

# Fire Science

## Core Curriculum

PROMOTING AWARENESS,  
UNDERSTANDING, AND RESPECT OF FIRE  
THROUGH KNOWLEDGE OF THE SCIENCE

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University

# Fire Science

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Photo: Carrie Berger, © Oregon State University

OSU Forestry & Natural Resources  
Extension Program

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We would like to dedicate this effort to the many firefighters who have sacrificed much to serve and protect wildlands, homes, resources, and lives. We hope that these modules will provide sufficient education to lessen the risk of living with fire and to generate a respect for fire and firefighters.

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# Overview: Fire Science Core Curriculum

## Purpose of the curriculum

Author H.P. Lovecraft once said, “The oldest and strongest emotion of mankind is fear, and the oldest and strongest kind of fear is fear of the unknown.” We tend to fear what we do not understand. Not everyone is afflicted with pyrophobia (an irrational fear of fire), but many fear fire from personal experience or mainly through a lack of understanding

Fire is a chemical reaction that has been on the planet as long as there have been plants and carbon-based lifeforms on the ground and lightning in the sky. Fire is a force of nature we can control under certain conditions but can't control under other conditions.

Fire can take life and save life. Plants and animals have adapted to fire frequency and severity over the eons in different locations, especially in areas of drier climate. We will never eliminate fire from our workplaces, homes, yards, forests, or rangelands. As long as we live in a carbon-based world, we will live with fire.

Fire science is complex and can take years of study to fully understand. Professional firefighters and fire scientists learn everything from fire theory, knot tying, and ladder and hose deployment to fluid dynamics and physics. They do this for national, state, and local certifications.

This curriculum is not designed to train professional firefighters, although some learners just starting on that path will find it useful. The basic intent of this curriculum is to teach the basics of fire to non-fire-professional community members, including instructors, and landowners, such as ranchers and farmers. The goal is to replace fear and misunderstanding with knowledgeable respect. We want to reduce risk and fire hazard through education and understanding.

Each of these five modules — **What is Fire?**, **Fire Ecology**, **Fire Behavior**, **Fire Management**, and **Fire Prevention for Home and Landscape** — is formatted to include:

- Proposed agenda
- Learning objectives
- Learning outcomes
- Content outline
- Narrative with activities and graphics imbedded
- Notes to instructors
- Professional insights
- Additional resources for students (and instructors)
- Glossary of Terms
- References
- Evaluations
- PowerPoints

Each module has a PowerPoint suitable for modification as needed for various student audiences. The narrative text in each module is meant as a main resource to instructors to choose subject matter as needed to meet the lesson objectives. The modules are guidelines, not mandates.

Each module, if followed completely, can take up to 8 hours in the classroom and in the field to complete. Modules can be delivered independently, in succession with the other modules, or as resources with other curricula. Each module is unique, but there is some overlap of information from one module to another in order to reinforce key ideas.

This curriculum addresses both wildland and structure fires because a home fire can lead to a wildland fire and a wildland fire can burn homes. Vehicle fires on the side of the highway have caused home and wildland fires. Fire behavior,



risk, and hazard are similar across all forms of fire, regardless of the environment.

This curriculum incorporates many educational activities given to firefighters in their training. This is so participants can learn the basics without needing a medical release or facing the same risks as professional firefighters face. Learners are not expected to make decisions in the heat, smoke, and exhaustion of a real-life fire, but we hope this curriculum helps them understand what it means to do so.

As with a basic firefighter academy, there are live fire activities within these curricula. There are simulations and tool and equipment demonstrations. As with all fire training, safety is always first. No activity is completed here without all safety precautions in place.

There are some activities and lectures where professional firefighters or fire scientists need to be recruited to carry out the objectives. Our intent is to consult fire partners in the U.S. Forest Service, Bureau of Land Management,

Park Service, Oregon Department of Forestry, local fire departments, or private firefighting contractors to help teach and deliver these lessons. This will benefit all of us by strengthening collaboration between Extension agents, communities, and firefighters.

Every fire is similar. Every fire is unique. Firefighters are taught to work as a team and to cover each other's backs. Lives depend on working together with trust—and education and training are the glue holding it all together. With good leadership and barring random accidents, everyone should go home after a fire. Our equipment, standard of training, education, and protocols are based on the lessons learned over centuries.

These modules will help students learn to respect fire—and firefighters—and to protect themselves, their families, their homes, and their property. If we can prevent the negative effects of fire while encouraging the positive use of fire, we will have succeeded.



The Cabinet View Fire Department, Libby, Montana (2006 to 2012). Honoring our men and women for their bravery, honesty, and integrity. Thank you for your service and sacrifice. Hope through example.

# Module 1: What is Fire?



## Proposed Agenda

Time		Section name
9:00	9:30	Welcome and group introductions
9:30	10:00	Course overview
10:00	10:40	Wildland fire history
10:40	11:00	Break
11:00	11:40	The influence of fire on cultural mythology, with activity
11:40	12:15	Basic chemistry
12:15	1:15	Lunch
1:15	2:00	Fire triangle with activity
2:00	2:30	Break
2:30	3:10	Fire intensity and fire severity
3:10	3:30	Future module plans, wrap-up

## Overview

This module provides a brief overview of wildland fire history and the influence that fire has had on cultural mythology around the world. Module 1 also addresses the general principles of fire that are applicable to both wildland and structural fire. These principles include elements required for a fire to burn, and some definitions pertaining to fire effects. Understanding these principles is essential to understanding fire.

## Learning Objectives

- Understand wildland fire history
- Understand the influence that fire has had on cultural mythology around the world
- Know that fire is part of a chemical reaction called combustion

- Know the components of the fire triangle
- Know the difference between fire intensity and fire severity

## Learning Outcomes

Demonstrate knowledge of fire including the components necessary for fire, combustion, and ways to put a fire out.

## Content Outline

- Wildland fire history
- Fire's influence on cultural mythology around the world
- Basic chemistry
- Fire triangle
- Fire behavior triangle
- Fire intensity and severity

*“The agent by which fire was first brought down to earth and made available to mortal man was lightning. To this source every hearth owes its flames”*

**Lucretius**

*De Rerum Natura, 50 BC*

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## Wildland Fire History

The origin of fire is tied to the origin of plants. Plants are responsible for two of the three elements essential to the existence of fire: oxygen and fuel. The third element, a heat source, has been available throughout the history of Earth—mainly through lightning (Pausas and Keeley 2009).

Plants and trees smoldering from a lightning strike or any source of hot coals may have been the first resources exploited by humans to control fire. Friction using the flint-and-steel method, where hot sparks are struck from a piece of steel

or iron onto suitable tinder, was a commonly used primitive technique for making fire. Fire was used as a tool to clear ground for human habitats, to facilitate travel, to kill vermin, to hunt, to regenerate plant food sources (for both humans and livestock), to use for signaling, and even to use in warfare among tribes.

Much is written about the dense, primeval forests of North America—from coast to coast. Equally impressive to early European settlers were the great open expanses of prairies, meadows, and savannas, most of which were created and maintained by native burning (Figure 1).



Image: Frederic Remington

Figure 1. “The Grass Fire” by Frederic Remington depicted Native Americans setting a grass fire. The picture was painted in 1908 and is owned by Amon Carter Museum in Fort Worth, Texas.

A story on native burning was written by Sharon Levy (2005), a freelance writer in Arcata, California. Levy wrote about Amelia Lyon, who was a member of the Hupa Tribe of northern California. Amelia practiced what generations of women in her culture did—maintaining the open oak woodlands near what is now Redwood National Park. Amelia tended the open oak stands by burning the undergrowth every year and thereby encouraging health and vigor in the standing trees, and more importantly, generous acorn crops. Since her death in the late 1800s, the native tradition of burning ended.

*Other historical accounts suggest that the Takelma women (from the Rogue Valley of interior southwest Oregon) were responsible for the majority of the seasonal burns used for harvesting foods (Tveskov et al. 2002). They used fire to roast and collect sunflower and tarweed seeds, grasshoppers, and yellow jacket larvae, and to make it easier to locate acorns for collection while also suppressing boring insects. These regular fires in the oak or grass savanna also encouraged the growth of healthier basketry materials; the same was done at higher elevations to encourage the new growth of beargrass, the leaves of which are another important basket-weaving and regalia-making material.*

*An expansive, grassy oak savanna is the perfect foraging ground for game animals like deer and elk. When the Takelma burned the oak savanna, keeping trees and brush out and grass growth abundant, they also ensured the deer and elk populations would stay in the area, providing an important meat source.*

*When it was time to hunt the mammals, larger fires were used once again for deer drives, frightening the scattered deer into smaller areas and eventually trapping them in a brush enclosure where hunters waited.*

*In some instances, the Takelma used fire during warfare to scare away or hinder travel of*

*competing tribes or to use the smoke to cover up an escape. They also used fire to burn potential enemy hiding places and to signal war activity to nearby groups (Tveskov et al. 2002, Pullen 1996, LaLande and Pullen 1999).*

*For the Takelma, fire was an essential tool for maintaining healthy food sources year after year. As a result of the tarweed seed, grasshopper, and deer-drive burns, overgrowth of brush and small trees was kept to a minimum, maintaining a larger open, oak savanna. The Takelman use of anthropogenic fire provided them with sustainable food resources, but also maintained a healthy habitat for large game animals, encouraged biological diversity, minimized fuels, and decreased the probability of catastrophic wildfires (LaLande 2004).<sup>1</sup>*

### ✓ Activity I – Fire history<sup>2</sup>

- Demonstrate how a fire is started using flint and steel, bow and friction, and a fuel source such as tinder.

Legendary forest fires like the [Peshtigo Fire of 1871](#) in Wisconsin and the [Great Fire of 1910](#) in Montana and Idaho bolstered the argument that forest fires threatened commercial timber supplies and contributed to the philosophy that fire was a danger that needed to be suppressed. Before the middle of the 20th century, most forest managers believed that fires should be suppressed at all times. By 1935, the U.S. Forest Service's fire management policy stipulated that all wildfires were to be suppressed by 10 a.m. the morning after they were first spotted. Complete fire suppression was the objective. In 1968, policies started to shift and the National Park Service changed its policy to recognize

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<sup>1</sup> LaLande, J. and R. Pullen. 1999. Burning for a 'Fine and Beautiful Open Country': Native Uses of Fire in Southwestern Oregon. Indians, Fire, and the Land in the Pacific Northwest. Oregon State University Press, Corvallis, OR.

<sup>2</sup> Refer to the Activities section for more details on all Activities in this curriculum.

fire as an ecological process. The Forest Service followed suit in 1974 by changing its policy from fire control to fire management. Current fire suppression efforts by land managers have focused on protecting the public, the wildland-urban interface (WUI), and other valuable resources.

Shifts and changes in policy and management have altered **fire regimes** over time. Historically high-frequency, low-severity fire regimes have been replaced with low-frequency, high-intensity crown fires that are outside the natural range of variability.

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*Natural range of variability uses history as the benchmark for comparison between the range of ecological conditions prior to human alterations and the desired range of future conditions.*

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How do we know what the historic fire regimes were? There are several methods to measure and assess fire and disturbance history through time. Ice core analysis is one method that has been conducted for the last 40 years by measuring gases and charcoal sediments trapped in the ice. Measurements can go back in time over 100,000 years.

The negative aspects are that ice core measurements are by necessity taken in remote sites and do not measure local vegetation variability.

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*Fire has had a very strong albeit different impact on forests throughout Oregon depending on the fire regime of the ecoregion. Forests that historically burned frequently (every 4–25 years) but with low intensity include the Willamette Valley oak and the drier conifer forests like ponderosa pine. High-severity wildfires occurred in the state's wetter regions and higher elevations (i.e., coastal forests, lodgepole pine and subalpine forests). These fires were very intense, killing most of the trees. Historically, they occurred infrequently—only every 100 to 450 years—and often were very large. Some forest types had a history of both low- and high-severity fires. These forests typically burned every 40 to 80 years (i.e., dry/wet mixed conifer forests).*

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One study conducted by Zennaro et al. (2014) measured 2,000 years of boreal forest fire history from Greenland. Fourteen major events (“megafires”) were recorded where fires of such great magnitude burned that charcoal from plumes carried to Greenland were deposited.

The highest concentrations of charcoal in ice cores from Greenland coincide with Viking settlements during the “Little Climatic Optimum” between 920 and 1110 Common Era (CE). The lowest concentrations of charcoal in ice cores was measured during the “Little Ice Age” between 1400 and 1700 CE. Another rise was measured during 1910 when the Great Fire occurred in Montana and Idaho.



Photo: Taxelson/CC BY-NC-SA 2.0

Figure 2. Tree rings of a Norwegian spruce.



Photo: Chris Schnepf, University of Idaho

Figure 3. Fire scars are visible on this crosscut section of *Pinus ponderosa*.

Dendrochronology is another method of measuring fire and disturbance history. It is the extraction of tree cores to measure growth rings and fire scars (Figures 2 and 3). This method is site specific and is good for mapping fire history across a landscape. Also, this method can illustrate the level of fire intensity—assuming the tree survived a wildland fire—and frequency for potentially hundreds of years. Disadvantages are that the record is limited to certain species (trees prone to heart rot cannot be measured) and only measures back a few hundred years at most (the lifespan of most tree species). Another disadvantage is that high-intensity fires cannot be measured due to mortality of trees, and very low-intensity fires cannot be measured because they are not intense enough to leave a scar, and therefore be recorded in growth rings.

#### ✓ Activity II – Fire history

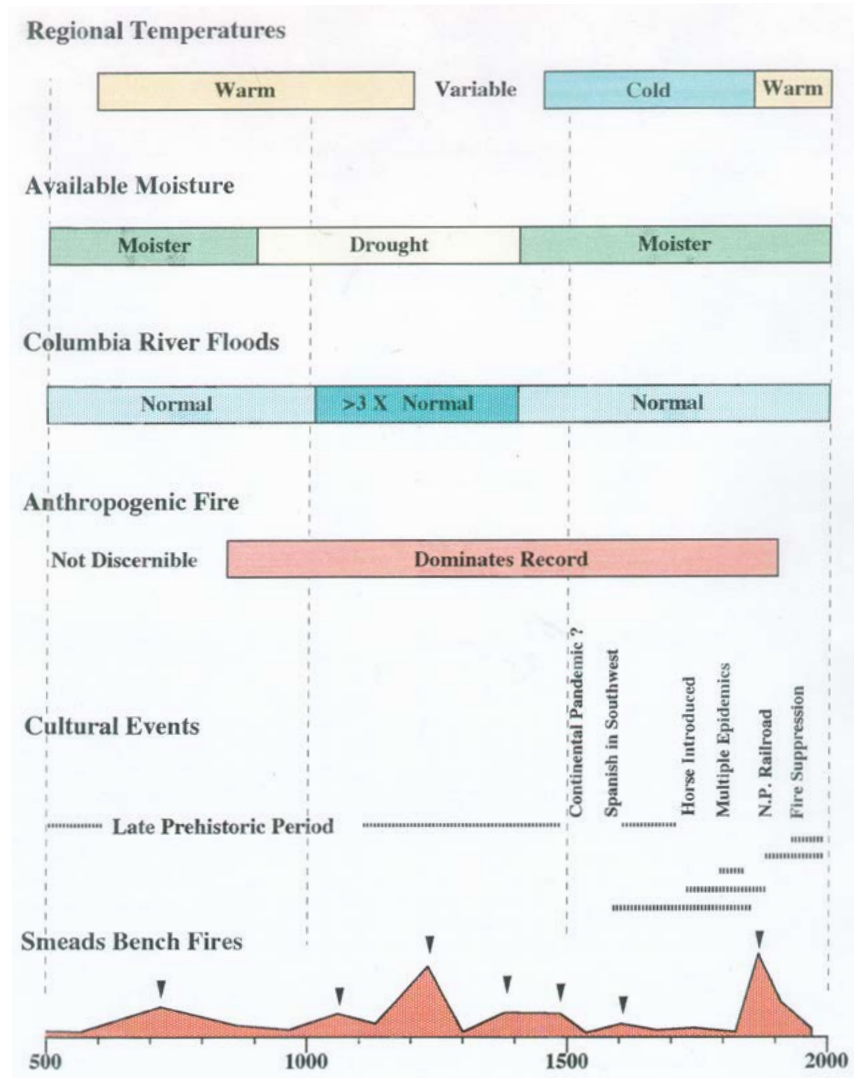
- Examine cores from trees and compare growth, climate, and disturbance history.

Sediment (including pollen, sediment, and charcoal) cores have also been used to measure disturbance history. Similar to tree cores, these cores may not give a clear picture of low-intensity fires and are relatively site specific—primarily to water-prone, miosites, extracted from lakes, fens, and/or bogs. The measurement is also restricted to certain species of tree, shrub, and grass due to the nature of pollen decomposition of certain species. However, these cores can give a good vegetation succession history that can go far back in time—potentially over thousands of years. For example, a measurement core was taken in a western red-cedar/hemlock plant association in northwest Montana. Precipitation at the time (1995) was about 70 inches annually, which resulted in the warm and moist conditions suitable for those species. The sediment core measured back 7,000 years and illustrated a changing climate and different vegetation—as well as different fire frequencies and severities. On this particular landscape, 4,000 to 7,000

years previous, the climate was cooler and drier with subalpine fir being the dominant species. From 2,500 to 4,000 years previous, the climate was cooler and drier with true fir (*Abies*) being the dominant species. The current vegetation assemblages did not appear dominant in the record until 2,500 years from the present time of measurement (Chatters and Leavell 1994).

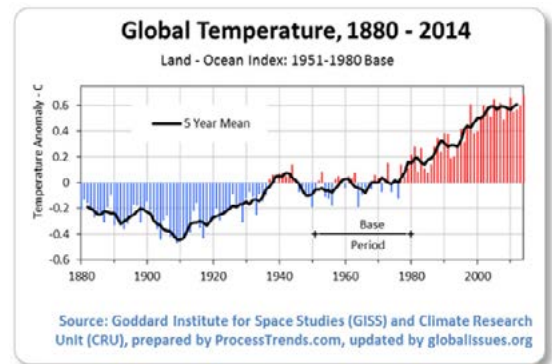
A correlation was made to regional temperature measurements, available moisture, regional flooding events, and native population rises and declines (Figure 4).

Humans have had profound impacts on fire history and consequently have altered fire regimes across the landscape. The interaction between fire and anthropogenic-induced climate change contributes to future uncertainty. For example, an increase in the frequency of extreme droughts as a result of climate change may facilitate the spread and intensity of fires. An increase in global temperature may also alter fuel continuity in very different ways in different ecosystems (Figure 5). An understanding of the natural range of variability, both past and future, in which a forest will remain resilient, dynamic, and productive is helpful for developing forest- and fire-management activities for the future.



Credit: D. Leavell (2000).

Figure 4. Graphic illustrates the relationship between temperatures, available moisture, Columbia River floods, and anthropogenic fire in the Kootenai National Forest.



Source: Goddard Institute for Space Studies

Figure 5. Graph illustrates how global land and ocean temperatures have been rising in recent decades.



## Fire's Influence on Cultural Mythology Around the World

*Fire can be a friendly, comforting thing, a source of heat and light, as anyone who has ever sat by a campfire in the dark knows. Yet fire can also be dangerous and deadly, racing and leaping like a living thing to consume all in its path. In the mythology of virtually every culture, fire is a sacred substance that gives life or power.<sup>3</sup>*

*Agni, the god of fire in Hindu mythology, represents the essential energy of life in the universe (Figure 6). He consumes things, but only so that other things can live. Fiery horses pull Agni's chariot, and he carries a flaming spear. Agni created the sun and the stars, and his powers are great. He can make worshipers immortal and purify the souls of the dead from sin. One ancient myth about Agni says that he consumed so many offerings from his worshipers that he was tired. To regain his strength, he had to burn an entire forest with all its inhabitants.*

*Chinese mythology includes stories of Hui Lu, a magician and fire god who kept 100 firebirds in a gourd. By setting them loose, he could start a fire across the whole country. There was also a hierarchy of gods in charge of fire. At its head was Lo Hsüan, whose cloak, hair, and beard were red. Flames spurted from his horse's nostrils. He was not unconquerable, however. Once, when he attacked a city with swords of fire, a princess appeared in the sky and quenched his flames with her cloak of mist and dew.*

*A number of Native American cultures believe that long ago some evil being hid fire so that people could not benefit from it. A hero had to recover it and make it available to human beings. In many versions of the story,*



Image: E.A. Rodriguez, / CC BY-NC-SA 2.0

Figure 6. Agni, the god of fire.

*a coyote steals fire for people. Sometimes a wolf, woodpecker, or other animal steals the fire. According to the Navajo, a coyote tricked two monsters that guarded the flames on Fire Mountain. Then he lit a bundle of sticks tied to his tail and ran down the mountain to deliver the fire to his people.<sup>4</sup>*

*In the Christian belief system, the Devil himself appears in some fire-related folktales. In parts of Europe, it is believed that if a fire won't draw properly, it's because the Devil is lurking nearby. In other areas, people are warned not to toss bread crusts into the fireplace because it will attract the Devil (although there's no clear*

<sup>3</sup> This material drawn from <http://www.mythencyclopedia.com/Dr-Fi/Fire.html>

<sup>4</sup> This section is excerpted from <http://www.mythencyclopedia.com/Dr-Fi/Fire.html>

*explanation of what the Devil might want with burnt bread crusts).*<sup>5</sup>

*The manifestation of the divine in the form of fire may be found in the Abrahamic faiths as well. In Christianity, for example, the Holy Spirit is said to have descended on the apostles in the form of tongues of fire on the day of Pentecost. The manifestation of God in the element of fire is also found in the Old Testament, as evident from a passage in the book of Exodus where God spoke to Moses from the burning bush. Abrahamic faiths also acknowledge the destructive power of fire. The destructive dimension of this element is at times associated with the wrath of God, and a number of verses from the Bible have been used to illustrate this. Another way of interpreting the destructive power of fire is to view it as a means of purification. In other words, fire could be symbolically seen as a way to ‘burn’ away one’s evil urges.*<sup>6</sup>

According to the National Park Service (NPS.gov), fires remove dead trees and litter from the forest floor. Shrubs and trees invading grasslands also are killed by fires. In each example, new healthy regrowth occurs. Fire does not imply death, but rather change. As fire was associated with rebirth and renewal in mythology, so fire is now recognized as an instrument of change and a catalyst for promoting biological diversity and healthy ecosystems.

✓ **Activity III – Fire’s influence on cultural mythology**

- Have students read Personal and Professional Insights.
- Have students bring in stories, poems, or other art pieces about fire. Then have students work in groups to share and discuss their pieces.

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<sup>5</sup> Excerpt from “Fire Folklore and Legends,” <https://www.meetup.com/es-ES/ashevillepagans/messages/boards/thread/29446062>

<sup>6</sup> Material drawn from <http://www.ancient-origins.net/myths-legends/fire-symbolism-flames-ignite-faiths-and-inspire-minds-004404>.

*“In simplest terms, fire exists because the Earth holds life. Life pumped the atmosphere with oxygen. Life lathered the land with hydrocarbons. The chemistry of combustion is among life’s most elemental reactions, for it simply takes apart what photosynthesis puts together.”*

**Stephen J. Pyne**  
*Tending Fire*

## Basic Fire Chemistry

Fire is a chemical reaction in which energy in the form of heat is produced. The chemical reaction is known as **combustion**. Combustion occurs when fuel or other material reacts rapidly with oxygen, giving off light, heat, and flame. A flame is produced during the ignition point in the combustion reaction and is the visible, gaseous part of a fire. Flames consist primarily of carbon dioxide, water vapor, oxygen, and nitrogen.

Combustion is the opposite process of photosynthesis. Combustion is the breaking apart of the building blocks put together through photosynthesis. Combustion is the release of the energy acquired during photosynthesis. Oxygen is introduced, and bonds in the fuel of hydrogen and carbon are broken (releasing energy), the resulting hydrogen and carbon combining separately with the oxygen as H<sub>2</sub>O and CO<sub>2</sub>, releasing heat in the process. Photosynthesis is the process of plants slowly absorbing the energy (heat) from the sun and building/growing tissue (Figure 7). Carbon dioxide is stored in the tissue, and oxygen is given off into the atmosphere. Combustion is the process of that tissue (plant matter) burning—oxygen is consumed, and carbon dioxide and heat are released into the atmosphere.

## Fire Triangle

The **fire triangle** includes the three components that must be present for a fire to burn. These components are fuel, oxygen, and a heat/

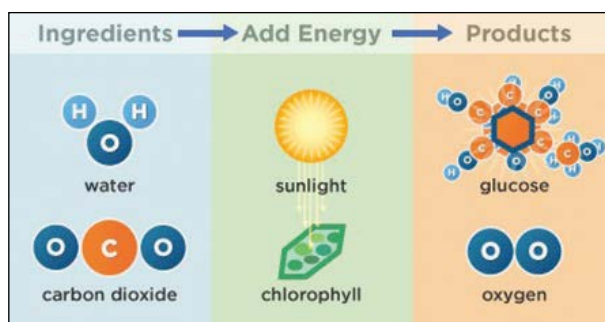


Image: Education Development Center/CC BY-NC-SS 4.0

Figure 7. Diagram depicting photosynthesis.

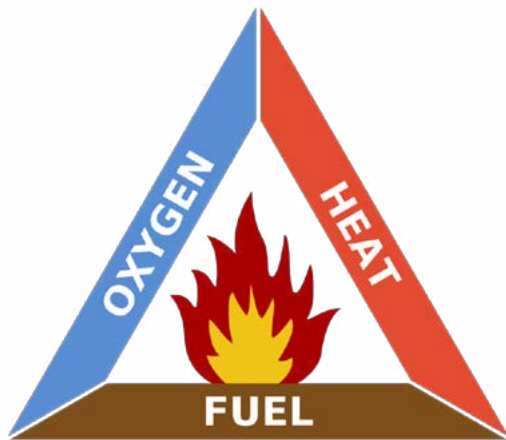
ignition source (Figure 8). Without one of these components, fire cannot exist. For a fire to ignite, there must be an initial and continued heat source—this is called a chain reaction and is part of what makes up the **fire tetrahedron**.

Heat allows fire to spread by removing the moisture from nearby fuel, warming surrounding air, and preheating the fuel in its path. When the fire becomes either fuel-controlled (i.e., there is no more fuel to burn) or ventilation-controlled (i.e., there is not enough oxygen to sustain combustion), the fire decays to a smoldering state.

Four ways to put out a fire:

1. Cool the burning material.
2. Exclude oxygen.
3. Remove the fuel.
4. Break the chemical reaction.

Heat/ignition sources include anything capable of generating heat—lightning, cigarettes, powerlines, catalytic converters, small engine sparks, matches, a magnifying glass.



Source: Gustavb/CC BY-SA 3.0

Figure 8. The Fire Triangle

Fuel sources include any kind of combustible material—grass, shrubs, trees, houses, propane tanks, wood piles, and decks. Fuels are characterized by their moisture content (how wet the fuel is), size, shape, quantity, and the arrangement in which they are spread over the landscape.

The last part of the triangle is oxygen. Ambient air is made up of approximately 21 percent oxygen and most fires require at least 16 percent oxygen content to burn. A fire ignited in an area that has little oxygen will support only a small flame.

If oxygen is suddenly and rapidly added to a nearly suffocated fire, the re-oxygenated air will quickly ignite, creating large and dangerous flames known as a flashover or backdraft. **Flashover** is a term used in structural firefighting and is by definition “the sudden involvement of a room or an area in flames from floor to ceiling caused by thermal radiation feedback.” A flashover reaches high temperatures (over 1,000°F) so quickly that all flammable contents spontaneously ignite and conditions become untenable and unsafe.

A **backdraft** is a smoke explosion that occurs when additional air is introduced to a smoldering fire and heated gases enter their flammable range

and ignite with explosive force. A backdraft is an air-driven event, unlike a flashover, which is temperature driven. The fact that most fires are air regulated and not fuel regulated makes the understanding of backdrafts so important.

A “flashover” in the wildland environment is called a **Generalized Blaze Flash (GBF)** phenomenon. The GBF is defined as a rapid transition from a surface fire exhibiting relatively low intensity to a fire burning in the whole vegetation complex, from surface to canopy, and demonstrating dramatically larger flame heights, higher energy release rates, and faster rates of spread. This can occur when the ambient air temperature rises dramatically, the relative humidity drops significantly, and the wind speed rises. When all three conditions occur in the wildland, a GBF can develop from a slow-moving ground fire to a raging crown fire. All fuel (forest, range, grassland) burns simultaneously. From all appearances, this looks, acts, and feels just like a flashover in a confined space structure—but over many acres in a wildland setting.

#### ✓ Activity IV – Fire Triangle

- This demonstration illustrates that if you take one factor (oxygen, fuel, heat source) of the Fire Triangle away, the fire will go out.

### Fire Behavior Triangle

While the fire triangle describes the components required to sustain a fire, the **fire behavior triangle** describes the components that determine how a fire burns—topography, weather, and fuels. Fuels is the common denominator between the two triangles. The fire behavior triangle and its components will be covered in more depth in Fire Behavior Module 3.

### Fire Intensity and Fire Severity

Fire intensity and fire severity will be defined in more detail in Module 3 but, for now, it helps to understand that fire intensity and fire severity



Photo: Mike McMillan, © U.S. Forest Service

Figure 9. 2013 Rim Fire in and near Yosemite National Park in California

both characterize a fire but describe entirely different concepts. **Fire intensity** is the amount of heat (energy) given off by a forest or structure fire at a specific point in time (Figure 9).

**Fire severity** is a product of fire intensity and residence time, and refers to the effects of a fire on the environment, typically focusing on the loss of vegetation both aboveground and belowground but also including soil impacts (Figure 10).

While a fast-moving, wind-driven fire may be intense (lots of heat), a long-lasting fire that just creeps along in the forest underbrush could transfer more total heat to plant tissue or soil in a given area. In this way, a slow-moving, low-intensity fire could have more severe and complex effects on something like forest soil than a faster-moving, higher-intensity fire in the same vegetation. (Hartford and Frandsen 1991).



Photo: Northern Research Station, © U.S. Forest Service

Figure 10. High-severity fires can cause intense damage to both the overstory and understory.

Fire conditions can also vary considerably throughout a structure. One area of the building could be in a fully developed stage while a different area might be in the growth or decay



Photo: Sylvain Pedneault

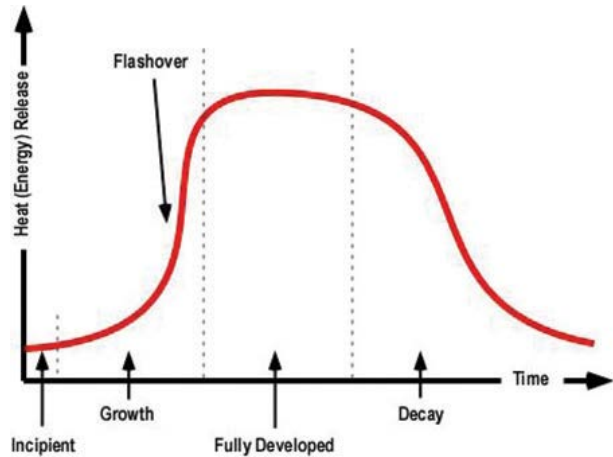
Figure 11. A major fire engulfs an urban structure despite efforts by firefighters to extinguish it.

stages of the fire. Like in wildland fire, the intensity and severity of these fires at each stage will depend on available heat, fuel, and oxygen (Figure 11).

Fire developmental stages include (Figure 12):

- Incipient stage
- Growth stage
- Flashover stage
- Fully developed stage
- Decay stage

Development of the incipient fire is dependent on the characteristics and configuration of the fuel involved. If there is adequate oxygen, additional fuel will become involved and the heat release rate from the fire will increase; this is considered the growth stage. The flashover point is the sudden transition from a growth stage to fully developed fire. When flashover occurs, there is a rapid transition to a state of total surface involvement of all combustible material within the compartment. In the post-flashover stage, energy released is at its greatest but is limited by ventilation. When the available fuel is consumed or there is limited oxygen, the fire is then considered in decay stage (Hartin 2008).



Source: Battalion Chief Ed Hartin, www.firehouse.com

Figure 12. Fire development and fire behavior indicators.

## Notes to Instructor

### Room Setup

The facilitator should secure a room large enough to comfortably accommodate participants. Organize the room in a U-shape fashion with long tables and chairs. The room should have a large screen to display the presentation. There should be a table up front (6 to 8 feet in length) for the instructor to use for in-class demonstrations and to display various props. The room should be equipped with a fire extinguisher, water faucets (or access to a water supply), and be suited for demonstrations that require the use of fire.

### Total Time Needed

Approximately 6 hours in the classroom

### Equipment/Materials Needed

- Computer with PowerPoint
- Projector and screen
- Handouts
- Flipcharts and easels or wall space
- Tree cores
- Flint, steel, and tinder bundle
- Candle, glass jar, petroleum jelly, and lighter

## Delivery Methods

- Presentation from instructors
- In-class demonstrations
- Outdoor demonstration
- Discussion
- Online with Canvas

## Handouts

- NWFS, 2015 – [What is? Fire Intensity](#)
- NWFS, 2015 – [What is? Fire Severity](#)
- A copy of the PowerPoint presentation (3 slides per page to allow for note taking)
- Other handouts can be downloaded from the section, “Additional Student Resources.”

## PowerPoints/Videos

- Module 1 – What is Fire?—PowerPoint
- Why Fire is Good (But you still shouldn't start a forest fire)—video <https://www.youtube.com/watch?v=14USIqGFSW4&feature=youtu.be>

## Evaluation Instrument

Student evaluation—Have a set of questions that touch on the different topics covered in the module. Ask people to provide thoughts and discussion on one or two questions. The

instructor should then evaluate and weigh in on the discussion.

Class evaluation—Provide a survey for student feedback for each module as a form of formative evaluation.

## Activities

### I. Fire Starting

- Demonstrate how a fire is started using flint and steel, bow and friction, and a fuel source such as tinder (outside demonstration)

### II. Tree Examinations

- Examine cores from trees and compare growth, climate, and disturbance history (in-class demonstration)

### III. Mythology

- Fire's influence on cultural mythology (in-class discussion)
- Have students bring in stories, poems, or other art pieces about fire. Then have students work in groups to share and discuss their pieces.

### **III. (con't) Personal and Professional Insights**

*Fire, fire, fire. Not that it means anything, but he was born in March—on a date that is supposed to be influenced by the fire sign. Adults told him later that when around 2 to 3 years old he played alone in the utility room where his cot lay.*

*He found a screwdriver and tried to take apart the bare-wire socket hanging on the wall. When the adults rushed in through the smoke, the wall had caught on fire and he stood there laughing at the flames.*

*Growing up poor, he had no store-bought toys, but delighted by the hour in building model homes, trees, cars, and people out of scraps of cardboard. When the city was finished, he would burn it all down with matches stolen from the kitchen—or with the magnifying glass—or the butt-end of illicit cigars. As a teenager, running with gangs wasn't enough, and he proved his delinquency by stuffing 15-foot-diameter storm drains with dried shrubs and tumbleweeds. Once the drains were full, he would ignite them with stolen matches he always seemed to have. The 100-foot flames that shot out of the storm drain attracted the police—and the juvenile delinquency court.*

*Released on the half-hearted promise to stay out of trouble, he graduated high school by the skin of his teeth and went into the military as a way to stay out of trouble and get into a college, if they would pay for it. Before he went in, the fantasy of burning the shack down in which he was raised almost became a reality. If his entrance into the military was delayed by a day, he would have done so, believing fire was the Great Sanitizer—the Great Destroyer of bad trash and worse memories. But fortunately for him and his future, he went in the service earlier than planned and he never burned down the shack.*

*He scored high enough on the entrance scores to get into a communication/intel school back East. Before he left, he was permitted to attend the military's fire academy. The emphasis was on shipboard firefighting, but all the basics were covered. The live-fire exercises in the huge concrete bunker were the best, even though so many others were frightened of the black, oily smoke and intense heat. He didn't have the sense to be fearful—only encouraged to be closer to the flames.*

*The shipboard fires on the high seas did not deter his desire to be close to the flames. After leaving the service, he enrolled in a college, courtesy of the GI Bill, and worked towards a bachelor's degree in Forestry—because it was a ticket to working in the woods away from cities and people.*

*His first part-time job with the Forest Service was as a grunt technician at the Fire Control Laboratory in Riverside, California. At that time in the early '70s, the first wildland fire-behavior research was being conducted and published. He was glued to every word. He stuck with the Forest Service after college and remained for the next 35 years.*

*The career really started with a transfer to the wilds of north Idaho at a remote duty station. At that time, the Forest Service required any position to have a firefighting component to it. If a person did not fight fire in those remote stations, they did not have a job. After the joys of that first summer—fighting fires wherever the dispatch sent him—he followed a parallel path of forestry and firefighting in remote areas across the West.*

*Developing both forestry and fire skills from grunt positions to positions of leadership, he eventually obtained a Master's and PhD in forest science and training, becoming a staff officer for vegetation management in a*



National Forest. He also received certification, training, and experience necessary for fire management leadership. The best part was to combine and interchange both fire management and vegetation management—they complemented each other very well.

*Living in remote areas with cold, dark winters was great for skiing and snowshoeing—and also for learning how fire can save a life close to hypothermia and death. Being on fire-fatality investigations and managing fire in subdivisions also taught him how fire can take life and property away, too. After serving on several hundred fires from Florida to Alaska, he also learned how fire behaves and how to predict what it will do, when it will do it, and why it will do it. He never had a fear of fire, but eventually learned how to respect it as neither good nor bad—but as a force of nature. As much as he tried over the years, he could not keep fire out of his life.*

*Nor should he.*

#### IV: Fire Triangle (in-class demonstration)

This demonstration illustrates that if you take one factor (oxygen, fuel, heat source) of the fire triangle away, the fire will go out. This demonstration is conducted in front of the class on a table with a fireproof surface. You will need a clear glass jar, a T-lite candle, petroleum jelly, and a lighter or match. Place a little petroleum jelly on the rim of the jar (to create a seal between jar rim and the table top). Light the candle (T-lite) and place the jar over the candle. After a few moments, the candle will begin to dim and go out.

Ask participants the following questions:

- Why did the candle go out? (Lack of oxygen).
- What else can we do to extinguish flames? (Deny the fire fuel; reduce or eliminate

the heat source by using water; take away the oxygen by using a chemical fire extinguisher for chemical, fuel, or grease fires.)

## Assessment of Knowledge Gained

### (Questions and answers)

1. Name one heat source that has been available throughout the history of Earth.

*Answer: Lightning*

2. What is combustion?

*Answer: Combustion is a chemical reaction in which energy in the form of heat is produced.*

3. Fire cannot exist without these three components. What are they?

*Answer: 1. Fuel. 2. Oxygen. 3. Heat/ignition source*

4. Name four ways to put out a fire.

*Answer: 1. Cool the burning material. 2. Exclude oxygen. 3. Remove the fuel. 4. Break the chemical reaction.*

5. What component does the Fire Triangle and the Fire Behavior Triangle have in common?

*Answer: Fuel*

6. Compare and contrast fire severity and fire intensity

## Additional Resources

Pausas, J.G., and J.E. Keeley. 2009. A burning story: The role of fire in the history of life. *BioScience* 59(7):593.

Agee, J.K. 1990. The historical role of fire in Pacific Northwest forests. p. 25–38 In Walstad, J. et al. (eds.). *Natural and Prescribed Fire*

in *Pacific Northwest Forests*. Oregon State University Press, Corvallis, OR.

Agee, J.K. 1993. *Fire Ecology of Pacific Northwest Forests*. Island Press, Washington D.C.

Elements of Fire: <https://smokeybear.com/en/about-wildland-fire/fire-science/elements-of-fire>

Fire and Aviation Management: <https://www.nps.gov/fire/wildland-fire/learning-center/fire-basics/fire-triangle.cfm>

All about fire: <http://www.nfpa.org/news-and-research/news-and-media/press-room/reporters-guide-to-fire-and-nfpa/all-about-fire>

Northwest Fire Science Consortium. 2015. What is? Fire Intensity <http://www.nwfirescience.org/biblio/nwpsc-fire-facts-what-fire-intensity>

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## Glossary of Terms

**Backdraft:** Instantaneous explosion or rapid burning of superheated gases that occurs when oxygen is introduced into an oxygen-depleted confined space. It may occur because of inadequate or improper ventilation procedures.

**Combustion:** A chemical reaction in which energy in the form of heat is produced.

**Fire behavior triangle:** The fire behavior triangle describes the elements (weather, topography, and fuels) that determine how a fire burns.

**Fire intensity:** A general term relating to the heat energy released by a fire.

**Fire regime:** A fire regime is the pattern, frequency, and intensity of the wildfires that prevail in an area. It is an integral part of fire ecology, and renewal for certain types of ecosystems.

**Fire severity:** Degree to which a site has been altered or disrupted by fire; loosely, a product of fire intensity and residence time.

**Fire tetrahedron:** The fire tetrahedron is a four-sided geometric representation of the four factors necessary for fire: fuel (any substance that can undergo combustion), heat (heat energy sufficient to release vapor from the fuel and cause ignition), oxidizing agent (air containing oxygen), and uninhibited chemical chain reaction.

**Fire triangle:** Instructional aid in which the sides of a triangle are used to represent the three factors (oxygen, heat, fuel) necessary for combustion and flame production; removal of any of the three factors causes flame production to cease.

**Flashover:** Rapid combustion and/or explosion of unburned gases trapped at some distance from the main fire front. Usually occurs only in poorly ventilated topography. Stage of a fire at which all surfaces and objects within a space have been heated to their ignition temperature, and flame breaks out almost at once over the surface of all objects within the space.

**Generalized Blaze Flash:** A rapid transition from a surface fire exhibiting relatively low intensity to a fire burning in the whole vegetation complex, from surface to canopy, and demonstrating dramatically larger flame heights, higher energy release rates, and faster rates of spread.

**Photosynthesis:** The process by which green plants and some other organisms use sunlight to synthesize foods from carbon dioxide and water.

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# Evaluations



OREGON STATE UNIVERSITY  
CITIZEN EVALUATION OF TEACHING

USE NO. 2 PENCIL

INSTRUCTOR'S NAME	EXTENSION EVENT	DATE
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**YOUR RESPONSES TO THIS QUESTIONNAIRE WILL HELP INSTRUCTORS CONFIRM QUALITY TEACHING AND IMPROVE TEACHING SKILLS AND METHODS.**

PLEASE FILL-IN THE APPROPRIATE RESPONSE.  
MARK ONLY ONE CIRCLE PER QUESTION/

	VERY POOR	POOR	FAIR	GOOD	VERY GOOD	EXCEL- LENT	UNABLE TO RATE
1. Overall, the quality of the educational event as a whole was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. The quality of instruction in this educational event was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Clarity of educational objectives was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. Clarity of how you might use this education was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. Teaching organization was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. Instructor's use of examples was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Instructor's use of teaching aids (slides, overheads, charts, etc.) was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. Instructor's ability to stimulate my thinking more deeply about the subject was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. Instructor's responsiveness to questions was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. Instructor's use of participant discussion to enhance my learning was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. Instructor's ability to develop a welcoming environment for all participants was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. Instructor's skill in making the information useful to me was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**Your comments will be helpful to improve instruction.**

Please comment:


# PowerPoint Slides

**Module 1: What is Fire?**  
FIRE SCIENCES CORE CURRICULUM



**1**

**WILDLAND FIRE HISTORY**



*"The agent by which fire was first brought down to earth and made available to mortal man was lightning. To this source every hearth owes its flames."*

—Lucretius, De Rerum Natura, 50 B.C.

**3**

**LEARNING OBJECTIVES**

- Understand wildland fire history
- Understand the influence that fire has had on cultural mythology around the world
- Know that fire is part of a chemical reaction called combustion
- Know the components of the fire triangle
- Know the difference between fire intensity and fire severity

**2**

**WILDLAND FIRE HISTORY**



**4**



**BASIC CHEMISTRY**

**Combustion**

Exhaust

Heat

Fuel

Oxygen

Heat

NASA

Glenn Research Center

7

**BASIC CHEMISTRY**

**Photosynthesis**

Ingredients

Add Energy

Products

water

carbon dioxide

sunlight

chlorophyll

glucose

oxygen

8

**WILDLAND FIRE HISTORY**

Ice core analysis

Dendrochronology

Sediment cores

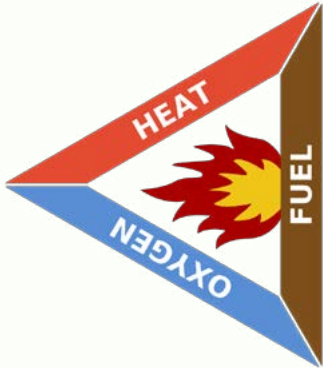

5

**CULTURAL MYTHOLOGY**

Fire does not imply death, but rather change."



6

**FIRE TRIANGLE**



**9**

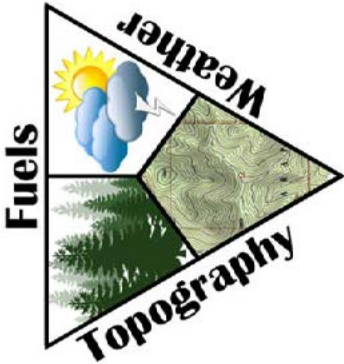

**FIRE INTENSITY**



Amount of heat (energy) given off by a forest or structure fire at a specific point in time.



**11**

**FIRE BEHAVIOR TRIANGLE**



**10**


**FIRE SEVERITY**




**LOW Severity**      **HIGH Severity**

A product of fire intensity and residence time

**12**



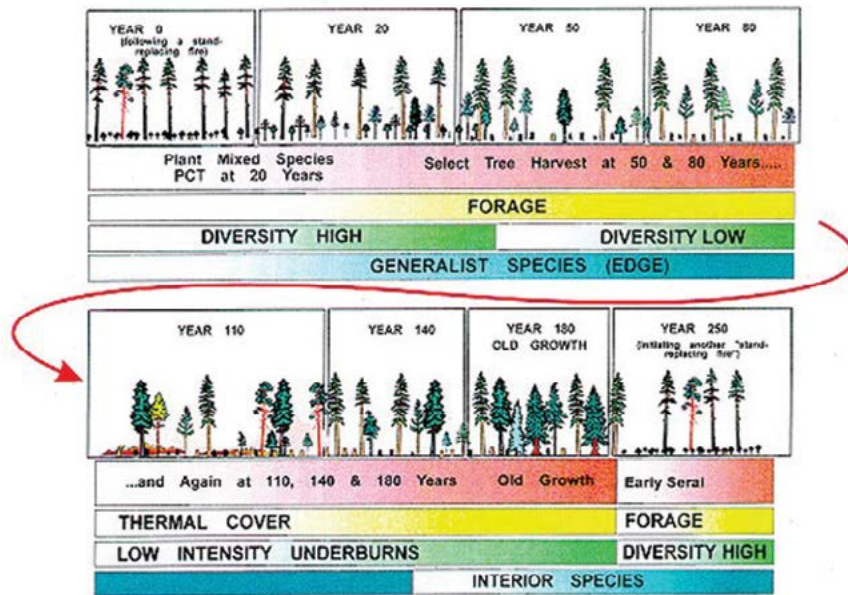
Oregon State  
University



This concludes Module 1 training.

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# Module 2: Fire Ecology



## Proposed Agenda

Time		Section name
8:00	8:30	Welcome
8:30	9:00	Introduction and Objectives
9:00	9:30	Activity I and discussion
9:30	10:00	Break
10:00	10:30	Fire Regimes and Fire Behavior Across Gradients
10:30	11:00	Example of Wildland Fire Dynamics Across an Oregon Gradient (1)
11:00	11:30	Activity II (Fire Adaptations)
11:30	12:00	Example of Wildland Fire Dynamics Across an Oregon Gradient (2)
12:00	12:30	Lunch
12:30	1:00	Activity III (Cooperation, Collaboration, and the WUI)
1:00	1:30	Abiotic Effects
1:30	2:00	Biotic Effects (1)
2:00	2:30	Biotic Effects (2)
2:30	3:00	Activity IV (Fire Ecology Crossword)
3:00	3:30	Break
3:30	4:00	Activity V (Fire Ecology Information System)
4:00	4:30	Wrap-up
4:30	5:00	Discuss plans for the Fire Field Trip

## Overview

Fire is a disturbance agent across landscapes. Fire has occurred often enough through time over our forests, rangeland, meadows, and wetlands that plants and animals have adapted to it and in some cases depend on it. In this module, students will create a fire-adapted animal, plant, or house and work with a group to determine the fire regime and fire ecology of their creation. Students will also examine case studies and work with a partner or small group to create a poster illustrating living and nonliving relationships to fire. Students will define common vocabulary used when discussing fire ecology.

## Learning Objectives

- Understand how individual plants and communities of plants have adapted to occupy niches along an environmental

gradient and how these adaptations relate to wildlife habitat and disturbance

- Describe the relationship of fire behavior across environmental gradients. Describe the role of plant succession within a historic context. Given the historic context, understand how that has defined fire regimes over time.
- Understand the role humans have to influence and affect disturbance and succession more than natural causes—and the results on individuals, populations, communities, and landscapes.

## Learning Outcomes

Apply concepts learned in this module to design a landscape for your area with natural vegetation adapted to your local climatic and topographic conditions—paying close

*“Light yourself on fire with passion and people will come from miles to watch you burn.”*

**John Wesley**  
*English theologian*

attention to microsites. Monitor the growth and development—and resistance to weather and disease effects of these plants and compare to non-natives.

