

RADIAL GROWTH AND WOOD DENSITY OF WHITE PINE
IN RELATION TO FOSSIL-FIRED
POWER PLANT OPERATIONS

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ABSTRACT

The objectives of this study were twofold: (1) to develop a gamma densitometry technique for measuring the relative wood density and radial growth of trees from 12 mm increment cores; and (2) to determine whether changes in the relative wood density and radial growth of "resistant" eastern white pine (Pinus strobus L.) occurred after initiation of operations of the Kingston and Bull Run steam plants in eastern Tennessee. The study area was surveyed by air to determine the distribution of white pine around the Kingston and Bull Run steam plants. It was found that white pine was distributed into roughly three "groups" (11 sampling locations): Group 1, located west of Bull Run Steam Plant; Group 2, located northeast of the Kingston Steam Plant; and Group 3, located southwest of the Kingston Steam Plant. These groups served as the basis for subsequent analyses. Two 12 mm increment cores were taken from each of 89 dominant or codominant eastern white pine for analysis using the gamma densitometry technique. Within each core, two five-year periods were analyzed for: (1) relative wood density, (2) radial growth, (3) percent earlywood, and (4) percent latewood. One five-year period was designated as the "pre-impact" (before steam plant operations) period and the other was designated as the "post-impact" period (after steam plant operations). The annual ring for the year of steam plant start up was not included in this study. Four questions were asked: (1) was there a difference in the pre- and post-impact relative wood density and radial growth of eastern white pine in the vicinity of the Kingston and Bull Run steam plants, (2) were there any difference in the pre- and post-impact relative wood density and radial growth among groups, (3) if so, did distance and azimuth from each location to the nearest steam plant influence the difference between the pre- and post-impact relative wood density and radial wood growth at each location, and (4) could differences between pre- and post-impact relative wood density and radial growth at each location be described by age or certain environmental variables.

There was a significant difference ($P < 0.01$) between the relative wood density (average of 5-year periods) of the wood formed before (pre-impact) and after initiation of operations (post-impact) at the Kingston and Bull Run steam plants. At ten of eleven sampling locations, the relative wood density was greater after steam plant operations started. Orthogonal comparisons of 8 locations within groups indicate no significant differences ($P < 0.10$) in relative average density. The effects of azimuth and distance on the relative density of the pre- and post-impact wood samples were significant ($P < 0.10$). Of the variation found in the estimated relative density differences at each location, about 48 percent is related to the distance and azimuth from the nearest steam plant. The partial regression coefficients for distance and azimuth were negative, with the partial regression coefficient of distance being significant ($P < 0.10$). Thus, as the distance from the steam plants increases, there was a corresponding decrease in the relative density differences between the pre- and post-impact wood. Although the partial regression coefficient of azimuth is not significant, it was negative which suggested that as the direction from the steam plant changes relative to the prevailing winds, the influence of the steam plant is reduced. The following environmental variables were not significantly related ($P < 0.10$) to relative wood density after the effects of distance and azimuth were removed: (1) available moisture holding capacity of the soil at each location; (2) the average maximum, average minimum, and mean monthly temperature by month; (3) the mean number of drought days by month at each location; (4) the mean number of excess moisture days by month at each location; and (5) the cambial age at breast height of the pre- and post-impact wood samples.

There were significant differences ($P < 0.10$) between the percentage of earlywood and latewood formed before and after initiation of operations at the Kingston and Bull Run steam plants. At nine of eleven sampling locations (3 groups), percent earlywood decreased and percent latewood increased after initiation of steam plant operations. An orthogonal contrast between group 1 and groups 2 and 3 indicates that a significant difference ($P < 0.10$) in percent early wood and percent latewood existed. Of the variation found in the group mean differences, about 44 percent can be attributed to the grouping of trees around the steam plants. The effects of azimuth, distance, and the aforementioned environmental variables on the differences in pre- and post-impact percent earlywood and percent latewood at each location (within groups) were not significant ($P < 0.10$). No significant difference was found in radial growth between the pre- and post-impact samples. No significant difference was found in radial growth between the pre- and post-impact samples.