<u>Module 6 – FIRE</u>

1. Introduction
   a. Read "What is Fire Behavior?"
   b. Read "Forest Fuel"
   c. Read "Fire Behavior"
   d. Look at "Fire Ladder"
   e. Look at "CA Wildfire History"
   f. Look at graphic "Wildfires in the US 1960-2014"
2. Prescribed Fire
   a. Read "Prescribed Fire Gains Momentum"
   b. Watch "California Wildfires: The New Normal" (12:41)
      https://www.youtube.com/watch?time_continue=761&v=cWl68Iwnmu4
3. Position Papers / Issues
   a. Read "Seven Myths about Forest Fires"
4. Complete Forest Fire Worksheet

Fire Vocabulary

Crowning—active fire movement through the tree canopy.

Extreme Fire Behavior—fire that precludes methods of direct control.

Extreme Fire Weather—high temperatures, low humidity, low fuel moisture, and high winds that can lead to extreme fire behavior.

Fire Behavior—rate of spread (in feet/hour) and intensity.

Fire Duration— rate of spread plus smoldering time.

Fire Ecology—the study of fire in the context of its environment.

Fire Frequency— average number of years between fires at a specific location.

Fire Intensity— amount of energy or heat released; temperature and flame length.

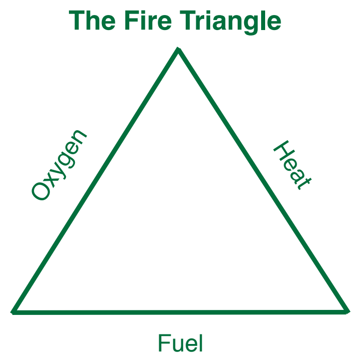
Fire Regime— frequency, extent, intensity, severity, and seasonality of fires within an ecosystem.

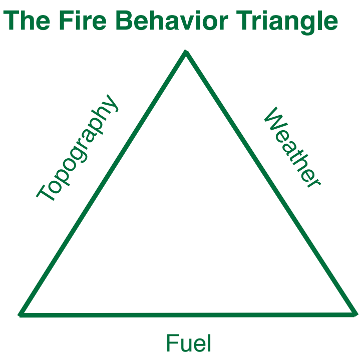
Fire Severity— degree to which a site has been altered by fire; postfire appearance of soil, litter, vegetation, or other resource of interest; proportion of overstory trees killed.

Fire Weather Outlook—air temperature, relative humidity, precipitation, wind conditions.

(*continued next page*)

What is fire behavior?





Simply put, fire behavior is the manner in which a fire reacts to the influences of fuel, weather, and topography. But that's not to say it's simple.

Fire science is extremely technical with a language all its own. You'll need to understand some of that vocabulary and science to give you a framework for management decisions. But for now, let's just start with the basics.

Tale of two triangles

The Fire Triangle. A fire needs three things to burn: oxygen, heat, and fuel. Take away any one of these and there is no fire. Firefighters rely on this triangle. They either smother the fire to take away its oxygen, cut off the fuel supply, or cool it below the ignition point. For example, when firefighters create a fire line down to mineral soil they are removing the combustible surface fuels. Fire retardants both cool the fire and smother it.

The Fire Behavior Triangle. The fire behavior triangle also involves three factors: fuel, weather, and topography. These determine a fire's magnitude, direction, and intensity of spread.

Fires behave in various ways, and some of these have names. A fire that spreads slowly with low intensity is called a *creeping fire*. A rapidly spreading, low-intensity fire is *running*. A fire that spreads rapidly with low intensity is *flashy*. And a high-intensity fire is often referred to as a *conflagration* or *firestorm*.

The fire behavior triangle offers insights into changing fire behavior and possible solutions. We are currently seeing major changes in two sides of the triangle: fuel loads and weather patterns. Since there is little we can do to change weather or topography, we have to focus on the fuel side of the triangle. There are many ways to manipulate fuel. We can remove it, burn it, adjust its density, modify its arrangement, masticate it, and more.

Fire regime change

Natural fires generally occur at a frequency, intensity, severity, and seasonality that is characteristic of the location. This long-term pattern is known as the *fire regime*. Fire regime is specific to the ecosystem and varies by forest characteristics including topography, species composition, climate, elevation, aspect, and other factors. The fire regime in the mixed conifer forest, for example, is very different from that of the redwood forest.

Changes in the fire regime can have profound effects on the forest ecosystem. Years of excluding fire from our forests have left them overcrowded, stressed, and with altered species composition. Both vegetation and wildlife are affected.

Frequency. Also known as the *fire return interval*, fire frequency is the average number of years between fires. For example, before suppression, fire occurred in the mixed conifer on average every 10 years. The frequent burns kept fuels from accumulating on the ground and removed excess growth so fires tended to be low to moderate in intensity. Now, after decades without fire, these forests have large accumulations of ground fuel, plus dense living biomass. Lack of fire has changed many characteristics of the ecosystem.

Intensity and Severity. *Fire intensity* is a measure of how hot a fire burns. *Fire severity* is more difficult to quantify; it refers to the fire's effects on vegetation, litter, soils, etc. Fire severity depends not only on the fire's intensity, but also on its duration. A long-lasting creeping fire may actually transfer more heat and could have a more severe effect on soil and vegetation than a fast-moving intense fire.

Generally speaking, *low-intensity fires* do not burn into the forest canopy. They clear out the

(*continued next page*)

underbrush, thin out young trees, and reduce the fuel accumulated on the forest floor. *Moderate-intensity fires* burn into the forest canopy, but typically don't kill the large trees. *High-intensity fires* consume all the ground cover and much of the forest canopy.

All fires are complex. Due to differences in topography, weather, and fuels, fires burn in a mosaic of low-, moderate-, and high-intensity areas. Historically, in mixed-conifer forests only a small percentage of a fire burned at high intensity. Recent wildfires have been a lot hotter: 40% of the Rim Fire burned at high intensity and 50% of the King Fire.

Seasonality. *Fire season* is the period when fires are expected to occur, based on knowledge of long-term climate patterns. This is when fire agencies gear up to fight fires.

With long-term patterns changing, short-term weather conditions are less predictable. Due to the incendiary condition of California forests right now, large fires can occur almost any time of year.

The typical fire season in California is from May to November, with the most intense fires in late September and October (although intense fires can occur in July and August too). But fire season has been expanding. It is now about 70 days longer than 40 years ago.