## Content Outline

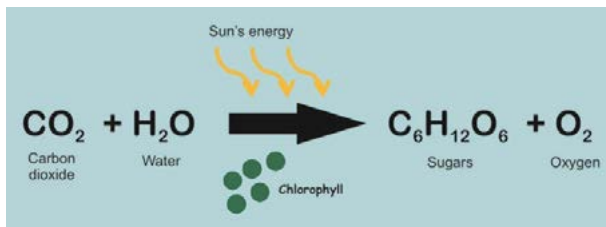
- Introduction
- Dynamics of fire
  - Plant succession
  - Fire regime
  - Fire behavior across an environmental gradient
- Example of Wildland Fire Dynamics across an Environmental Gradient
- Fire Effects to Abiotic
- Fire Effects to Biotic
  - Vegetation gradient
  - Vegetation succession
  - Wildlife
  - Humans

## Introduction

Fire ecology is a branch of ecology that concentrates on the origins of wildland fire and its relationship to the nonliving (abiotic) and living (biotic) environment (together making up the ecosystem). We also propose that the definition of fire ecology applies to the relationship of a structure fire to its environment.

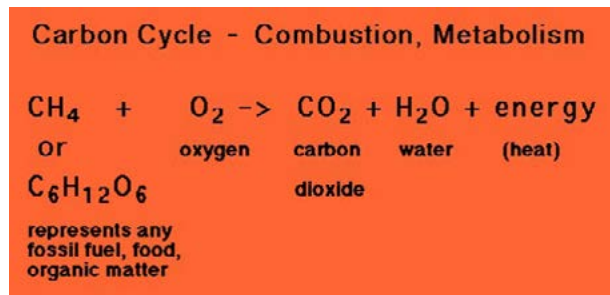
Fire does not have a personality, is neither evil nor good. Fire can save life and take it. Fire can be beneficial and detrimental. Our history has ingrained into us a fear of fire more than a respect for it. How many of us have a history of family members or neighbors negatively affected by a forest or house fire?

In the 1930s, early fire researchers in the southeastern United States challenged the public’s predominant negative feeling towards fire. They argued that controlled, prescribed fire was essential to the wildlife and the longleaf pine



Source: <http://chemistry.elmhurst.edu/vchembook/540carbohydrates.html>

Figure 1. Plants take carbon dioxide molecules from the air, water molecules, and the energy from the sun to produce a simple sugar such as glucose, with oxygen molecules as a byproduct. The simple sugars convert into other molecules such as cellulose.



Source: <http://chemistry.elmhurst.edu/vchembook/540carbohydrates.html>

Figure 2. Combustion occurs when any organic material (such as cellulose) is reacted (burned) in the presence of oxygen to give off the products of carbon dioxide and water and energy.

forests of that region. This was one of the first times fire was perceived by credible science as having a benefit to ecosystems and not entirely negative or harmful. Fire ecology was born with this understanding. The scientists would have used the words “ecosystem” and “ecology” then, but for the fact that these terms first appeared in 1935 (credited to George Tansley—1871–1955).

Plants take in energy from the sun during photosynthesis (Figure 1). Combustion burns the organic matter stored in plants and releases energy (Figure 2).

✓ **Activity 1<sup>1</sup> – Personal and professional insights**

Fire is a chemical reaction. It is a natural disturbance process and a component of an ecosystem. How fire fits into and reacts with an ecosystem requires an understanding of systems. Look beyond an ecosystem’s present state for that understanding. Build on that understanding with an investigation of:

- An ecosystem’s origin
- Possible future stages of an ecosystem
- The cycles through which an ecosystem progresses

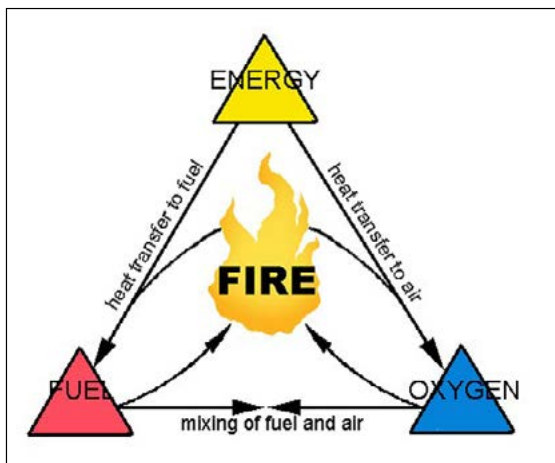
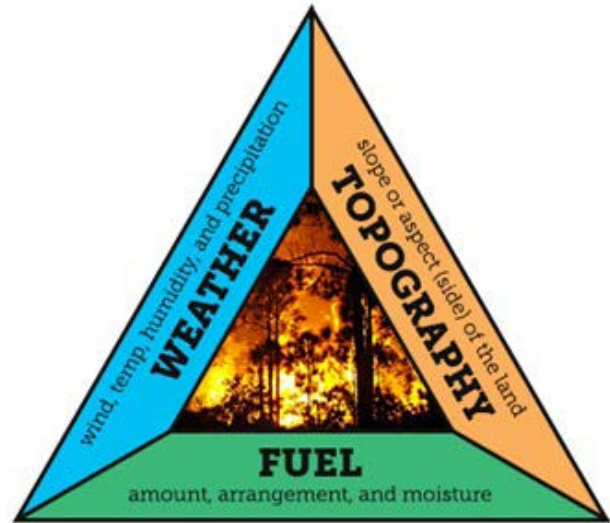


Image: University of Southern Mississippi

Figure 3. The fire triangle demonstrates how energy, oxygen, and fuel combine to create fire.

<sup>1</sup>Refer to the Activities section for details on all activities in this curriculum.



**Fire Behavior Triangle**

Source: <https://learn.weatherstem.com/modules/learn/lessons/121/12.html>

Figure 4. Weather is the most unpredictable of the three sides—and the most variable. Topography ties directly to the environmental gradient.

Fire has a place throughout. Fire, similar to floods, earthquakes, storms, and other disturbances, is a dynamic force of nature that induces change in an ecosystem. When the Fire Triangle is complete, fire will occur (Figure 3). When the Fire Behavior Triangle is complete—how a fire progresses and to the intensity and severity it burns across the landscape or in a structure becomes predictable—the relationship of fire to the nonliving and living components of an ecosystem begins to make sense.

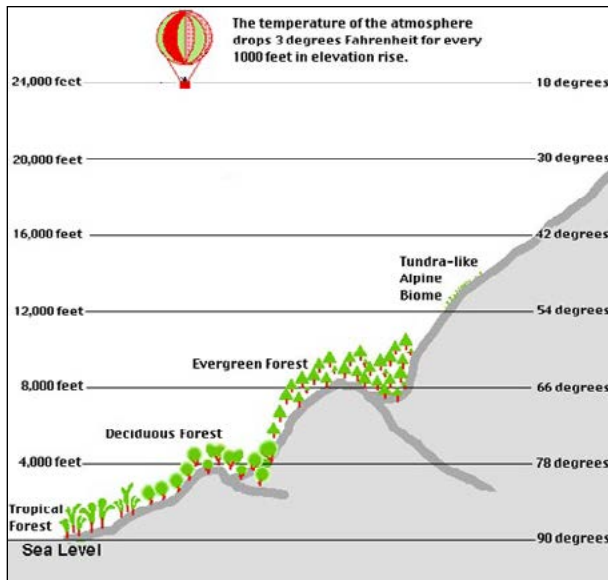
Disturbance interacts with environmental variables such as slope, elevation, aspect, wind patterns, precipitation, and terrain, to shape succession modifications of vegetation structure and composition (Figure 4). All living things have some traits that are adaptations to disturbances and constraints of their environments. Disturbances include physical and biological disturbances, of which fire is one. Hurricanes, floods, and insect and disease epidemics are other forms of cyclic disturbances to which vegetation has adapted. Human disturbances such as road building, heavy logging, agriculture, housing developments, cities, and introduction

of invasive species occurring over a long-enough period of time will influence how species adapt. Human disturbances can severely alter a natural community.

There is a fire ecology to structure fires. Since the beginning, fires have historically been beneficial in our dwellings, especially in cold climates. Cooking, warming, and aesthetics are all good and common uses of fires indoors. Conversely, our ancestors found out right away how that welcoming warmth can quickly become detrimental and destructive, consuming everything flammable. The fire ecology of structure fires has a direct relationship, positive or negative, to the abiotic and biotic components either directly within or outside any dwelling or place of work.

✓ **Activity II – Fire Adaptations**

- Discuss plant, animal, and ecosystem adaptations to fire, fire history, and fire regimes—and why all are different across an environmental gradient.



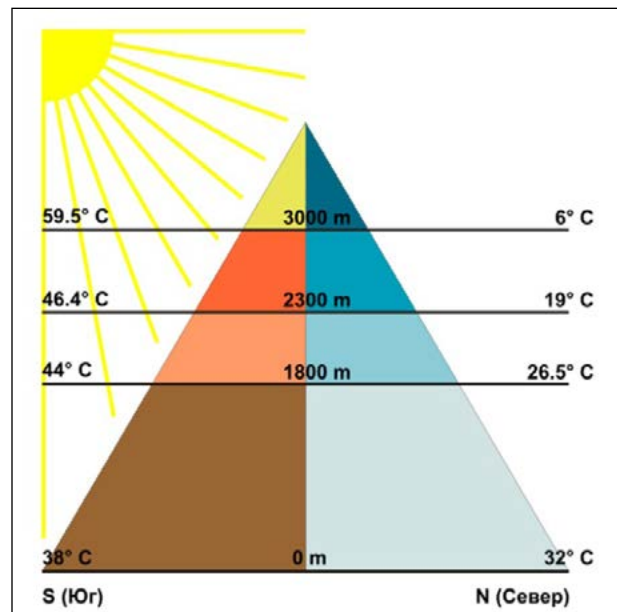
Source: Climate Types for Kids

Figure 5. Temperature drops 3 degrees for every 1,000-foot increase in elevation. Vegetation has adapted to these changes.

**Dynamics of Fire**

Fire dependence applies to species of plants and animals that rely on the effects of fire to make the environment more hospitable for their regeneration, growth, and regrowth. Examples of fire-dependent species are whitebark pine (*Pinus albicaulis*) in the alpine forests of the Pacific Northwest and Rocky Mountains, and longleaf pine (*Pinus palustris*) found in the southeast (eastern Texas, Virginia, and Florida). Being fire-adapted means plants and animals have behaviors, physical features, and/or characteristics enabling them to live, survive, and sometimes thrive with repeated fire. Examples of fire-adapted species include ponderosa pine (*Pinus ponderosa*), western larch (*Larix occidentalis*), and snowbrush ceanothus (*Ceanothus velutinus*).

The genetic make-up of living organisms constantly strives to mutate and adapt in



Source: Flora of the Earth (in Russian)

Figure 6. North aspects on steep slopes are cooler than at the same elevation on south aspects. More solar heat reaches the surface of a steep south slope than on the same elevation north slope—for a longer period during the day. Humidity increases going up in elevation and temperature decreases at the same time during the day. Plants have adapted to these changes and fire behaves differently.



response to changes in an ecosystem that occur over a long-enough period. The genetic adaptations are manifest in physiologic characteristics. Opportunism, competition, and the basis of survival interact with these adaptations. When change occurs too fast or too intensively, organisms cannot adapt quickly enough and will leave the system, replaced by those organisms that can.

The following are core beliefs of the science of fire ecology from the *Association for Fire Ecology*:

- Fire is a critical ecological process in many ecosystems throughout the world.
- Land-management goals often reflect plant communities with a past history of repeated fire events. However, fire regimes have been significantly altered on many landscapes, which may threaten native plant and animal assemblages, resulting in uncharacteristic ecological consequences.
- Plant communities, species composition, and soils have been significantly altered on many landscapes, causing change in the fire regime.
- Cultural burning has historically been part of the fire regime in many areas of the world.
- Restoring and maintaining native plant and animal assemblages and appropriate fire regimes is desired, although it is recognized that this may not always be possible.
- Science and education are critical in helping us understand ecological patterns and processes, how land management has affected fire regimes, and how vegetation and fire regimes can be restored.
- Science should inform both policy and land-management decisions that affect fire regimes.

We also try to adapt our structures to fire. Our ancestors depended on fire within their dwellings for survival. The majority of our dwellings

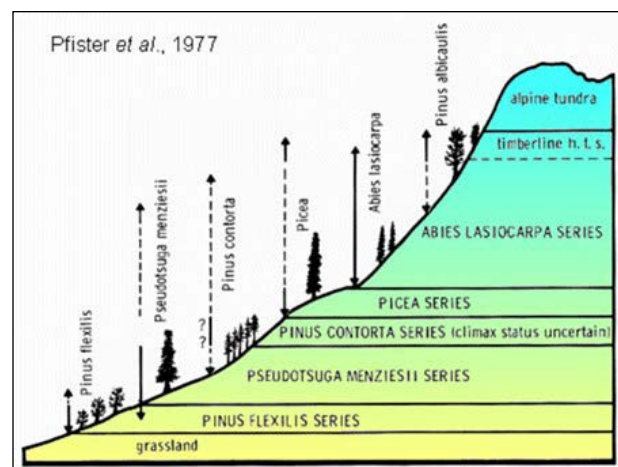
**Examples of fire adaptability of structures:** Metal roofs; fire-resistant siding on the outside and fire resistant building materials on the inside; fire alarms; sprinkler systems; fire extinguishers; clean gutters; defensible space surrounding the structure and outbuildings; and fire-resistant vegetation close to the outside of a house.

**Examples of fire adaptability of plants:** Thick bark on trees that will slough off when burning; the ability to send roots underground, insulating the plant from surface fires; thick, lignotubers that will sprout following a fire; and serotinous cones that break open with heat.

**Examples of fire dependence:** Fire prepares the soil for seeding establishment and growth by making nutrients more available for plant use. Fire also reduces competition from other species that may absorb needed nutrients or shade out necessary sunlight for sun-tolerant species.

throughout history (and today) are composed of the third side of the fire triangle: fuel.

Throughout history, our dwellings have adapted over time with better building materials for strength and weather resistance—and for fire



Source: U.S. Forest Service, Intermountain Forest & Range Experiment Station

Figure 7. An elevation gradient in northwest Montana illustrates forest communities from low elevation to high.

prevention and fire resistance. As wildland plants adapted to survive with fire, we also adapted to the constant presence of fire in our lives and in our dwellings. Yet, even after all the adaptations made to reduce detrimental, harmful fires in our structures, the National Fire Protection Association states, “Cooking equipment is the leading cause of home structure fires and home fire injuries. Smoking is the leading cause of civilian home fire deaths. Heating equipment is the second most common cause of home fire fatalities.”

There is a fire ecology within and adjacent to our structures. Fire behavior is predictable within a structure and has an effect to the abiotic (building materials, stored materials, synthetic furniture, etc.) and to the biotic (organic materials, living things in dwellings—including us) to the degree of amount and composition of all the flammable—or flame-resistant materials. An example of this is a research study that times the fire behavior in terms of spread and intensity between “legacy” furniture and furnishings compared to “modern” materials. Watch the video and see the differences:

<https://www.youtube.com/watch?v=IEOmSN2LRq0&t=53s>

The video documents a study conducted by the Underwriter’s Laboratory (UL) (Kerber 2012). This research documents the much shorter times a structure fire takes to achieve the highly combustible state of flashover compared to some decades ago—less than 5 minutes now vs. over 30 minutes in the past. This is important because firefighters cannot enter a structure when flashover occurs due to extreme danger of heat and smoke. In the past, firefighters had more time to conduct rescues and put out the fire directly.

The UL study cited many reasons for the difference, including houses built with larger, more open spaces and shorter ceilings. The video illustrates the modern synthetic, more flammable furnishings vs. the older, more organic

furnishings and the effect on fire behavior. This is an example of structure fire ecology and fire effects on biotic vs. abiotic in a structure environment.

## Plant Succession

A fire starts when fuel, heat, and oxygen interact together. Remove any one of these and the fire goes out. How a wildland fire behaves—how intense and severe it becomes—is determined by weather, fuel, and topography. The interaction between intensity, severity, and frequency of fire as a disturbance process and vegetation as fuel across a landscape creates different patterns in the successional process, structure, and composition of vegetation, to which some animal species have adapted. Vegetation structure and composition also effects how fire behaves. Successional patterns within and between associations of plants across a landscape also continue in the absence of major disturbances. Landscape patterns created by disturbance or by the absence of disturbance form habitat for opportunistic species.

The fire regime of an area is defined as the historical context for the pattern, frequency, and severity of wildland fire interacting with that area’s topography, weather, and vegetation.

Fire intensity (the amount of energy or heat given off by a forest fire at a specific point in time); severity; the effects of a fire on the environment, including vegetation and soils; and frequency will shape the structure and composition of vegetation across the landscape over time.

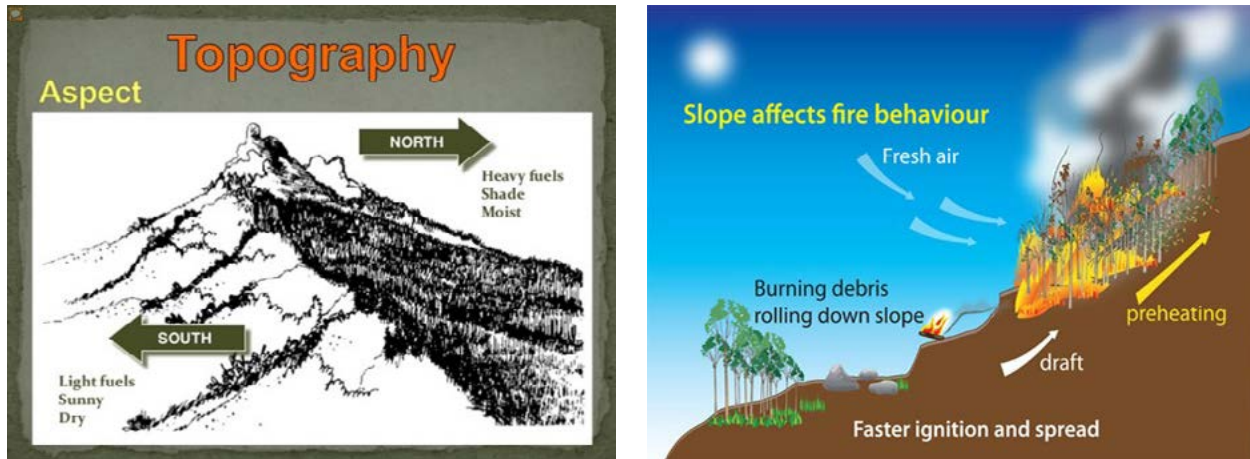
### ✓ Activity III – Local Fire Ecology

○ Remind students that their neighborhood or local area is subject to adaptations to slope, elevation, and aspect, whether urban or rural, where homes exist and where extending into forested or grassland ecosystems.

<b>Low-severity regime</b>			
	<i>Fire interval</i>	<i>Role of fire and post-fire regeneration</i>	<i>Type of forest created</i>
<b>Arno and Fiedler</b>	Low severity: 1 to 30 years	Fire spares large trees, eliminates and trims some saplings and branches, cleans the ground, facilitates growth	Open forest Abundant ponderosa pines, white pines (○), hemlocks, cedars (●); Douglas-firs (●) less abundant Widespread herbaceous species, flowers, small trees
<b>Baker and colleagues</b>	Low severity: perhaps 60-300 years	Burns surface fuels, kills or damages some canopy trees Limited regeneration because a part of the light is trapped by the understory and canopy	No notable difference compared with Arno and Fiedler apart from a more important heterogeneity of landscapes
<b>Variable-severity regime (low, moderate and high)</b>			
	<i>Fire interval</i>	<i>Role of fire and post-fire regeneration</i>	<i>Type of forest created</i>
<b>Arno and Fiedler</b>	Low severity: 1-30 years Moderate: 30-100 years High: 100-400 years	Fire of moderate severity eliminates most saplings, preserves a part of the oldest trees High-severity fire creates an heterogeneous forest See above about the role of low-severity fire	Open or partly open forest Well-spaced in height (various tree ages) Dominated by ponderosa pines, lodgepole pines (○), Douglas-firs, hemlocks, cedars (●)... Widespread herbaceous and shrub species
<b>Baker and colleagues</b>	Low severity: perhaps 60-300 years Moderate: perhaps more than 200 years High: perhaps 300-700 years	Ecological role of high-severity fire (usually during the summer or early fall) much more important than low-severity fire High-severity fire kills 70 percent of the trees or more* and is influenced by climatic conditions Fire stimulates tree regeneration and growth of shrubs Faster tree regeneration if post-fire decades moister than usual	Heterogeneity of landscapes alternately high or low due to: - climate variations - the variable severity of fire across time and space - natural thinning - insects and diseases that kill some high trees Dense stands alternate with heterogeneous or open stands (with older trees) After a severe fire, shrubs are more widespread than herbaceous species
		● shade-tolerant species ○ shade-intolerant species	
Sources: Arno et Fiedler, 2006; Baker et al., 2007; Baker, 2009; *Hessburg et al., 2007 Conception: Nicolas Barbier			

Source: Journal of Alpine Research

Figure 8. Differences in low-intensity, low-severity fire regime interpretations.



Source: Introduction to Wildland Fire Behavior, © National Wildfire Coordinating Group

Figure 9. Diagrams demonstrating the effect of slope on fire behavior.

## Fire Regime

Fire regime refers to the nature of fire occurring over long periods (generally hundreds of years) and to the prominent immediate effects of fire that generally characterize an ecosystem.

Fire regimes are patterns of wildland fires that include factors such as frequency, extent, intensity, severity, type, and reason for burning (Figure 8). The role fire plays in an ecosystem varies with the characteristics under which the ecosystem evolved and or adapted.

The interactions of humidity conditions, wind, temperature, fuels, and ignition sources will determine the fire regime (based on fire behavior) for a particular land area. A fire regime is a function of the frequency of fire occurrence, the fire intensity, the fire severity, and the amount of fuel consumed.

Both frequency and intensity of fire vary and are interdependent. Frequency of fire depends on the ignition sources and the duration and character of weather.

Intensity of fire depends on the quantity of fuel available and the fuels' combustion rates. Wind, topography, and other weather influences, such as temperature and humidity, also affect the interaction between frequency and intensity of fires.

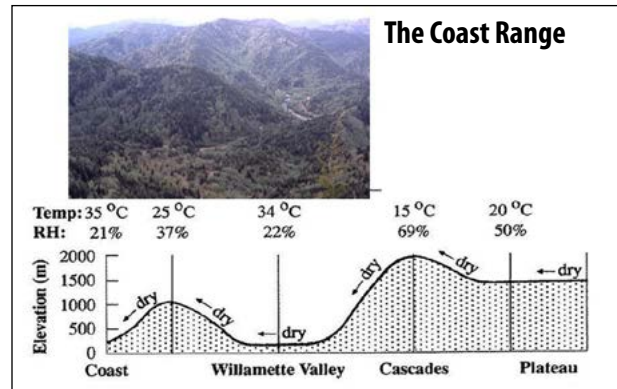
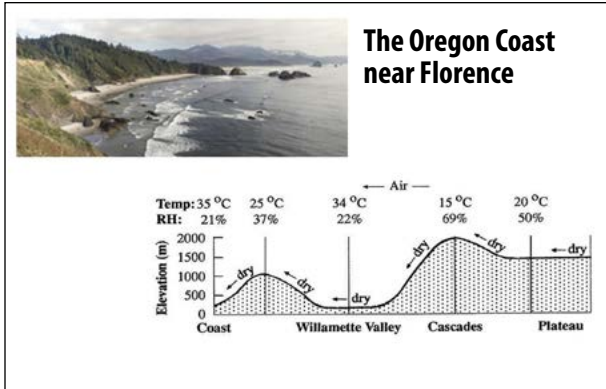
## Fire Behavior Across an Environmental Gradient

Many components contribute to a wildland fire behavior. One of these components is topography (Figure 9). Fire will generally burn uphill faster than downhill. The steeper the slope and the higher the fuel load, the faster the fire will burn, especially with wind driving the burning. The next topographic component is the breaks in steep terrain.

On saddles (low areas between two higher ridges) and in box canyons, fire moves upslope very rapidly due to a chimney-like preheating of the higher-level fuels and upslope winds. If a canyon is very narrow, radiant heat can raise the temperature of fuels on the opposite slope closer to their ignition temperature. Then fire spotting can more easily propagate multiple ignitions on the other side. Night downdrafts can lower temperatures and increase humidity, slowly moving a fire downhill.

Fuel load and depth can help determine whether a fire ignites, its rate of spread, and its intensity. Fuel load and depth directly relate to vegetation structure and composition. Structure and composition are the result of vegetation adapted to slope, elevation, precipitation, and soil types—and to disturbance succession. As vegetation changes in response to the



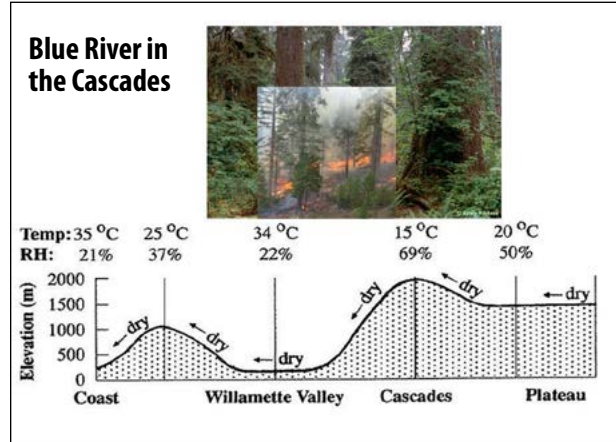
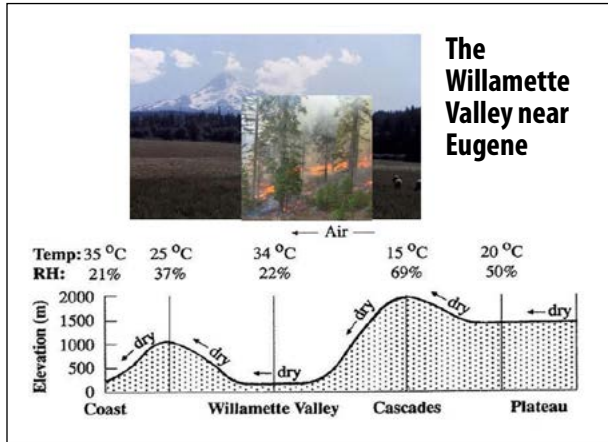


of the Pacific Ocean. Florence, located on the convergence of the Siuslaw River tidelands and the Oregon Dunes, has an average of 71 inches of rain per year and snowfall of 1 inch. On average, there are 160 sunny days per year. The July high is around 69 degrees. The January low is 39. Coniferous forests in this region occur on soils ranging from stabilized sand to soils on old marine terraces. These forests are primarily composed of shore pine, Sitka spruce (*Picea sitchensis*) and, in more protected areas, Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*) and western hemlock (*Tsuga heterophylla*). These coastal forests have a dense understory composed of many shrubs, such as red alder (*Alnus rubra*), rhododendron (*Rhododendron macrophyllum*), salmonberry (*Rubus spectabilis*), black twinberry, and wax myrtle (<http://oregonexplorer.info/content/coastal-vegetation-and-plant-ecology>). Some of the more dense forests in Oregon lay just east of Florence. With minimal frost and abundant rainfall, trees grow large and undergrowth is very dense. Most vegetation has a thick layer of moss. Fires do not occur often, but when temperature, humidity, and wind combine and red flag conditions result, fires can burn with high intensity and severity. Historic fires include

Tillamook Burn (350,000 acres 1933-1951); Yaquina Fire (480,000 acres 1853); Siletz Fire (800,000 acres 1849); and the Nestucca Fire (290,000 acres in 1848). Fire regime: Mixed severity, with fires every 250–500 years, intermediate sites 150–200 years (Frost and Sweeney 2000).

2. Cougar Pass—Here, at the 769-foot summit of the Coast Range between Florence and Eugene, an orographic effect takes place as maritime winds carry precipitation eastward, lifting up over Cougar Pass and bringing up to 120 inches of precipitation a year. This creates a rain shadow going into the Willamette Valley towards Eugene. Plants include large stands of Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*), western hemlock (*Tsuga heterophylla*), and western redcedar (*Thuja plicata*), with portions of these forests including old-growth stands. Other flora include Sitka spruce (*Picea sitchensis*), salmonberry (*Rubus spectabilis*), salal (*Gaultheria salon*), tanoak (*Lithocarpus densiflorus*), and western azalea (*Rhododendron occidentale*). Portions of the range are in the Elliott State Forest. The 1868 Coos Bay Fire burned over 300,000 acres throughout this section of the Coast Range. Fire is infrequent but

*Red flag conditions are in effect when air temperature is greater than 80°F, humidity in the atmosphere is less than 20 percent, and surface wind speed is greater than 10 mph.*



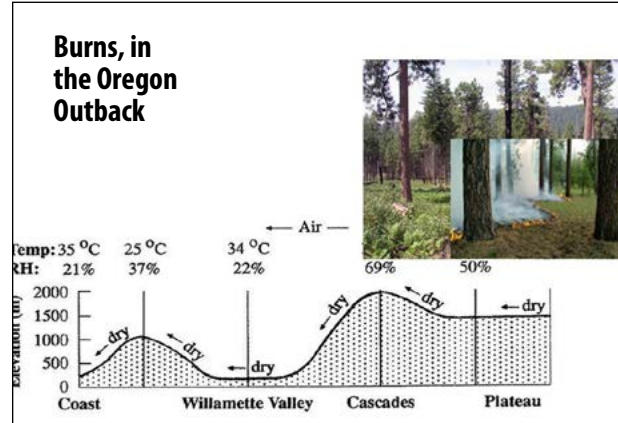
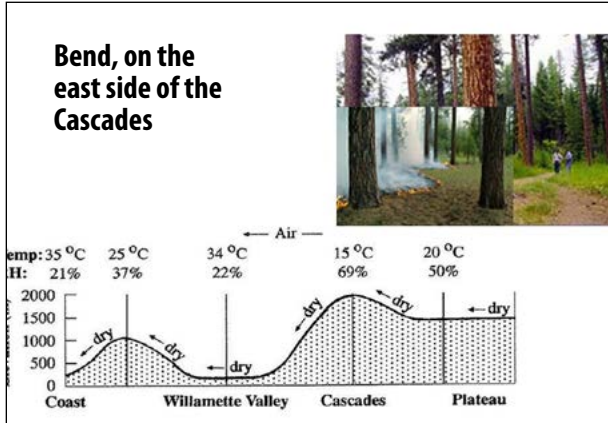
potentially severe and widespread when conditions allow it. Fire regime: mixed severity, with fire return intervals of 95–145 years (Frost and Sweeney 2000).

3. Eugene—Here at 430 feet elevation in the Willamette River Valley, average annual temperature is 52.1°F and annual precipitation is 50.9 inches. Average snowfall is 5 inches. There are 155 sunny days per year. Prairie, savanna, and woodland or forest vegetation with an oak component occupy nearly 64 percent of the area. Prairie and savanna dominate the southern and central valley, with woodland and forest occurring as small to large patches usually peripheral to prairie and savanna. Native Americans routinely burned back the vegetation, changing the habitat from forested, scrub-shrub wetland to wet prairie grasslands. While the native wetland habitat may have been changed by burning practices, the amount of wetland acreage remained the same, not affecting hydrologic conditions. Despite periodic burning, the Willamette Valley retained a mosaic of wetland—marshes, wet forests, and wetland prairies intermingled with upland prairies, wetland shrub/swale, and forested streams and swales. The Willamette Valley resembled a Midwest prairie predominantly covered with tall tufted hair grass (*Deschampsia cespitosa*) (<https://www.eugene-or.gov/1763/>)

[Historical-Vegetation-in-West-Eugenected](#).

The largest fire in Oregon’s history burned almost 1 million acres in the Willamette Valley about 60 to 70 miles north of Eugene in 1865 (the Silverton Fire). Fire regime: Frequent, low-intensity, with fires every 3 to 55 years (Frost and Sweeney 2000).

4. Blue River—This area, east of Eugene at 2,500-foot elevation in the Cascade Range, averages 47 inches of rain per year. Snowfall is 52 inches. There are 157 sunny days per year. The orographic effect of rain-laden storms crossing the Willamette Valley and proceeding up the western slope of the Cascades exceeds that of the Coast Range due to greater elevation change. Douglas-fir (*Pseudotsuga menziesii*) is the predominant species and forest type on the densely forested slopes. Other species such as western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), white fir (*Abies concolor*), and grand fir (*Abies grandis*) are common at lower elevations, with Pacific silver fir (*Abies amabilis*), mountain hemlock (*Tsuga mertensiana*), lodgepole pine (*Pinus contorta*), and subalpine fir (*Abies lasiocarpa*) found at higher elevations. Wildfire is the main natural disturbance in the western Cascades. Studies in the Blue River watershed have determined that the fire regime was of mixed severity and varied greatly with elevation and aspect in



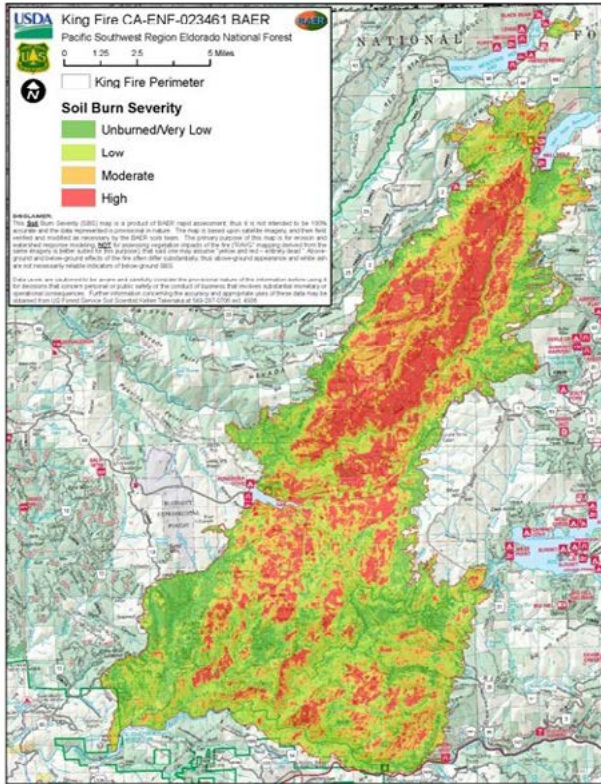
the watershed (Teensma 1987, Morrison and Swanson 1990, Weisberg 1998). Wildfire in the lower elevations was historically of moderate frequency and intensity. Fire history in the upper elevations was of more infrequent and severe fire behavior. Patch sizes were larger in the upper elevations. Topography played an important role in affecting local fire severity and tree survival in the western Cascades, with a tendency towards higher severity on dry upper slopes and lower severity in moist draws (Cisel, et.al. 1999). Fire Regime: Mixed severity with a fire return interval of 130 to 150 years (Agee 1993).

5. Bend—This area, over the 5,128-foot Willamette Pass, down the eastern slope of the Cascades, and north about 50 miles is at an elevation of 3,623 feet. Annual average high temperature is 59.6°F; annual average low temperature is 33.4°F, average annual precipitation in rainfall is 11.38 inches and average annual snowfall is 23 inches. Annually, there are about 162 sunny days in Bend. The difference on the east side of the Cascades and in the rain shadow of the mountain range is striking. Ponderosa pine is the dominant tree species surrounding Bend, with common shrub species such as bitterbrush (*Purshia tridentata*), bearberry (*Arctostaphylos uva-ursi*), greenleaf manzanita (*Arctostaphylos patula*), wax currant (*Ribes cereum*), and prince's pine (*Chimaphila umbellata*). Fire history within

the landscape typified by Bend was frequent, low-intensity burns caused mainly by lightning activity. Brush species, more affected by wildland fire exclusion than other vegetation associations, have grown in, and tree densities are normally higher than in historic times. Past logging practices have also removed much of the older, overstory trees. Current conditions without management have created high risk for severe and high-intensity fires. Fire regime: Frequent, low intensity, with a fire return interval of 2 to 47 years (Fitzgerald 2005).

6. Burns—Approximately 130 miles east-southeast from Bend, Burns is in the Oregon Outback and the northern Basin and Range ecoregion at 4,147 feet in elevation. Annual average high temperature is 59.1°F, average annual low temperature at 29.8°F, and the average temperature is 44.45°F. Average annual precipitation in rainfall is 10.89 inches and average annual snowfall is 35 inches. There are 211 sunny days per year in Burns. Vegetation is diverse and related to topographic changes—and the influence of the mountainous Malheur National Forest to the north and the Basin and Range ecoregion to the south. Ponderosa pine forests predominate on the Malheur (southern extent of the Blue Mountain Range). There is also an extensive northern Great Basin sagebrush/bunchgrass system to the south and high-elevation, sub-alpine vegetation, and





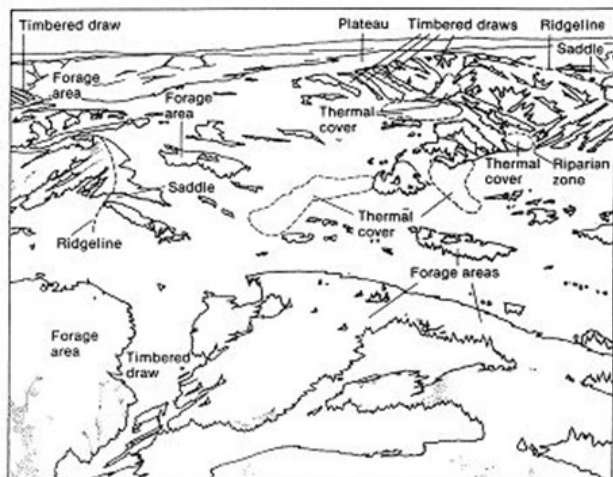
Images: U.S. Forest Service

Figure 11. Most large fires burn in a mosaic pattern of varying intensities and severities. This creates a patchwork quilt of succession stages of vegetation, which becomes habitat for species.

aspen forest, found on Steens Mountain, Trout Creek, and the Pueblo Mountains. Interspersed throughout the Burns area are extensive juniper forests and woodlands. Lightning storms and Native American burning shaped fire history. Over 1,000 lightning strikes occur each year. Prior to active fire suppression, wind-driven fire

burned over large areas and kept vegetation at a low density. This resulted in low fire severity. Active fire suppression over the last 100 years has allowed brush species and juniper to expand range dramatically. Current fires are now burning much hotter and over larger areas. Fire regime: Frequent, low intensity with a fire return interval of 2 to 47 years (Fitzgerald 2005).

7. Adrian—The last stop eastward before the Idaho border, Adrian is 136 miles from Burns at 2,225 feet in elevation. Adrian



Source: U.S. Forest Service

Figure 12. The patchwork of openings can be a natural landscape feature, or created by management.

has approximately 10 inches of rain and 6 inches of snow per year. The average annual number of days with any measurable precipitation is 60. On average, there are 209 sunny days per year. The average July high is around 93°F. The end of our gradient from the Pacific Coast to the Idaho border is on flat terrain and subject to seasonal winds. It has the highest annual temperature and the lowest average humidity. Vegetation is primarily high desert sage or grasslands. Fire history has been frequent and intense, but of short duration, due to lightning and fast-spreading and wind-driven fires.

#### ✓ Activity IV – Fire Ecology Crossword

○ Have students create a crossword puzzle using at least 10 vocabulary words used in discussing and understanding fire ecology (e.g. fire regime, fire scar, or disturbance).

### Fire Effects to Abiotic

Wetlands are less likely to burn, and when they do, they burn less severely than upland sites. Breeding and survival for certain wildlife species occurs with little interruption within wetlands that provide a refuge from fire disturbance. Fire in wetlands usually increases areas of open water and stimulates an increase in forage.

Streams, lakes, and meadows can act as firebreaks influencing the spread of the fire. There is inherent moisture in these habitats. Humidity can be higher than the surrounding upland vegetation. Because wetlands are predominantly in lower-elevation terrain than the surrounding upland, cool air drains downward, especially in the evening. Fires can burn in these habitats, but usually not to the intensity and severity as the upland.

Mosaic landscape patterns usually result during a wildland fire (Figure 11). Few fires burn over many acres in one pattern, one intensity, or uniform severity. Mosaic patterns are mixtures of totally

burned (with varying intensities and severities) and unburned sections of a landscape within the burn perimeter. This creates a mixture of openings, partial openings, and full-canopy conditions with minor disturbance (Figure 12). This can possibly create forage, hiding cover, and breeding areas for many species of wildlife.

Ash and charcoal from wildfires will drift with the wind and settle on water surfaces, ultimately ending up on the bottom with other sediments. This can produce a record of wildfire intensity and severity over time when sampled.

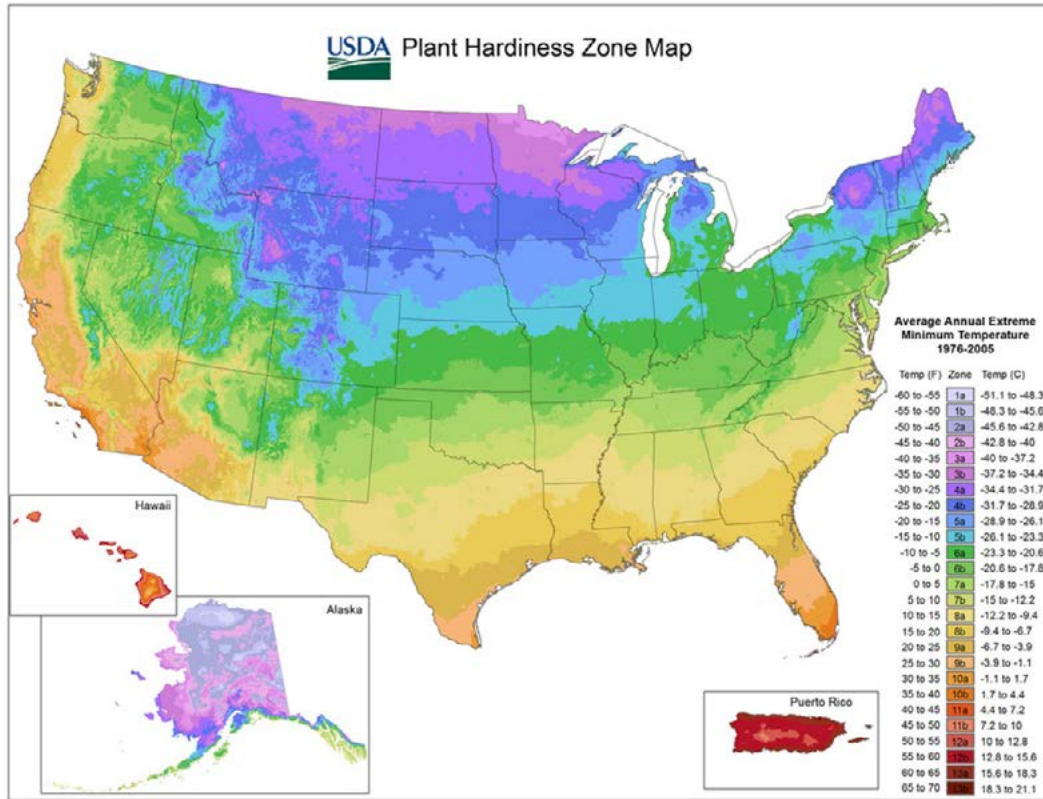
The degree of heat transfer from the burning fire on the surface directly to the soil is the measure of fire severity. When that transfer is hot enough, the soil's physical and chemical properties can be altered. Chemicals and nutrients can volatilize.

### Fire Effects to Biotic

#### Vegetation Gradients

Plants have adapted as individuals and communities to occupy niches along environmental gradients, such as from moist valley bottoms to dry ridgetops. Weather (solar radiation, precipitation, persistent winds) and topography (slope, elevation, aspect) affect plant adaptations, too, resulting in vegetation structure, composition, and diversity differences along this gradient. There are inherent differences in fuel type: moisture content, size/shape, continuity, and arrangement are a result of these relationships. Plant associations (an aggregation of plants growing together in a given habitat) reacting to persistent or episodic disturbance also alters fuel characteristics. Vegetative species—individually and in association—have developed physiological characteristics in response to disturbance when it's persistent over a long-enough period.

An example most are familiar with is the



Source: U.S Department of Agriculture

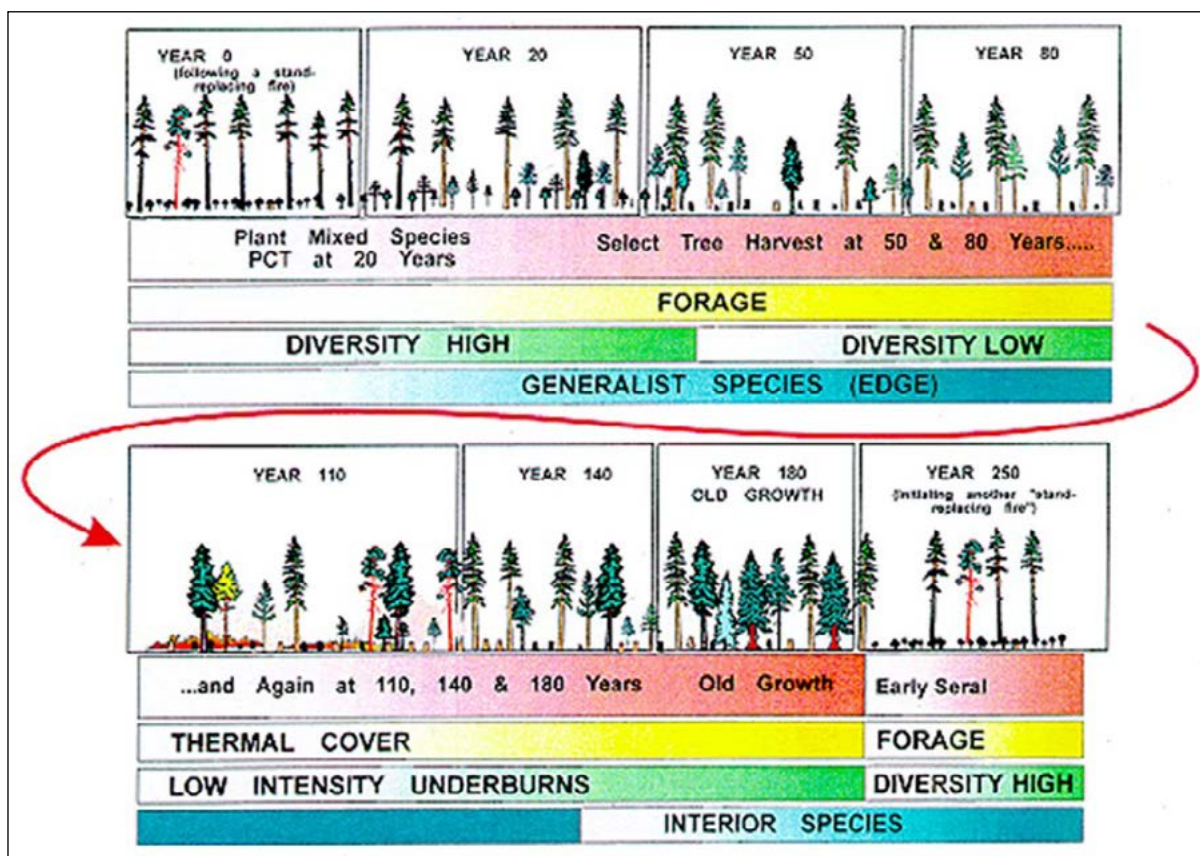
Figure 13. The USDA Plant Hardiness Zone Map helps gardeners and growers determine what will thrive at a certain location.

USDA Plant Hardiness Zone Map. The map is the standard by which gardeners and growers can determine which plants are most likely to thrive at a location. That is nothing more than a climatic and environmental gradient to which plants have adapted. We can grow banana plants anywhere—as long as we provide the proper growing conditions to which it has adapted for survival.

An adaptive trait is a behavior, physical feature, or other characteristic that helps a plant or animal survive and make the most of its habitat. Arrayed across landscapes, aggregations of plants—in the complexes of assemblages, populations, and associations of vegetation communities—are in the process of adapting to the environment. These communities have adapted to moisture (precipitation, water holding capacity), solar radiation (angle of incidence, slope, aspect), and elevation differences that have occurred for a long-enough period for individual

adaptations to occur. These factors are the main explanation for why vegetation is where it is on the landscape.

Plant species are not mobile and cannot migrate to adapt to changes in the environment. Species have had a greater need to adapt over time to acquire physiological characteristics in response to repeated fire intensities and frequencies. Tree species such as ponderosa pine (*Pinus ponderosa*) and western larch (*Larix occidentalis*) are more fire-adapted and sun-tolerant than the shade-tolerant western redcedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*). Ponderosa pine (*Pinus ponderosa*) and giant sequoia (*Sequoiadendron giganteum*) have thick, platy bark adapted to resist fire. Lodgepole pine can establish itself following a high intense fire due to its serotinus cones and mycorrhizae, which allow lodgepole pines to colonize nutrient-poor sites following an intense



Source: D. Leavell, (2000). School of Forestry, University of Montana, Missoula, MT

Figure 14. This chart shows vegetation and process of Kootenai National Forest.

fire. Snowbrush ceanothus (*Ceanothus velutinus*) has seeds with a very hard outer layer that needs a high-temperature fire to scarify in order to germinate. These seeds can remain buried in duff for over 200 years until a wildfire occurs. Highly sun-tolerant, shade-intolerant snowbrush can fix nitrogen and disappear when overtopped by tree species.

