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# EFFECTS OF ROAD MAINTENANCE ON THE HEALTH OF EASTERN HEMLOCKS (*TSUGA CANADENSIS*)

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## ABSTRACT

Eastern Hemlocks (*Tsuga canadensis)*, are found in the eastern United States from Maine to Kentucky, and are so common in Pennsylvania that they are the official state trees. I compared growth rates and crown condition of hemlocks in Rothrock State Forest, PA to examine the effects of road maintenance on the tree health. I hypothesized that Eastern Hemlocks along maintained roads would have a slower growth rate and an inferior crown condition when compared to the trees along a non-maintained site. At two sites, I measured and compared growth rates and crown condition of the hemlocks. Growth rates of hemlocks along maintained roads (0.17cm/yr) were slightly higher than those of non-maintained roads (0.14 cm/yr), but the difference is not statistically significant ($t$ = 1.25, $df$ = 22, $P$ = 0.226). Crown condition, as measured by pixel counts, along a maintained road (1754) did not differ significantly from a non-maintained road (1475) ($W$ = 140.0, $df$ = 24, $P > 0.05$). Tree health did not visibly appear to differ between the two treatments and I concluded that both forests seemed to be of decent physical condition and unaffected by the factor of road maintenance.

*Keywords: canopy, crown condition, crown transparency, forest health, Rothrock State Forest, tree vigor,* Tsuga canadensis

## INTRODUCTION

Cold and snowy winters in Pennsylvania require the use of sodium chloride to melt ice and aid in the removal of snow. In the United States, over 10 million tons of such rock salt is spread each year over the country's roads (Blasius 2002). Great concern is extending throughout the environmental community over the harm that salt additions and vehicle exhaust are having on groundwater and soil quality as well as the roadside vegetation (Blasius 2002). The health of roadside trees is important for their ecological and aesthetic roles as they are know to catch particulate matter and reduce point source pollution from vehicle emissions and the nearby roads (Cumming 2001). One major concern is that phytotoxic concentrations of NaCl leeching into the soil and spraying in the air are causing damage to all trees close to the road (Hartl 2002). Therefore, it is important on the effects of road maintenance on vegetation. The goal of this study was to find a greater growth rate and better crown condition of *Tsuga canadensis* in the site with no maintenance when compared to the site that is maintained.

## FIELD SITES

I conducted this study within Rothrock State Forest, Huntingdon County, Pennsylvania (Fig. 1). I selected a non-maintained section located in Whipple Dam State Park on Laurel Run Road, which is a stone road, not heavily traveled and not maintained in the winter (Fig. 2). I also selected a maintained site is along route 305 between Greenwood Furnace and the Huntingdon County line (Fig. 3). Route 305 is a highly traveled state road that is salted and treated appropriately in the winter months. The two sites are on slight downward slopes from the roadside, facing to the northwest at elevations of 1200-1400 feet above sea level. The two forests are of similar composition (per. obs.). The dominant trees are Eastern Hemlock (*Tsuga canadensis*), Sugar Maple (*Acer saccharum*), Red Maple (*Acer rubrum*), Black Oak (*Quercus velvutina*), Red Oak (*Quercus rubra*), Yellow Birch (*Betula alleghaniensis*), and Sweet Birch (*Betula lenta*). The forests' floors were rocky and moist, scattered with ferns, decomposing trees and tip-ups. The maintained site had many more fallen trees, giving way to a larger fern community and more sunlight diffusing to the ground.

## METHODS & MATERIALS

During October and November of 2002, at each study site, I randomly selected 12 hemlock trees between 0 and 30 meters off the road. During these days, there was variable weather; it was sometimes sunny or overcast and rainy. At each tree, I recorded the diameter at breast height (DBH), and took two digital photos of the canopy using a Sony MVC-FD88. I took one photo at the base of the tree looking directly up, while the other photo zoomed in further to get a better view of the canopy. This is to evaluate the transparency of the tree's crowns, as higher black pixel counts indicate thicker crown foliage. If a particular tree is very transparent, this could signify a stressed or unhealthy tree (Metzger 2001). I analyzed each digital photograph for light penetration using the computer program MultiSpec (Biehl and Landgrebe 2002). I compared pixel counts between maintenance and no maintenance roads using the Mann Whitney U test (Gravetter 2000). I used an alpha level of 0.05 and considered differences to be significant if $p \leq 0.05$.

