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Historical Fire Regimes and Their Application to Forest Management

NCSR Fire Ecology and Management Series

Northwest Center for Sustainable Resources (NCSR)
Chemeketa Community College, Salem, Oregon

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Fire Ecology and Management Series

This six-module series is designed to address both the general role of fire in ecosystems as well as specific wildfire management issues in forest ecosystems. The series includes the following modules:

- Ecological Role of Fire
- Historical Fire Regimes and their Application to Forest Management
- Anatomy of a Wildfire - the B&B Complex Fires
- Pre-Fire Intervention - Thinning and Prescribed Burning
- Post-Wildfire (Salvage) Logging – the Controversy
- An Evaluation of Media Coverage of Wildfire Issues

The *Ecological Role of Fire* introduces the role of wildfire to students in a broad range of disciplines. This introductory module forms the foundation for the next four modules in the series, each of which addresses a different aspect of wildfire management. *An Evaluation of Media Coverage of Wildfire Issues* is an adaptation of a previous NCSR module designed to provide students with the skills to objectively evaluate articles about wildfire-related issues. It can be used as a stand-alone module in a variety of natural resource offerings.

Please feel free to comment or provide input.

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NCSR curriculum modules are designed as comprehensive instructions for students and supporting materials for faculty. The student instructions are designed to facilitate adaptation in a variety of settings. In addition to the instructional materials for students, the modules contain separate supporting information in the "Notes to Instructors" section. The modules also contain other sections which contain additional supporting information such as a “Glossary” and “Suggested Resources.”

Acknowledgements

We thank Steve Resh of Allegany College of Maryland in Cumberland, Maryland, and Harry Hutchins of Itasca Community College in Grand Rapids, Minnesota, and Rick O’Hara of Chemeketa Community College in Salem, Oregon for their thoughtful reviews. Their comments and suggestions greatly improved the quality of this module.

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Historical Fire Regimes and their Application to Forest Management – Module Description

This module is the second in the *Fire Ecology and Management Series*. The module is designed for courses that support natural resource disciplines such as Forestry, Wildlife and Environmental Science. Although the module can be taught independently, faculty should consider teaching it as part of the series. Specifically, the module *The Ecological Role of Fire in Forest Ecosystems* is designed to prepare students for this module. This lecture-based module introduces the concept of historical fire regimes and describes how they are applied to modern forest management. A *PowerPoint* presentation describes how fire histories are determined and provides maps of fire regimes across the United States. The causes of altered fire regimes including climate change are discussed as well as the risk they pose to humans and ecosystems. Examples of how disturbance regimes are used in forest management are also provided.

Historical Fire Regimes and their
Application to Forest Management

Introduction

In this lecture-based module, historical fire regimes and their application to forest management are described. The module is presented as a series of *PowerPoint* slides paired with a textual outline of the major points. Supplementary lecture notes for use by the instructor are included in the notes section for each slide. Citations of relevant print, video and web-based resources are also provided for the instructor as background, supplemental use in the classroom and for additional research.

The module is most appropriate for use as an introduction to fire behavior for courses such as *Fire Ecology, Wildfire Management, Environmental Science* and *Introduction to Natural Resources*.

Objectives

Upon completion of this module students should be able to:

1. Describe the various components of natural wildfire regimes
2. Describe the various methods used to determine natural wildfire regimes
3. Describe the causes for significant departures from natural wildfire regimes and the implications of these departures for wildfire behavior and impacts
4. Discuss how fire regimes are applied to modern forest management

Procedure

Fire behavior, fire history, fire effects and the various methods that are used in their analysis are important topics in any fire management curriculum. These topics may also be relevant in less specific forestry or natural resource programs. For example, the topic may be addressed in the context of ecological succession, forest ecology or forest management.

The accompanying *PowerPoint* presentation should be delivered to students at an appropriate time in the course. In its current form, the presentation will take approximately two 50-minute lecture sessions. Alternatively, the presentation could be made available to students on-line, where they could review the material on their own.

A wide variety of web, print and video resources are cited in the “Supplemental Lecture Support” and “Resources” sections at the end of this module. Instructors looking for an introduction to historical fire regimes will find chapter 3 in Arno and Fiedler (2005) and Noss, et al. (2006) to be especially helpful.

The list of recommended videos should also be considered to supplement the *PowerPoint* presentation.

Additional text or titles may be added to the *PowerPoint* slides to match your particular instructional style.

Assessment

Student learning of the material in this module is probably best assessed with essay or short answer questions on an exam. I suggest the following:

What are "natural wildfire regimes" and what methods are used in their determination?

Explain why departures from natural wildfire regimes are relevant to wildfire behavior and impacts.

Explain how natural fire regimes can become altered resulting in impacts that "lie outside the natural range of variability."

What benefits might be gained when forest management more closely approximates natural fire regimes?

