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Managing Fire and Fuels in a Warmer Climate

By DAVID L. PETERSON

Will a warmer climate affect wildfire in the northwestern United States? The simple answer is "yes," but those effects will be somewhat different in different places. A look at the historical record can improve our understanding of fire-climate interactions.

We know that more forest area burns during years when the weather is warm and dry than when it is cool and wet. Not only is this logical, it is borne out by historical data going back to the early 1900s. It is further illustrated by fire histories, or fire scar data from trees, going back centuries. And charcoal from sediment cores extracted from lakes support a fire-climate connection going back over 10,000 years.

Furthermore, we know that fire occurrence in the Northwest varies over time based on specific climatic phenomena. The El Niño Southern Oscillation produces alternating patterns of warm, dry weather (El Niño) and cool, wet weather (La Niña) on a cycle of about three to seven years. Historical fire data indicate that more forest area does indeed burn during El Niño years and less during La Niña years. The Pacific Decadal Oscillation produces alternating periods of warm, dry weather (warm phase) and cool, wet weather (cool phase) on a cycle of about 30 years. Historical fire data and fire histories indicate that considerably more area burns during the warm phase of the Pacific Decadal Oscillation than during the cool phase.

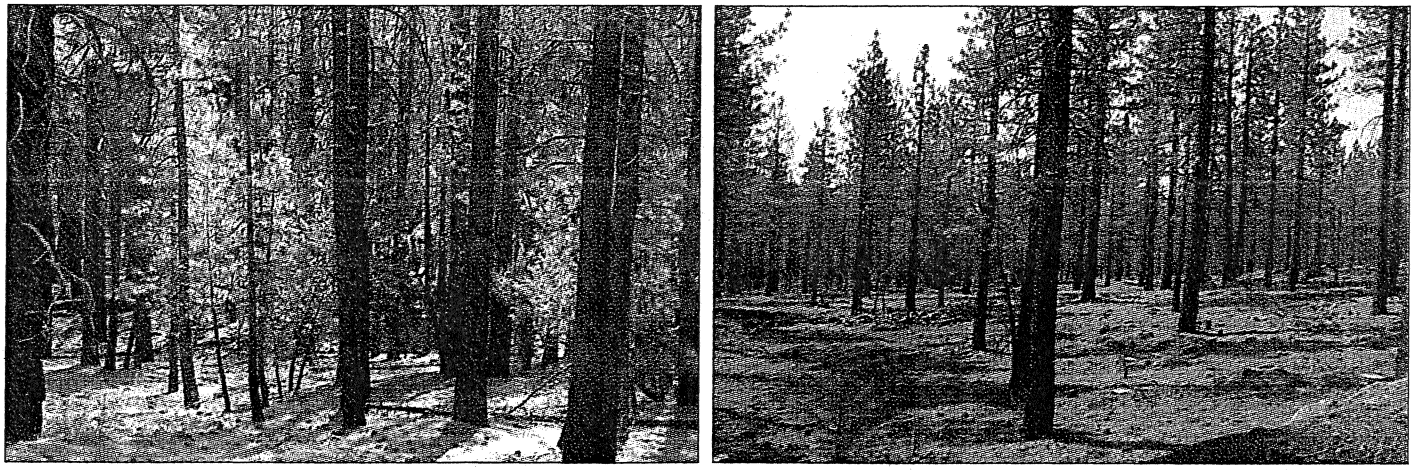
This historical perspective on fire provides a window into the future of fire in the Pacific Northwest. Although fire will always be more common in the interior portion of the region, a warmer climate could bring more fire to the westside of the Cascade Range where summers are typically dry and will probably become drier.

If future climate resembles the climate now experienced during the warm phase of the Pacific Decadal Oscillation, then we can expect fire occurrence to be similar to its historical pattern during those warm phases, that is, more area will burn on average. We can also expect longer fire seasons. The typical fire season of July and August will probably stretch into June and September, extending the time during which precautions are needed for fire prevention and fire suppression.

The biggest concern for the future will be an increase in extreme weather events, which can lead to conditions that produce large and rapidly spreading wildfire. Average warm conditions are not a big concern. High temperature, low humidity and high wind are the combination of factors that, when coupled with an ignition source and adequate fuels, can produce fires. These rare but extreme weather events will drive changes in fire that we will observe in the future.