I took core on the side of the tree facing the road. I measured each core and counted the dark rings with the aid of a magnifying microscope. I divided the number of dark rings by the length to obtain the average annual growth. I compared tree growth rates between the two sites by using a 2-sample t-test (Gravetter 2000) and the same significance as above. I evaluated tree health by examining needle thinning, discoloration, and canopy class of each tree using the procedures set in the UNEC Visual Assessment of Crown Condition (United Nations Economic Commission for Europe 2000).

## RESULTS

Growth rates of trees along the maintained road (0.17 cm/yr) were somewhat higher than that of the non-maintained road (0.14 cm/yr) but the difference was not statistically significant ($t = 1.25$, $df = 22$, $P = 0.226$) (Fig. 5). Black pixel counts were higher (1754) in the maintained site than in the non-maintained site (1475) yet the difference was not statistically significant ($W = 140.0$, $P > 0.05$) (Fig. 5). I saw no substantial variation in needle discoloration or needle loss between the sites. Not more than two trees in each site showed any needle discoloration or needle loss over 5%.

## DISCUSSION

I found no significant difference between the two sites. The no maintenance road trees appear healthier than the maintenance site trees (per obs.). There were many more fallen trees at the maintenance site, giving way to a larger fern community and more sunlight diffusing to the ground (per obs). I expected more understory growth, but there was not. The tree understory growth of both sites was minimal (per obs.). With the relatively recent tree falls on the maintenance site, and the recent lower annual growth seen in the core bores, I believe that this site is not as healthy as my tests are showing. A 1995 study on

hardwood forest decline in Quebec found average ring widths much greater than my hemlock study. Sugar maples average ring size was 0.994 cm and American beech was 1.000 cm (Payette 1995).

*Tsuga canadensis* are hardy trees affected by climate change over any other factor, so road salt leeching into the soil or exhaust in the air, may have little or no effect on their health (Gustafson 2002). Increased levels of nitrogen and carbon from exhaust on the more frequently traveled and maintained road may have a positive effect on the trees' health. Further studies in this area will be of great benefit to forest managers and road maintainers as roadside trees are central "in reducing point source pollution" (Cumming 2001), and the need for drivable roads in the winter increases.

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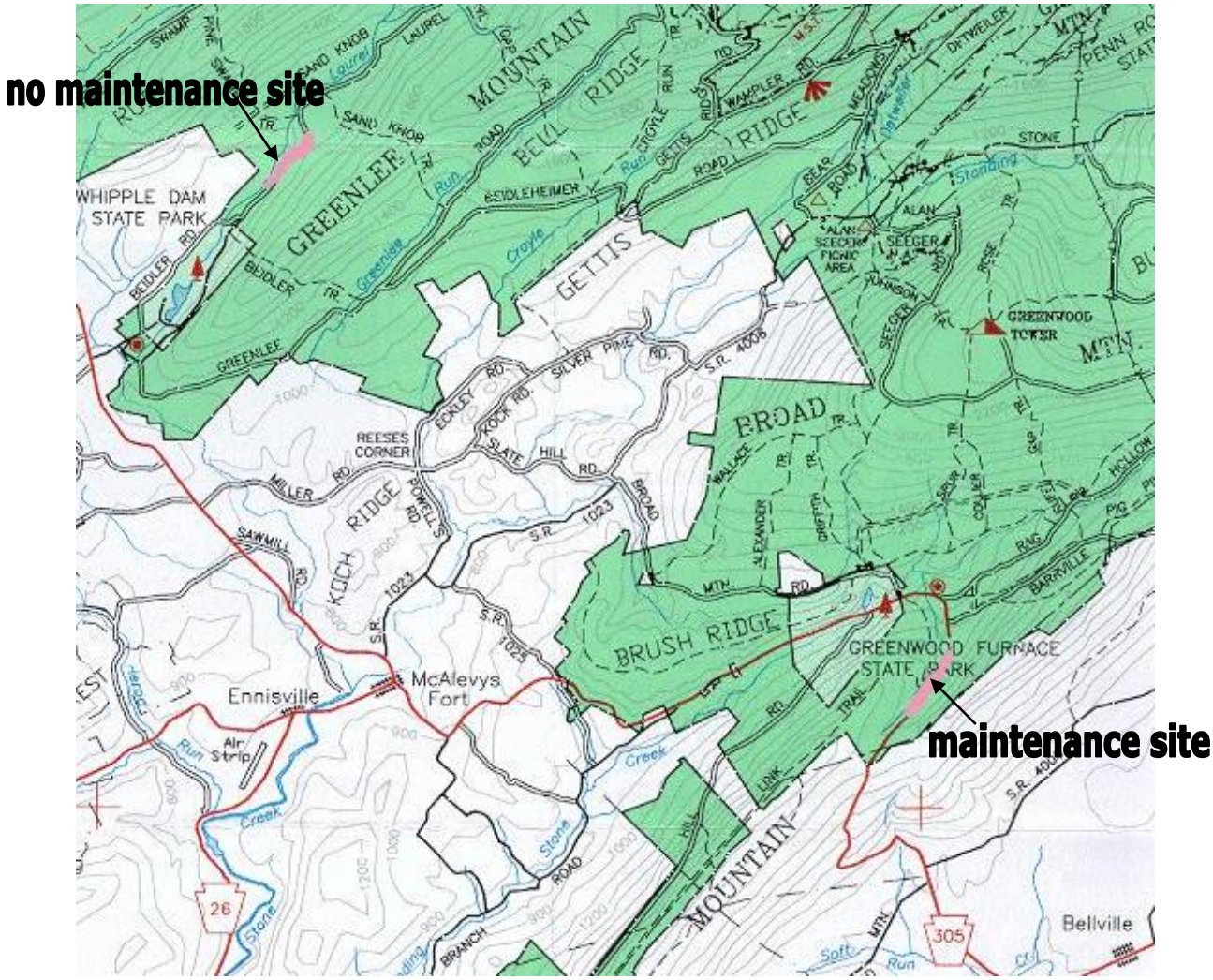


