Research Brief for Resource Managers

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Smart Practices and Architecture for Prescribed Fire in California (SPARx-Cal) - https://sites.uci.edu/sparxcal/

Pyrosilviculture: Merging prescribed fire and silviculture

York, Robert A., Hunter Noble, Lenya N. Quinn-Davidson, and John J. Battles. "Pyrosilviculture: Combining prescribed fire with gap-based silviculture in mixed-conifer forests of the Sierra Nevada." Canadian Journal of Forest Research 51, no. 999 (2021): 1-11. https://doi.org/10.1139/cjfr-2020-0337

Management Implications

- Pyrosilviculture is the adaptation of silvicultural actions and burn plans to facilitate the coexistence of prescribed fire and other objectives.
- In dry western forests, regeneration harvests create coarse-scale heterogeneity that is often considered resilient, while prescribed fires can reduce fuel loads and further enhance heterogeneity and resilience at the stand scale.
- Prescribed fire is a necessary part of dry western forests, and pyrosilviculture helps to plan for its sustainable use.

The value from increasing prescribed fire use in dry western forests is well recognized. However, common perceptions of prescribed fire as incompatible with objectives that rely on high rates of forest growth hinder its adoption. In this study, pyrosilviculture is presented as a conceptual management framework that merges prescribed fire and silvicultural systems for promoting resilient and sustainably managed forests.

Pyrosilviculture is "the design of treatments in forests to (i) use fire directly to meet management objectives or (ii) alter nonfire silvicultural treatments explicitly so that they can optimize the incorporation of prescribed fire in the future" (pg. 5). This brings fire into the realm of silviculturalists, reducing limitations that result from the siloing of management into separate disciplines.

The study documents prescribed fires in a group selection system to demonstrate the concept of pyrosilviculture. The effects of the fire are shown across thinning methods and age classes, and alternative management actions to produce more desirable fire effects are discussed. By keeping prescribed fire in the management plan and changing either fire implementation or nonfire silvicultural actions to produce desired fire effects, this discussion demonstrates how pyrosilviculture integrates silviculture and prescribed fire.

Study results

The burns were conducted in October across 12-, 22-, and 32-year-old group selection stands, and the 100-year-old matrix between them. The authors note that burns were done during relatively hot and dry conditions and that this is an important context of the study. Of the 12-year-old stands, half were thinned with chainsaws and

half were masticated, both reducing tree density by ~50%. The 100-year-old matrix was harvested with a commercial thin from below to a target basal area in 2001, followed by a mastication and prescribed burn in 2002, with a second mastication of shrubs in 2017 and 2018 prior to the 2018 burn documented in the study. The combination of mastication and prescribed fire, repeated twice here, is a maintenance treatment to limit fuel buildup in the understory.

Given the dry conditions, there were notable impacts to the stands, including fairly high crown damage (measured through percent crown volume scorch or PCVS) and high mortality. Overall, roughly half of all of the trees in the 12-year-old stands died as a result of the burning. Notable results in the pre-commercial thin (PCT) implementation include a decline in PCVS with lop-and-scatter versus mastication in 12-year-old stands (Fig. 1). Both PCVS and mortality declined precipitously with stand age (Fig. 1, Fig. 2), with mature stands experiencing only 8% mortality. This low mortality rate in the mature stand during a hot burn also reflects the earlier "bottlenecking" of tree structure, where many of the vulnerable trees were previously removed from the first entry with fire. Underscoring the importance of species composition as a factor of burn effects, giant sequoia (*Sequoiadendron giganteum*) and ponderosa pine (*Pinus ponderosa*) had significantly lower mortality than other species across all stand ages (Fig. 3).

Discussion

Those with objectives of increasing snag recruitment or structural heterogeneity may see the results of this treatment as desirable. For others, the burn resulted in higher crown scorch and mortality in young cohorts than what many would describe as desirable for sustainable timber or carbon production. Applying the concept of pyrosilviculture to the outcome generates ideas for making future prescribed fires more in-line with objectives. For example, considering a timber objective, these methods include:

- Burning in winter when fuels will burn less intensely, especially masticated activity fuels (see **Further Reading** below).
- Planning for salvage harvests of commercial tree mortality following hot prescribed fires.
- Burning in wetter conditions - Bellows et al. (2016) found 5-8% mortality in young stands at 1 year post burn following a mid-prescription fall burn (see **Further Reading** below).
- Excluding young stands from burns.
- Timing burns to occur at least ~20 years post-regeneration, when mortality in young stands was found to drop significantly even during hot burns.
- Using fire to thin young stands: in this study, fire removed ~50% of young trees, similar to the intentional PCT, preferentially removing small trees and fire-intolerant species. Rather than thin the young stands prior to burning, they could have been burned without thinning.