## Vegetation Succession

Plants adapt to varying levels of precipitation, soils, solar radiation (slope and aspect), and elevation even in the absence of disturbance. Plants also adapt to disturbance frequency, intensity, and severity. Depending on the severity and intensity of disturbance, there will be an immediate effect to species and communities and an effect that can last long afterward. In the absence of disturbance, species and communities

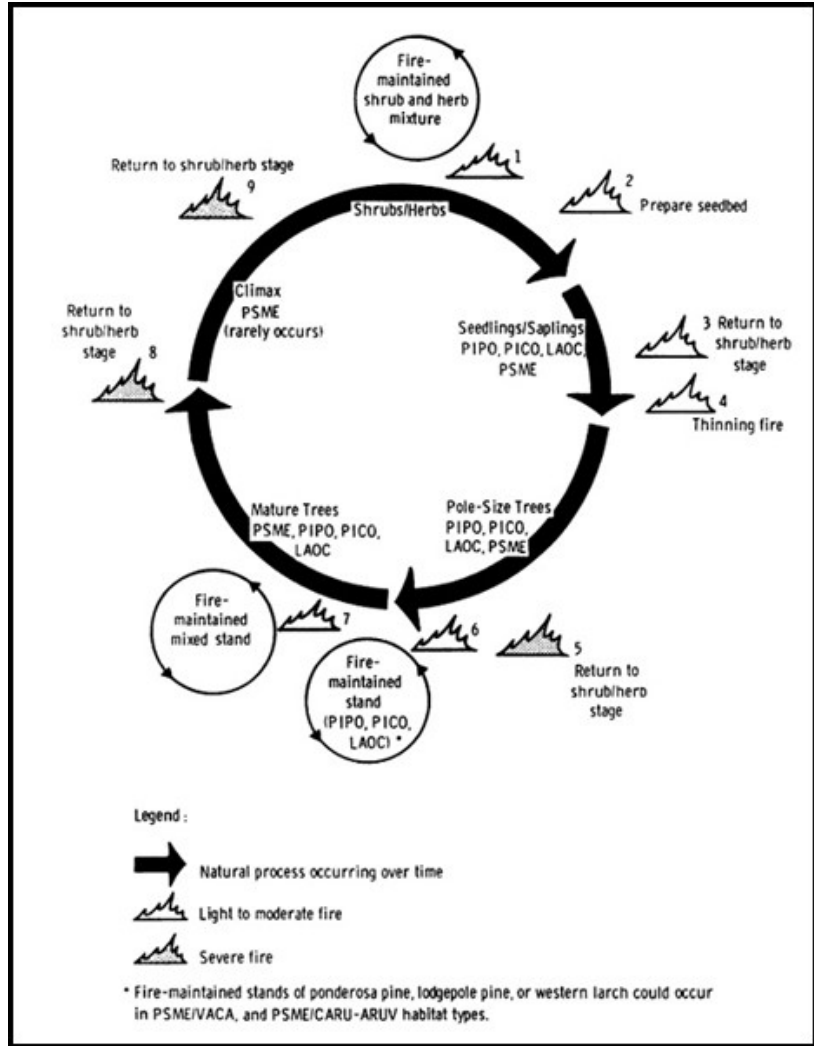
will proceed through succession, which can result in severely overstocked forests or grasslands. Ecosystems do not remain static with or without disturbance.

Plant communities are not static, even though some may have successional stages that can last for hundreds of years. Plants can shift in structure, composition, and function in response to disturbance and to the absence of disturbance. Plants are opportunists in order to gain a competitive edge and to perpetuate populations. (See Figures 14 and 15)

Snowbrush ceanothus (*Ceanothus velutinus*) is an example of a fire-adapted species (Figure 16). Adaptations include the production of seed that can be dormant in the duff for hundreds of years until a very hot fire (more than 200°F) scarifies the seed coat, enabling germination.

Ceanothus is very shade intolerant and thrives in open, full-sun conditions following a fire, with roots that fix nitrogen, making it ideal to establish following a severe fire. It is so shade-intolerant that once overtopped by tree species, ceanothus leaves the system until another fire burns through. Ceanothus leaves, twigs, and stems contain volatile waxes or oils, and the thick, leathery leaves have a strong odor when crushed or when exposed to the hot afternoon sun. Sap is gummy, resinous, and has a strong smell. This sap is extremely flammable and burns very hot, making way for other seeds to germinate and produce vigorous plants.

False huckleberry (*Menziesia ferruginea*) is an example of a non-fire-adapted species (Figure 17). False huckleberry contrasts with ceanothus in being very shade tolerant (it grows best in 5 percent of full sunlight) and is associated with cool, moist sites on northerly



Source: U.S. Forest Service

Figure 15. A model of forest succession in a moist Douglas-fir habitat as influenced by fire. PIPO is ponderosa pine; PSME is Douglas-fir; LAOC is larch; PICO is lodgepole pine.



Photo: Oregon State University

Figure 16. Snowbrush ceanothus (*Ceanothus velutinus*) is a fire-adapted shrub found on south to northeast aspects.



Photo: Oregon State University

Figure 17. False huckleberry (*Menziesia ferruginea*) is a fire-resistant shrub found on north aspects.

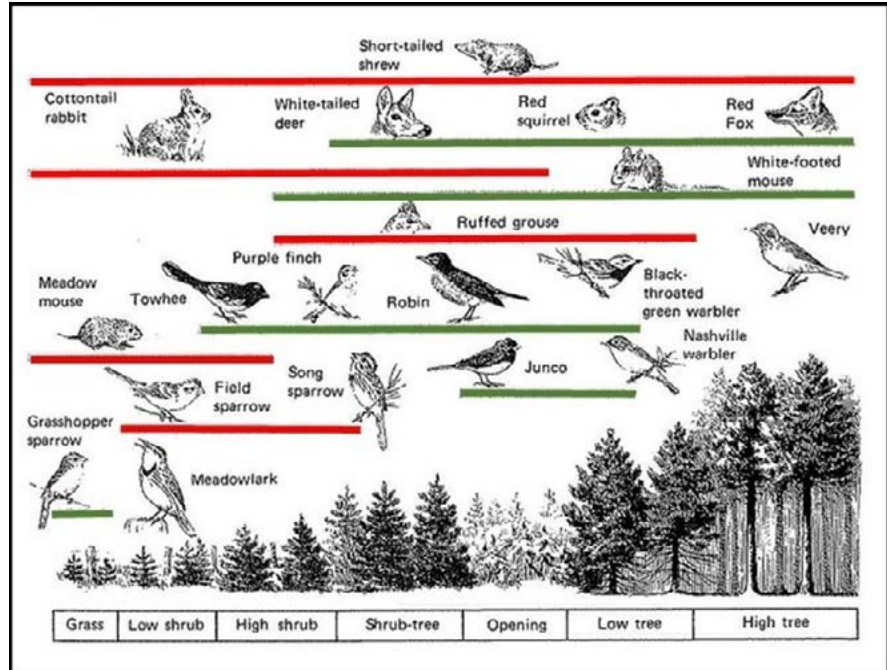
aspects. False huckleberry is fire-resistant with moist, supple leaves. It does not accumulate dry, dead material within the plant. The sap is watery without a strong odor.

Exactly what happens after a fire occurs depends on the landscape, the severity of the fire, and the species involved. The event always sparks a succession of changes as plants, microbes, fungi, and other organisms recolonize the burned land. As trees and plants age, light and other features change—and the composition of creatures in the area changes in response.

**Wildlife**

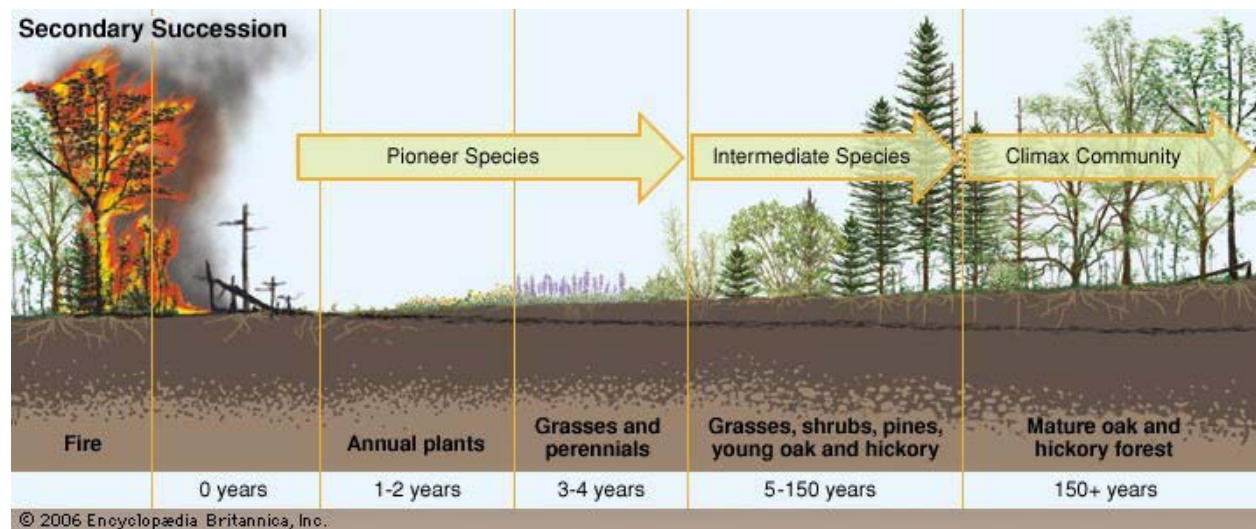
Fire changes wildlife habitat. Wildlife habitats, like forests, are not static; they evolve and respond to disturbances, as do other natural systems. Fire changes the proportion,

arrangement, and characteristic of habitats across the landscape (Figure 18). Immediately after a fire, there can be a temporary loss of or increase in food and shelter. Animal species are opportunists. Unlike plants, animal species and populations may shift from species that prefer



Source: Ecology and Field Biology

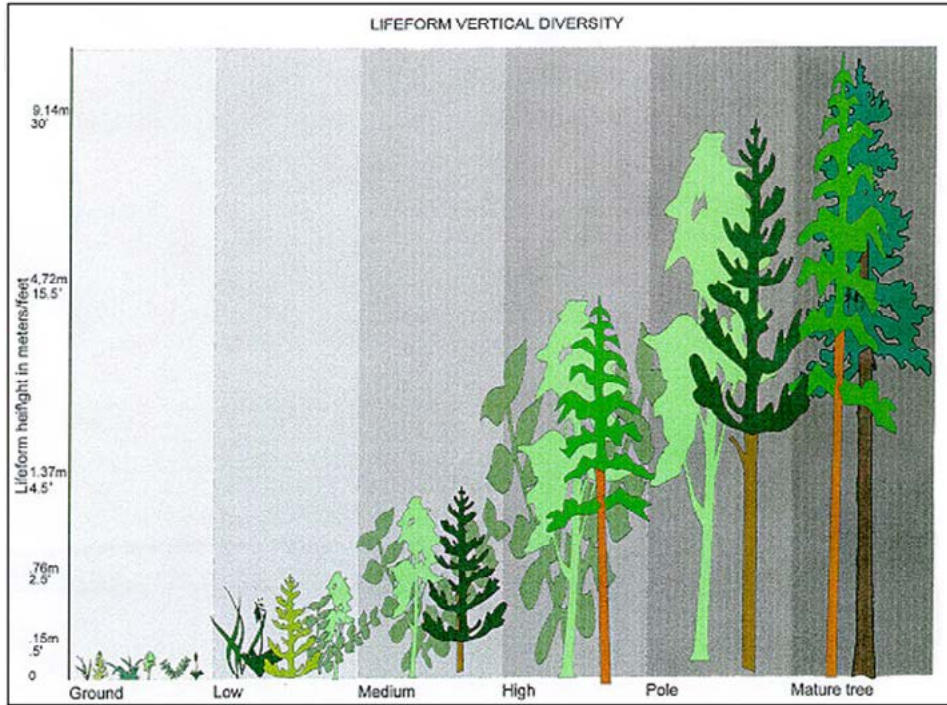
Figure 18. Mammals and birds adapt to different successional stages historically created by fire intensity and severity.



© 2006 Encyclopædia Britannica, Inc.

Source: Encyclopedia Britannica

Figure 19. Fire creating secondary succession in Yellowstone National Park.



Source: University of Montana

Figure 20. Vertical stratification of plants create diversity of habitats for wildlife created by fire or human disturbance.

*Fire-generated spatial patterns across landscapes determine the distribution of animal species. Given a long-enough period of time, animal species adapt to the habitat resulting from disturbance.*

dense forest conditions to ones that prefer warm, open forest conditions. Some animals can leave a burned area that does not suit their needs to an unburned area that does. Unburned areas adjacent to burned areas supply a mosaic of habitats with a range of vegetative conditions from which wildlife can find food and cover. Herbivores and species that prefer herbaceous vegetation for cover prefer the grass/forb habitats or broad-leaved forests that often establish after a burn. Depending on the vegetation type, burning can increase or improve forage for wildlife from a few years to as long as 100 years. In some cases, the nutritional content and digestibility of plants will temporarily increase as well. Fire-killed trees become food for millions of insect larvae, becoming food for species of birds. Snags and downed woody debris also provide important habitat for cavity nesters, reptiles, small mammals, and even large mammals such as bears.

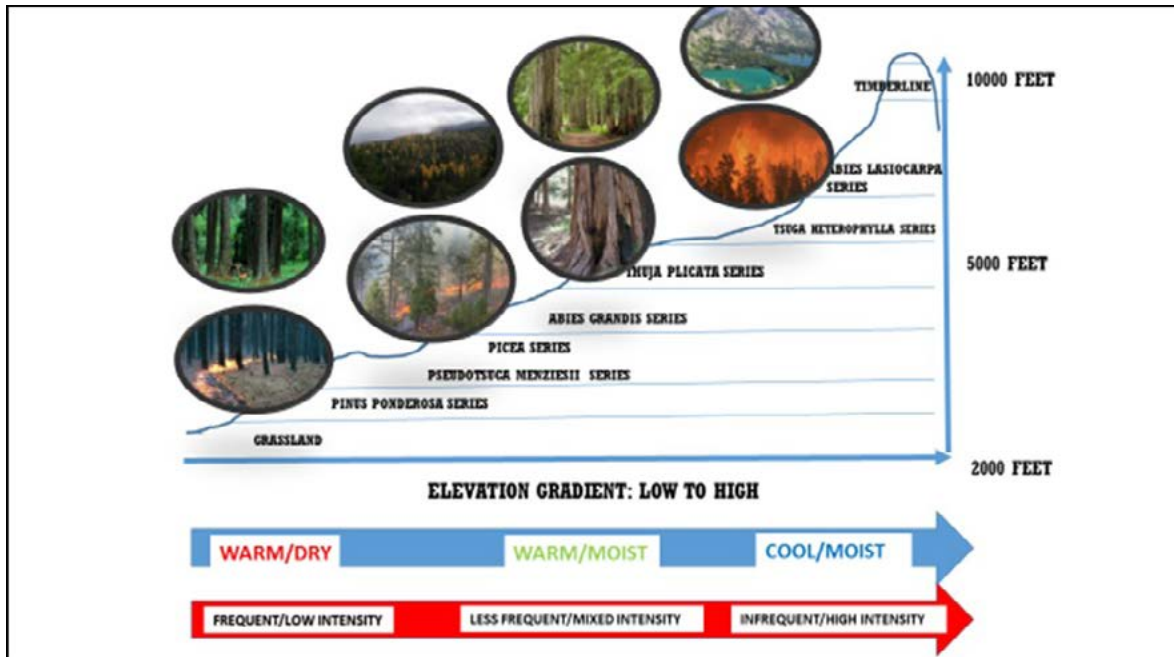
Fire can provide temporal habitat for some

wildlife species. Cavity-nesting birds favor high- to moderate-burn severities; open-cup, ground-nesting birds occupy moderate to low severity burn areas; and open-cup, canopy-nesting species favor unburned habitats. Fire-killed trees become food for millions of insect larvae and/or snags that provide perches and feeding sites for many bird species. The black-backed woodpecker is an “eruptive” species, meaning it thrives in response to increased insect population build-up. The black-backed population will increase in response to the insect build-up, but will decrease in number as the insect population decreases. (Figures 19–21)

### ✓ Activity V – Fire Effects Information System

#### Humans

Humans are a part of the biosphere and connected to most ecological systems around the planet. We have become one of the significant disturbance factors. We can plant vegetation where it would not likely migrate and plant



Source: Daniel Leavell, © Oregon State University

Figure 21.

species that would not normally adapt. Trying to gain a mastery over fire or reeling in fear of fire has affected all of us in one way or another. We cannot generate hurricanes or tornados, but we can light a fire for beneficial or destructive purposes.

Our wildland fire suppression efforts are over 90 percent effective, yet thousands of acres burn every year—the 10 percent we can't suppress. "People have triggered five out of six wildfires in the U.S. over the last two decades, tripling the length of the wildfire season and making it start earlier in the East and last longer in the West, a new study finds. Scientists analyzing fire data from 1992 to 2012 found that 84 percent of all US wildfires—but only 44 percent of the total acres burned—were started by people, either by accident or on purpose. Human-caused blazes have more than tripled the length of the wildfire season from 46 days to 154 days, according to a study in the journal *Proceedings of the National Academy of Sciences* (Balch, et al. 2017).

The Florida fires of 1998 were the largest, most destructive and costly seasonal blazes on

record. Before settlement of the area, fire was a sustaining force on the coastal prairie. Fires set by lightning fed on the dormant grasses and kept trees in check, while the roots and bulbs of the native prairie plants remained unaffected by fire at the surface. Fire suppression practices, grazing, mowing, and fragmentation of the prairie landscape through agriculture and urban sprawl have all but eliminated wildfire as a dominant factor in the modern coastal prairie ecosystem. (<https://www.nwrc.usgs.gov/factshts/018-00.pdf>)

*"What made the fires of 1998 so devastating, and what is causing the 2007 fires to be so hard to stop, is that despite lots of warnings, we have allowed huge quantities of fuel to accumulate. Plummeting pulpwood prices have spurred industrial forest owners to plant lower densities and thin their stands, but many plantations and forests are still too dense.*

*Consequently, instead of the creeping surface fires that have burned across Florida for millennia, we now face unstoppable crown*



*fires. Instead of investing in fuel management through controlled burning and fire-preventing treatments such as thinning, we let pine-needle brush collect in tinderboxes of epic proportions.*

*Some of us remember back in 1998, when the fire bearing down on the town of Waldo was transformed from a raging crown fire to a moderate-intensity understory fire when it reached landowner Clark Smith's well-managed pinelands. His efforts at ecosystem management through frequent controlled burns saved the town. We need more Clark Smiths, more savannas and open-canopied woodlands, and more preventive action so as to lessen the extent and the power of the wildfires inevitable in Florida. Instead, we have burdensome regulations on controlled burns, native savannas choked by invasive hardwoods, residents who don't recognize the benefits of frequent low-intensity fires, pines planted as thick as the hair on a dog's back, massive amounts of fuel, firefighters risking their lives, homeowners losing their homes and smoke in the air." (Not learning lessons of '98 fires will prove costly. May 20, 2007. Francis E. 'Jack' Putz, *Special to the Sentinel*)*

Working and living with a knowledge of fire ecology and applying the concepts through which these ecosystems adapted over time can only benefit us—and all abiotic components that inhabit these systems with us. We can grow a banana tree anywhere we want and we can place a house anywhere we want. How much we are willing to pay? The consequences we are willing to accept should influence our decisions.

James Agee, in his concluding chapter of *Fire Ecology of Pacific Northwest Forests* (1993, Island Press), states, "Consensus on fire management, however, requires the incorporation of human values, and most past fire management policies have been derived from

the view of fire only as a threat, rather than from a broader perspective of values evident in today's society."

Benefits we can achieve with judicious management of fire-adapted ecosystems where we live are:

1. Fire removes low-growing underbrush, cleans the forest floor of debris, opens it up to sunlight, and nourishes the soil. Reducing this competition for nutrients allows established trees to grow stronger and healthier.
2. Wildlands provide habitat and shelter to forest animals and birds. Fire clears wildlands of heavy brush, leaving room for new grasses, herbs, and regenerated shrubs that provide food and habitat for many wildlife species.
3. Fire kills diseases and insects that prey on trees and provides valuable nutrients that enrich the soil. More trees die each year from insect infestation and disease than from fire.

### ✓ Activity VI – Fire Ecology Field Trip

## Notes to Instructor

### Room Setup

Facilitator should secure a room large enough to comfortably accommodate participants. Organize the room in a U-shape fashion with long tables and chairs. The room should have a large screen to display the presentation. There should be a large table up front (6 to 8 feet in length) for the instructor to use for in-class demonstrations and to display various props, such as samples of various trees, shrubs, and forbs.

### Total Time Needed

Approximately 8 hours in the classroom

## Equipment/Materials Needed

- Computer with PowerPoint
- Projector and screen
- Handouts
- Flipcharts and easels or wall space
- Plant samples
- FEIS manuals
- Maps to illustrate the gradient trip across Oregon
- Photographs of specific stops along that gradient

## Delivery Methods

- Presentation from instructors
- In-class demonstrations
- Outdoor demonstration
- Discussion
- Online with Canvas

## Handouts

- A copy of the PowerPoint presentation (3 slides per page to allow for note taking)
- Other handouts can be downloaded from the section Additional Student Resources.

## PowerPoints/Videos

- Module 2: Fire Ecology—PowerPoint
- Underwriters Lab research demonstration video of legacy vs. modern furnishings <https://www.youtube.com/watch?v=IEOmSN2LRq0&t=53s>

## Evaluation Instrument

1. Students take on the role of journalists working for a podcast such as “On Air” or “Think Out Loud” on Oregon Public Broadcasting (OPB). Students will be responsible for creating a graphic organizer outlining their podcast. Students will then record a 10- to 20-minute podcast about a Fire Ecology topic. This podcast can pertain to house fires, fires in the WUI, or wildland fires. It must include information about how communities (human or wildlife) learn to live with fire, ways that communities can be fire resistant or fire resilient, and how post-fire succession affects communities.
2. After Action Review (AAR): Conduct an AAR after the prescribed fire field trip exercise. The AAR has these components:
  - What was planned?
  - What really happened?
  - Why did it happen?
  - What can be done better next time?

Source: <http://www.fireleadership.gov/toolbox/after-action-review/aar.pdf>

Class evaluation—Provide a survey for student feedback for each module as a form of formative evaluation.

## Activities

### I. Personal and Professional Insights

*Some years ago in northwest Montana, a passing lightning storm ignited a wildfire. It was late in the season, one of those fall storms that had a little rain with it, but still ignited the downed fuel, shrubs, and grass made drier with the early morning frost. The fire occurred on a relatively isolated mountaintop, as lightning fires do and it quickly spread on the south slope warmed by the sun. This part of Montana, west of the Continental Divide and near to the Idaho border, has steep, dissected topography and has an annual precipitation of 60 to 80 inches—much in the form of winter snow. The contrast between north and south aspect is striking. Gain elevation, and even more so. As soon as the local fire lookout reported it, a crew of smokejumpers dispatched to the fire. This crew was busy all during the fire season throughout the southwest and eastside of Montana where fires burned on and off since the previous May.*

*The smokejumpers landed, designated their Incident Commander (IC), selected their gear and made a quick assessment of the fire conditions—sufficient to set a strategy in place, get the tactics together, and order resources to deal with the fire. While this was happening, a local Type 3 Team was put together to take over the management of the fire.*

*Meantime, the new Type 3 IC was circling the fire in the local helicopter, doing the initial recon and ready to take over from the smokejumper IC. That's when the fire, heated by the afternoon sun on that south slope—made its run. The ceanothus from an old fire, the plentiful beargrass, and the clumps of sub-alpine fir (all with high fuel content in the sap) burned hot on contact with the flames and heated the fire to 80-foot*

*scattered and clumped flame lengths as the wind blew up the slope. The smokejumpers retreated to a safety zone off the flank of the fire and the IC ordered air tankers of fire retardant and helicopter buckets of water to stop the flames from going over the ridge into what the smokejumper IC thought could become an escaped, uncontrolled burn that could easily get out of hand. He then ordered six 20-person crews to assist. The local Type 3 IC heard the radio traffic, landed at the nearest helispot, and officially assumed command of the fire with the smokejumper IC's blessing. The first thing the Type 3 IC did was cancel the air tankers, helicopters, and four of the six crews. Why the change in tactics?*

*Neither IC was right or wrong—that was not the issue. The smokejumper IC made his calls based on his experience in the Southwest, which has drier, more open burning conditions where most species of vegetation are born to burn. The local Type 3 IC had worked in northwest Montana for years and knew the vegetation, terrain, and other environmental conditions that created the fire response typical for that landscape. At that higher latitude (near the Canadian border) and at that elevation (7,000+ feet), and on steep slopes, the angle of sunlight late in the season and maritime weather influence created fire-adapted species on the south slopes and fire-resistant species on the cooler, more shaded, higher humidity north slope. The false huckleberry was thick on the north slope just over the ridge from the fire—the temperature dropped 20°F, the humidity rose 20 percent. In spite of the wind coming over the ridge, the fire behavior immediately dropped to almost nothing when it crossed on to the north slope. The flanks of the fire also cooled down, making mop-up (after they anchored in) by the two crews that came later that afternoon easy work.*

*That night, the Type 3 IC ordered a good meal delivered at the old mining camp that served as the Incident Command Post to thank the jumpers, reminisce about bygone fires, enjoy good times with old friends, and feed the crews for the next day's shift. Later that night and towards the early morning, the storms driven by westerly/northwesterly winds dropped over an inch of rain and snow. The fire season had officially ended for that year and everyone went home—safe and sound.*

## II. Fire Adaptations

- Discuss plant, animal, and ecosystem adaptations to fire, fire history, and fire regimes—and why all are different across an environmental gradient.
- Ask students to identify characteristics that make plants and animals more fire resistant or fire resilient across an environmental gradient, such as Mount Lemon in Arizona; Southern Oregon Cascade Range from Newport to Bend; and Steens Mountain.
- Have students design their own fire-adapted animal, plant, or house.
- Once students are finished, have them share their creation with the class.
- Put all of the creations together in fire-adapted communities and ecosystems across the gradient, based on their characteristics.
- Wrap up the activity by having students work with the other students to discuss how fire would likely affect their community or ecosystem.

## III. Local Fire Ecology

- Remind students that their neighborhood or local area is subject to adaptations to slope, elevation, and aspect, whether urban or rural, where homes exist and where extending into forested or grassland ecosystems.

- Have students take notes about their areas, including: 1) site conditions, 2) vegetation both native and introduced to the area, and 3) other information they think is pertinent to understanding the vegetation ecology and fire ecology of the area.
- Students will then work in groups to discuss how fire regimes and fire ecology are similar and different in rural, urban, and “wild” areas

## IV. Fire Ecology Crossword

- Have students create a crossword puzzle using at least 10 vocabulary words used in discussing and understanding fire ecology (e.g. fire regime, fire scar, or disturbance).
- Each vocabulary word should have a hint that is different from the definition of the word.
- These links could be helpful in this assignment:
  - <http://learnforests.org/sites/default/files/EcologicalRoleofFire.pdf>
  - <http://learnforests.org/sites/default/files/HistoricalFireRegimesModule.pdf>

## V. Fire Effects Information System (FEIS)

- Have the class collectively log on to the FEIS homepage (<http://www.feis-crs.org/feis/>) and explain the sidebar and options for use of this system.
- Discuss the publications, webinars, and other features.
- Have the class come up with species they have studied in the course of this module and enter names for the species reviews, related fire studies, and fire regimes.

## VI. Fire Ecology Field Trip

- Arrange a field trip to permit your students to view a prescribed burn with an agency that conducts prescribed burns as part of their natural resource management

plans. Suggested agencies include The Nature Conservancy, Oregon Department of Forestry, Walker Range Fire Protection Association, the Fremont-Winema National Forest, Bureau of Land Management, and Crater Lake National Park. Arrange transportation, safety training, a pre-trip orientation and a follow-up activity.

- At a minimum, students can participate in the field trip and engage in follow-up discussions. As part of a pre-trip activity, suggest that the fire manager visit the classroom and discuss prescribed burns.
- If the activity takes place in the spring, a follow-up visit later in the season will show the students how a management-ignited prescribed fire stimulates forest or grassland succession.
- Conduct a photo poster session, written essays, and/or a poetry/prose workshop for the students. Place students into three groups and instruct them to illustrate with words, drawings, or photos before the burn (the forest or grassland before the burn and the preparation and materials for the burn), the prescribed burn-taking place, and the result after the burn and how various plants respond.
- Although this can be an exciting field experience, make safety a top priority. Also, teachers must be prepared for a “no burn” decision based on unacceptable environmental conditions (e.g., high wind, high temperature) for prescribed burning.

## Assessment of Knowledge Gained

### (Questions and Answers)

1. What are the differences between biotic and abiotic? Give two examples of each that pertain to fire ecology.

*Answer: Biotic: any living organism(s). Abiotic: any nonliving components of the planet. Examples of biotic: Snowbrush ceanothus and black-back woodpeckers. Examples of abiotic: soils and rocks.*

2. What is the difference between the organic formula for photosynthesis and the formula for combustion?

*Answer: In photosynthesis, plants take energy from the sun, carbon dioxide from the atmosphere, and water from the soil to produce plant-building materials, while releasing oxygen back into the atmosphere. Combustion is the process where carbon-based living or non-living fuel ignites, producing heat and releasing carbon dioxide into the atmosphere.*

3. Give one example of a fire-dependent species and one example of a fire-adapted species.

*Answer: Fire-dependent species: whitebark pine. Fire-adapted species: ponderosa pine.*

4. Explain “Fire regime.”

*Answer: Fire regimes are patterns of wildland fires taking place over long periods of time that include factors such as frequency, extent, intensity, severity, type, and reason for burning.*

5. Give an example of a vegetation gradient.

*Answer: Florence, Oregon across the state, east to the Idaho border—the state of Oregon in a transect east from the Pacific Ocean to the Idaho border.*

6. Out of all the millions of species that exist on Earth, what is the only one that can start, extinguish, and/or manipulate fire?

*Answer: The human variety.*

## Additional Resources

- <http://fireecology.org/>
- <http://learningcenter.firewise.org/Firefighter-Safety/1-10.php>
- [http://www.pacificbio.org/initiatives/fire/fire\\_ecology.html](http://www.pacificbio.org/initiatives/fire/fire_ecology.html)
- <https://www.nps.gov/romo/learn/education/upload/Fire-Ecology-Teacher-Guide-for-web.pdf>
- [http://www.fema.gov/pdf/library/woods/athome\\_woods.pdf](http://www.fema.gov/pdf/library/woods/athome_woods.pdf)
- <http://learnforests.org/sites/default/files/EcologicalRoleofFire.pdf>
- <http://learnforests.org/sites/default/files/HistoricalFireRegimesModule.pdf>
- <http://www.feis-crs.org/feis/>

## Glossary of Terms

**Adaptation:** An alteration in structure or function of a plant or animal that helps it change over the course of successive generations in order to be better suited to live in its environment.

**Biological diversity:** The sum total of all living organisms and the interaction thereof.

**Ecosystem:** An area in which energy, nutrients, water, and other biological and geological influences, including all living organisms, work together and influence one another.

**Fire community:** A plant or animal community that is adapted to live in a habitat frequented by fires.

**Fire Dependent Ecosystems:** Plants or plant communities that rely on fire as one mechanism to create the optimal situation for their survival.

**Fuel load:** The amount of combustible material (living and dead plants and trees) found in an area.

**Habitat:** An area that supplies the needs of a population of animals or plants living there.

**Humus layer:** Decomposed organic matter

that is found in the top layer of soil.

**Mechanical treatments:** The use of people or machines to thin or reduce the density of live and dead trees and plants.

**Predators:** Animals that prey on other animals as a food source.

**Prescribed fire:** The planned application of fire to fuels, including logging debris, grasslands and/or understory vegetation, such as palmettos, in order to meet outlined resource management objectives.

**Scavengers:** Animals that feed on dead or dying animals or discarded materials from human societies.

**Serotinous:** A pinecone or other seed case that requires heat from a fire to open and release the seed.

**Succession:** The gradual replacement of one plant and animal community by another, as in the change from an open field to a mature forest.

**Wildland Fire Use:** A commonly used term to indicate a policy of allowing naturally ignited fires, such as those started by lightning, to burn while being closely monitored to meet specific management objectives without initial fire suppression.

**Wildfire:** Unplanned fire burning in natural (wildland) areas such as forests, shrub lands, grasslands, or prairies.

**Wildlands:** Forests, shrub lands, grasslands, and other vegetation communities not significantly modified by agriculture or human development. A more specific meaning for fire managers, used by the National Wildfire Coordinating Group (which coordinates programs of participating wildfire management agencies nationwide), refers to an area in which development is essentially non-existent (except for roads, railroads, power lines, and similar transportation facilities); structures, if any, are widely scattered.

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# Evaluations



OREGON STATE UNIVERSITY  
CITIZEN EVALUATION OF TEACHING

USE NO. 2 PENCIL

INSTRUCTOR'S NAME	EXTENSION EVENT	DATE
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**YOUR RESPONSES TO THIS QUESTIONNAIRE WILL HELP INSTRUCTORS CONFIRM QUALITY TEACHING AND IMPROVE TEACHING SKILLS AND METHODS.**

PLEASE FILL-IN THE APPROPRIATE RESPONSE.  
MARK ONLY ONE CIRCLE PER QUESTION!

	VERY POOR	POOR	FAIR	GOOD	VERY GOOD	EXCEL- LENT	UNABLE TO RATE
1. Overall, the quality of the educational event as a whole was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. The quality of instruction in this educational event was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Clarity of educational objectives was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. Clarity of how you might use this education was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. Teaching organization was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. Instructor's use of examples was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Instructor's use of teaching aids (slides, overheads, charts, etc.) was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. Instructor's ability to stimulate my thinking more deeply about the subject was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. Instructor's responsiveness to questions was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. Instructor's use of participant discussion to enhance my learning was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. Instructor's ability to develop a welcoming environment for all participants was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. Instructor's skill in making the information useful to me was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**Your comments will be helpful to improve instruction.**

Please comment:

# PowerPoint Slides

**Module 2: Fire Ecology**  
FIRE SCIENCES CORE CURRICULUM

**1**

**FIRE**

**Carbon Cycle - Combustion, Metabolism**

**Photosynthesis:**  

$$\text{CO}_2 + \text{H}_2\text{O} \xrightarrow{\text{Sun's energy}} \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2$$
 Carbon dioxide + Water → Sugars + Oxygen

**Respiration:**  

$$\text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{energy (heat)}$$
 Sugars + Oxygen → Carbon dioxide + water + energy (heat)

**CH<sub>4</sub> + O<sub>2</sub> → CO<sub>2</sub> + H<sub>2</sub>O + energy (heat)**  
 or  
**C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>** represents any organic matter

**3**

**FIRE**

**DEATH RIDES THE FOREST**

**WHEN MAN IS CARELESS**

**Stoichiometric formula of combustion**

$$\text{C}_{4.17}\text{H}_{6.5}\text{O}_{2.71} + 4.44\text{O}_2 \rightarrow 4.17\text{CO}_2 + 3.25\text{H}_2\text{O}$$

**FIRE IS JUST A CHEMICAL REACTION and VERY PREDICTABLE.**  
(A FORCE OF NATURE)

**2**

**FIRE**

**Figure 14-1: Areas of average yearly lightning fire distribution on the western United States, showing the distribution of lightning fire reported from 1950 to 1980.**

**4**

**FIRE ECOLOGY**




**BASIC FIRE BEHAVIOR**



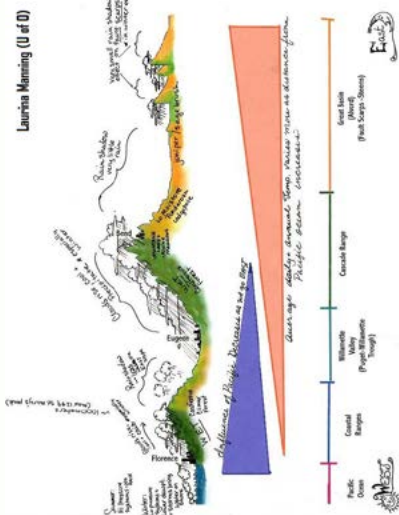


7

**FIRE ECOLOGY**


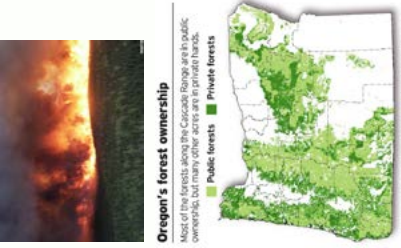




**Laurin Manning (U of D)**




8

**FIRE**



5

**FIRE ECOLOGY**



**Definition of Fire Ecology:**

A branch of ecology that focuses on the origins of wildland fire and its relationship to the environment (both living and nonliving) in which it occurs.

6

**FSHORE FLOW**

Fire Name	Year	Acres
Yaquina I	1853	480,000
Tillamook Burns	1933-1951	350,000
Nestucca Fire	1948	290,000
Siletz F	1865	800,000
Silverton F	1845	968,000
Columbia Fire	1902	770,500
36 Pitt Fires	2014	5,500

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9

**CAUSE AND EFFECT**

**Fire Disturbance** + **Fire Behavior** = **Patterns of Habitat**

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11

**FIRE ECOLOGY**

**Patterns of Vegetation** + **Fire Disturbance** = **Fire Behavior**

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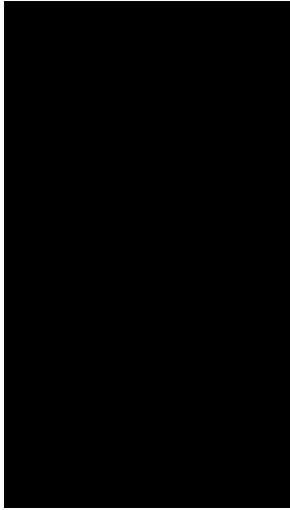
10

**Patterns of Habitat**


**Water** **Food** **Shelter**

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12


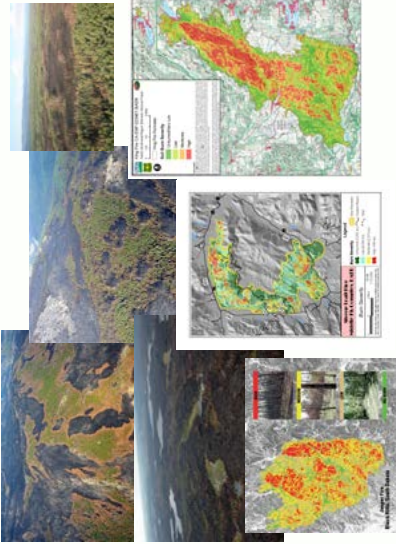
15




**ANTI-DISTURBANCE**




16

13



**CHANGE**



"Bigger, Hotter, and Longer Wildfires are the New Normal as the Climate Changes in the West"


"Costs of Wildfires Could Swallow U.S. Forest Service Budget"

"Catastrophic Fire Seasons Likely to Increase and Their Impacts Worsen"

14



**GET LOCAL**




<http://www.bloomberg.com/graphics/2014-hottest-year-on-record/>

<http://www.bloomberg.com/graphics/hottest-year-on-record/>

17

**GET LOCAL**




**Nine Miles**

Government Camp (at 4,416 feet, 1,346 meters) has a dry-summer, subarctic climate, with cool, dry summers and cool very wet winters with huge snowfall: annual 87.1 inches precipitation and 267 inches snowfall; average high temp at 50 degrees F and low at 34 degrees

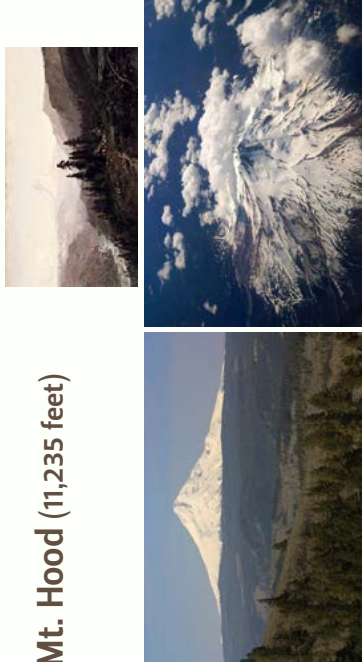
Rhododendron (at 1,776 feet, 1,346 meters) has a moist, maritime climate, with cool, wet summers and cool to cold, wet winters with low snowfall: annual 61 inches precipitation and 3.1 inches snowfall; average high temp at 68 degrees F and low at 24 degrees

19

**GET LOCAL**




**Mt. Hood (11,235 feet)**



18

**GET LOCAL**




**1909 - 2012**

Estacada, Oregon: 426 feet elevation;  
 Average high temp: 62.5 degrees  
 Average low temp: 42.1 degrees  
 Average annual precip: 57.78 inches  
 Average annual snowfall: 7.1 inches

**2014**


Estacada, Oregon: 426 feet elevation;  
 Average temp: 65 degrees  
 Average low temp: 47 degrees  
 Total annual precip: 38 inches  
 Average annual snowfall: .3 inches



<http://koin.com/2014/09/13/fire-burning-near-lazy-bend-campground/>

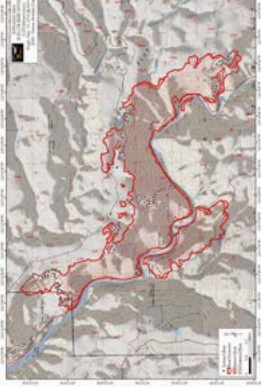

20

**GET LOCAL**





**36 Pit Fire**



1. Started September 13, 2014
2. Human-caused
3. Total: 5,520 acres
4. Burned 1,000 acres a day
5. Over 1,000 firefighters dispatched
6. Contained October 29, 2014
7. "Spread through grass and timber in part due to the steep slope and dry conditions in the area."

21





23

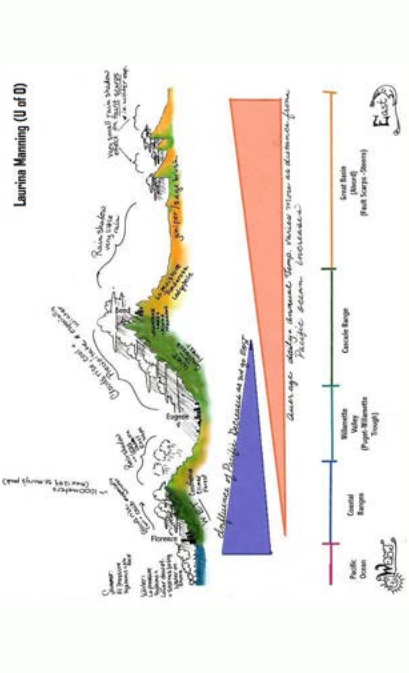



22

**USE THE SCIENCE**



**Laurisa Manning (U of O)**



24

 **USE THE SCIENCE**

**BASIC FIRE BEHAVIOR**









**THE THREE ZONES OF DEFENSIBLE SPACE**








**THANK YOU FOR LISTENING**

**27**

 **USE THE SCIENCE**

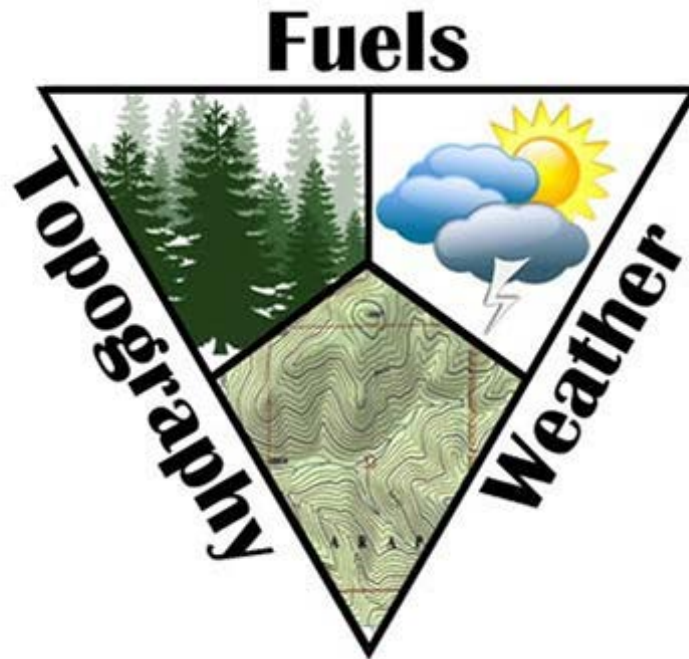


**25**

 **USE THE SCIENCE**

**26**

# Module 3: Fire Behavior



## Proposed Agenda

Time		Section Name
8:00	8:30	Welcome
8:30	9:00	Course overview and objectives
9:00	10:00	Fire behavior triangle
10:00	10:30	Break
10:30	12:00	Fire intensity, severity, and spread
12:00	1:00	Lunch
1:00	2:00	Fire types
2:00	3:00	Fire regimes
3:00	3:30	Break
3:30	4:30	Effects of climate change
4:30	5:00	Wrap-up
5:00	5:30	Discuss plans for the fire field trip

## Overview

This module provides an in-depth review of the fire behavior triangle and its components—topography, fuels, and weather—and the fire tetrahedron for structure fires. Module 3 also addresses fire severity, fire intensity, fire spread, fire types, fire regimes, and the impact of climate change.

## Learning Objectives

- Understand how weather, topography, and fuels affect fire behavior
- Compare and contrast fire severity and fire intensity
- Create a landscape and matchstick forest. Hypothesize how a fire will behave on their landscape
- Explain how fire regimes are influenced by fire behavior
- Understand how fuel size and arrangement contribute to fire spread and fire type

## Learning Outcomes

Whether there is a wildfire, structure fire, or you're conducting a prescribed burn, utilize concepts in this module to size up the fire, as with wildfire and structure fires for safety and suppression purposes; and utilize fuel, weather, and topographic elements to plan and conduct a safe and effective prescribed burn to achieve predetermined objectives.

## Content Outline

- Introduction
- Fire behavior triangle
- Topography
- Fuels
- Weather
- Extreme fire behavior
- Fire intensity and severity
- Fire spread
- Fire types
- Fire regimes
- Potential climate change effects

“From the little spark may burst a mighty flame.”

**Dante Alighieri**  
*Italian poet*

## Introduction

Several key variables affect how fires behave. These include weather, topography, and fuels. In this module you will learn some of the many behaviors that occur within a fire and across a landscape as a fire burns. Fire behavior includes such things as how fast a fire burns (rate of spread), how hot it burns (fire intensity), the presence of fire whirls, and ember production and spotting.

In a structure fire, Building Factors, Smoke, Air Track, Heat, and Flame (B-SAHF) are critical fire behavior indicators. Understanding these burn indicators is important, but more important is the ability to integrate these factors in the process of reading the fire as part of size-up and dynamic risk assessment. In structure fires, the process of reading fires involves recognizing the stages of fire development. Remember that fire conditions can vary considerably throughout the building, with one compartment containing a fully developed fire, an adjacent compartment in the growth stage, and still other compartments not yet involved. Recognizing the stages of fire development and likely progression through this process allows firefighters to predict what will happen next if action is not taken. Firefighters can also predict potential changes due to unplanned ventilation, such as failure of a window, and the likely effect of tactical action. This applies to wildland fires as well.

### ✓ Activity I<sup>1</sup> – Personal and Professional Insights

<sup>1</sup> See Activities section for details on all activities in this curriculum

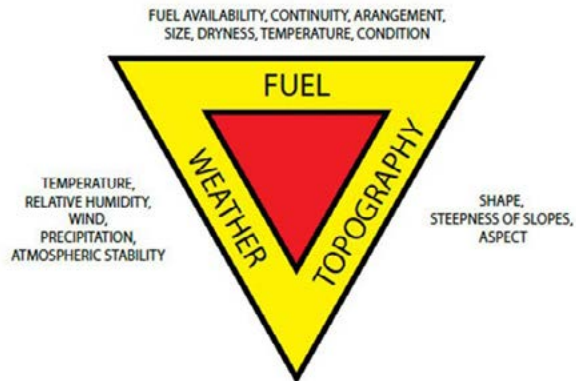


Image: US Forest Service

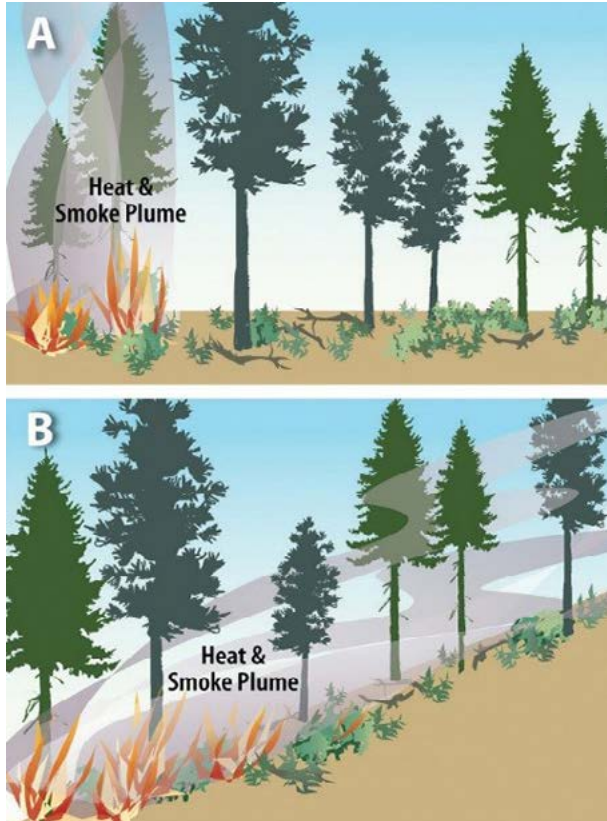
Figure 1. The Fire Behavior Triangle

## Fire Behavior Triangle

As mentioned in Module 1: What is Fire?, fire behavior can be broken into a triangle with three main components: topography, fuels, and weather (Figure 1). Each component will be explained in more detail here. Also, refer to Appendix B in the publication *Reducing Fire Risk on Your Forest Property* (PNW 618) listed in “Additional Student Resources” and available in the Oregon State University Extension catalog (<https://catalog.extension.oregonstate.edu/pnw618>).