*Figure 1. Location of maintained and non-maintained road transects in Rothrock State Forest, Huntingdon and Centre counties, Pennsylvania, 2002.*

*Figure 2. No maintenance site on Laurel Run Road, in Whipple Dam State Park and Rothrock State Forest, Huntingdon County, PA, 2002.*

*Figure 3. Maintained Site along route 305 between Greenwood Furnace and Bellville, 30 meters from the road in Rothrock State Forest, Huntingdon, PA, 2002.*

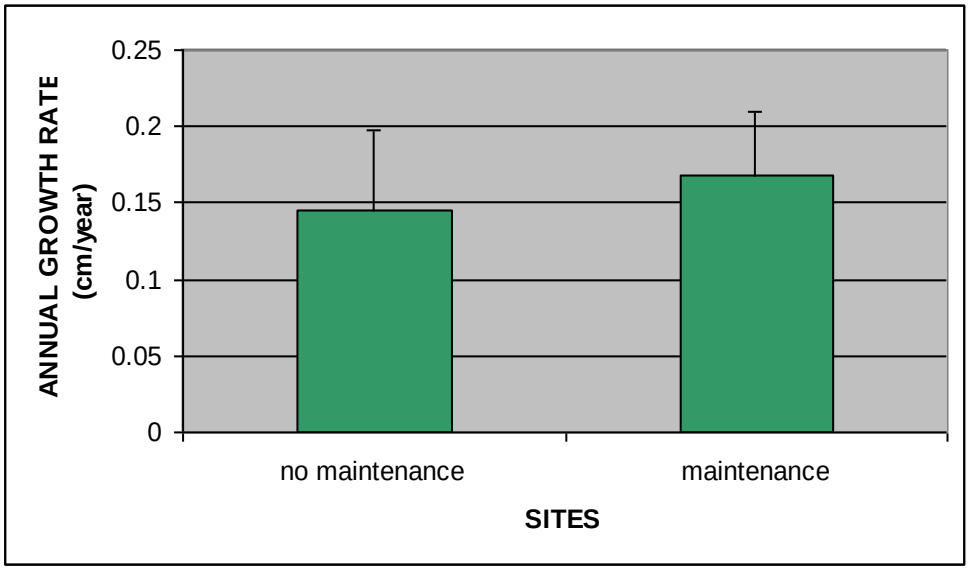


*Figure 4. Annual growth rate in centimeters per year from the maintenance and no maintenance sites in Rothrock State Forest, Huntingdon County, Pennsylvania, 2002.*


*Figure 5. Median number of black pixels from each site in Rothrock State Forest, Huntingdon County, Pennsylvania, 2002.*