General Lecture Outline

I. Introduction
II. Wildfire history
- Historic vs. current fire behavior
- Evidence for increasing frequency and severity

III. Natural fire regimes
- Definitions and components
- Classification schemes
- Methods for determination

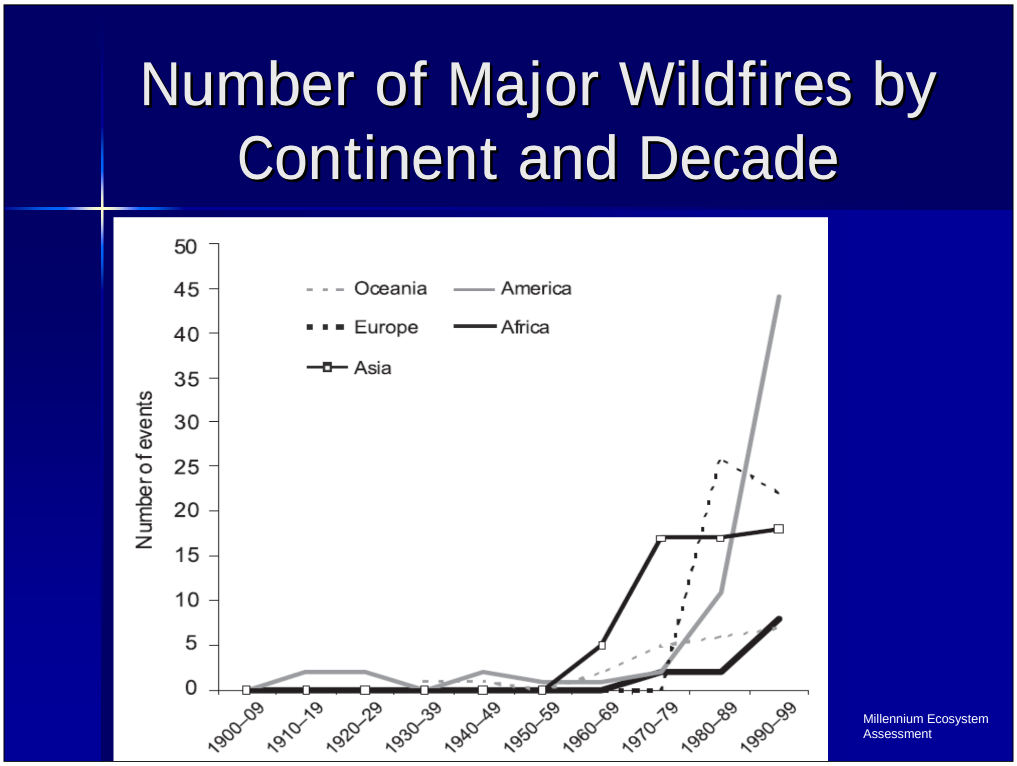
IV. Altered fire regimes
- Fire regime condition classes (FRCC)
- Causes of altered fire regimes
- Impact of global climate change

V. Application to forest management
- Disturbance regimes
- Dynamic landscape management
- Blue River Landscape Study

See notes on *PowerPoint* slides for detailed lecture notes for *Historical Fire Regimes and their Application to Forest Management* presentation.

PowerPoint Slides with Instructor's Notes

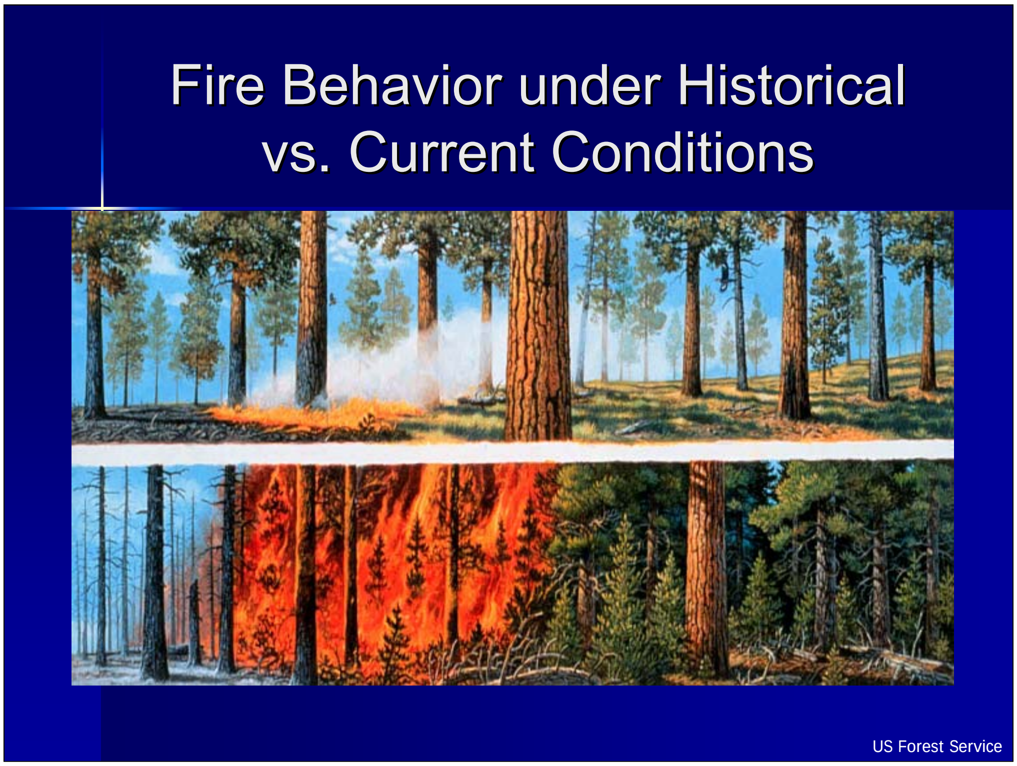
This lecture-based module introduces the concept of historical fire regimes and describes how they are applied to modern forest management. The presentation describes how fire histories are determined and provides maps of fire regimes across the United States. The causes of altered fire regimes including climate change are discussed as well as the risk they pose to humans and ecosystems. Examples of how disturbance regimes are used in forest management are also provided.