## Topography

Fire generally spreads faster uphill than downhill because fuels are more efficiently preheated by the uphill-spreading flames and heat (Figure 2). Additionally, the steeper the slope, and the more fuel, the faster the fire will burn and spread. Fuels dry earlier in the season on south slopes compared to north slopes. Low areas that lie between two higher ridges, called saddles, also influence fire behavior. Topographic features such as “chimneys,” which are vertical drainages on either side of a hill, can draw fire



Source: National Park Service

Figure 2. Fire is influenced by many factors, including geography, climate, weather, and topography.

up them very rapidly as the hot air rises, even creating their own winds. As a result, topography can alter the normal heat-transfer process in a fire, modify general weather patterns, and result in microclimates with localized moisture conditions. For example, in steep, highly dissected terrain varying slopes and aspects can create cooler temperatures, higher humidity, and protection from prevailing wind resulting in animal and plant refugia.

## Fuels (Wildland)

Simply stated, fuels are anything that will burn. Fuels in the wildland environment are measured on horizontal and vertical axes. Vertical fuels include ground fuels, surface fuels, ladder fuels, and crown fuels (Figure 3). Ground fuels include organic matter, duff mounds around trees, peat, and decomposing tree roots. Surface

*Topography includes slope steepness and terrain.*

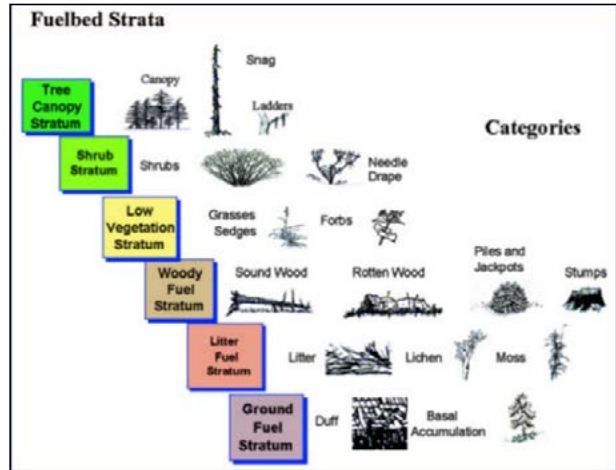


Illustration: Don McKenzie, © US Forest Service

Figure 3. Fuelbed strata and categories

fuels are fuels on the ground, including needles, the herbaceous layer, small shrubs, branches, and tree trunks. Ladder fuels are fuels that convey flames from the ground to the crowns of trees, such as tall shrubs and small and medium-sized trees with low-hanging limbs.

Crown fuels are the fuels contained in the foliage and small branches of the forest canopy. Crown fuels can be connected, as in dense forests, or sparse, as in an open forest. Fuels such as conifer needles that contain oils or resins promote combustion. These fuels ignite and burn more easily, quickly, or intensely than fuels, such as many broadleaf and deciduous trees, that don't have such oils.

Surface fuels in the wildland are characterized by the amount of time it takes to increase or decrease the moisture level within them by 63 percent. In general, these units include 1-hour, 10-hour, 100-hour, and 1,000-hour fuels. One-hour fuels are ¼-inch or less in diameter and are flashy, light vegetation (needles and grasses) that respond very quickly to weather changes. Ten-hour fuels are ¼ to 1 inch in diameter and include small limbs, branches, and other small pieces of organic matter. Hundred-hour fuels are

Fuel category	Diameter (inches)	Description	Impact on fire behavior
1-hour	0.00–0.25	Needles, twigs, moss, lichens, small shrubs, and grasses	Easily ignited. Supports initial fire spread and the heating and combustion of larger fuels. Under dry conditions, these fuels are flashy and surface fires spread quickly.
10-hour	0.25–1.00	Small branches, shrubs	Supports fire spread and the heating and combustion of larger fuels. Under very dry conditions fires spread quickly.
100-hour	1.00–3.00	Medium-sized branches	Supports fire spread and the heating and combustion of larger fuels.
1,000-hour	3.00–8.00	Large branches, small logs	Supports fire spread. Increases fire duration and influences fire severity, depending on loading.
10,000-hour	>8.00	Large, downed logs that are solid or moderately decayed	Ignites after flaming front has passed. Large fuel pieces do not support fire spread, but can increase fire duration and severity near the log. If fuel loading is high and distributed across the site (such as from beetle-killed trees), high fire severity can be more widespread and can increase both resistance to control and the duration of burning.
Snags	Variable	Bole only or bole with large branches, depending on snag condition	When snags combust, they can torch, lofting embers and firebrands ahead of the main fire, starting additional spot fires. Snags may increase resistance to control.

1 to 3 inches in diameter. The combustibility of these fuels is determined by weather patterns averaged over a 24-hour period. Thousand-hour fuels are 3 to 8 inches in diameter. The combustibility of these fuels is determined by averaging weekly weather conditions. Finally, 10,000-hour fuels are small to large logs, greater than 8 inches in diameter. The effect of fuel size on fire behavior is summarized in Table 1.

### Fuels (Structures)

Homes and other structures contain a variety of fuels besides wood (Figure 4). Many structure fuels are comprised of synthetic or petroleum-based materials that burn differently than typical wildland fuels. The fire tetrahedron (Figure 5) is the fire triangle with the added element of a chemical chain reaction. Fire extinguishers put out fires by taking away one or more elements, such as oxygen, from the fire tetrahedron.

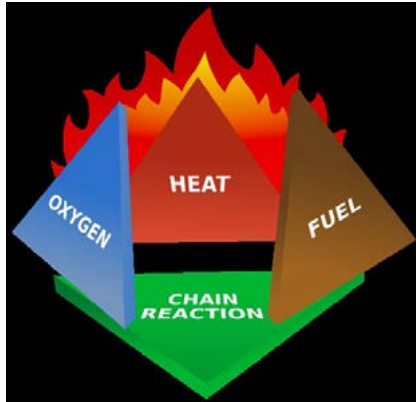
Extinguishing agents used to put out structure fires depend on what type of fuel is burning.

For both wildland and structure fires, there are three generally recognized stages of combustion (Figure 6). The incipient stage, smoldering stage, and flame stage. The incipient stage is a region



Figure 4: Characteristics Class A,B,C,D and K fuel types.

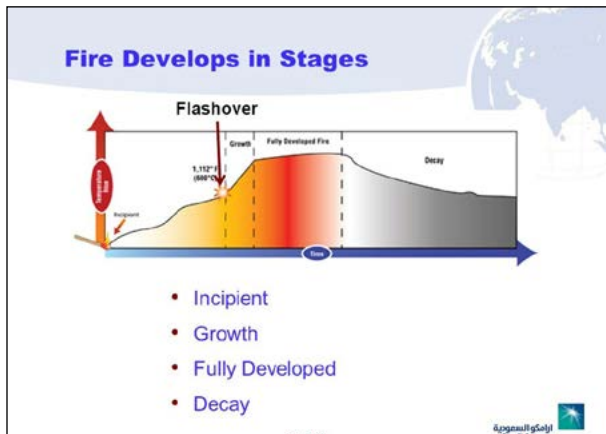




Source: Jefferson College Campus Fire Department

Figure 5. The fire tetrahedron takes the three elements of the fire triangle (oxygen, heat, and fuel) and adds other passive materials. An uninhibited chain reaction also needs to occur for fire to continue to burn. Different fuels cause different chain reactions within a structure. Depending on the material burning, firefighters use various forms of extinguishing. Ordinary wood-based combustibles; flammable liquids; flammable gases; electrical equipment; combustible metals; and cooking oil or fat all require different extinguishing agents.

where preheating, distillation and slow pyrolysis are in progress. Gas and sub-micron particles are generated and transported away from the source by diffusion, air movement, and weak convection movement, produced by the buoyancy of the products of pyrolysis. The smoldering stage is a region of fully developed pyrolysis that begins with ignition and includes the initial stage of combustion. Invisible aerosol and visible smoke



Source: International Fire Service Training Association

Figure 6. Stages of fire development

particles are generated and transported away from the source by moderate convection patterns and background air movement. The flaming stage is a region of rapid reaction that starts with the first appearance of flame and continues to a fully developed fire. Heat transfer from the fire occurs predominantly from radiation and convection to the fuels in front of the flame.

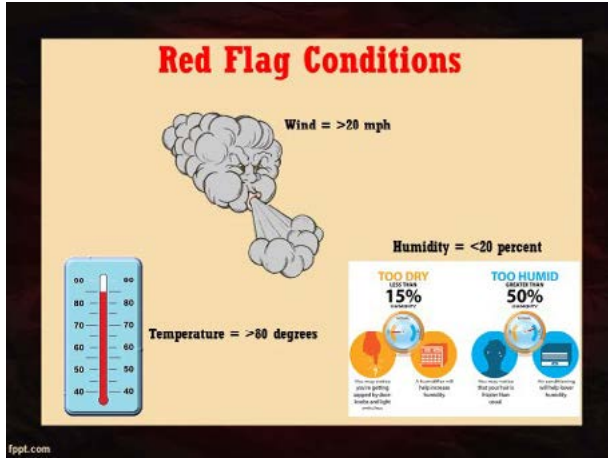
### ✓ Activity II—Fuels

- This demonstration illustrates how size and arrangement of fuels affects combustibility, fire spread, fire duration, and heat transfer to various fuel sizes.

## Weather

Weather can affect many aspects of a fire, such as intensity, severity, and fire size. Weather primarily influences fire through wind, temperature, precipitation, and relative humidity. Wind increases oxygen to the fire, carries embers aloft to create spot fires away from the main fire, dries fuels out, and influences the direction and speed of a fire. Temperature influences fire primarily by drying out fuels, but it also affects the temperature of the fuel itself. Thus, fire generally ignites more readily at high temperatures and spreads faster than at low temperatures.

Additionally, if the temperatures are high during the fire, the fire will likely burn more intensely and severely. Precipitation influences moisture content of fuels. If fuels are wet, such as in spring or early summer or after a long rain, fire is less likely to ignite and will burn slower, or will go out. Relative humidity has a major influence on fire behavior. At low humidity levels, fuels become dry, ignite more easily, and burn more quickly than when relative humidity is high. Small fuel particles dry out or absorb moisture more quickly and are most influenced by hourly or daily changes in relative humidity. For example, a fire may escalate as the day heats up and relative humidity goes down, resulting in a smoke plume that builds by late morning



Source: National Weather Service

Figure 7. Red Flag conditions are created under certain weather conditions.

or early afternoon and may persist until early evening. As the day cools and relative humidity goes up—and fine fuel absorbs moisture—the fire’s combustion and energy release decreases, resulting in a collapsing of the smoke plume. This pattern may repeat itself for a few to several days until there is a major weather change. It should be noted that other factors, such as wind and topography, can have a greater influence on a given fire’s progression and intensity.

### Extreme Fire Behavior (Red Flag Warnings)

The three components of a red flag condition are: wind, temperature, and humidity (Figure 7). Red flag weather conditions affect fire behavior to the extreme. A red flag condition occurs when

wind speed is greater than 20 miles per hour at slightly above ground level, temperatures reach 80°F or above; and relative humidity is less than 20 percent.

These conditions are also known as a Fire Weather Warning—a forecast issued by the United States National Weather Service to inform area firefighting and land management agencies that conditions are ideal for wildland fire. In these conditions, fires can spread rapidly, making for dangerous conditions for firefighters and the public. Fire whirls (Figure 8) are another example of extreme fire behavior. They represent an unstable atmosphere where superheated air and turbulent wind conditions combine to form whirling eddies of air. Ash and embers are often dispersed by fire whirls. Fire whirls tell firefighters that caution and safety are paramount.

### Fire Intensity and Fire Severity

Fire intensity and fire severity both characterize a fire, but they describe entirely different concepts (See sidebox on fire intensity and severity, page 8). Fire intensity is a measure of the heat energy released during flaming combustion. Fire severity is a measure of a fire’s impact on the site—in other words, fire effects. Fire intensity is the amount of heat (energy) given off by a forest or house fire at a specific point in time. As a general rule, we can say that fire is hot.



Source: livescience.com

Figure 8. The photos above depict the formation of a fire whirl, in which whirling eddies are created by an unstable atmosphere with superheated air and turbulent wind.

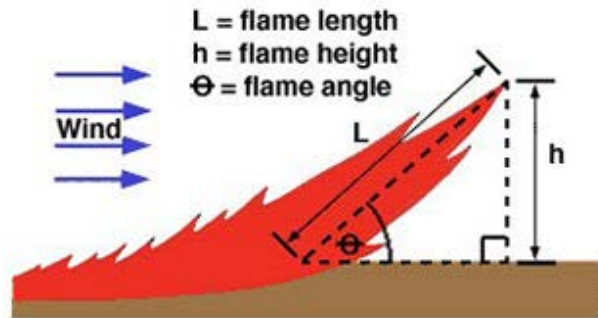
## Fire Intensity and Severity

The components of the fire behavior triangle also determine fire intensity, sometimes referred to as “fireline intensity.” Fireline intensity is the rate of heat energy released per unit time per unit length of fire front, regardless of the depth of the flame zone (Byram 1959). It is calculated as the product of available fuel energy and the fire’s rate of advance. Fireline intensity can be calculated by measuring or estimating flame length.

$$I = 258 FL^{2.17}$$

*I* = energy release (Btu) per unit length (feet) of fire line per unit time (seconds)  
*FL* = flame length (ft.)

Fire severity is a product of fireline intensity and the duration of heat and its effects on vegetation and soil. A given fire may display high, medium, or low fire severity effects.



Source: National Wildfire Coordinating Group

Diagram and photo illustrate what is meant by flame height and flame length.

But how hot? The heat from a Bunsen burner is much greater than the heat from a candle flame. The same is true with forest fires and house fires. Some fires give off much more heat than others. They are more intense. Fire intensity in the wildlands is influenced by weather conditions; amount, size, and moisture content of the fuel (i.e., fuel load); plant chemistry (e.g., conifer needles that emit flammable terpenes contribute more to fire intensity than green maple leaves); and topography. Fire intensity in house fires is also influenced by similar factors like weather (e.g., wind, unstable air, etc.); “topography” (e.g., chimney); and fuels (e.g. fuel type: wood vs. synthetic material).

The intensity of a fire can be low, medium, or

high, and different areas within a large wildland fire may burn with different intensities, leaving a mosaic of post-fire conditions. Low-intensity fires occur when conditions are cool or moist, wind speeds are low, or fuel loads are low. Low-intensity fires may help maintain healthy forests by thinning out crowded stands of young trees, reducing the amount of fuel in the understory and on the forest floor, and releasing nutrients in the soil. High-intensity fires occur when conditions are hot, dry, and windy; the fuel load is high; and the topography is steep. High-intensity fires accelerate rapidly and burn through the tree crowns, releasing tremendous smoke and heat and consuming understory vegetation and leaves, branches, bark, and stems

**Table 2. Burn severity classification based on postfire appearances of litter, soil, and soil-temperature profiles.**

Soil and litter parameter	Low	Moderate	High
Litter	Scorched, charred, consumed	Consumed	Consumed
Duff	Intact, surface char	Deep char, consumed	Consumed
Woody debris—small	Partly consumed, charred	Consumed	Consumed
Woody debris—logs	Charred	Charred, deeply charred	Consumed,
Ash color	Black	Light colored	Reddish, orange
Mineral soil	Not changed	Not changed	Allered structure, porosity, etc
Soil temp. at 0.4 in (10 mm)	<120° F (<50° C)	210-390° F (100-200° C)	>480° F (>250° C)
Soil organism lethal temp.	To 0.4 in (10 mm)	To 2 in (50 mm)	To 6 in (160 mm)
Proportion of area in each burn severity category	<2% severe <15% moderate Remainder either low or unburned	<10% severe >15% moderate	>10% severe >80% mod. severe

Image: Stephen Fitzgerald, © Oregon State University

on the forest floor. High-intensity fires can be hard to control because they burn extremely hot. High-intensity fires are part of the natural fire regime for some forest types. Coastal forests, for example, have historically burned with a large proportion of high intensity fires, while ponderosa pine forests have historically burned with a large proportion of low-intensity fire (NWFSC 2015).

Fire severity refers to the effects of a fire on the environment. This assessment typically focuses on the loss of vegetation, both aboveground and belowground, and on soil impacts. Fire severity is sometimes called burn severity (Table 2). It is determined by what is burned, what plants were killed, and how much bark was charred and

foliage scorched.

Fire severity has both positive and negative effects on plant and ecosystem adaptations. It can result in erosion and socioeconomic impacts on people and communities, but it can also trigger regrowth of vegetation and colonization by wildlife. (NWFSC 2015).

Fire intensity and fire severity are not synonymous or interchangeable.

A fast-moving, wind-driven fire may be intense, but a long-lasting fire creeping through the forest underbrush could transfer more total heat to plants or soil and have much more severe and complex effects on something like forest soil than a faster-moving, higher-intensity fire in the same vegetation. (Hartford and Frandsen 1991).

✓ **Activity III—Fire Intensity/Severity**

- This demonstration illustrates and summarizes the fire behavior triangle (fuel, weather, topography).

**Fire Spread**

Fire spread is measured or estimated in feet per minute or chains (1 chain = 66 ft) per hour. Fire spread through cured, standing grass is much faster than a surface fire moving through forest fuels. Refer to Table 3 for rate-of-spread comparisons.

Fire spread is influenced by the ratio of the heat source (of combusting fuels) and heat sink (adjacent unburned fuel) (Sugihara et al. 2006). In other words, the more heat that is generated during combustion, the faster adjacent fuels are ignited. Fire spread rates depend on the amount

Fuel type	Rate of spread <sup>1</sup>
grass and bitterbrush	46 chains/hour
ponderosa pine/bitterbrush (4-PP-4)	9 chains/hour
dense ponderosa pine/heavy surface fuels (6-PP4)	5 chains/hour
Adapted from U.S. Forest Service General Technical Report PNW105	
<sup>1</sup> chain = 66 feet	

and arrangement of fuels, wind, weather, and topography.

Fire spreads through convection, radiation, or conduction. Conduction is the transfer of heat from a flame directly to a fuel source through direct contact. For example, a flame touching and lighting a candle wick is an example of conductive heat.

Convection is the transfer of heat from a flame indirectly to a fuel source in the path of the flaming front through the heating of gases or air or both. As the air heats, it rises. In wildland fires, this heated air continues to rise, creating a plume of heat, smoke, and ash. In house fires, this heated air typically makes contact with the ceiling, where it then moves horizontally. As the heated air is trapped, it becomes denser, and then moves down through the air column.

Radiation is the transfer of heat from a flame indirectly to a fuel source via electromagnetic waves. Radiant heat generally travels from the sides or edges of a fire until the heat waves reach another object, such as a tree or house. It is the least efficient method of heat transfer to fuels.

Wet fuels take a long time to dry out and ignite using conduction or radiation. Convection tends to dry and preheat fuels faster, which is why trees at the top of a hill tend to catch fire faster as a fire moves upslope (preheating upslope fuels) than trees at the bottom of a hill as fire moves downslope (backing fire).

#### ✓ Activity IV —Fire Spread

- This activity helps students develop critical thinking skills by observing fire indicators, making quick risk assessments, and constantly re-evaluating risk as fire conditions present themselves.

## Fire Types

Wildland fire can be described as ground, surface, or crown fires. A wildfire will generally exhibit all three fire types throughout the



Photo: Teresa Brennan, © U.S. Geological Survey

Figure 9. A surface fire burns along the ground.

duration of the fire. However, the proportion of each type can vary greatly day to day depending on fuel, terrain, and weather conditions.

Ground fires burn mostly in the duff and in decayed roots below ground, and they can go undetected as they produce little smoke. Ground fires can emerge and ignite surface fuels or burn beneath firelines and ignite fuels on the other side of the fire line. This is why firefighters often extinguish (mop up) fires in old stumps within 50 feet of the fire line.

Ground fires can exhibit both low and high severity (e.g., peat fires). Surface fires move along the forest floor and consume needles, moss, lichen, herbaceous vegetation, shrubs, small trees, and saplings (Figure 9).

Surface fires can ignite large woody debris and decomposing duff, which can then burn (glowing combustion) long after the surface flames have moved past. Surface fire severity can be categorized as low, medium, or high.

Crown fires move through tree canopies (Figure 10). Factors that influence the transition from a surface fire to crown fire include: surface fuel and foliage moisture content, surface flame length, height to the base of tree crowns, and the density and compactness of tree crowns, known as crown bulk density. Crown bulk density is

the weight (in kilograms) of foliage and small branches per cubic foot of crown volume. Forests with crown bulk densities above 0.10 kilograms per cubic meter of crown volume are more prone to crown fires (Graham et al. 2004).

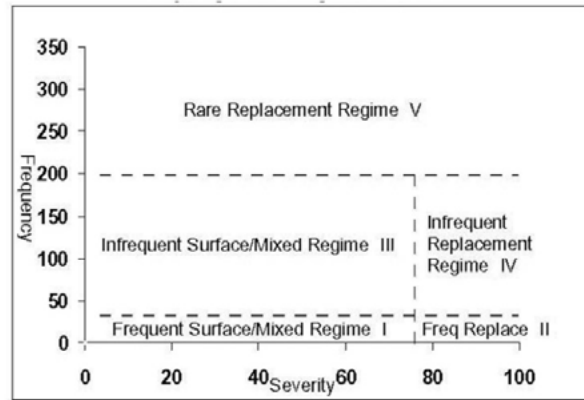
Crown fires are either passive or active. Passive crown fires involve the torching of individual trees or groups of trees. Torching is the precursor to an active crown fire.

Crown fires become active (crown-to-crown combustion) when enough heat from combined surface and ladder fuels preheats and combusts fuels above the surface, followed by active fire spread from tree crown to tree crown through the canopy. Crown fires are usually intense and stand replacing, and are strongly influenced by wind, topography, and crown density. Occasionally crown fires can spread independent of surface fuel combustion, where crown-to-crown combustion is sustained on its own due to combinations of high temperatures, wind, and topography. Independent crown fires are rare and typically last for short periods. But during that time, wildfires can make great lateral advances.



Source: Wikimedia

Figure 10. A crown fire races through the canopy of a ponderosa pine forest.



Source: FRCC Guidebook, Version 3.0

Figure 11. Fire regimes relative to fire frequency and severity.

## Fire Regimes

Fire regimes describe the predominant types of fire (frequent or infrequent surface, mixed, stand replacing fire) as well as temporal and spatial patterns of fire on a landscape. These patterns include how frequently an area burns, how many years it takes for a defined area to burn, fire severity, fire intensity, and the fire season (spring, summer, fall). Fire regimes are largely influenced by vegetation, climate, and topography, which in turn affect fire behavior. Fires historically in ponderosa pine forests burned with frequent surface fires of low to mixed severity (Regime I). Wildfires in western Oregon and in Washington Coast Range forests were generally rare and stand-replacing (Regime V, Figure 11).

Fire regimes in some areas of the United States have shifted over time and appear to be associated with changing climatic variables, increased fuel loadings from past fire suppression and more structures built in the forest environment. For example, some forests with historic low severity/frequent fire regime are now experiencing high severity/infrequent fire. Many wildland fires now burn hotter and longer (with higher overall intensity and severity) than 30 years ago. Wildland fire season is starting earlier and lasting longer (Westerling et al. 2006). Wildland fires are harder to extinguish, require

more resources, and carry greater risk of damage and costs than two generations ago.

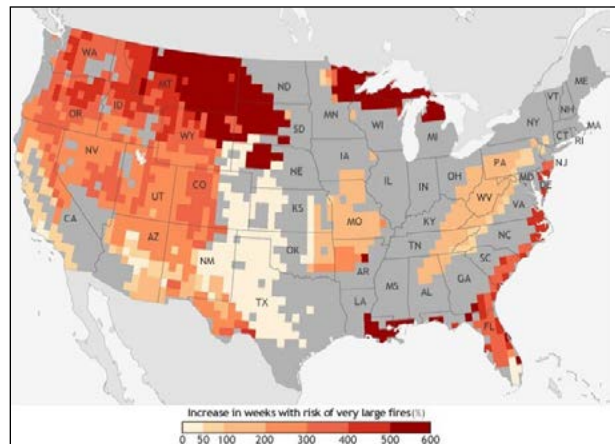
Structure fires are also harder to extinguish than in the '60s and '70s, even though methods and equipment to extinguish fires have improved. With new furniture made out of blended synthetic materials and tight, weather-resistant building materials, house fires burn hotter and flash sooner than two generations ago. Where fire crews once had 30 minutes to enter a building to conduct a suppression tactic or carry out a rescue, modern homes can now flashover in 3 minutes or less. Just like the wildland environment, structure fires require more resources with greater risk of damage and loss of life than two generations ago.

For these reasons, dealing with structure fires within wildland areas can be the most dangerous of all conditions.

## Potential Climate Change Effects

Climate warming due to increasing greenhouse gas emissions will likely increase the potential for “very large fires”—the top 10 percent of fires, which account for a majority of burned areas in many regions of the United States. Climate change is expected to intensify fire weather conditions and lengthen the season during which very large fires spread. On top of this, fire suppression policies for the last 100 years have allowed fuels to increase, exacerbating and contributing to very large wildfires in the western United States.

Researchers predict that beginning in 2042 the number of weeks in which very large fires



Source: National Oceanic and Atmospheric Administration

Figure 12. The projected percentage increase in the number of “very large fire weeks”—weeks in which conditions are favorable to the occurrence of very large fires—by mid-century (2041-2070) compared to the recent past (1971-2000).

could occur will increase by 400 to 600 percent in portions of the northern Great Plains and the Northwest (Figure 12).

Many other areas in the West will see a 50 to 400 percent increase. Red flag conditions will happen earlier, last longer, and be much more common as climate gets warmer.

If these predictions are correct, the effects of climate change are not generations away. Firefighters starting out today will be dealing with this on a large scale during their careers. This will have huge implications for fire-suppression tactics and costs, protection of human infrastructure, and major changes to vegetation across the landscape.

## Notes to Instructor

### Room Setup

The instructor should secure a room large enough to comfortably accommodate participants. Organize the room in a U with long tables and chairs on the outside. The room should have a large screen to display the presentation. There should be a large table up front for the instructor to use for in-class demonstrations or to display various props.

### Total Time Needed

About 8 hours.

### Equipment/Materials Needed

- Computer with PowerPoint
- Projector and screen
- Handouts
- Flipcharts and easels or wall space

### Delivery Methods

- Presentation from instructors
- In-class demonstrations
- Outdoor demonstration
- Discussion
- Online with Canvas

## Prep/Background

Not all instructors for this course will have fire experience. Those who don't could invite a fire professional to the training to provide additional expertise and commentary. Instructors can also review textbooks about fire, fire ecology, and fire management to develop an understanding about fire. Fire investigation reports also provide good insight to understand fire and its aftermath.

## Demonstration Set-Up

Simulations help explain fire. The sand table exercise is a proven technique for teaching concepts presented in the module. Try to make it as authentic as possible. Use fire demonstrations (e.g., matchstick forest) whenever it is safe to do so. Safety always comes first.

## Handouts

- A copy of the PowerPoint presentation (3 slides per page to allow for note taking)
- Other handouts can be downloaded from the section Additional Student Resources.

## PowerPoint

- A scripted PowerPoint presentation for this module is provided.

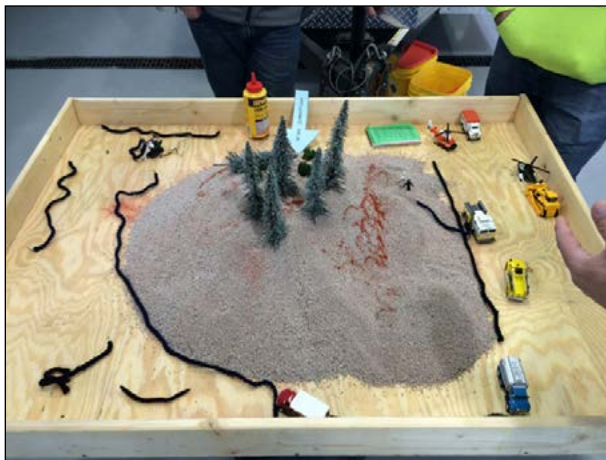


Photo: Northern Bucks Wildland Fire Crew

Northern Bucks Wildland Fire Crew training sand table.



Photo: Studentoffire.org

A sand table training display.





Photo: U.S. Department of Defense

A large-scale depiction of military operations in Afghanistan.

## Video

- The 10-minute video, *2017 WFSTAR: Introduction to Fire Behavior*, can be used instead of the PowerPoint, particularly if the instructor is pressed for time. The video covers the fire triangle, fire spread, fire-line intensity and other fire-behavior topics. The video is listed in “Additional Resources for Students” below.

## Evaluation Instrument

(For Professional Fire Personnel Only)

To assess student understanding of the topics in this module, students will select an ecosystem,

such as a ponderosa-pine-dominated forest, and write a 1,000-word essay about the fire regime of their system.

This essay needs to include information about fire severity, fire intensity, how fire spreads in this system, and how other elements of the fire behavior triangle influence the fire regime in this system. Students will also give a 5-minute presentation about the fire regime of their chosen forest ecosystem.

Class evaluation—Provide a survey for student feedback for each module as a form of formative evaluation.

## Activities

### I. Personal and Professional Insights

*Firefighting has changed since the '60s and '70s. When we started then, our "Personal Protective Equipment" (PPE) was a pair of blue jeans, maybe an orange fire retardant shirt, a metal hardhat, leather or cloth gloves, and boots. The packs we took to the fireline were canvas "FS" haversacks or Army surplus butt packs. Our radios for the field used 12 "D" batteries and weighed 12 to 15 pounds with all the paraphernalia. The lookouts on every mountaintop provided more communication for us than did those heavy radios.*

*We attacked wildland fires throughout the '60s, '70s, and '80s as soon as we could get to them, and we usually had them out (every ember cold-trailed) within a week or two—the largest fires after a maximum of 4 weeks. It was rare to have a wildland fire burn out of control longer than that. It started to change noticeably in the mid-90s. Snow melted off earlier in the spring in the high country. We kicked up dust on the roads sooner in the year. Leaves changed color and dried out earlier in the season. Humidity fell further and earlier in the day—temperatures rose higher. Night-time temps and humidity didn't recover as much. The trend continued throughout the 2000s.*

*In 2008, near the Bob Marshall Wilderness in Montana, lightning started a small fire of about 120 acres on a mountaintop. Dispatch sent a Type 1 Hot Shot crew of 20 firefighters to contain and control it. The Type 2 Incident Management Team in charge of the fire sent its operations section chief and safety officer to spike out at the crew mountaintop camp to oversee the operation. No one was worried. Rising bright and early the next morning, crew members improved*

*their fire line and had almost encircled the 120-acre spot. At 0900, the humidity was about 30 percent—same as the previous week. Temperature was 65°F and winds were light at about 1 to 5 miles per hour. Flames burning through the duff at the last corner were about 1½ feet with slow movement. Two hours would be all it took to contain the fire with a solid line. Mop-up would take another couple of hours. Control was imminent.*

*At 10:30, the world changed. Humidity dropped to single digits, temperature rose to the 80's, and winds kicked up to 40 mph. Red-Flag conditions with no warning. The flame lengths were fanned by hot, dry wind and shot up from 1½ feet to over 200 feet as the crown fire swept up the steep slope like a tornado. We only had minutes to jump into the already-burned-over area, which thankfully served as a safety zone. We were dazed, but safe. We retreated to our camp and were marooned there five days while a thousand freight trains consumed tens of thousands of acres of forest all around us, day and night. When the storm finally abated and we could go back to camp, the 120-acre fire was about 70,000 acres.*

*The average wildland fire now behaves much like the "extreme" fires of decades ago. Wildland fires now are more extreme, harder to manage, more dangerous, and last longer. Fire seasons start earlier, end later, and cover more parts of the country than they used to. Fire behavior is so extreme so often now that one to two fire-retardant drops that used to quash the fire into a quiet mode now takes a dozen drops.*

*House fires are more extreme, too. We used to have 30 minutes in an average house fire to conduct rescue, find the fire source, and put it out. Now, because building and furniture materials are made of new, synthetic materials that are more flammable and burn hotter, we have 3 minutes before it's too hot*

*to enter a building. These factors and the loss of firefighters in both structure and wildland fires have made us more risk adverse and prone to err on the side of protecting firefighter lives.*

## II: Fuels

- Provide students with a safe area, such as an outdoor fire pit, fire table or clear area, to burn different sizes and types of fuel.
- Provide students with a variety of 1-hour, 10-hour, 100-hour, and 1,000-hour fuels (e.g., pine needles, small branches, large branches, and a piece of a tree trunk).
- Divide students into three or four groups, one for each fuel type.
- Have students attempt to light their fuel on fire without using kindling, accelerants, or things of that nature.
- You could also have students build a model house with different sizes and types of fuels and see how easily these fuels ignite and burn.
- Have students record how thoroughly their fuel ignited and burned. Then have students regroup into groups containing a representative from the 1-hour, 10-hour, 100-hour, and 1,000-hour groups.
- Students should work together to identify differences in ignitability and combustibility.

## III: Fire Intensity/Severity

- Provide students with aluminum pans, clay, matches, a stopwatch, and a lighter.
- Have students work in teams to build their own landscapes, using the clay in the aluminum pans.
- Then have them build their own forest using the match sticks (matchhead up). Use cedar chips (from a pet store) or crinkled up paper shreds to serve as surface fuels beneath the matchsticks.

- Once students have built their own forest, have them hypothesize about how their forest will burn (fire severity and intensity).
- Then have students ignite one of their matchstick trees and time how fast the fire burns.
- Once the fire is out, have them record how many “trees” burned. Discuss the pattern of burning and overall severity.

## IV: Fire Spread

- Have students read the excerpts about the Great Chicago Fire ([http://ethw.org/images/d/dd/The\\_Great\\_Chicago\\_Fire.pdf](http://ethw.org/images/d/dd/The_Great_Chicago_Fire.pdf)) and the Tillamook Fire (<http://oregonstate.edu/instruct/geo422/522-Paper%20hoadley.pdf>).
- Have students identify the different types of heat (radiation, convection, conduction) that may have influenced how these fires behaved and spread.
- Then have students compare their results with a partner.
- Alternatively, have some students read the excerpt about the Great Chicago Fire and some read the excerpt about the Tillamook Fire. Then pair students from the Great Chicago Fire with students from the Tillamook Fire and have them work together to identify how fuels and fire spread (radiation, convection, conduction) influenced these fires. Have them identify several similarities and differences between these fires and associated fire behavior.

Instructors can also have students do the “Inquiry Lesson” written by David Huss (also in the Additional Resources for Students) and then answer the questions for these two scenarios.

- You have responded to a fire in a one-story, single-family dwelling of wood-frame construction. An incipient fire is burning a bedroom on the corner of the structure. The fire is limited to a plastic trash can

containing waste paper, which is located next to the bed.

- What conditions would you expect to see from the exterior of the structure?
- What indicators may be visible from the front door as you make entry?
- What might you observe traveling through the living room and down the hallway?
- What conditions would you find in the bedroom? It is essential to think about what you are likely to find inside when observing fire behavior indicators from the exterior and performing a risk assessment. After making entry, consider if conditions are different than you anticipated.
- Why might this be the case?
- What differences in conditions would be cause for concern?
- You have responded to a fire in a one-story, single-family dwelling of wood-frame construction. A fire which started in a bedroom on the corner of the structure has gone from fully developed to the decay stage due to a lack of oxygen as building openings (doors and windows) remain closed and intact.
- What conditions would you expect to see from the exterior of the structure?
- What indicators may be visible from the front door as you make entry? A fire in the decay stage (particularly when this is due to limited oxygen) still presents a significant threat as conditions can change rapidly.
- If the door at your entry point remains fully open, how will this influence fire behavior (assuming no other ventilation has been performed)?
- How would fire behavior be influenced if a window or windows in the fire compartment are opened along with the door at your entry point?
- What indicators would you anticipate



Photo: Oregon State University

Students can build their own matchstick forest.

observing as you traveled through the living room to the hallway leading to the bedroom?

- What conditions would you find in the hallway outside the fire compartment? After making entry, consider if conditions are different than you anticipated. Why might this be the case?
- What differences in conditions would be cause for concern?

## Additional Resources

Tillamook Fire. Online at: <http://oregonstate.edu/instruct/geo422/522-Paper%20hoadley.pdf>

Great Chicago Fire. Online at: [http://ethw.org/images/d/dd/The\\_Great\\_Chicago\\_Fire.pdf](http://ethw.org/images/d/dd/The_Great_Chicago_Fire.pdf)

Inquiry Lesson Plan exploring the roots of the Chicago Fire. Online at: (<https://www.uww.edu/Documents/colleges/coeps/cni/social%20studies/lesson%20plans/2009-2010/Inquiry%20Lesson%20Plan-%20Great%20Chicago%20Fire%20tragedy%20to%20occur.pdf>)

Fire Regime information from firescience.gov. Online at: [https://www.firescience.gov/projects/09-2-01-9/supdocs/09-2-01-9/Chapter\\_3\\_Fire\\_Regimes.pdf](https://www.firescience.gov/projects/09-2-01-9/supdocs/09-2-01-9/Chapter_3_Fire_Regimes.pdf)

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## Glossary of Terms

- Backing fire:** A fire burning into the wind.
- Backburn:** Firefighter technique used to reduce fuels in front of an advancing fire.
- Conduction:** The transfer of heat from a flame directly to a fuel source through direct contact.
- Convection:** The transfer of heat from a flame indirectly to a fuel source in the path of the flaming front through the heating of gases or air or both.
- Distillation:** Conversion of a liquid into vapor that is subsequently condensed back to liquid form.
- Pyrolysis:** The heating of an organic material, such as biomass, in the absence of oxygen. Because no oxygen is present, the material does not combust. But the chemical compounds (i.e., cellulose, hemicellulose, and lignin) that make up that material thermally decompose into combustible gases and charcoal.
- Radiation:** The transfer of heat from a flame indirectly to a fuel source via electromagnetic waves.
- Spotting:** Small fires ignited by fire brands or embers.

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# Evaluations





**OREGON STATE UNIVERSITY  
CITIZEN EVALUATION OF TEACHING**

**USE NO. 2 PENCIL**

INSTRUCTOR'S NAME	EXTENSION EVENT	DATE
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**YOUR RESPONSES TO THIS QUESTIONNAIRE WILL HELP INSTRUCTORS CONFIRM QUALITY TEACHING AND IMPROVE TEACHING SKILLS AND METHODS.**

PLEASE FILL-IN THE APPROPRIATE RESPONSE.  
MARK ONLY ONE CIRCLE PER QUESTION/


	VERY POOR	POOR	FAIR	GOOD	VERY GOOD	EXCEL- LENT	UNABLE TO RATE
1. Overall, the quality of the educational event as a whole was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. The quality of instruction in this educational event was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Clarity of educational objectives was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. Clarity of how you might use this education was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. Teaching organization was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. Instructor's use of examples was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Instructor's use of teaching aids (slides, overheads, charts, etc.) was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. Instructor's ability to stimulate my thinking more deeply about the subject was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. Instructor's responsiveness to questions was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. Instructor's use of participant discussion to enhance my learning was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. Instructor's ability to develop a welcoming environment for all participants was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. Instructor's skill in making the information useful to me was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>


**Your comments will be helpful to improve instruction.**

Please comment:


# PowerPoint Slides

**Module 3: Fire Behavior**  
FIRE SCIENCES CORE CURRICULUM

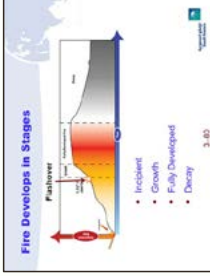





1



**Fire Develops in Stages**




Flashover demonstration: <https://www.youtube.com/watch?v=BtMymOx6jc>



3

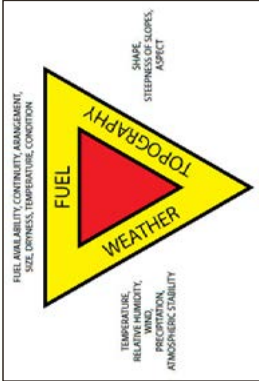
**LEARNING OBJECTIVES**


- Understand how weather, topography, and fuels affect fire behavior:
  - Create a landscape and 'matchstick forest' and hypothesize how a fire will behave.
- Understand how fuel size and arrangement contribute to fire spread and fire type
- Compare and contrast fire severity and fire intensity
- Be able to explain what factors produce or influence fire regimes



2

**THE FIRE BEHAVIOR TRIANGLE**





4

**THE FIRE BEHAVIOR TRIANGLE**



What do we mean by fire behavior? What does it include?

**Terminology**

- Rate of spread
- Intensity
- Flame length
- Torching
- Crowning
- Spotting
- Whirlwinds


**Meaning**

- How fast a fire moves in ft./min. or chains/hr.
- How hot a fire burns (heat released in BTUs)
- Surrogate measure for fire intensity
- Flames moving up from the surface into tree crowns
- Flames spreading through the main tree canopy
- Spot fires ignited by embers ahead of main fire front
- Superheated air and turbulent wind conditions form whirling eddies of fire



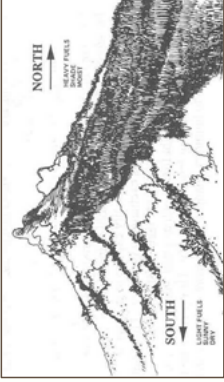
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**THE FIRE BEHAVIOR TRIANGLE**




**Topography**

- Slope angle, aspect, and elevation affects:
  - Drying of fuels on a daily and seasonal basis
  - Air temperature and temperature of fuels



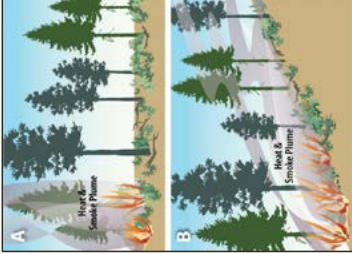
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**THE FIRE BEHAVIOR TRIANGLE**




**Topography**

- Fires spread faster upslope:
  - Slope tilted toward the flames
  - Fuels more effectively preheated by approaching flames





**6**

**THE FIRE BEHAVIOR TRIANGLE**




**Topography**


- Other landscape features
  - Box canyons, saddles, narrow canyons affect:
    - Air flow and wind currents on a daily basis
    - Safety zones for firefighters

**BOX CANYON & CHIMNEY EFFECT**



**8**

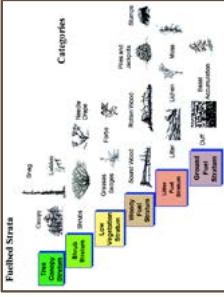



**THE FIRE BEHAVIOR TRIANGLE**


**Fuel**

- Fuel is anything that will burn under the right conditions!
- Fuel continuity:
  - Vertical and horizontal dimension to fuels
  - Natural vs. activity fuels

**9**








**THE FIRE TETRAHEDRON**


**Structure Fuels**

- Fire triangle with the added element of a chemical chain reaction
- Petroleum-based products used in home construction

**11**



**The Fire Tetrahedron**



**THE FIRE BEHAVIOR TRIANGLE**

**Fuel**

- Fuel moisture:
  - Live FM
  - Dead FM
- Fuel size
  - Surface-to-volume ratio
- Chemical makeup
  - Resin, sap, foliar chemicals

**10**

Fuel category	Dimension (in.)	Description	Impact on fire behavior
1-hour	0.00-2.0	Small twigs, sticks, leaves, needles, grass, and grasses	These fuels are easily and rapidly consumed. They contribute to the heating and combustion of larger fuels. Little dry matter remains.
10-hour	0.25-1.00	Small branches, shrubs	Supports the spread and the heating and combustion of larger fuels. Under very dry conditions, fuels may char.
100-hour	1.00-3.00	Medium size branches	Supports the spread and the heating and combustion of larger fuels.
1,000-hour	3.00-4.00	Large branches, small logs	Supports the spread, increases fire duration and contributes to the severity, depending on fueling.
10,000-hour	> 4.00	Large diameter logs, snags, stumps, charred wood, etc.	Spreads fire during slow burning. Large fuel for duration and severity over the long term. Fuel heat from burning fuels, light fire intensity can be maintained for long periods of time, depending on fueling and the duration of burning.
100-year	Variable	Large logs, snags, stumps, charred wood, etc.	When snags combust, they can torch, falling and igniting additional fuels. Snags may maintain fire for long periods of time.



**THE FIRE TETRAHEDRON**


**Structure Fuels**

**Fuel Classifications**

- Class A: Wood, paper, cloth, trash, plastics—solids that are not metals.
- Class B: Flammable liquids—gasoline, oil, grease, acetone. Includes flammable gases.
- Class C: Electrical—energized electrical equipment. As long as it's "plugged in."
- Class D: Metals—potassium, sodium, aluminum, magnesium. Requires Metal-X, foam, and other special extinguishing agents.
- Class K: Cooking oils and fats.

**12**


**THE FIRE BEHAVIOR TRIANGLE**



**Weather**

**Wind**

- Increases oxygen supply
- Dries fuels
- Causes spot fires




Influence direction of fire spread.  
Moves air heated by convection into more fuels

Example: Dry east winds are particularly dangerous during August and September in Oregon.

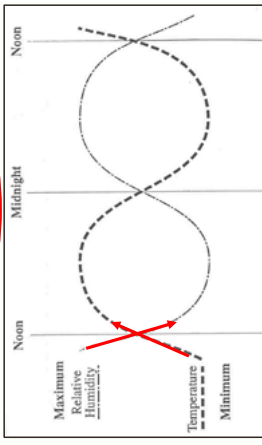
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**THE FIRE BEHAVIOR TRIANGLE**



**Weather**


**Relative Humidity**



- Affects diurnal wetting and drying of fuel
  - Dependent on fuel surface-to-volume ratio

**15**


**THE FIRE BEHAVIOR TRIANGLE**



**Weather**

**Precipitation**

Duration generally has greater effect than volume



Pattern of yearly precip. affects fuel drying

Other influences, such as a marine layer, can affect relative humidity and fog drip and the wetting and drying of fuels.

**14**

**THE FIRE BEHAVIOR TRIANGLE**




**Weather Extremes**


**Red Flag Conditions**



**16**



**THE FIRE BEHAVIOR TRIANGLE**




**Weather Extremes**


Fire Whirls

- Unstable atmosphere
- Superheated air plus turbulent wind conditions

17




**FIRE INTENSITY AND FIRE SEVERITY**



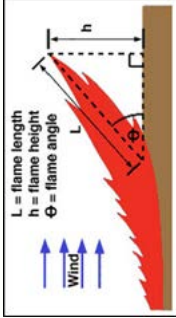
**Fire Severity**

- Refers to the effects of a fire on the environment:
  - Damage to vegetation and trees
  - Damage to soils and watersheds

19




**FIRE INTENSITY AND FIRE SEVERITY**



**Fire Intensity or "Fireline Intensity"**


$$I = 258 FL^2 \cdot 17$$

*I = energy release (Btu) per unit length (ft.) of fire line per unit time (seconds)*  
*FL = flame length (ft.)*

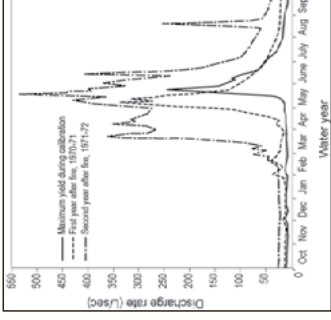


- Measure at the midpoint of the flame
- Can be easily observed with proper reference point

18




**FIRE INTENSITY AND FIRE SEVERITY**



**Fire Severity**

- Fire severity is rated as low, moderate and high based on visual fire effects to soil or vegetation. Example below for soil.


20




## THE FIRE BEHAVIOR TRIANGLE

### Fire Spread


- Fire spread is the movement or progression of fire through a fuel bed
- It is measured by feet per minute or chains (66 ft.) per hour.
- Fire spread is influenced by the type and continuity of fuel, moisture content of fuel, topography, and weather factors, such as wind.


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## FIRE TYPES

- **Ground fires**
- **Surface fires**
- **Crown fires**
  - Passive
  - Active


23







## FIRE SPREAD

### Fire Spread


Fuel Type	Rate of spread
Grass and bitterbrush (2-GR)	46 chains/hr. (3,036 ft.)
Ponderosa pine/bitterbrush (4-PP-4)	9 chains/hr. (594 ft.)
Dense ponderosa pine/heavy surf. fuels (6-PP-4)	5 chains/hr. (330 ft.)




Head fire in grass with rapid spread




Backing fire in grass with slow spread



Dense PP with heavy surface fuels



22

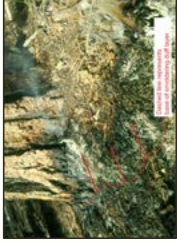



## FIRE TYPES

### Ground fires

- Burn below the surface in duff, roots, buried logs, and peat
  - Peat fires:
    - Slow rate of spread
    - Long duration, high severity
    - Peat fires can last for years
    - Difficult to extinguish
  - Burning in duff around large ponderosa pine trees
    - Long duration smoldering fire
    - Tree mortality







24




**FIRE TYPES**




**Surface fires**

- Consume litter layer, herbaceous vegetation, shrubs, twigs, and branches
- The higher the fuel loading on the surface, the greater the flame length and the greater the intensity of the fire

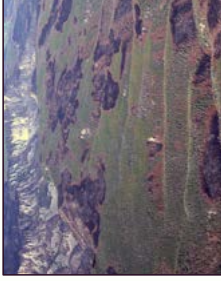


25

**FIRE REGIMES**




- Describe the predominant types of fire in ecosystems.
- Fire regimes have the following elements:
  - Frequency
  - Fire intensity and severity
  - Extent
  - Seasonality
  - Synchrony / synergy with other disturbances
- Vegetation, climate, and topography are factors that determine the fire regime in a given area.





