Not All Fires are Wild

Understanding Fire and Its Use as a Management Tool

EM 9114 • May 2015

R. Wolf, C. Berger, J. Creighton, and C. Olsen

Historically, fires have played an integral role in the vitality of our forests. Fire changes the landscape by altering population densities, removing some species and allowing others to thrive, and reducing surface fuels on the forest floor. These changes can lead to diverse ecosystems that are resilient to disease and pest outbreaks. Native tribes in the Pacific Northwest used fire to manage forests and grasslands to enhance wildlife habitat and create open hunting conditions. Fire also benefited these tribes by allowing more habitable space for desirable food species, such as camassia, roots (bitterroot, balsamroot), and berries (mainly huckleberries). In the late 19th century[1], fires—due to land use changes—were excluded from the landscape and more recently by land managers to protect the public and other valuable resources. As a result, forests that had once evolved and adapted to frequent, low-severity fires have undergone dramatic change. Following a century of fire suppression, the forests have become overcrowded with dense populations of small trees and have an overabundance of surface fuels. Consequently, these landscapes are at risk of uncharacteristically large and severe wildfires.

[1]The California fires in the 1880's actually started suppression concerns, but actual management through suppression began after the 1910 fires in the West.

Rebecca Wolf, Professional Science Master's Program; Carrie Berger, Extension associate; Janean Creighton, associate professor and Extension specialist; and Christine Olsen, research associate; all of Oregon State University College of Forestry