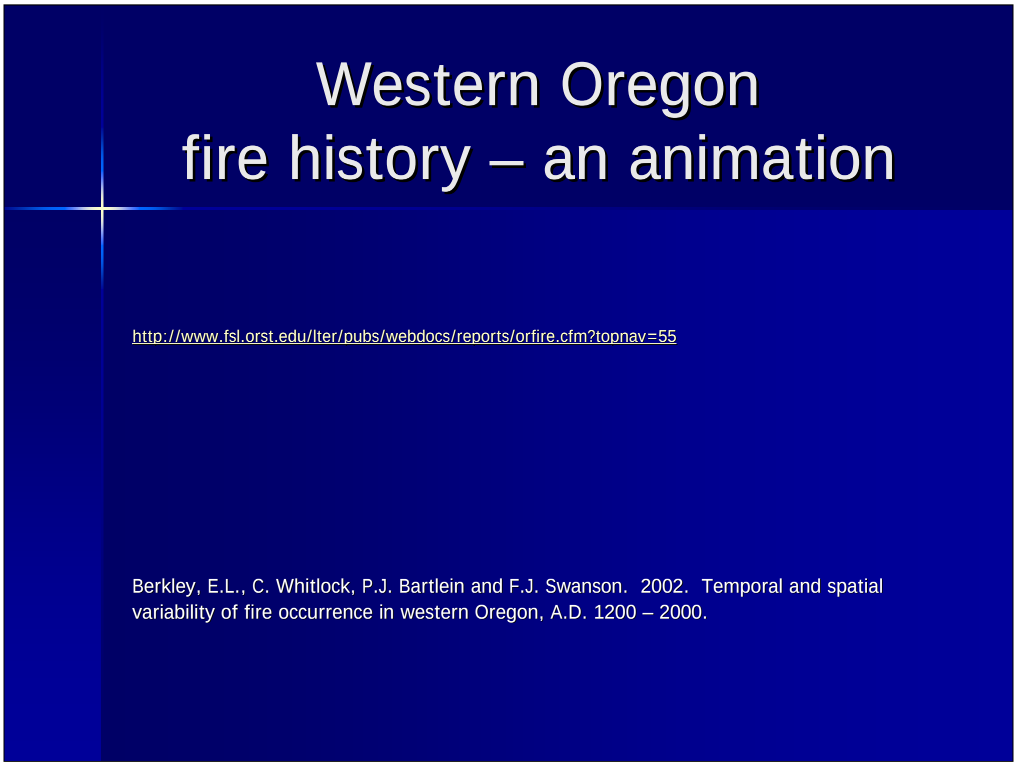
The frequency of major wildfires in North and South America has increased dramatically in recent decades. Similar patterns are shown in other parts of the world. A number of explanations have been offered for this trend including global climate change (warmer temperatures drying fuels and generating more lightning-producing thunderstorms), increased human activity and development in remote areas resulting in more human-caused ignitions and past fire management policy that has increased fuels by suppressing most fires.

For details, see:

www.millenniumassessment.org/documents/document.285.aspx.pdf

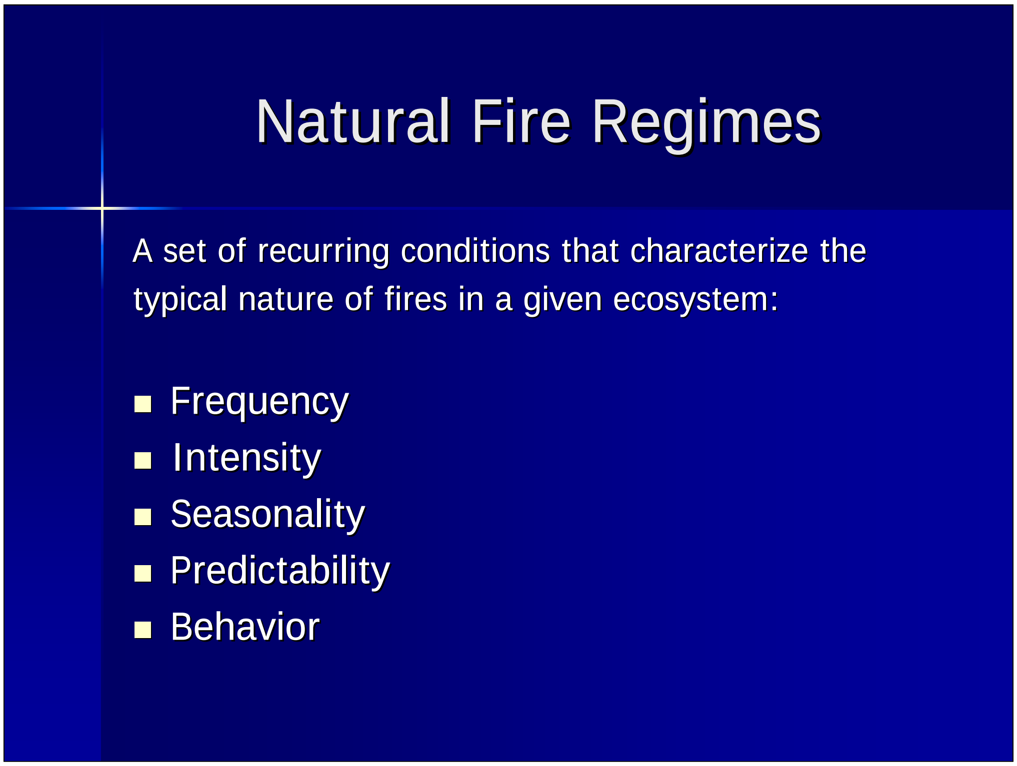


For many fire-dependent ecosystems, historical fire regimes were characterized by frequent, low intensity fires. These fires would burn dead wood, small shrubs and trees, but in most fires, dominant (larger, older) trees would not be killed. In contrast, as a result of fire exclusion, reforestation and other factors, current conditions promote less frequent, highly intense wildfires that can be stand-replacing, resulting in the death of a high percentage of dominant trees. (See NCSR module, *Ecological Role of Fire*, for details.)



This document includes an interesting animation of western Oregon fire history from A.D. 1200- 2000 (see figure 4).

An understanding of past fire regimes is necessary to assess the effects of fire on forest ecosystems and to improve fire management practices. This animation illustrates historic fire occurrence in western Oregon for the period A.D. 1200 to present. Fire events were most widespread and synchronous in the 1800s, particularly between 1850 and 1875 (a period of continent-wide drought), and also earlier (but less numerous) in the 1500s. Many fire events occurred during the 1600s and 1700s, but they were localized and asynchronous.



Fire regimes – definition:

A set of recurring conditions that characterize the typical nature of fires in a given ecosystem. These conditions include the following:

Frequency – How often does the ecosystem typically burn?

Intensity – At what intensity do these fires typically burn?

While most fire regime classifications emphasize these two criteria, more complex classifications may take into account:

Seasonality - During what season do they typically occur?

Predictability – A measure of <u>variation</u> in fire frequency (expressed as a range or standard deviation)

Behavior- What is the typical burn size and in what spread pattern?

Natural (historical) fire regimes <u>do</u> take into account the influence of aboriginal burning.

An understanding of fire regimes is important for management because it gives us some sense for what **natural range of variability** (in intensity and frequency) might be expected in an area. It is increasingly recognized that this knowledge is critical to understanding and managing ecosystems. Modern forest management recognizes fire as an integral component of ecosystems. Management plans for forests across the U.S. frequently include the desire to return forests to fire regimes that are within their historic range of variability. Fuel reduction practices, thinning and prescribed fire are commonly used tools to achieve this objective (See NCSR module entitled, "*Pre-Fire Intervention: Thinning and Prescribed Burning,*" for details).

The natural range of fire regimes represents a continuum and, hence, is difficult to classify into discrete categories. Boundaries between categories must be somewhat arbitrary. Due to the highly variable nature of fire, most fire regime classifications are necessarily quite general.

In the 1990's, scientists developed a simple 4-class classification scheme that recognized that fire behavior and its resulting effects on vegetation differ dramatically from region to region.

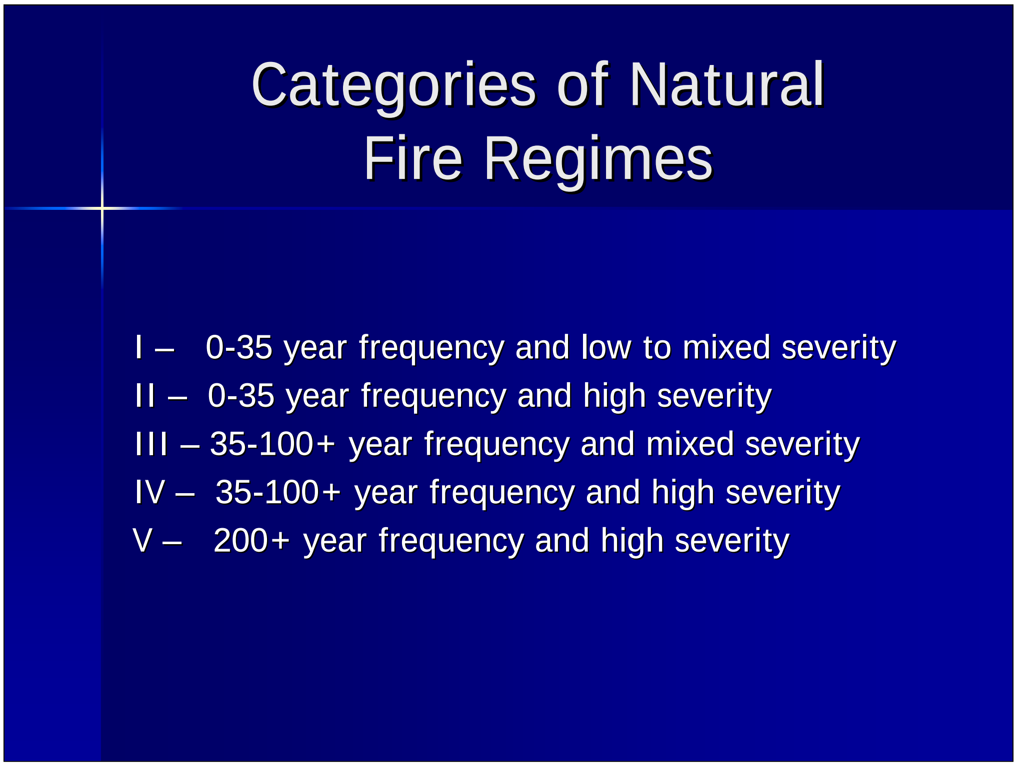
Understory Fire Regime – high (1-30 year intervals) fire frequency, low intensity fires burn leaf litter, grass, small shrubs and saplings but few dominant trees (e.g., ponderosa pine west of the continental divide, giant sequoia forests of the Sierra Nevada, redwood forests of northern California). Frequent fires maintain open, park-like conditions. In recent years large, stand-replacing fires have occurred in areas where historically, frequent, low intensity fires characteristic of this fire regime would have occurred.

