# 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*

## 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).*[1]

### ✔ Activity I – Fire history[2]

❍ 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

[1] 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.

[2] 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.

*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.*

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.

*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).*

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.

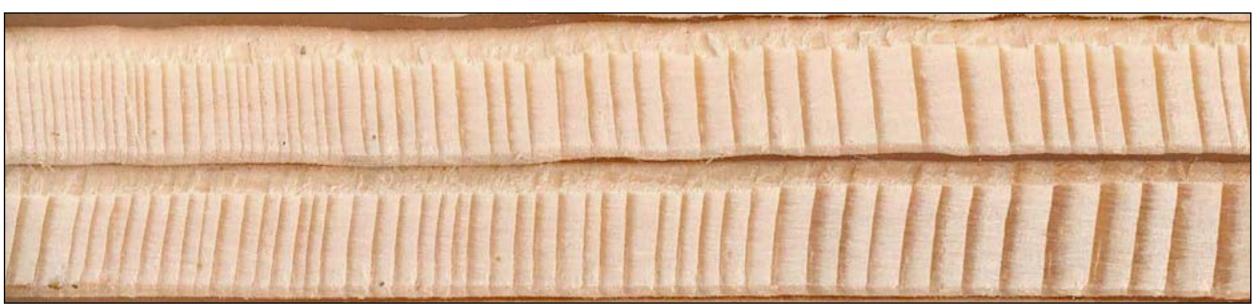




Figure 2. Tree rings of  a Norwegian spruce.


Photo: Chris Schnepf, University of Idaho

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

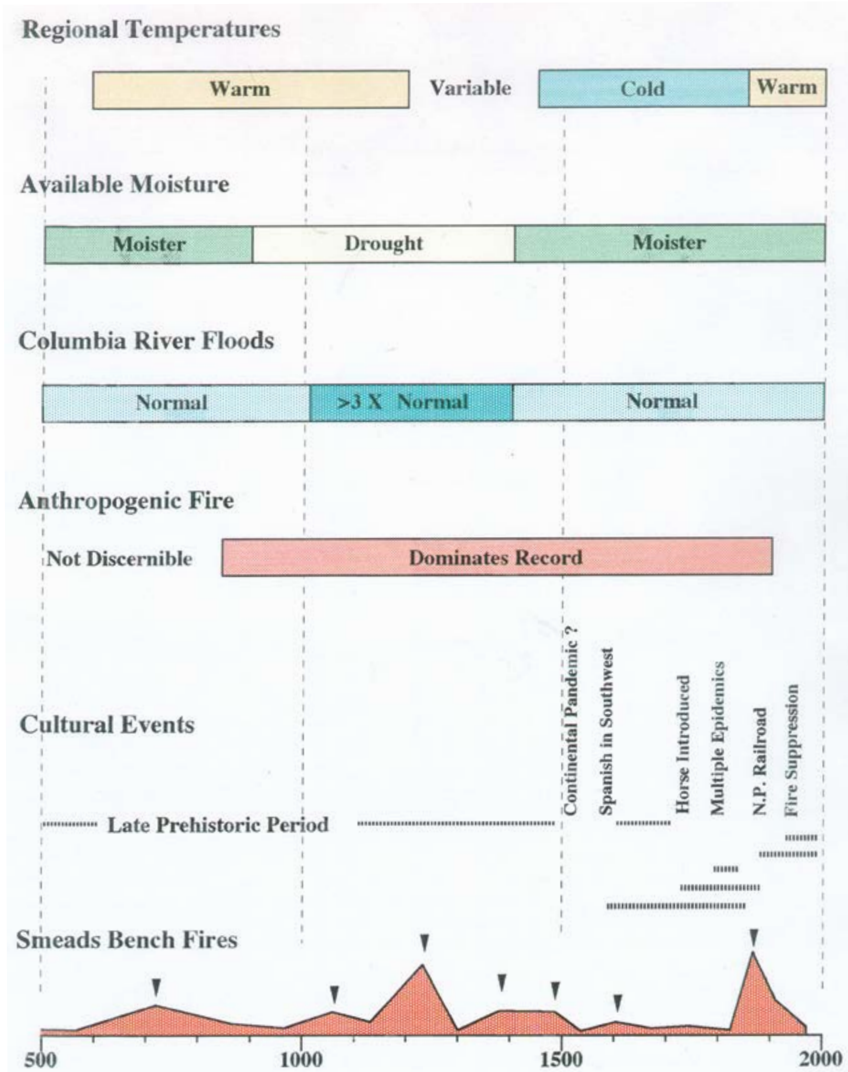
Dendrochronology is another method of measuring fire and disturbance history. It is the extraction of tree cores to measure growth rings and fire scars (Figures 2 and 3). This method is site specific and is good for mapping fire history across a landscape. Also, this method can illustrate the level of 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, micosites, 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).

