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Joint Fire Science Program Knowledge Exchange

Research Brief for Resource Managers

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Prescribed fire and season of burning influence levels of direct and beetle-caused tree mortality

Fettig, C.J., S.R. McKelvey, D.R. Cluck, S.L. Smith, W.J. Otrosina. 2010. Effects of prescribed fire and season of burn on direct and indirect levels of tree mortality in Ponderosa and Jeffrey Pine Forests in California, USA. Forest Ecology and Management 260: 207-218.
http://ddr.nal.usda.gov/bitstream/10113/42843/1/IND44380454.pdf

Tree mortality following prescribed burning may vary according to the season in which burning is conducted. Plants are more susceptible to heating damage early in the growing season, but late season burns are often of higher intensity due to low fuel moistures. The season of burning may also influence post-fire beetle-caused tree mortality.

A study published in Forest Ecology and Management by researchers from the USDA Forest Service investigated the effect of burn season on direct and indirect tree mortality in mechanically thinned ponderosa and Jeffrey pine stands in California's Tahoe National Forest.

Overall post-fire mortality was concentrated in the smallest tree diameter class (<20.2 cm dbh). Though the season of burning had no significant effect on total mortality, late season (fall) burning produced higher levels of mortality in the smallest diameter size class while mortality for the largest trees (>50.7 cm dbh) was higher following early season (spring) burning. For most intermediate diameter classes, mortality did not vary with season of burning.

Management Implications

- Some tree mortality is an expected and often desirable outcome of prescribed burning. The low levels of mortality seen in this study are not likely to concern managers.
- Less than 10% of all trees died within 3 years of burning; most of these were smaller than 20.2 cm dbh.
- Though more trees died as a direct result of burning than from post-fire beetle attack, bark beetles were responsible for most large tree mortality. Even so, only 15 large trees (<1 tree per ha) died from any cause over the course of the study.
- The authors note that concerns over high levels of mortality following early season burning are not justified based on these results, but caution that it is still unclear how burning under different conditions (e.g. during a drought or in a dense stand) might influence patterns of post-fire mortality.

The direct effects of prescribed burning were responsible for 56.5% of all tree deaths, but the season of burning had no effect on direct mortality (fig. 1). Levels of crown damage were higher for trees that died as a result of burning than for survivors.

Despite much higher levels of beetle-caused tree mortality in burned sites, the difference in total indirect mortality between burned and unburned sites was not statistically significant (fig. 2). In addition, there was no effect of season of burning on indirect mortality. Treatment effects *were* observed within some size classes, however. For the largest trees, early season burning produced significantly higher levels of beetle-caused tree mortality relative to the untreated control, while late-season burning increased small tree mortality over the control.

While total post-fire tree mortality seen in this study was low, over the 3-year period of observation precipitation levels were normal and both stand densities and bark beetle activity were low to moderate. Burning under more extreme conditions, such as in high-density stands, may produce higher levels of post-burn mortality.

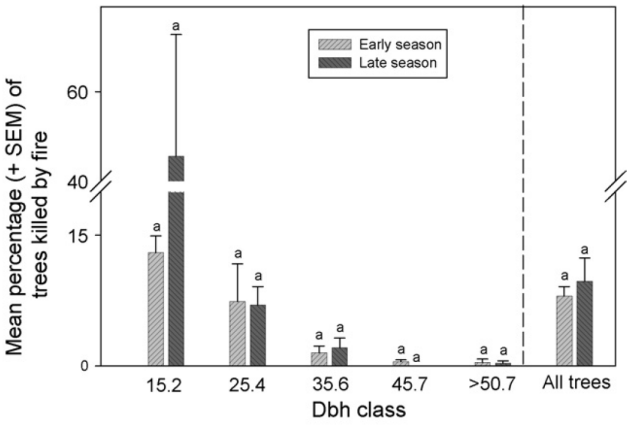

Figure 1. Mean percentage of trees killed by prescribed burns (direct mortality) by diameter class 3 years after prescribed burns were implemented (mid-point of 10-cm diameter classes shown except for largest diameter class). Means (+SEM) followed by the same letter within groups are not significantly different (P > 0.05).

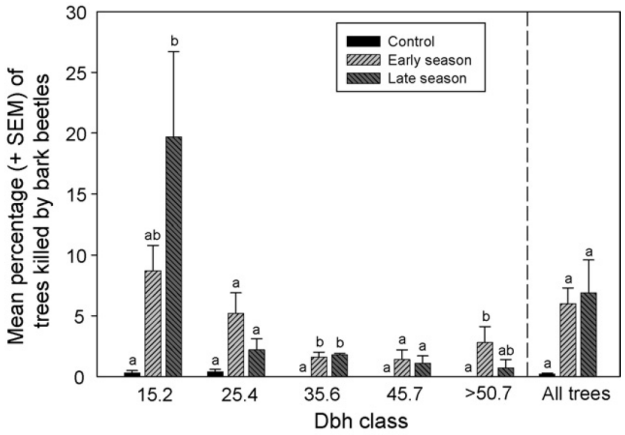

Figure 2. Mean percentage of trees killed by bark beetles (indirect mortality) by diameter class 3 years after prescribed burns were implemented (mid-point of 10-cm diameter classes shown except for largest diameter class). Means (+SEM) followed by the same letter within groups are not significantly different (Tukey's HSD, P > 0.05).

Suggestions for further reading:

Ganz DJ, Dahlsten DL, Shea PJ, 2002. The post-burning responses of bark beetles to prescribed burning treatments. In: Omi PN, Joyce LA (Eds.), Fire, Fuel Treatments, and Ecological Restoration: Conference Proceedings, Apr. 16–18, USDA Forest Service, RMRS, Fort Collins, CO, pp. 143–158. http://www.fs.fed.us/rm/pubs/rmrs_p029/rmrs_p029_143_158.pdf

Harrington M, 1993. Predicting *Pinus ponderosa* mortality from dormant season and growing season fire injury. International Journal of Wildland Fire 3: 65–72. http://www4.nau.edu/direnet/publications/publications_h/files/Harrington_1993.pdf

Knapp, E.E., Estes, B.L., Skinner, C.N., 2009. Ecological Effects of Prescribed Fire Season: a Literature Review and Synthesis for Managers. PSW-GTR-224. USDA Forest Service, PSRS, Berkeley, CA, 80 pp. http://www.treesearch.fs.fed.us/pubs/33628

Schwilk DW, Knapp EE, Ferrenberg SM, Keeley JE, Caprio AC, 2006.Tree mortality from fire and bark beetles following early and late season prescribed fires in a Sierra Nevada mixed-conifer forest. Forest Ecology and Management 232: 36–45. http://www.fs.fed.us/psw/publications/knapp/psw_2006_knapp%28schwilk%29005.pdf

Thies WG, Westlind DJ, Loewen M, 2005. Season of prescribed burn in ponderosa pine forests in eastern Oregon: impact on pine mortality. International Journal of Wildland Fire 14: 223–231. http://www.treesearch.fs.fed.us/pubs/25536