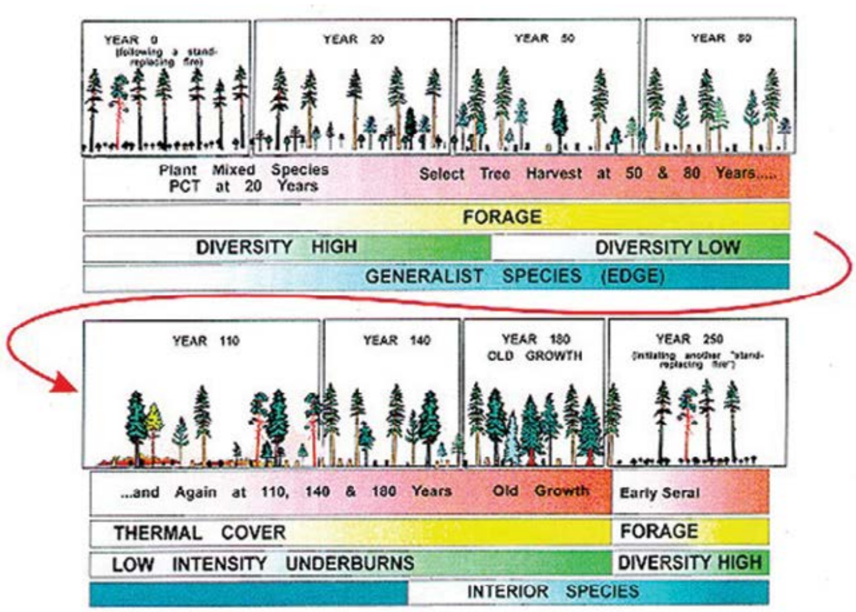
Module 2: Fire Ecology



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

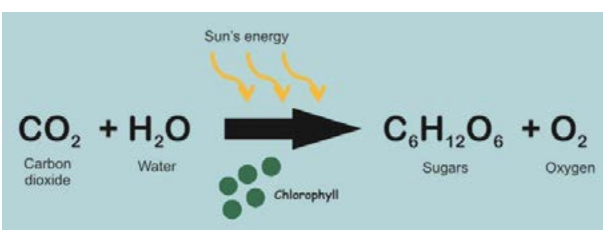
- Introduction
- Dynamics of fire
  - Plant succession
  - Fire regime
  - Fire behavior across an environmental gradient
- Example of Wildland Fire Dynamics across an Environmental Gradient
- Fire Effects to Abiotic
- Fire Effects to Biotic
  - Vegetation gradient
  - Vegetation succession
  - Wildlife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

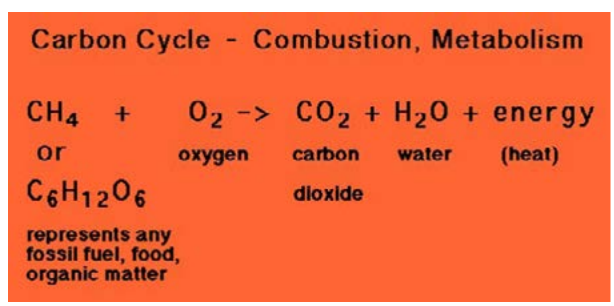
Fire does not have a personality, is neither evil nor good. Fire can save life and take it. Fire can be beneficial and detrimental. Our history has ingrained into us a fear of fire more than a respect for it. How many of us have a history of family members or neighbors negatively affected by a forest 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 I[1] – 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

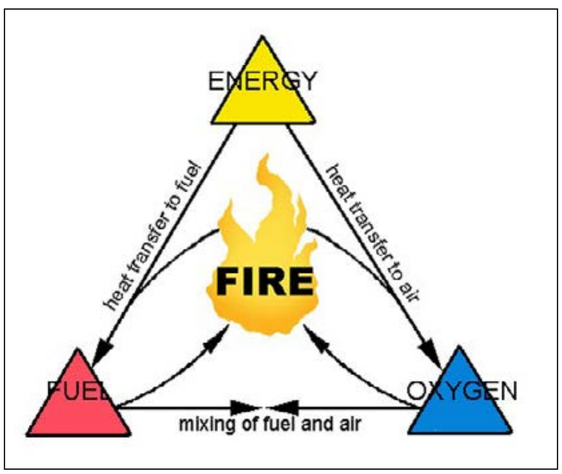
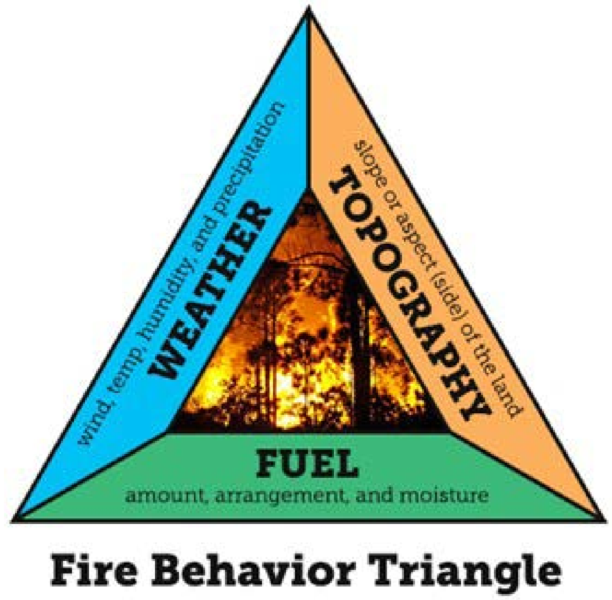


Image: University of Southern Mississippi

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

[1]Refer to the Activities section for details on all activities in this curriculum.



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.

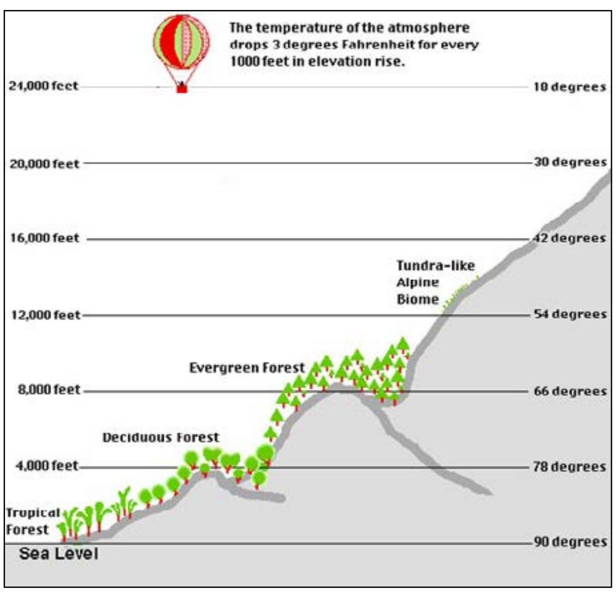
Fire has a place throughout. Fire, similar to floods, earthquakes, storms, and other disturbances, is a dynamic force of nature that induces change in an ecosystem. When the Fire Triangle is complete, fire will occur Figure 3). When the Fire Behavior Triangle is complete—how a fire progresses and to 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.



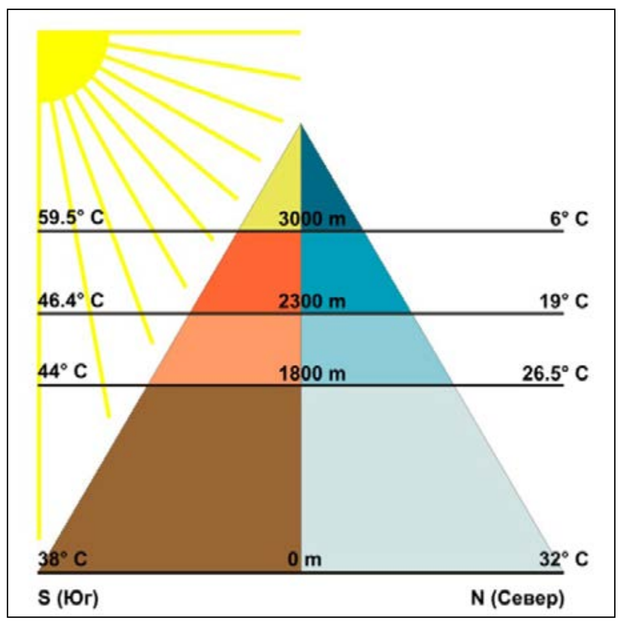
Source: Climate Types for Kids

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 eleva-tion 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.

