Special Topic: Synthesis for Resource Managers

Release:	Contact:	Phone:	Email:
March 2020	Hannah Lopez	707-845-1200	hlopez@berkeley.edu
	Rob York	530-333-4475	ryork@berkeley.edu
	Stacey Frederick	510-642-4934	ssfrederick@berkeley.edu

California Fire Science Consortium | 137 Mulford Hall MC #3114, Berkeley CA 94720

Prescribed burning in young stands

Prescribed burning has long been recognized as a management tool capable of building resiliency to wildfire in mature forest stands. In the western United States, a succession of fire seasons that saw catastrophic wildfires has illuminated the need for large scale fuels reduction projects in forest ecosystems. Prescribed fire has potential to decrease surface and ladder fuels, two fuel types that are primary contributors to increased fire severity. While commonly-used burning techniques can be utilized to reduce fuels in mature stands, fire effects and factors driving fire behavior in younger stands are not well known. Emerging research is beginning to explore how prescribed fire in young stands can build resilience. Given that significant investments in reforestation are often made following harvests and wildfires, managers are interested in how prescribed fire may be able to help protect reforestation investments and develop future forests where prescribed and wildfires can occur without excessive mortality. Here we synthesize findings of four studies that are relevant to prescribed burning as a fuels reduction method in young stands. Most studies also looked at potential effects of mastication as a fuels treatment in comparison to prescribed burning.

Management Implications

- Site preparation treatments in young stands can significantly reduce mortality related to prescribed and wildfires.
- It is not always necessary to apply mechanical treatments before burning in young stands but it can be helpful.
- Minimizing crown scorch is particularly important in young stands to increase tree survival.
- When using burning as a management tool in young stands, one should accept high degrees of variability in outcomes.
- It may be useful for managers to develop an acceptable level of prescribed fire-related mortality and/or damage to evaluate whether or not to burn in a young stand.

Research Questions

Each paper had unique research questions pertaining to young stand resiliency. Lyons-Tinsley and Peterson (2012) questioned if fuel treatments done at the time of reforestation reduces severity of subsequent wildfire in young stands and if species composition and stand structure influenced fire severity in the Okanogan-Wenatchee National Forest following the 2006 Tripod Fire. Bellows et al. (2016) looked at the feasibility of prescribed burning in particularly young conifer stands (12 to 13 years old) and the potential reduction in prescribed fire-related mortality and damage achieved by pre-burn pruning, raking, and masticating. Reiner et al. (2012) measured post-prescribed fire tree mortality and compared modelled wildfire behavior between mastication and mastication & fire treatments in a 25-yr old Sierra Nevada plantation of ponderosa pine (*Pinus ponderosa*).

Finally, Kobizar, et al. (2009) examined the effectiveness of 4 fuels treatments in a Sierra Nevada pine plantation: mastication, mastication & burning; burning; and no treatment.

Effectiveness of site-preparation treatments

How a fire behaves in a young stand depends largely on how that stand was managed since the time it was reforested. Relevant practices include site preparation, planting, thinning, and vegetation control. Of particular importance is site preparation, as the presence or absence of fuels from the preceding stand can greatly impact the fuel loading and, in turn, the feasibility of conducting a prescribed fire and the vulnerability to wildfire.

Lyons-Tinsley & Peterson (2012) found that treating fuels through broadcast burning after harvests significantly reduced the probability of high severity surface and crown fires in Sierra Mixed Conifer stands. Bellows et al. (2016) found that mortality was low following fall burning in young stands, but point out that the stands had been piled and burned previously. Subsequently, fuel loads were low. Site preparation as a general practice has tradeoffs and its use may be declining. One negative tradeoff of not doing site preparation as part of reforestation is the increased likelihood of higher mortality following future prescribed and wildfires.

Treatments prior to using prescribed fire

Bellows et al. (2016) implemented both pruning and raking on randomly selected trees to see the effects on young tree mortality after burning. Their study found that pruning, a common technique used to produce specific timber attributes and to reduce ladder fuels, had only a marginal affect associated with reduced mortality when fires burned at low intensities. Raking was associated with reduced crown scorch, but no conclusive results on tree mortality were observed. Hence the added fuel from the mastication did not result in fire-related mortality. Given that mortality was also low in untreated stands, their results suggest that costly pre-treatments in young stands may not be worthwhile.

When mastication is done prior to burning, Reiner et al (2012) found that following-up mastication with fire can be effective at reducing predicted wildfire severity. Predicted flame lengths in areas of mastication-only were three times as high as predicted values in areas of mastication with fire. Raking, used in this study to examine effects of long term heat exposure on tree roots, proved to increase tree survival.

In contrast to the Bellows study, mastication implemented in Kobizar et al. (2009) was affective at controlling modeled rates of spread, but was also associated with higher flame lengths that increased predicted torching within a stand. Increased torching, in turn, could relate to increased mortality. Combining mastication with prescribed burning was the most effective way of reducing fuel loads in young plantations and increasing the overall resiliency of a stand. The authors emphasized the cost-efficiency of prescribed burning in comparison to mastication.

Combined, the three studies suggest that mastication prior to burning can be an effective, albeit costly, approach. In particular, masticated fuel may be “burnable” in the shoulder season of burning or in small winter windows when mature forests are otherwise unavailable to burn because of wet conditions. The demonstration of effective burning without mastication, however, also suggests that mastication is not necessarily a prerequisite for young stand burning.

