Research Brief for Resource Managers

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Future forest management influence on fire and carbon storage in the Sierra Nevada

Krofcheck, D. J., M. D. Hurteau, R. M. Scheller, and E. L. Loudermilk. 2017. Restoring surface fire stabilizes forest carbon under extreme fire weather in the Sierra Nevada. Ecosphere 8(1):e01663. 10.1002/ecs2.1663
https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/ecs2.1663

Management Implications

In future extreme fire weather scenarios:

- Performing thinning and maintenance burning made a significant difference (>25%) in reducing fire severity.
- Carbon emissions also significantly dropped when landscape were thinned and burned, because fire severity was reduced and carbon, in turn, was more stable on the landscape.

With rising temperatures, future droughts and subsequent extreme fire weather forecasted, how will management, carbon storage and emissions and fire severity interact? These were questions approached in a recent paper by Krofcheck et al. (2017).

We are already seeing a change in wildfire extent and season length due to warmer temperatures and earlier snowmelt (Westerling 2016) which has translated into more extreme fire weather events (Collins 2014) and impacts how forests store carbon. Forests act as huge reservoirs for carbon and when decimated by a high-severity wildfire, a surge of greenhouse gasses contribute further to climate change. Overly-dense forest conditions due to a legacy of fire suppression exacerbates the influence of extreme weather on fire, causing fires to burn more severely over larger areas than they would have historically (Stephens et al. 2007, Miller et al. 2009). Studies support that managing forests with thinning and prescribed-burning can reduce the risk of high severity fires (Stephens et al. 2012), although we are uncertain of treatment effectiveness in future extreme weather conditions. We are also uncertain of how fuel treatments influence carbon dynamics, as carbon is lost when we remove biomass, although the loss may not be as significant as what would occur during a high-severity fire and may vary with climate.

To simulate how management and fire interact to influence carbon dynamics, Krofcheck et al. (2017) used a common model (LANDIS-II) that employed vegetation and soil data from the Dinkey Creek watershed on the Sierra National Forest in the southern Sierra Nevada, California. Three different management strategies were modeled (e.g. thinning only, thinning and maintenance burning, and no-management) under both contemporary and extreme fire weather conditions. Krofcheck et al. (2017) compared model outputs which included fire severity, carbon stocks and wildfire emissions, among each of the scenarios.

Krofcheck et al. (2017) found fuel treatments did not ameliorate fire severity under the contemporary weather scenario unless there was exceptionally high biomass present. The results are likely due to using relatively benign fire weather patterns and infrequent fires within models (they modeled fire occurrence probability from historic fire data in the area). However, under future conditions, performing thinning and maintenance burning made a significant difference (>25%) in reducing fire severity.

The two active management strategies, thinning alone and thinning and burning, both reduced aboveground carbon under contemporary fire weather conditions as carbon was removed from the system. However, in the extreme fire weather scenario, there was no difference between management and no-management in aboveground carbon, as less carbon was lost to wildfire in the management scenario and less carbon was lost to management in the no-management scenario.