Invasive species. Nonnative invasive species can change the fire regime of the plant communities they invade. For example, Scotch broom and cheatgrass are extremely flammable and can increase the fire frequency in an ecosystem. This can make it more difficult for native plants—which are adapted to a specific local fire regime—to survive and reproduce. Identifying and removing invasive species can help maintain healthy forest ecosystems.

Fire Types

Fires are classified by where in the fuel strata they burn: surface fires, understory fires, and crown fires. *Surface fires* are the most common. Depending on the fuels, weather, and topography, these fires can be low to high intensity. *Understory fires* have flame lengths up to 10 feet. They consume surface fuels, small trees, brush, and lower branches of overstory trees. *Crown fires* reach into the crowns of trees with flame lengths more than 10 feet. Their behavior is often unpredictable. Crown fires are the most difficult to control as they can spread quickly from crown to crown with high intensity. *Torching* is limited to burning the crown of a single tree.

Fuel

Fuel is the material that burns. It is characterized by its size, moisture content, flammability, and location.

Changes in the moisture content of dead and downed wood is used to predict fire behavior

(*continued next page*)

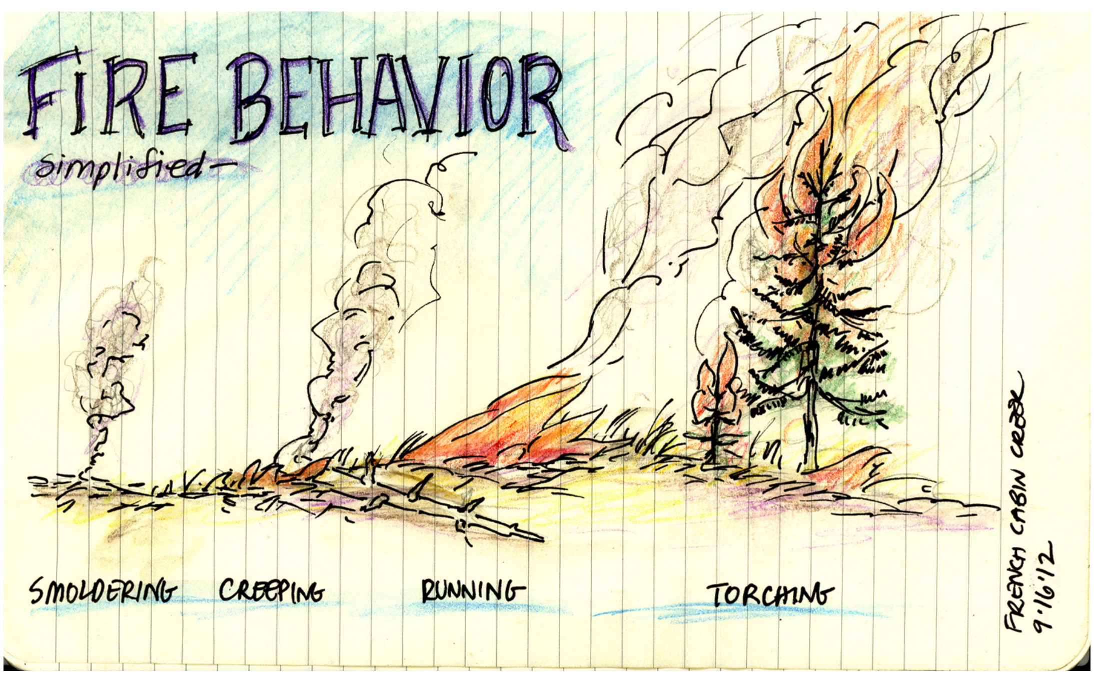


Illustration courtesy Debra Davis

(*cont. from page 4*)

Fire Whirls—upward-spinning columns of air that carry flames, smoke, and embers aloft; whirls often form in heavy fuels on the downwind side of ridges; in extreme conditions can be powerful enough to twist off entire trees.

Fuel Moisture—moisture content of vegetation.

Foehn Wind—dry, warm downslope wind that occurs in the downwind side of a mountain range.

Ladder Fuels—fuels that connect surface fuels to crown fuels.

Santa Ana Wind—strong, extremely dry downslope winds that blow through mountain passes in southern California.

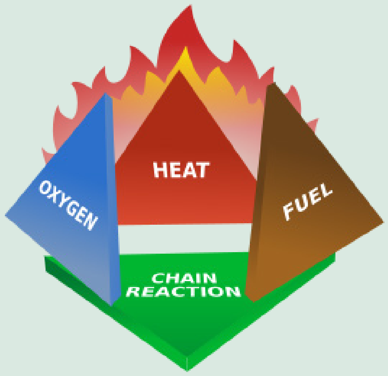
Spotting—firebrands (glowing embers) lofted up and ahead of the main fire front, igniting multiple spot fires that then feed back into the main fire front to create extreme and dangerous fire conditions.

Torching—movement of a surface fire up into the tree crown.

—more fire definitions at the Glossary of Wildland Fire Terminology (gacc.nifc.gov/nrcc/dc/idgvc/dispatchforms/glossary.pdf) and NOAA's Fire Terms and Definitions (www.erh.noaa.gov/gyx/firewx_definitions.html)

Be aware: factors that can affect fire behavior

Topographic Factors



Chimneys, chutes, gullies, and canyons: Topographical depressions, no matter how slight, can draw the leading edge of the fire. Convection currents of heated gases travel ahead of the fire.

Saddles: Saddles are at the top of canyons. Running fires are drawn to saddles. Expect more fire intensity here than anywhere else along the ridge-top.

Canyon mouths: During foehn (or Santa Ana) wind-driven fires, fire behavior at the low end of canyons is similar to that of the saddles during slope-driven fires (*see above*). Expect the greatest intensity there.

Aspect: Always note the aspect and time of day to help predict potential burning conditions for the daylight hours.

Fuel Factors

Flashy fuels: expect spot fires with sudden ignition and a rapid rate of spread.

Low dead fuel moisture: Expect greater fire intensity.

Low live fuel moisture: Contributes to faster spread and greater intensity.

Shrub and timber fuels: May create extreme fire intensity.

Weather Factors

Winds: Expect sudden changes in slope and valley winds from topographic features or fire behavior (e.g. eddies, roll eddies, fire whirls).