Levels and Timings of Mortality

Tree mortality can occur as a direct result of a burning (charring from direct combustion), but most often occurs many months or years after the fire. Of the empirical studies in both plantations and mixed forests, mortality (including both initial and delayed) ranged from 0 to 66%, with most results being in the range 5–25%. Had only direct mortality been assessed, this would have been vastly under-estimated.

Reiner et al. found that a majority of mortality observed for a 2 year period after burning occurred mainly within one year after mastication and fire was used. However, their study focused only on ponderosa pine plantations. Bellows et al. (2016) included mixed species in their analysis and found that delayed mortality greatly differed between species. In terms of initial mortality, sugar pine (*Pinus lambertiana*) and ponderosa pine had the highest rates of mortality, while species such as giant sequoia (*Sequoiadendron giganteum*), incense cedar (*Calocedrus decurrens*), and white fir (*Abies concolor*) had higher survival relative to other species. This may be because species at young ages (13-14 years) have not yet fully developed characteristics observed in mature trees that make them resistant to fire effects. While observation found that mortality was highest among sugar pine, a majority of that species mortality occurred within 1 year of burning. Conversely, giant sequoia, which had lowest overall rates of mortality, experienced most mortality within a 2 year period post-burning. Delayed mortality could be a result of interactions between fire, species characteristics, and factors not tested in these studies, such as beetles or pathogens.

Fuels reduction treatments have the potential to reduce mortality from fire and promote resiliency in stands at an early age. Similarly, stand-level practices such as thinning and pruning will affect stand structure and fuel loads, which will influence fire behavior in a stand. Figure 1 from Bellows et al. (2016) graphs survival by species in relation to percent scorch, a metric that can be influenced by surface fuel loading. It also reflects species differences in levels of mortality. Giant sequoia, for example, had much lower mortality when compared to sugar pine. Importantly, most of the sugar pine that died were in young stands that were burned in the Spring and not in the Fall.

Burning in early years may result in an initial mortality event, but this can also mean that the stand will be less likely to experience greater rates of mortality from future wildfires occurring in more extreme conditions. Burning at early stages of stand establishment can increase long-term resiliency across a landscape. Prescribed fire is not a precise tool, and land managers should be prepared to accept variable outcomes in terms of post-burn mortality and stand structure.

Bellows, R.S., Thomson, A.C., Helmstedt, K.J., York, R.A., Potts, M.D., 2016. Damage and mortality patterns in young mixed conifer plantations following prescribed fires in the Sierra Nevada, California. For. Ecol. Manage. 376, 193–204. https://doi.org/10.1016/j.foreco.2016.05.049

Kobziar, L.N., McBride, J.R., Stephens, S.L., 2009. The efficacy of fire and fuels reduction treatments in a Sierra Nevada pine plantation. Int. J. Wildland Fire 18, 791–801. DOI: 10.1071/WF06097

Lyons-Tinsley, C., Peterson, D., 2012. Surface fuel treatments in young, regenerating stands affect wildfire severity in a mixed conifer forest, eastside Cascade Range, Washington, USA. For. Ecol. Manage. 270, 117–125. [DOI: 10.1016/j.foreco.2011.04.016]

Reiner, A.L., Vaillant, N.M., Dailey, S.N., 2012. Mastication and prescribed fire influences on the tree mortality and predicted fire behavior in ponderosa pine. West. J. Appl. For. 27, 36–41. DOI: 10.1093/wjaf/27.1.36.

Suggestions for Further Reading:

North, M.P, et al. 2018. Tamm Review: Reforestation for resilience in dry western U.S. forests. For. Ecol. Mang. 432, 209-224. https://doi.org/10.1016/j.foreco.2018.09.007

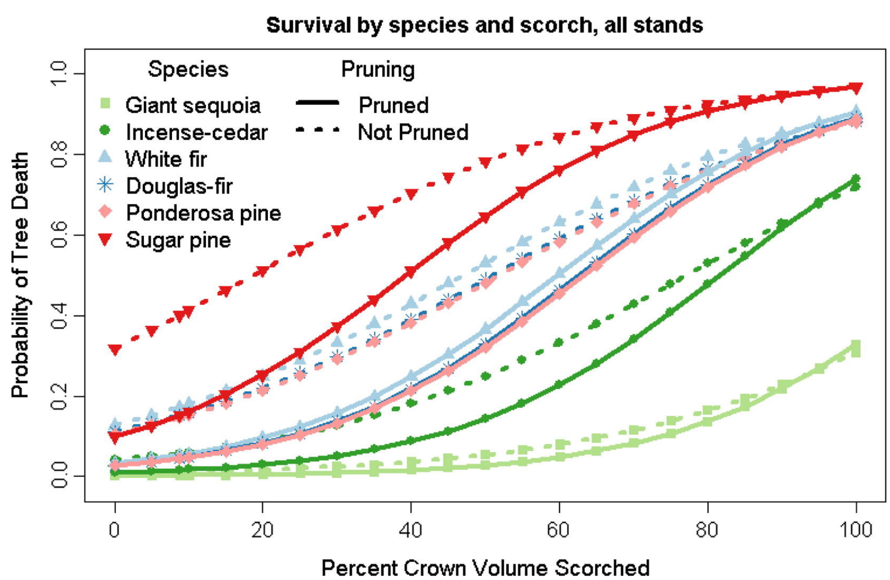

Figure 1: This graph visualizes post-fire mortality across all stands, species, and pruning treatments (Bellows et al., 2016)