Research Brief for Resource Managers

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Winter burning opportunities in the Sierra Nevada

York, R.A., Levine, J., Russell, K., Restaino, J. 2021. Opportunities for winter prescribed burning in mixed conifer plantations of the Sierra Nevada. Fire Ecology 17:33. DOI: https://doi.org/10.1186/s42408-021-00120-5

With the increasing urgency to address the prescribed fire deficit in mixed conifer forests and conditional barriers to burning, land managers may be interested in taking advantage of emerging opportunities to implement fuel treatments and reduce wildfire risk. The implementation of prescribed burning is dependent upon the alignment of conducive weather, suitable fuel moisture, the availability of operational resources, sanctioned burn days by the California Air Resource Board (CARB), and the issuance of a burn permit, if required. While weather and fuel conditions in the fall may be ideal, the prolonged wildfire season and burn permit suspension durations have severely constrained burning operations. Although it is typically a wetter time of year, as dry periods occur and snowpacks decrease, burning during winter may be an increasingly applicable option.

Adaptative management strategies, like winter burning, provide opportunities for land managers to reduce wildfire severity without threatening other management objectives. With narrowing and potentially non-existent opportunities during other times of year, winter may currently be the most realistic and advantageous time to conduct prescribed burns.

Management Implications

- Winter burning is a relatively low-cost and low-risk fuel treatment method
- Given fall permit restrictions, winter may provide more viable burn days
- Pyrosilvilcultural treatments, such as thinning and mastication, can increase winter burn opportunities by increasing dried fine surface fuels
- Consumption of duff and large woody debris can be low, but this is traded for lower damage to canopy trees
- Operable winter burn windows are brief and can occur anytime, thus requiring quick mobilization of resources to conduct burns

This study evaluated the effectiveness and feasibility of winter burning to demonstrate its potential utility. Specifically, the goals were:

1. Demonstrate and document the effectiveness of winter broadcast burning
2. Analyze pre- and post-burn structures to potentially identify factors that facilitate desired fire effects
3. Reconstruct the frequency and duration of winter burn windows over the past 20 years at the study site

Burns were conducted during a three-day period on three 20-acre stands in February 2020 in mixed conifer forests of the central Sierra Nevada. The stands were actively managed even-aged plantations composed of 30- to 40-year-old mixed conifer species. The authors note the importance of pre-fire treatments, which included a mastication treatment five years prior and a commercial thin three years prior to burning to a target basal area of 109 sq.ft./acre.

For each burn, researchers recorded the prescription parameters and operational logistics to provide an accessible and reproducible model for winter burning. At the time of burning, the 10-hour fuel moisture was 10-11%, relative humidity was between 25-30%, live fuel moisture averaged at 107%, and temperature ranged 59-68 °F. Crew size for each burn was 3-4 people. Plot-level data gathered pre- and post-burn evaluated changes in forest structure and assessed fine fuel consumption variables.

Weather conditions were recorded daily in 15-minute intervals from 1994-2020 at a nearby weather station. Researchers defined the winter season from the onset of the first significant rainfall (i.e., a "season-ending event") to May 1st, which is often the start of burn permit requirements in mountain counties. Based on decades of experience, the authors developed a burn feasibility standard defined by a continuous period of no rainfall for 10 days, followed by a day with low humidity less than 45%. This weather standard, along with air quality constraints set by the CARB (no burn days), accounted for the criteria used to identify the duration and occurrence of viable winter burn windows.

On average, 59% of fine fuels were consumed and shrub cover was reduced by 94% (Table 2). Notably, no mortality occurred in mid- and over-story trees. Crown damage of canopy trees, expressed as a percent of the crown volumes, averaged 25%. Statistical models utilized to assess the impact of relevant variables towards fine fuel consumption did not find any conclusive predictors. At the stand level, consumption generally increased across the burning window as fuels progressively dried with the number of consecutive precipitation-free days.

The reconstruction of burn windows over the past 20 years found that on average 12 days per winter were within prescription and approved by CARB. October and January averaged the highest number of viable burn days, but annual variability was extremely high. Burn window durations occurred primarily within one to three day periods. Notably, a third of the total days with favorable weather conditions were designated no-burn days by CARB, particularly during the first half of the winter season. The authors point out that the local air pollution control district has historically been collaborative in facilitating prescribed burning even when air quality was marginal.

This study demonstrated the effectiveness of winter burning as a low-cost and low-risk fuel treatment, particularly in stands transitioning into mature forest structures (~40 years old). A consideration of this research is that the prescribed fire effectiveness benefited from mechanical treatments prior to burning. This approach to preparing stands for prescribed burns is known as "pyrosilviculture." While this fuel manipulation is not always required, it increases the opportunities for and effectiveness of broadcast burns by increasing the rate at which surface fuels dry following rainfall. This is an especially important factor for winter burning.

Considerations for winter burning differ from those in fall as they operate on the wetter end of prescriptions (Table 1). Elevated fuel moisture content allows winter burning to occur at wider ranges of wind speed and relative humidity. Furthermore, burning in winter decreases the risk of undesirable fire behavior effects, such as escapes and tree canopy damage. For managers previously hesitant to attempt prescribed burning, winter burning may act as a "gateway burn," providing an efficient and low risk opportunity to gain experience.

Additional research into the potential and desirable application of winter burning across varied combinations of treatments within different forest structures could broaden the understanding of prescribed fire use throughout the winter season. By extending prescribed burn programs into winter, state agencies and landowners can capitalize on the advantages of winter burning as more opportunities inevitably arise in the future.

Further Reading:

Striplin, R., McAfee, S. A., Safford, H. D. and Papa, M. J. 2020. Retrospective analysis of burn windows for fire and fuels management: an example from the Lake Tahoe Basin, California, USA. Fire Ecology16:13. DOI: https://doi.org/10.1186/s42408-020-00071-3

Table 1 Environmental prescription ranges for winter burning and fall burning at BFRS

	Winter		Fall	
Parameter	**Low**	**High**	**Low**	**High**
Relative humidity (%)	45	18	65	23
6.1 m height wind speed (km h^{-1})	8	24	8	16
Mid-flame wind speed (km h^{-1})	2.4	9.7	2.4	4.8
Temperature (°C)	3	27	3	27
1-h fuel moisture (%)	13	3	13	5
10-h fuel moisture (%)	12	5	14	5.5

Table 2 Change in fuel loads and shrub cover following winter burns in mixed conifer plantations. The means are based on three stands, each with 10 sample plots on a 60-m grid and two fuel transects per plot. Variability in consumption between stands can be seen from the % reduction columns

	Pre burn mean (*n*=3 stands)	**Post burn mean (*n*=3 stands)**	**% reduction burn 1**	**% reduction burn 2**	**% reduction burn 3**
Fine fuels	31.9 mg ha^{-1}	13.1 mg ha^{-1}	58	42	78
1000 h	1.1 mg ha^{-1}	0.8 mg ha^{-1}	48	24	7
Duff	28.6 mg ha^{-1}	24.5 mg ha^{-1}	11	2	31
Shrub cover	21%	1%	86	96	98