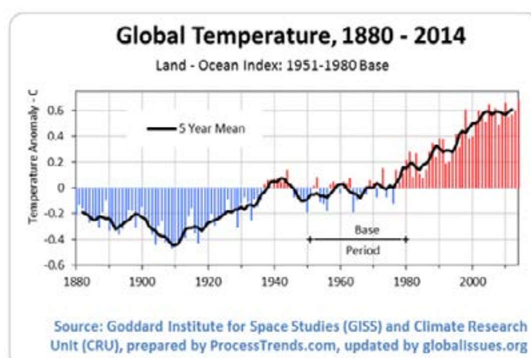
A correlation was made to regional temperature measurements, available moisture, regional flooding events, and native population rises and declines (Figure 4).




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.

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.




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.*[3]

*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, 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.*[4]



Figure 6. Agni, the god of fire.

*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*

[3] This material drawn from **http://www.mythencyclopedia.com/Dr-Fi/Fire.html**

[4] This section is excerpted from **http://www.mythencyclopedia.com/Dr-Fi/Fire.html**

*explanation of what the Devil might want with burnt bread crusts).*[5]

*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.*[6]

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.

[5] Exerpt from "Fire Folklore and Legends," https://www.meetup.com/es-ES/ashevillepagans/messages/boards/thread/29446062

[6] 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 H2O and CO2, 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.

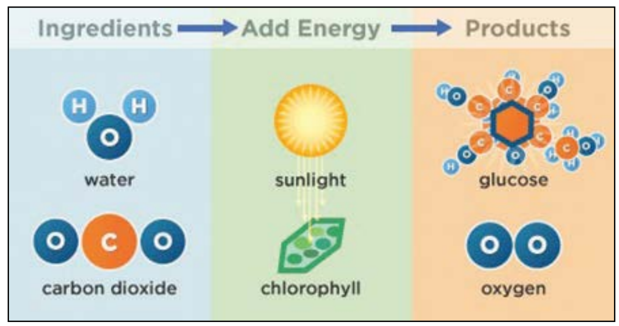





Figure 7. Diagram depicting photosynthesis.

## Fire Triangle

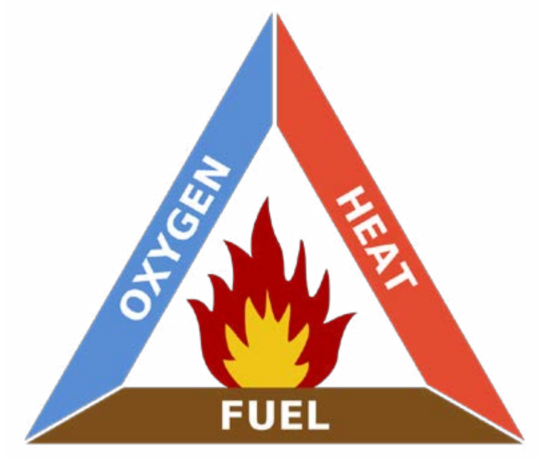
The **fire triangle** includes the three components that must be present for a fire to burn. These components are fuel, oxygen, and a heat/ignition source (Figure 8). Without one of these components, fire cannot exist. For a fire to ignite, there must be an initial and continued heat source—this is called 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).