Unstable air: Visible signs of unstable air may portend the possibility of large fire whirls and extreme fire behavior.

Temperature and moisture: Rising temperature, dropping relative humidity (RH), and dropping fine fuel moisture (FFM) may increase spot fires and rapid rates of spread.

Frontal systems and thunderstorms: As they form or approach, these systems may set the stage for sudden and extreme fire behavior changes.

Alignment of Forces

Any one of the above factors can lead to a sudden change in fire behavior that can catch you off guard. When your position includes several of these, the potential can be great.

—adapted from CA Professional Firefighters, www.cpf.org/go/cpf/health-and-safety/wildland-firefighter-safety/fire-behavior-factors/

changes throughout the day. For that purpose, dead fuels are grouped into four size classes: 1 hour = up to 1/4 inch in diameter, 10 hour = 1/4 to 1 inch diameter, 100 hour = 1 to 3 inches diameter, and 1000 hour = 3 to 6 inches diameter.

Moisture content is critical to how easily a fire burns. Larger fuels take longer to absorb or lose moisture. Drier fuel fires generally spread faster, are more intense, and are consumed faster. Right now, in year 4 of drought, moisture is at an all-time low and our forests are primed to burn.

Weather

Weather is one of the major determinants of fire behavior. *Weather* is the day-to-day condition of precipitation, relative humidity, etc. *Climate* is the long-term average of daily weather conditions. With a warming climate, weather patterns have become more unpredictable, with more periods of extreme and uncharacteristic weather.

Extreme Fire Behavior

Extreme fire behavior includes one or more of the following: high rate of spread, prolific crowning and/or spotting, presence of fire whirls, and strong convection columns. Under extreme conditions, fire behavior becomes difficult to predict because the fires can often create their own weather and behave in erratic, sometimes dangerous, ways. These fires are extremely difficult to control.

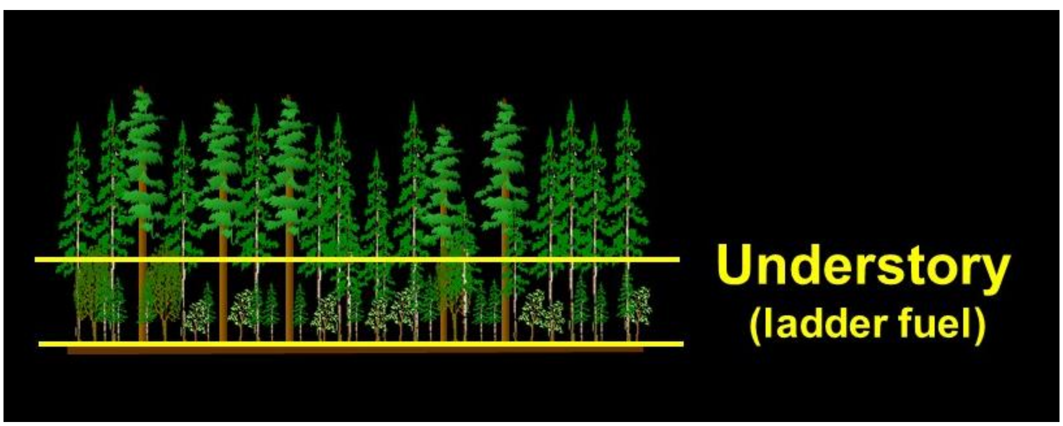
Fuels ignite in two ways: by lightning and by human activity. We have no control over lightning, but we can reduce human-caused ignitions, including equipment use, vehicles, smoking, campfires, power lines, and arson.

Photo: Lenya Quinn-Davidson

Redwood National Park during the Fall 2013 TREX. Prescribed fire is used to limit conifer encroachment into oak woodlands, conserve biodiversity, and maintain natural processes.

Forest Fuel

A forest consists of an overstory, or the uppermost layer of foliage that forms the canopy, and understory, underlying layers of trees, shrubs, and other plants. Together they are classified as aerial fuel. However, the distinction between overstory and understory is important for fire behavior. For example, the overstory is what carries crown fire, which is the most destructive, and the understory carries surface fire, which is less destructive. In addition, the understory includes ladder fuels (i.e., layers of trees and shrubs that allow fire to move upward from surface and ground fuels into the overstory and increase the chance of a crown fire).



Surface fuel is litter on the soil surface, normally consisting of fallen leaves or needles, twigs, bark, cones, and small branches that have not decayed enough to lose their identity. It also includes grasses, forbs, shrubs, tree seedlings, heavy branches, logs, and stumps.

Surface fuel is further broken down into dead heavy and fine fuels. Heavy fuel is of large diameter such as snags, logs, and large limbs that burn slowly. These are classified as 10-hour fuels (¼ -1 inch in diameter), 100-hour fuels (1-3 inches in diameter), and 1000-

hour fuels (3-8 inches in diameter). The number of hours is the time it takes (time lag) for fuel to reach the same moisture content as the surrounding atmosphere.

Surface Fuels

Fine fuels are fast-drying fuels, generally with a high surface area-to-volume ratio, which are materials less than ¼-inch in diameter (1-hour fuels). These fuels readily ignite and rapidly burn when dry.

Ground fuel is defined as all combustible materials below the surface litter, including duff, tree or shrub roots, punky (soft and decaying) wood, peat, and sawdust that normally support a glowing combustion without flame.

Fire Behavior

Fire behavior is a complex interaction among fuel, weather, and topography (primarily slope and aspect). Fires usually move faster uphill, but a large fire can move just as fast over flat or rolling terrain. Even so, a 30 percent slope can double a fire's rate of spread. It can double again on a 55 percent slope. (Percent slope is the change in elevation divided by the distance. For reference, a 45-degree slope is a 100 percent slope.)

Slopes with a south, southwest, or west aspect receive more direct and daily solar radiation. The drying of vegetation will result in high fuel temperatures and low fuel moistures leading to more extreme fire behavior.

Slopes with a north, northeast, and east aspect generally receive less direct and prolonged solar radiation and taller and denser vegetation typically shade them. These aspects usually have higher live and dead fuel moistures later in the season.

Weather involves wind and moisture, but a large fire can generate its own wind. In addition, topography interacts with wind. For example, chimneys, box canyons, or chutes can intensify fire behavior because they draw air from the bottom of a canyon or drainage and increase and channel upslope wind. Under these extreme conditions, it is possible for a crown fire to continue crowning even where fuels have been treated. Rates of fire spread also increase when pushed upslope through a saddle, or low area between ridges.