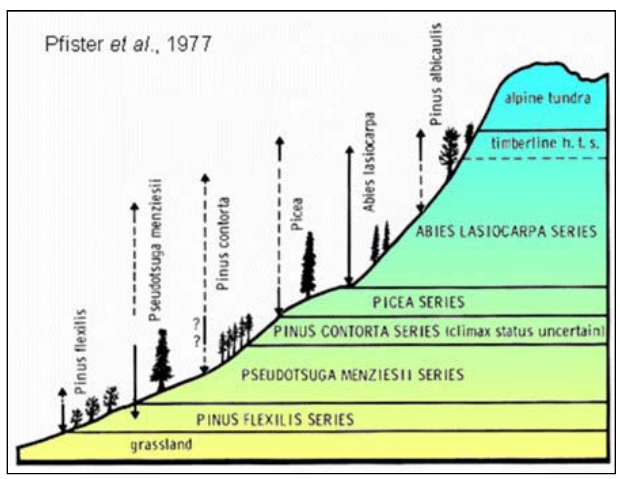
We also try to adapt our structures to fire. Our ancestors depended on fire within their dwellings for survival. The majority of our dwellings throughout history (and today) are composed of the third side of the fire triangle: fuel.

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

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.*



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.

Low-severity regime

	Fire interval	*Role of fire and post-fire regeneration*	*Type of forest created*
Arno and Fiedler	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
Baker and colleagues	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 com--pared with Arno and Fiedler apart from a more important heterogeneity of landscapes

Variable-severity regime (low, moderate and high)

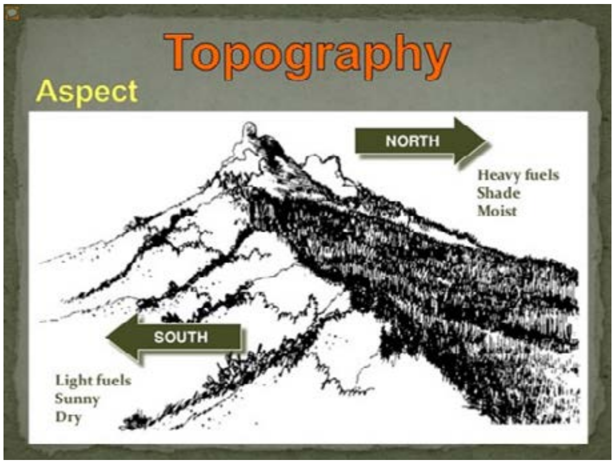
	Fire interval	*Role of fire and post-fire regeneration*	*Type of forest created*
Arno and Fiedler	Low severity: 1-30 years Moderate: 30-100 years High: 100-400 years	Fire of moderate severity eliminates most saplings, preserves a part of the oldest trees High-severity fire creates an heterogeneous forest 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
Baker and colleagues	Low severity: perhaps 60-300 years Moderate: perhaps more than 200 years High: perhaps 300-700 years	Ecological role of high-seve--rity 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 regene--ration 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

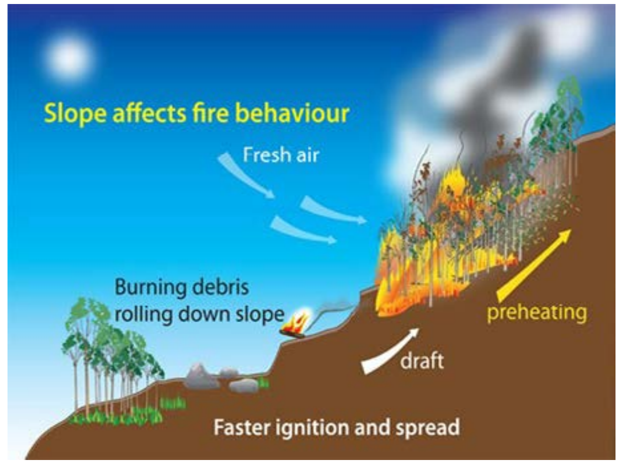
● shade-tolerant species
○ shade-intolerant species

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

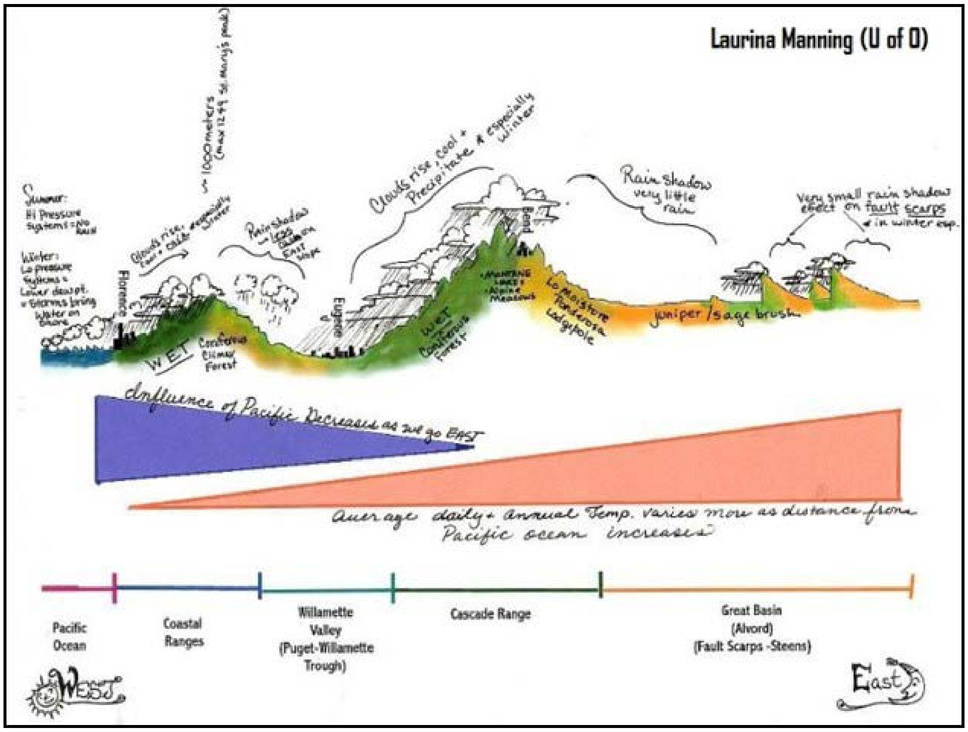


Illustration: Laurina Manning

Figure 10. An artist's conception of an environmental gradient bisecting the state of Oregon from the coastline to the Idaho border.

environmental gradient, fire behavior will also change. Land management—or the absence of it—can create higher or lower fuel loadings than would have happened historically.

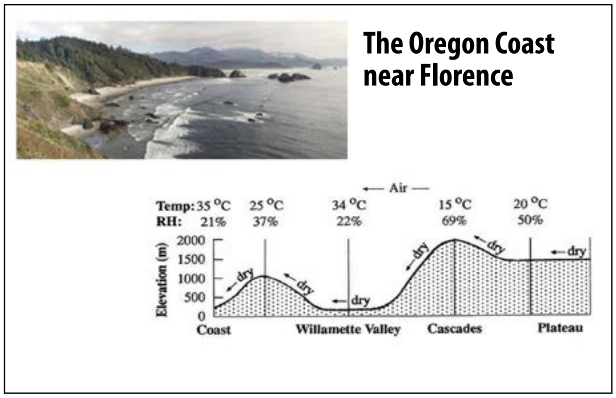
Environmental gradients affect structure fires. Homes built in box canyons, on steep slopes (especially south-facing slopes), within strong wind influences, and at the mouth of downwind ravines are much more susceptible to wildland fires or to fires that start in the structure.