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**FIRE TYPES**



**Crown fires:**

- Passive
  - “Torching” of individual trees or small groups of trees
- Active
  - Crown-to-crown combustion

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**FIRE REGIMES**




Characterizing fire regimes by frequency and severity

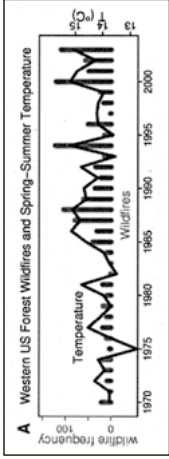


28

**POTENTIAL CLIMATE CHANGE EFFECTS**



- CO<sub>2</sub> levels have risen to over 400 ppm and global temperatures are 1.53°F higher than in early industrial times.
- Fire seasons are about 5 weeks longer today, with an uptick in very large wildfires across the western U.S.




**A** Western US Forest Wildfires and Spring-Summer Temperature

- Implications for plant ecology, human infrastructure, and fire suppression tactics and costs.

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**POTENTIAL CLIMATE CHANGE EFFECTS**



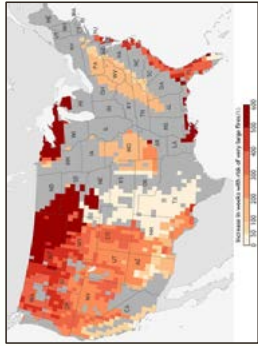
- In addition to climate change potential, other factors that may contribute to very large wildfires now and into the future include:
  - Effects of fire exclusion over the last 100+ years and the build-up of fuel in many of the dry forest types in the western U.S.
  - Changes to firefighting tactics. More conservative fire management approaches will err on firefighter safety rather than attack at all cost.
  - There is a growing sentiment that in order to get ahead of the wildfire problem, we need to allow wildfires to do more of the work (fuel reduction) by managing wildfires.

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**POTENTIAL CLIMATE CHANGE EFFECTS**



- The projected percentage increase in the number of “very large fire weeks” by mid-century (2042-2070) compared to recent past (1971-2000). (NOAA)



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**This concludes this module training.**

**Thank you!**



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# Module 4: Fire Management

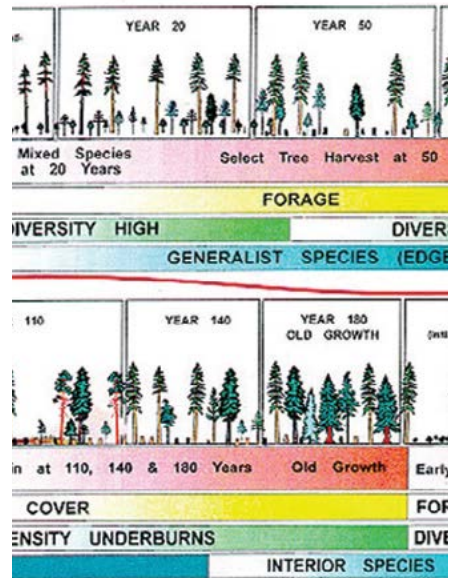


Photo: Michal Bukowski

Statue of St. Florian, the patron saint of firefighters, erected in the XIX century after a great fire in the village of Lipnica Murowana, in Lesser Poland.

## Proposed Agenda

Time		Section name
8:00	8:30	Welcome
8:30	9:00	Introduction and Objectives
9:00	9:30	Activity I and discussion
9:30	10:00	Break
10:00	10:30	History and Policies
10:30	11:00	Standards and Orders
11:00	11:30	1910 revisited
11:30	12:00	How Things Change
12:00	12:30	Lunch
12:30	1:30	Incident Command System
1:30	2:00	Wildland Fires
2:00	2:30	Structural Fires
2:30	3:30	Risk and Safety
3:30	4:00	Lessons Learned
4:00	4:30	Egos, Personalities, and Politics
4:30	5:00	Wrap-up
5:00	5:30	Discuss plans for the fire field trip

## Overview

This module focuses on the history and social contexts of fire management, how those contexts influence policies, how fire management evolved over time, and basic fire management objectives.

## Learning Objectives

- Understand the history of wildland fire fighting in a cultural, political, and social context
- Identify and define different approaches to suppressing and controlling fire
- Understand the management objectives for fire suppression (wildland and structure)
- Compare and contrast the uses of fire control vs. fire use vs. fire managed for natural resource benefit
- Try on a set of gear for wildland and structure firefighters (under supervision)

## Learning Outcomes

- Incorporate and compare a risk assessment process into your life with an understanding of fire risk concepts
- Organize a family event using an ICS organizational structure

## Content Outline

- Introduction
- History and Policies
  - The Incident Command System
  - The NWCG
  - More tragedies mean more adaptation
  - Standardization
- Wildland and Structural Fires
  - Wildland fires
  - Structure fires
  - Risk
- Put it out
  - Fire prevention
  - Fire control
  - Fire exclusion
  - Fire suppression
  - Fire containment
- Management Objectives for Suppression
  - Life and safety (tools used)
  - Incident stabilization
  - Property and resources
- Prescribed Fire
- Lessons Learned
- Work/Rest
  - Guidelines
- Regulations
  - Smoke, air quality, and health
- Egos, Personalities, and Politics

*“It is with our passions as it is with fire and water; they are good servants, but bad masters.”*

**Roger L’Estrange**  
*Aesop’s Fables, 1692*

## Introduction

No one knows when the first human “managed” fire. Some suggest the earliest form of fire management took place in South Africa over 5 million years ago—when that first human saw a lightning strike and swallowed fear to take away a firebrand to start another fire. Managing fire with tools such as wooden drills or flint stones dates to the Neolithic Age, about 7000 B.C.E. Prior to European settlement, Native American tribes throughout Oregon, the Pacific Northwest, and the Americas used wildland fire to manage ecosystems primarily to increase the availability of food plants such as camas (*Camassia* spp.) and huckleberry (*Vaccinium* spp.), and game species such as deer (*Odocoileus* spp.) (Figure 1). As pandemic disease took a toll on populations and settlements displaced native habitation, the use of “managed” fire by Native Americans had ceased by the early 1900s.

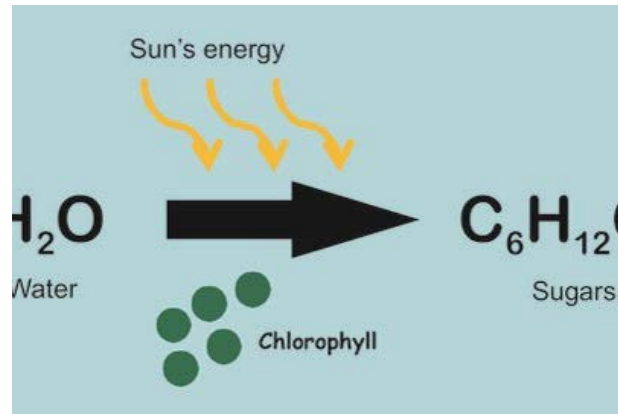


Image Source: PhotoBucket user RaxaCollective

Figure 1. An illustration shows Native Americans starting a fire to improve forest health.

Structure and wildland fire management shifted in the late 1800s and early 1900s after many catastrophic forest and structure fires hit the United States. On October 8, 1871, the Peshtigo fire started to burn in Wisconsin (Figures 3 and 4). Fueled by 110 mph winds, the fire ultimately consumed 1.28 million

## History and Policies

Fire management has evolved over time. In 1608, settlers in Jamestown, Virginia had the first recorded major fire in the New World. It burned down many structures in the settlement and destroyed provisions. Many settlers died that winter from lack of food and exposure to the severe winter. In 1653, Boston, Massachusetts purchased its first fire engine, and in 1678 formed the first paid fire company. Philadelphia and New York also formed fire companies in the 1700s (Figure 2). Following that, the U.S. began organizing fire management. The basic tools were leather buckets, hooks, and small ladders, and in some areas horse-drawn water wagons were employed.

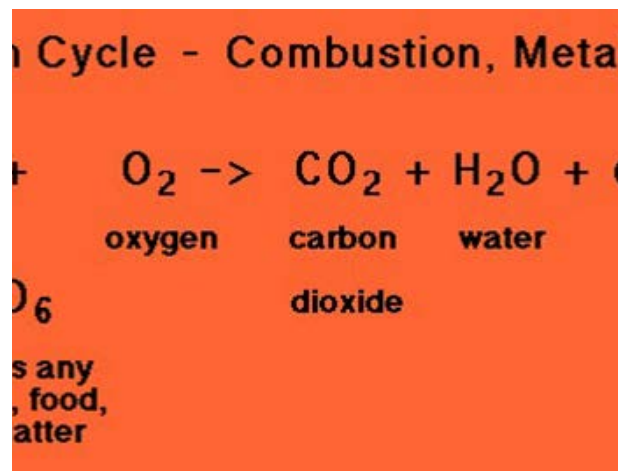


Illustration: Harvard Theatre Collection, Houghton Library, Harvard University

Figure 2. An illustration depicting firefighters battling a structure fire in New York City.

**Table 1. The largest Oregon fires from 1849–1945**

Year	Fire name	Acres burned	Notes
1849 (also listed as 1853)	Yaquina Fire	480,000	Started near Corvallis and swept across the Coast Range to Yaquina Bay on the Pacific Ocean at Newport.
1865	Silverton Fire	990,000	The largest fire in recorded history in Oregon, it started southeast of Salem and burned nearly 1,547 square miles—more than three times the size of Multnomah County.
1868	Coos Bay Fire	300,000	What is now the Elliott State Forest in Coos County
1902	Columbia Fire	170,000	Also known as the Yacolt burn. Near Mount Hood
1933	Tillamook Fire	240,000	Washington, Yahmill, Tillamook counties
1936	Bandon Fire	287,000	The city of Bandon and its surroundings, killing 13 people
1939	2nd Tillamook Fire	217,000	Near the Wilson and Salmonberry rivers
1945	3rd Tillamook Fire	173,000	Covering portions of the two earlier burns

Source: "Oregon's Largest Wildfires," The Oregonian, 2017

acres of forested land, 12 communities, and killed between 1,200 and 2,500 people. The Great Chicago Fire started that same evening, destroying up to 3.3 square miles (1/3 of the city), leaving 100,000 residents homeless, and up to 300 people dead. Oregon experienced large fires from 1849-1945 (see Table 1).

In 1906, the San Francisco Earthquake and resulting fires caused almost three times the economic loss of the Great Chicago Fire

(Figure 5). Fires caused more damage than the earthquake, burning for three days and destroying a quarter of the city (28,000 buildings and about 500 city blocks). More than 3,000 died and 250,000 were left homeless.

Getting “wet stuff on the red stuff” was proving a big problem with hand- and horse-drawn equipment. Many sought a better way to deliver water to fires. James Bichens Francis is credited with designing the first perforated pipe

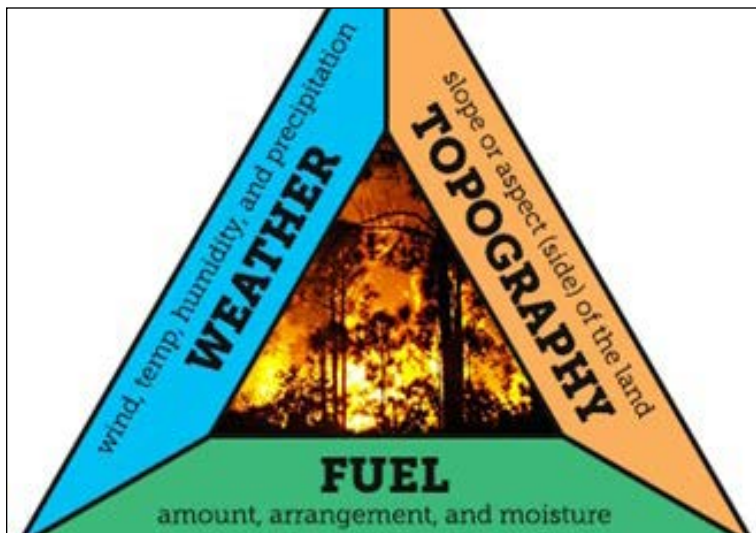


Illustration: Wisconsin Historical Society

Figure 3. A painting depicting the 1871 Peshtigo Fire.



Illustration: courtesy of [www.exploringoffthebeatenpath.com](http://www.exploringoffthebeatenpath.com)

Figure 4. Map showing the Peshtigo Fire.



Photo: Arnold Genthe, 1906

Figure 5. After the 1906 quake, people on Sacramento Street are awestruck by the enormity of the devastation and the resulting fires in San Francisco.

water delivery system, a precursor to today's sprinkler systems. He installed the first system in 1852 in Massachusetts. Throughout the mid-to late-1800s, sprinkler systems were tested and installed with varying levels of success. In the latter part of the 1800s, the National Fire Protection Association (NFPA) and sprinkler system innovators teamed up to improve fire management.

### ✓ Activity I<sup>1</sup> – Personal Reflections

#### ○ Appendix A

Early catastrophic fires shifted perception of the dangers of large fires and directed fire management for the next 100 years. Citizens and legislators demanded better fire protection and suppression.

The NFPA formed in 1896 as a direct response to the public pressure. NFPA developed codes and standards for fire and safety. In 1897, NFPA adopted a standard regulating the installation of fire-protection sprinkler systems in structures as the general policy became to establish

standards to suppress, exclude, and control fire. NFPA is the current building code and fire department standard and is going strong to this day. According to its website, the organization publishes more than 300 codes and standards intended to eliminate death, injury, property, and economic loss due to fire, electrical, and related hazards. NFPA codes and standards are administered by more than 250 technical committees employing nearly 9,000 volunteer committee members, and the organization's standards are used throughout the world.

### ✓ Activity II

#### ○ Videos

NFPA also produces training and equipment standards, offers public education, and conducts and supports research.

Many fires from the mid-1800s to the early 1900s were caused by mining construction, forest clearing, railroads with fire-prone equipment, and farmers clearing land. Brian Fagan, author of the book *The Little Ice Age* (2000 by Basic Books, New York, NY), concluded that a sustained warming and a “high incidence of westerly winds and mild winters” began between 1890 and 1900

<sup>1</sup> See Activities section for details on all activities in this curriculum



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*“Wallace has fallen at last,” the front-page story reported. “This morning, unless an act of Providence intervened, only the ashes and smoldering embers mark the place where yesterday morning stood the most beautiful city in the Coeur d’Alenes.”*

**—The Big Burn by Timothy Egan**  
(2009, Mariner Books, New York)

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and “continues, with one short interruption, to this day.” This resulted in increased “red flag” conditions of increased temperatures, lowering humidity, and high winds that may have contributed to the catastrophic fire conditions of that time.

Regardless of the reason, the structure fire service adapts to fit the needs—and responds most to calamities and tragedies.

Federal forest management started wildland fire service in 1876 when Congress created the office of special agent in the U.S. Department of Agriculture to assess the quality and conditions of forests in the United States. In 1881, the department expanded the office into the Division of Forestry. A decade later Congress passed the Forest Reserve Act of 1891 authorizing the president to designate public lands in the West into what were then called “forest reserves.” Responsibility for these reserves fell under the Department of the Interior until 1905, when President Theodore Roosevelt transferred their care to the Department of Agriculture’s new U.S. Forest Service. Gifford Pinchot led this new agency as its first chief, charged with caring for the newly renamed national forests (<https://www.fs.fed.us/learn/our-history>.)

The great Chicago and San Francisco fires destroyed cities, infrastructure, and people. The structure fire service and the building industry adapted and adjusted to prevent that from happening again. The Peshtigo fire is the deadliest fire in American history, leaving 1,200 to 2,500

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*From the courage of the Buffalo Soldiers who saved so many lives in Wallace and upper St. Joe country to Ed Pulaski, who lost five firefighters but saved 41 others just outside of Avery, there are many stories of heroism and cool leadership during the 1910 fires. (Figure 6)*

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people dead. It consumed the town of Peshtigo, Wisconsin and many other villages.

It also burned over approximately 1.5 million acres of forest. This was a reason used to create a forest service to provide a stewardship role in caring for the nation’s forests. Forest fires as well as the need to manage the nation’s national forests played a role in creating the U.S. Forest

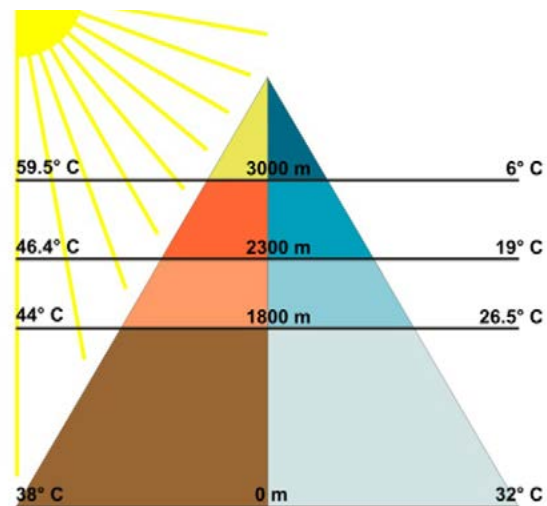


Photo: U.S. Forest Service

Figure 6. Mine shaft where Ed Pulaski kept his crew at bay – and safe—from the 1910 fire near Avery, Idaho.

*“Excitement is the enemy of effectiveness. A fire is an awe-inspiring thing and the roar, smoke and flame too frequently shake the nerve and judgment. Intelligent caution has its place, but nothing more than the roar of a flaming tree or a small watershed sometimes produces what is really a panic in the minds of fire bosses. Everyone has heard otherwise levelheaded mountaineers say, ‘If it gets across the road all the men in the county can’t stop it.’ Everyone has also seen just such fires cross and then be controlled quickly and with comparative ease where some cool head got hard, steady work substituted for scare. Barring always high continuous winds, there is no such thing as a fire which cool, hard work, properly applied, will not corral in a few days with a few thousand dollars.”*

**Roy Headley, 1916**

*Fire Suppression, District 5. U.S. Forest Service*

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Service (USFS). From the beginning, the Forest Service took no chances and adopted a policy of total fire suppression, even though early foresters recognized the need for “light burning” to manage understory vegetation. This was problematic in that the national forests in the West were large, remote tracts of land and personnel and fire equipment consisted of a ranger with a horse and pack mule—or a fire backpack. Fire lookouts installed to assist the rangers in detecting and traveling to wildfires were no more than a platform precariously affixed to the top of a tall tree on a ridge.

Five years after the initiation of the USFS, the fledgling agency faced a test. The Big Burn of 1910 flared up with hurricane-force winds on a hot, dry August and spread through northeast Washington, northern Idaho, and western Montana (Figure 7). It spawned 1,736 fires, consumed 3 million acres, and killed 85 people in just two days. Entire towns and drainages were burned and blackened. The north Idaho town of Wallace lost the entire east end of the town.

Wallace eventually rebuilt and is now an historic town nestled under an interstate overpass. Travel from St. Maries, Idaho and on past Avery along the mountainous terrain on the upper reaches of the St. Joe River: one can still see the tops of 1910-burned western redcedar (*Thuja plicata*) snags poking up through the thick forests that regenerated following the fire. Anyone traveling in that area today can imagine the pain and sacrifice, flames and heat everyone endured that summer of 1910.

There are many stories of heroism, cowardice, panic, fear, and cool leadership during those 1910 fires. The tiny whistle-stop of Avery became the logistics center for the fires in the upper St. Joe. Army troops, homeless travelers, former vagrants, federal agents, and evacuated folks from all over the forest and mountains converged on the town.

They were loosely organized and sent into the Bitterroots to stop the fires or were evacuated. Avery was the last outpost at that time, with trails that led up into the upper reaches of the St.

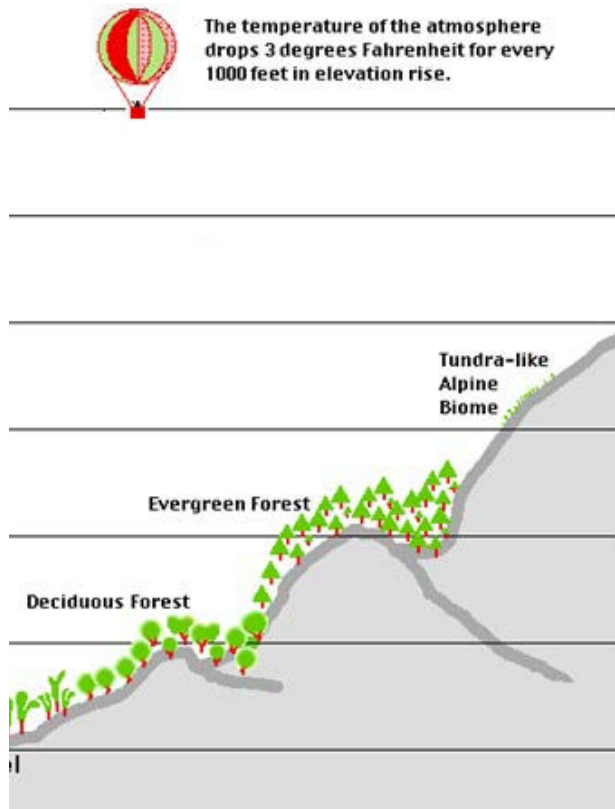


Photo: U.S. Forest Service

Figure 7. The Great Burn of 1910 consumed 3 million acres, having thousands of individual fires of various sizes over three states.

Joe River where the fires burned. The Civilian Conservation Corps built a group of buildings 37 miles upriver from Avery in the 1930s to plant trees, build roads, and repair watersheds still damaged by the fires of 1910. They also had to fight the new fires of the 1930s that included reburns of 1910. The Red Ives Ranger District used that same group of buildings for the District compound up until 1984, augmented by trailers for the employees and crews.

Fire crews mustered there in the '70s and were sent out over areas first burned in 1910 and the 1930s and reignited as dry weather and summer thunderstorms struck the area. Crews in the '70s did not face the same conditions as the crews in 1910, but fires did burn with varying levels of severity and kept things lively all summer long.

What happened during that summer of 1910 influenced an agency, a nation, and Congress to

change wildland fire management. Improving fire management became the main objective. Visions of burned-over canyons and hillsides, bodies wrapped in canvas, and towns in ashes drove Forest Service chief William Greeley to keep that summer from happening again.

The Weeks Act signed in 1911 allowed more cooperation between federal and state governments for fire control. Soon after, many fire protection associations organized to ensure proper budgets, equipment, and personnel were available to fight fires, especially on commercial timberland. Some of the first fire protection associations in the country appeared in southern Oregon. The Klamath Fire Protection Association started in 1908, and the Walker Range Forest Protective Association (Walker Range Fire Patrol Association) originated in 1927. Both are still in existence.

Still buffeted by the catastrophic 1910 fires and severe fires in the '30s, the wildland fire service responded for many decades by increasing budgets and resources to fight fires above all else. The quality of resources also changed after 1910. Conscripting men from the skid rows did not work well and the Forest Service made the first attempt to get better-quality firefighters by the admonition given in 1916 (Table 2, page 10). In 1935, the Forest Service created the "10:00 a.m." rule: all wildland fires were completely out by 10:00 a.m. the next morning after initially reported. All fires—all puffs of smoke and all embers—were extinguished by early morning the next day. This was modified in the late '70s and '80s to allow some flexibility in contain-and-control strategies.

Records of wildland firefighter fatalities began following the Great Burn of 1910. That year, 78 firefighters lost their lives in the line of duty. According to records kept since then by the National Interagency Fire Center in Boise, Idaho, 430 firefighters died from 1911 to 1970; 387 died from 1971 to 1999; and 241 lost their lives from 2000 to 2011 (the latest available official record).

**Table 2. Firefighter classifications, 1916**

Firefighter classification	Description
Class A	Men worthy of complete confidence; exerting a well-recognized anti-fire influence, possessing superior physical ability and power of endurance. Men who on a control line "work on their nerve," or who will do so if given proper inducement. Men who have the experience and personality to succeed as Crew Bosses (not merely Crew Leaders.)
Class B	Trustworthy men equal to those of Class A, except that they do not possess the qualifications of successful Crew Bosses or have not as yet had an opportunity to prove them.
Class C	Trustworthy but ordinary men.
Class D	Shirkers; disorganizers; men without proper shoes; men who are from inexperience or inclination disinclined to respect authority and orders; men suspected of incendiary tendencies or of nursing a fire; men not trustworthy for any other reason.

Admonition from the 1916 Forest Service Fire Suppression Manual: "Class D men should never be hired when it can be avoided. There are circumstances which make it necessary to hire about every known type of Class D men, but the necessity should be clear."

Fire management policies, procedures, and guidelines for wildland and structure fires evolve with significant events, which are primarily loss of lives and resources. Richard E. McArdle, the Forest Service chief in 1957, asked a task group to look back on the fatalities that occurred in the previous 20 years of wildland firefighting (records show 167 fatalities between 1937 and 1957). The impetus for this effort was the 1957 Inaja Fire in Southern California, where 11 firefighters lost their lives. This tragedy required a new look at training, protective clothing, and fire behavior

research, such as developing fire shelters. There were fire orders prior to this, but the loss at the Inaja required a new perspective. These are what resulted:

Wildfire fighters in the 1970's followed these orders carefully. They memorized these orders and aggressively fought fire.

Fire management at that time resembled military campaigns. Firefighters in the '70s and '80s understood the need for risks and sacrifice, since many were veterans of the Vietnam War.

### Original Standard Fire Fighting Orders

1. Keep informed of FIRE WEATHER conditions and forecasts.
2. Know what your FIRE is DOING at all times observe personally, use scouts.
3. Base all actions on current and expected BEHAVIOR of FIRE.
4. Have ESCAPE ROUTES for everyone and make them known.
5. Post a LOOKOUT when there is possible danger.
6. Be ALERT, keep CALM, THINK clearly, ACT decisively.
7. Maintain prompt COMMUNICATION with your crew, your boss, and adjoining forces.
8. Give clear INSTRUCTIONS and be sure they are understood.
9. Maintain CONTROL of your men at all times.
10. Fight fire aggressively but provide for SAFETY first.

Every Forest Service employee who will have firefighting duties will learn these orders and follow each order when it applies to his assignment.

**In the 1980s, the 10 Standard Firefighting Orders were rearranged into an “acrostic” series in which the first letter in each line spelled out: “FIRE ORDERS:”**

- |   |  |
|---|--|
| <b>F</b> ight fire aggressively, but provide for safety first.            | <b>R</b> emain in communication with crewmembers, your supervisor, and adjoining forces. |
| <b>I</b> nitiate all actions based on current and expected fire behavior. | <b>D</b> etermine safety zones and escape routes.  |
| <b>R</b> ecognize current weather conditions and obtain forecasts.        | <b>E</b> stablish lookouts in potentially hazardous situations.                          |
| <b>E</b> nsure instructions are given and understood.                     | <b>R</b> etain control at all times.   |
| <b>O</b> btain current information on fire status.                        | <b>S</b> tay alert, keep calm, think clearly, act decisively.                            |

Fatalities still happened and management continued to structure an organization that tried to minimize that.

Fatalities continued to drive the efforts of the Standard Fire Orders and Situations That Shout Watch Out. The fatalities also pushed the development of fire management and fire research overall. A 2002 article published by Ted Putnam (USFS employee, smoke jumper,

leader of wildland fire fighting, and role model) recommended several changes to the Standard 10 (see chart below).

Following the fires of the early 2000s, the Standard Firefighting Orders changed back to the 1957 Orders with a few key differences (see Current Standard Firefighting Orders, page 12). Jennifer A. Ziegler, the dean of the graduate school and continuing education at Valparaiso

**Ted Putnam Recommended Changes to the STANDARD FIRE ORDERS (2002):**

**Situational analysis**

1. Mindfully attend to your current state of mind — to stay alert, keep calm, think clearly, and act decisively.
2. Size up fire behavior, weather, topography, and fuels. Use lookouts and obtain forecasts as needed.
3. Provide for safety by assessing relevant risk factors including escape routes, survival zones, and safety zones.
4. Plan key actions based on your mental, fire behavior, and safety size-ups.

**Take action**

5. Communicate with others including adjoining forces using clear, standardized, systematic protocols.
6. Act decisively.

**Re-evaluate**

7. When you stop noticing changes, WAKE UP, go back to number 1.
8. When you notice significant internal or external changes, go back to number 1. Degree of changes in situational size-up and actions should correspond to the degree of observed change.

**Disengage**

9. Disengage from the fire when you no longer feel alert or safe.

**Accountability**

10. Supervisors shall conduct on-the-job training in the application of the above orders to ensure their understanding and operational use.

### Current Standard Firefighting Orders

1. Keep informed on fire weather conditions and forecasts.
2. Know what your fire is doing at all times.
3. Base all actions on current and expected behavior of the fire.
4. Identify escape routes and safety zones and make them known.
5. Post lookouts when there is possible danger.
6. Be alert. Keep calm. Think clearly. Act decisively.
7. Maintain prompt communications with your forces, your supervisor, and adjoining forces.
8. Give clear instructions and be sure they are understood.
9. Maintain control of your forces at all times.
10. Fight fire aggressively, having provided for safety first.

University, gave an excellent summary of how the Orders have changed in her video *History of the Standard Fire Orders*. Ziegler said the original orders of 1957 controlled and directed the individual firefighter. The current orders allow the firefighter to better assess risk and question conditions that may not be safe. Time will tell if the organization can reduce dreaded fatalities in the high-risk environment of wildland firefighting.

#### ✓ Instructor Resources

○ The 2014 Incident Response Pocket Guide (<https://www.nwccg.gov/sites/default/files/publications/pms461.pdf>).

Firefighters in the '70s also had *13 Situations That Shout Watch Out* to guide them on the fireline. These are the original 13 established by an unknown source in the '60s and adapted by the El Cariso Hot Shots (Cleveland National Forest in Southern California) in 1972–1973 for the first curriculum for basic wildland firefighter training (<https://www.youtube.com/watch?v=KKT-KH3QMx0>.)

1. YOU—feel like “Taking a Little Nap” NEAR the FIRE LINE!
2. YOU are in country YOU have NOT Seen in Daylight!
3. YOU—are in an area where You are Unfamiliar with Local Factors Influencing FIRE BEHAVIOR!

4. YOU—have been given an assignment and/or instructions NOT CLEAR TO YOU!
5. YOU—are building a line downhill TOWARD A FIRE!
6. YOU—are attempting to make a frontal assault on a FIRE with TANKERS (modern meaning is engine or water tender)
7. YOU—are in heavy cover with unburned fuel Between YOU and FIRE!
8. YOU—cannot see Main Fire and YOU are NOT in Communication with anyone who can!
9. YOU—are on a hillside—rolling fire can ignite fuel BELOW YOU!
10. YOU—feel weather getting HOTTER and DRIER!
11. YOU—notice wind CHANGE!
12. YOU—are getting frequent Spot Fires OVER YOUR LINE!
13. YOU—are in an area where Terrain and/or cover make Travel SLOW and DIFFICULT!

In 1987, the Situations added five common “Watch Outs,” again based on lessons learned during the fire seasons that followed, and reordered all 18. These current “Watch Out” situations are dangerous enough to develop a higher level of situational awareness while fighting wildland fires:

1. Fire not scouted and sized up.
2. In country not seen in daylight.
3. Safety zones and escape routes not identified.

4. Unfamiliar with weather and local factors influencing fire behavior.
5. Uninformed on strategy, tactics, and hazards.
6. Instructions and assignments not clear.
7. No communication link with crewmembers or supervisor.
8. Constructing line without safe anchor point.
9. Building fire line downhill with fire below.
10. Attempting frontal assault on fire.
11. Unburned fuel between you and fire.
12. Cannot see main fire, not in contact with someone who can.
13. On a hillside where rolling material can ignite fuel below.
14. Weather becoming hotter and drier.
15. Wind increases and/or changes direction.
16. Getting frequent spot fires across line.
17. Terrain and fuels make escape to safety zones difficult.
18. Taking a nap near fire line.

✓ **Activity III – Fire Exclusion**

✓ **Activities IV and V – Field Exercises**

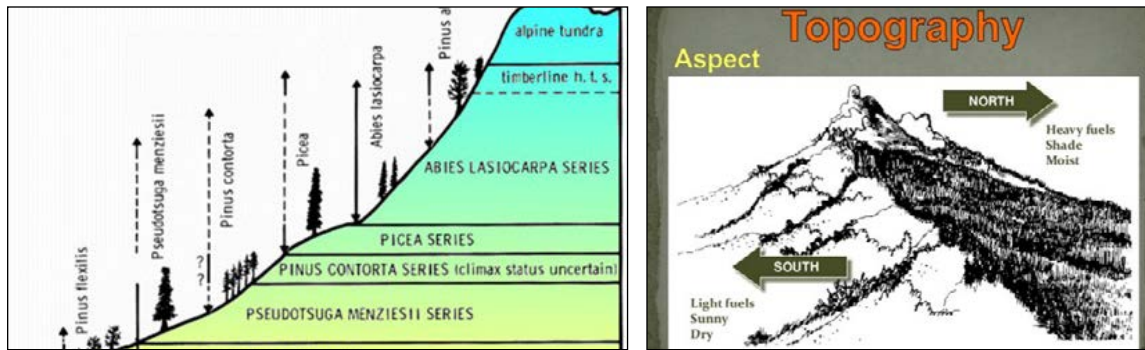


Photo: U.S. Forest Service

Figure 8. The Red Ives Ranger Station, now a historic cabin for rent on the rugged, upper St. Joe River.

## 1910 Revisited and How Things Change (A Personal Narrative)

*Living and working in the Red Ives Ranger District in the 70s (37 miles upriver from Avery) was a constant reminder of what the 1910 firefighters faced in the Great Burn (Figure 8).*

*Avery, Idaho should be the end of the road. Located 47 miles up the St. Joe River from St. Maries, Avery is a small, whistlestop village of a few buildings, a saloon, and an abandoned railway station. The Red Ives Ranger District in the '70s was located 37 miles farther up the St. Joe River from Avery. The location was so remote, a person felt like an intruder. The Civilian Conservation Corp (CCC) built and maintained this compound in the '30s. The CCC had an encampment here and built cabins, administration buildings, a shop, a warehouse, and a water wheel for power. It took an hour to drive the 10 miles off the main gravel road from Avery to St. Regis, Montana to the District offices and housing facilities. The 10-mile road was narrow, ungraveled, and spotted with innumerable potholes. Five miles in, Wahoo Pass (aptly named) had a rocky knob on one edge of the one-lane road, an 8-foot width, and a 1,000-foot drop-off down the ravine. We had an old diesel generator that worked off and on and a gravity-fed water supply. This is where the crews of the 1910 fires journeyed to confront the flames, hiking in with packhorses. We also responded to lightning strikes when puffs of smoke appeared. We followed the same roads and hiked miles in the same remote country to put all fires dead out. Whether forester, technician, or biologist, we all made up fire crews during the summer and fall. That was expected. The land was steep and communication was poor in the '70s. We fought fires in the same area and terrain as the firefighters recruited from the skid rows of Portland and Spokane that summer of 1910.*

*Our radios in the '70s were bulky and hard to carry, operating on 12, D-cell batteries. Only a few of us had them and reception was limited. The fire crews in 1910 had shouts, cries, and nothing else to communicate. We had metal hardhats, jeans, and logger boots—and maybe a newly designed fire-resistant shirt. Firefighters in 1910 had fedoras, wool pants, flannel shirts, and maybe boots. We had some training in using a map and compass. Some firefighters in 1910 had never been in a forest before. We had Pulaskis and shovels. Firefighters in 1910 had pick axes and shovels when they could get them. We didn't have fire shelters yet, but among the biggest differences between fire management in the '70s and 1910 was the organization, equipment, and training. We had fire supervisors who mentored and guided us through training and application of skills. The Big Burn had conscripted firefighters led by untested and inexperienced leaders. We also had helicopters.*



	Variable-severity regime (low, moderate and high)	
	Fire interval	Role of fire and post-fire regeneration
<b>Arno and Fiedler</b>	Low severity: 1-30 years Moderate: 30-100 years High: 100-400 years	Fire of moderate severity eliminates most saplings, preserves a part of the oldest trees High-severity fire creates a heterogeneous forest See above about the role of low-severity fire
<b>Baker and colleagues</b>	Low severity: perhaps 60-300 years	Ecological role of high-severity fire (usually during the...
		Type of forest created Open or partly open forest Well-spaced in height (various tree ages) Dominated by ponderosa pines, lodgepole pines (○), Douglas-firs, hemlocks, cedars (●)... Widespread herbaceous and shrub species

Photo: Paul Mashburn

Figure 9. C rations typically used by firefighters decades ago.

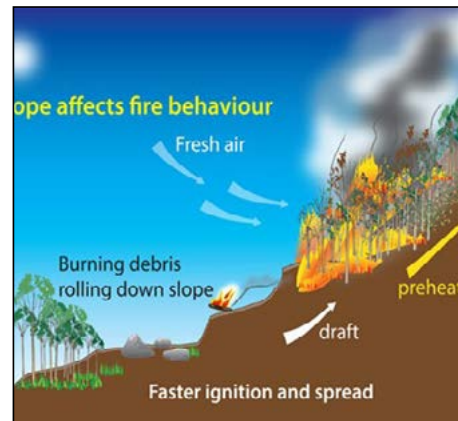


Photo: Daniel Leavell, © Oregon State University

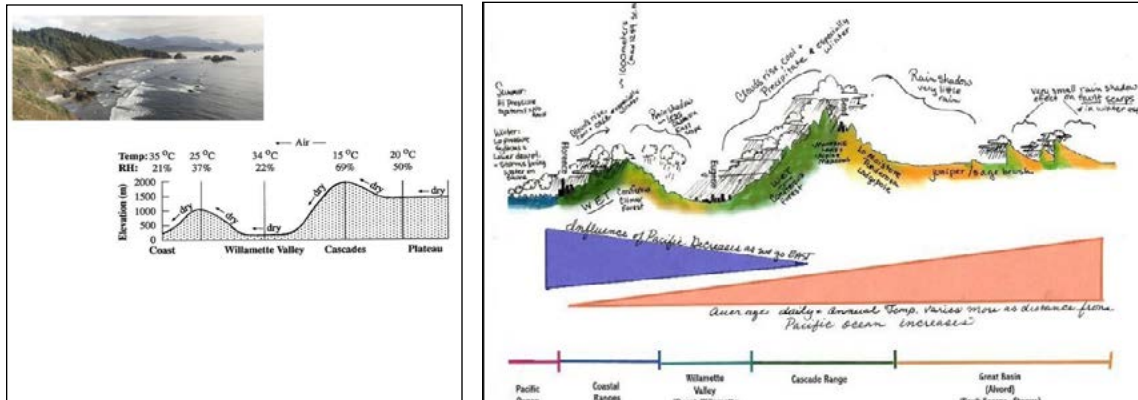
Figure 10. P-38 can opener, designed by military specs. The device was developed in 1942.

## How Things Change

*In the 1970s we had the food we carried in our Army surplus “butt-packs” and green, canvas FS backpacks we hauled to the fire line. If we were lucky, that turned out to be old, dusty boxes of C-Rations that were also surplus from the military and stored in fire warehouses (Figure 9). We were out for weeks at times and maybe re-supplied whenever a helicopter made a drop, which wasn’t often. The C-Rats kept us going. The trusty P-38 can opener in each box was highly prized to open the small cans of food (Figure 10). Warmed over embers inside the line made it quite tasty. Fire management was always trying new things to make life better on remote fires. In the late ’70s we passed quickly through a makeshift central fire camp. They had the new gut bags for our meals. A gut bag was food processed into plastic bags and boiled in large garbage cans over burners. There was a gut bag for breakfast, lunch, and dinner. We had to move out, and only had time to grab a bag and eat it fast. The breakfast bag consisted of two sausage links, green scrambled eggs, and a blueberry muffin. I didn’t have time to eat it all, so I wolfed down the sausage and eggs and wrapped the muffin in a napkin and threw it into my butt pack and headed out. We went from fire to fire that entire summer and into the fall. The muffin was lost in the pack throughout the season and forgotten when I threw the pack into the closet for the winter. The next spring I had to prepare for the new fire season and emptied the pack upside down to clean it. There rolled the muffin along the floor. I picked the thing up and was amazed —it was as fresh and soft as if it was baked that morning.*

*Food and lodging on fires evolved as new safety clothing, equipment, and management were introduced. Over the years, sleeping on the ground rolled up in duff and needles evolved into curling up in paper sleeping bags, then issued mummy bags, then tents, then air mattresses. Fire camps began to produce catered meals out of kitchens—shower facilities showed up, and cleaning and washing stations (Figure 11). Food went from C-Rats to MRE’s (meals ready to eat) to steak and mushrooms and full salad bars. Fire camps in the 2000s were luxurious and clean compared to the early days.*

*Structure firefighting has also changed. When attending fire academy in the early ’70s, we had leather helmets, rain slickers, rubber boots, and gloves. Our live fire training took place in a 3-story concrete building with a metal grate for a floor. The instructors would light the jet fuel under that grate and flames and black smoke would engulf the building and fill the atmosphere above. Our training task: take the hose, get in there, and put it out. No self-contained breathing apparatus, no flame-resistant turnout gear, no radios—but we did have a hose and water.*



Photos: Incident Catering Services

Figure 11. Photos show washing and dining facilities set up to support firefighters working on a wildfire.

## The Incident Command System

Tragic, catastrophic events prompted the Fire Service and fire management to adapt and evolve over the last 200 years in the United States. Safety clothing, equipment, communication, expectations, training, technology, policies, rules, and guidelines have all dramatically changed in response to key events. Organization has also changed, and the Incident Command System is an example of this (Figure 12).

Death Valley in Southern California is one of the hottest places on Earth, with 3,000 square miles of desert, elevation at almost 300 feet below sea level, and temperatures that can reach over 130 degrees at the height of summer. “Devil Winds” form when cool, dry, high-desert winds originating further east in the Great Basin blow over the desert furnace and westward towards the Pacific Ocean. These hot, dry winds, also known as Santa Ana winds, usually occur in fall and early winter and can blow up any fires that burn inland towards the coast. This is a danger every year—and can become a fire-management nightmare.

That is what happened in September and October 1970. Santa Ana-fanned wildfires blew up 773 wildfires, burned 576,508 acres, destroyed 722 homes, and killed 16 people. This tragic event created the federally funded project called the “Firefighting Resources of Southern California Organized for Potential Emergencies,” otherwise

known as FIRESCOPE. Research coming out of FIRESCOPE led to the Incident Command System (ICS). Before this, fire management depended on local standard operating procedures and organizations. New York City was famous for keeping individual cultures alive at every neighborhood fire station, and fire departments were more likely to compete than to collaborate. Likewise, law enforcement agencies and medical services did not have the best means of integrating resources prior to the development of ICS.

Findings from the 1970 fire season concluded:

1. At the incident or field level, firefighting crews were confused because different units used different terminology, organizational structure, and operating procedures.
2. At the agency or coordination level, fire managers did not have adequate mechanisms to coordinate and handle competing resource demands and to establish consistent resource priorities.

Congress allocated funds to research how to improve things. Previous wildland fire organizations relied on the Large Fire Organization (LFO) structure. LFO originated after World War II when returning veterans adapted their military command and control experience to wildland fire management. LFO bore some resemblance to military command and control. It was adapted to wildland fire

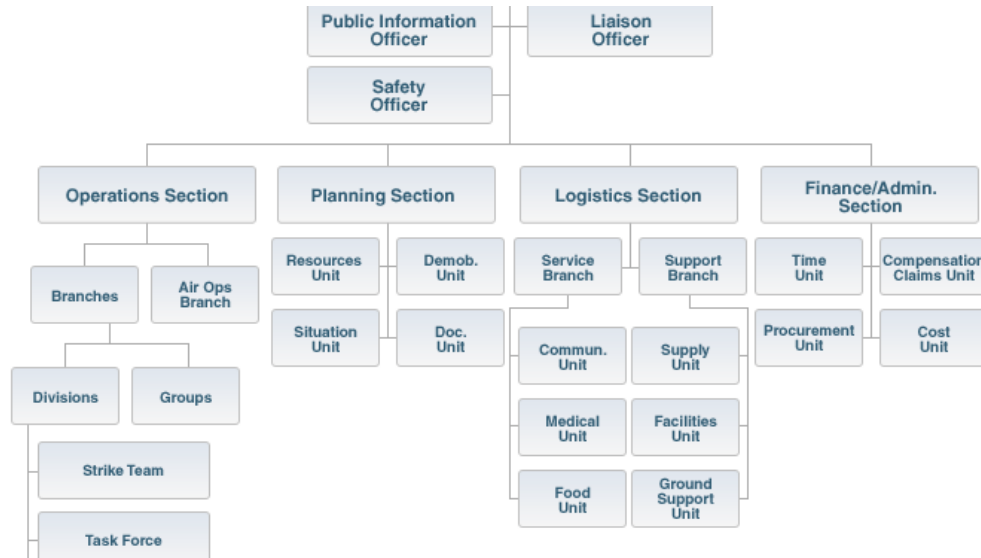


Figure 12. An example of the Incident Command System organization chart. It has not changed very much from the original and has formed the basis of wildland fire management organization ever since. The ICS system brought order to chaos. One of the benefits is that the organization expands and contracts and is very adaptable to fit any emergency incident. It's been used on one-person spot fires to 100,000-acre wildfires employing thousands of resources.

management. Many veterans hired by the fire management agencies were comfortable working with an organization familiar to them.

LFO could incorporate multiple agencies and resources for a fire, but it lacked strong, central coordination. This was one of the shortcomings exposed during the 1970 fire season. LFO, originally called the Field Command Operations System, was designed to “field a system which would provide uniform terminology, procedures, and incident organization structure required ensuring effective coordinated action when two or more agencies are involved in a combined effort,” according to the U.S. Forest Service’s 1981 record of significant decisions on FIRESCOPE.

In 1974, the Field Command Operations System was renamed the Incident Command System with a purpose to “be able to provide resource status monitoring, situation assessment, logistics, communications, lines of decision making, and the ability to meet operational needs.” Based upon these requirements, the system created five key functions that had not existed before, including: situation assessment, status keeping, resource utilization, logistics

management, and housekeeping (e.g., feeding personnel and maintaining incident facilities).

✓ **Instructor’s Resource:**

- USDA ICS 100 course is included as an Appendix to this module. Five lessons take a half hour each.

**The NWCG**

Established in 1976 with a memorandum of understanding between the U.S. Department of Agriculture and the U.S. Department of the Interior, the National Wildfire Coordinating Group (NWCG) defined the function and purpose as follows:

*“To establish an operational group designed to coordinate programs of the participating agencies so as to avoid wasteful duplication and to provide a means of constructively working together. Its goal is to provide more effective execution of each agency’s fire management program. The Group provides a formalized system to agree upon standards of training, equipment, aircraft, suppression priorities, and other operational*

*areas. Agreed upon policies, standards, and procedures are implemented directly through regular agency channels.”*

Over the years since, these other agencies also bolstered NWCG membership. They are listed in the order in which they joined:

1. U.S. Forest Service
2. Bureau of Indian Affairs
3. Bureau of Land Management
4. National Park Service
5. U.S. Fish and Wildlife Service
6. National Association of State Foresters
7. US Fire Administration
8. Intertribal Timber Council
9. International Association of Fire Chiefs

### ✓ **Activity VI – Dilemmas in Fire Management**

Just as the National Fire Protection Association became the gatekeeper for structure firefighting qualifications and training, the NWCG is the gatekeeper for all standardized wildland fire training, certification procedures, and position descriptions adhering to the ICS organization chart structure. The 195-page document titled “PMS-310-1” has specific job descriptions and qualifications needed for hundreds of positions within each of the four functional areas of ICS: Operations, Planning, Logistics, and Finance/Administrative. Strict adherence to these specifications drives training, development of task books (Figure 13), and certification of those who are qualified to assume the responsibilities of every position (Figure 14). It can, and should, take years to develop skills, knowledge, and experience to assume higher-level positions. This is the result of many lessons learned the hard way since the 1910 Big Burn. Firefighters are expected to present a qualifications card (the Red Card) when arriving at fire incidents to prove their ability to do the jobs assigned (Figure 15).

As the Incident Command System developed,

early users recognized that the system they were designing and testing needed to be simple enough for the “common man,” work within every emergency response entity’s day-to-day response structure, and be effective for a wide range of incidents, expanding and contracting as needed. It did not make sense to have different organization and management systems for different types of emergency incidents. A member of the development task force noted that they “had to build a system that worked for a dumpster fire, a high-rise fire, a flood, or a major haz-mat (hazardous materials) incident.”

ICS in the ’80s and ’90s became a standard for organizing for incidents beyond firefighting. Incident Management Teams were dispatched to hurricanes, floods, and other emergencies. The Federal Emergency Management Agency (FEMA) began training with ICS in the mid-80s. Other agencies began using ICS for military and law enforcement applications.

ICS was used for Florida fires in the ’90s, Alaska fires in 2004, hurricanes in 2005, hurricane recovery in the 2000s, floods, house fires, large multi-building fires, vehicle accidents, and other emergencies. ICS could be adapted for a wide variety of emergencies because the command system of organization is a constant—and consistent training, communication, and equipment shrink risk variables dramatically.

### **More Tragedies Mean More Adaptation**

Seconds after the terrorist attack of 9/11, a call went out to dispatch centers across the country for help to assist the brave men and women responders rushing to the epicenter. Incident Management Teams quickly responded. In 2003, President Bush issued the Homeland Security Presidential Directive-5 (HSPD-5) in response to lessons learned from the attack. HSPD-5 created the National Incident Management System (NIMS). These are the reasons for the creation of

NIMS, as stated in HSPD-5:

1. Emergencies occur every day somewhere in the United States. These emergencies are small to large and everything in-between and range from fires to hazardous materials incidents to natural and technological disasters.
2. Each incident requires a response. Whether from different departments within the same jurisdiction, from mutual aid partners, or from state and federal agencies, responders need to be able to work together, communicate with each other, and depend on each other.
3. Until now, there have been no standards for domestic incident response that reach across all levels of government and all emergency response agencies.
4. The events of September 11 have underscored the need for and importance of national standards for incident operations, incident communications, personnel qualifications, resource management, and information management and supporting technology.
5. To provide standards for domestic incident response, President Bush signed Homeland Security Presidential Directive-5. HSPD-5 authorized the Secretary of Homeland Security to develop the National Incident Management System, or NIMS. NIMS provides for interoperability and compatibility among all responders.