Mixed Fire Regime – characterized by an intermediate fire frequency (averaging 30 – 100 years); fire intensity is highly variable with both understory and stand replacement fires represented. However, most fires are of intermediate severity resulting in the elimination of most shrubs, saplings and mature fire-susceptible trees, but large fire-tolerant species survive. Due to this variability, landscapes within a mixed fire regime tend to show a high degree of variability in species composition, structure and tree age. Examples that illustrate this regime include inland and some coastal Douglas-fir forests, pinyon-juniper forests and ponderosa pine forests east of the Continental Divide.

Stand Replacement Fire Regime – characterized by long (100-400 year) intervals between fires and fires that burn at high intensity such that most dominant trees are killed in large irregular patches. The result is a mosaic of burned and unburned areas across the landscape. This pattern is typical of moist, cool forests where fires occur only in summer during or after a prolonged period of drought and high temperatures. Examples include subalpine forests in the Rocky Mountains and wet, temperate forests in northern Idaho and western Washington and British Columbia. The 1988 stand replacement fires in Yellowstone National Park burned large areas of lodgepole pine, subalpine fir and Engelmann spruce.

Non-fire Regime – Little or no occurrence of natural fire in this regime

Fire frequency intervals shown above may need to be adjusted for some eastern U.S. forest types.



A number of more complex methods have been devised to establish fire regime classes or categories. This widely used system emphasizes differences in fire frequency, severity and behavior. Based on these criteria, natural (historical) fire regimes are categorized as follows :

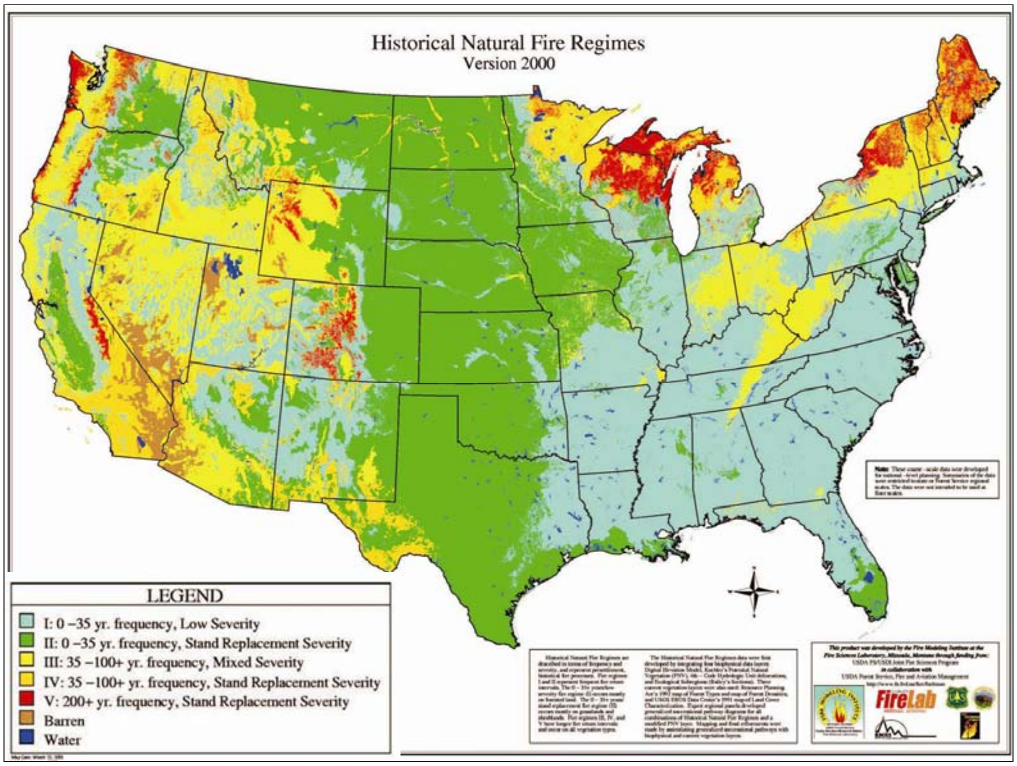
I – 0-35 year frequency and low (surface fires are most common) to mixed (<75% of dominant overstory vegetation replaced) severity