Fire behavior is classified as ground fire, surface fire, or crown fire. Mixed fires are a combination of these three fire types, although the crown fire component is usually sporadic and small.

Mixed Fire

A ground fire is difficult to detect because it burns under the forest floor. It is a slow moving and smoldering fire that can flare up into a surface or crown fire under the right conditions. However, it usually follows such faster moving fires and consumes tree roots and other material they leave behind. Ground fire is relatively easy to control.

A surface fire can be fast, slowing moving, or just creeping as it burns surface fuels and small trees and shrubs. Even though it may flare up and torch a few trees here and there, it is still a surface fire because it stays close to the ground. Surface fire is relatively easy to control.

Surface Fire

Crown fire is the most spectacular and the most lethal fire type. Flames leap from treetop to treetop, or from shrub to shrub in brush fields, and they can move at 60 feet per minute or more. For example, in 2002 Colorado's Hayman Fire burned a 19-mile long strip of forest totaling 60,000 acres in one day. Modern firefighting techniques and equipment rarely control crown fires. A change in weather, such as a drop in wind speed, or rain or snow, usually stops a crown fire.

Crown fires do not just burn in one direction. The faster moving part of the fire is the head or front, which usually burns with the wind. However, a crown fire also burns in the opposite direction against the wind. This is a slower moving backing fire. Therefore, crown fires expand quickly in one direction and slowly in the opposite direction. In addition, a wind shift could change the flank of a crown fire into the head and the opposite flank into a backing fire. This is one reason why crown fires are so unpredictable, dangerous, and difficult to control.

Crown fires are classified as dependent or independent. Dependent crown fires move forward because radiation from both burning surface fuels and tree crowns preheat and dry unburned trees so that they easily ignite. Independent crown fires move much faster because wind, often generated by the fire itself, drives flames through the canopy without the aid of surface fuels.

Dependent Crown Fire

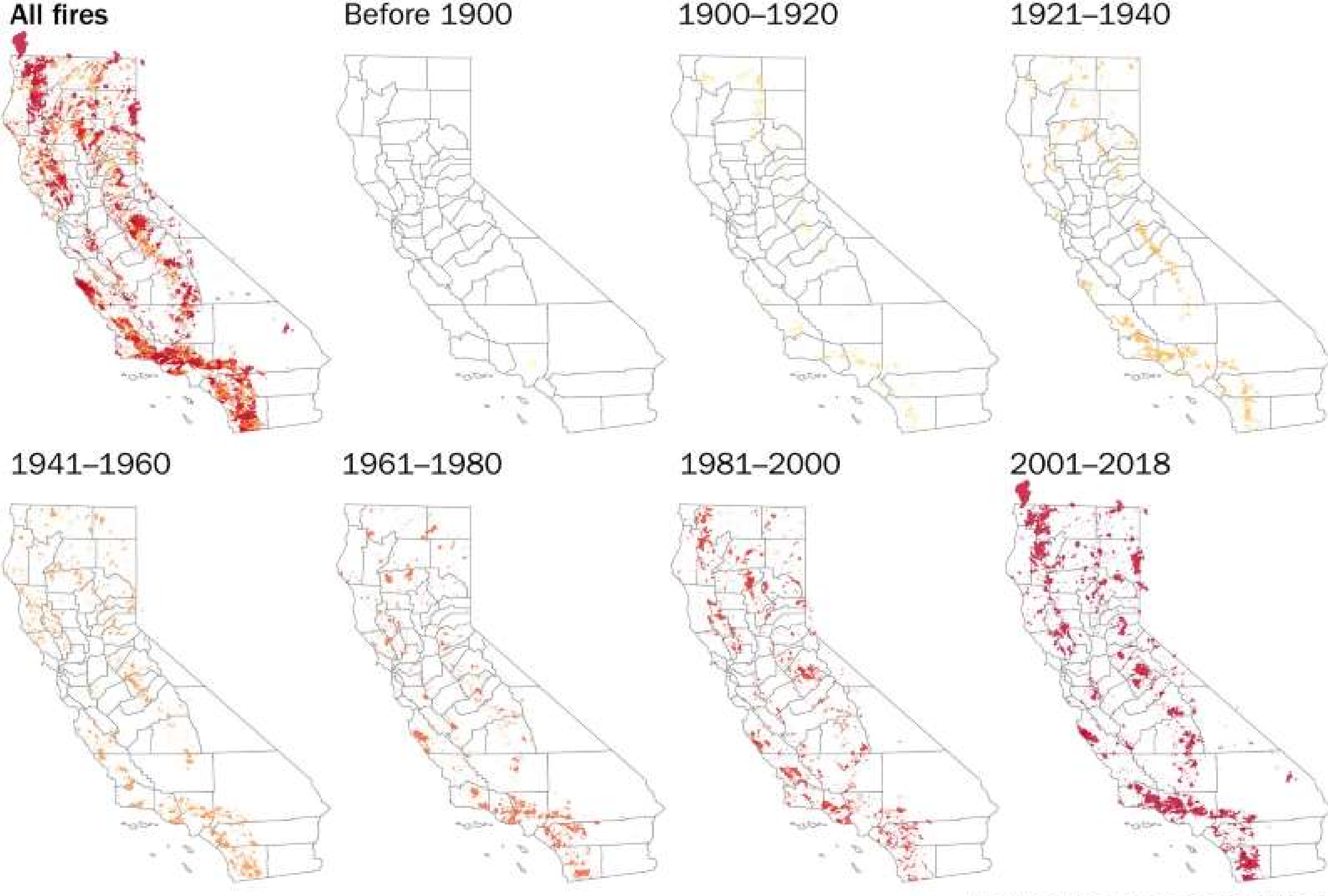
Independent Crown Fire

Crown fire behavior is extreme and unpredictable, and crown fires are usually unstoppable. They can create dust devil or tornado-sized fire swirls, and skip from place to place by throwing burning debris a mile or more ahead of the fire front. They can also blow holes in the canopy here and there by creating updrafts of heated air that suck wind into the inferno from the sides. Temperatures also can reach 3,000 degrees Fahrenheit or more, which is enough to melt steel, and flame heights can reach hundreds of feet.