Figures

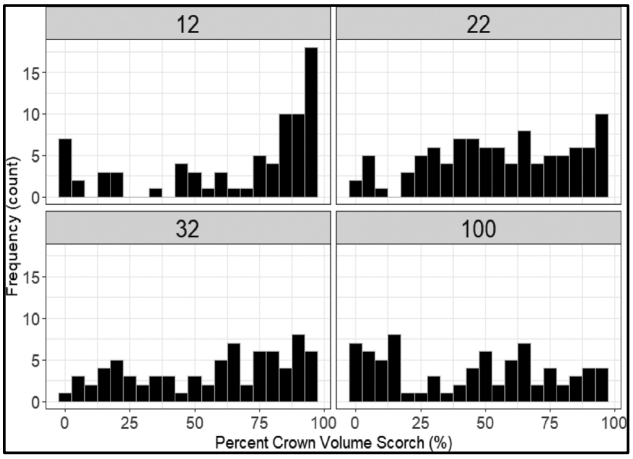

Figure 1*. Crown scorch generally declined with age, although all ages had both low and high scorch on different trees. Note: within the 12-year-old stand, PCVS averaged 91% for masticated stands and 77% for PCT stands.*

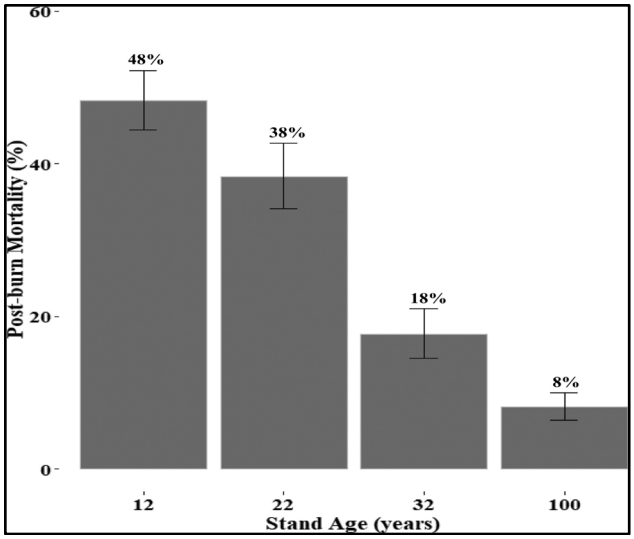

***Figure 2**. Mortality at 1 year post burn declined with stand age, with a large decrease between age 22 and 32. This implies that burns done after ~20 years post-regeneration will have mortality <20%. Mortality significantly decreases if burn conditions are wetter (see **Further Reading** below).*

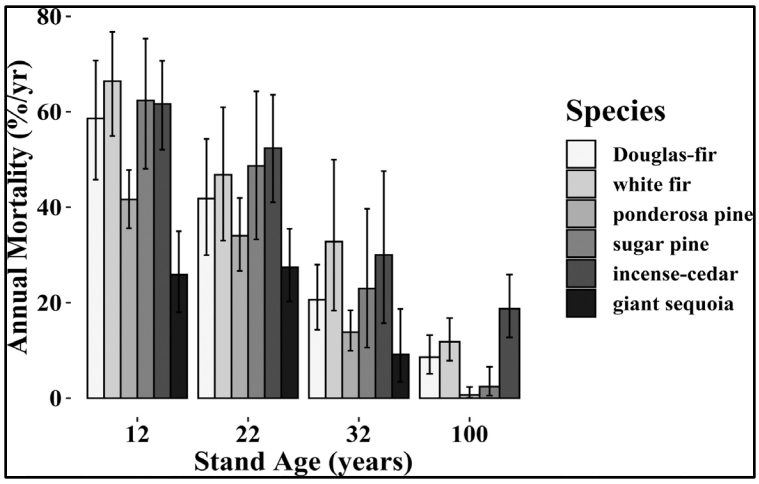

***Figure 3**. Ponderosa pine and giant sequoia showed statistically significant lower mortality across all stand ages (besides the 100-year-old stand which had no giant sequoia). This implies that using prescribed fire to thin young stands will select for fire-resistant species and increase stand resistance to wildfire.*

Suggestions for further reading:

Bellows, Robin S., Ariel C. Thomson, Kate J. Helmstedt, Robert A. York, and Matthew D. Potts. "Damage and mortality patterns in young mixed conifer plantations following prescribed fires in the Sierra Nevada, California." Forest Ecology and Management 376 (2016): 193-204. https://doi.org/10.1016/j.foreco.2016.05.049

York, Robert, Jacob Levine, Kane Russell, and Joseph Restaino. "Opportunities for winter prescribed burning in mixed conifer plantations of the Sierra Nevada." (2021). https://doi.org/10.21203/rs.3.rs-423745/v1