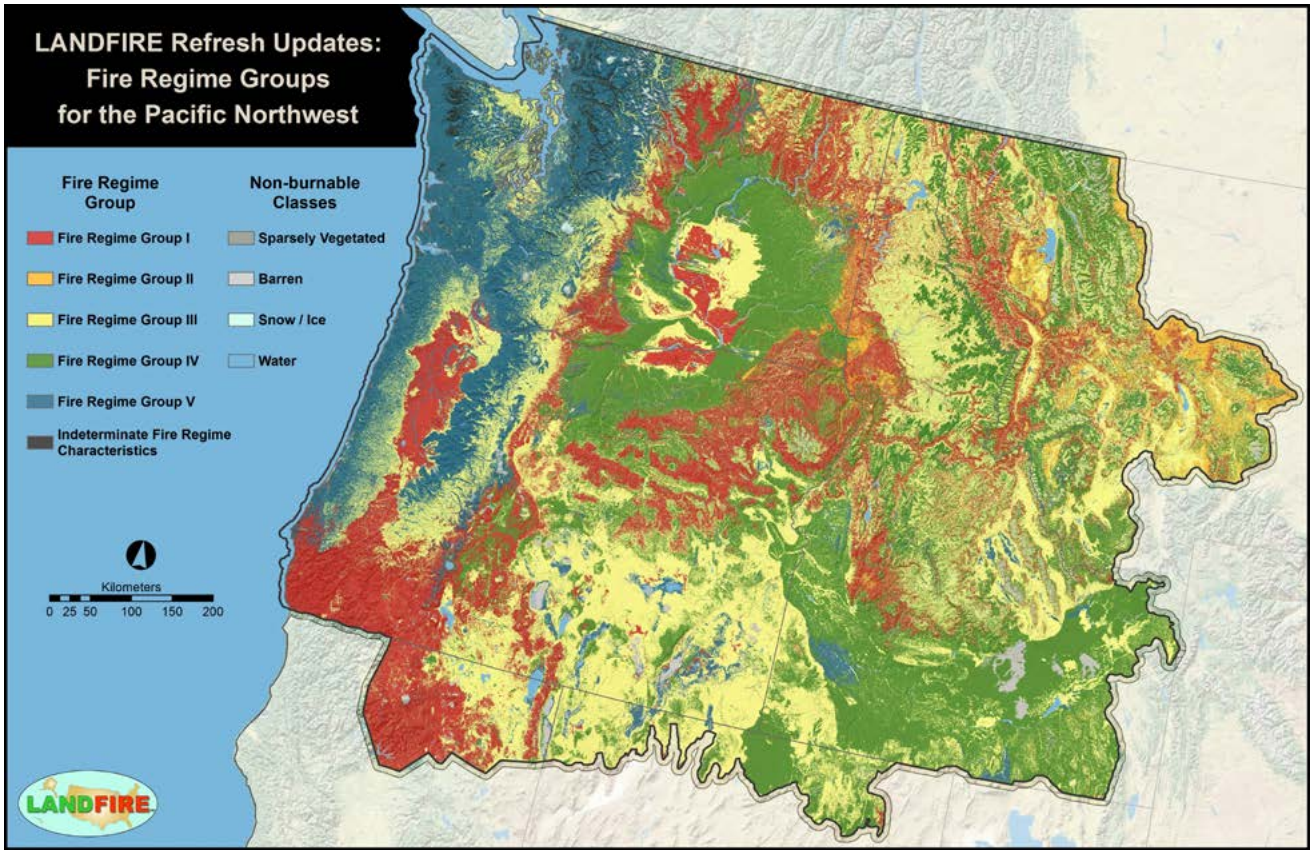

Figure 1. LANDFIRE map of Fire Regime Groups for the Pacific Northwest (www.landfire.gov/maps_pnw.php)

Fire regimes in the Pacific Northwest

How often did fires occur on the landscape? 'Fire regime' is a term used to describe patterns of fire that are presumed to have repeatedly occurred historically in a landscape, and includes both the frequency and severity of fires. There are five fire regimes in the Pacific Northwest (Figure 1). Each regime varies in the amount of time (fire-return interval measured in years) between fires and the fire severity. In forest types like the ponderosa pine forests of eastern Oregon, the fire-return interval was every 0 to 35 years, and fires burned at low to mixed severity (Figure 1 and Table 1, see Fire Regime I). Coastal forests in this region, however, burned less frequently and had a greater fire-return interval (200-plus years). As a result, those coastal forests burned with a stand-replacement severity (Figure 1 and Table 1, see Fire Regime V).

'Fire severity' is a term that describes the effects of fire on soil (sometimes called burn severity) or on fuels and vegetation, and measures the degree to which an area has been altered or changed by fire. Fire severity descriptors may include loss of or change in organic matter, both aboveground and below ground, with indicator measures such as bark char and foliage scorch. Fire severity often is incorrectly used interchangeably with fire intensity. Fire intensity is a measure of the energy (rate of heat) released during a fire. Fuels, weather (wind, temperature, and humidity), and topography are important in determining the rate of heat released by a fire.

Table 1. Fire-return intervals and fire severity described for each fire-regime group

Fire Regime	Frequency	Severity
I	0 to 35 years	low to mixed
II	0 to 35 years	replacement
III	35 to 200 years	low to mixed
IV	35 to 200 years	replacement
V	200+ years	Replacement/any severity

Fire behavior

There are two triangles to consider when understanding basic fire behavior. The first triangle is the fire triangle composed of fuel, oxygen, and heat

(Figure 2). In order for fire to occur, these three components are needed. Fuels and ignition sources (heat) are the most common limiting factors in the fire triangle. Historically, ignition was caused by lightning and by Native American burning. Today, the leading natural cause of wildfire is lightning. Humans are also major sources of ignition, either directly from arson or untended campfires, or indirectly from machines, vehicles, and power lines. The behavior of a fire is affected by fuel, weather, and topography; these components influence the fire's rate of spread, flame length, torching, crowning, spotting, and whirling (Figure 3).

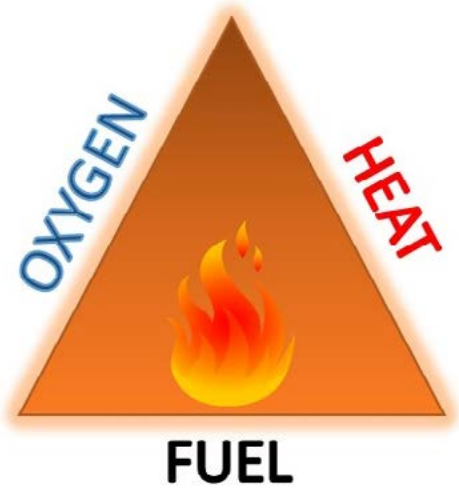

Figure 2. Fire triangle

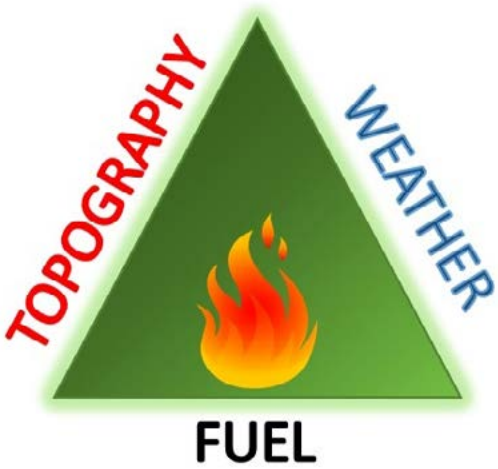

Figure 3. Fire behavior triangle

Fuels

Fuel is the common component in the fire triangle and fire behavior triangle. Fuels are comprised of vegetation (alive or dead) and other combustible material. There are four types of fuels—ground, surface, ladder, and crown.