Understand your fuels

Wildland fire managers refer to the "fire behavior triangle," a combination of factors that affect the fire environment at any particular location. First, as noted above, *weather* (the short-term manifestation of climate) determines if a fire can be sustained if it does occur. Weather varies from week to week, day to day, and even hour to hour, thus affecting the potential for fire to occur at all these time scales. Second, *topography* affects the nature of fire spread. Fire hazard is higher on steep slopes because fire normally spreads more rapidly uphill due to convective heating in front of the flaming front and is therefore more difficult to suppress. Third, *fuels* are the organic materials that combust during fire, including both living and dead material from the ground up to the forest canopy. The



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The thinned ponderosa pine stand on the right achieved all four principles of a fire safe forest. Fire intensity, flame length and tree mortality will all be low if wildfire burns through this stand. The photo on the left is of the pre-thinned stand.

amount, size, arrangement and dryness of fuels affect their potential to burn and release heat.

Looking at the forest from the perspective of fuels, not just vegetation, helps landowners understand their local fire environment and how fire will behave if it does occur. Surface fuels provide the combustible materials that create much of the heat that carries fire through the forest. These fuels consist mostly of dead wood and leaf litter on the forest floor. Only smaller fuels, typically three inches diameter or less, actively burn and carry a flame across the forest floor. Larger fuels, such as logs, burn only on their outer surface and do not add much heat to the fire. However, logs and stumps can burn slowly for hours to days after the flaming front has passed, often producing large amounts of smoke. Ground fuels, the partially decomposed material below the surface fuels and above the mineral soil, are involved in flaming combustion in some forests and can also burn slowly through residual combustion.

Shrubs and small trees in the understory contain live and dead fuels that can burn and carry fire from the surface fuel layer to the forest canopy. Often called "ladder fuels," this layer is a critical factor that facilitates the transition from surface fire to crown fire. As with surface fuels, only the smaller diameter fuel components actively burn during a wildfire.

Finally, the forest canopy is an important but often overlooked fuel layer. It may help to think of branches, twigs and leaves as *aerial fuels*. As noted earlier, fire needs to transition from the surface to the understory and then to the canopy. Once that occurs, considerable heat is needed to sustain the movement of fire through the crowns of trees, but once those conditions are reached, crown fires can burn for days or weeks if weather is sufficiently warm and dry.

Manage fuels to reduce fire severity and increase resilience

Remember the fire behavior

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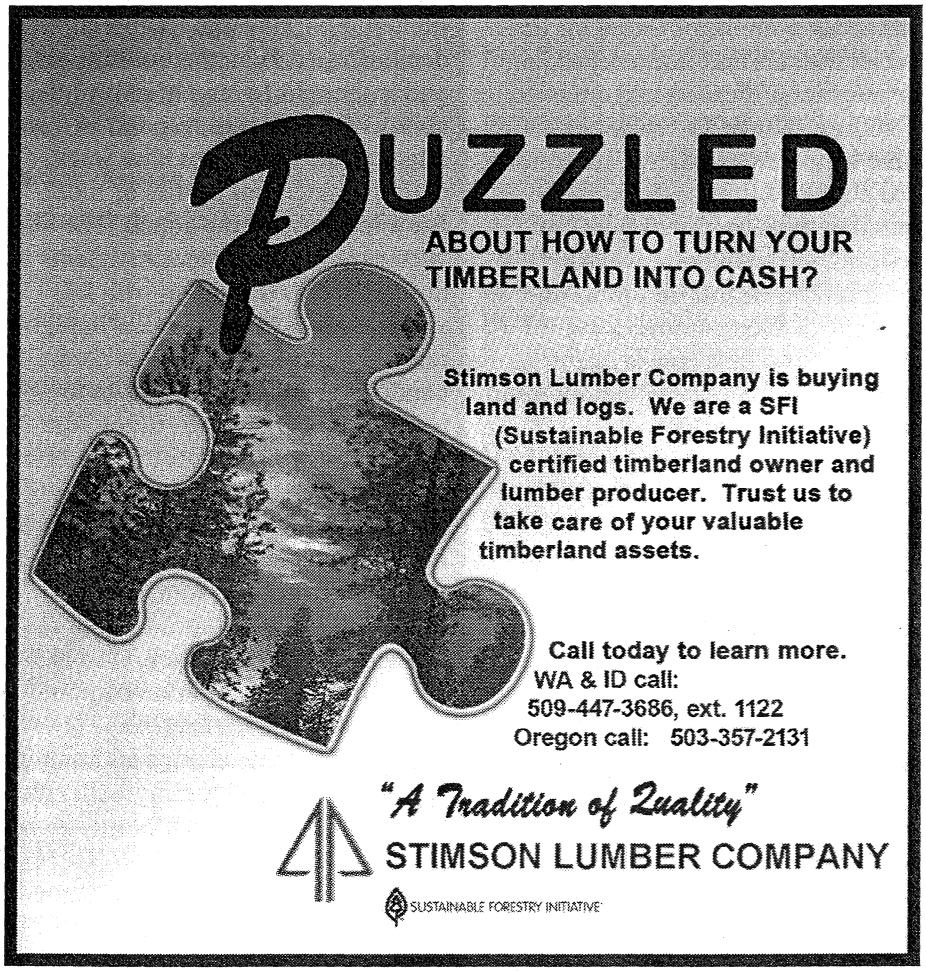