The best firefighters can do is attack the flank or side of a crown fire, not the head or front. Even then, firefighters are likely to fail in stopping it.

In a forest where fires rarely happen, fuel builds up: There's **surface fuel** (grass, logs, woody debris, brush); **ladder fuel** (shrubs, small trees, snags); and **tree crowns**.

1. Surface fires spread quickly through brush and woody debris.
2. Ladder fuels allow the fire to move up toward the forest canopy.
3. Tree crown fires are so intense, they're difficult to control.



WASHINGTON POST VISUALIZATION OF CALFIRE DATA

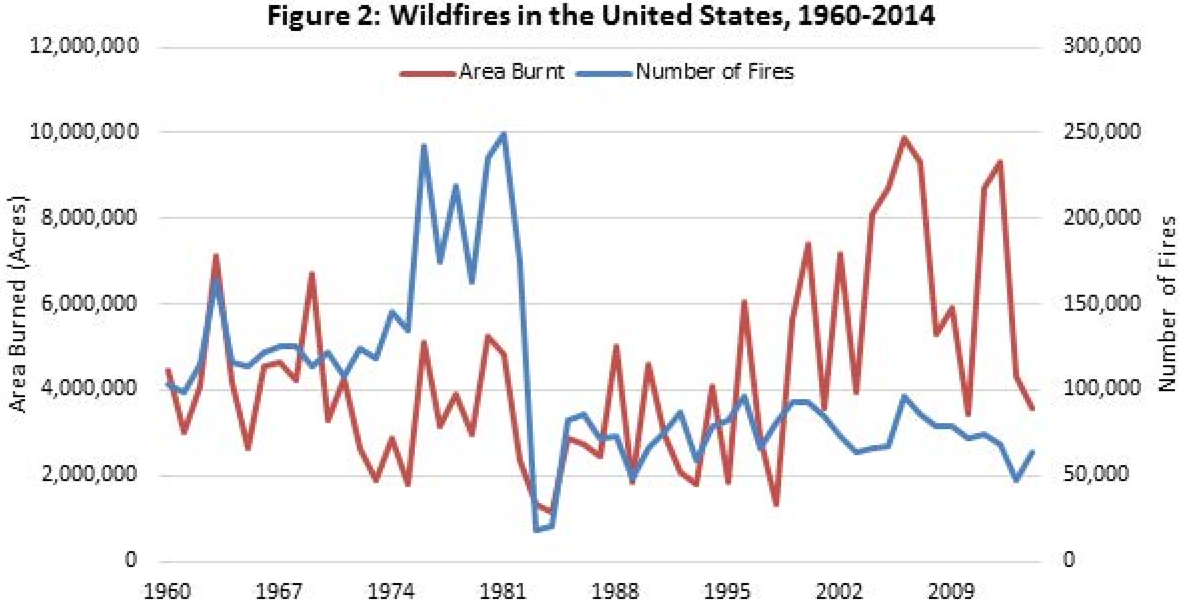


Figure 2: Wildfires in the United States, 1960-2014
Area Burnt
Number of Fires
Area Burned (Acres)
Number of Fires
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
300,000
250,000
200,000
150,000
100,000
50,000
0
1960
1967
1974
1981
1988
1995
2002
2009

NEWS

Prescribed fire gains momentum

In recent decades, California has made sparing use of fire as a land management tool. But policy changes, partnerships and attitude shifts are creating conditions for expanded use of prescribed fire.

As Californians know too well, the 2018 wildfire season was historically severe. But for *prescribed* fire — fire set deliberately to achieve management objectives — 2018 was historically important.

California's fire management regime needed change — a strong conviction to that effect had developed in state government by 2018. The previous year's fire season had been unusually fierce, with the wine country fires rampaging in the north and the Thomas Fire, the state's largest-ever wildfire until that time, raging in the south. Leaders throughout state government recognized that climate change was exacerbating the state's perpetual wildfire problem — and would continue to do so. So it was that advocates for prescribed fire found the Legislature and former Gov. Jerry Brown broadly receptive to policy proposals that might mitigate the wildfire crisis. "Conversations were wide open," says Nick Goulette, former chair and current member of the steering committee at the Northern California Prescribed Fire Council. "Committees said 'Anything is on the table. What do we need to do?'"

In September 2018, the Humboldt County Prescribed Burn Association conducted a burn at the McBride Ranch near Cape Mendocino in Humboldt County, targeting about 350 acres of coyote brush that had invaded coastal rangelands.

Lenya Quinn-Davidson

They did a lot. It started in May, when Gov. Brown issued an executive order on forest health that, among its many provisions, instructed the California Department of Forestry and Fire Protection (Cal Fire), as well as the California Air Resources Board (CARB), to increase opportunities for projects in prescribed fire (Brown 2018). Then in September, the Legislature passed and the governor signed four pieces of legislation related to fire and forest health. One law, Senate Bill (SB) 901, provides Cal Fire $1 billion over five years for forest heath and fire prevention activities — including $35 million a year for prescribed fire and other fuel reduction projects (the $1 billion in funding is generated by California's greenhouse gas cap-and-trade program). The same law specifies that Cal Fire and UC Cooperative Extension (UCCE) will cooperate to deliver technical assistance on wildfire resilience to nonindustrial timberland owners. SB 1260 requires Cal Fire to cooperate on prescribed burns with public and private landowners. It also instructs Cal Fire to create a program for pre-certification of "burn bosses" — individuals who direct operations at prescribed fires — so that vetting of burn bosses needn't be conducted for each proposed burn. SB 1260 also, along with Assembly Bill 2091, aims to ease the way for prescribed burners to purchase private insurance.

In recent years, prescribed fire has played a very modest role in California's land management practices. It wasn't always so. Native American tribes conducted burns to manage resources long before Europeans arrived in the Americas. As recently as the 1980s, Cal Fire burned 30,000 to 65,000 acres a year (Quinn-Davidson 2018). In recent times, however, Cal Fire has burned fewer than 10,000 acres a year, and the acreage treated by all prescribed burners — Cal Fire, nongovernmental organizations, tribes, private landowners and so forth — has been inadequate to slow the ongoing buildup of fuels across California's forests and rangelands. Now, however, change is afoot — and the new laws and the executive order are only part of the story. To be sure, important policy changes now being implemented by Cal Fire are mandated by 2018 governmental directives, but changes at the agency also seem part of a cultural shift in attitudes toward prescribed fire. This cultural shift — which Lenya Quinn-Davidson, a Humboldt County UCCE fire advisor, has watched develop over her years as a prescribed fire practitioner — has itself been nurtured through partnerships established among stakeholders across the prescribed fire landscape. Today, prescribed fire seems on course to play a larger role in California's land management regime and — ideally

Lenya Quinn-Davidson

Jeffery Stackhouse, a Humboldt County UCCE livestock and natural resource advisor, participates in a restoration-focused prescribed fire in deciduous oak woodlands on a ranch in eastern Humboldt County.