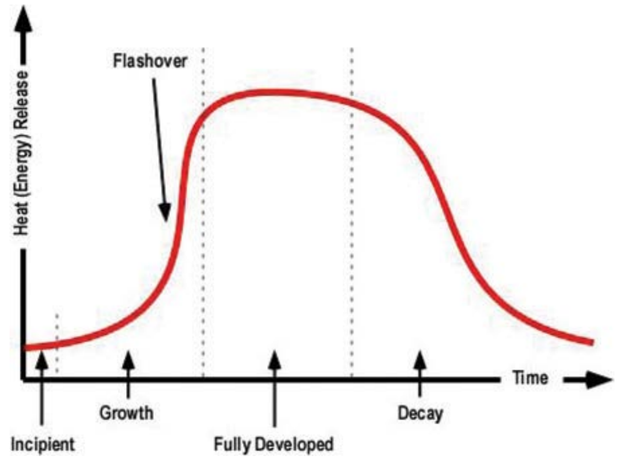
Photo: Northern Research Station, © U.S. Forest Service

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.




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

Figure 12. Fire development and fire behavior indicators.

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).

## 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 large 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

- NWFSC, 2015 – **What is? Fire Intensity**
- NWFSC, 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/nwfsc-fire-facts-what-fire-intensity

Northwest Fire Science Consortium. 2015. What is? Fire Severity http://www.nwfirescience.org/biblio/nwfsc-fire-facts-what-fire-severity

Pyne, S.J. 1982. *Fire in America: A Cultural History of Wildland and Rural Fire*. Princeton University Press, Princeton, New Jersey, USA.

## 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.

## References

BLM.gov. https://www.blm.gov/or/resources/recreation/tablerock/table-rock-anthropogenic.php. Date accessed: December 5, 2016.

Chatters, J.C. and D. Leavell. 1994. Smeads Bench Bog: a 1,500-year history of fire and succession in the hemlock forest of the lower Clark Fork valley, Northwest Montana. Report prepared for the Kootenai National Forest, Libby, MT. Contract number RFQ 14-93-05.

Hartford, R.A. and W.H. Frandsen. 1991. When it's hot, it's hot . . . or maybe it's not! (Surface flaming may not portend extensive soil heating). *International Journal of Wildland Fire* 2:139–144.

Hartin, E. 2008. Fire Development and Fire Behavior Indicators. CFBT-US, LLC. www.firehouse.com Date accessed: January 19, 2017.

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.

LaLande, J. 2004. So, Just How Extensive was Anthropogenic Fire in the Pacific Northwest?: Southwestern Oregon as a Case Study. Eugene, OR. Paper presented at the Northwest Anthropological Conference. Copy on file at Bureau of Land Managemen,t Medford District

Levy, S. 2005. Rekindling Native Fires. *BioScience* 55 (4):303–308.

NPS.gov (Fire and Aviation Management), https://www.nps.gov/fire/wildland-fire/learning-center/fire-in-depth/cultural-interp-fire.cfm. Date accessed: February 16, 2017

NFPA.org. http://www.nfpa.org/press-room/reporters-guide-to-fire-and-nfpa/all-about-fire. Date accessed: November 12, 2016.

Pausas, J.G. and J.E. Keeley. 2009. A Burning Story: The Role of Fire in the History of Life. *BioScience* 59(7):593.

Pullen, R. 1996. Overview of the Environment of Native Inhabitants of Southwestern Oregon, Late Prehistoric Era. Bureau of Land Management Medford District. Medford, OR.

