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/

Forest mid-story interactions with prescribed fire behavior

Tirtha Banerjee, W Heilman, S Goodrick, K Hiers, and R Linn. 2020. Effects of canopy midstory management and fuel moisture on wildfire behavior. Nature Scientific Reports 10:17312 https://doi.org/10.1038/s41598-020-74338-9

Wildland fire behavior modeling is tremendously important for prioritizing the types of fire hazard reduction treatments and their placement on the landscape. Here, a super-fine scale model that incorporates complex interactions between fuel structure and atmospheric air flows was used to predict detailed fire behavior outputs. The study used models to predict fire behavior differences according to two primary factors: mid-story density (i.e. the ladder fuel layer) and live fuel moisture. This is relevant for prescribed burns because both of these factors can be modified when conducting burns. The modification of forest structures in order to facilitate more prescribed burns is one of the definitions of Pyrosilviculture, an approach developed in order to increase prescribed burn use in California (see further reading below). The second factor—live fuel moisture—is modified based on the season in which burns are conducted.

Are pre-fire treatments necessary?
Technically, no. But realistically, yes.
It is common to consider conducting treatments that remove or reduce mid-story fuel prior to prescribed burns, especially in forests that are very dense and have high fuel loads. While experienced burners know that even very dense forests can be burned successfully without any pre-fire treatments, this "burn-first" approach depends greatly on being able to burn when conditions are just right. Realistically, however,

Management Implications

- If burning dense forests during late summer or fall, burning at night may mitigate intense heat outputs that are predicted to occur.
- If burning during the winter or spring, removing the mid-story prior to burning is likely to increase the effectiveness of the burn.
- The long-term use of a prescribed fire program can result in a sparse mid-story that can be beneficial for wildfire hazard reduction, replacement of canopy trees, and supplying wildlife habitat variability.
- Understanding heat-wind-vegetation interactions that occur at small scales during prescribed fires can help practitioners develop Smart Practices and Architecture for Prescribed fire in California… SPARx-Cal!

Fig. 1. Prior to this winter burn, the mid-story was removed. The burn was feasible because of the "pyrosilviculture" preparation of forest structure. A sparse mid-story, like the tanoak seen behind the burner on the right, has developed and persists even with high frequency burning (every ~3 years).

"just right" often occurs when other factors make it impossible to burn. For example, it may be ideal to burn high density forests during the summer or early fall, but this is also during wildfire season and wind-caused power outages, making it unlikely to get clearance to burn during this time.

To get a dry season burn right, burn at night

For practitioners or landowners who are able to burn high density stands during the dry season, an implication from this study is that it may actually be counter-productive to aggressively remove mid-story vegetation prior to burning. **Vegetative drag**, which decreases wind speeds from mid-story vegetation, can slow a fire down and make it more controllable during prescribed burn weather conditions. The other implication for those wanting to burn high density stands during the dry season is to **burn at night.** The models suggested that dense forests burned under dry conditions create heat at a magnitude (a lot!) and orientation (upward!) that is likely to damage or kill canopy trees. Burning at night, when fuels are still dry but air temperatures are low, can be a way to reduce canopy damage while still consuming high amounts of surface fuel.

If you must, burn when it is green…
But first make the ladder fuels lean

For those who are more comfortable with reducing density prior to burning, or for those who are forced to burn during wetter conditions because of other factors, the implications are different. Winter and spring burns are often more about maximizing heat and consumption, rather than minimizing it. With that being the case, this study suggests the following approach:

1. If planning on broadcast burning during the cool end of a prescription or during the winter or spring, be aggressive with a pre-fire treatment and remove most of the mid-story. This can be done with a whole tree yarding treatment or a pile and burn treatment.
2. On private land, a significant challenge may be getting a burn permit when conditions are right for burning (see further reading section).
3. If the first burn is effective, it should make maintenance burns easier, whether they are done during dry or wetter conditions.
4. A sparse mid-story will inherently develop from variable prescribed fire consumption over time (not all areas will burn the same). This sparse and disjunct mid-story can be beneficial in terms of wildfire severity.

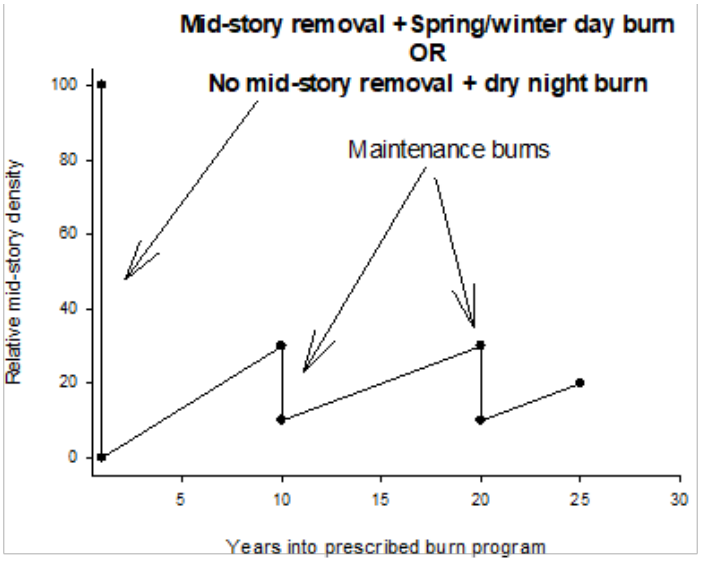

Fig. 2. A conceptual diagram of how a forest mid-story can be reduced using two approaches. Whether one takes a "burn-first" approach or a "prep-first" approach, the same result of low fire hazard can eventually be achieved once maintenance burns are occurring.

One of the model outputs is Particle Momentum Flux. This is a measure of gustiness that can occur right next to a fire. It is relevant for prescribed fires because escapes can occur when quick, strong gusts project embers up and across fire lines. All of the dry condition scenarios had much higher fluxes, with dry + dense forest conditions having the highest. This suggests value in reducing mid-story density along the edges of an area that will be burned when conditions are dry. Models predict much lower fluxes when live fuel moisture is high, suggesting that preparing edges may be unnecessary for winter/spring burns.

Suggestions for further reading:

York, R.A. et al. 2021. Pyrosilviculture: Combining prescribed fire with gap-based silviculture in mixed-conifer forests of the Sierra Nevada. Canadian Journal of Forest Research https://doi.org/10.1139/cjfr-2020-0337

York, R.A. et al. 2020. Burn permits need to facilitate – not prevent – "good fire" in CA California Agriculture http://calag.ucanr.edu/archive/?article=ca.2020a0014