— to reduce the risk that wildfire seasons such as the last two become a permanent phenomenon.

Why to burn (and why not)

Prescribed fires can be conducted to achieve a variety of management objectives. For example, they can reduce fuel loads in forests so that high-intensity fires become less likely. Prescribed fire can establish diverse ecosystems in which threatened species thrive. In other contexts, they can help control invasive species. A recent study involving researchers from UC Irvine and UC Merced suggests that burning off water-hungry vegetation in the Sierra Nevada could increase California's water abundance (National Science Foundation 2018; Roche et al. 2018). Prescribed burns may also, by reducing the overall severity of wildfires, decrease the potential for erosion and sedimentation after fires. Over time, because low-intensity fires produce much less air pollution than do infernos feeding on dense accumulations of fuel, prescribed fire could even improve average air quality (Long et al. 2017; Schweizer et al. 2017).

Prescribed fire, then, can be a powerful tool for land management. But for a formidable set of reasons described by Quinn-Davidson and Goulette, California has made only modest use of prescribed fire in recent years. According to the state's Forest Carbon Plan — a May 2018 document developed by state agencies that partially underpinned Gov. Brown's executive order — only 17,500 acres of nonfederal land in California have undergone "forest restoration and fuels treatment" in the average recent year. Moreover, "forest restoration and fuels treatment" includes not just prescribed fire but mechanical thinning as well.

The greatest impediment to prescribed burning in California is the climate — the state's hot, dry summers and damp winters allow "burn windows" only during brief periods at the beginning and end of each fire season, and during intermittent periods over the rest of the year (Quinn-Davidson and Varner 2011). Even when conditions would seem to allow prescribed burning, permits are required from Cal Fire during fire season (typically, from May 1 through October 31) and from air quality management districts at all times. Cal Fire has often been skittish about issuing permits because, according to Goulette, "they worry about liability. What if they don't put out [an escaped] fire you started?" Permits from air quality management districts, meanwhile, can be challenging to obtain because of the state's persistent air pollution problem — and permits can be rescinded at the last hour if CARB declares a "no burn" day. (In 11 of the state's air basins, local air districts issue permits for specific burns but CARB decides whether burning is allowed at all. In the remaining four basins, local air districts have authority to declare their own "burn" and "no-burn" days.) The state also suffers from a shortage of people trained in conducting prescribed burns. The bottom line is that, though California desperately needs to reduce fuel loads across its forests, the state has lagged far behind other areas — Quinn-Davidson points to the Southeast and the Great Plains — in its willingness to embrace prescribed fire.

But things are changing fast — especially at Cal Fire, an agency that sits at or near the center of any prescribed fire discussion in the state. All prescribed fires on nonfederal land in California require a Cal Fire permit during fire season. Advocates for any policy change related to fire, Goulette says, must negotiate with Cal Fire. That's why prescribed fire supporters are glad that — according to Craig Thomas, the recently retired conservation director at Sierra Forest Legacy — "Prescribed fire is back in the realm for Cal Fire. They are regaining their burning skills." By November of last year, Ken Pimlott — the since-retired chief of Cal Fire — was telling the national radio program "Science Friday" that "Putting prescribed fire back out on the landscape at a pace and scale to . . . actually make a difference is a high priority" (Science Friday 2018). Indeed, in accordance with SB 901, Cal Fire is now establishing 10 year-round crews dedicated solely to prescribed fire and fuels reduction.

Thomas is grateful for the new crews — but he'd like to see more of them. "We need a robust Cal Fire prescribed burn crew," he says, "in every county with significant vegetation." Goulette, meanwhile, argues that Cal Fire should institute what he calls an "objective permitting process" to make permit issuance more predictable. Hugh Scanlon — Cal Fire's former unit chief for Humboldt and Del Norte counties — finds Goulette's permitting suggestion generally reasonable. He cautions, however, that any statewide permitting

A dog protects drip torches in the back of a truck. With prescribed fire, land managers can achieve objectives that range from reducing fuel loads in forests to establishing diverse ecosystems in which threatened species can thrive.

Due to legislative action, an executive order and changes in attitudes toward controlled burning, prescribed fire seems set to play a larger role in California's land management practices.

process must be broad enough to account for the variable conditions — climatic conditions especially — that can exist across the state. Otherwise, a permit might be denied in one part of the state because conditions are wrong in a different part.

Burning together

The new laws, the executive order, the changes at crucial agencies — all of it seems bound up with the recent cultural shift that Quinn-Davidson discerns in California's attitude toward prescribed fire. The cultural shift in turn seems inseparable from partnerships established over recent years among key players in fire policy and practice. An example is the Northern California Prescribed Fire Council — the first organization of its kind in the West — which Quinn-Davidson cofounded in 2009 and directs today. A key element of the council's work, Quinn-Davidson says, has been building relationships among Northern California's large users of prescribed fire, including federal and state agencies, tribes, nongovernmental organizations and so on. A second key has been demonstrating to Cal Fire, among others, that prescribed fire enjoys widespread support in Northern California and in fact is already in use.

A more ground-level cooperative initiative is the Humboldt County Prescribed Burn Association, a group that Quinn-Davidson formed last year with Jeffery Stackhouse, a Humboldt County UCCE livestock and natural resource advisor. Prescribed burn associations are collectives of property owners who pitch in to burn one another's land. Burns conducted under this model produce all the land management benefits usually associated with prescribed fire and also provide burn training to nonprofessionals. In a state such as Nebraska, Quinn-Davidson reports, one encounters nonprofessional but well-trained individuals who have participated in as many as 200 burns through prescribed burn associations. In California, such associations are new. But Quinn-Davidson and Stackhouse are working to expand them — with help from a grant program administered by UC ANR and originating with the federal Renewable Resources Extension Act. Funds from the grant program have helped Quinn-Davidson and Stackhouse further their objectives with the prescribed burn association in Humboldt County — and also perform outreach efforts in other counties, where they have conducted prescribed fire programs that include a daylong indoor workshop and a day of real, live burning. This June, again with the help of money distributed through the grant program, the pair will host a prescribed fire training session in Humboldt County for UCCE advisors and specialists.

