

Western Ecological Research Center

Publication Brief for Resource Managers

Release:
July 2004

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How Are Trees Killed by Fire?

Tree death is one of the most obvious results of forest fires. Understanding how fire causes mortality for individual trees is important for predicting fire effects. Models of fire-caused tree mortality often rely on opportunistic post-fire measurements, making it difficult to draw firm conclusions. Recent research by USGS ecologist Dr. Phil van Mantgem and Dr. Mark Schwartz of the University of California, Davis, published in *the Canadian Journal of Forest Research*, experimentally demonstrates the importance of stem damage as a predictor of post-fire tree mortality. The researchers manipulated the amount of stem scorch that individual ponderosa pine trees sustained, which had a large effect on the subsequent probability of surviving the fire. Their results suggest that stem damage is an important determinant of post-fire survival for this species, although this factor is often underappreciated when assessing the effects of fire.

The researchers subjected 159 small ponderosa pine trees to treatments designed to test the relative importance of stem damage as a predictor of post-fire mortality. The treatments consisted of a group for which the basal bark was artificially thinned, a second group for which fuels were removed from the base of the stem, and an untreated control group. Following prescribed burning, crown scorch severity was equivalent among the groups. Post-fire mortality was significantly less frequent in the fuels removal group compared to the bark removal and control groups. No model of mortality for the fuels removal group was possible because dead trees comprised < 4 % of subject trees. Mortality in the bark removal group was best predicted by crown scorch and stem scorch severity, while death in the control group was predicted by crown scorch severity and bark thickness. The relative lack of mortality in the fuels removal group and the increased sensitivity to stem

Management Implications:

- Predictions of post-fire tree mortality are improved by including measurements of severity of fire-caused stem damage, although this may not be readily apparent from observational data.
- The process of fire-mediated tree mortality is complicated and likely involves the integration of damage to the tree crown and stem.
- Experimental approaches, when possible, may help overcome problems of predicting fire effects.

damage in the bark removal group suggest that stem damage is a critical determinant of post-fire mortality for small ponderosa pines.

Understanding the process of fire-caused death, particularly for small trees, is important in the context of forest management. In the American Southwest, researchers have found low-intensity prescribed fire to be relatively ineffective for selectively removing small trees, which has translated into recommendations for forest restoration that emphasize mechanical thinning. In contrast, prescription burning in the Sierra Nevada has been successful at reducing small-tree densities, and prescribed fire without mechanical treatments remains a viable forest thinning tool. Systematic differences in stem damage patterns, perhaps mediated by differences in fuels characteristics, could provide a partial explanation for these regional differences.

van Mantgem, P., and M. Schwartz. 2004. An experimental demonstration of stem damage as a predictor of fire-caused mortality for ponderosa pine. Canadian Journal of Forest Research 34:1343–1347.