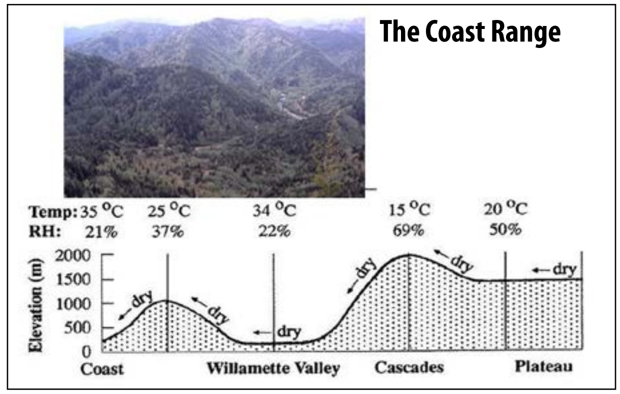
Example of Wildland Fire Dynamics Across an Environmental Gradient

The best example of wildland fire dynamics follows a cross-section of Oregon from the Pacific Coast eastward up the slopes of the Coast Range. Continue over the top and down to the Willamette Valley. Pass across the valley and upward against the west slopes of the Cascade Mountain Range and over the top to the eastern slopes. Pass eastward into the Basin and Range flats and ultimately against uplifts typified by the Steens Mountain to the Idaho border (Figure 10). The topographic gradient from west to east affects weather patterns originating from the Pacific Ocean. Vegetation has adapted to this topographic gradient. Vegetation composition and diversity developed in response to changes in elevation, precipitation, and solar radiation with general weather patterns. Fire, once started within this context of weather and topographic influence, will behave with available fuels and burn with intensity and severity until weather or fuels change. These abiotic and biotic elements interact with fire disturbance to shape landscape and local patterns of wildlife habitat.

Here are some capsulated examples of vegetation (as fuel) adaptation to environmental attributes such as: precipitation, slope, aspect, elevation, and solar radiation (and as adapted to fire response and behavior)—going from the Oregon coastline east to the Idaho border:

1. Florence—This area (elevation 14 feet) is strongly influenced by the maritime climate

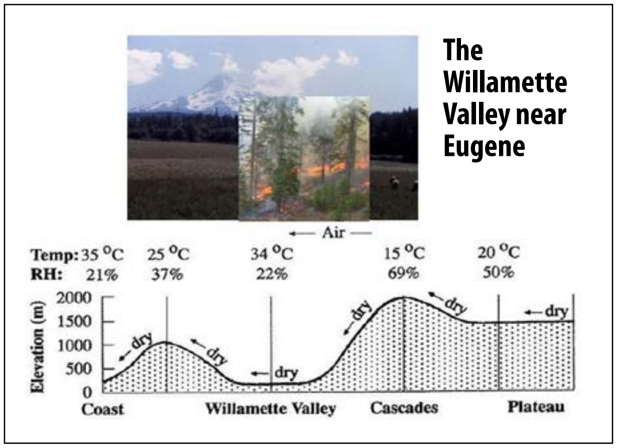


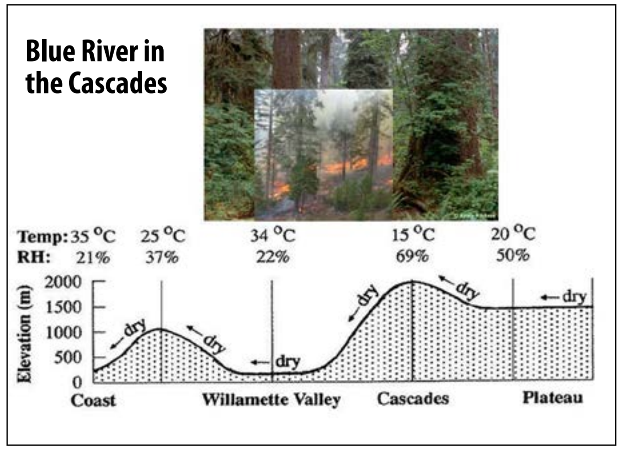


of the Pacific Ocean. Florence, located on the convergence of the Siuslaw River tidelands and the Oregon Dunes, has an average of 71 inches of rain per year and snowfall of 1 inch. On average, there are 160 sunny days per year. The July high is around 69 degrees. The January low is 39. Coniferous forests 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.

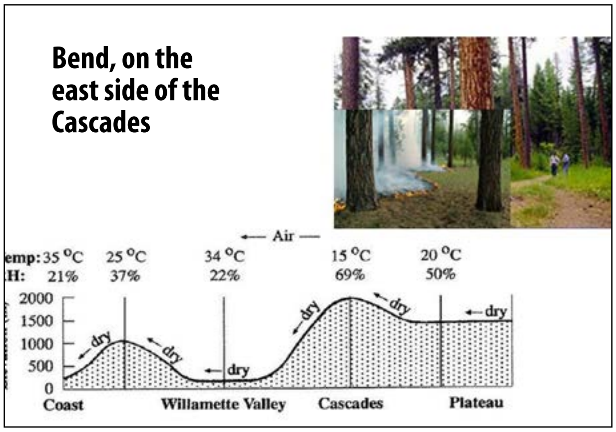


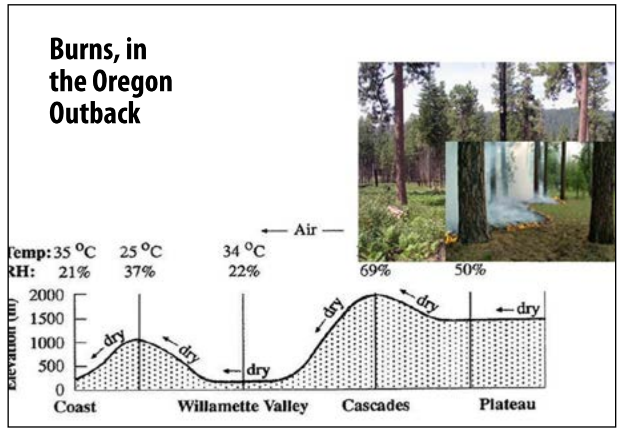


potentially severe and widespread when conditions allow it. Fire regime: mixed severity, with fire return intervals of 95–145 years (Frost and Sweeney 2000).

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

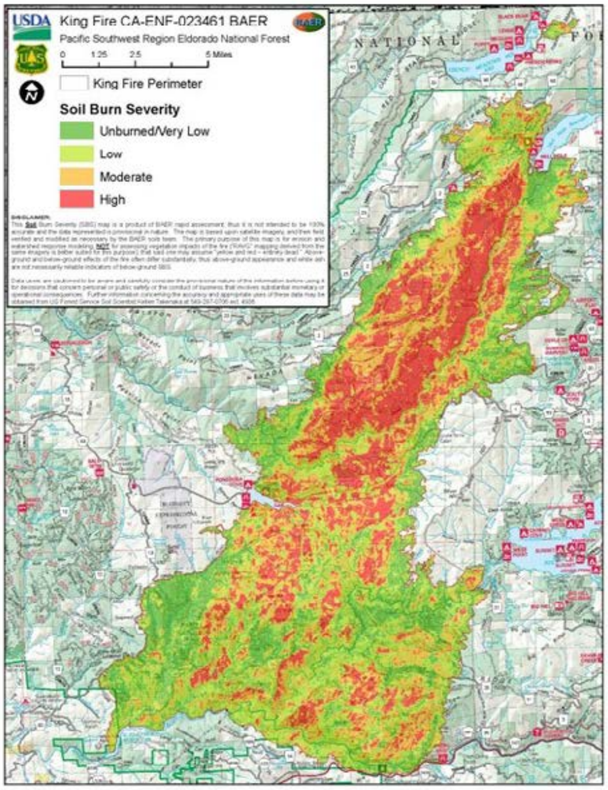




the watershed (Teensma 1987, Morrison and Swanson 1990, Weisberg 1998). Wildfire in the lower elevations was historically of moderate frequency and intensity. Fire history in the upper elevations was of more infrequent and severe fire behavior. Patch sizes were larger in the upper elevations. Topography 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

