Testimony of

Dr. Brandon M. Collins

Research Scientist

Center for Fire Research and Outreach, Berkeley Forests, University of California, Berkeley

Before the House Committee on Energy and Commerce's Subcommittee on Energy and Subcommittee on Environment and Climate Change

"Out of Control: The Impact of Wildfires on our Power Sector and the Environment"

January 28, 2020

Fire has been a part of many western U.S. forests for millennia, and its removal has slowly but markedly changed forests in unintended ways. The cumulative effects of removing fire for over 100 years are manifested in the large and uncharacteristically severe fires that are now happening annually. Additionally, the recent drought in California spotlighted another major vulnerability of California forests, large-scale tree mortality from bark beetles and possibly other yet-unseen insect and pathogen outbreaks. While climate certainly had a role in recent fire and tree mortality events, the current forest conditions are undoubtedly contributing to both. As stewards of a resource unique to our nation, our great challenge is to manage forests such that they can tolerate fire, even under more extreme weather conditions, and still retain their fundamental character. Further, we need to do this at a rate that exceeds the currently increasing rate of severe wildfire. This means proactive management using all appropriate approaches. In this testimony I present information on the altered condition of contemporary forests and the impacts of these conditions on recent wildfires. Additionally, I discuss different approaches for reducing wildfire hazard and restoring these fire-adapted forests.

For many western U.S. forests what we see today does not look at all like what existed in previous centuries. For the sake of brevity, I will simplify the findings from numerous studies to a handful of key points on how forests have changed relative to the historical period: large increases in tree density (particularly in smaller size classes), greater amount of dead fuel on the forest floor, loss of large trees, greater proportions of shade-tolerant tree species, and homogenized vegetation patterns (e.g., Hessburg *et al.* 1999; Brown *et al.* 2008; Taylor *et al.* 2014; Stephens *et al.* 2015; Collins *et al.* 2017). Historical forests were shaped by frequent fire (every 10-15 years) that generally burned on the forest floor with occasional torching of individual trees, so called “low- to moderate-severity”. One important point to emphasize is that these frequent fires did not result in uniformly low density, low fuel forest conditions. The variable nature of fire, interacting with moisture availability (controlled by topography, soil) created a mosaic of vegetation conditions across a landscape. This mosaic included patches of dense forests, shrubs, young regenerating trees, within a matrix of low to moderate density forests (Hessburg *et al.* 2005; Collins *et al.* 2015). This heterogeneity was particularly evident at larger spatial scales (>1000 acres), which has diminished considerably in contemporary forests (Lydersen and Collins 2018).

The changes in contemporary western U.S. forests are primarily attributed to the exclusion of fire for over 100 years and timber harvesting focused on large tree removal (Taylor 2004; Merschel *et al.* 2014). Fire exclusion over this amount of time removed a key regulating process that consumed dead fuel, limited tree establishment, and created spatial heterogeneity. Large tree removal opened a considerable amount of growing space, allowing for rapid tree establishment and growth. This response was welcomed by early foresters whose primary motivation was to generate a sustainable supply of wood to growing nation (Show and Kotok 1924). However, over the long-term these practices ultimately exposed contemporary forests to a very different pattern of wildfire effects from what they experienced historically (Hessburg *et al.* 2015). The most concerning characteristic of contemporary wildfires is not their overall size, but rather the size of patches with complete (or nearly complete) tree mortality. These so-called “stand-replacing patches” have been increasing in size over the last couple decades in California (Miller and Safford 2012; Stevens *et al.* 2017). In forests historically adapted to frequent-fire the trees lack an ability to naturally regenerate large stand-replacing patches. As a result, these patches are commonly converted to shrublands, which dramatically changes the ecosystem function (e.g., habitat) and the services provided (e.g., timber, carbon sequestration).

In response to these trends in forest loss there has been a push to restore forest structure and composition to that akin to historical conditions. Forest restoration can be done by mechanically removing trees (with chainsaws or heavy equipment), with fire (either prescribed fire or intentional use of naturally ignited wildfire), or a combination of the two. The intent with these methods is reduce tree density by removing smaller and mid-sized trees, and in case of fire use, consume accumulated fuels on forest floors. The duel benefit achieved with forest restoration is wildfire hazard mitigation. The *Fire and Fire Surrogate Study* at Blodgett Forest (near Georgetown, CA) was initiated in order to study the effectiveness and overall ecological impacts of these different forest restoration/fire hazard reduction treatments (Stephens and Moghaddas 2005). Through the combined commitment of the forest managers and researchers at UC Berkeley, the study has been maintained continuously since its onset in 2001.While 18 years is a relatively short time frame relative to the lifespan of trees, the study is nonetheless a uniquely long-term look at forest management options and their effectiveness.