There are many characteristics of fuel, such as fuel particle size, fuel loading, fuel arrangement and continuity, and fuel chemical makeup. But one of the most important characteristics is fuel moisture content. Fuel moisture is influenced by relative humidity, temperature, and precipitation. Moisture content is determined by weighing fuels' before and after percentage. The formula for that calculation is Wet Weight minus Dry Weight divided by Dry Weight multiplied by 100 (wet weight – dry weight/ dry weight x 100). Live fuels have moisture contents from 30 to 300 percent, while dead fuels usually range from 2 to 30 percent. Fuels are categorized by the length of time it would take the fuels to reach the moisture content at which the fuels are in equilibrium with the air around them.

Fire managers are often most concerned about 1-hour fuels because they are the most likely to respond quickly to changes in weather. Examples of 1-hour fuels are grass, leaves, mulch, and litter. Conversely, larger-diameter fuels such as brush piles take up to 1,000 hours to respond to changes in weather conditions.

4 types of fuel

Ground—Fire that takes place below the ground surface through the combustion of roots and other organic material. There are no visible flames, and these fires are usually detected by heat.

Surface—Fire that combusts grasses and small shrubs as well as fallen vegetation, duff, leaves, and needles.

Ladder—Fires that combust large bushes or small trees and transfer fire to tree crowns.

Crown—Fires that occur within the upper branches of trees. Because leaves and needles are thin, fires consume them rapidly. Crown fires move more quickly than the other fire types and often result in high tree mortality.

Fuels are classified into 4 categories according to how they respond to changes in moisture

- 1-hour fuels: up to ¼ inch in diameter
- 10-hour fuels: ¼ inch to 1 inch in diameter
- 100-hour fuels: 1 inch to 3 inches in diameter
- 1,000-hour fuels: 3 inches to 8 inches in diameter

Weather

Hot, dry, and windy weather increases the risk of wildfires. As the temperature rises, the relative humidity (the amount of moisture in ambient air) decreases. The less moisture available in the air, the drier the fuels become. Windy conditions desiccate fuels further and increase the oxygen supply. A Red Flag Warning is issued when the temperature is above 80º F, humidity is less than 10 percent, and winds are above 20 mph. This warning is used to inform firefighting and land-management agencies that conditions are ideal for wildland fire combustion.

Topography

Topographic factors that influence fire behavior include: slope steepness and position of fire on a slope; aspect and elevation; and natural topographic barriers, such as roads and rivers. Fire tends to run faster up hills as heat from the flames dries out the plants upslope, making them more combustible. South-facing slopes have drier fuels because of a higher intensity of solar radiation. Fire managers use topography to inform the use and location of resources when fighting a wildfire or planning a prescribed burn.

Prescribed fire

Over 11 million acres (40 percent) of forestland are in need of restoration in the Pacific Northwest region (Haugo, et al. 2015). Coupled with predicted hotter and drier summers, these landscapes are at risk for uncharacteristically large and severe wildfires. Prescribed fire is the controlled application of fire to the land and is one tool used by land managers to achieve specific management goals. Because fire behavior is dependent on fuels, weather, and topography, prescribed fire enables land managers to manage fuels in a situation where weather and topography are predictable. Prescribed fires are beneficial because they:

Reduce fuel buildup—By reducing the available amount of fuel on the ground, including woody debris left behind after harvesting and thinning, future fires in these areas will be less intense, resulting in a decreased probability of catastrophic wildfires.

Improve wildlife habitat and forage for grazing—Prescribed fire is used to create a varied land and vegetation pattern that provides diverse habitat for plants and animals. Openings in the landscape created by fire encourage the growth of grasses and other grazing materials for grazing wildlife.

Manage competing vegetation—Historically, fire-prone and fire-adapted forests that have experienced fire exclusion have been invaded by weeds and fewer fire-tolerant species. Reintroducing fire removes some of these invasive plants while allowing native, fire-adapted plants to thrive.

Control disease—Fire is a natural control of disease and pathogen outbreaks in plants.

