Using prescribed fires in young forests: A pyrosilvicultural approach

Research Brief • December, 2024

As a result of ubiquitous Indigenous burning and unsuppressed lightning fires, a spatially complex and multiaged structure with low stocking densities and low fuel loads dominated the 7.4-million-acre landscape of Sierra mixed conifer (SMC) forests in California for millennia. This paper asserts that prescribed fire will be a key tool in the development of new approaches to reintroduce structural complexity in young forests and enable them to persist through future wildfires. However, the proper timing, and reforestation practices that aid the feasibility of these prescribed fires has been an area of uncertainty for managers.

MANAGEMENT IMPLICATIONS

- If tree survival is a primary objective of a prescribed burn, waiting until stands are 30 years old limits mortality even during hot burns
- Delayed mortality post prescribed fire is especially present in young stands
- Having a variety of age classes among stands to pick from improves chances of being able to conduct a burn in a wider range of conditions
- Sequencing of treatments, from planting to pre-fire manipulation, is important in preparing for prescribed burns

Following large canopy disturbances, active reforestation through seedling planting bypasses the sensitive germination and establishment phases of regeneration. This provides a higher probability and speed of development toward mature forest structures. If the exclusion and suppression of fire was the root cause of the alteration of ecological process that has caused the increase in high severity fire, the reintroduction of fire as soon as possible is likely an important, and necessary method of restoration.

This study took place at the University of California Blodgett Research Station in the north-central Sierra Nevada. The areas burned included replications of 12-, 22-, and 32-year-old cohorts planted with the five SMC species: white fir, ponderosa pine, sugar pine, Douglas-fir, and incense-cedar. Giant sequoia was also planted in this study to test the species' relative capacity to persist through fire. All age classes were prescribe burned over two consecutive days in October 2018, limiting experimental variability that would otherwise come from burning different age classes at different times. The authors suggest that this accomplishment of burning several age classes at one time was a key and unique aspect of the study.

Following the hot burns, average stand survival rates one year post-burns were 52% (12-year-old stands), 62% (22-year-old), and 82% (32-year-old). Remeasurement after two years saw survival in the 12-year-old stands drop to 31%, while the 22- and 32-year-old stands remained relatively unchanged at 63% and 78% respectively. (Figure 1).

Mirroring the typical pattern observed following prescribed fire in mature stands, the fires preferentially removed smaller trees, increasing average diameter at base height (DBH) for all age classes. (Figure 2)

Giant sequoia and ponderosa pine showed greater resistance to fire mortality than the other SMC species. Using a logistic regression model, stand age was found to be a significant factor in mortality. Notably, stand density was not found to be a significant factor of mortality.

An important context for management implications is that the prescribed fires for this study were conducted on the hot and dry side of prescription. Ten-hour fuel moisture was between 5% and 6%; relative humidity was between

23% and 39%. Most prescribed burns would occur under cooler and wetter conditions, so are expected to result in less mortality. The results of this study, then, can be considered a 'worst case' scenario in regard to mortality from prescribed fire, if minimizing tree mortality is a management objective during a burn.

While ~70% mortality in 12-yr old stands may be considered unacceptable by conventional standards, this level of mortality may be desirable for goals such as tree density reduction and the development of structural heterogeneity. More often, cooler burns in young stands have been observed with lower tree mortality (0-24%). Regulatory boundaries and limited prescribed burning windows may necessitate managers burning whenever they satisfy permitting requirements and are in prescription, whether conditions are at the high or low ends of the prescribed range. More often than not, burning will occur at the lower/cooler end of prescriptions. The willingness of a manager to accept a wide range of fire effects, especially in young stands, will likely be necessary.

If maximizing tree survival is a primary objective, the conservative approach would be to wait until stands reach 30-years-old before burning. Ideally, burn plans would include multiple stand ages so that a particular age could be chosen from a group of available stands to minimize mortality during a burn window. Specifically, on a hot and dry day, a manager can chose to burn a stand that is >30 years old. On a cool/wet day, a younger stand can be chosen for burning. Further reading of this article will reveal a variety of other treatments that can be applied to a stand prior to prescribed fire to both limit mortality and improve the ability to conduct a prescribed burn. The sequence of these treatments is the key factor to increase the likelihood of prescribed fires achieving management goals.

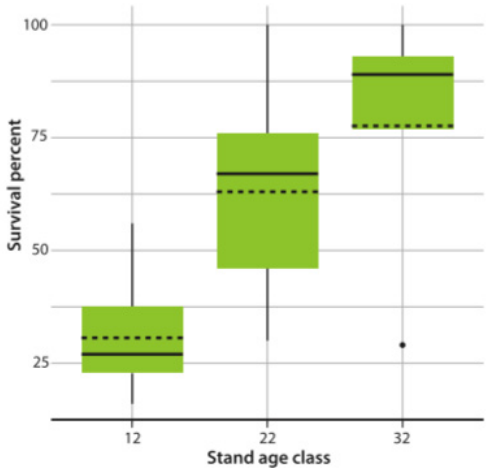

Fig. 1. Two-year post-burn stand level survival by age class. Boxes represent the interquartile range, solid black lines the median, black dashed lines the mean, and whiskers 1.5 times the interquartile range. Black dots represent outliers in data.

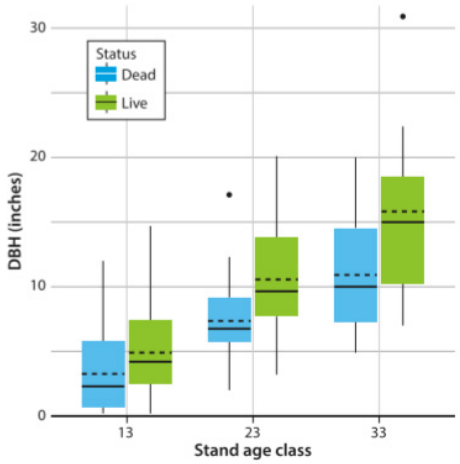

Fig. 2. Mean, median, and range of the DBH of live and dead trees in each age class. Boxes represent the interquartile range, solid black lines the median, black dashed lines the mean, and whiskers 1.5 times the interquartile range. Black dots represent outliers in data.

Additional Information

This brief is based on the following article:
Noble, Hunter, and Robert A. York. "Using Prescribed Fires in Young Forests: A Pyrosilvicultural Approach." California Agriculture 78, no. 2 (May 9, 2024). https://doi.org/10.3733/001c.117485.

This brief was written by Cooper Herrington and Robert A. York, reviewed by Autym Shafer, and produced by the CFSC Statewide Team.

For additional information, contact: cafirescience@gmail.com