The Fire and Fire Surrogate study at Blodgett Forest is comprised of a network of twelve stands (35-70 acres each) that were randomly assigned to four treatments representing the basic range of forest restoration/fire hazard reduction options. The treatments were:

- Control: no active management.

- Mechanical-only: commercial timber harvest, which removed mid-sized trees, followed by mastication, which chipped/shredded smaller trees in place. Initial treatment was completed in 2002, with a second mastication done in 2017.
- Fire-only treatment: prescribed fires applied in 2002, 2009, and 2016
- Mechanical+fire treatment: same mechanical treatment described previously, followed by prescribed fire. Initial treatment was completed in 2002, with second mastication and prescribed fire applied in 2018.

The initial effects of the different treatments followed a somewhat expected pattern. Both treatments involving fire were quite effective at reducing modeled wildfire hazard, even under fairly extreme weather conditions. This was due to the high consumption of fuel on the forest floor (called surface fuel) and to the considerable reduction in small trees and low branches (called ladder fuel). The effectiveness of the mechanical-only treatment at reducing wildfire hazard was not obvious initially. While this treatment largely eliminated ladder fuels, it did so at the expense of augmenting surface fuels (from the masticated material left on site).

By 2009 it was apparent that the treatments were on distinct and somewhat surprising trajectories. The most surprising finding was that the augmented surface fuel in the mechanical-only stands was gone, presumably from natural decomposition. As a result, the modeled wildfire hazard decreased significantly (Stephens *et al.* 2012). Hence, the mechanical treatment "aged well" from the perspective of hazard mitigation. The second most surprising finding was the vigorous understory shrub response in the mechanical+fire stands. The increased light to the forest floor from the commercial thinning, coupled with the removal of surface fuels and the heat/smoke stimulus from fire allowed for rapid establishment of large stature shrubs, mainly *Ceanothus* species. The mechanical+fire treatment was still effective at reducing wildfire hazard in 2009, but this was likely to be compromised as the shrubs grew taller and denser. The fire-only stands started to accumulate surface fuels as the small to mid-sized trees killed by the initial fire began to fall to the forest floor, hence the need for a second prescribed fire applied in the fall of 2009. This emphasized an important distinction between the two mechanical treatments and the fire-only treatment related to the fate of killed trees. It would take multiple “entries” to entirely remove those unwanted trees with fire alone; whereas with mechanical methods they could be removed immediately.

The distinction among treatments became even more interesting over time. Tree growth was accelerated in the mechanical-only stands. This was evident in diameter and crown expansion for overstory trees that remained after thinning, as well as for regenerating trees in the understory. This increased growth in overstory trees had a noticeable effect of increasing individual tree vigor relative to the other treatments (Collins *et al.* 2014). Tree regeneration in the understory was so strong that another mastication was warranted in 2017 to maintain low fire hazard. Similarly, the shrub growth in the mechanical+fire warranted another mastication before a second prescribed fire could be applied. This was done because it would have been difficult and quite risky to burn the shrubs effectively without torching the entire stand. The fire-only stands continued to “recruit” dead trees into the surface fuels, but an interesting phenomenon became apparent. After two burns the fire-only stands were developing a “patchy” pattern of tree clumps, openings with shrubs, and large isolated individual trees. This pattern appears to be a common characteristic of historical forests that experienced frequent fire. It is also thought to provide a suite of habitat types for wildlife species that are adapted to distinct structural/compositional environments. Recent research also suggests there may be additional benefits of this patchy tree/opening pattern tied to snow retention and water yield (Stevens 2017). The basic premise is that more snow accumulates in the small openings, which melts out slowly because of shading from adjacent trees.

The state of California recently put forth some unequivocal statements on the need for large-scale forest restoration/fire hazard reduction. So, which treatments examined in this nearly 20-year study should be used in this effort? The answer that I offer is 'all of the above'. Each of the treatments studied had direct benefits for forest restoration/fire hazard reduction and several co-benefits (e.g., wood products, habitat improvement, water yield, reduced wildfire emissions, stabilizing forest carbon). The different land management, ownership, and societal constraints requires a diversified approach to forest restoration that includes prescribed burning, commercial thinning, and mastication. In fact, landscape-level restoration will also need to include managing naturally ignited wildfires (North *et al.* 2015), hand thinning (removing only small diameter trees), pile-burning, and grazing. The uncharacteristically high vulnerability to wildfire and drought exists at such great scale throughout many western U.S. forests that action is warranted *now*, even if our current scientific understanding is imperfect. Our current rate of forest restoration is falling woefully short of what is needed in these forests (North *et al.* 2012; Vaillant and Reinhardt 2017). We know enough from studies like the Fire and Fire Surrogate Study at Blodgett, and many others not highlighted here, to move forward competently with large-scale forest restoration. I recognize the need to continue studying treatment impacts on various ecosystem components and adjust future treatments. It is time to prioritize forest health and resilience, even over other resource concerns, in order to ensure their continued provisioning of services we depend on.