Another node of cooperation is known as the Fire MOU Partnership. This initiative, according to its underlying memorandum of understanding, focuses on cooperation among entities "to increase the use of fire to meet ecological and other management objectives" (USDA 2015). The partnership includes a broad range of organizations, from Cal Fire to the U.S. Forest Service to the Nature Conservancy; since its 2015 inception, the partnership has grown from 12 to 36 members. Thomas was the primary drafter of the memorandum of understanding, though the Forest Service, Cal Fire and Scott Stephens — the widely known UC Berkeley forestry expert — also provided input. "What's exciting," Thomas says, "is that the air districts are joining. Previously, the fire managers and the air quality regulators weren't as collaboratively engaged."

Collaboration will need to flourish if California, so often ahead of national trends but lagging other regions in controlled burning, is to take full advantage of prescribed fire's benefits. "We always think we know best," Quinn-Davidson says of her state and its people — but "we're gaining some humility, which we need to do. We've got a lot to lose." CA

—Lucien Crowder

References

Brown EG. 2018. Executive order B-52-18. State of California Executive Department. www.gov.ca.gov/wp-content/uploads/2018/05/5.10.18-Forest-EO.pdf

Long JW, Tarnay LW, North MP. 2017. Aligning smoke management with ecological and public health goals. J Forest 116(1):76–86. https://academic.oup.com/jof/article/116/1/76/4746805

National Science Foundation. 2018. Billions of gallons of water saved by thinning trees. News release 18-029. https://nsf.gov/news/news_summ.jsp?cntn_id=245128

Quinn-Davidson L. 2018. Bringing fire back to California's private lands. UCCE Sonoma blog, UC Agriculture and Natural Resources Division. https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=27800

Quinn-Davidson LN, Varner JM. 2011. Impediments to prescribed fire across agency, landscape and manager: an example from northern California. Int J Wildland Fire 21(3):210–8. www.publish.csiro.au/wf/WF11017

Roche JW, Goulden ML, Bales RC. 2018. Estimating evapotranspiration change due to forest treatment and fire at the basin scale in the Sierra Nevada, California. Ecohydrology 11(7). https://onlinelibrary.wiley.com/doi/full/10.1002/eco.1978

Schweizer D, Cisneros R, Traina S, et al. 2017. Using national ambient air quality standards for fine particulate matter to assess regional wildland fire smoke and air quality management. J Environ Manage 201:345–56. www.ncbi.nlm.nih.gov/pubmed/28692834

Science Friday. 2018. Can California use more planned burns to prevent catastrophic wildfires? www.sciencefriday.com/segments/can-california-use-more-planned-burns-to-prevent-catastrophic-wildfires/

[USDA] US Department of Agriculture, Forest Service. 2015. Memorandum of understanding for the purpose of increasing the use of fire to meet ecological and other management objectives. www.sierraforestlegacy.org/Resources/Community/PrescribedFire/Fire-MOUSigned.pdf

Seven Myths about Forest Fires

By Thomas M. Bonnicksen, Ph.D.*

March 2017

The debate over how to protect against wildfires and restore health to our forests, especially in the western United States, is probably the most important ecological debate of our time. Yet like so many important issues, the debate is fraught with misinformation.

Forty years of forestry and fire experience have taught me that such misinformation can do as much damage to forests as any fire. I compiled a list of current myths and their corresponding realities, which should prove helpful for the average citizen.

Myth 1: *All fires are good and forest management is bad.*

This argument confuses small, naturally occurring fires with large conflagrations, and calls all of them good. It blames forest managers for wanting to thin our incredibly thick forests to prevent their destruction.

Historically, natural fires burned a far different kind of forest than the uniformly thick, overpopulated forests we have today. Many forests of the past were resistant to monster fires, with open understories, and clearings and patches of open forest that acted as mini-fuel breaks. So fires were far smaller and less severe than today. These lighter and naturally contained fires cleared away potentially dangerous fuels.

Fires can't burn that way in modern forests. They sweep through an abundance of fuel, burn super-hot, destroy whole forests, and leave a desolate landscape scarred by erosion and littered with dead animals. Sadly, many of these monster fires also destroy the seed trees needed to restore a forest, and planting young trees often is blocked by people who think it is unnatural. The result is brush fields that gradually replace our forests.

This is why forest management, which involves thinning in order to make our forests more like they used to be, naturally resistant to fire, is so desperately needed.

Myth 2: *Wildfires and massive infestations of insects are a natural way for forests to thin and rejuvenate themselves.*

On the contrary, "no-cut" policies and total fire suppression have created the overcrowded forest conditions that enable fires and tree destroying insects to spread over vast areas. The resulting devastation is not natural. It is human-caused.

We must accept responsibility for the crisis we created and correct the problem.

Myth 3: *If management is unavoidable, then deliberately set fires, or prescribed fires, are the best way to solve today's wildfire crisis.*

Prescribed fire can be an effective tool in some cases, but it is ineffective and unsafe in the overcrowded forests of today. It is ineffective because any fire that is hot enough to kill trees over a few inches in diameter, which is too small to eliminate the fire hazard in many forests, has a high probability of becoming uncontrollable. Many forests are crowded with trees 12-24 inches in diameter that grew to that size because of over a hundred years of neglect.

Even carefully planned fires can be unsafe, as the 2000 Los Alamos fire amply demonstrated. A chainsaw would do wonders and it is far less dangerous than setting fires to thin forests.

Myth 4: *Thinning narrow strips of forest around communities, or fuel breaks, is more than adequate as a defense against wildfire.*

Anyone who thinks roaring wildfires can't penetrate these narrow barriers could not be more mistaken. Fires often jump over railroad tracks and even divided highways. In strong winds and high temperatures any fuel break less than a quarter to a half mile wide is ineffective.

Fuel breaks are also impractical in many areas because forest communities are spread out, with homes and businesses scattered over the landscape. And fuel breaks only work if firefighters are on the scene to attack the fire when it enters the area. Otherwise, the fire will drop to the ground below the trees and move along the forest floor even faster than in a thick forest.