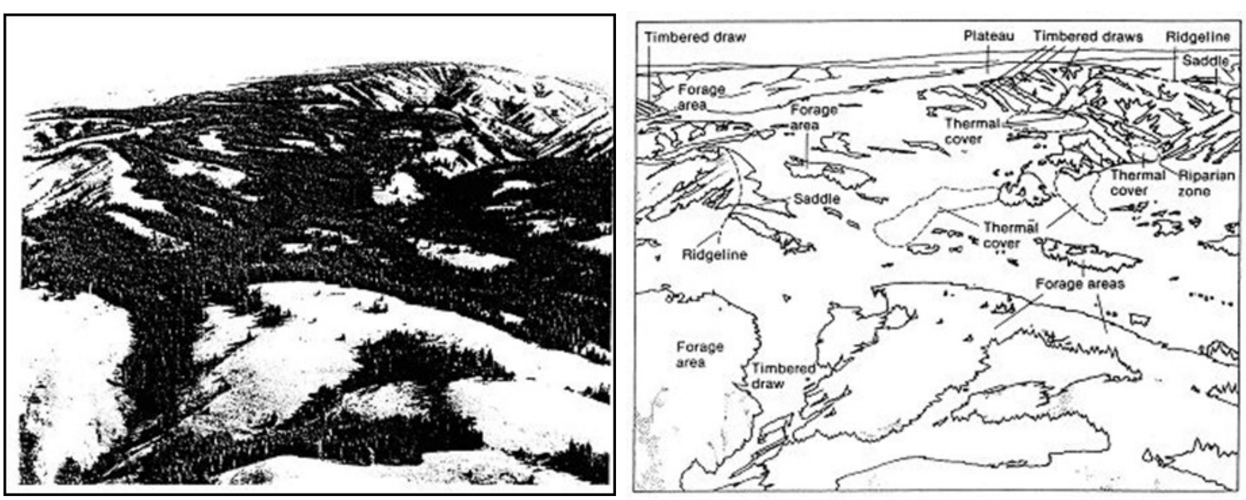


Images: U.S. Forest Service

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.

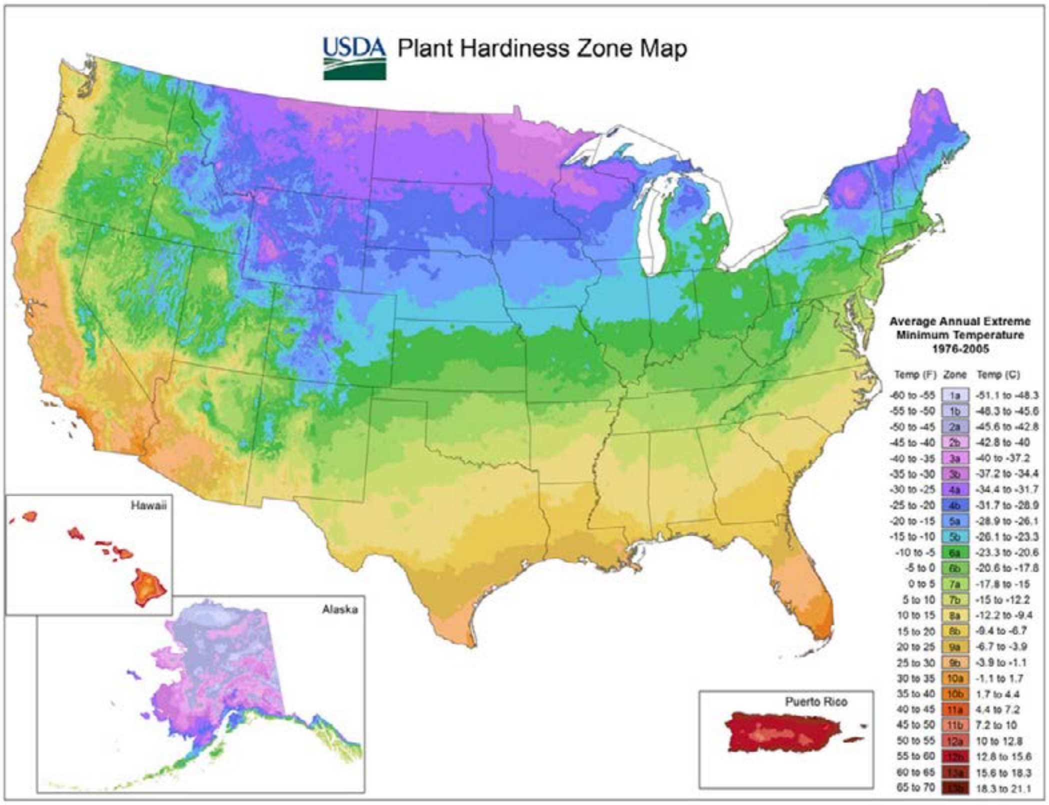
The degree of heat transfer from the burning fire on the surface directly to the soil is the measure of fire severity. When that transfer is hot enough, the soil's physical and chemical properties can be altered. Chemicals and nutrients can volatilize.

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



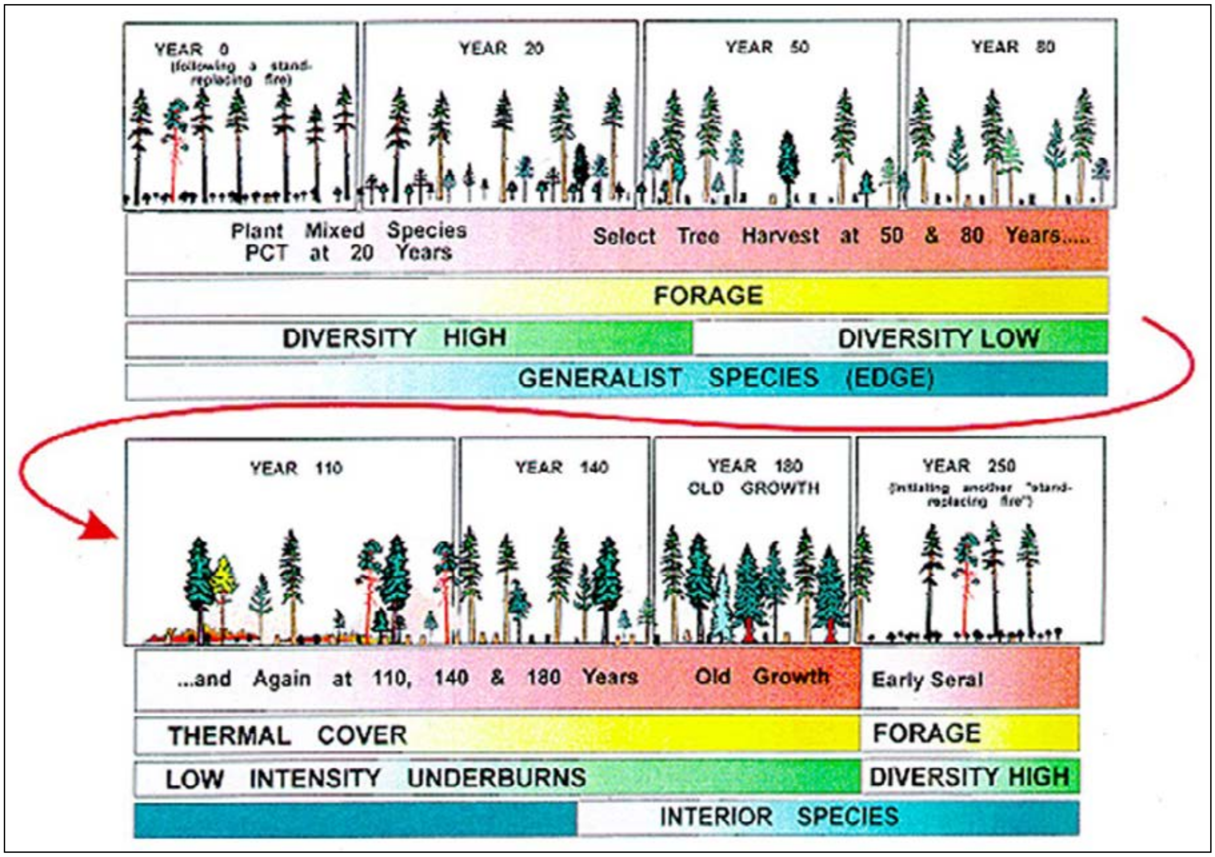
Source: U.S Department of Agricultiure

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 (*Thula 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

