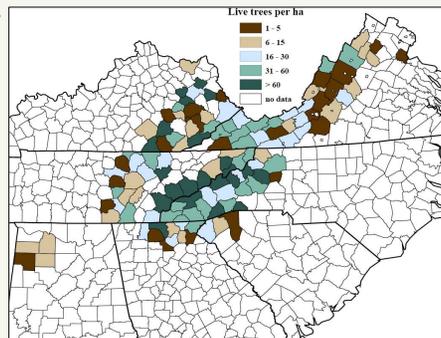


Figure 4. Density of live hemlock by county.

## Symptoms of hemlock woolly adelgid

- Poor crown condition
- Conspicuous wool-like ovisacs on underside of branch tips (USDA FS 2005)



Photo courtesy: www.forestryimages.org



- Areas of extensive hemlock mortality and decline

UGA3225077

Photo courtesy: Connecticut Agricultural Experiment Station Archive, www.forestryimages.org

## Conclusions

Seventy percent of counties with > 2.0% mortality per year were in Virginia and North Carolina. This agrees well with the onset of adelgid infestation, where hemlocks showed infestation in the early to mid 1990's in Virginia and North Carolina, while Tennessee and Kentucky have shown signs of infestation more recently. Although the scale at which FIA collects data is broad, this program is the only one that conducts systematic surveys of forest land across the U.S. Without landscape-scale information, critical biological thresholds that indicate population decline are difficult to ascertain. Future studies and important trends will result from carefully monitoring the FIA plots included in this study.

## References

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## CITATION

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