Harnessing Fire for Wildlife

FUELS MANAGEMENT IN CALIFORNIA'S MIXED-CONIFER FORESTS

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Credit: Tom Rambo

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On a dry afternoon in September of 2007 the "Moonlight Fire" started in a northeastern California mixed-conifer forest that had been accumulating fuels for over a century. Twelve days later the fire was contained after burning 65,000 acres, destroying seven structures, injuring 34 firefighters, and costing $32 million. Much of the forest within the fire perimeter had not been treated to reduce fuels because the area contained 22 protected areas set aside as habitat for two threatened species, the spotted owl (*Strix occidentalis*) and northern goshawk (*Accipiter gentilis*). A year after the fire, one lone male spotted owl remained within those charred 65,000 acres.

Such are the unintended consequences of neglecting fuels management for the sake of threatened species. The question is, how can forest managers integrate the needs of both?

Fire's Role in Forests

In the early nineteenth century, an estimated 460,000 forested hectares burned each year in California alone. By the second half of the 20th century, fire suppression had reduced annual burn acreage by 95 percent (Stephens *et al.* 2007). As a result, forests have accumulated large loads of surface fuels (litter, branches, and logs) as well as ladder fuels, small trees that allow surface fire to burn up into the overstory canopy where it becomes lethal for trees.

This fuel accumulation has changed the nature of wildfire. Historically, slow burning, low-intensity wildfires recycled nutrients and cleared out dense thickets of small trees. Today wildfire often "crowns out," quickly burning through the canopy and killing many of the oldest and largest trees. Fire size has also dramatically increased. Within the last seven years, Arizona, Colorado, and Oregon have

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Credit: USFS

Feeding on heavy fuel loads, the Moonlight Fire of September 2007 spread from "ground to crown," burning 65,000 acres of mixed-conifer forest in northeastern California. Wildlife habitat might have been spared through strategic fuels management.

all been burned by the largest wildfires in each state's recorded history.

For the USDA Forest Service (USFS), firefighting efforts now consume one-third to one-half of its annual budget. This leaves few funds to pay for fuels treatments, which follow two general approaches. To contain the spread of wildfire, "linear defense zones" are created, where surface and ladder fuels and some overstory trees are removed from strips near homes or along roads or ridge tops. Within this perimeter, the second approach involves strategically placing low-fuel patches in the landscape to act as 'speed bumps' that slow the spread and reduce the intensity of wildfire. Fire science models suggest that strategic treatment of 20 to 30 percent of the landscape can significantly reduce wildfire severity (Finney 2001).

Though often effective, these approaches were never designed to address how forests might be ecologically restored or wildlife habitat enhanced. Most of the landscape matrix—some 70 to 80 percent—is untreated and continues in an 'unhealthy' condition from decades of fire suppression, leaving important habitat susceptible to high-intensity burns like the Moonlight Fire. In addition, because many fuels projects face legal challenges over potential impacts to threatened and endangered species habitat, agencies often avoid treating such areas.

The Dinkey Creek area in California's Sierra Nevada range offers a classic case in point. Its mixed-conifer forest provides rare habitat for the threatened Pacific fisher (*Martes pennanti pacifica*) and contains many summer homes, yet it also has high fuel accumulations. Managers proposed a fuels-treatment project back in the early 1990s, but in November of 2007, after 15 years of proposals and litigation, the project failed to be resolved even after months of mediated conflict resolution.

This case prompted USFS managers in California to ask several of us at the Pacific Southwest Research Station to develop a summary of current research that might inform best management practices in fire-prone forests (North *et al.* 2009). Although the project's scientists had different expertise, (fire science, forest ecology, silviculture, and wildlife biology), their recommendations coalesced around a common theme: the importance of creating variable forest structure and fuels conditions for ecological restoration, forest resilience, and wildlife habitat. Based on our research, we propose the following

Credit: Chris Hamma

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The Moonlight Fire burned with different intensity depending on how fuels had been managed. An area without prior fuels treatment (top) was left severely charred and denuded. In an area where ladder fuels and underbrush had been cleared, some trees retained leaves and life.

strategy using localized site conditions and landscape position as templates for varying forest treatments.