## Standardization

Fire management relies on rules, policies, and standard operating guidelines or procedures (SOGs/SOPs). Over the decades, we have learned the hard way to standardize whenever possible to avoid confusion. When confusion and chaos reign, consistency in training, equipment, communication, terminology, and procedures can help save lives.

The following scenario describes how responders react to an emergency incident.

The lead position responding to an incident is termed the “Incident Commander.” That person needs to have certain qualifications, experience, and training—and be certified as an “IC.” There are still response agencies that do not meet certification standards, but for this scenario, assume the individual meets minimum qualifications, and is dispatched to a 911 call to any local emergency management incident. Training, education, and experience teach the following six-step procedure on arrival to an incident:

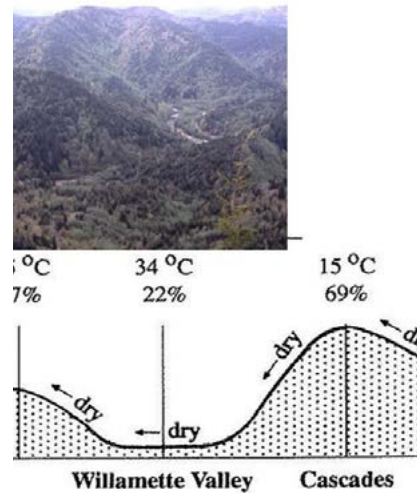


Figure 13. Example of a task book for an ICS position. Qualification depends on competence, obtained through many years of training and experience. This task book took three fire seasons as a trainee to complete—only after the individual spent almost 15 years coming up through the ranks.

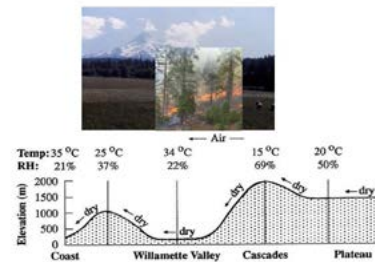


Figure 14. Each ICS course is strictly monitored for adherence to NWCG curriculum rules. It is only taught by approved and certified instructors. Upon successful completion, proof is presented in the form of certificates. Firefighters keep a “certificate bible” as record and proof of these accomplishments.

1. Conduct an Initial Size-up. This initial assessment and intelligence-gathering step sets the stage for the plan to follow. External and internal factors, fire behavior, rescue needed, resources there, go defensive, go offensive, anticipate what will happen in the next few minutes—and the long-term—anticipate and become pro-active to respond. The initial response resources need to know and expect to know what to do and where to go. Establish communication links between all resources and with dispatch. Order additional resources as needed. The rule of thumb is that a house fire can double in size every three minutes and a wildland fire can consume thousands of acres in hours. An Incident Commander needs to simultaneously make decisions for both the short term (next few hours) and the long term (the next few days).
2. Initial Risk Assessment. This step is continually in play—from the beginning and throughout the emergency. The IC constantly considers whether to risk a little, to risk a lot, or to risk nothing. Chapter 8, Section 8.3.2, of NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, 2007 edition, states risk management shall be based on the following principles:
  - ❑ Activities that present a significant risk to the safety of members shall be limited to situations where there is a potential to save endangered lives. (Risk a lot.)
  - ❑ Activities that are routinely employed to protect property shall be recognized as inherent risks to the safety of members, and actions shall be taken to reduce or avoid these risks. (Risk a little.)
  - ❑ No risk to the safety of members shall be acceptable when there is no possibility to save lives or property. (Risk nothing.) In situations where the risk to responders is excessive, activities shall be limited to defensive operations.

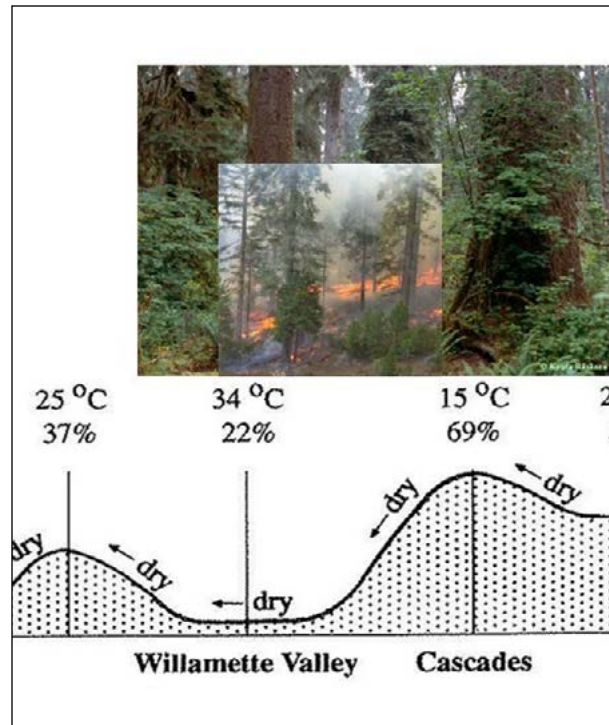


Figure 15. This is the “Red Card” each firefighter carries to every incident. It is updated every season and is proof of qualifications to do certain ICS positions. The Red Card is the recognized passport at any incident.

3. Set Up a Command Structure. On the strategic level, set an overall direction for the incident. On the tactical level, assign operational objectives. On the task level, make specific assignments for resources. All resources need to know where to go, who to report to, and what is expected. The ideal ratio of supervisors to resources is one to five and can range from one to three to one to seven.
4. Develop a Plan. This is a detailed Incident Action Plan modified according to resources available and the need to document. A good plan sets out strategy and tactics, documents resources for record and accountability, and sets the stage for relieving resources and ensuring continuity. A good plan establishes communication and allows benchmarks as references to achieve as the incident progresses.

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**NIMS Standard incident management structures are based on three key organizational systems:**

**1. The Incident Command System (ICS):**

*Defines the operating characteristics, management, components, and structure of incident management organizations throughout the life cycle of an incident.*

**2. Multiagency Coordination Systems:**

*Define the operating characteristics, management components, and organizational structure of supporting entities.*

**3. Public Information Systems:** *Include the processes, procedures, and systems for communicating timely and accurate information to the public during emergency situations.*

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5. Set up Geographic and Functional Designations. Sending resources (such as firefighters and equipment) to different parts of an incident required standardizing to avoid confusion and lost time. Sending resources to the “left of the house” on a structure fire or to “the top of the ridge” on a wildland fire did not work. Requesting a “fire truck” or “water” may have worked when options were very limited, but did not as equipment developed over time. Maps have developed from a stick-in-the-sand map with everyone hunkered around, to GIS technology. We have standards for mapping out and designating specific areas of a house and specific areas of wildland fires (Figures 16 and 17).

Functional designations are also standardized. A “fire truck” is not just any type of fire engine to the Fire Service. Merriam-Webster defines a fire truck as, “an automotive vehicle equipped with firefighting apparatus.” The Fire Service defines a fire truck as a specialized vehicle that carries multiple ground

ladders of varying length and purpose; an aerial ladder used to reach upper floors of buildings; rescue equipment for forcible entry, extrication, etc.; and numerous power tools such as chainsaws, ventilation fans, and lighting equipment. A fire engine is a vehicle that carries a designated amount of fire hose, nozzles, hose couplings, and water in a tank for a quick attack that is critical to fire control. Tank water is used until firefighters can establish a dedicated water supply from a fire hydrant or water tender. Fire engines are categorized by size and capacity. A Type 1 fire engine normally used in structure firefighting has the following capacities: a 1,000 gallons-per-minute pump, 400 gallons of water per tank, 1,200 feet of 2½-inch hose, 400 feet of 1½-inch hose, 200 feet of 1-inch hose, 20 feet of ladder, a 500 gallons per minute master stream, and a minimum of four people. A Type 6 fire engine normally used in wildland firefighting has a 50 gpm pump, 200 gallons per tank, 300 feet of 1½-inch hose, 300 feet of 1-inch hose, and a minimum of two people.

6. Safety. Every thought, action, and plan needs to be as safe as possible. The Primary Objective is to have everyone come home safe and sound with no one hurt. A 2004 Firefighter Life Safety Summit in Tampa, Florida addressed the need to reduce the number of deaths and injuries and resulted in 16 Life Safety Initiatives designed to promote “Everyone Goes Home” (Figure 18). The Everyone Goes Home Program, founded by the National Fallen Firefighters Foundation, provides free training, resources, and programs to promote and implement the 16 Firefighter Life Safety Initiatives. The goal of the Everyone Goes Home® Program is to reduce the number of preventable firefighter line-of-duty deaths and injuries. The Everyone Goes Home® Firefighter Life Safety Initiatives

Program was funded by the Department of Homeland Security, Assistance to Firefighters grant (<https://www.everyonegoeshome.com/about-us/>).

The ICS system can expand or contract according to the size and severity of the incident. The standardized approach and the many hours of training help firefighting crews make quick decisions and avoid the chaos that can accompany frightening or dangerous situations. The National Fire Protection Association and National Wildfire Coordinating Group have developed standardized protocols for use throughout all emergency response agencies. The system relies on competent, brave, and compassionate leaders and teamwork and trust among firefighters. (Webcast of a lecture by U.S. Marine Corps Reserve Colonel (Ret.) Art Athens, at <http://www.usna.edu/Ethics/>).

## Wildland and Structural Fires

It is important to understand the differences and commonalities between structure and

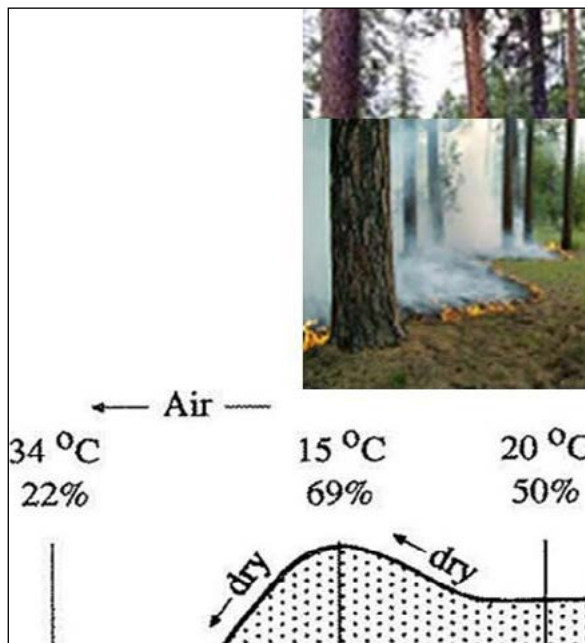


Figure 16. Structure divisions start at the front and proceed clockwise. Names of divisions start with Alpha and continue sequentially with the phonetic alphabet for each side. Wildland fires maintain a similar system for consistency.

wildland firefighting. Throughout the West, certain agencies manage structure fires while others focus on wildland fires. Rural area fire agencies sometimes manage both, but this is not common.

Reducing fire risk and hazard in the home is just as important as reducing it in the yard and landscape, especially in the wildland urban interface.

## Wildland Fires

Wildland fire management objectives have changed over the years—usually in response to a tragedy. Wildland firefighters make up only 5 percent of all firefighters in the United States, but they suffer 27 percent of all firefighter fatalities (Fahy, et al. 2017). This disproportionate number has made firefighter and public safety a higher priority in wildland fire management than property and resource loss.

Risk management is the key to minimize firefighter exposure to inherent hazards and the key to sound strategies and tactics. Wildland

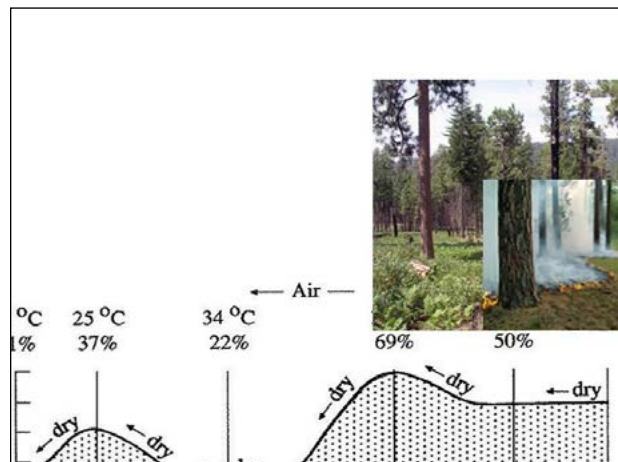


Figure 17. Wildland fire divisions start with Alpha at the origin of a fire and continue alphabetically in a clockwise direction. A growing wildland fire requires the continuation of divisions to designate the additional land area. Achieving a manageable span of control by supervision of resources and achievement of objectives determines the size of the division. When fires outgrow the initial alphabet, a double alphabet designation is used.



firefighters use a five-step risk management process:

1. Establish situation awareness
2. Identify hazards and benefits and assess the risk
3. Control, mitigate, or eliminate the hazard
4. Make go/no-go decisions based on acceptability of remaining risk
5. Evaluate effectiveness of hazard controls and continuously re-evaluate

### Structure Fires

The historic objectives for all structure fires have been rescue, fire control, and property conservation. Many fire departments have added victim stabilization and firefighter safety and welfare. Recent texts on fire management have recommended this order of priorities:

1. Firefighter safety; 2. Civilian safety; 3. Stop the fire; 4. Conserve property.

The risk-management tool used by structure firefighters confirms the degree of risk and hazard. Factors used in initial risk assessment include:

1. That the structure of the fire is not so involved that building material collapse is imminent
2. The fire dynamics are understood
3. Truss impingement times (as lightweight roof trusses break apart when burned) can be estimated with some accuracy

The Occupational Safety and Health Administration (OSHA) developed a “two-in-two-out policy” that ensures two fully geared-up firefighters enter a building and two fully geared firefighters are standing by for rescue or to relieve as needed.

The first-arriving resource to a structure fire does the following:

1. Establish command
2. Make the initial size-up
3. Request/deploy available resources

4. Communicate the situation to the communication center and other responding units

### Risk

Fire management, as with all other types of emergency management, depends on an analysis and management of risk. NFPA gives these definitions:

**Hazard** is a condition, an object, or an activity with the potential of causing personal injury, equipment damage, loss of material, or reduction of the ability to accomplish the mission.

**Risk** is the chance of injury or loss and mitigation is the prevention or reduction of potentially negative effects.

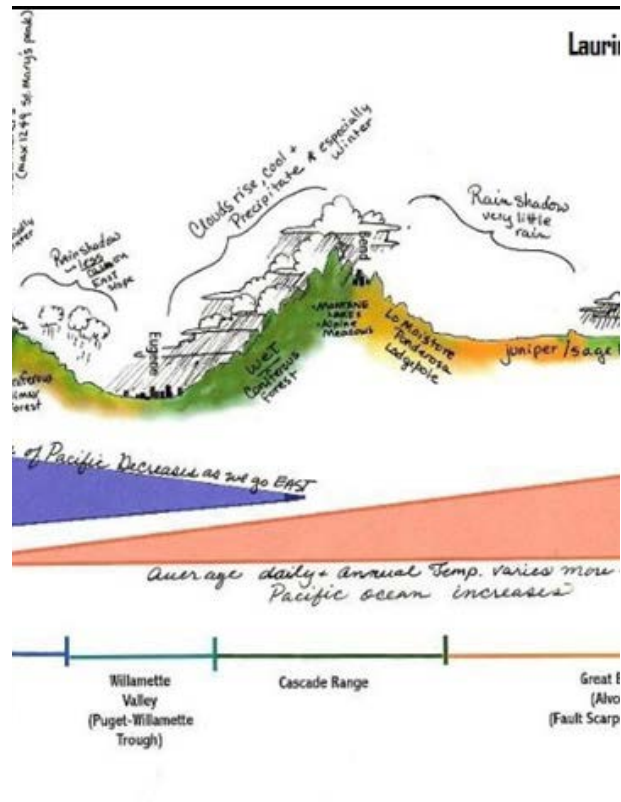


Figure 18. A 2004 Firefighter Life Safety Summit in Tampa, Florida addressed the need to reduce the number of deaths and injuries and resulted in 16 Life Safety Initiatives designed to promote “Everyone Goes Home.” The Everyone Goes Home® Program, founded by the National Fallen Firefighters Foundation, provides free training, resources, and programs to promote and implement the 16 Firefighter Life Safety Initiatives.

The first thing a firefighting leader must do is identify known or potential hazards and then define any detrimental effects they may have on the responders. The decision to intervene or not, or whether to approach a situation offensively or defensively, depends on the estimated risk levels. If it is determined that direct intervention is necessary, the risk control component involves creating a management strategy, designing tactics to implement the strategy, and evaluating any selected control measures.

The U.S. Department of Labor, Occupational Safety and Health Administration developed a simple matrix to illustrate the management of risk (Figure 19).

## Put it Out

### Fire Prevention / Fire Control / Fire Exclusion / Fire Suppression / Fire Containment

Fire management involves planning, preventing, and suppressing fires to protect people, property, and resources. Fire management also utilizes fire as a tool to attain certain resource management and fire-suppression objectives. Thus, fire management activities divide into two general types of management: putting out the fire and using the fire. Putting it out includes preventing, excluding, containing, and suppressing fire. Using fire includes lighting prescribed fires and using naturally ignited fires to meet prescribed management goals by allowing wildland fires to burn.

Fire **prevention** involves education and actions that lead to a reduced risk of wildland and household fire ignition. Preventing unintentional wildland fires generally centers on putting out campfires, matches, cigarettes, and other burning material. Preventing household fire centers on education about how to avoid electrical fires, woodstove and oven safety, and FireWise landscape measures.

Fire **control** includes suppression, exclusion, and containment. In general, the goal of controlling fire is to protect life, property, and perceived damages to resources (Figure 19). Fire **exclusion** refers to keeping fire from the landscape, while fire **suppression** refers to putting burning fires out. **Containment** refers to actions that keep a fire from moving beyond a given point (or points). This is commonly done through the creation of fire lines around a fire, or by spraying nearby houses with water so that a house fire won't spread to nearby houses.

## Management Objectives for Fire Suppression

### ✓ Note to Instructor

- In this section (Management Objectives for Fire Suppression), it is recommended that a guest presenter or facilitator from a state or local fire department or agency lead activities #5 and #6.

CONTINUED ON PAGE 27

**Contained:** When firefighters say a fire is “contained,” they mean a control line has been completed around the fire and that they expect that line to stop the fire’s spread.

**Controlled:** For a fire to be called “controlled,” firefighters need to have removed any unburnt fuel and cooled down all hot spots adjacent to control lines to the point that they can reasonably be expected to hold.

**Out:** A fire is considered “out” when NO hot spots are detected within containment lines for at least 48 hours.

## Firefighter Helmets

Personal Protective Equipment (PPE) includes any covering (helmets, gloves, coats, etc.) a firefighter uses to protect the body from injury. Our bodies are very sensitive to the firefighting environment and have always needed protection, especially our extremities and head.

The *Vigiles Urbani* (“watchmen of the City”) or *Cohortes Vigilum* (“cohorts of the watchmen”) were the firefighters and police of Ancient Rome. No one knows what they looked like, but chances are they wore the typical battle gear of the Roman soldier – complete with helmet.

Napoleon directed French firefighters (*Sapeurs-pompiers* or *marins-pompiers*) to adhere to a standard for firefighting gear and required a helmet quite more elaborate than the standards used today.

An early German firefighting helmet resembled and became a model for the World War II helmets (*Stahlhelme*) worn by the German Army.

Firefighters in early New York had leather helmets with a long backside to protect their necks from embers. The leather helmet is still a tradition in some fire departments, but most strive to meet National Fire Protection Association (NFPA) standards for safety.

Today, most fire department helmets are made of a composite material to NFPA certification specs. Helmets also meet impact and heat-resistance standards. There are also some manufacturers making helmets to meet all safety specs and to resemble the old leather helmets. Colors are significant for most fire departments. For some departments, color indicates rank. In the heat of firefighting when everyone has on heavy turnout gear and every inch of skin is protected, it is very difficult to determine who is in charge. The basic scheme is white is for chief officers, red for captains, yellow for firefighters



Photo: Mario Recchia via <http://cadwork.tv.it>

A replica of a Roman Legion helmet.



Photo: User Mattes /CC BY-NC-SA 2.0

Napoleon’s French firefighters wore elaborate helmets.

without rank, black for engineers, and blue for medics.

That’s the basic scheme and many departments will have variations of that—maybe adding striping for other designations, etc. Many departments use colors and ranking decals or



Photo: liveauctioneers.com

An early German firefighting helmet, which became the model for World War II helmets for Germany.

front badges for number and rank—which helps officers with firefighter accountability.

### The Future of Helmets

The latest Swedish firefighting helmet is based on the design for diving helmets and takes protection and functionality to a new level.

The “C-Thru Smoke Diving Helmet helps firefighters see clearly in smoke-filled buildings to do rescue missions. When using traditional firefighting equipment, firefighters must keep hand contact with walls or crawl on the ground while carrying heavy air support and hand-held equipment. This can slow down the rescue process.

This new helmet provides a wire frame vision of the interior geometry. With it, firefighters can identify their surroundings easily and search for victims more accurately.



Photo: ebay.com

A vintage leather helmet from the New York Fire Department.



Colors are used to distinguish the rank or role of firefighters.



The C-Thru Smoke Diving Helmet allows firefighters to see better in smoke-filled buildings.

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## Life and Safety

Life and safety refer to the rescuing of civilians (and pets) who are in danger from a fire; treating the injured; and providing for the safety, accountability, and welfare of all response personnel. Life safety is an ongoing priority objective throughout any fire or any emergency incident. Everyone should go home safely. There are many aspects to managing for life-safety objectives and most apply to wildland and/or structure firefighting. These include managing risk; accountability for firefighters and the public we serve; and enabling firefighters to gauge the

risk for themselves and be able to communicate that to superiors. The following things are also important:

- The public needs to be able to communicate its concerns
- Firefighters must have solid standard operating procedures in place that are applicable to the hazards being confronted
- The health and physical fitness of firefighters
- The proper design and safety of equipment
- The best training, certified by national, state, and local standards
- Technological advancements



Photo: Woody Chain, Obadiah's Wildfire Fighters Fire Team, used with permission

Figure 19. A hot and dry spring in 1994 produced an active fire season in northwest Montana. Resources were at a premium due to demand. Fires were just outside Libby, threatening the town of 2,500. Firefighters faced steep, forested, and mountainous terrain. Out-of-work loggers modified a forwarder/skidder (a modified and articulated troop carrier from the military used to yard logs out of the woods) by placing a 3,000-gallon water tank on the rear, attaching hoses and pumps, and mounting a blade in front. This machine could deliver water through hoses anywhere on steep to flat ground, and firefighters could follow the driver in a safety cab. The machine, called a SKIDGEN, was the most versatile wildland fire engines ever invented.

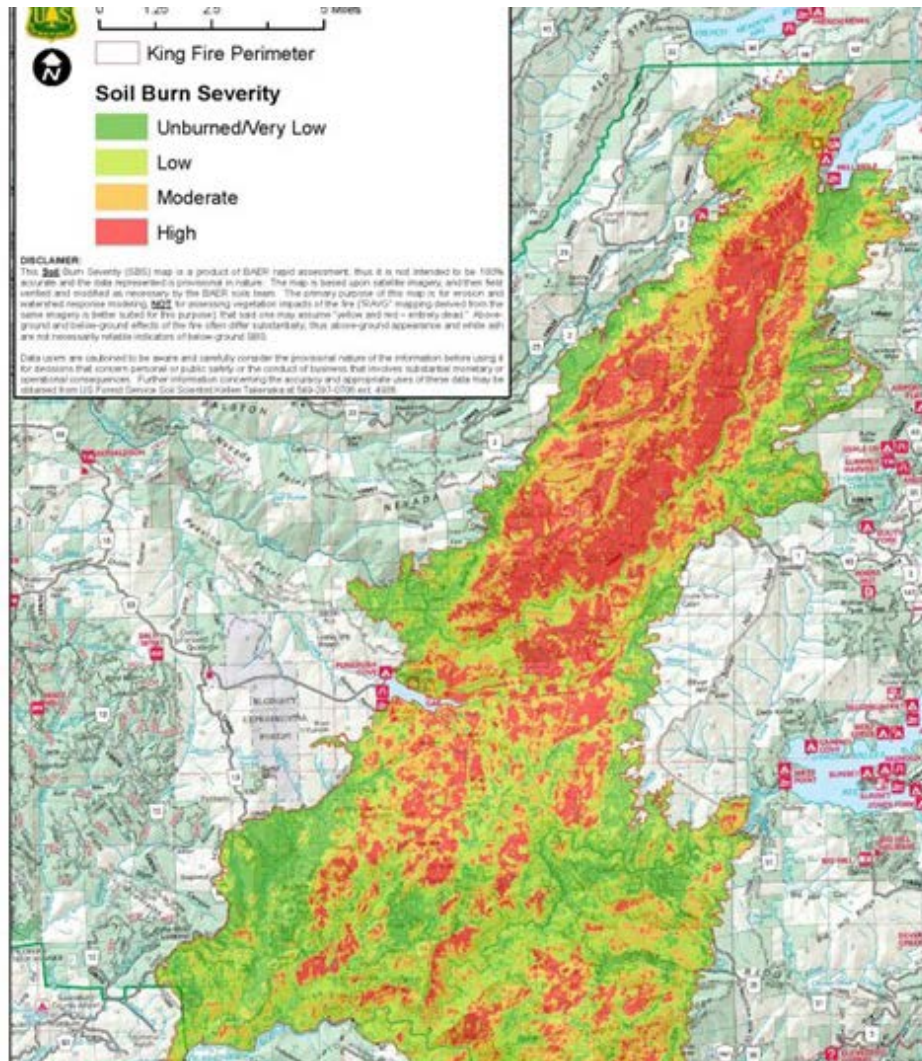


Figure 20. Example OH&S Hazard Risk Event Value Matrix

Emergency response personnel cannot come to the aid of anyone or anything else if they do not take care of themselves first.

Managing risk for life and safety—managing for the probability of a hazardous event occurring vs. the consequence of that hazard event occurring—relies heavily on experience. An experienced first responder will understand and calculate risks better than a less-experienced first responder.

### Incident Stabilization

The primary objectives during a fire are to keep the incident from escalating, minimize effects and impacts, and work towards bringing

all under control. This requires conducting a “size up,” or gathering intelligence about the incident; communicating throughout the response organization—and to the public involved; setting control points; ordering sufficient response resources to deal with the incident; and carrying out appropriate and flexible strategies and tactics.

Control of incidents, containment, and mitigation of adverse effects drive all management efforts.

### Property and Resources

Property can refer to natural resources threatened by wildfire or structure fires. Property in another sense includes structures,

outbuildings, and all property within the structures. Property conservation also applies to traffic routes (highways, roads, access paths); infrastructure; utilities; and bridges, dams, and flood-control systems.

## Prescribed Fire

Prescribed fire is the application of fire to meet management objectives. Beneficial uses of fire include: cooking food, heating homes (and bodies), running engines, smelting metals, generating electricity, driving industrial processes, maintaining ecological processes, improving habitat, and lessening the risk of wildfire while improving fire resilience. As covered in previous modules, fire is an important part of many ecosystems, serving as a major or minor agent of change. Historic fire regimes vary by region, depending primarily on climate, vegetation, and human influence. Since fire-suppression efforts began in the early 1900s, fire regimes in some areas have shifted from frequent, low-severity fires to infrequent, high-severity fires. Fires are also generally burning larger than they did around 100 years ago. As a result, many ecosystems are becoming overgrown and experiencing shifts from fire-resistant species to fire-susceptible species. In order to restore these forests to a healthy, free-to-grow condition, and to prevent large, dangerous, or uncontrollable fires, managers use prescribed fires. Prescribed fires are fires planned, ignited, and controlled by land managers.

### ✓ Activity VII – Prescribed Fire

- Videos

## Lessons Learned

During the heat of a stressful emergency incident, the chances of mistakes occurring are very high. The many variables at work in a fire make it difficult to analyze these mistakes and assign blame. There must be investigations, of course, but it is always better for all involved to learn from what happened in an effort to improve.

The After Action Review (AAR), a military tool adapted for use in the Fire Service, is a structured review of what happened, why, and what can be changed for future incidents (Table 3). All United States military services and many emergency-response organizations use AARs. Businesses have adopted them as a knowledge-management tool and a way to build a culture of accountability.

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*We use fire for many domestic and industrial applications. My office window faces out onto an agricultural field of about 20 acres. As I write this, farm hands are burning the chaff from last year's harvest of grains. Wind speed is very low, humidity is up and the sky is cloudy on this early spring day. It is a good day to burn. The fire is being monitored and burning safely and effectively across the chaff. As soon as it burns to the end of the field, it goes out. Plowing will start soon when the soil dries out and the ash and lack of stubble and chaff will make it easygoing and beneficial to the next crop. The fire burns off some harmful insect larvae, along with some weed seeds that would otherwise invade the field when things start growing. That is a prescribed fire – using fire in a beneficial way to achieve management objectives.*

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✓ **Instructor Resource:**

○ <http://www.betterevaluation.org/en>

**Work/Rest**

Fighting fires on a crew in the '70s meant responding when called and working until done. Firefighting was part of everyone's job in the Forest Service at that time. Many were veterans or off the farm or logging crew, and did what they were told and worked hard without complaint. At remote fires, that could mean working on the fire line for days or weeks at a time, 18 to 20 hours a day. Firefighters would work for up to 40 days straight without a break on large fires. They took naps during infrequent breaks, ate what they had with them, and slept on a bed of needles and duff. When they came home after a long, grueling fire, their kids would think it the funniest thing to see how black the bathtub was after Dad's first shower in weeks. The stress, poor diet, and fatigue took a toll, but we were young and used to long hours and dirty, sweaty work.

Fire behavior research accelerated in the '70s following the large Southern California fires. Those efforts still benefit wildland fire management today. In the mid-80s, the Missoula Technology and Development Center (MTDC) began research into the human side of firefighting and produced the first results addressing fatigue and diet. The MTDC, Spring 2002,

*Wildland Firefighter Health and Safety Report* recommended guidelines for:

1. Work/rest issues
2. Assignment length
3. Shift length
4. Fatigue countermeasures

In July of 2002, the National Multiagency Coordination Group produced the following guidelines.

**Work/Rest Guidelines**

The Incident Business Handbook, Chapter 11, Part 12.7-1 states:

*To maintain safe, productive incident activities, incident management personnel must appropriately manage work and rest periods, assignment duration, and shift length for crews, overhead personnel, and support personnel. Plan for and ensure that crews, overhead personnel, and support personnel are provided a 2 to 1 work to rest ratio (for every 2 hours of work or travel, provide 1 hour sleep and/or rest)."*

**Clarification(s)/Addition(s)**

*Provide the opportunity for a minimum of 1 hour of rest for every 2 hours of work or travel regardless of work performed (incident/*

**Table 3. An example of an After Action Review (AAR).**

Question	Purpose
<ul style="list-style-type: none"> <li>• What was supposed to happen?</li> <li>• What actually happened?</li> <li>• Why were there differences?</li> </ul>	These questions establish a common understanding of the work item under review. The facilitator should encourage and promote discussion around these questions. In particular, divergences from the plan should be explored.
<ul style="list-style-type: none"> <li>• What worked?</li> <li>• What didn't?</li> <li>• Why?</li> </ul>	These questions generate reflection about the successes and failures during the course of the project, activity, event, or task. The question 'Why?' generates understanding of the root causes of these successes and failures.
<ul style="list-style-type: none"> <li>• What would you do differently next time?</li> </ul>	This question is intended to help identify specific actionable recommendations. The facilitator asks the team members for crisp, clear, achievable, and future-oriented recommendations.



*non-incident), incident type or jurisdiction, time of incident or operational period, or regular work schedule. Work shifts, including the first operational period, will not exceed 24 hours.*

*All work shifts exceeding 16 hours, and every instance where work-rest cycles will be exceeded, require preapproval and documentation by the appropriate Agency Administrator, Incident Commander, or other individual with expressly delegated authority. A work shift includes all hours of work or travel since the last rest period meeting the 2 to 1 work-rest ratio.*

### Length of Incident Assignments

*The National Mobilization Guide states in Chapter 10, part 13: Incident assignments will not exceed 14 days, excluding travel.*

The NFPA Standard 1584, “Standard on the Rehabilitation Process for Members during Emergency Operations and Training Exercises,” provides guidance on firefighter safety, fitness, and health. Rehabilitation applies to repairing or restoring conditions after a structure fire and applies to personal care for firefighters. Most fire department standard operating procedures allow for a break when the air supply on a self-contained breathing apparatus is low. That’s normally after about 15 or 20 minutes. That may not seem like a long time, but with a full set of turnout gear and breathing apparatus—and in extreme heat and smoke—that is long enough.

A good place for rehab is set up away from the fire where firefighters can rehydrate, take a few layers off, breathe clean air, and check for signs of heat stress or exhaustion.

Heat builds up quickly when wearing a full set of insulated turnout gear, helmet, heavy boots, gloves, full face mask, and air tank. The facemask fogs up immediately with sweat. Then a firefighter has to go to work in the heat and smoke. It is hard to consider this when the

majority of structure firefighters in the United States are volunteers.

## Regulations: Smoke, Air Quality, and Health

Every state must comply with the federal Clean Air Act by having an approved and active Smoke Management Plan that regulates the amount of smoke released into the atmosphere. In Oregon, air-quality regulations are administered by the Department of Environmental Quality (DEQ), but the Oregon Department of Forestry (ODF) regulates agricultural and forest burning, with oversight by the DEQ. Meteorologists from the ODF dictate the size and number of prescribed burns that are allowable, dependent upon weather and wind conditions, in an effort to minimize impacts of smoke intrusion on populated areas. Regions in the state are divided into different levels of regulatory protections (Figure 21) based upon:

- proximity to population centers and smoke sensitive regions
- whether the forest is federally or privately owned
- whether the land is classified as timberland, grazing land, or agricultural land
- if the land is considered a federally protected viewshed, such as designated wilderness areas and national parks

### ✓ Activity VIII – Smoke

- YouTube: Minimizing smoke impacts of prescribed fire (six-part USFS video series)
- Video: Public Health Issues: Smoke from wildfire and prescribed fire (University of British Columbia)
- Discussion of trade-offs between health and fuels management

The objectives for the Oregon Smoke Management Plan<sup>2</sup> are to:

<sup>2</sup> Operational Guidance for the Oregon Smoke Management Program. [www.oregon.gov/ODF/Documents/Fire/smd.pdf](http://www.oregon.gov/ODF/Documents/Fire/smd.pdf)

1. Prevent smoke resulting from prescribed burning on forestlands from being carried to or accumulating in Smoke Sensitive Receptor Areas (SSRAs) or other areas sensitive to smoke, and to provide maximum opportunity for essential forestland burning while minimizing emissions
2. Coordinate with other state smoke-management programs
3. Comply with state and federal air quality and visibility requirements
4. Protect public health
5. Promote the reduction of emissions by encouraging cost-effective utilization of forestland biomass, alternatives to burning, and alternative burning practices

The Oregon Department of Forestry (ODF) must approve all prescribed burning operations. Prescribed burning is a legitimate forest management practice, and ODF is responsible for ensuring that emissions are minimal, consistent with the federal Clean Air Act and the State of Oregon's Clean Air Act Implementation Plan. Anyone planning a prescribed burn must first draw up a plan that indicates how weather will

be monitored during the burning process, how the burn will be conducted to reduce smoke intrusion into SSRAs and other areas sensitive to smoke, and describes the resources to ignite the burn and measures to be taken to prevent a wildfire.

Research suggests that most people living in fire-susceptible areas realize that smoke is part of their environment. However, the cause of the smoke can influence its acceptance by local communities. Smoke from prescribed burning (reducing slash, invigorating plant species for forage) may be more acceptable if perceived as producing healthier forests. This doesn't negate the health concerns of smoke for many people. Wildfire emissions, such as smoke, contain particulate matter and dangerous gases that can have far-reaching effects over a wide geographical range.

People with asthma and respiratory conditions are especially at risk for health problems due to smoke, as are pregnant women and diabetics.

### ✓ Activity IX – Living with Fire



Source: Oregon Department of Forestry

Figure 21. Application of the Oregon Smoke Management Plan

## Egos, Personalities, and Politics (EPP)

The hardest and most difficult part of fire management is not the fire. We have a clear science that is consistently growing and developing—giving us the best understanding of fire behavior and how to use and manage it. We have excellent training opportunities. We have the best equipment, researched and tested for maximum safety. We have the best technology, including thermal imaging devices, drones, lighting, generators, and pumps. We know what to do, how to do it, and have the equipment to do it right.

The most difficult part of fire management is dealing with the egos, personalities, and politics (EPP). If not dealt with properly, EPP can cause severe harm to firefighter health and safety. EPP can become the biggest barrier to fulfilling objectives and the mission we are all dedicated to do.

One problem with properly dealing with EPP is that we are least trained to handle it. It is like the lack of life-skills training in high school. Many kids go out into the world with a high school diploma and do not know how to balance a checkbook or negotiate with a high-pressure salesperson trying to cheat them. Life is much more difficult without these skills.

This Fire Management Module contains material about fire management history, which has resulted in shaping current policy, rules, guidelines, and procedures. This module also includes information directed toward the individual firefighter. The stories, the 10 Standard Fire Orders and 18 Situations That Shout Watch Out, risk and consequences—all relate to the individual. We need to provide the policies and SOPs/SOGs, but the culture of successful management of fire depends on the character—the heart—of the individual. Success depends on each firefighter having character, operating as a team member under leadership that also adheres

to what Col. Arthur J. Athens, USMC (ret.) calls the core components of leadership: competence, courage, and compassion.

When this type of leader can identify the strengths, weaknesses, and potential of every firefighter, he or she can shore up the weaknesses by capitalizing on the strengths and form a team based on trust.

Each firefighter must take personal responsibility to acquire knowledge and experience; make personal decisions; and take responsibility to learn from those decisions, be safe; and look out for every other firefighter. When the culture can learn from the strengths of tradition—and not be tied and bound by the limits of tradition—there is nothing we can't accomplish.

## Notes to Instructor

### Room Setup

Facilitator should secure a room large enough to comfortably accommodate the number of participants. Organize the room in a U-shape fashion with long tables and chairs. The room should have a large screen to display the presentation. There should be a large table up front (6 to 8 feet in length) for the instructor to use for in-class demonstrations and to display various props.

### Instruction in the Field

Location for suppression exercise (if applicable). In the section “Management Objectives for Fire Suppression,” it is recommended that a guest presenter/facilitator from a state or local fire department or agency lead Activities #5 and #6. These hands-on activities can be skipped if not applicable to the class.

## Total Time Needed

8 hours in the classroom and 8 hours in the field (including travel time)

## Equipment/Materials Needed

- Computer with PowerPoint
- Internet access
- Computer access for students
- Projector and screen
- Handouts
- Flip easels or wall space
- Sand table (optional)
- Firefighting equipment: Pulaskis, shovels, axes, halligans, water-delivery systems, water handling hardware, hoses, nozzles, PPE for both, fire-line pack, NOMEX clothing, SCBA, and turnout gear

## Delivery Methods

- Presentation from instructors
- In-class demonstrations
- Outdoor demonstrations
- Discussion
- Online with Canvas

## Prep/Background

Students should read: “The Politics of Fire and Social Impacts of Fire Exclusion on the Klamath” <http://pages.uoregon.edu/norgaard/pdf/Politics-Fire-Social-Impacts-Fire-Exclusion-Norgaard-2014.pdf>

## Handouts

- Copies of Personal and Professional Insights
- Forest Dilemma background information sheets
- NWFSC, 2016—What is? IMET <http://www.nwfirescience.org/biblio/nwpsc-fire-facts-what-imet>
- NWFSC, 2016—What is? Incident Command System [http://www.nwfirescience.org/sites/default/files/publications/FIREFACTS\\_IncidentCommandSystem\\_0.pdf](http://www.nwfirescience.org/sites/default/files/publications/FIREFACTS_IncidentCommandSystem_0.pdf)

[org/sites/default/files/publications/FIREFACTS\\_IncidentCommandSystem\\_0.pdf](http://www.nwfirescience.org/sites/default/files/publications/FIREFACTS_IncidentCommandSystem_0.pdf)

- NWFSC, 2016—When is? A Fire Contained, Controlled, Out [http://www.nwfirescience.org/sites/default/files/publications/ControlledvsContained\\_0.pdf](http://www.nwfirescience.org/sites/default/files/publications/ControlledvsContained_0.pdf)
- A copy of the PowerPoint presentation (3 slides per page to allow for note taking)
- Other handouts can be downloaded from the section, “Additional Student Resources.”

## PowerPoints/Videos

- National WUI Fire Protection Program, <https://www.youtube.com/watch?v=QUxmaXp0a28>
- Sand Table Exercise, <https://www.youtube.com/watch?v=Vt1Rn8-OjB4> (4 minutes)
- Simtable demo <https://www.youtube.com/watch?v=W-Pn-aV5DtE> (3:45 minutes)
- Simtable Tactical Tools <https://www.youtube.com/watch?v=Rs1P3r8O8JM> (4:42 minutes)
- Prescribed Fire: A multi-purpose tool (NW Fire Science Consortium) [https://www.youtube.com/watch?v=s\\_Fj00\\_4n6Q](https://www.youtube.com/watch?v=s_Fj00_4n6Q)
- Traditional Uses of Fire (National Interagency Fire Center) <https://www.youtube.com/watch?v=JgxWG2XknJc>
- Living with Fire game available at [www.fs.fed.us/rm/fire\\_game/](http://www.fs.fed.us/rm/fire_game/)
- YouTube: Minimizing smoke impacts of prescribed fire (six-part USFS video series)
- Video: Public Health Issues: Smoke from wildfire and prescribed fire (University British Columbia)

## Evaluation Instrument

Student evaluation—Have a set of questions that touch on the different topics covered in the module. Ask people to provide thoughts and discussion on one or two questions. The instructor should then evaluate and weigh-in on the discussion.

Class evaluation—Provide a survey for student feedback for each module as a form of formative evaluation.

## Activities

### I. Read and Discuss

- Students will read copies of Personal and Professional Insights (Appendix A)
- Discussion of obstacles faced by the Ops Chief; alternative decision, etc.

### II. Fire Behavior

- Students will view YouTube promotional fire video: <https://www.youtube.com/watch?v=ZxkeYnEBZzg>
- Prerequisite of Module 1, or review of basic fire behavior/ecology
- Compare and contrast wildland and structural fire behaviors

### III. Fire Exclusion

- Students discuss a journal article about fire exclusion and the Karuk Tribe (“The Politics of Fire and Social Impacts of Fire Exclusion on the Klamath”) <http://pages.uoregon.edu/norgaard/pdf/Politics-Fire-Social-Impacts-Fire-Exclusion-Norgaard-2014.pdf>. (pre-coursework)
- Have students identify three ways that fire exclusion has impacted the Karuk socially, environmentally, and culturally.
- Students will then work with a partner to compare and contrast the effects they identified.

### IV. Field Exercise

- Review elements of Personal Protective Equipment (PPE) for wildland and structure
- Demonstration of proper use and maintenance of appropriate hand tools used in suppression activities
- Have students construct a control line

- Proper spacing when walking and working (10 to 15 feet apart);
- Extending line to mineral soil, water level, or permafrost;
- Proper intra-crew communications;
- Proper use of crew for specified method;
- Proper tool carrying techniques

### V. Field Exercise

- Sand table exercise or
- YouTube videos:
  - <https://www.youtube.com/watch?v=Vt1Rn8-OjB4> (4 minutes)
  - Simtable demo <https://www.youtube.com/watch?v=W-Pn-aV5DtE> (3:45 minutes)
  - <https://www.youtube.com/watch?v=Rs1P3r808JM>

### VI. Dilemmas in Fire Management (Appendix B)

- In this activity, students will consider three dilemmas faced by fire managers. They will make an initial decision about what action they think would be most responsible.
- Students will then research one dilemma further (from the Dilemma Background Information Sheets) in order to make an Informed Decision.
- Finally, students will discuss the similarities and differences between their original and informed decisions.

### VII. Prescribed Fire

- View YouTube video: [Prescribed Fire: A multi-purpose tool](#) from the Northwest Fire Science Consortium(NWFSC)
- View YouTube video: Traditional Uses of Fire (National Interagency Fire Center) <https://www.youtube.com/watch?v=JgxWG2XknJc>
- Discussion of using prescribed fire as a

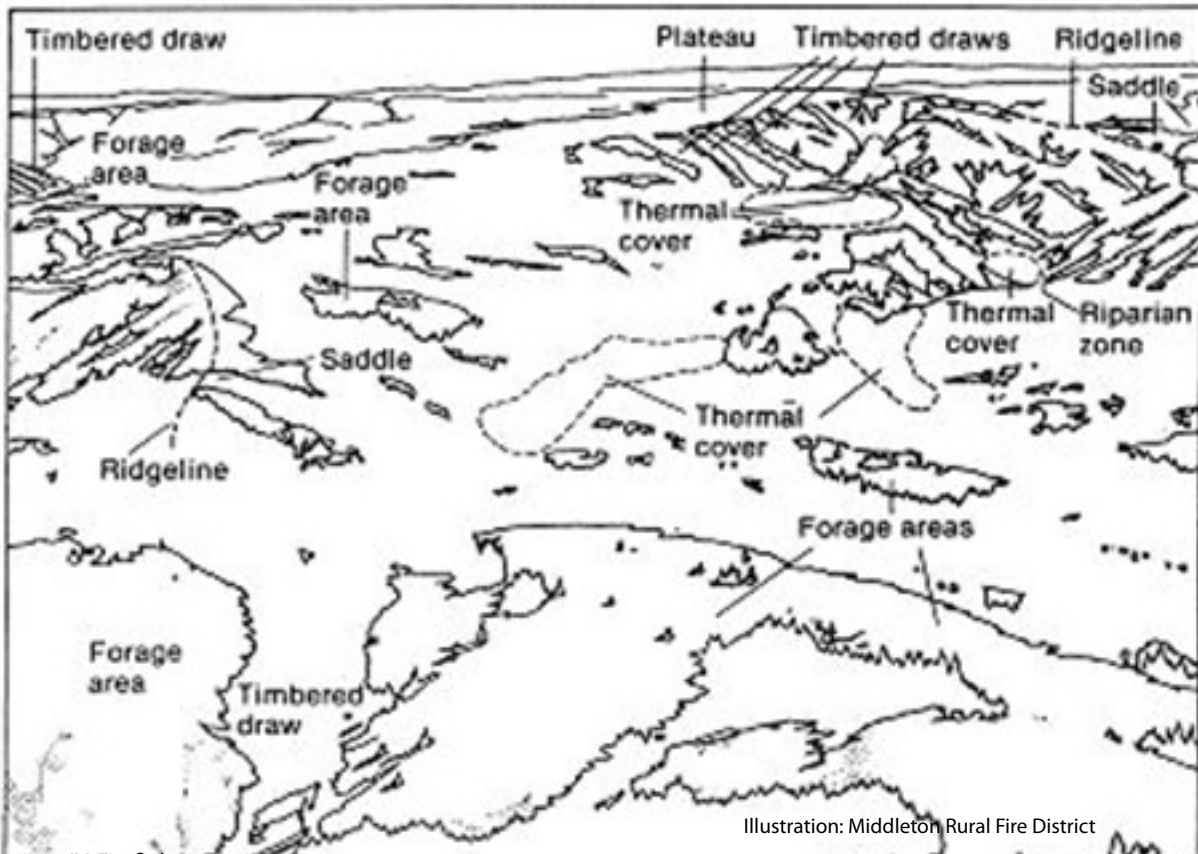
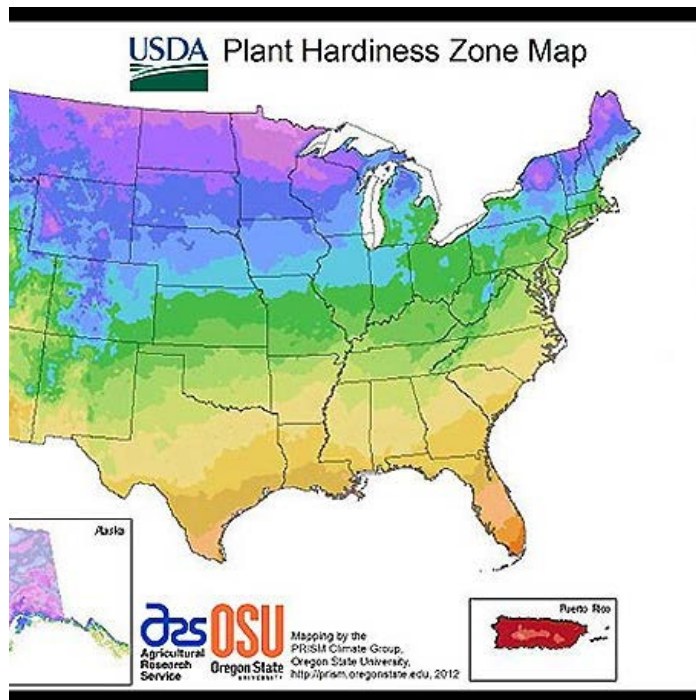


Illustration: Middleton Rural Fire District

Activity IV. Firefighter equipment



Source: New York Times, used with permission

Activity IV. Firefighter equipment

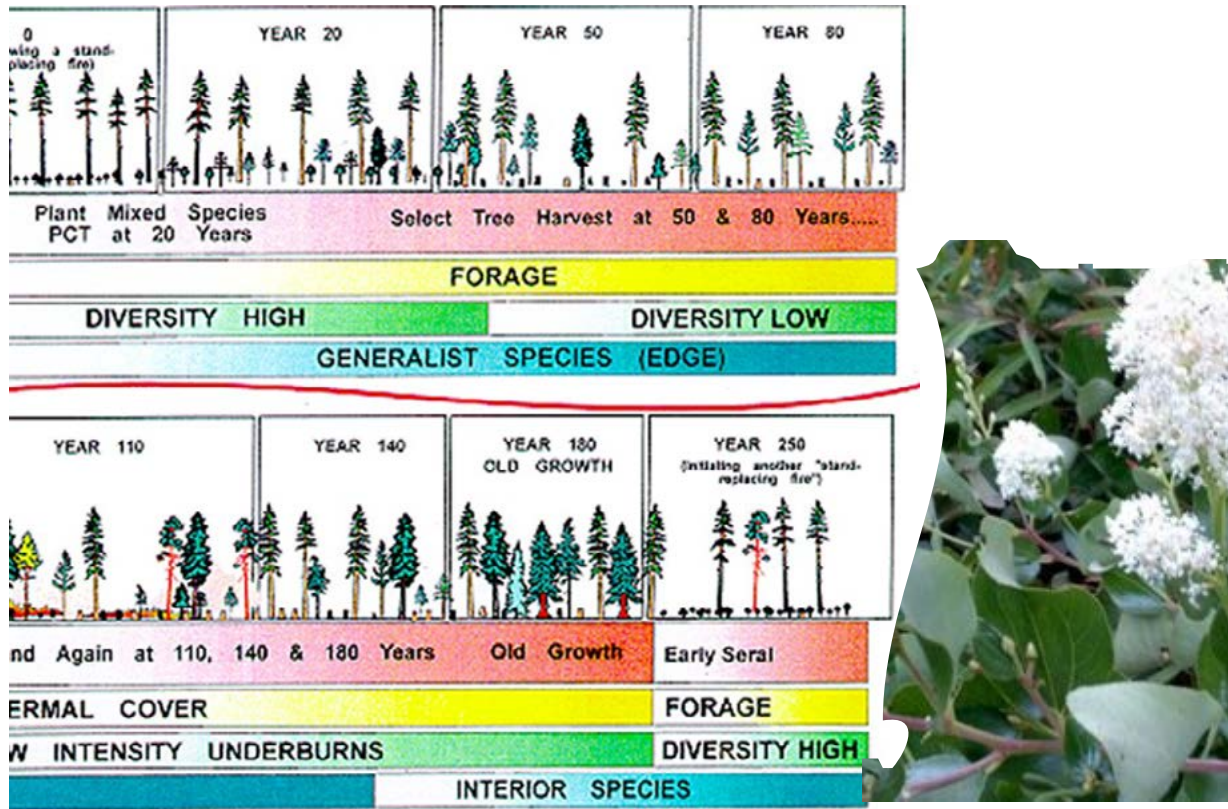


Image: Courtesy of lakepowelllife.com

Activity IV. Firefighter equipment

Activity IV. A typical wildland firefighter backpack.