II – 0-35 year frequency and high (stand replacement) severity (>75% of dominant overstory vegetation replaced)

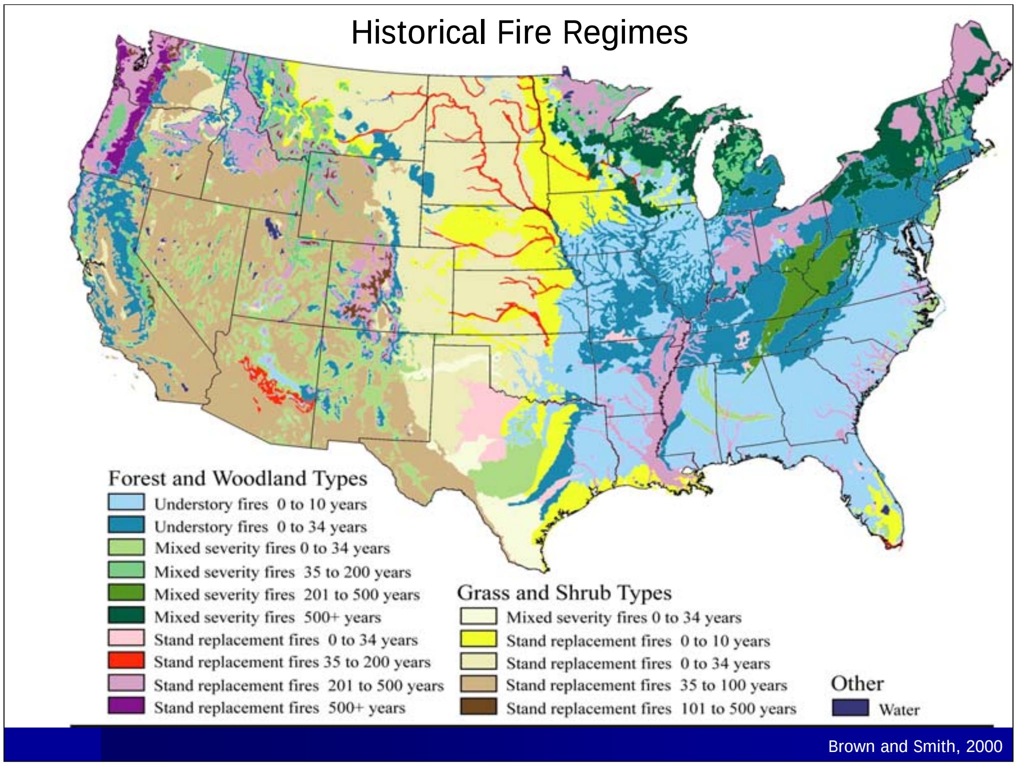
III – 35-100+ year frequency and mixed severity (<75% of dominant overstory vegetation replaced) (e.g., mixed conifer stands – sequoia, Jeffrey pine, sugar pine, white fir – of the California Sierra Nevada)

IV – 35-100+ year frequency and high (stand replacement) severity (>75% of dominant overstory vegetation replaced) (e.g., some lodgepole pine forests such as those in the Greater Yellowstone Ecosystem that burned with high severity in 1988)

V – 200+ year frequency and high (stand replacement) severity (e.g., Coastal Douglas-fir forests in NW Oregon, western Washington and British Columbia)



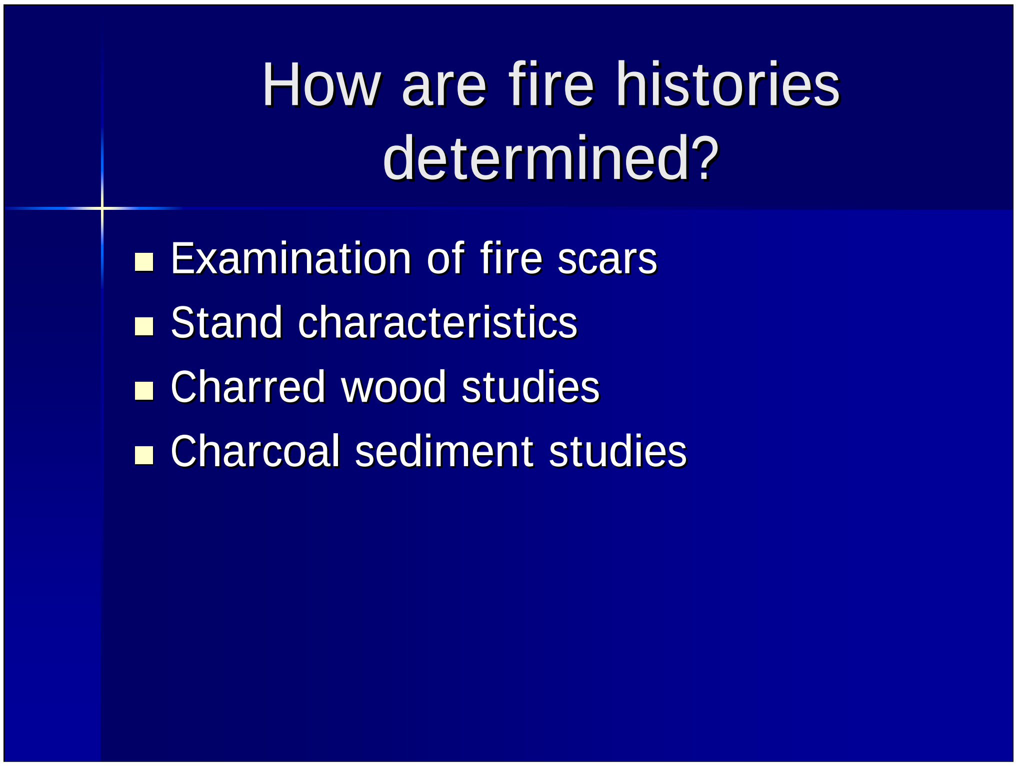
This map illustrates the distribution of this 5-class system of categorizing historical natural fire regimes in the United States.