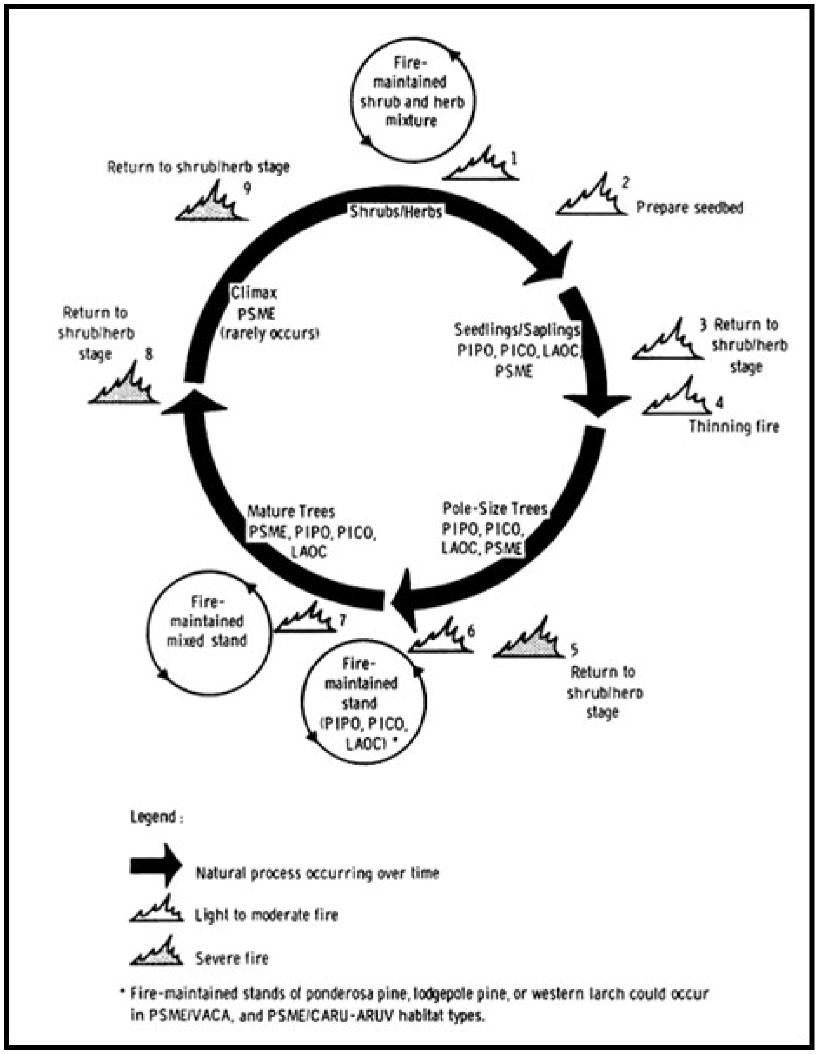
Plants adapt to varying levels of precipitation, soils, solar radiation (slope and aspect), and elevation even in the absence of disturbance. Plants also adapt to disturbance frequency, intensity, and severity. Depending on the severity and intensity of disturbance, there will be an immediate effect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

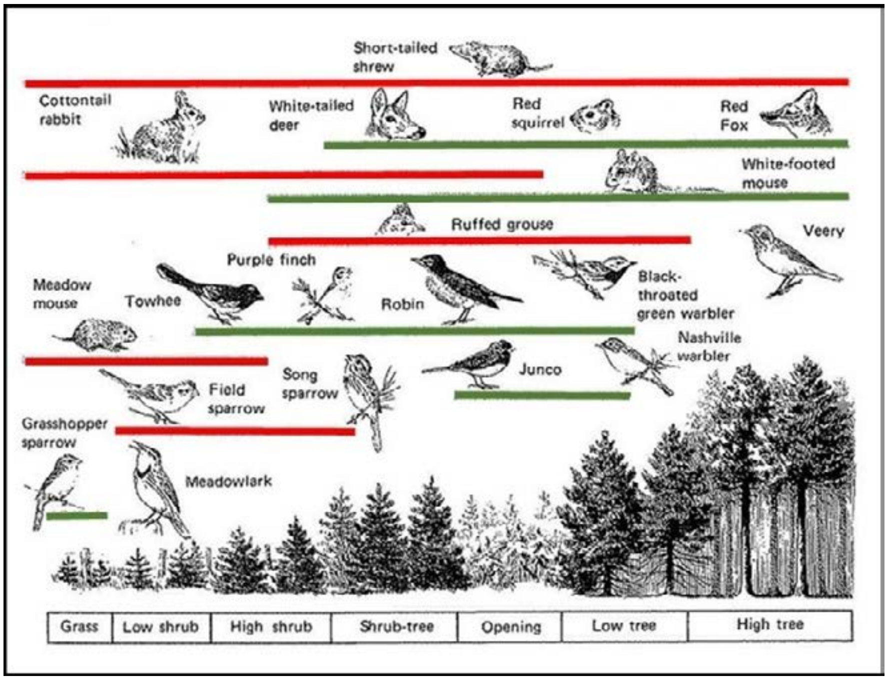
Figure 16. Snowbrush ceanothus (*Ceanothus velutinus*) is a fire-adapted shrub found on south to northeast aspects.

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.

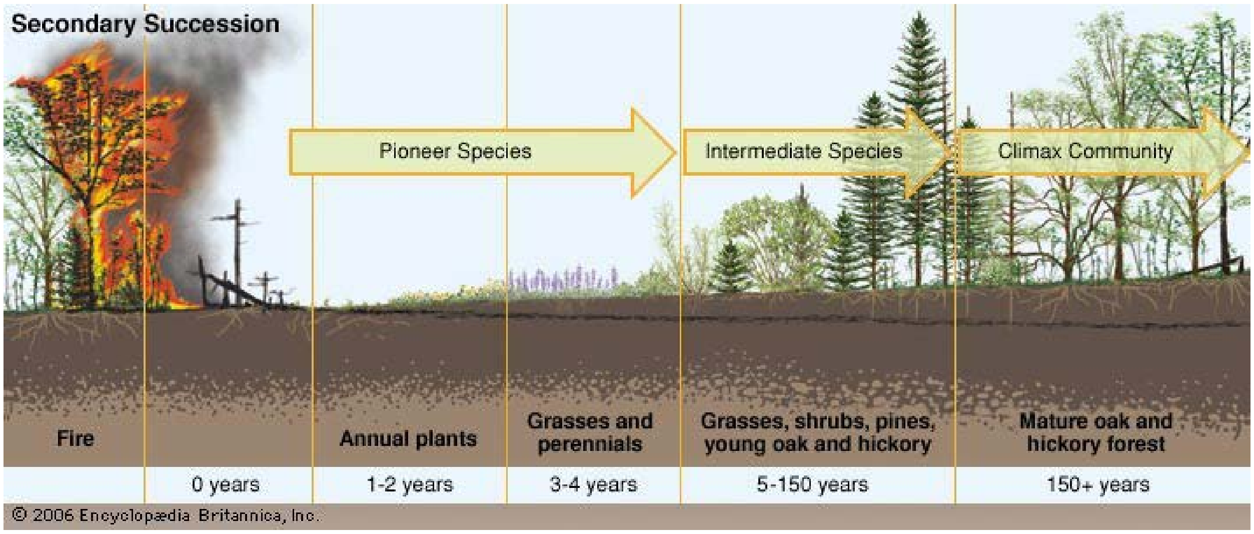


Source: Ecology and Field Biology

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

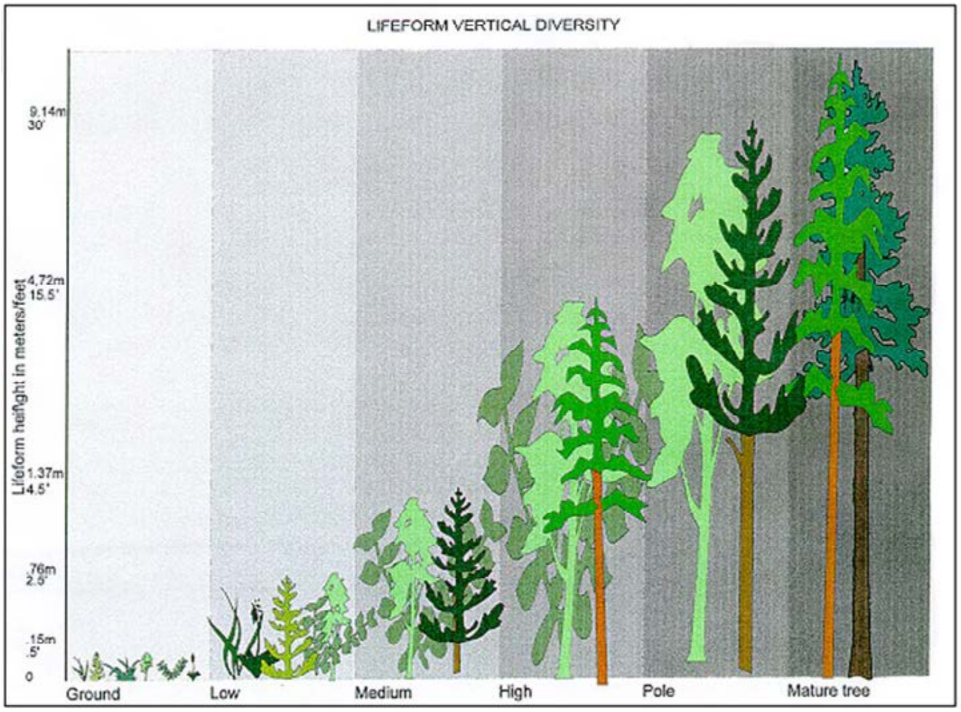
Wildlife

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: 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.