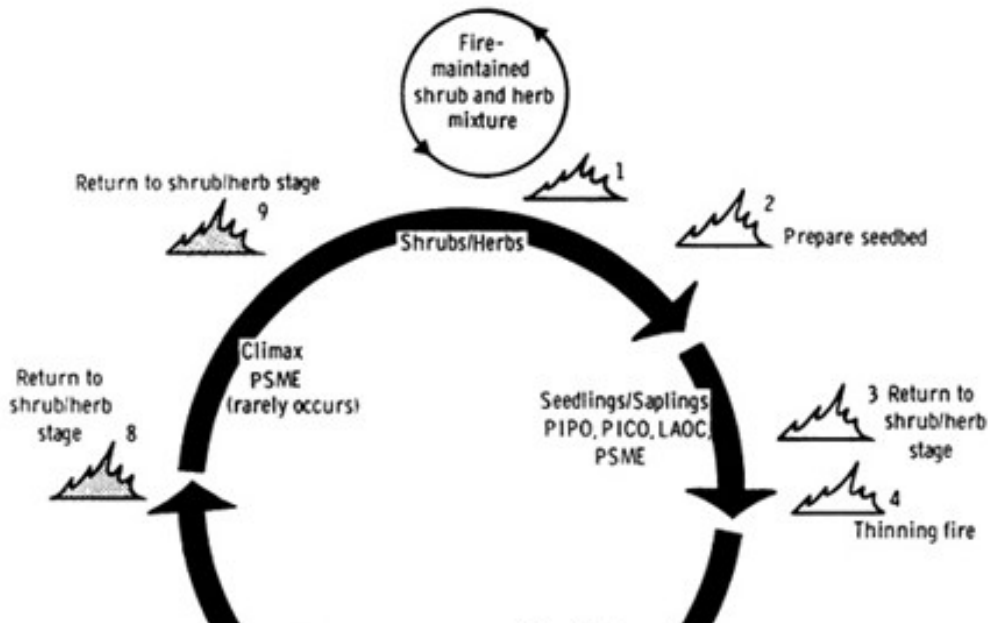
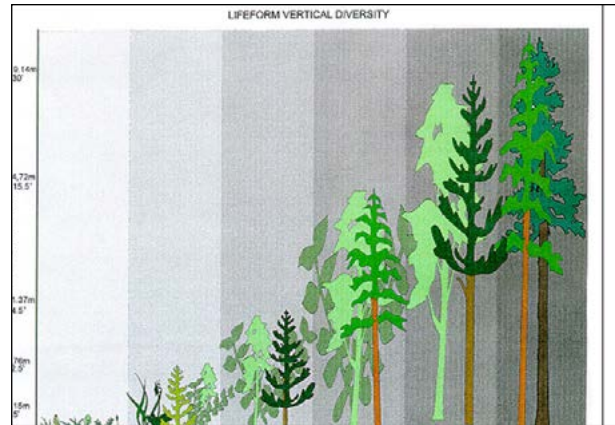
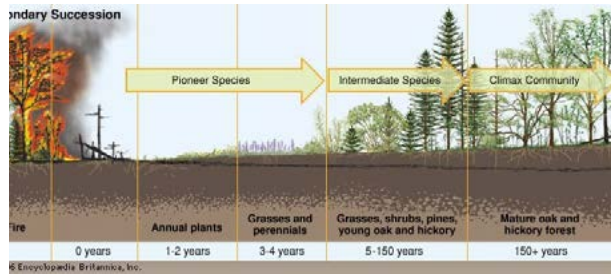


Image: Courtesy of lakepowelllife.com

Activity IV. An emergency shelter used by wildland firefighters.



Activity IV. The flat-head axe and haligan are the "Irons".

Activity IV. Various handtools used for wildland firefighting.

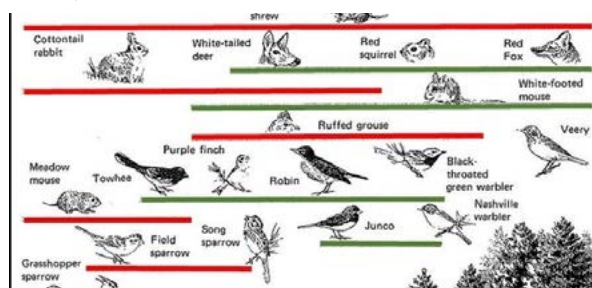


Photo: cascadefire.com



Photo: firequick.com

Activity IV. Hot Shot crew buggy with tool compartments. A team of 8 sits in the back, while the supervisor and captain sit in front.

Activity IV. The Dual Launcher III launches two types of flares and features a six-round, 22-caliber swing-out cylinder with a built-in casing ejector.

tool, comparing and contrasting the two videos

- Optional: students can read "Origin and History of Wildland Fire Use in the U.S. National Park System" (Appendix D)

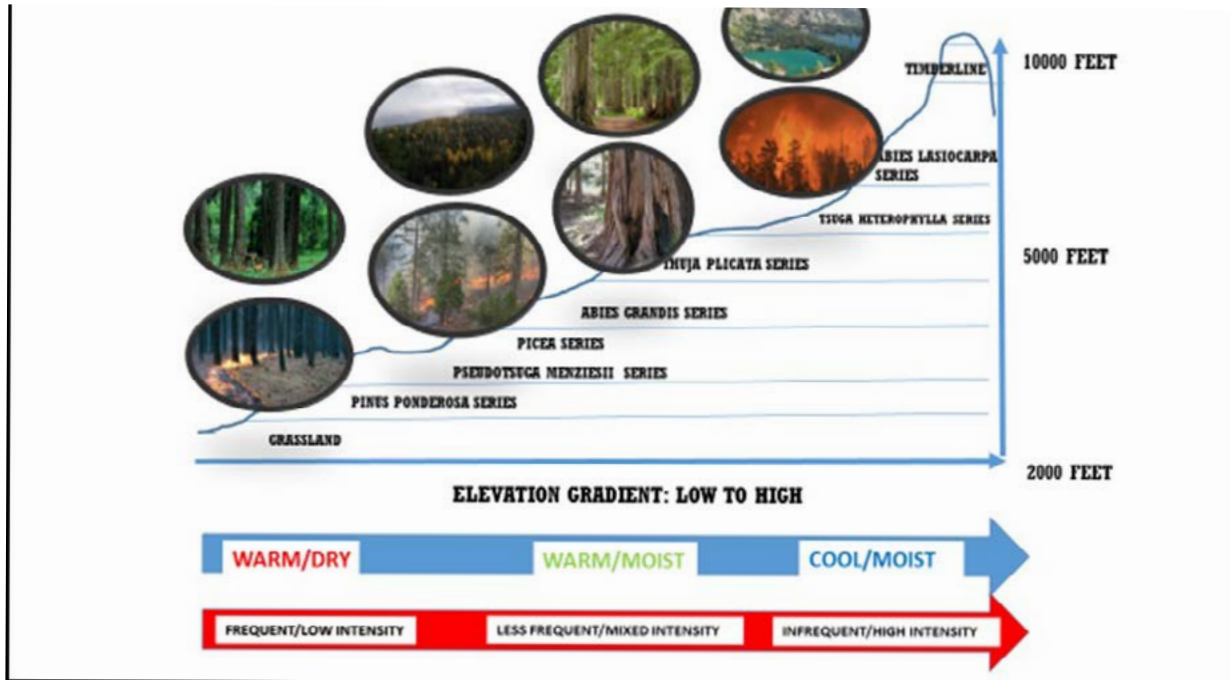
### VIII. Smoke

- YouTube: [Minimizing smoke impacts of prescribed fire](#) (six-part USFS video series)
- Video: [Public Health Issues: Smoke from wildfire and prescribed fire](#) (University British Columbia)
- Discussion of trade-offs between health and fuels management

### IX. Living with Fire

- For this activity, students will play Living with Fire (available at [www.fs.fed.us/rm/fire\\_game/](http://www.fs.fed.us/rm/fire_game/)).
- For this activity, they will choose to work in either a young or old growth ponderosa pine forest. They will then choose two treatments to test, comparing how their forest looks after each treatment. Then students will find out how wildland fire will behave after their treatments.
- Finally, they will describe benefits and disadvantages of each treatment.
- Have students use the Student Worksheet





Activity IV. An example of the type of gear a wildland firefighter carries.

on the Guided Tour and Lesson Plan page of Living with Fire.

- ❑ As a wrap-up to this activity, have students identify some economic, environmental, and social costs of their two treatments.

## Assessment of Knowledge Gained

### (Questions and answers)

1. What are the elements of the five-step process used by wildland firefighters to manage risk?

*Answer: Establish situational awareness; identify hazards and benefits and assess risk; control, mitigate, or eliminate the hazard; make go/no go decision based on acceptability of remaining risk; evaluate*

*effectiveness of hazard control and re-evaluate.*

2. Name, by priority, the four recommendations for fire management for structural firefighters.

*Answer: 1. Firefighter safety; 2. Civilian safety; 3. Stop the fire; 4. Conserve property*

3. What are firefighters protecting that is worth dying for?
4. Name three wildland firefighting tools and describe their basic structure.

*Answer: Pulaskis, shovels, axes, halligans, water-delivery systems, water-handling hardware, hoses, nozzles, PPE for both, fire-line pack, NOMEX clothing, SCBA, and turnout gear.*

5. Explain how to dig a fire line OR make entry into a burning home.

6. What is a contained fire?

*Answer: The status of a wildfire suppression action signifying that a control line has been completed around the fire, and any associated spot fires, which can reasonably be expected to stop the fire's spread.*

7. What is a controlled fire?

*Answer: The completion of a control line around a fire, spot fires, and any interior islands to be saved; burn out any unburned area adjacent to the fire side of the control lines; and cool down all hot spots that are immediate threats to the control line, until the lines can reasonably be expected to hold under the foreseeable conditions.*

8. If the perimeter of a fire is 10,000 feet, and 8,000 feet of the perimeter has completed black line, what is the containment percentage?

*Answer: 80 percent*

9. House fire! Define defensive fire strategy. Hint: The first defensive line should be placed to protect life and emergency egress, then placed to protect the most endangered exposure. The second line will be placed using the same criteria. This may mean sacrificing the building on fire to save others that are not involved.

*Answer: Isolate or stabilize the incident to ensure it does not get any worse. The purpose is to place apparatus used to prevent injury or damage when the initial or subsequent structures collapse. Attempt to place apparatus in a position that allows for safety should the fire location impinge upon apparatus.*

10. House fire! Define offensive fire strategy. Hint: If there are occupants unaccounted for who may be trapped alive inside, then an offensive mode is indicated if fire conditions are such that survival is feasible.

*Answer: Take direct action to mitigate the problem. Personnel have selected to utilize an aggressive interior attack by one or more engine companies because initial crews believe there is a chance that occupants may be inside the structure and conditions may be such that they could still be alive.*

11. Wildland fire! Define indirect attack strategy. Hint: Indirect attack is used on very intense or fast-moving fires when direct attack is impossible.

*Answer: A strategy in which firefighters build a fire line far away from the fire's edge in preparation for its advance. Backfires are set to burn out fuels ahead of the main fire, and the fire line can be combined with existing natural barriers to strengthen the overall control line.*

12. Wildland fire! Define direct attack strategy. Hint: Though it may sound risky, direct attack can actually be safer for firefighting personnel than indirect attack, since it means they can more easily escape to areas that have already burned—a strategy known as “keeping one foot in the black.”

*Answer: A strategy in which firefighters work very close to the fire's edge, either building a fire line or attempting to douse the flames directly with water or dirt. Direct attack can generally only be made if the flames are less than 4 feet long.*

## Additional Resources

- *Role of Fire in Alaska* curriculum (<https://www.fws.gov/alaska/nwr/visitor/fire/PDFs/Unit%203%20-%20Fire%20Management.pdf>)
- “The Politics of Fire and Social Impacts of Fire Exclusion on the Klamath,” *Humboldt Journal of Social Relations*. (<http://pages.uoregon.edu/norgaard/pdf/Politics-Fire-Social-Impacts-Fire-Exclusion-Norgaard-2014.pdf>)
- *Not All Fires Are Wild: Understanding Fire and its Use as a Management Tool* (EM 9114). 2015. Oregon State University Extension Service and NWFSC. <https://catalog.extension.oregonstate.edu/em9114>
- *A Land Manager’s Guide for Creating Fire-Resistant Forests* (EM 9087). 2013. OSU Extension Service and NWFSC. <https://catalog.extension.oregonstate.edu/em9087>

## Glossary of Terms

**Apparatus:** Equipment, tools, and instruments having a particular function or intended for a specific use

**Backfire:** A fire set along the inner edge of a fire line to consume the fuel in the path of a wildfire and/or change the direction of force of the fire’s convection column

**Burn out:** Setting fire inside a control line to widen it or consume fuel between the edge of the fire and the control line

**Dampening fire:** Activities that prevent, exclude, contain, and suppress fire

**Fire containment:** When a control line has been constructed around a fire’s perimeter, including any associated spot fires, with the reasonable expectation that the fire will not spread

**Fire control:** Includes suppression, exclusion, and containment

**Fire exclusion:** Keeping fire from the landscape

**Fire line:** A linear fire barrier that is scraped or dug to mineral soil

**Fire prevention:** Actions that lead to a reduced risk of wildland and household fire ignition

**Fire suppression:** All the work of extinguishing or containing a fire, beginning with its discovery

**Fire use:** Igniting or using fire to meet an objective

**Incident:** Human-caused or natural occurrence, such as wildland fire, that requires emergency service action to prevent or reduce the loss of life or damage to property or natural resources

**Mop-up:** To make a fire safe or reduce residual smoke after the fire has been controlled by extinguishing or removing burning material along or near the control line, felling snags, or moving logs so they won’t roll downhill

**NOMEX**®: Trade name for a fire-resistant, synthetic material used in the manufacturing of flight suits and pants and shirts used by firefighters

**Operational Section Chief (Ops Chief):** Individual responsible for the management of all operations directly applicable to the primary mission

**Personal protective equipment (PPE):** Equipment worn to minimize exposure to hazards in the work-place. All firefighting personnel must be equipped with proper equipment and clothing in order to mitigate the risk of injury from, or exposure to, hazardous conditions encountered while working. PPE includes, but is not limited to; 8-inch, high-laced leather boots with lug soles; fire shelter; hard hat

with chin strap; goggles; ear plugs; aramid shirts and trousers; leather gloves; and individual first-aid kits.

**Prescribed fire:** Fire ignited by management actions under certain predetermined conditions to meet specific objectives related to hazardous fuels or habitat improvement

**Pulaski:** A combination chopping and trenching tool, which combines a single-bitted axe-blade with a narrow adze-like trenching blade fitted to a straight handle. Useful for grubbing or trenching in duff and matted roots. Well-balanced for chopping.

**Smoke management:** Application of fire intensities and meteorological processes to minimize degradation of air quality during prescribed fires.

**Smoke Sensitive Receptor Areas (SSRA):** Population centers such as towns, villages, hospitals, nursing homes, schools, roads, and airports

**Spot fire:** A fire ignited outside the perimeter of the main fire by flying sparks or embers

**Structural fire:** Fire involving various types of residential, commercial, or industrial buildings

**Volunteer Fire Department (VFD):** A fire department of which some or all members are unpaid

**Wildland fire:** A non-structural fire, other than prescribed fire, that occurs in the wildland

**Wildland-urban Interface (WUI):** Line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels.

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Mine shaft where Ed Pulaski kept his crew at bay—and safe—from the 1910 fire near Avery, Idaho. Photo courtesy of the U.S. Forest Service. Accessed 6/15/2015.

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## Appendix A

### Personal Reflections

*Some years ago, the wildland fire season was another hot one and burned many acres across the northern Rocky Mountains. Colorado was especially dry and hot that year, and fires flared all across the state. A community with around 20,000 residents located in and around one of the major rivers struggled with a wildland fire that started in June and burned for almost 40 days. Subdivisions of homes were located throughout the area. The fire burned at the whim of wind, hot temperatures, and single-digit humidity, threatening homes and resources. The fire would eventually burn 70,000 acres and consume over 50 homes. Within the official fire boundary, many homes were located on the plateau above the river and some on the river bottom below the steep slope. There were also homes located across the wide river not included in the fire boundary because no one expected the fire to cross the river. Each night the hot and dry down-canyon winds would drive the fire down the side canyons to the bottom and blow out many homes in the process. Managing the fire was complex and difficult. A Type 1 incident management team was dispatched to take control. The team had three operation section chiefs assigned. These positions were responsible for managing resources to implement the strategies and tactics necessary to meet the objectives of life safety, incident stabilization, and property and resource conservation. There were thousands of resources assigned to the fire from all over the country. The team put together a plan. The Ops Chiefs carried it out and made decisions on the ground each shift, day and night. One tactic in the plan was to burn out the tops of side drainages to reduce fuel sufficiently during the day to prevent the catastrophic fires from burning out the houses at night.*

*This worked very well and stopped the loss of homes for the first time in many days. The ops chief assigned to the day shift had one more incident to qualify for a permanent place on the team and to be certified as the highest level of expertise in operations. He had over 20 years' experience managing wildland fires and succeeded in carrying out the burn out on the last drainage. In addition to all ground-based resources, the ops chief was also responsible for all resources assigned to air operations. He had worked with the Hot Shot crews on the ground and with Air Attack in the air for many years. On this fire, starting at first light of day, they had all conducted a careful burn out with coordination with other crews and with the fourteen helicopters and air tankers supporting with buckets of water and fire retardant drops strategically placed to minimize damage to firefighters and resources. Just as the last operation was successfully completed and the crews and aircraft began to disperse, the wind picked up to gale force (just in time for the crews) and the ops chief noticed a flare of a fire begin on the opposite side of the river near another subdivision. At a long distance away, he saw someone start a fire, which immediately flared to dangerous size driven by fierce winds right towards a 300-house subdivision. He had seconds to make a decision on an area outside his jurisdiction (the designated and approved fire boundary): send resources to stop the advance of the fire—or let it go until local resources could be “officially” dispatched. The second option would have taken too long and the structures—and anything else—would have burned. The air attack platform (his old friend) also saw this and asked for an order to act. The ops chief made a decision on the spot to send 14 aircraft to stop the fire. Ground resources were sent to back them up (crews, structure engines, wildland engines). Air Attack coordinated the water bucket drops and the air tanker retardant drops at*

*the head of the fire between it and the homes. All resources were in place to extinguish the flanks of the fire and firefighters safely did so. The fire was stopped and put out within feet of the first home. All homes were spared, but the landscaping was scorched in the first rank of houses. A massive deployment of resources went into this operation to save the subdivision—without authority and without permission. It was not part of the plan approved by the team. When the ops chief got back in to camp that evening, he was called in to see the incident commander with the other two chiefs. He was dismissed from the team—his career as an advanced fire manager was over. He had diso-beyed the rules and protocols and could no longer be trusted. He left camp the following day to fly back home and drove across the river to the subdivision. He walked between the houses and came across homeowners meeting together, still amazed at what happened the day before. They saw the ex-ops chief in fire clothes, brought him over, and asked who was responsible for what happened. When he told them, they cried and hugged him with thanks. He didn't tell them the aftermath.*

*The ops chief worked on other teams over the next 10 years filling in and doing various support jobs as needed, eventually retiring after a full career. Almost 20 years after that wildland fire incident, he was teaching a fire academy in another state. Towards the end of the academy, he asked the class full of potential firefighters, "What is the greatest challenge to managing fires?" They answered, "learning the tools" and "how to read fire behavior." He told the class what experience had taught him—that the real challenge to managing a fire is not the fire at all (that is black and white and based on science). The real challenge is the egos, personalities, and politics—the factors we are least trained to handle.*

## Appendix B

### Dilemmas in Fire Management

- ❑ Divide students into groups. Have one member of each group act as the reader and recorder.
- ❑ Have the reader read each dilemma, one at a time.
- ❑ After reading each dilemma out loud, the other members of the group will write a number, 1-4 (1. Definite NO, 2. Uncertain NO, 3. Uncertain YES, 4. Definite YES) on a slip of paper.
- ❑ Once everyone in the group has written their number down, they will pass their number to the reader. The reader will then record the results and make a bar graph.
- ❑ Have groups share their results once all of the groups have worked through the three dilemmas.
- ❑ Now, hand out the Dilemma Background Sheets. Ideally, provide each group with one dilemma to focus on, but if time allows groups can work on more than one dilemma.
- ❑ Have group members research articles and/or talk to local experts of agency people. Then have groups use this expanded information to formulate an informed decision.
- ❑ Have groups give a presentation about their dilemma, including background information, resources they used or consulted, and their decision.
- ❑ Finally, have students write a 1,000-word paper about the differences between their initial decision and their informed decision.

### Three Dilemmas

1. The intentional, planned use of fire to alter habitat is known as prescribed burning. Resource managers will prescribe burn an area to reduce a buildup of fire fuels or

to maintain vegetation to benefit wildlife. Should prescribed fires be started or should nature be allowed to take its course?

2. Spruce bark beetles kill thousands of trees on public forest land. The intentional, planned use of fire to alter habitat is known as prescribed burning. Should the government do prescribed burning in an attempt to stop the spread of the beetles?
3. Some areas in southwest Alaska should be categorized as limited-action areas where fires are mainly monitored but not fought. The people who live a subsistence lifestyle in this area are very dependent on caribou herds that prefer the lichens that are destroyed by hot fires. Should another level of protection be given those areas to help maintain the reindeer herds that these people are so dependent upon?

## Appendix C

### Forest Dilemma Background Information Sheet #1

*The intentional, planned use of fire is known as prescribed burning. Forest managers will prescribe burn an area to reduce a buildup of fire fuels or to maintain vegetation to benefit wildlife. Should prescribed fires be started or should nature be allowed to take its course?*

#### Fire As A Natural Force

Fires burn in a patchwork pattern called a mosaic. This vegetation mosaic results in diverse habitat for wildlife.

People benefit from the availability of wildlife whether they hunt, fish, photograph, or simply observe them. When fire is excluded from fire-dependent ecosystems, the ecosystem's diversity, productivity, and stability are reduced.

#### Prescribed Burning As A Management Tool

Research has taught us much about the behavior of fire. By analyzing weather conditions, fuel types, and the topography of an area, a professional fire manager can begin to predict how fast a fire will spread, how high the flames will go, and how intensely the fire will burn the area.

Prescribed burning is the intentional, planned use of fire. It can be used to duplicate the historic cycle of natural fire. The **fire interval** is the length of time that passes between natural fires in a given area. The fire interval for interior Alaska is as often as every 50 to 100 years.

Prior to setting a prescribed burn, managers complete a burn plan. These plans consider such things as the purpose of the burn, fuel load of the area, public notification plans, ignition source and patterns, prefire surveys, and manpower and equipment needed. Sometimes prescribed burns "escape" and cause damage. This is usually due to an unexpected change in the weather.

Prescribed burning can benefit wildlife. The mosaic patchwork pattern of a fire creates many **edges** between vegetation. These **edges** are often preferred by wildlife for feeding areas and travel corridors. Prescribed burning on lake margins in the fall removes dead vegetation and promotes regrowth of grass and sedge shoots desired by waterfowl for food and nesting materials.

Prescribed burns can be used to create fire breaks. **Fire breaks** are areas where fuels have been removed to stop a fire from spreading. Fire breaks are often used to protect privately owned lands and developed areas from fire.



## Effects Of Smoke

Smoke produced by fires can have a variety of effects on residents and visitors. Long-lasting fires can lead to disruption of air service due to smoke-density problems and can pose serious aviation safety problems for aircraft. Smoke can interfere with the tourism industry.

It can also cause health problems for elderly residents and those with respiratory ailments. For most people, however, smoke is an irritation rather than a health hazard.

## Forest Dilemma Background Information Sheet #2

*Spruce bark beetles kill thousands of trees on public forest land. The intentional, planned use of fire is known as prescribed burning. Should the government do prescribed burning in an attempt to stop the spread of the beetles?*

### The Effects Of The Spruce Bark Beetle

The spruce bark beetle attacks white spruce trees by boring through the bark to feed and breed in the phloem.

The phloem is the layer of tissue that transports food manufactured in the tree's leaves to the rest of the tree. If this layer is totally destroyed, the tree dies. The beetle has infected trees on the Kenai Peninsula and in the Yukon and Kuskokwim Valleys. The beetles are spreading north and are a serious threat to Alaska's forests.

### What Has Led To The Spruce Bark Beetle Epidemic?

Small populations of the beetle are always present in white spruce forests, feeding and breeding in dead and dying trees. Under normal conditions, beetle populations are controlled by parasites (such as ichneumon wasps) and predators (such as woodpeckers). However, when conditions are favorable, spruce beetle

populations may suddenly increase to epidemic proportions. Conditions that favor beetle reproduction include very dry summers and the presence of many dead or dying trees. When populations reach epidemic size, the beetles begin moving from dead and dying trees into healthy, living trees nearby.

Beetles that attack healthy trees are usually trapped by pitch the tree produces. Patches of resin may be produced on the infected tree's trunk and the needles may turn a yellowish-green, then a reddish-brown color, before falling off.

Many human activities disturb the growing conditions of white spruce, contributing to spruce beetle attacks and epidemics. Timber harvest, land clearings (roads, seismic lines, pipelines, powerlines, or building construction), and fire can injure healthy trees or leave dead wood where beetles can reproduce.

### The Spruce Bark Beetle And The Boreal Forest Ecosystem

Epidemics of the spruce bark beetle and other insects are a natural phenomenon in the boreal forest. Even in severely affected forest stands, some white spruce trees are able to survive beetle attacks. The survivors are more vigorous, less attractive to beetles, or are perhaps better able to trap the beetles with their pitch.

Dead and insect-infested spruce trees provide important habitat for certain wildlife species. Woodpeckers feed primarily on bark beetles and other wood-boring insects. They excavate nesting and roosting cavities in diseased trees with rotten interiors. Flying squirrels, boreal and black-capped chickadees, tree and violet-green swallows, and boreal owls require nesting and roosting holes (usually old woodpecker holes) in dead and dying trees in order to raise their young and to survive the winter. Juncos, sparrows, and several thrush species use fallen trees for nesting cover. Small mammals such as voles, squirrels,

and hares use fallen trees for important cover from predators. The decomposition of dead trees returns minerals to the soil where they can be used again by growing plants. Burning dead trees returns minerals to the soil more quickly than decomposition. When dead trees are removed from the site, so are the minerals.

### **Preventative Measures Against The Bark Beetle**

Some people believe that pesticides should be used to stop the spread of the spruce bark beetle. Others feel that use of chemicals should be avoided since they may adversely affect the entire food chain. Some forest entomologists (people who study insects and insect-caused diseases) suggest removing old, diseased, and dead trees and harvesting white spruce trees when they reach 150 years of age to reduce or prevent spruce bark beetle epidemics. They also recommend removing slash from logging, wind-damaged trees, and trees killed or injured by fire. Forest ecologists recognize that healthy forests consist of a variety of tree species and ages. These kinds of forests provide habitat for a variety of bark beetle predators, such as birds, wasps, ants, and spiders. A greater variety of predators may decrease the probability of beetle epidemics.

### **Various Policies Concerning Tree Removal**

The Alaska Division of Forestry removes dead, diseased, and dying trees in accessible areas of the Tanana Valley State Forest; the U.S. Forest Service does this in accessible parts of the Chugach National Forest. On lands managed by the U.S. Fish and Wildlife Service, dead, dying, and diseased trees, including those killed by beetles, are left in place to serve as nesting habitat and cover for wildlife. The U.S. Bureau of Land Management encourages harvest of dead, dying, and diseased trees on most accessible forested lands under their jurisdiction.

## **Tundra Dilemma Background Information Sheet # 3**

Some areas in southwest Alaska should be categorized as limited-action areas where fires are mainly monitored but not fought.

The people who live a subsistence lifestyle in this area are very dependent on reindeer herds that prefer the lichens that are destroyed by hot fires. Should another level of protection be given those areas to help maintain the reindeer herds that these people are so dependent upon?

### **Problems From Fire**

There is a problem with establishing some areas of southwest Alaska as limited-action areas where fires are only monitored unless they threaten lands in other higher-valued categories or critical sites within the area.

The value of the resources lost during a fire in these areas would be much less than the cost of fighting those fires.

Reindeer herds are kept in this area and support much of the local subsistence economy. Most people agree that the lichens that are burned in very hot fires are a preferred food for caribou and reindeer. These lichens may not revegetate these areas for 15 to 100 years, depending upon the severity of the burn and the environmental conditions of the area. This does not present a serious problem for caribou, which can move to other areas for winter food. The reindeer cannot be moved to a new area, so these fires may have a devastating effect on these herds and the people who depend upon them.

### **Advantages Of Fire**

Fast shallow burns may increase the lichen cover, especially where thick carpets of mosses have developed. These burns may favor the growth of some lichen species preferred by caribou and reindeer.

Some burns may also increase the early spring plant growth for reindeer and waterfowl. A fire in the Selawick area caused an increase from 21.0 ducks per square mile to 33.3 ducks per square mile the next year.

# Evaluations



OREGON STATE UNIVERSITY  
CITIZEN EVALUATION OF TEACHING

USE NO. 2 PENCIL

INSTRUCTOR'S NAME	EXTENSION EVENT	DATE
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**YOUR RESPONSES TO THIS QUESTIONNAIRE WILL HELP INSTRUCTORS CONFIRM QUALITY TEACHING AND IMPROVE TEACHING SKILLS AND METHODS.**

PLEASE FILL-IN THE APPROPRIATE RESPONSE.  
MARK ONLY ONE CIRCLE PER QUESTION/

		VERY POOR	POOR	FAIR	GOOD	VERY GOOD	EXCEL- LENT	UNABLE TO RATE
■	1. Overall, the quality of the educational event as a whole was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
■	2. The quality of instruction in this educational event was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
■	3. Clarity of educational objectives was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
■	4. Clarity of how you might use this education was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
■	5. Teaching organization was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
■	6. Instructor's use of examples was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
■	7. Instructor's use of teaching aids (slides, overheads, charts, etc.) was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
■	8. Instructor's ability to stimulate my thinking more deeply about the subject was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
■	9. Instructor's responsiveness to questions was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
■	10. Instructor's use of participant discussion to enhance my learning was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
■	11. Instructor's ability to develop a welcoming environment for all participants was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
■	12. Instructor's skill in making the information useful to me was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**Your comments will be helpful to improve instruction.**

Please comment:


# PowerPoint Slides

**Module 4: Fire Management**  
FIRE SCIENCES CORE CURRICULUM

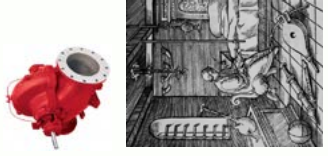






**1**



From the beginning, it was about getting wet stuff on the red stuff.

**3**




**FIRE MANAGEMENT**  
Tradition:  
View the History to  
Understand the Present

**2**



**MALTESE CROSS**








**4**



**THE POINTS (FIRE)**

 Oregon State University

**Gallantry** — The qualities of a hero or heroine; exceptional or heroic courage when facing danger (especially in battle).

**Perseverance** — Persistent determination.

**Loyalty** — The quality of being loyal.

**Dexterity** — Ability to move the hands easily and skillfully.

**Explicitness** — Fully and clearly expressed; leaving nothing implied.

**Observation** — The act of observing; taking a patient look.


**Tact** — Consideration in dealing with others and avoiding giving offence.

**Sympathy** — An inclination to support or be loyal to or to agree with an opinion.

(<http://hpfirefighter.com/2012/08/what-does-the-maltese-cross-stand-for-and-where-did-it-come-from/>)

**5**

**DALMATIAN**






When there were horse-drawn fire wagons racing to the scene, the Dalmatians would run out of the firehouse, barking to let bystanders know that they should get out of the way because the firefighters' wagon would soon come roaring by. Then they stood guard near the wagon to ensure that no one stole the firefighter's belongings, equipment, or horse. They were also good ratters, known to catch and kill rats that resided in the old firehouses.

**7**

**THE POINTS (EMS)**

 Oregon State University

**Observant** ("what they may note the causes and signs of injury")

**Tactful** ("that they may without thoughtless questions learn the symptoms and history of the case, and secure the confidence of the patients and bystanders")

**Resourceful** ("that they may use to the best advantage whatever is at hand to prevent further damage, and to assist Nature's efforts to repair the mischief already done")

**Dexterous** ("what they may handle a patient without causing unnecessary pain, and use appliances efficiently and neatly")

**Explicit** ("that they may give clear instructions to the patient or the bystanders how best to assist them")

**Discriminating** ("that they may decide which of several injuries presses most for treatment by themselves, what can best be left for the patient or bystanders to do, and what should be left for the medics")

**Persevering** ("that they may continue their efforts, though not at first successful.")

**Sympathetic** ("that they may give real comfort and encouragement to the suffering")

(St. John Ambulance, The Venerable Order of St. John)

**6**

**ALARM BOX**

 Oregon State University









When the alarm sounds, the firefighter goes, whenever on shift — day or night, 911 calls have replaced the old telegraph lines that ran for miles.



**8**

**RINGING OF THE BELL**











The 5-5-5 code has been used in the city's firehouses since 1870; it signals a death, generally of a colleague or the mayor, and tells firefighters to lower the American flag to half-staff.

9





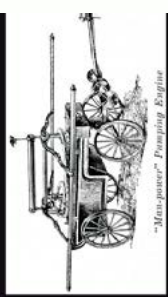
**APPARATUS**

Ingenious devices – but hand power was getting old and tectious.

11

**APPARATUS**

It was all by hand – hauling buckets and carts.

10

**APPARATUS**






Horse power made a difference

Top – Oregon History Project (1913); right – Reddit.com (1910); top right – Flickr as Siberian steam fire engine and horses (1858)

12

**JAPANESE FIREFIGHTING**

Oregon State University

15

**FRENCH FIREFIGHTING**

Oregon State University

The fire service in France is known as Sapeurs-pompiers, except in Marseille, where naval "sailor-firefighters," marins-pompiers, provide fire and rescue services.

16

**APPARATUS**

Oregon State University

A lot of horse power

13

**ROMAN FIREFIGHTING**

Oregon State University

Wooden statue of St. Florian at the St. Joseph's R.C. Church in Rosebank, Staten Island

The Vigiles or more properly the Vigiles Urbani ("watchmen of the City") or Cohortes Vigilum ("cohorts of the watchmen") were the firefighters and police of Ancient Rome.

Marcus Licinius Crassus - 100 - 50 BC (Louvre Museum) Fire Management by Extortion

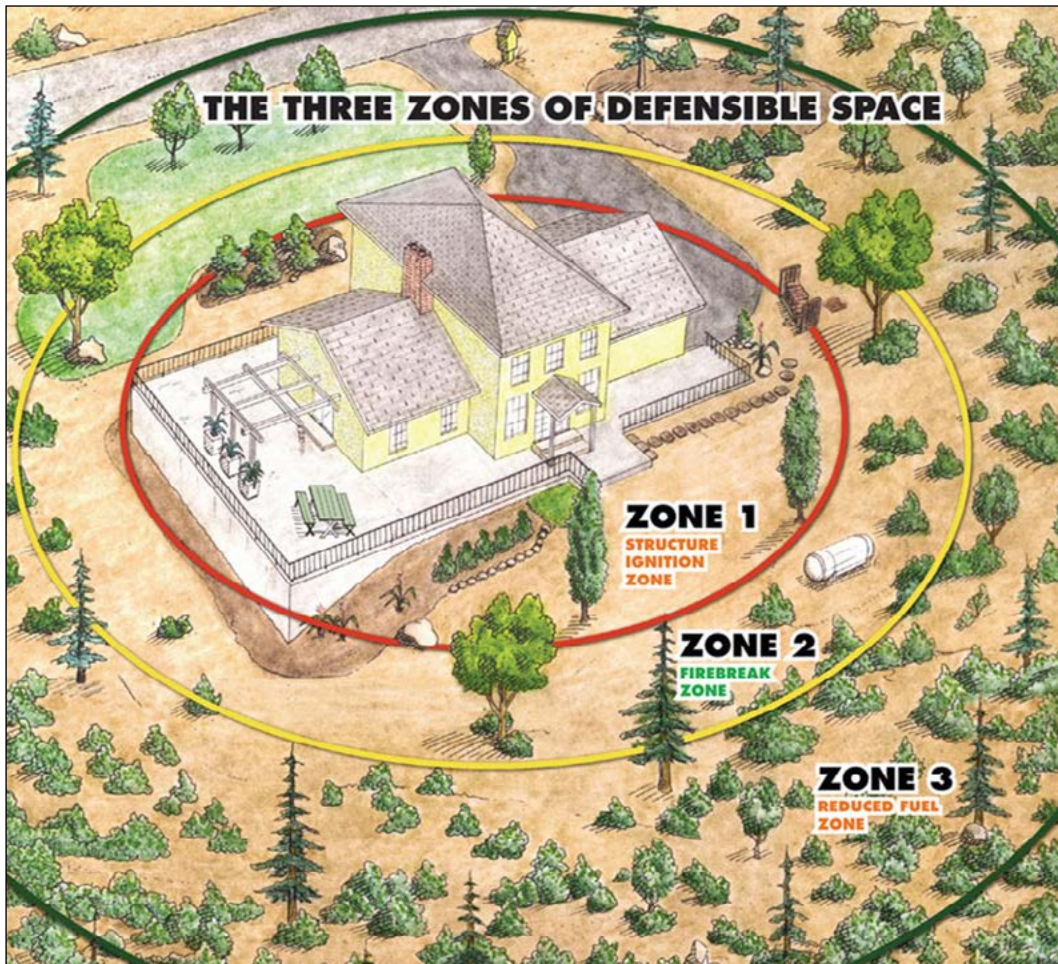
14





21

# Module 5: Fire Prevention for Home and Landscape



## Proposed Agendas

Home Ignition Zone		
Time		Section name
9:00	9:15	Welcome, introductions, and class objectives
9:15	9:30	Historical context for fires and fire facts
9:30	10:30	Risk assessment
10:30	10:45	Break
10:45	12:00	Designing and creating a fire-resistant home
Noon	12:30	Lunch
12:30	1:00	Resources available
1:00	4:00	Field tour and hands-on application exercises

Defensible Space		
Time		Section name
9:00	9:15	Welcome, introductions, and class objectives
9:15	10:30	Defensible space: Getting into the zone
10:30	10:45	Break
10:45	12:00	Defensible space treatments
Noon	12:30	Lunch
12:30	1:00	Ready, Set, Go! When disaster strikes
1:00	4:00	Field tour and hands-on application exercises

*No fire prevention, know pain. Know fire prevention, no pain.*

**Author**

*Unknown*

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## Overview

This module teaches students how to prevent or minimize fire related losses in and immediately around the home by learning how to recognize fire hazards and take appropriate mitigation strategies.

## Learning Objectives

- Understanding home fire risk management and prevention
- Know the risks of flammable or combustible material surrounding home
- Understand management alternatives for minimizing those risks

## Learning Outcome

Develop and implement the practices necessary for minimizing fire risks.

## Content Outline

- Historical Context for Fires
- Strategies and Tactics
- Risk Assessment
- Resources Available
- Home Ignition Zone (HIZ)
- Defensible space
  - Zone 1
  - Zone 2
  - Zone 3
- Defensible space treatments
  - Fuel Treatment Options
- Ready, Set, Go!
- Public Awareness Campaigns: Smokey the Bear and Sparky the Fire Dog
  - Public Safety Education

## Historical Context for Fires

Over the last 20 years, the frequency and extent of damaging wildfire events have increased dramatically (Figure 1), resulting in the tragic loss of natural resources, homes, and human lives. Between 2002 and 2011, insured losses from wildfire-related events in the United States increased \$6.2 billion dollars from the prior 10 years, from \$1.7 to an astounding \$7.9 billion. In some years thousands of homes were lost due to wildfires, such as in 2003 when nearly 4,000 homes were destroyed in Arizona and California wildfires. Wildfires may be inevitable, but the destruction of homes, ecosystems, and lives is not. The question we face is how can our agencies, first responders, and affected communities minimize the risk of loss?

The answer to that question is that preventing losses within the Wildland-Urban Interface (WUI) requires special attention to the hazards within and surrounding the homes themselves. Consequently, the principal responsibility for managing those hazards falls to the property owners. As one author noted “If we are to prevent extensive home destruction within the WUI, property owners must become engaged, matching their authority over the Home Ignition Zone (HIZ) with the responsibility to create ignition-resistant homes.” (Cohen 2010)

This module will provide students with information, knowledge, tools and guidelines that will assist them in recognizing, reporting, and controlling fire hazards and risks at home and within the landscape. This will help eliminate or reduce the causes of fire, and prevent the loss of life and property by fire within the WUI areas.



✓ **Activity I<sup>1</sup> – Personal and professional insights**

- Students read Insights from a Wildland Fire Professional

**Strategies and Tactics**

In recent years, the focus of fire prevention has changed. While the end goal of preventing catastrophic loss of life, property, and natural resources has remained the same, the strategies and tactics involved have been modified. Increasing fuel loads and a warming climate (Figure 2) have made today’s wildland fires harder to control, expensive to suppress, and a threat to the lives of firefighters and civilians. Potential negative wildland fire consequences now involve more than blackened acres and property loss. Now wildland fires often burn with intense heat and erratic fire behavior, severely impacting and even altering ecosystems and communities, challenging their ability to recover, and sometimes claiming human lives.

Parallel to wildland fires, modern home fires burn hotter, are more erratic, and flashover (the sudden involvement of a room or an area in flames from floor to ceiling) faster than homes of the past. Homes now have furniture, carpeting, and materials creating fires that involve hydrocarbon and synthetic-based contents such as foam rubber, nylon, rayon and polypropylene. These fires have a relatively high heat release rate when compared to the natural fiber products found in legacy fires, materials consisting of solid wood, wools, and cottons. Where firefighters could have had 30 minutes to enter a burning building in the past, they now have 2 to 3 minutes before the intense flashover occurs. At that point, the room and all within it are completely destroyed.

Consequently, it is paramount that the ignition risk be minimized. While past suppression tactics have been effective, fire prevention tactics and

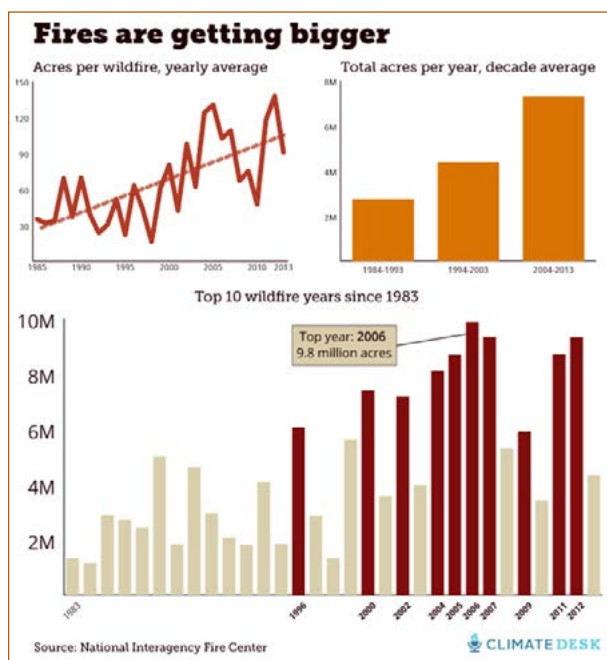


Figure 1. The increasing impact of fire

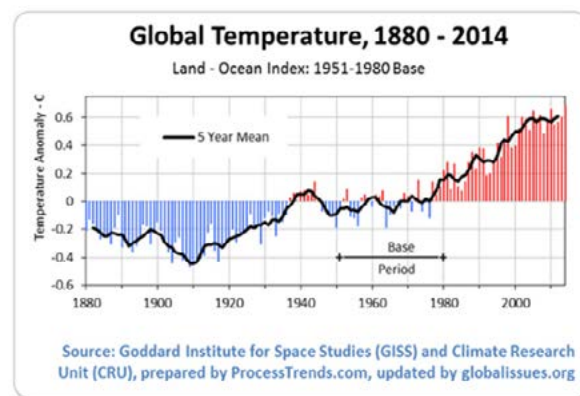


Figure 2. Changes in global temperatures

strategies have changed. We no longer can afford to invest all our resources in fire suppression forces, equipment, and strategies. “Reactive” fire suppression programs must evolve into “proactive” fire management programs. We must effectively apply fire prevention and hazardous fuels reduction techniques that focus on mitigating the susceptibility of structures to the wildfire exposure. Property owners, agencies, and first responders must all work collaboratively to achieve the best results.

<sup>1</sup> See Activities section for details on all activities in this curriculum

A good way for WUI property owners to begin taking responsibility for making their homes safe from wildfire is not to ask **if** a wildfire will hit their community—but **when**. The likelihood of a fire and potential severity of consequences leads to the next question: What can I do to minimize my risks? A good overview of the topics that are covered in this module is the OSU Extension publication *Before Wildfire Strikes! A Handbook for Homeowners and Communities in Southwest Oregon* (EM 9131).

✓ **Activity II – Fact Sheets**

- Fire Overview Fact Sheet
- Fires in the United States during 2015 Fact Sheet

## Assessing the Risks

Once a property owner recognizes that risks exist and commits to minimizing those risks, the first step is to develop an understanding of what those risks are. We'll begin with an overview of the rich sources of information available, in particular the abundant **Firewise** materials that are available online. We will learn about concepts such as the **Home Ignition Zone** (HIZ) and how to assess the risks to the home by methodically examining construction design and materials used. We'll also learn about **defensible space** and how to evaluate the risks of ignition from potential fire fuel sources such as fences, outbuildings, propane tanks, and so on.

There are a variety of excellent resources to begin evaluating your exposure to wildfire risks, including homeowner's checklists that detail the numerous considerations that need to be examined carefully.

These checklists not only identify the important criteria for creating a fire safe home but also provide suggestions on what to do when a problem is identified. A good example of that is the *Defensible Space Planning and Preparation Fire Awareness Checklist* which leads

the homeowner through everything from road access and availability of water, to a detailed examination of the home and appurtenances (fencing, decks, propane tanks, etc.), to the vegetation surrounding the home. This and other helpful checklists are the Fire Safe Council's Homeowners Checklist and the Structure Assessment Checklist, which can be found in the Additional Resources section.

If you would like to have professional help with conducting a comprehensive assessment of your property, consult with your local Fire Department, Rural Fire Department, Oregon Department of Forestry office, or other entity responsible for providing fire protection for your community.

✓ **Activity III – Assessing the risks**

- Students will review publications and websites listed in the Activities section.
- Students will review, discuss, and apply the Homeowners Checklist and the Fire Awareness Checklist.
- Students will review, discuss, and apply the checklist Defensible Space Planning and Preparation.