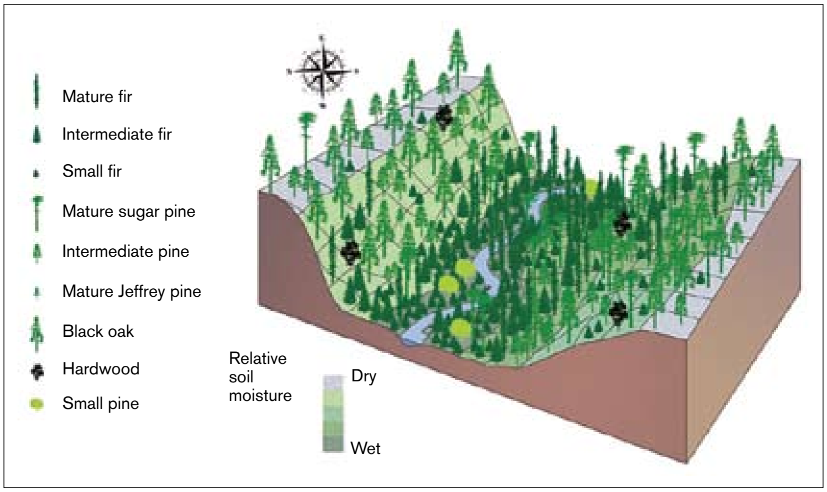
Using Topography as a Tool

Reconstructions of forest landscapes as they would have looked prior to fire suppression have found that forest structure and composition varied with topography at both stand and landscape scales. Within a stand, wetter areas such as seeps, concave pockets, and cold air drainages usually burned less frequently or at lower intensity. Across an entire forest watershed, forest and fuel conditions varied depending on slope position (location in a valley or riparian bottom, at mid-slope, or on an upper slope or ridge top) and aspect (cooler northeastern orientations versus hotter, drier southwestern aspects). Slope and aspect affect fire intensity and frequency.

In many Sierran mixed-conifer forests, higher slopes and more southwesterly aspects generated pine-dominated, open forests, while valley bottoms and northeastern aspects had fir-dominated forests with higher stem density and canopy cover. The latter, with riparian and cool microsite areas, likely provided movement and nesting/resting habitat for several species including some that are now threatened or endangered, such as the fisher.

We propose that fuels can be managed to create or sustain the types of conditions in which such species evolved. In cooler, lowland areas, fuel treatments can focus on reducing the smaller surface and understory ladder fuels, while leaving high levels of overstory canopy cover as well as large logs for resting, prey habitat, and maintaining microclimate conditions. In contrast, on upslope and more southwestern aspects, forests can be treated to produce more open, fire-resistant conditions, with selective tree removal to create larger gaps between trees. A landscape treated in these ways would have a range of habitats for different species, mimicking the historic forest variability produced by low-intensity fire (see diagram below).

To test these ideas we analyzed the Dinkey Creek and Big Creek mixed-conifer watersheds in the Sierra Nevada, identified as preferred habitat for fishers and California spotted owls (*Strix occidentalis occidentalis*). We divided the landscape into nine topographic categories: three aspects (northeast, southwest, and neutral) crossed with three slope positions (riparian/lower slope, mid-slope, and ridge top), and calculated the percentage of the total watershed in each category. We then compared the proportion of owl nests and fisher resting sites in each area. Both species had significantly higher-than-expected use of the more mesic, high canopy cover areas (in riparian/lower slopes and northeast aspects) and lower-than-expected use of open ridge tops. Such information can guide fuels management in various topographic regions for the benefit of at-risk species.



Credit: Steve Oerding

Variable forest structures that reflect historic patterns can benefit the wildlife that evolved in those forests. Historically, in mixed-conifer forests (as shown in this schematic), tree density and the percentage of fire-sensitive fir and cedar increased on northern-facing, flatter slopes, while steeper southwest-facing slopes and ridge tops had the lowest stem density and greatest percentage of fire-resistant pine. Forest managers can promote these variable structures by using fuel and harvest treatments that differ depending on topographic features such as slope position and aspect.

Strategic Treatments

Reducing surface and ladder fuels achieves the greatest reduction in fire severity. In the western U.S., thinning can remove fire-sensitive tree species such as firs and cedar, and leave more fire-resistant pines. When thinning overstory trees, the goal is to leave openings and tree groups rather than a regular spacing of the remaining or "leave" trees. This pattern, which is found in most forests with active fire regimes, creates habitat heterogeneity and still provides breaks in the forest canopy to reduce crown fire spread.