The 2007 Angora Fire in South Lake Tahoe proves the point. One narrow shaded fuel break built by the Forest Service failed. The widely spaced trees on the fuel break were saved, but that was not the purpose of building it. It was supposed to help save the community, but 254 homes were destroyed.

Myth 5: *Defensible space around your home will save it from a wildfire.*

Again, the Angora Fire and many others not named here, demonstrate how such an idea can lead to a false sense of security.

It didn’t matter whether homeowners thinned trees on their property or took other precautions like raking needles to create defensible space. Everyone was vulnerable because burning debris came from half a mile away and simply fell from the sky on their houses. After the Angora Fire, I saw houses with metal roofs lying on their foundations and houses with few trees on the property that were entirely gone. High winds also blasted flaming pinecones and branches through windows where they set homes on fire from the inside.

Myth 6: *Removing dead trees killed by wind, insects or fire will not reduce the fire hazard.*

Can you light a fire in an empty fireplace? Of course not. You need fuel and the more fuel the hotter the fire. If dead trees are not removed, they fall into jackstraw piles intermingled with heavy brush and small trees. These extreme fuels become bone dry by late summer, especially during a drought, and will create a savage wildfire if ignited.

Acting quickly to rehabilitate a wind or insect ravaged forest, or a burned forest, is one of the surest ways to prevent wildfires or dampen their spread.

Myth 7*: We should use taxpayer money to solve the wildfire crisis rather than involve private enterprise.*

The private sector must be involved. A minimum of 73 million acres of federal forest needs immediate thinning and restoration. Another 120 million also need treatment. Subsequent maintenance treatments must be done on a 15-year cycle.

The total cost for initial treatment would be $60 billion, or about $4 billion per year for 15 years. Then it would cost about $31 billion for each of the following 15-year maintenance cycles.

This is far more money than the taxpayers will bear. But if private companies could harvest and thin only the trees required to restore and sustain a healthy, fire-resistant forest, the tax burden would be lessened dramatically. In exchange, companies could sell the wood and minimize public expenditures.

The obvious conclusion: There aren't any shortcuts. Human intervention has created forests that are dense, overgrown tinderboxes where unnatural monster fires are inevitable. This means we must manage our forest to prevent and limit wildfires. Leaving forests alone caused the problem and it will lead to even greater destruction if we continue this failed policy.

We have to restore our forests to their natural fire resistant and productive condition. Thinning and restoring forests on a landscape level is the only way to safeguard our natural heritage and protect people and property.

**Thomas M. Bonnicksen, Ph.D., is Professor Emeritus in the Department of Ecosystem Science and Management at Texas A&M University, and author of the book "Americas Ancient Forests." Parts of this commentary were excerpted from his testimony before the Committee on Resources, U.S. House of Representatives.*

WORKSHEET – FOREST FIRE

NAME: ________________________________

1. The three elements required for a fire to exist are _________________, ____________________, and __________________. These elements make up the "fire triangle". A base chemical reaction is needed to start the fire. If any of these elements is removed, the fire will go out.
2. Different types of fires can occur in a forest. ____________ ___________ is the planned application of fire to natural fuels. When it is confined to a specific area, it can be called ______________ ______________. Further planning to set the fire when the conditions will create a specific outcome, such as the elimination of a particular type of fuel is called ___________________ ____________________. An area with uniform conditions of tree stands and fuel that is treated with one type of burn is a _____________ __________.
3. A modified form of broadcast burning is ______________ _____________, where slash is piled into small areas, and only those spots are allowed to burn.
4. An unplanned and uncontrolled fire is a ______________________, which can be started by natural or human means. A fire started unlawfully with the intent to burn property is an ________________ _____________.
5. Fire behavior is influenced by topography, weather, and fuel type; these three factors make up the "fire behavior triangle". Fuel types vary, from grass, leaves, and moss that ignite readily and are consumed rapidly when dry (____________ _____________), to large wood pieces that burn slowly (____________ _____________), to foliage, twigs, and small branches that are not in direct contact with the ground (______________ ____________).

6. Weather conditions such as wind, temperature, and humidity occur in such combinations at certain times of the year that make fires likely to occur, spread, and do damage to forest value. This time of the year is called the __________ _________________. Also, within each 24 hour period there are hours (10 am to sundown) when fire spreads most rapidly, a ____________ ____________.

7. Information about weather and fuels can be translated into one number that defines the probable ease of ignition of a fire and its behavior. This number is a ____________________ _______________, which can be described in general _____________ _____________ categories, such as "severe", or "low".

8. Fires are not always confined to trees. The uppermost layer of soil and/or surface organic matter (_______________) can catch on fire, creating a _______________ _______________, which can burn unnoticed and can even burn under ground, consuming roots as well. Sometimes fires get so hot near the ground that the heat alone kills foliage above without any signs of charing or browning. This damage is called ______________ ______________.

9. All activities concerned in the protection of a forest from fire is called ______ _________________, and includes prevention, pre-suppression, detection, and suppression.

10. One method of fire detection is to assign a person (a fire _____________) to detect and report forest fires from a vantage point, such as the top of a mountain.

11. Fire suppression is the act of controlling a fire once it starts. Any natural or man made barrier to stop the spread of a fire is a __________ __________ or ___________ ______________. Heavy equipment can be used to dig down to mineral soil, and can be used as a control line from which fire fighters can

work. Often a fire is set against the control line, a ______________, to consume the fuel in the path of a forest fire and/or to change the direction of the fire.

12. The front edge of a fire is the ____________, the sides of the fire, roughly parallel to the direction of spread, are the ______________, and the back portion is the _______________.

13. ________________ _________ after a fire involves making a fire safe after it has been controlled, and can include extinguishing or removing burning material along or near the control line, felling snags, or digging trenches to prevent logs from rolling out of the burned area.

VOCABULARY LIST FOR WORKSHEET – FOREST FIRE

aerial fuels
backfire
broadcast burning
burning block
burning index
burning period
controlled burning
fire break
fire control
fire danger
fire line
fire season
flanks
flash fuels
fuel
ground fire
head
heat
heat kill
heavy fuels
heel
incendiary fire
litter
lookout
mopping up
oxygen
prescribed burning
spot burning
wildfire