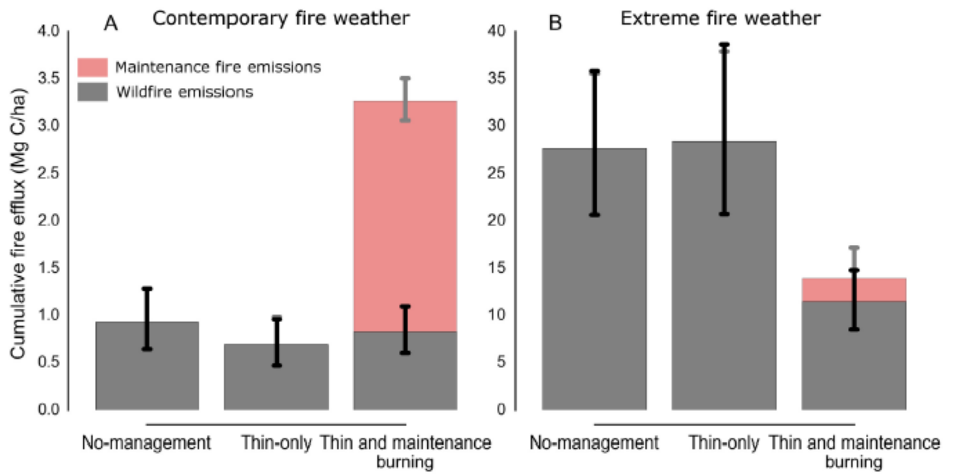

Figure 1. Cumulative C emissions from fire following 100 yr of simulation for contemporary (A) and extreme (B) fire weather. Gray bars represent emission from wildfire, whereas the red bar on the thin and maintenance burn scenario adds the emissions generated from prescribed burning. Figure and caption from Krofcheck et al. (2017).

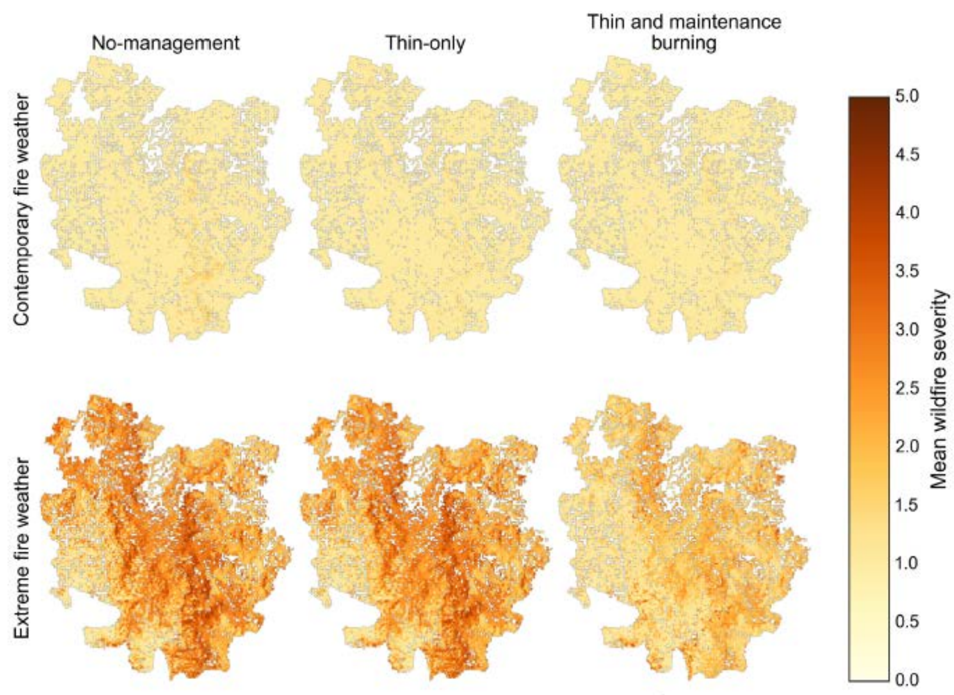

Figure 2. Mean wildfire severity for the 50 replicates of 100-year simulations across the Dinkey Creek watershed. Figure and caption from Krofcheck et al. (2017).

Under contemporary conditions, emissions increased when stands were both burned and thinned due to the prescribed-burning emissions. However, under extreme fire weather, emissions were significantly reduced in the burning and thinning scenario, because fire severity was reduced and carbon, in turn, was more stable on the landscape than it would be if extreme wildfires were common.

Krofcheck et al. concluded the paper with a recommendation to capitalize on the more benign contemporary fire weather to restore natural fire regimes. Given that fuel treatments do reduce fire severity (Stephens et al. 2012) and that we can expect more extreme weather and fires in the future, it would demonstrate forethought to actively step-up thinning and prescribed–burning treatments now.