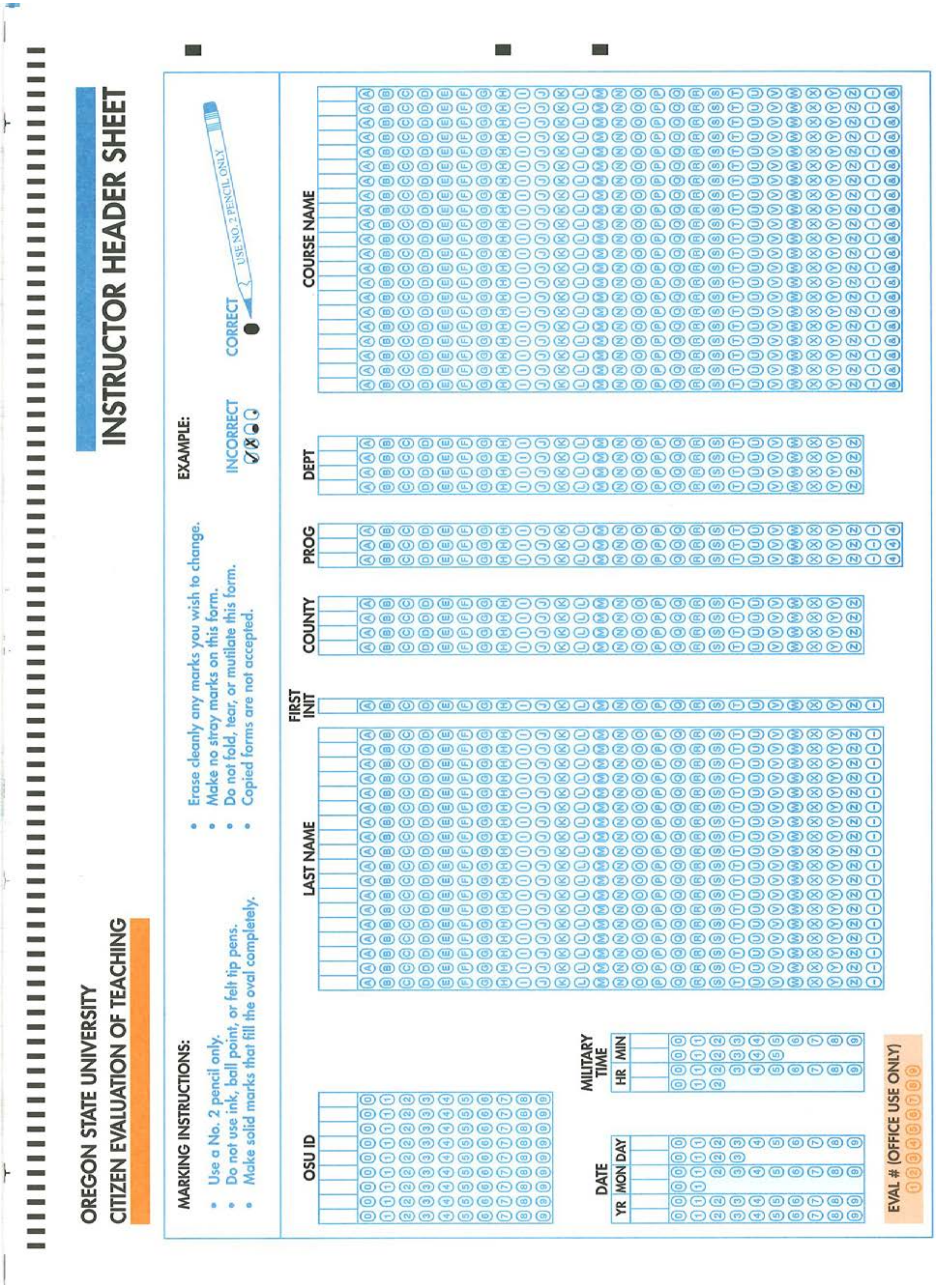
Pyne, S. Tending Fire: Coping with America's Wildland Fires. Washington, D.C.: Island Press. 2004.

The National Wildfire Coordinating Group https://www.nwcg.gov/

Tveskov, M., N. Norris, and A. Sobiech. 2002. The Windom Site: A Persistent Place in the Western Cascades of Southwest Oregon. *SOULA Research Report 2002-1*. Ashland, OR.

