California Society of American Foresters

The Role of Mechanical Treatments in Reducing Risks of Catastrophic Wildfire in California

A Position of the California Society of American Foresters

Originally adopted on May 17, 2019. This position will expire in 2024 unless, after subsequent review, it is further extended by the CA SAF board of directors.

Position

California's strategy for reducing the frequency and destructiveness of wildfires should include reducing hazardous fuels in the wildland-urban interface (WUI) and throughout our wildland landscapes. Much of California's forestland is overstocked with relatively small trees, which pose significant risk of loss of life and property due to catastrophic wildfire. In the WUI, the proximity of hazardous fuels and residential developments poses heightened risks that require especially diligent fuel management. WUI areas should be our highest priority for reducing hazardous fuels. Mechanical timber harvesting can reduce hazardous fuels and generate revenue to enable comprehensive restoration of forest resilience. To effectively reduce risks of destructive wildfire, surface fuels, including the stand's smallest trees, shrubs, and slash (tops and limbs of felled trees), must be treated, in addition to harvesting trees large enough to qualify as timber. Although often essential to achieving forest owners' objectives, traditional timber harvesting is generally ineffective in reducing fire hazards, and often increases hazards in the short term, relative to pre-harvest conditions, because it increases fuel loads by producing slash. To be effective, mechanical treatments must be part of a comprehensive harvest prescription specifically designed to reduce fuels and create adequate tree spacing. A large portion of California's forestland is too steep for mechanical fuels operations, which points to the need to also use fire-based fuel treatments. Mechanical treatment is virtually unique among the myriad available environmental restoration options in that it usually produces a valuable commodity, the revenues from which can offset restoration costs. Moreover, mechanical treatments are usually more readily acceptable to nearby residents and air-quality regulators than prescribed or managed fire.

Issues

Loss of life and property to catastrophic wildfire has increased in recent years, as wind-driven fires burn intensively and spread rapidly with increasing frequency across California's forestlands. The main causes of the increased frequency of destructive fires are unnaturally high fuel loads in overstocked stands and changes in climate causing longer fire seasons, more drought, and stronger winds. The main reason that fire damages have accelerated is the proliferation of homes in the WUI in recent decades.

As more fuelbreaks and related hazardous fuel treatments have been implemented and have intersected with advancing wildfires, convincing evidence has accumulated that fuel treatments reduce fire intensity and rate of spread. Research also shows that, as the portion of the landscape on which fuels have been treated increases, less of the landscape burns or burns intensively over the long term.

The main fuel treatment techniques available to natural resource managers are mechanical treatments, prescribed fire, and managed wildfire. Each of these treatments has advantages over the others in certain forest ecosystems, and the use of each is relatively constrained in other contexts. However, only mechanical treatments provide opportunities to harvest natural resources and convert them to valuable commodities.

Background

Agee and Skinner (2005) identify four principles for increasing fire resistance in dry forests, such as those in California:

- reduce surface fuels,
- increase height to live crown,
- reduce canopy density, and
- retain large, fire-resistant trees.

Mechanical treatment refers to tree removal using mechanized equipment such as mechanized harvesters and skidders and powered hand tools. Prescribed fire involves setting fires to achieve specified management objectives. Managed wildfire refers to allowing lightning-ignited wildfires to burn without suppressing them, so long as fire conditions conform to previously prescribed parameters such as maximum wind speed and rate of fire spread.

Protecting the state from destructive wildfires requires treating hazardous fuels throughout our wildland and WUI areas. The objectives and approaches for specific fuel treatments depend on whether they are located in the WUI, in the surrounding wildlands, or in more remote wildlands. As discussed below, mechanical treatments are applicable to reduce wildfire risks in many forest ecosystems, but are constrained from being applied on much of our montane forests by steep topography or other restrictions.

Defensible Space

Defensible space refers to partial removal of flammable vegetation in a WUI area to slow an approaching wildfire, reduce the likelihood of fire igniting houses and other structures, and increase opportunities for effective fire suppression. California law requires maintenance of defensible space within 100 feet of structures, or to the property line if less than 100 feet from a structure. However, to protect residential developments from wildfire, especially wind-driven fires, defensible space must be created throughout the WUI. To reduce the rate of wildfire spread, the density of the forest canopy should be reduced by creating adequate tree spacing. Mechanical treatment is an essential tool for achieving safe tree spacing for defensible space, but must be accompanied by treating surface fuels, limbing trees to increase height to live crown, removing limbs overhanging roofs, and hardening of buildings to resist being ignited by airborne embers. In many cases, powered hand tools are more applicable to creating defensible space than mechanized equipment.

Fuelbreaks

Fuelbreaks are forest areas in which fuels have been permanently modified to make wildfires burning into them more readily controllable. Specifically, by reducing fuel continuity, fuelbreaks reduce the fuel available to a crown fire and thereby force it to the ground, so it can be directly attacked by suppression crews. The recommended width of fuelbreaks has increased as more experience has been gained with wind-driven wildfires; in the late 1990s, the Quincy Library Group proposed they be 0.25-mile wide (Agee et al. 2000). Fuelbreaks can be constructed in any forest setting, but they can be particularly effective when located on the windward side of towns or WUI areas to protect residential developments from approaching wildfire (Friedman 2017). Locating fuelbreaks along roads in valley bottoms or ridgetops can maximize their effects on fire intensity and controllability. Mechanical treatment, supplemented by slash treatment, is a necessary component of fuelbreak construction. Whole-tree logging uses mechanized harvesting equipment to transport entire felled trees to landings (staging areas), and substantially reduces the volume of slash left in the woods. Other options for slash treatment include piling and burning, mastication, and lopping and scattering.