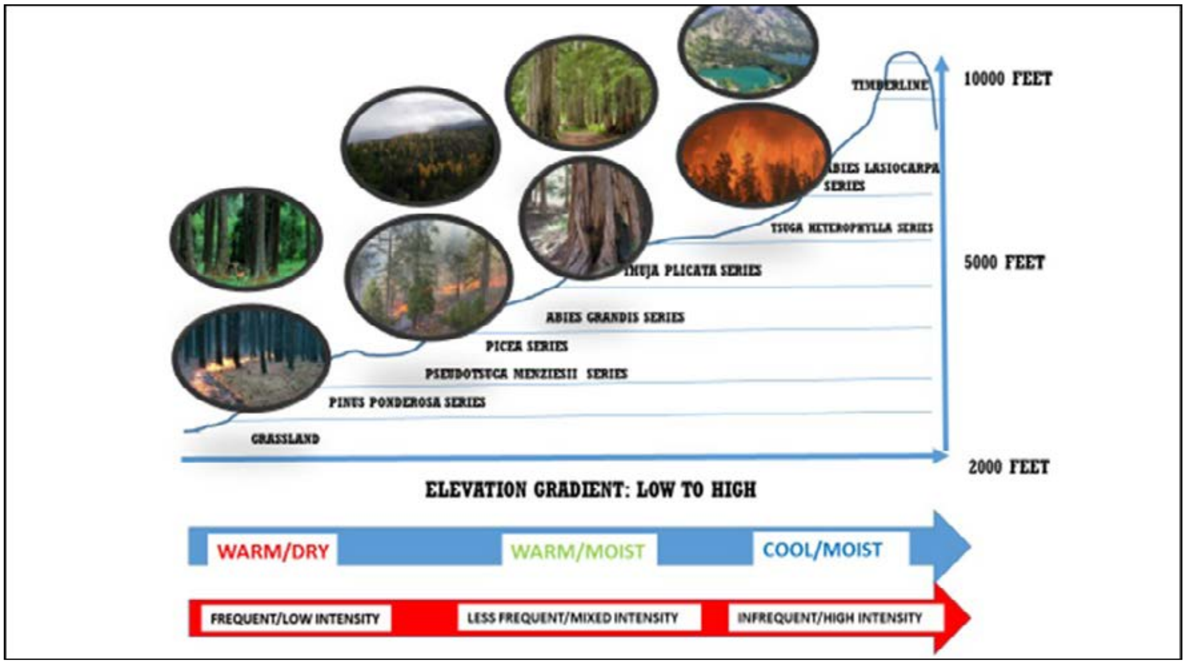
dense forest conditions to ones that prefer warm, open forest conditions. Some animals can leave a burned area that does not suit their needs to an unburned area that does. Unburned areas adjacent to burned areas supply a mosaic of habitats with a range of vegetative conditions from which wildlife can find food and cover. Herbivores and species that prefer herbaceous vegetation for cover prefer the grass/forb habitats or broad-leafed 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 P*roceedings 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 home,s 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 wild-lands 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 20ºF, 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
- 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://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

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/

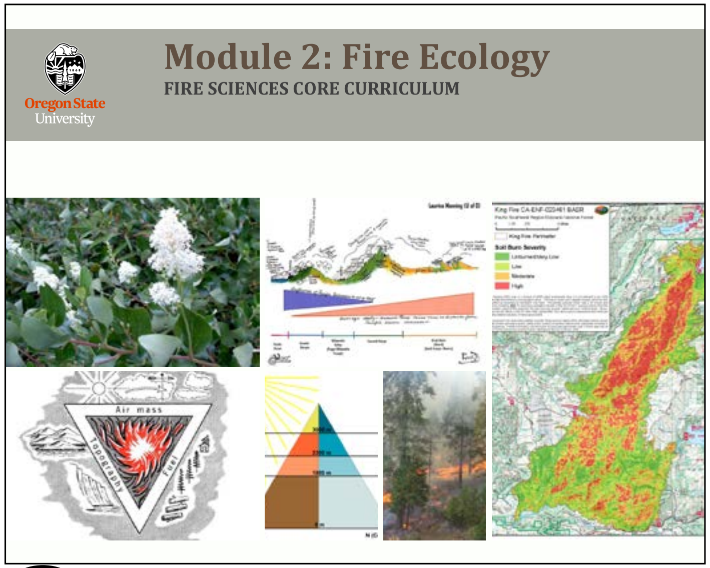
	VERY POOR	POOR	FAIR	GOOD	VERY GOOD	EXCEL-LENT	UNABLE TO RATE
1. Overall, the quality of the educational event as a whole was	○	○	○	○	○	○	○
2. The quality of instruction in this educational event was	○	○	○	○	○	○	○
3. Clarity of educational objectives was	○	○	○	○	○	○	○
4. Clarity of how you might use this 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.

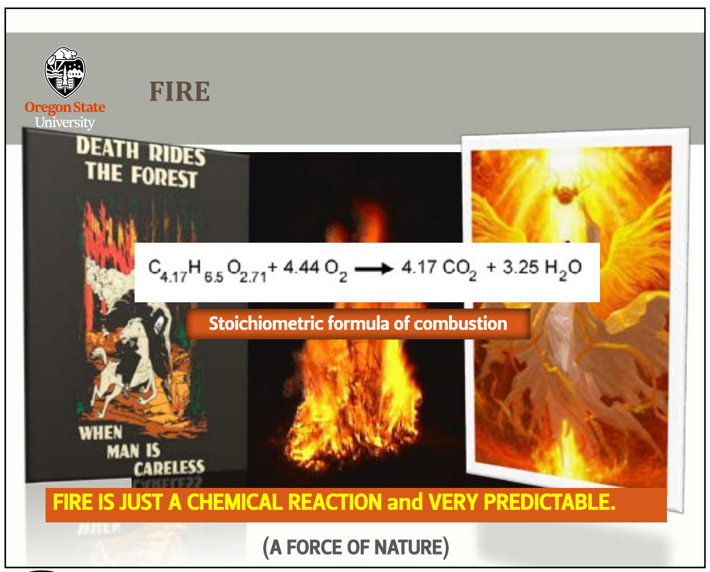
Please comment:

99006PCN0103

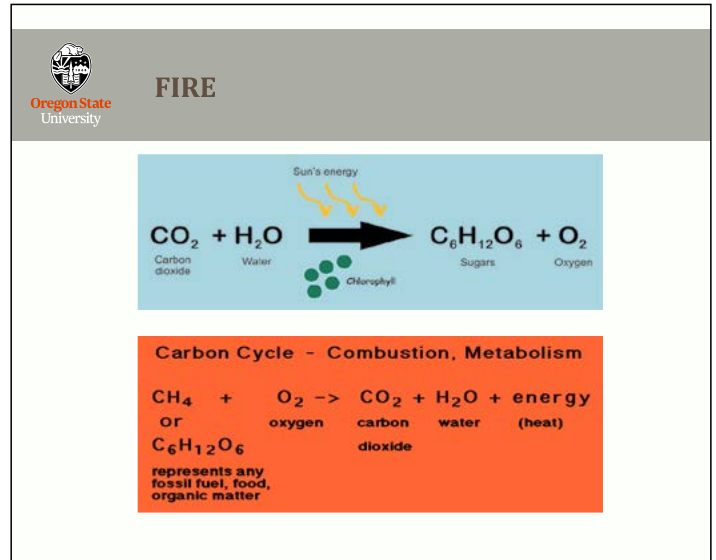
PowerPoint Slides


Oregon State University
Module 2: Fire Ecology
FIRE SCIENCES CORE CURRICULUM
Air mass
Topography
Fuel