Zennaro, P., N. Kehrwald, J.R. McConnell, S. Schüpbach, O.J. Maselli, J. Marlon, P. Vallelonga, D. Leuenberger, R. Zangrando, A. Spolaor, M. Borrotti, E. Barbaro, A. Gambaro, and C. Barbante. 2014. Fire in ice: two millennia of boreal forest fire history from the Greenland NEEM ice core. *Climate of the Past* 10(5):1905.

# Evaluations


OREGON STATE UNIVERSITY

CITIZEN EVALUATION OF TEACHING

INSTRUCTOR HEADER SHEET

MARKING INSTRUCTIONS:

- Use a No. 2 pencil only.
- Do not use ink, ball point, or felt tip pens.
- Make solid marks that fill the oval completely.
- Erase cleanly any marks you wish to change.
- Make no stray marks on this form.
- Do not fold, tear, or mutilate this form.
- Copied forms are not accepted.

EXAMPLE:

INCORRECT

CORRECT

USE NO. 2 PENCIL ONLY

OSU ID

LAST NAME

FIRST INIT

COUNTY

PROG

DEPT

COURSE NAME

DATE

YR MON DAY

MILITARY TIME

HR MIN

EVAL # (OFFICE USE ONLY)

SCANTRON

Mark Reflex® EM-289079-1:65432

ED06

OREGON STATE UNIVERSITY
CITIZEN EVALUATION OF TEACHING

**USE NO. 2 PENCIL**

| INSTRUCTOR'S NAME | EXTENSION EVENT | DATE |
|---|---|---|
| | | |

**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 | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 2. The quality of instruction in this educational event was | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 3. Clarity of educational objectives was | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 4. Clarity of how you might use this education was | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 5. Teaching organization was | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 6. Instructor's use of examples was | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 7. Instructor's use of teaching aids (slides, overheads, charts, etc.) was | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 8. Instructor's ability to stimulate my thinking more deeply about the subject was | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 9. Instructor's responsiveness to questions was | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 10. Instructor's use of participant discussion to enhance my learning was | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 11. Instructor's ability to develop a welcoming environment for all participants was | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 12. Instructor's skill in making the information useful to me was | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

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

Please comment:

99006PCN0103

# PowerPoint Slides

## Module 1: What is Fire?

FIRE SCIENCES CORE CURRICULUM

Oregon State University

1

## LEARNING OBJECTIVES

Oregon State University

- 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

Oregon State University

*"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."*

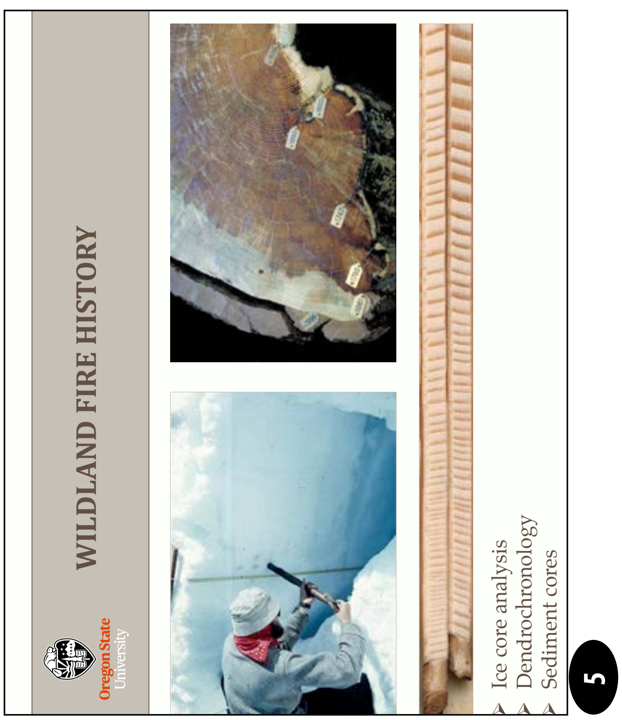
—Lucretius, De Rerum Natura, 50 B.C.