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triangle? Forest landowners cannot do anything about two legs of the triangle—weather and topography. But they can do something about the third leg—fuels. Four principles define the scientific basis for reducing fire hazard by reducing specific fuel components of a forest (Table 1). The objective of these principles is to reduce fire severity, not to eliminate fire from the forest. These principles were developed for dry interior forests (e.g., ponderosa pine, Douglas-fir, mixed conifer), but they can be applied to forests in wetter locations as well.

First, *remove surface fuels*, especially the fine surface fuels, to reduce flammable material that will carry fire across the forest floor. This is especially important following timber harvest and thinning operations, which create even more fuels. Surface fuels can be removed by hand, with machines or through prescribed burning.

Second, *raise canopy base height* to increase the distance that a surface flame would need to extend to reach the lower canopy. This is typically accomplished by removing the smaller trees to reduce ladder fuels, although ambitious landowners can increase canopy base height by pruning the lower branches.

Table 1. Principles of a firesafe forest; adapted from Agee and Skinner (2005).

Objective	Effect	Advantage	Concerns
Reduce surface fuels	Reduces potential flame length	Fire control easier, less torching	Low surface disturbance
Increase canopy base height	Requires longer flame length to begin torching	Less torching	Opens understory, may allow surface wind to increase
Decrease crown density	Makes independent crown fire less probable	Reduces crown fire potential	Surface wind may increase, surface fuels may be drier
Retain larger trees	Thicker bark, taller crowns, higher canopy base height	Increases survivability of trees	Removing smaller trees is economically less profitable

Third, *decrease crown density* to reduce the amount and continuity of living and dead fuels in the understory and upper tree canopy, thus reducing the capability of fire spread in aerial fuels. This is also accomplished by removing the smaller trees.

Fourth, *leave as many large trees as possible*, because these trees, which have thicker bark and higher crowns, are the most resistant to fire. The desired tree density will vary by location, species and expected fire behavior, but will generally need to be less than 100 trees per acre to effectively reduce crown continuity.

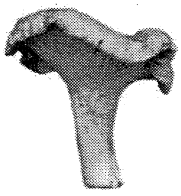
Over time, the forest canopy will expand, fuels will accumulate, and the understory may reestablish. Therefore, a long-term plan for treating fuels in each forest stand is necessary. In most dry interior forests, this means implementing additional thinning and/or surface fuel treatments every 20-30 years.

Fuel reduction activities are highly compatible with managing for resilience to climate change, where resilience is defined as the ability to return to previous structure and function. Density management enhances the vigor of individual trees, thus improving their resistance to fire damage, insect attack and fungal pathogens. This leads to forests that can experience many fires with low mortality of overstory trees. Managing for resilience is also compatible with managing for sustainable timber production, habitat for ungulates, good water quality and many other values.

Managing for resilience does not necessarily change management plans or activities very much. If you are thinning forest stands, removing surface fuels and otherwise enhancing tree vigor, then you are already doing most of the things necessary to prepare for a warmer climate and more fire. You may want to thin to lower densities and remove more surface fuels than you would have done in the past in order to account for increased stress in a warmer climate.