This historical fire regime map is based on a method that identifies 10 forest and woodland types and 5 grass and shrub types (Brown and Smith, 2000). Note the prevalence of high frequency, understory fires (represented in light and medium blue here) through much of the eastern United States and portions of the West.

Fire regimes are closely associated with climate, so notice that particularly where north-south mountain ranges (Cascades, Sierra Nevada, Rockies) occur, very different fire regimes may be adjacent to each other. For example, in Central Oregon a low frequency, stand replacement fire regime (represented in dark purple in the map) in the Cascade Range is adjacent to a regime of high frequency, understory fires immediately to the east.

More detailed historical fire regime maps are available at the Landscape Fire and Resource Management Tools Project web site. (www.landfire.gov)



Fire histories are generally based on fire behavior before widespread settlement by European-Americans and therefore, prior to the impacts of extensive land use conversion and forest management activities, including fire suppression. Thus, most fire histories in the U.S. are based on a time frame from approximately 1500 to the late 1800s. Fire histories are determined by synthesizing information from a number of different sources. When available, written accounts (e.g., surveyors notes) and oral reports are used, but more commonly on-site evidence is collected.

Fire scars - Fire scars are formed when heat persists around the base of the tree long enough to penetrate the bark and damage a portion of the cambium layer. The tree, however, survives and in the years after the fire, the adjacent cambium grows over the fire scar. Cross sections taken through these external scars reveal a record of previous fires that the tree has survived.

In cross section each fire is recorded in the annual rings of the tree (dendrochronology). The result is a natural archive of fire frequency, which can be used to establish the historical fire regime in an area. This information is used as an indication of the natural range of variability.

Stand characteristics – The appearance of different age classes of trees in a stand can also be used as an indication of past disturbance events including fire. This method is based on the assumption that a new age class begins after each major fire. Ages of trees representative of different age classes in the stand are determined using standard methods such as tree ring counts on stumps or increment bore analysis.

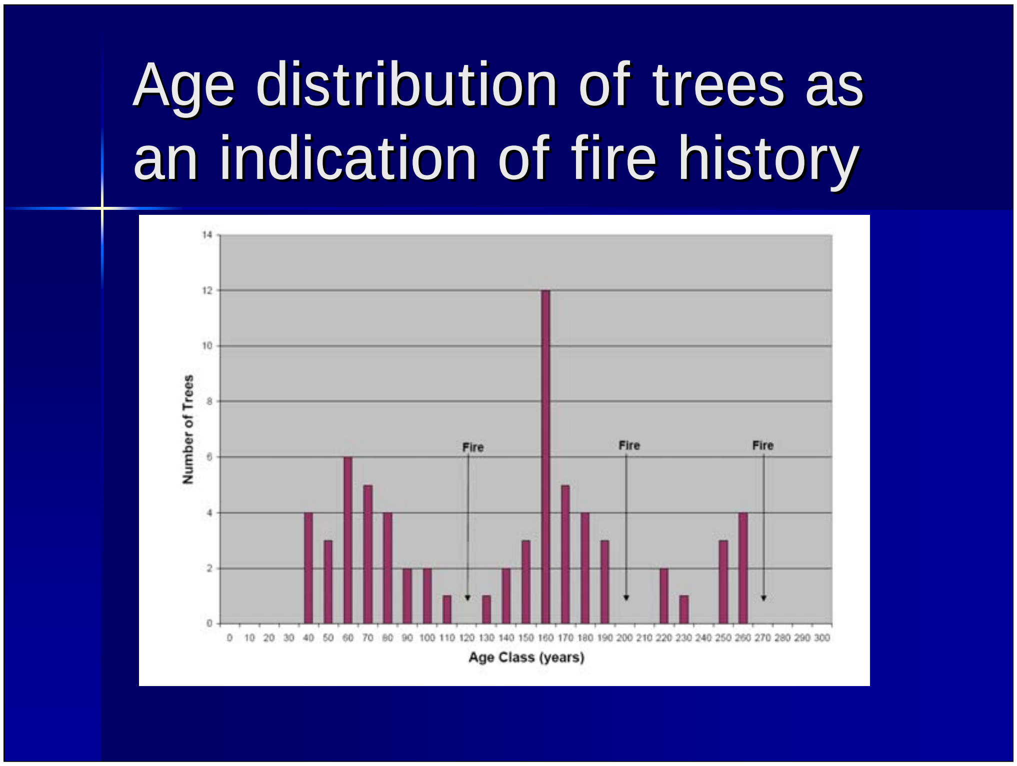
Charred wood on the bark of live trees can be used as an indication of past fires. Some species such as Douglas-fir retain this char for centuries.