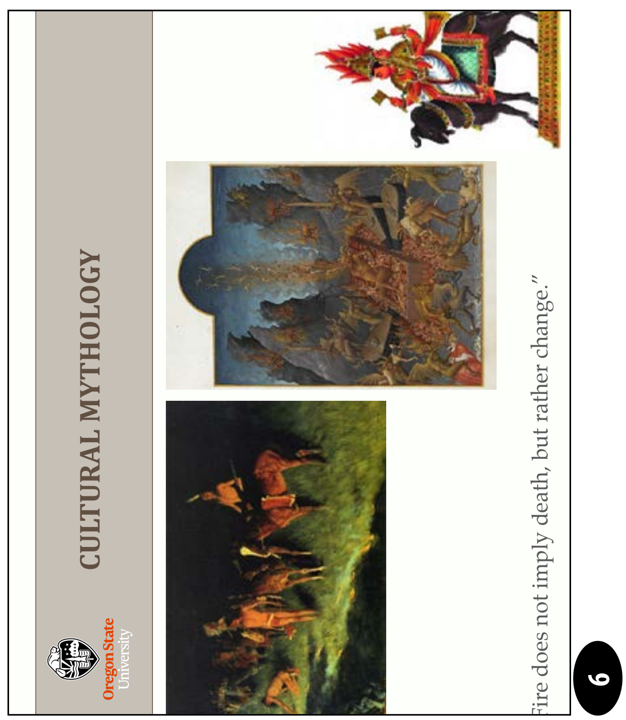
3

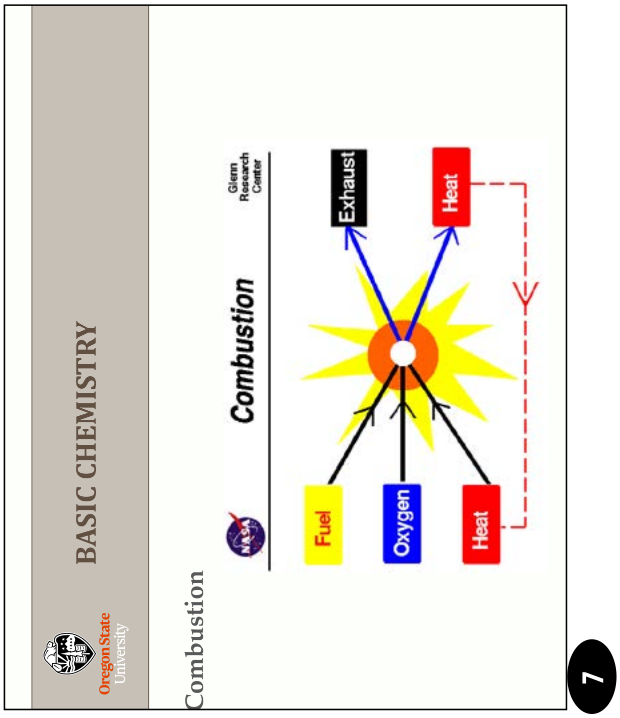
## WILDLAND FIRE HISTORY

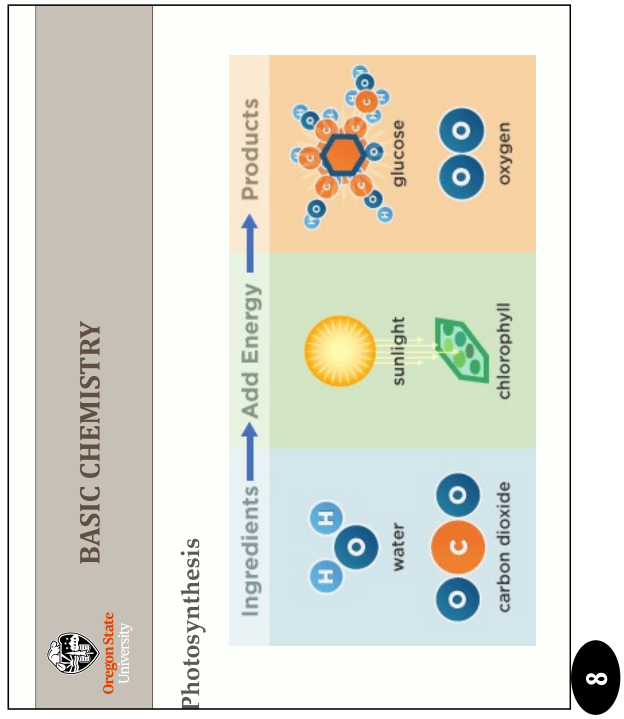
Oregon State University


4

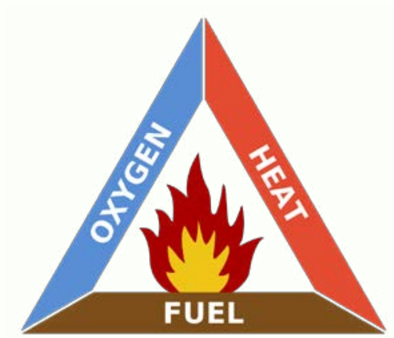

Oregon State University
WILDLAND FIRE HISTORY
Ice core analysis
Dendrochronology
Sediment cores
5


Oregon State University
CULTURAL MYTHOLOGY
ire does not imply death, but rather change."
6


Oregon State University
BASIC CHEMISTRY
Combustion
NASA
Combustion
Glenn Research Center
Fuel
Oxygen