Prepare for change, protect your property

Your home and other structures on



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CSREES OSU Oregon State Institute for Culture and Ecology

your property contain large amounts of combustible materials, so you can also think of buildings as fuels. Keeping vegetation and fuels to a minimum adjacent to buildings will reduce the direct spread of flames in surface and aerial fuels. Having water available to increase the moisture level of live and dead fuels, including building materials, is another important means of reducing ignitions and fire spread. The Firewise Communities organization (www.firewise.org) offers excellent guidance on how to reduce fire hazards around your home.

Managing hazardous fuels on your forestland will reduce extreme fire behavior and tree mortality across the landscape and provide more options for when wildfire occurs. Although it has been traditional for homeowners to evacuate their homes during large wildfires, you may want to stay and defend your property if you have proper training and are confident that fire spread will be relatively slow. Your main job will then be extinguishing occasional embers that fall on or near structures. This is truly "living with fire," and is a personal choice to be determined in cooperation with local fire agencies.

Working with your neighbors is one of the best ways to prepare for wildfire. Landowners with adjacent properties who are willing to work together can create firesafe landscapes that are much more effective at reducing fire severity than isolated firesafe properties. Coordination of management plans and the location and timing of fuels management activities ensure that everyone's management objectives, including resilience to fire and climate change, are respected within a community of forest landowners.

A warmer climate will almost certainly increase the prevalence of wildfire in forests throughout the Northwest. However, it should be possible to prepare for these changing conditions by managing for resilience through science-based principles of fuels management. Active management that includes resilience to climate change as one of several possible objectives will give forest owners more options in the future, and timely reduction of hazardous fuels will provide insurance for sustainable forest management. ■

David L. Peterson *is a research biologist with the U.S. Forest Service Pacific Northwest Research Station, Seattle, Wash., and lives on a tree farm in Skagit County, Wash. He can be reached at peterson@fs.fed.us.*

CALENDAR

Starker Lecture Series-Ecosystems Services Capstone Lecture, May 6; **Capstone Field Trip,** May 7, Corvallis, OR. Contact: http://starkerlectures.forestry.oregonstate.edu.

Measuring Your Trees, May 7, Orofino, ID; and May 8, Coeur d'Alene, ID. Contact: UI Extension.

Washington State SAF annual meeting, May 12-14, LaConner, WA. Contact: Paul Wagner, psq@glacierview.net.

Pruning to Restore White Pine, May 14, Kellogg, ID. Contact: UI Extension.

Thinning and Pruning Field Day, May 15, Kellogg, ID; June 5, Bonners Ferry. Contact: UI Extension.

Inland Empire SAF annual meeting, May 20-22, Wallace, ID. Contact: Richard Reid, 509-758-2411, rreid66519@aol.com.

Klamath Tree School, May 22, Klamath Falls, OR. Contact: Susan Honea, 541-883-7131, susan.honea@oregonstate.edu.

Washington Tree Farm Management Plan Spring workshops, May 22, Chehalis; June 19, Battle Ground; and June 26, Spokane. Contact: Bob Falkner, 360-789-1265, wtfp.bob@gmail.com.

Spray Drift Management in Rights-of-Way and Forestry, June 4, Portland, OR. Contact: WFCA, 503-226-4562, www.westernforestry.org.

Forestry Shortcourse, June 9-July 14, Wednesday mornings, Sandpoint, ID. Contact: UI Extension.

ID/WA Forest Owners Field Day, June 12, Rathdrum Prairie, ID. Contact: UI Extension.

Adaptive Silviculture on the McGovern Forest, June 18, Coeur d'Alene, ID. Contact: UI Extension.

Forest Insects and Disease Field Day, July 16, Sandpoint, ID; July 23, Orofino, ID. Contact: UI Extension.

Pacific Logging 6th annual In The Woods Show, Sept. 16-18, Clatskanie, OR. Contact: Julie Woodward, 503-584-7259, woodward@ofri.com.

CONTACT INFORMATION

UI Extension: Sessions in Benewah, Bonner, Boundary and Kootenai counties, contact Chris Schnepf, cschnepf@uidaho.edu, 208-446-1680. Sessions in Clearwater, Latah, Lewis and Nez Perce Counties, contact: Randy Brooks, rbrooks@uidaho.edu, 208-476-4434.

Send calendar items to the editor at rasor@safnwo.org.

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