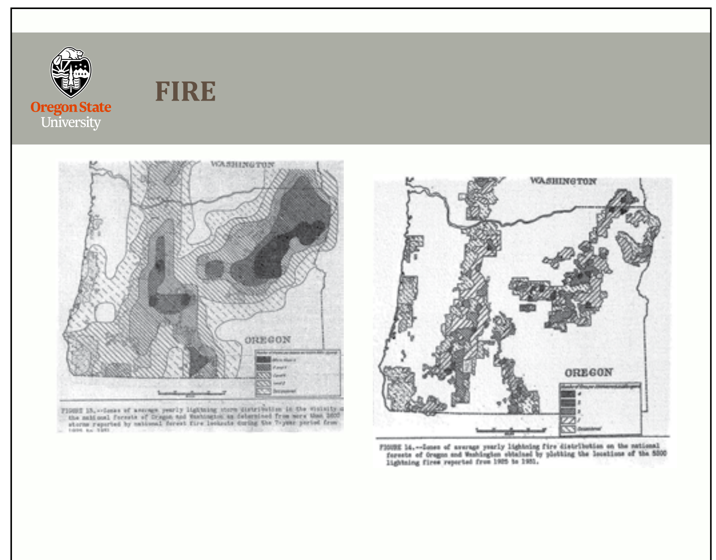
1


Oregon State University
FIRE
DEATH RIDES THE FOREST
WHEN MAN IS CARELESS
$C_{4.17}H_{6.5}O_{2.71} + 4.44\ O_2 \longrightarrow 4.17\ CO_2 + 3.25\ H_2O$
Stoichiometric formula of combustion
FIRE IS JUST A CHEMICAL REACTION and VERY PREDICTABLE.
(A FORCE OF NATURE)

2

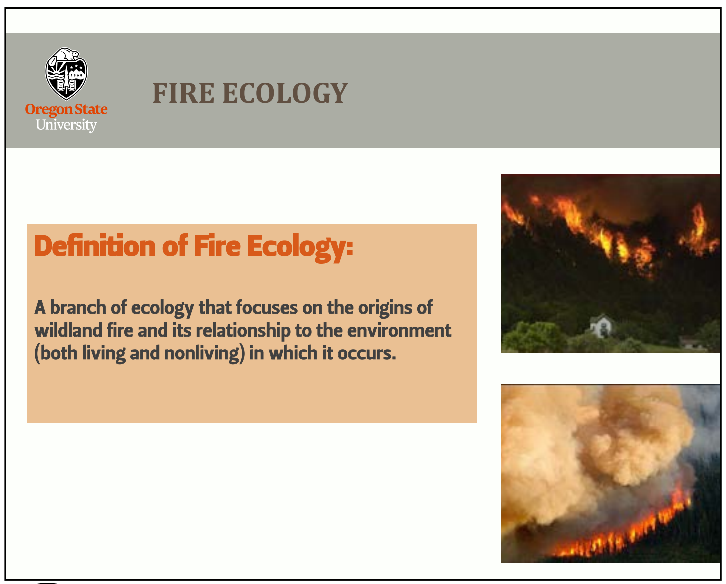

Oregon State University
FIRE
Sun's energy
$CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2$
Carbon dioxide
Water
Chlorophyll
Sugars
Oxygen
Carbon Cycle - Combustion, Metabolism
CH_4 or $C_6H_{12}O_6$ + O_2 -> CO_2 + H_2O + energy
oxygen
carbon dioxide
water
(heat)
represents any fossil fuel, food, organic matter

3


Oregon State University
FIRE
WASHINGTON
OREGON
WASHINGTON
OREGON

4


Oregon State University
FIRE
WASHINGTON
OREGON
Oregon's forest ownership
Most of the forests along the Cascade Range are in public ownership, but many other acres are in private hands.
Public forests
Private forests
Source: Oregon Department of Forestry
STEVE COWDEN/THE OREGONIAN
5


Oregon State University
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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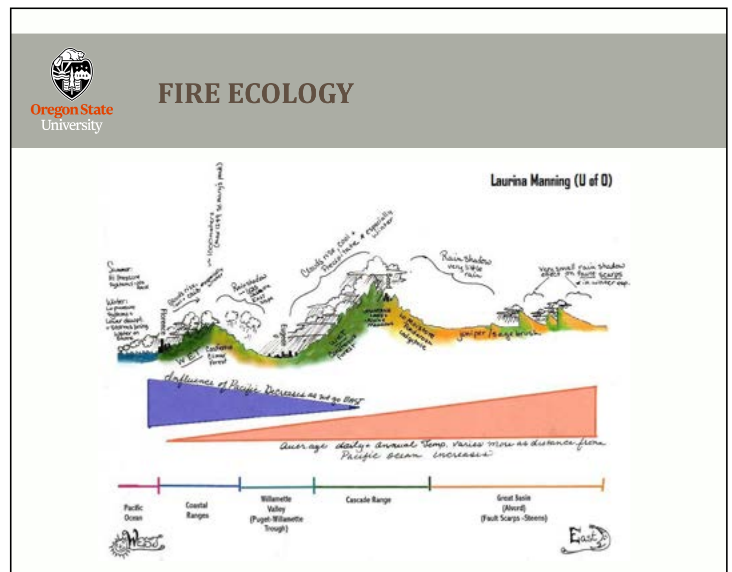
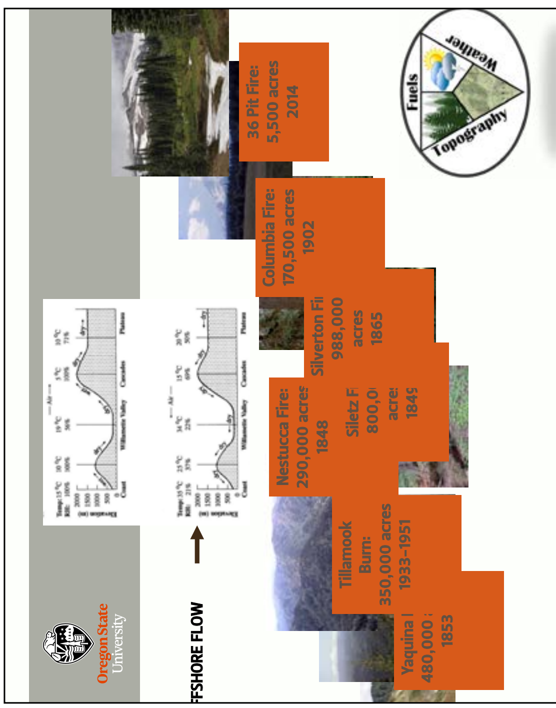
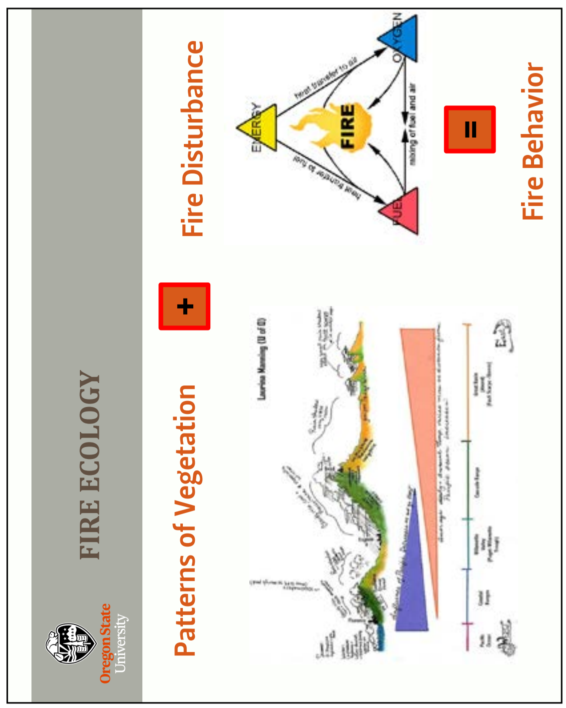
FIRE ECOLOGY
BASIC FIRE BEHAVIOR
OXYGEN
HEAT
FUEL
Fuels
Topography
Weather
THE NATURE OF HEAT
PACIFIC SOUTHWEST Forest and Range Experiment Station
7