Landscape Area Treatments

Establishing defensible space in WUIs along with fuelbreaks in surrounding forests will not, by themselves, solve California's wildfire emergency. We also need to modify unnaturally heavy fuels throughout the forest landscape. Hazardous fuels in relatively remote forests pose threats to urban areas because (1) high winds can push fires from remote areas into urbanized areas before they can be controlled, and (2) smoke from wildfires throughout the landscape is an important and growing public health problem and a major nuisance (Cascio 2018).

Prior to the onset of industrial-scale logging and concerted wildfire suppression efforts, western forests displayed a remarkable diversity of vegetation types and stand structures that imparted substantial resistance to wildfire expansion and reduced the frequency of landscape-level (i.e., covering tens of thousands of acres) fire disturbances (Hessburg 2017). Commercial logging, which removed the largest and most fire-resistant trees from much western forest land, along with commercial livestock grazing and effective fire suppression, converted formerly diverse landscapes into vast areas of relatively uniform, overstocked, highly-flammable forest susceptible to destructive wildfire covering entire landscapes.

A primary management objective for California's forests, particularly outside of private industrial forests where timber production is the primary objective, is to restore fire resilience to the landscape by thinning overstocked stands and restoring meadows and other special habitats. Restoring fire resilience in forests will allow wildfires, when they do ignite, to burn relatively safely, thus restoring fire as an important habitat element of the California landscape. Mechanical treatments are a necessary component of most such management prescriptions, although in some cases desired conditions can be achieved using prescribed fire or managed wildfire, in the absence of mechanical treatment. Of course, using fire to treat fuels also has adverse impacts, including air pollution and risk of escape.

We now have convincing empirical evidence that specific fuel treatments effectively reduce wildfire intensity and tree mortality when they intersect (Kennedy et al. 2019; Kalies and Kent 2016; Skinner et al. 2004). A separate question is whether or to what extent progressively treating the landscape for hazardous fuels reduces wildfire damages over the entire landscape over the long term. We currently lack sufficient observations of landscapes with substantially modified fuel profiles in relation to wildfires to test this hypothesis empirically. However, a growing body of evidence obtained from rigorously-tested simulation models strongly suggests that, as the share of a forest landscape that has received fuel treatment increases, opportunities to control wildfires increase and the portion of the landscape burned intensively decreases substantially over the long term (Nechodom 2010; Syphard et al. 2011; Tubbesing et al. 2019).

Access Constraints

Mechanical treatments are generally operationally infeasible on lands where slope exceeds 35%, which encompasses much of California's montane forests in need of hazardous fuel treatments. For example, a recent analysis of operational constraints on Sierra Nevada lands in watersheds with at least 25% national forest acreage found that an estimated 25.6% of the study area's productive forest is inaccessible to mechanical harvesting equipment. When administrative and legal constraints are also taken into account, the share of inaccessible productive forest increases to an estimated 43.8%. These results indicate that mechanical treatments alone are incapable of solving our catastrophic wildfire problem, and a preferred strategy might include using mechanically treatable areas as anchors from which to expand fire-based fuel treatments. However, prescribed fire and managed wildfire also face significant application constraints. The solution to California's wildfire emergency lies in the combined use of all available fuel treatment techniques. (North et al. 2015)

Economic Benefits

California faces enormous costs to protect residents from wildfire and restore fire resilience to forests. A study of converting hazardous fuels to woody biomass in the western U.S. found that the per-acre cost to cut and extract trees to the roadside from a ponderosa pine forest in the Sierra Nevada region averaged $819 (all monetary values expressed in 2018 dollars) on gentle terrain and $996 on rolling terrain (USDA Forest Service Research and Development 2003). Applying prescribed fire in western forests cost an estimated average of $134 per acre. In the Lake Tahoe Basin, mechanical thinning to remove hazardous fuels cost $2,422 - $4,238 per acre, while prescribed burning cost $484 - $1,816 per acre (Steve Holl Consulting and Wildland Rx 2007). With millions of acres of California forest needing fuel treatment, restoration costs will ultimately total billions of dollars.

Mechanical treatments can generate revenues to offset the costs of hazardous fuel treatments. Depending on the location, size, density, and species of trees present, fuel treatments can be either a net cost to or a net revenue for the landowner. An analysis of managing forests to reduce wildfires and generate biomass energy found that, for its 2.7 million-acre northern Sierra Nevada study area, treatment costs (including costs of power production) over a 40-year timeframe totaled $85.0 million, in comparison to revenues from sales of sawlogs and power totaling $130.0 million (Nechodom 2010).

Advancements in sawmilling have increased opportunities to manufacture lumber from small trees, such as at a sawmill that produced pallet stock in Siskiyou County utilizing logs down to 4 inches in diameter (Conner pers. comm.). In addition, depending on available subsidies and proximity to biomass energy facilities, small trees from some forestlands can be economically utilized to produce electricity. The commodities produced by mechanical fuel treatments can clearly offset a large share of the cost society will incur restoring our forests. Unfortunately, much of southern California's forestland has no wood products manufacturing facility within economic hauling distance, and thus no opportunity to utilize the trees produced by mechanical treatments, so restoring these forests will require larger subsidies.

Any reductions in wildfire damages attributable to hazardous fuel treatments would be additional to wood product revenues. The 2018 Camp Fire, which was the costliest fire in California history, resulted in estimated damages of $16.5 billion (Reyes-Velarde 2019). Avoiding even one similarly devastating fire by treating hazardous fuels would produce enormous net benefits for Californians.

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