Increase aesthetics—Burning can increase flowering annuals, open stands, and improve aesthetics.

Cycle nutrients—Fire stimulates important chemical reactions for nutrient cycling, such as releasing nitrogen and phosphorous into the soil for uptake by many plant species.

Before a prescribed fire is set in place, a burn plan is written and submitted to local forest or agriculture departments for approval. The burn plan sets guidelines for how the area will be treated, and how risk will be mitigated through evacuation and contingency plans. The burn plan also includes ideal weather parameters for the prescribed burn, which are determined using computer simulations. Land managers

Stephen Fitzgerald, © Oregon State University

A fire crew has ignited a prescribed fire to create a "black line" that will help keep the fire under control.

Teresa Brennan, U.S. Forest Service

A carefully managed prescribed fire helps reduce the hazard of catastrophic wildfire caused by excessive fuel buildup.

look for days that are cool and clear, and dry enough to start a fire but with enough moisture from previous rainfall to ensure fuels have very low moisture content. Smoke management is also an important part of the burn plan, as smoke is one of the biggest challenges for fire managers.

Common concerns

Smoke—Fires (prescribed or wildfire) produce a mixture of gases and fine particles from burning trees and other plant materials. This smoke is a valid public concern. Smoke can cause health problems and decrease visibility on nearby roads. Land managers work to mitigate the negative impacts of smoke by looking carefully at what they plan to burn and the proximity to homes and roads in the planned burn area. While prescribed fires do produce smoke, they prevent heavy fuel accumulation that would send a larger amount of smoke into the air should a wildfire occur. Other concerns surrounding prescribed fire are tree mortality, aesthetics, and wildlife.

Tree mortality—Even fire-sensitive species can survive some fires. Prescribed burns are also set during weather conditions that should prevent large flame lengths.

Aesthetics—Plants resprout quickly after a fire. By the following year, the only evidence of a fire may be some charring on trees.

Wildlife—There are usually very few wildlife fatalities during fires. Most animals are able to remove themselves from the threat. There are many species that rely on fire to improve food resources and habitat conditions, including species that use dead trees for foraging and nesting.

Summary and conclusion

Fire is an important natural disturbance that helps maintain the health and diversity of our forests and grasslands. Wildfires, however, are behaving differently than historically described due to a number of factors, including human actions. Prescribed fire is one of the many tools available to help maintain healthy, resilient forests. Carefully managed prescribed fire can help maintain fire's natural role across the landscape and reduce the hazard of catastrophic wildfire caused by excessive fuel buildup.

For more information

Videos (available to view online):

Prescribed Fire: A Multi-purpose Tool. Produced by the Northwest Fire Science Consortium. https://www.youtube.com/watch?v=s_Fj00_4n6Q

State of Fire. Produced by Oregon Forest Resource Institute. http://oregonforests.org/video/state-of-fire

Forests Under Fire. Produced by Ecological Restoration Institute, Northern Arizona University. https://www.youtube.com/watch?v=5WcT5cdbu5Q

Braids of Truth: Celebrating Traditional Knowledge and Fire. Produced by Northern Rockies Fire Science Network.

- *Part 1: Fire and Forest Management*. https://www.youtube.com/watch?v=pOcHi9RMgMM
- *Part 2: Climate Change*. https://www.youtube.com/watch?v=BYrFz_4pTa4
- *Part 3: Collaboration Challenges*. https://www.youtube.com/watch?v=mCfpWiUyuio

Catching Fire: Prescribed Burning in Northern California. Produced by Klamath-Salmon Media. https://www.youtube.com/watch?v=LWriDpfZnXQ

Forest Fast Break: Forest Fire. Produced by Oregon Forest Resources Institute. http://ow.ly/HR40c

Forest Fast Break: Fire Safety. Produced by Oregon Forest Resources Institute. http://ow.ly/HR3VI

Forests Born on Fire. Produced by Wild Nature Institute. http://ow.ly/HRaLF

Websites:

Washington Prescribed Fire Council: http://www.waprescribedfire.org/

Oregon Prescribed Fire Council: https://www.facebook.com/OregonPrescribedFireCouncil

Coalition of Prescribed Fire Councils: http://www.prescribedfire.net/membership/state-councils

References

Haugo, R., et al. 2015. "A new approach to evaluate forest structure restoration needs across Oregon and Washington, USA". *Forest Ecology and Management* 335(1): 37-50.

Cover photo courtesy of the Bureau of Land Management

Published May 2015.