References

Brown PM, Wienk CL, Symstad AJ (2008) Fire and forest history at Mount Rushmore. *Ecological Applications* **18**, 1984-1999.

Collins BM, Das AJ, Battles JJ, Fry DL, Krasnow KD, Stephens SL (2014) Beyond reducing fire hazard: fuel treatment impacts on overstory tree survival. *Ecological Applications* **24**, 1879-1886.

Collins BM, Lydersen JM, Everett RG, Fry DL, Stephens SL (2015) Novel characterization of landscape-level variability in historical vegetation structure. *Ecological Applications* **25**, 1167-1174.

Collins BM, Fry DL, Lydersen JM, Everett R, Stephens SL (2017) Impacts of different land management histories on forest change. *Ecological Applications* **27**, 2475-2486.

Hessburg P, Churchill D, *et al.* (2015) Restoring fire-prone Inland Pacific landscapes: seven core principles. *Landscape Ecology* **30**, 1805-1835.

Hessburg PF, Smith BG, Salter RB (1999) Detecting change in forest spatial patterns from reference conditions. *Ecological Applications* **9**, 1232-1252.

Hessburg PF, Agee JK, Franklin JF (2005) Dry forests and wildland fires of the inland Northwest USA: contrasting the landscape ecology of the pre-settlement and modern eras. *Forest Ecology and Management* **211**, 117-139.

Lydersen JM, Collins BM (2018) Change in vegetation patterns over a large forested landscape based on historical and contemporary aerial photography. *Ecosystems* **21**, 1348-1363.

Merschel AG, Spies TA, Heyerdahl EK (2014) Mixed-conifer forests of central Oregon: effects of logging and fire exclusion vary with environment. *Ecological Applications* **24**, 1670-1688.

Miller JD, Safford HD (2012) Trends in wildfire severity 1984-2010 in the Sierra Nevada, Modoc Plateau and southern Cascades, California, USA. *Fire Ecology* **8**, 41-57.

North M, Collins BM, Stephens SL (2012) Using fire to increase the scale, benefits and future maintenance of fuels treatments. *Journal of Forestry* **110**, 392-401.

North M, Brough A, Long JW, Collins BM, Bowden P, Yasuda DA, Miller JD, Sugihara NG (2015) Constraints on mechanized treatment significantly limit mechanical fuels reduction extent in the Sierra Nevada. *Journal of Forestry* **113**, 40-48.

Show SB, Kotok EI (1924) The role of fire in the California pine forests. U. S. Department of Agriculture Bulletin No. 1294,80 p. (Government Printing Office, Washington, DC, USA)

Stephens SL, Moghaddas JJ (2005) Experimental fuel treatment impacts on forest structure, potential fire behavior, and predicted tree mortality in a California mixed conifer forest. *Forest Ecology and Management* **215**, 21-36.

Stephens SL, Collins BM, Roller GB (2012) Fuel treatment longevity in a Sierra Nevada mixed conifer forest. *Forest Ecology and Management* **285**, 204-212.

Stephens SL, Lydersen JM, Collins BM, Fry DL, Meyer MD (2015) Historical and current landscape-scale ponderosa pine and mixed conifer forest structure in the Southern Sierra Nevada. *Ecosphere* **6**, art79.

Stevens JT, Collins BM, Miller JD, North MP, Stephens SL (2017) Changing spatial patterns of stand-replacing fire in California mixed-conifer forests *Forest Ecology and Management* **406**, 28-36.

Stevens JT (2017) Scale-dependent effects of post-fire canopy cover on snowpack depth in montane coniferous forests. *Ecological Applications* **27**, 1888-1900.

Taylor AH (2004) Identifying forest reference conditions on early cut-over lands, Lake Tahoe Basin, USA. *Ecological Applications* **14**, 1903-1920.

Taylor AH, Vandervlugt AM, Maxwell RS, Beaty RM, Airey C, Skinner CN (2014) Changes in forest structure, fuels and potential fire behaviour since 1873 in the Lake Tahoe Basin, USA. *Applied Vegetation Science* **17**, 17-31.

Vaillant NM, Reinhardt ED (2017) An evaluation of the Forest Service hazardous fuels treatment program—are we treating enough to promote resiliency or reduce hazard? *Journal of Forestry* **115**, 300-308.