✓ **Activity IV – Pre-Plans**

- Review and create examples of pre-plans for fire preparedness.

✓ **Activity V – Safety/art**

- Students discuss and illustrate fire safety hazards in the home.

## Resources for Assistance

While it is essential for each landowner to assess their risks and take proactive steps to minimize those risks, it is helpful to think more broadly about the risks that threaten the whole community. For example, landowners may do everything right to protect their home, but if the neighbors don't follow suit, all their efforts may be in vain. A *Fire-Adapted Community* in

which all the residents are *Firewise* requires little assistance from firefighters during a wildfire event. These residents accept their responsibility for living in a fire-prone area and they possess the knowledge and skills to prepare their home and property; evacuate early, safely, and effectively; and most importantly, survive if they become trapped by a wildfire (Figure 3).

It is important to know that there are well-established, proven steps that homeowners can take to improve their personal safety and home survival during a wildfire. Once implemented, especially at the neighborhood level, these recommendations will assist communities in becoming Fire Adapted Communities.

When the area needed to create an effective defensible space exceeds your own property boundaries, you'll need to contact your neighbors, whether private citizens or government agency entities, to discuss opportunities to work cooperatively. The effectiveness of Defensible Space Zones improves dramatically when entire neighborhoods implement the recommended practices. Before proceeding with efforts to create a Firewise community in your area, always check with your local fire department or fire district to enlist their help. Reducing fire risks through home improvements, vegetation fuels management, or other steps can be expensive. Some landowners may be able to do the work themselves and thereby reduce the costs, but others, lacking the time, skills, or physical ability, may have to use contract services, which can be expensive. Funding through grants or cost-share programs may be available to help offset the costs, but the availability of those resources can vary widely from area to area and from year to year. Check with the appropriate agencies in your area on what may be available and how to apply. Agencies to consider include the Oregon Department of Forestry, USDA Forest Service and the Bureau of Land Management.

*A good way to begin to understanding the potential fire risks is gaining an appreciation for how fire ignition actually occurs. We typically think of homes catching fire from direct contact with flames, visualizing the massive flame front of a raging wildfire. The reality is often much different. Small seemingly inconsequential embers are often the culprit as noted in Vulnerabilities of Buildings to Wildfire Exposures.*

### ✓ Activity VI – Resources for Assistance

- Have students review the documents and websites listed in the Activities section.
- Students will discuss the resources that are available and how their communities may benefit.
- Students will evaluate their own communities following the suggestions and guidelines within the materials provided in the Activities section.



Image: Kentucky Division of Forestry

Figure 3. Figure shows area of your property where you can improve your home's ability to survive a wildfire.

## Home Ignition Zone - HIZ

The two factors that primarily determine whether a home survives a wildfire are its structural ignitability and the effectiveness of the defensible space surrounding it. These two things form the basis for a concept called the *Home Ignition Zone* or HIZ. Homeowners must recognize and take the steps needed to reduce or eliminate potential fuel and ignition sources within the HIZ which includes flammable vegetation and materials surrounding the home.

While building a noncombustible home can be prohibitively expensive, careful attention to utilizing appropriate construction materials and fuel management on the site around the home can make it possible to construct homes that are resistant to fire on their own, or at least make the job of protecting homes much easier for the homeowners and firefighters.

Selecting the most appropriate construction design and materials requires understanding the nature of the risks of any given site. A homeowner should look at the probable *intensity* of the fire, or how hot it will burn, and its *duration*, or how long the fire will burn. If intensity and duration will be low, it may be possible to make the home safe with relatively few precautions. But if intensity and duration risks are high or even extreme, then all possible precautions will have to be considered to create a survivable structure.

A useful way of looking at the risk of fire to your home is comparing fire and water. Just like water, fire will try to find a way into a home. Most parts of the structure can be fire-resistant but a single weak point that allows fire to get in will undo all the other good work. Although wildfires always present significant risk of loss, homeowners and communities that take appropriate precautions can successfully live in fire-prone areas.



Photo: Firewise.org

Figure 4. This home is in the forest, but the surrounding land has been treated to remove fuels and create defensible space.

### ✓ Activity VII – Home Ignition Zone (HIZ)

- Students review “Wildfire: Preventing Home Ignitions, Parts I & II” (videos)
- Students review “FireWise Construction: Site Design & Building Materials”
- Students review and discuss a “Home Ignition Zone Structure Assessment Guide” form

## Defensible Space

The general rule regarding the HIZ also applies to Defensible Space. ***Fire will find the weak link in your home’s protection safeguards.*** Unmanaged fuels in the defensible space can doom even a superbly built home (Figure 4).

Fire professionals have developed a system for analyzing and managing defensible space. This includes identifying three distinct zones, each with its own treatment goals and prescriptions. (Figure 5)

**Zone 1:** The “lean, clean, and green” zone extends 30 feet out from the edges of the structure. This area should not have any continuous fuels that would enable fire to burn up to the structure. This includes wood fences,

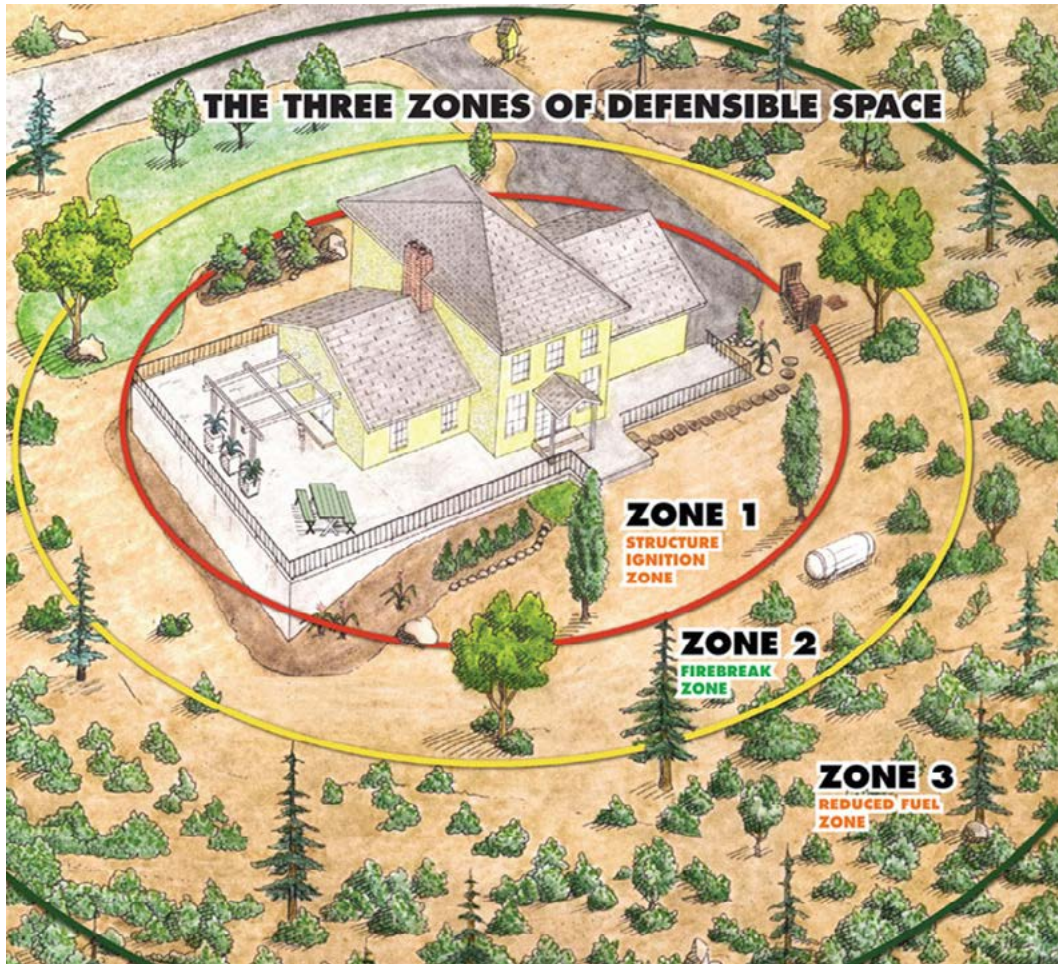


Figure 5. The three zones of defensible space

particularly if a building has flammable siding or other materials. If non-flammable home construction materials are used, then judicious use of “fire-wise” plants can be utilized. Never store combustible materials such as firewood in Zone 1.

**Zone 2:** This is an area of fuel reduction extending out 100 feet from the outer edge of Zone 1. The goal in Zone 2 is to reduce a fire’s intensity. Actions within this zone include thinning out trees and shrubs and removing ladder fuels from under the remaining trees. Keeping the grass mowed is critical, especially later in the year when grasses dry out. It’s OK to stack firewood or have other fuels stored in this zone, but keep them at least 30 feet away and uphill from the home.

**Zone 3:** Includes everything from the outer edge of Zone 2 to the outer boundary of your property. Treatment recommendations include thinning, pruning, and slash-disposal processes like piling and burning, chipping, or lop-and-scatter.

Annual maintenance of your defensible space is very important. Trees and other vegetation continue to grow, so their fuel hazard “profile” will change and require treatment (Figure 6).

## Defensible Space Treatments

Module 3 provides an in-depth review of the factors that affect fire behavior. This section will show how those principles applied to on-the-ground treatments can greatly reduce wildfire risks. Homeowners can use this information to



Photos: California Fire Northern Region

Figure 6. Photos show an area before and after FMZ treatment to reduce the fire hazard.

learn how to alter the total amount, composition (sizes), and arrangement of fuels and thus reduce the intensity and severity of a wildfire. No forest is “fire proof” but a properly treated WUI property will have a much higher probability of survival (Figure 7).

There are three types of fires—ground, surface and crown—and a wildfire may have all three. The proportion of each type will determine fire severity damage risk. Ground fires stay close to the ground surface and mostly consume duff (accumulated dried and decomposing vegetation) in a low intensity burn. Lower intensity surface fires consume needles, moss, herbaceous vegetation, shrubs, small trees and saplings and are generally not too harmful. However, high-severity surface fires can kill most of the trees but the impacts can be highly variable from point to point. Crown fires, which are very destructive, occur when enough heat is released in a fire to preheat and combust fuels above the surface leading to active crown fire spread from tree crown to tree crown. Strong winds and steep topography can greatly exacerbate the rate of spread.

The goal for homeowners is to manage their fuels so fire will remain a ground or low-intensity surface fire. The six principles for creating and maintaining a fire-resistant property are:

- Reduce surface fuel quantity

***Defensible space:** It is the area around your home in which the fuels and vegetation are managed so that if a fire approaches, the rate of spread, intensity, and duration are reduced to a level at which the structure can resist ignition. Strategically, a homeowner should start with the low-hanging fruit—the easiest and least expensive actions closest to the home—and then systematically and progressively move outwards. The overall design of a defensible space will depend on factors such as the size and shape of the buildings on the property, construction materials used, the slope of the home site, the surrounding topography, and the type and volume of combustible vegetation.*

- Increase the spacing of fuels, both structural and vegetative
- Increase the height from the ground to the base of tree crowns
- Increase spacing between tree crowns
- Retain larger trees of more fire-resistant species
- Promote fire-resistant forests at the landscape level

By following these guidelines, fire intensity will be reduced so firefighters will have an easier time fighting the fire and a large part of the landowners’ woodlands will be able to survive a fire.



Photo: UCANR.edu

Figure 7. A home in California survived a wildfire thanks to effective defensible space.

## Fuel Treatment Options

Thinning trees is one of the most powerful forest management tools available, allowing landowners to pursue their goals and objectives by altering stand density, stand structure, and species composition (Figure 8).

In addition to creating healthy, vigorous stands for wildlife habitat, wood production, and aesthetics, thinning decreases wildfire hazards by reducing the quantity and distribution of forest fuels. Leaving larger, more vigorous trees and removing smaller trees reduces the total fuel load, removes the ladder fuels, raises the height to the base of the tree crowns, and increases the spacing between crowns, making it harder for a crown fire to spread.

Pruning tree branches to increase the height to the bottom of the crown may be an additional action conducted at the time of a thinning, or as a stand-alone treatment (Figure 9). Pruning is especially effective in young stands where the shading effect has not yet caused the tree crowns to lift. In general, at least 50 percent of

the live crown needs to be retained for good tree growth, but if the trees are tall enough, then a reasonable pruning height is 10 to 12 feet. This amount of separation between the ground and lower branches will increase the fire resistance substantially.

Prescribed burning to reduce surface fuels, especially after treatments like thinning and pruning, is often accomplished by piling and burning the slash within the stands. Piling may be accomplished by hand or by machine and is highly effective for reducing the fuels. Underburning is also effective and can serve other ecological goals such as controlling unwanted vegetation, improving wildlife habitat, increasing species diversity, and releasing nutrients (Figure 10). More people are using prescribed underburning, but it requires a high level of expertise to get the desired results and may expose the landowner to substantial liability if the fire escapes its boundaries and damages neighboring property.

In situations where burning fuels is not an option, mechanically treating the fuels is an



Photo: Oregon State University

Figure 8. A forest after it has been thinned and pruned and the slash piled for burning.

effective way to substantially reduce homeowner liability (Figure 10). For example, in stands with light surface fuels, it may be practical to cut small trees, branches, and even brush into smaller pieces and scatter them about the site.

While this practice, called “cut and scatter,” doesn’t get rid of the fuel, it does redistribute it so that a ground fire will not become a threat.

Another method to consider is employing mechanical fuels reduction processes, known as mastication, in which machines are used to grind, chop, crush, or mow fuels, breaking it apart into relatively small pieces and distributing the material across the site. Mastication is an effective tool, but it can be expensive, not suitable for steep terrain, and may result in undesirable soil compaction or damage to desirable trees.

The fuels management requirement is not a “do it and forget it” process. Forests are dynamic systems; trees and brush continuously grow over time, requiring periodic follow-up treatments.

Property owners may want to do fuel management on their property every year in order to spread out the workload and make it more manageable and economically feasible.



Photo: Oregon State University

Figure 9. A landowner hand pruning his trees.

### ✓ Activity VIII – Defensible Space

- Students will review defensible space videos.
- Class will visit WUI home sites and create management plans for reducing fire risks.

### ✓ Activity IX – Defensible Space Treatments

- Students will review Defensible Space Treatments publications in the Activities Section.
- Students will visit WUI home sites and create defensible space management plans to reduce fire risks.

### ✓ Activity X – Action steps for around your home

- Students will review the Firewise Toolkit and Have A Firewise Home publications.
- Students will review the Ready website: <https://www.ready.gov/home-fires>
- Students will discuss actions their families should to take and create an action plan.

## Ready, Set, Go!

Now let’s turn our attention to what to do when a fire comes to your area. As many experts





Photos: Oregon State University

Figure 10. A prescribed burn (left) is used to remove a forest understory while heavy equipment (right) can also help clear brush and reduce fire risk.

will say, it's not a matter of **if** a fire will occur, but **when**. Just as the primary responsibility for making your home and property fire safe falls to you, the responsibility for protecting yourself, your family, and your property is up to you. And the old adage of "hope for the best but plan for the worst" applies well here. When a wildfire strikes a WUI community, things can happen extremely fast and be extremely chaotic: roads jammed with people leaving and firefighters arriving, visibility reduced by heavy smoke, and a strong sense of panic and fear.

It's not a good time to be scratching your head trying to figure out what to do. You need to be physically and mentally prepared for such a scenario, and that includes creating and following a sensible evacuation plan.

The checklists included in the *Ready, Set, Go!* reading for this section provide an excellent basis for planning.

It's a good idea to review your plans with your local firefighting agency. It would also be a good idea to work with that agency to organize your community into a *Firewise Community* so that

all homeowners create fire-resistant homes and property and their own Ready, Set, Go! checklists.

#### ✓ **Activity XI – Ready, Set, Go!**

- Students will review Awbrey Hall Fire, Bend
- Students will review Ready, Set, Go! Your Personal Wildfire Action Plan.
- Students will review Get Ready to Go.
- Students will review Forest Home Fire Safety.
- Students will create and share their own Ready, Set, Go! checklists.

### **Public Wildfire Awareness Campaigns: Smokey & Sparky**

Minimizing the risks to homes, private woodlands, and public forests from wildfire needs everyone's awareness and participation. However, creating and distributing a message that large numbers of people will hear, understand, and respond to is a bit daunting. Enter two iconic heroes who for nearly 70 years have educated many millions of Americans about the dangers of fire: Smokey Bear and Sparky the Fire Dog.

## Origins of the Preventing Wildfire Campaigns

### Smokey Bear

Smokey's history begins with World War II (Figure 11). The spring following Japan's December 7, 1941 attack on Pearl Harbor, Japanese submarines surfaced near the coast of Santa Barbara, California, and fired shells that exploded on an oil field, very close to the Los Padres National Forest. People feared more attacks that would kill people, destroy property, and ignite wildfires in the forests along the Pacific Coast.

Forest protection became a national concern. Many thought that people could prevent wildfires by being careful. The Forest Service, with the help of the War Advertising Council and the Association of State Foresters, organized the Cooperative Forest Fire Prevention (CFFP) program, which was designed to educate people about wildfire, suggesting that preventing wildfires would help win the war. The CFFP created posters and slogans, including "Forest Fires Aid the Enemy," and "Our Carelessness, Their Secret Weapon."

Then in 1942, along came Walt Disney's wildly popular motion picture, "Bambi" and Disney allowed the CFFP program to use the film's characters on a 1944 poster. The "Bambi" poster was a success, proving the effectiveness of using an animal as a fire prevention symbol. But, Disney only loaned the characters to the campaign for one year so a new animal face that the CFFP could own and control was needed. What could be more fitting than the majestic, powerful (and cute) bear?

### The Orphan Cub

On August 9, 1944 the legendary Smokey Bear was authorized by the Forest Service, and the first poster was delivered on October 10 by artist Albert Staehle. Smokey Bear soon became popular, and his image began appearing on more posters and cards. But Smokey was just an image.

Six years later on a spring day in 1950, in the Capitan Mountains of New Mexico, a major wildfire swept through the forests. As the crews battled to contain the blaze, about 30 of the firefighters were caught directly in the path of the fire storm and barely survived by lying face down on a rockslide for over an hour as the fire burned past them.



Photos: Smokeybear.com

Figure 11. Smokey Bear was created as the face of wildfire prevention during World War II.



Photos: smokeybear.com

Figure 12. A bear cub rescued from a forest fire in New Mexico was the inspiration for Smokey Bear.

As the crew started to leave, they found a little cub that had not fared as well. He climbed a tree that became completely charred, and escaped with his life but with badly burned paws and hind legs. The crew carefully removed the cub from the tree and eventually handed him over to a New Mexico Department of Game and Fish ranger who was able to get the cub on a plane to Santa Fe, where his burns were treated and bandaged (Figure 12).

News about the little bear spread swiftly and soon, United Press International and Associated Press broadcast his story nationwide, striking a chord with many people. The state game warden wrote to the chief of the Forest Service, offering to present the cub to the agency as long as the cub would be dedicated to a conservation and wildfire-prevention publicity program. Smokey Bear was no longer just a made-up character; he was real.

Over the years Smokey Bear's message has been broadcast to the American public in radio and video ads featuring famous celebrities such as John Wayne, Bing Cosby, Roy Rogers, Jonathan Winters, Ray Charles, and even The Grateful Dead.

The Smokey Bear Wildfire Prevention campaign is now the longest-running, and most effective, public service advertising campaign in

U.S. history. Smokey is one of the world's most recognizable characters, and the "Only You Can Prevent Wildfires" campaign has enjoyed tremendous success. Smokey's message is still relevant today as wildfire prevention remains one of the most critical issues affecting our country. For more information on Smokey, visit his website at: <https://smokeybear.com/en>

### Sparky the Fire Dog

Sparky the Fire Dog was created for the National Fire Protection Association (NFPA) in 1951 and has been the organization's official mascot and spokesdog ever since (Figure 13). Like his friend Smokey, Sparky is a widely recognized fire-safety icon who is beloved by children and adults alike.

Millions have learned about fire safety through educational lessons and materials featuring his image and he is more active than ever today. Sparky frequently visits schools and participates in community events to spread fire safety messages, often accompanied by his firefighter friends.

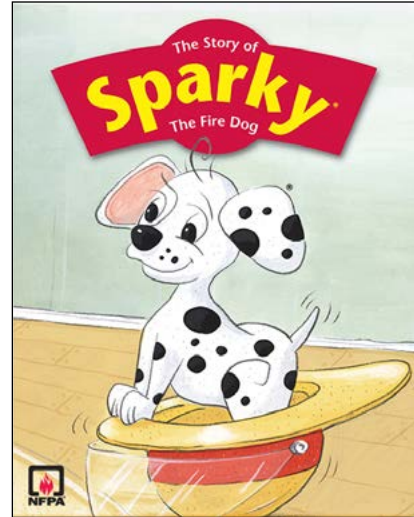
In addition to connecting with the public through public service announcements and his featured role in Fire Prevention Week campaigns each October, he hosts a very active website: <http://www.sparky.org/>.

The NFPA was first formed in 1896 by [insurance](#) firms hoping to standardize the new and burgeoning market of [fire sprinkler](#) systems. NFPA's mission is to "help save lives and reduce loss with information, knowledge and passion." Today it has more than 65,000 members around the world, and the scope of NFPA's influence has grown from sprinklers and fire extinguishers to include building electrical systems and almost all aspects of building design and construction.

## Public Safety Education

Sponsoring a variety of life-saving campaigns and training programs, the NFPA devotes much of its efforts to protecting lives and property through educational outreach programs such as:

- The annual national Fire Prevention Week in October
- Remembering When, a program developed to address the leading causes of injuries and death among older adults
- Risk Watch and Learn Not to Burn, programs developed to address the leading causes of injuries and death among children
- The resources and activities associated with Sparky the Fire Dog, the official mascot of NFPA.
- Fire educators and professionals all know and love Sparky the Fire Dog, and now he has been recognized as one of the country's top-notch mascots on Madison Avenue's Advertising Walk of Fame in New York City.



Images: National Fire Protection Association  
Figure 13. Sparky has been the mascot for the National Fire Protection Association since 1951.

## Notes to the Instructor

### Room Setup

The facilitator should secure a room large enough to comfortably accommodate the number of participants. Organize the room in a U-shape fashion with long tables and chairs. The room should have a large screen to display the presentation. There should be a large table up front (6 to 8 feet in length) for the instructor to use for in-class demonstration(s) and to display various props.

### Instruction in the Field

It is recommended that a guest presenter/facilitator from a state or local fire department or agency lead exercises. These hands-on activities can be skipped, if not applicable to the class.

### Total Time Needed

Approximately 8 hours in the classroom and 8 hours in the field (including travel time)

### Equipment/Materials Needed

- Computer with PowerPoint
- Internet access
- Computer access for students
- Projector and screen handouts
- Flip easels or wall space

### Delivery Method(s)

- Presentation from instructors
- In-class demonstrations
- Outdoor demonstrations
- Discussion
- Online with Canvas

### Prep/Background

The information within this module is extensive and detailed, and while personal WUI wildfire experience and education would be beneficial for teaching the module, the

resource materials such as the Firewise and OSU Extension publications are written for the non-professional audience. Reviewing the materials ahead of class will be helpful to teach confidently. Many of our firefighting agencies are eager to help their constituents better understand how to proactively reduce their wildfire risks and may be able to provide personnel to assist with key parts of the discussion and activities.

The agendas shown on Page 2 are just suggestions. Your audience, class goals and objectives, and time constraints may require a very different approach. The material presented here is merely a tool to help your educational outreach needs, so modify them as needed.

You are strongly encouraged to require students to review selected readings ahead of class so they arrive prepared to discuss. Have students study the assessment checklists for HIZ and Defensible Space and apply them to their own situations before class.

### Demonstration Set-up

Many student activity exercises involve using the processes and checklists from the reading materials. For those situations, obtaining help from a qualified professional may provide a more thorough and rigorous educational experience due to the “real-world” knowledge and experience professionals possess.

### Handouts

- Each student should receive his or her own binder containing copies of the suggested readings or lists of the websites where other materials such as videos are located. It may not be practical for the students to study all the suggested materials, so the instructor may want to select a few publications or highlight certain sections for review.
- A copy of the PowerPoint presentation (3 slides per page to allow for note taking)

- Other handouts can be downloaded from the section, “Additional Student Resources.”

## **PowerPoints/Videos**

Module 5—Fire Prevention for Home and Landscape—PowerPoint.

## **Evaluation instrument**

In this module, students will take on the role of a firefighter conducting a risk assessment and fire-management plan for an urban community or community in the WUI. Have students use the resources from the activities above to create a risk assessment for a neighborhood in their community. Students will then create a fire management plan (or incident plan) for a fire that hypothetically started in the neighborhood. A final product will include a map of the neighborhood, evacuation routes, areas that might be particularly dangerous for firefighters, the risk assessment, and a written fire-management plan.

Class evaluation— Provide a survey for student feedback for each module as a form of formative evaluation.

## Activities

### I. Personal and Professional Insights

*It was a typical winter in western Montana with lots of snow and cold temperatures going down to minus 15 to 20 degrees each night. We got the dispatch at about 11 pm and raced to the station over ice-slick roads, started up the engines (thank goodness we can plug in our engine heaters in the winter) and drove into the night, glad to have the heavy turnout gear to insulate against the cold. The drive was through the woods and over a couple of miles of backcountry roads with 2 feet of snow on the ground. The Fire Department to the east made it to the cabin fire first and had already deployed their hoses and had a ladder to the roof. Smoke was boiling out of the eaves and the start of a flame was beginning to show out a small attic window. We cut the metal roof out, provided ventilation for the fire to escape, and doused the attic with water. Thank goodness, the electricity had been off before we arrived. The investigation for the fire's origin and cause started as the crew did the clean-up. We kept the engines running to prevent the water lines from freezing. What we found in the house was unfortunately somewhat typical: the attic had old wiring frayed with age and brittle insulation. As the appliances in the house overloaded the capacity of the wires, the frayed and cracked lines heated up and started to spark and flare. The fire had started along the underside of the roof trusses and was just beginning to heat the contents of the attic and spark below when our hose water hit the heat and cooled everything down. The heat of the chimney on this cold winter night going up through the attic also helped to crack the old insulation of the wires as they passed next to it. Stacks of newspapers and boxes of old papers stuffed into the attic for storage would have created an explosive*

*situation if we hadn't arrived when we did. The owner had asked us to conduct a landscape assessment for fire risk that past summer. He was worried about wildland fires. We recommended a lot of proactive prevention and to his credit he had reduced a lot of fuel throughout his landscape, pruned up branches, and reduced the risk by creating a defensible space. We didn't know it at the time, but the inside of the house needed an inspection, too. The wiring should have been replaced, the fuel in the attic should have been removed, and fire alarms should have been installed. The fire that winter did not need to happen.*

*We got back to the Fire Station at about four that morning. We hung up the frozen hoses, knocked the ice off our gear and cleaned our tools and ourselves just in time to get ready for our day jobs since we were all volunteer firefighters.*

*Two nights later at two in the morning, we responded to another house fire. This one was right off the highway about three miles from our Station. The Assistant Chief and I raced to the scene ahead of the crew to size up the situation and get a plan together for the soon-to-arrive crews and equipment. When we pulled up to the house, we saw the cold and shivering family of six kids and two adults in the front yard. We bundled them up and put them inside the warm rescue truck that had just arrived on scene. We did our walk-about around the house and saw fire jetting out of the top of the chimney into the frozen night sky. The basement was filling with smoke and flames were beginning to show through the basement window. As the crew and engines pulled up, we set them to putting the chimney fire out—and laying out hoses for the fire burning in the wood furnace in the basement. The Assistant Chief grabbed a fire extinguisher from the first engine, ran downstairs and put out the fire just beginning*

*to burn the floor joists adjacent to the furnace. It was also sparking on a pile of oily rags on the floor. Just three feet from that burning pile was a wall of shelving. On each shelf were stacked can after can of solvents, paints, and other extremely flammable materials. Within minutes, the house would have exploded when the fire burned to that wall. His quick thinking and action prevented that. After the chimney fire was out, we cleaned the firebox of the wood furnace.*

*Years of creosote had built up inside the furnace and within the chimney. The creosote within the chimney burned so hot when ignited that the walls adjacent to the insulated pipe were too hot to touch. One of these walls was in the bedroom where four young kids had been sleeping a short while ago. The house had fire alarms, but not one was working. By sheer luck, one of the teenagers sleeping in a room in the basement woke up when the smoke started, led the rest of the family outside, and called 911.*

*An annual cleaning of the furnace and chimney, storage of flammable materials outside the house, and batteries and tests for the fire alarms all could have prevented this one, too.*

## II. Fact Sheet Reading

Use the Fire Facts sheets (below). Use the following questions to check students' comprehension of the information contained in the fact sheets. (Answers are shown in parentheses.)

- What is the leading cause of home fires? (Cooking)
- How often does a fire department somewhere in the United States respond to a fire? (every 23 seconds)
- Who is more likely to die in a home fire? Young children or older adults? (Older adults)

- What is the leading cause of home fire deaths? (smoking)
- How many civilians died in home fires in the United States in 2015? (3,280)
- What percent of home fire fatalities occurred in homes with no functioning smoke alarms? (3 in 5 or 60 percent)
- Fire departments in the United States respond to a home about every 86 seconds. Use that information to figure out the answers to these questions: How many home fires do U.S. firefighters respond to every hour? (about 42) Every day? (about 1,008) Every month? (about 30,240) Every year? (about 367,920)
- Fire Overview Fact Sheet
- Fires in the United States during 2015 Fact Sheet

## III. Assessing the Risks

Students will review:

- Firewise Communities website: <http://www.firewise.org>
- A Guide to Firewise Principles: PDF.
- The Wildland-Urban Interface Fire Problem. PDF. Cohen 2010.
- Vulnerabilities of Buildings to Wildfire Exposures. S. Quarries. eXtension
- The Basics of Defensible Space and the "home ignition zone" <http://www.firewise.org/wildfire-preparedness/be-firewise/home-and-landscape/defensible-space.aspx>
- YouTube video Carpenter 1 Fire Defensible Space. <https://www.youtube.com/watch?v=ZFmqpLqIJQo>
- Wildfire is Coming. Are You Ready to Go! PDF.

Students will review, discuss, and apply the *Homeowners Checklist Tips* and the *Fire Awareness Checklist* as a class exercise.

- [www.firewise.org/~media/Firewise/Files/Pdfs/Toolkit/FW\\_TK\\_Tips.pdf](http://www.firewise.org/~media/Firewise/Files/Pdfs/Toolkit/FW_TK_Tips.pdf)



- <http://www.napafirewise.org/defensable-space-live/pdf/FireAwarenessChecklist09.pdf>

Students may optionally review, discuss, and apply the checklist Defensible Space Planning and Preparation as a class exercise.

- <http://www.napafirewise.org/defensable-space-live/index.html>.

#### IV. Pre-Plans

- Following are examples of fire preparedness pre-planning checklists.
- Students can fill these out based on their recollection of the property and landscapes in which they live.
- Another exercise can be to lead the class to different subdivisions in town—or to various homes in the WUI, break into groups, and complete risk assessments.
- Come together at the end of the session and present and compare ratings.
  - Farm Fire Pre-Plan Data Sheet PDF
  - Sparky the Fire Dog: My Fire Inspection Checklist PDF
  - Sparky the Fire Dog: My Home Fire Escape Plan PDF.
  - National Fire Protection Association, Emergency Preparedness. <http://www.nfpa.org/public-education/by-topic/safety-in-the-home>

#### V. Safety/Art

- Talk about fire safety hazards in the home.
- Make a list of hazards.
- Invite students to draw a cutaway picture of a home that shows a living room, a kitchen, a bathroom, and a bedroom. The illustration should include at least 10 fire hazards for others to identify. Hazards might include a T-shirt tossed over a lamp; a lit candle near a window; a hair dryer teetering on the edge of a sink full of water; a towel close to a space heater; an adult smoking as he lies down on the couch; a frying pan on the stove with the handle

pointing outward (a small child nearby); newspapers close to the fireplace; too many electrical cords plugged into one outlet; a smoke detector hanging loosely from the ceiling; a lit cigarette in an unattended ash-tray; and a lighter left on a table, to name just a few!

- Once complete, students should exchange illustrations and list the fire hazards in the picture they receive.

#### VI. Resources for Assistance

Students will review:

- Fire Adapted Communities: The Next Step in Wildfire Preparedness in Klamath County. PDF
- Firewise Communities/USA Recognition Program: PDF.
- USDA Forest Service Community Assistance Grants <https://www.fs.fed.us/cooperativeforestry/programs/loa/cfp.shtml>
- Community Fire Protection Road Map. PDF.
- BLM OR-WA WUI Fuels Reduction Grants: <http://www.federalgrants.com/BLM-OR-WA-Wildland-Urban-Interface-WUI-Fuels-Reduction-and-Fire-Dependent-Ecosystem-Restoration-Eugene-Oregon-31570.html>
- Students will discuss the resources that are available to them and how their communities could benefit from them.
- Students will evaluate their own communities and discuss where improvements might be made and how they as individuals can help the community to accomplish those improvements.

#### VII. Home Ignition Zone - HIZ

Students will review:

- Wildfire: preventing home ignitions, Parts I & II <https://www.fs.fed.us/rmrs/wildfire-preventing-home-ignitions>

- FireWise Construction: Site Design & Building Materials. PDF.
- Home Ignition Zone: Assessment Details PDF.
- Home Ignition Zone Structure Assessment Guide PDF.
- Students review, discuss, and apply a Wildfire Hazard Assessment Checklist PDF.

### VIII. Defensible Space

Students will review:

- Wildfire is Coming... Are You Ready? PDF.
- Carpenter 1 Fire Defensible space (video) <https://www.youtube.com/watch?v=ZFmqpLqIJQo>
- Creating Defensible Space (video) <http://firewisemaderacounty.org/firewise-videos/>
- Fire behavior in The Wildland/Urban interface (video) <https://www.youtube.com/watch?v=QUxmaXp0a28>
- Benton County Hazard Rating form PDF.

Class will visit WUI home sites and create management plans for reducing fire risks.

### IX. Defensible Space Treatments

Students will review:

- Firewise Guide to Landscape and Construction. PDF.
- *A Land Manager's Guide for Creating Fire-Resistant Forests* (EM 9087) <https://catalog.extension.oregonstate.edu/em9087>.
- *Reducing Hazardous Fuels on Woodland Property: Thinning* (EC 1573) <https://catalog.extension.oregonstate.edu/ec1573>.
- *Reducing Hazardous Fuels on Woodland Property: Mechanical Treatments* (EC 1575) <https://catalog.extension.oregonstate.edu/ec1575>
- *Reducing Hazardous Fuels on Woodland Property: Pruning* (EC 1576) <https://catalog.extension.oregonstate.edu/ec1576>
- *Reducing Hazardous Fuels on Woodland Property: Disposing of Woody Material*

(EC1574) <https://catalog.extension.oregonstate.edu/ec1574>

- *Fire Resistant Plants for Home and Landscapes: Selecting plants that may reduce your risk from wildfire* (PNW 590) <https://catalog.extension.oregonstate.edu/pnw590>
- *Not all Fires Are Wild: Understanding Fire and Its use as a Management Tool* (EM 9114) <https://catalog.extension.oregonstate.edu/em9114>.

Students will visit WUI home sites and create defensible space management plans to reduce fire risks using the techniques described in the readings.

### X. Action Steps for Around your Home

- Students will review the Firewise Toolkit PDF and Have A Firewise Home PDF publications.
- Students will review the Ready website: <https://www.ready.gov/home-fires>
- Students will discuss actions their families should take and create an action plan.

### XI. Ready, Set, Go!

- Students will review Awbrey Hall Fire, Bend. <https://www.bendfirehistory.org/pages/awbery-hall-fire>
- Students will review How to Get Firewise by Firewise Madera County. <http://firewise-maderacounty.org/how-to-get-firewise>
- Students will review Ready, Set, Go! Your Personal Wildfire Action Plan.
- Students will review Get Ready to Go.
- Students will review Home Fire Safety.
- Create their own checklists using the Ready, Set, Go! suggested guidelines.
- Share and discuss their checklists with the rest of the class.
- Share and discuss their preparations, including working with relevant fire-fighting agencies

## Assessment of Knowledge Gained

### (Questions and Answers)

1. Modern homes tend to burn faster than older homes. How much time do firefighters have after entering a home before a flashover occurs?

*Answer: 2–3 minutes*

2. What are the two factors that primarily determine whether your home survives a wildfire?

*Answer: Structural ignitability and effectiveness of defensible space management.*

3. How far do each of the three defensible zones extend from the home?

*Answer: Zone 1, 30 feet; Zone 2, 100 feet; Zone 3, from outer edge of Zone 2 to property boundary.*

4. What are the five principles for creating and maintaining a fire-resistant property?

*Answer: Reduce surface fuel quantity; increase the spacing of fuels, both structural and vegetative; increase the height from the ground to the base of tree crowns; increase spacing between tree crowns; retain larger trees of more fire-resistant species; promote fire-resistant forests at the landscape level.*

5. What should homeowners do to be prepared for when a wildfire strikes?

*Answer: Complete a Ready, Set, Go! checklist.*

6. What famous character was used in the first public outreach fire prevention campaigns in the 1940s?

*Answer: Bambi.*

## Additional Resources

### Agency Contact Information

- Bureau of Land Management (BLM) <https://www.blm.gov/>
- Oregon Department of Forestry <http://www.oregon.gov/ODF/Pages/index.aspx>
- USDA Forest Service Region 6 <https://www.fs.usda.gov/main/r6/home>
- Fire Safe Council's Homeowner Checklist [https://www.nifc.gov/PIO\\_bb/pio\\_documents/DefensibleSpaceBrochure.doc](https://www.nifc.gov/PIO_bb/pio_documents/DefensibleSpaceBrochure.doc)
- Fire Safe Council's Structure Assessment Checklist [http://www.areyoufiresafe.com/files/5813/6615/2767/Structure\\_Assessment\\_Checklist\\_-\\_130416.pdf](http://www.areyoufiresafe.com/files/5813/6615/2767/Structure_Assessment_Checklist_-_130416.pdf)

### Glossary of Terms

**Firewise Communities:** Firewise is a national program that emphasizes community involvement and provides important information for residents to reduce the risk of wildland fire igniting homes. NFPA's [Firewise Communities Program](#) encourages local solutions for safety by involving homeowners in taking individual responsibility for preparing their homes from the risk of wildfire.

**Fire Adapted Communities:** A Fire Adapted Community takes responsibility for its wildfire risk. Actions address resident safety, homes, neighborhoods, businesses and infrastructure, forests, parks, open spaces, and other community assets. The more actions a community takes, the more fire adapted it becomes.

**Flashover:** Flashover by definition is “the sudden involvement of a room or an area in flames from floor to ceiling caused by thermal radiation feedback.” Thermal radiation feedback is the energy of the fire being radiated back to the contents of the room from the walls, floor, and ceiling. This radiation of energy to the contents of the room will raise ALL the contents to their ignition temperature. When the contents of the room suddenly and simultaneously ignite, this

is flashover. (<http://www.fireengineering.com/articles/2014/06/understanding-and-avoiding-a-flashover.html>)

## References<sup>2</sup>:

Activity X - Action Steps Around the Home. <https://www.ready.gov/home-fires>.

Awbery Hall Fire, Bend, Oregon. <https://www.bendfirehistory.org/pages/awbery-hall-fire>

Basics of Defensible Space and the “home ignition zone.” <http://www.firewise.org/wildfire-preparedness/be-firewise/home-and-landscape/defensible-space.aspx>

BLM OR-WA WUI Fuels Reduction Grants. <http://www.federalgrants.com/BLM-OR-WA-Wildland-Urban-Interface-WUI-Fuels-Reduction-and-Fire-Dependent-Ecosystem-Restoration-Eugene-Oregon-31570.html>.

Carpenter 1 Fire Defensible Space YouTube Video. <https://www.youtube.com/watch?v=ZFmqpLqIJQo>

Cohen, Jack. 2010. The Wildland-Urban Interface Fire Problem. *Fremontia*. Volume 38:2/38:3

Creating Defensible Space (video). <http://firewisemaderacounty.org/firewise-videos/>

Defensible Space Planning and Preparation checklist. [http://www.napafirewise.org/defensible-space-live/17\\_defensiblespace.html](http://www.napafirewise.org/defensible-space-live/17_defensiblespace.html).

Fire behavior in the wildland/urban interface (video). <https://www.youtube.com/watch?v=QUxmaXp0a28>

Fire Safe Council’s Homeowner Checklist. [https://www.nifc.gov/PIO\\_bb/pio\\_documents/DefensibleSpaceBrochure.doc](https://www.nifc.gov/PIO_bb/pio_documents/DefensibleSpaceBrochure.doc).

Firewise Communities. <http://www.firewise.org>

Fire Safe Council’s Structure Assessment Checklist. [http://www.areyoufiresafe.com/files/5813/6615/2767/Structure\\_Assessment\\_Checklist\\_-\\_130416.pdf](http://www.areyoufiresafe.com/files/5813/6615/2767/Structure_Assessment_Checklist_-_130416.pdf).

Flashover definition. <http://www.fireengineering.com/articles/2014/06/understanding-and-avoiding-a-flashover.html>.

Homeowners Awareness Checklist. <http://www.napafirewise.org/defensible-space-live/pdf/FireAwarenessChecklist09.pdf>

Homeowners Checklist Tips. [www.firewise.org/~media/Firewise/Files/Pdfs/Toolkit/FW\\_TK\\_Tips.pdf](http://www.firewise.org/~media/Firewise/Files/Pdfs/Toolkit/FW_TK_Tips.pdf)

How to Get Firewise by Firewise Madera County. <http://firewisemaderacounty.org/how-to-get-firewise>

National Fire Protection Association, Emergency Preparedness. <http://www.nfpa.org/public-education/by-topic/safety-in-the-home>

Quarles, Stephen PhD 2012. Vulnerabilities of Buildings to Wildfire Exposures. eXtension. 2012. <http://articles.extension.org/pages/63495/vulnerabilities-of-buildings-to-wildfire-exposures>.

Ready website. <https://www.ready.gov/home-fires>.

Smokey Bear. <https://smokeybear.com/en>

Sparky the Fire Dog. <http://www.sparky.org/>.

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<sup>2</sup> All websites accessed June 8, 2017 unless otherwise noted.

U.S. Forest Service Community Assistance

Grants. [https://www.fs.fed.us/  
cooperativeforestry/programs/loa/cfp.shtml](https://www.fs.fed.us/cooperativeforestry/programs/loa/cfp.shtml)

Wildfire: preventing home ignitions, Parts I & II.

[https://www.fs.fed.us/rmrs/wildfire-preventing-  
home-ignitions](https://www.fs.fed.us/rmrs/wildfire-preventing-home-ignitions)

# Evaluations



OREGON STATE UNIVERSITY  
CITIZEN EVALUATION OF TEACHING

USE NO. 2 PENCIL

INSTRUCTOR'S NAME	EXTENSION EVENT	DATE
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**YOUR RESPONSES TO THIS QUESTIONNAIRE WILL HELP INSTRUCTORS CONFIRM QUALITY TEACHING AND IMPROVE TEACHING SKILLS AND METHODS.**

PLEASE FILL-IN THE APPROPRIATE RESPONSE.  
MARK ONLY ONE CIRCLE PER QUESTION!

		VERY POOR	POOR	FAIR	GOOD	VERY GOOD	EXCEL- LENT	UNABLE TO RATE
1.	Overall, the quality of the educational event as a whole was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2.	The quality of instruction in this educational event was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3.	Clarity of educational objectives was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4.	Clarity of how you might use this education was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5.	Teaching organization was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6.	Instructor's use of examples was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7.	Instructor's use of teaching aids (slides, overheads, charts, etc.) was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8.	Instructor's ability to stimulate my thinking more deeply about the subject was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9.	Instructor's responsiveness to questions was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10.	Instructor's use of participant discussion to enhance my learning was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11.	Instructor's ability to develop a welcoming environment for all participants was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12.	Instructor's skill in making the information useful to me was .....	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

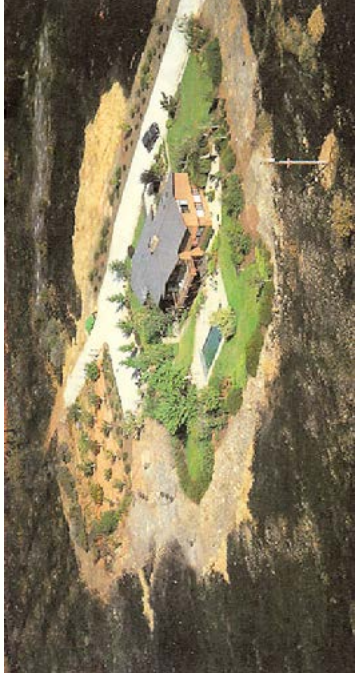
**Your comments will be helpful to improve instruction.**

Please comment:



# PowerPoint Slides

**Module 5: Fire Prevention for Home and Landscape**  
FIRE SCIENCES CORE CURRICULUM

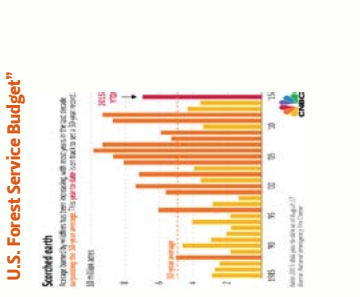


**Oregon State University**

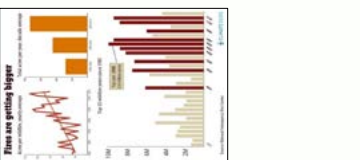
1

**HISTORICAL CONTEXT**

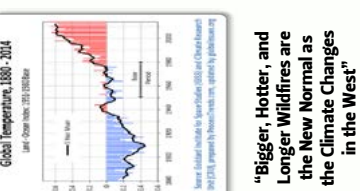
**“Costs of Wildfires Could Swallow U.S. Forest Service Budget”**



**“Bigger, Hotter, and Longer Wildfires are the New Normal as the Climate Changes in the West”**



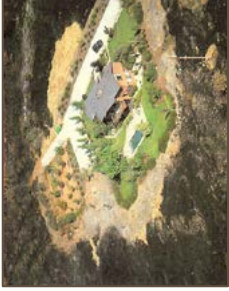
**“Fires are getting bigger”**



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3

**COURSE OUTLINE**



1. Historical context for fires
2. Risk assessment
3. Resources available
4. Designing and creating a fire-resistant home
5. Defensible space: zones 1, 2, and 3
6. Defensible space treatments
7. Ready, set, go!
8. Public education campaigns
9. War story

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2

**FIREWISE TOOLKIT**

<http://www.firewise.org/wildfire-preparedness/firewise-toolkit.aspx>


**Handout: Firewise Toolkit\_2016.pdf**





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4

**A DAY WITH SMOKEY**



**A day in the woods with Smokey**

**5**

**FIRE-RESISTANT HOME**





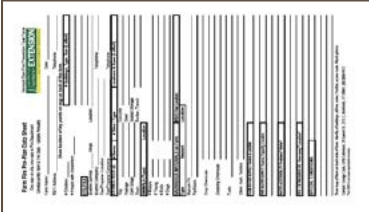

**Designing and creating a fire-resistant home**

**7**

**RISK ASSESSMENT**





**FIRE RISK ASSESSMENT: PRE-PLANS**

**6**

**FIRE-RESISTANT HOME**

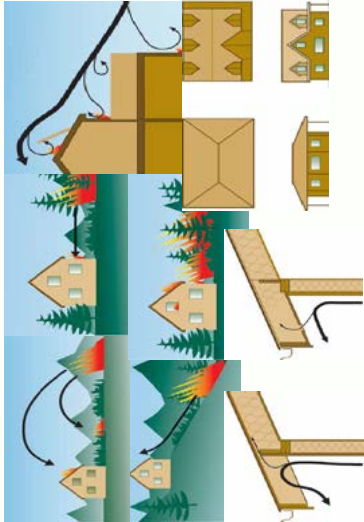





**Designing and creating a fire-resistant home**

**8**

**HOME CONSTRUCTION GUIDELINES**

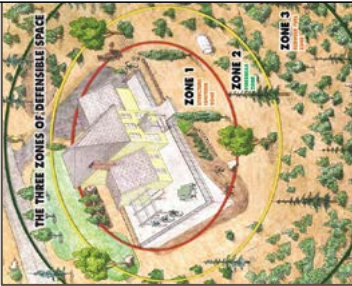



**9**

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**ARE YOU FIREWISE?**

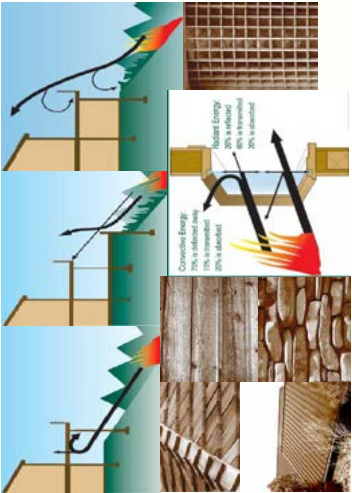
**Defensible Space zones 1, 2 & 3**



**11**

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**HOME CONSTRUCTION GUIDELINES**



**10**

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**DEFENSIBLE SPACE**

**Defensible space treatments**



**12**

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**PUBLIC AWARENESS CAMPAIGNS**



**15**


**FIRE SCIENCE CORE CURRICULUM**

**THANKS! AND BE FIRE SAFE**




**16**

**ACTION STEPS**




<http://www.firewise.org/wildfire-preparedness/be-firewise/home-and-landscape/defensible-space.aspx>

**Action Steps Around Your Home**




**13**

**READY, SET, GO!**



<https://www.grantspassoregon.gov/924/Disaster-Preparedness---Ready-Get-Set-Go>



**14**