Heat
Exhaust
Heat
7

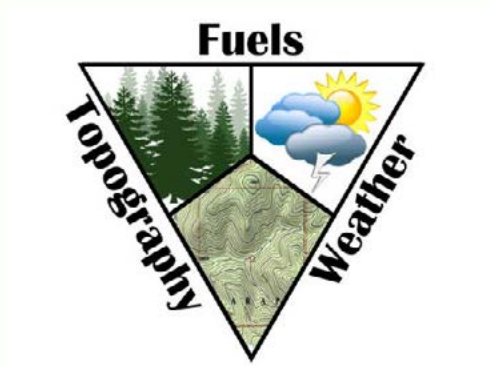

Oregon State University
BASIC CHEMISTRY
Photosynthesis
Ingredients
Add Energy
Products
water
carbon dioxide
sunlight
chlorophyll
glucose
oxygen
8

## FIRE TRIANGLE




9

## FIRE BEHAVIOR TRIANGLE




10

## FIRE INTENSITY

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

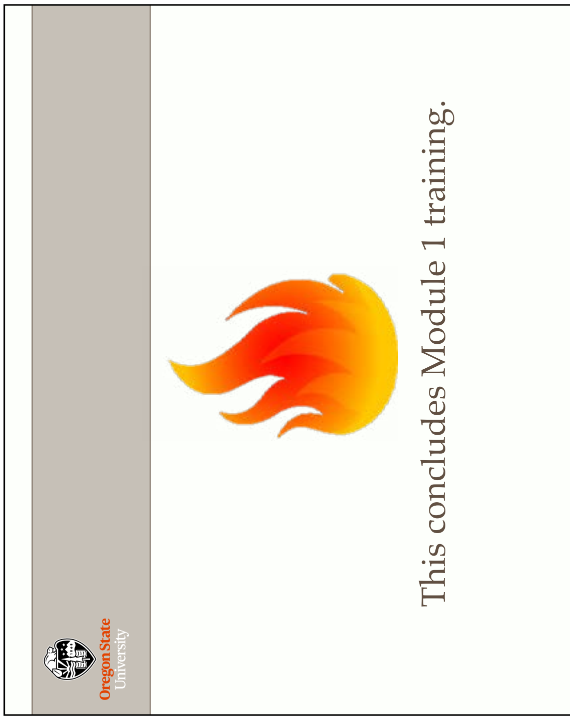
11

## FIRE SEVERITY

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

A product of fire intensity and residence time

12




13