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Research Brief for Resource Managers

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Bark Beetle Responses to Differences in Forest Structure and the Application of Prescribed Fire in Interior Ponderosa Pine

Fettig, Christopher J., Robert R. Borys, Stephen R. McKelvey, and Christopher P. Dabney. 2008. Blacks Mountain Experimental Forest: bark beetle responses to differences in forest structure and the application of prescribed fire in interior ponderosa pine. Canadian Journal of Forest Research 38: 924-935. http://www.nrcresearchpress.com/doi/abs/10.1139/X07-243

Management Implications

- In this study, short-term levels of bark beetle-caused tree mortality (1.5% of all trees) did not interfere with management objectives, particularly considering that almost half was represented by fir engraver infesting true fir.
- Use of prescribed fire significantly increases the probability of bark beetle-caused mortality in surviving trees, but not in larger diameter classes.
- Prescribed burning has differential effects, in terms of subsequent beetle attack, on different size classes and different tree species.

It is recognized that fire can stress trees and potentially make them more vulnerable to bark beetle attack. With increased interest in the use of prescribed fire as a management tool, it's important to determine how the use of this tool to restore fire-adapted ecosystems influences the incidence and distribution of these attacks. Previous observations determined that stand density is the single most important variable related to the probability of bark beetle attacks. Management activities strive to regulate stand density for a number of reasons, only one of which is to improve resilience against bark beetles. This study assessed the effects of both prescribed burning and stand structure management through thinning on bark beetle activity and associated levels of tree mortality.

At Blacks Mountain Experimental Forest on the east side of the southern Cascades in California, the research team divided the study area into 12 units of 76-136 ha each. The authors selected the units by elevation and year of treatment. Within each block, they created a "structurally simple" stand type by removing both small and large trees and leaving intermediate tree sizes. They complemented this treatment with a "structurally complex" stand type that was thinned from below, leaving a much greater large-tree component in the forest. Within each treatment type, they treated half the study units with prescribed fire.

In the second year after each prescribed burning treatment, the authors conducted a 100% cruise of each unit to locate dead and dying trees, and to

determine associated causes of tree mortality (e.g., prescribed fire, bark beetles, wood boring beetles, root pathogens).

Overall (by all causes), a total of 9500 trees died (5% of the total number of trees). Thinning treatment (and resulting stand structure) did not significantly affect mortality except in two of the diameter classes, and these classes displayed opposite trends. Prescribed fire significantly increased tree mortality over the unburned units, with the exception of the largest diameter class. Additionally, use of prescribed fire significantly increased bark beetle-caused mortality, with the exception of the largest trees (greater than 21.5 inches in diameter).

Damage caused by fir engraver beetle (*Scolytusventralis*)
Photo credit: Don Owen - CalFire, bugwood.org.

The paper discusses the results of this study in relation to each mortality agent: western pine beetle, mountain pine beetle, Jeffrey pine beetle, *Ips* beetles, and fir engraver beetle. It also discusses the effects of prescribed fire on red turpentine beetle and wood borer attacks.

Although prescribed fire apparently enhances the activity of each mortality agent, the effect of silvicultural changes in stand structure is more variable. The most important factor in many cases is the diameter distribution of residual trees. For example, fewer western pine beetle-killed trees were counted in the "structurally simple" treatments, perhaps because western pine beetle preferentially attacks large trees. Conversely, more *Ips* beetle attacks were noted in the "structurally simple" treatments, probably because these beetles attack smaller-diameter trees. Nearly half the beetle-caused mortality in this study was caused by fir engraver beetle on true fir; the authors note that this can actually be a positive when managing for ponderosa pine dominance.

In general, this study suggests that concerns regarding mortality of large-diameter trees after prescribed burning and silvicultural manipulation may be unfounded, at least shortly after treatments are applied. Also, the two kinds of stand structures that were created by the treatments in this study appear to have similar levels of resilience to bark beetle attacks, although it may be some time before the full picture of prescribed fire-related mortality becomes apparent in these stands.

Suggestions for further reading

Breece, C.R., Kolb, T.E., Dickson, B.G., McMillin, J.D., & K.M. Clancy. 2008. Prescribed fire effects on bark beetle activity and tree mortality in southwestern ponderosa pine forests. Forest Ecology and Management. 255: 119-128.

Fettig, C.J., Borys, R.R., & C.P. Dabney. 2010. Effects of fire and fire surrogate treatments on bark beetle-caused tree mortality in the southern Cascades, California. Forest Science. 56: 60-73.