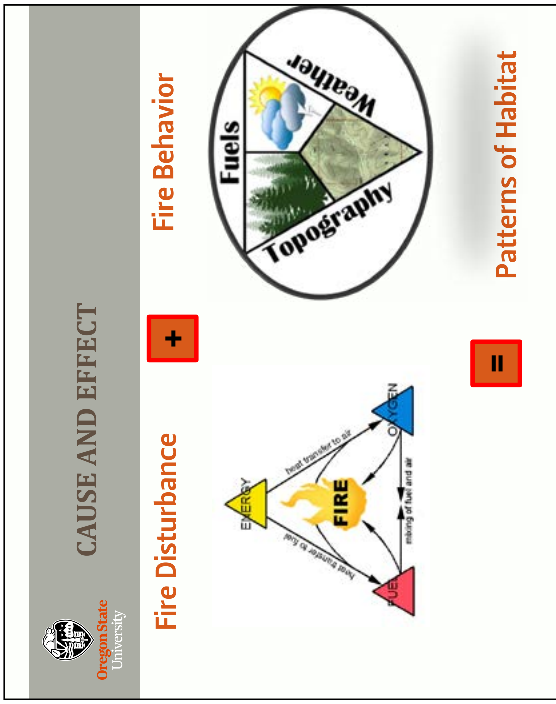

Oregon State University
FIRE ECOLOGY
Laurina Manning (U of O)
Pacific Ocean
Coastal Ranges
Willamette Valley (Puget-Willamette Trough)
Cascade Range
Great Basin (Alvord) (Fault Scarps -Steens)
West
East
8


Oregon State University
FSHORE FLOW
Tillamook Burn: 350,000 acres 1933-1951
Nestucca Fire: 290,000 acres 1848
Columbia Fire: 170,500 acres 1902
36 Pit Fire: 5,500 acres 2014
Fuels
Weather
Topography

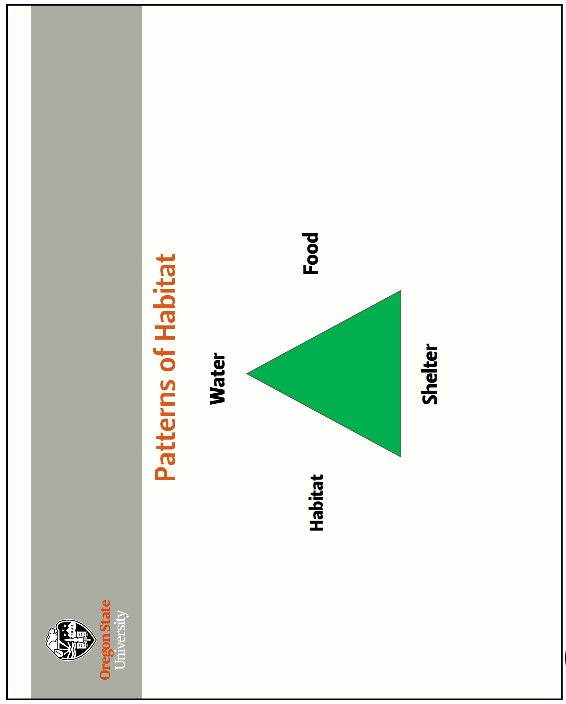
9


Oregon State University
FIRE ECOLOGY
Patterns of Vegetation
+
Fire Disturbance
heat transfer to air
heat transfer to fuel
mixing of fuel and air
FIRE
=
Fire Behavior

10

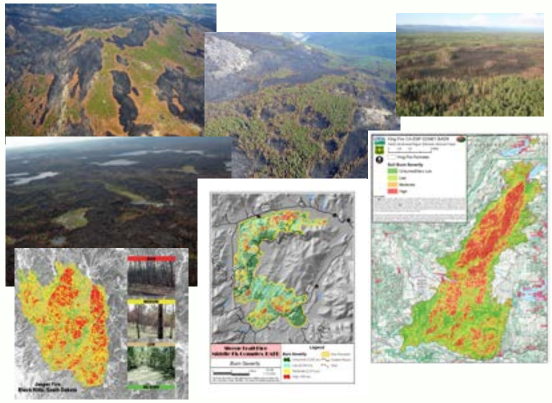

Oregon State University
CAUSE AND EFFECT
Fire Disturbance
heat transfer to air
heat transfer to fuel
mixing of fuel and air
FIRE
+
Fire Behavior
Fuels
Weather
Topography
=
Patterns of Habitat

11


Oregon State University
Patterns of Habitat
Water
Food
Habitat
Shelter

12

Oregon State University



13

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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

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15

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ANTI-DISTURBANCE

16

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

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

17

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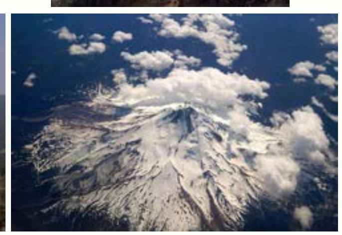
GET LOCAL

Mt. Hood (11,235 feet)



18

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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

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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/

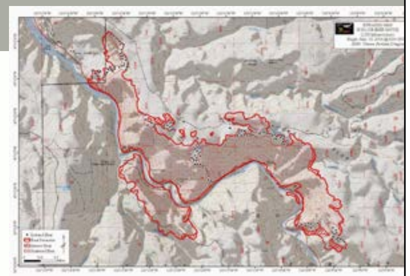
20

Oregon State University

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

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23

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22

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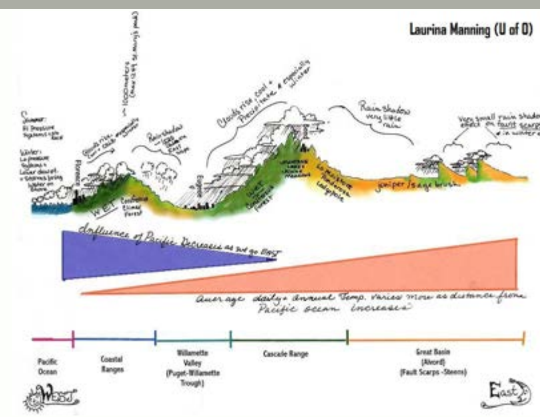
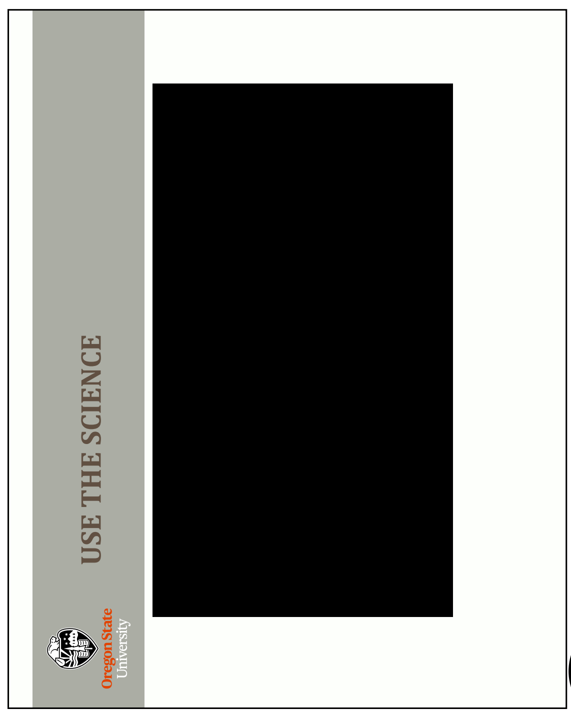
USE THE SCIENCE



24


USE THE SCIENCE
Oregon State University
BASIC FIRE BEHAVIOR
THE NATURE OF HEAT
PACIFIC SOUTHWEST Forest and Range Experiment Station
Air mass
Fuel
Topography
Fuels
Weather
Topography
HEAT
FUEL
OXYGEN

25


USE THE SCIENCE
Oregon State University

26


Oregon State University
THE THREE ZONES OF DEFENSIBLE SPACE
ZONE 1
ZONE 2
ZONE 3
THANK YOU FOR LISTENING

27