Local stand conditions will often determine what size tree groups and gaps can be created. High canopy-cover areas are usually defined by groups of larger trees. Gaps can be located in areas with thinner soils or lower productivity since these areas historically supported lower tree densities and fuel loads. In the forest matrix between tree groups and gaps, frequent-fire forests generally consisted of widely spaced, large trees, most of which were pines. The relative proportion of these conditions—low density, dispersed large trees, and large and small gaps and tree groups—and their composition vary depending on forest conditions and topographic position.

Thinning larger, overstory trees can have ecological benefits under certain conditions. In drier, upslope areas, for example, thinning larger fire-sensitive trees can reduce moisture stress in the leave trees, reducing large-scale mortality risk from bark beetles and increasing forest resilience to fire. Given the deficit of large trees in many managed forests, however, their removal should be balanced against the need for large trees and snags.

Preserving Key Habitat

Forest managers must determine how to provide the right combination of variable forest conditions and high canopy cover, old-forest sites to maintain or increase threatened and endangered species populations across a forested landscape. A few key considerations:

Know a species' needs. Conserving wildlife habitat requires providing specific stand structures associated with preferred use sites—for nests, dens, and resting—as well as managing the whole landscape to support foraging and movement. Some sensitive species like the spotted owl prefer old-forest conditions that, because of fire suppression, now have high surface and ladder fuel loads.

Managers can locate habitat for these species where, historically, fire would have burned less frequently or at lower severity owing to cooler microclimate and moister soil and fuel conditions.

Allow for movement. Landscapes need to provide foraging habitat and movement corridors, which often require a range of forest conditions associated with different prey, as well as dense canopy or shrub cover. Riparian forests provide valuable corridors in many dry areas, yet can have very high fuel loads and serve as landscape wicks in the advent of wildfire. Prescribed burning of riparian forest will help reduce fuels in these corridors, thus protecting important wildlife habitat.

Leave 'defect' trees. Perhaps the rarest structures in managed forests are large trees with habitat features such as broken tops, cavities, and platforms. The importance of these 'defect' trees for wildlife habitat is widely acknowledged, thus explicit guidance for retaining these trees is recommended.

Focus on Resiliency

In the face of changing climate conditions, forest and habitat restoration can only be effective if it increases ecosystem resiliency. One measure of resilience is that disturbance should produce mortality patterns consistent with the dynamics under which the forest evolved.

In fire-dependent forests, resilience might be best ensured two ways. The first is to reduce fuels such that if the forest burns, the fire will likely be a low-severity surface fire. This requires focusing more on influencing fire severity by manipulating fuels than on adhering to tree diameter and density goals.

The second measure for resilience is to produce a forest structure that keeps insects and pathogens at low, chronic levels. Drought-stressed trees are far more susceptible to insects and disease, now the dominant mortality agent in drier forests, which can result in large-scale, episodic tree die-off. Fire-dependent forests have persisted through more severe droughts than they are currently facing, but they have not adapted to the high densities and fuel loads found today in many stands. Much is unknown about the potential long-term effects of a warming and/or drying climate. In the more immediate future, however, reducing surface fuels and the densities of small diameter stems may be the best means of creating more resilient forests.

Credit: Rebecca Green

A threatened Pacific fisher rests on the mossy limb of a large black oak in the Klamath Mountains, which straddle the Oregon-California border. Old trees with broken limbs, hollow trunks, and other "defects" provide vital habitat for many species and can be retained through strategic fuels management.

Some forest managers express concern that the types of strategies we describe will constrain their ability to design and implement forest management plans and practices based on local conditions. Our intent is not to dictate forest management for specific conditions at the local level. Instead we endeavor to provide a research-based conceptual approach for managing fire-dependent forests, against which proposed management plans and practices can be fairly evaluated.

Epilogue

The Dinkey Creek case surfaced again in December 2009, when all interested parties finally reached a compromise and signed a memorandum of understanding for a fuels-treatment project. The resolution arose from the hard work of the participants, who built trust and found common ground in the understanding that wildlife, particularly sensitive species, historically thrived in frequent-fire conditions.

In fire-prone forests, management inaction is not an option. Wildfire is inevitable, as is the loss of habitat provided by high canopy cover forest. Yet it is possible to integrate the goals of fuel management, ecosystem restoration, and wildlife habitat. We've proposed using local topography to produce the variable, resilient forest structure in which forests' species evolved. As fuels treatments are finally implemented in Dinkey Creek, we'll be following fisher and spotted owl populations to see how they respond. ■

This article has been reviewed by subject-matter experts.