Charcoal can be also detected in **sediment** cores and used as evidence of past fires. Microscopic examination of soil sample cores and detection of charcoal fragments may be required.

Fire scar at the base of a giant sequoia, a particularly fire resistant species in northern California being held up here by Steve Eubanks, Forest Supervisor of the Tahoe National Forest in California. Trees like this provide a natural archive of past fire events.

A fire history can be determined by fire scars, which are formed over the life of a tree by a series of fires. The first fire burns through the bark and kills the underlying cambium. The bark then sloughs off and scar tissue begins to grow over the wound. Before the wound can completely heal, however, a second fire kills the cambium under the thin bark of the scar tissue. The second fire leaves some charcoal on the exposed surface of the initial scar. The process repeats with each subsequent fire. Since the bark in this portion of the tree is thinner than non-scar areas, the region becomes a sensitive indicator of fires.

Fire scar photo from: www.ltrr.arizona.edu/sngc/images/fbsm/scardts.jpg



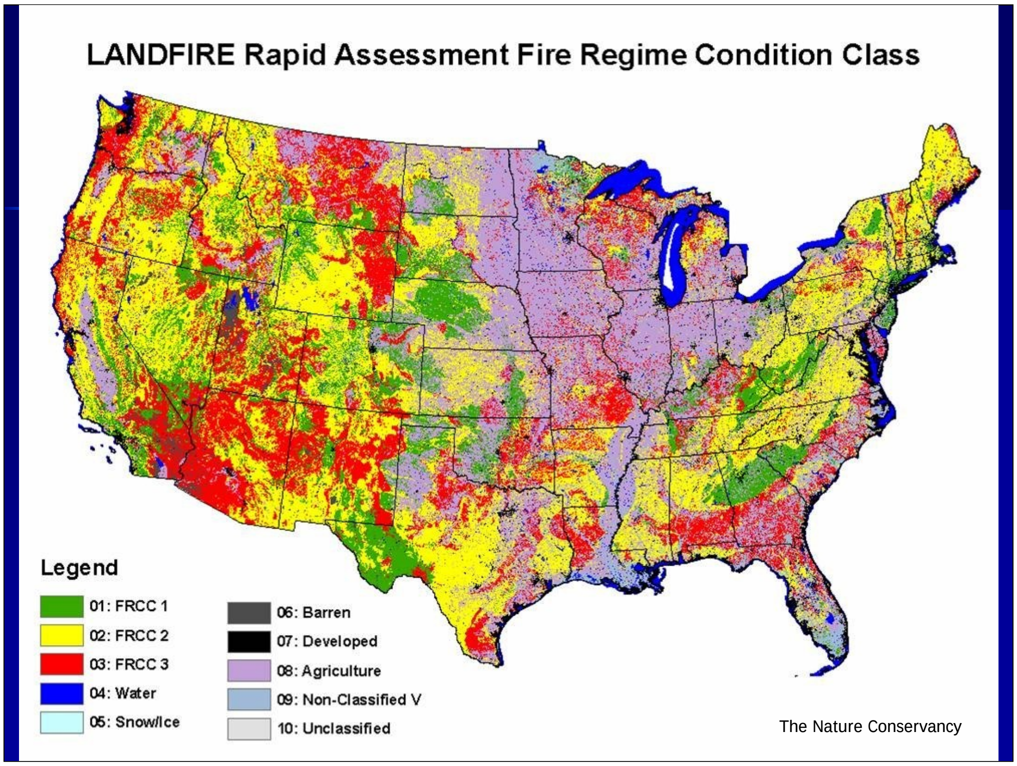
An analysis of the age distribution may also be used to determine past fire history. This method is based on the assumption that each fire event resulted in a pulse of establishment of new trees following the fire. The disturbance by fire opens up space for the establishment of shade intolerant trees. In this hypothetical example, three age classes are represented with median ages of approximately 60, 160 and 260 years. This distribution suggests the timing of fires indicated in the graph.

This type of analysis could also be accomplished by visiting a recent harvest in a fire-dependent ecosystem and estimating tree age by counting annual rings on cut stumps.

Charred wood on the bark of live trees can be used as an indication of past fires. Some species such as Douglas-fir retain this char for centuries. Residual trees (i.e., those remaining after a fire) in two-hundred-year-old stands in the Olympic Mountains of Washington, for example, still show evidence of the fire that initiated the stand. Other species like this Ponderosa pine, shed their bark over time and thus, do not retain char for as long. However, past fires can still be detected by examination of the small jig-saw-like pieces that accumulate at the base of trees.

Charcoal is formed when a fire incompletely burns plant material. Charcoal sediment analysis measures the accumulation of charcoal particles in sediments. Layers with abundant charcoal are inferred to be evidence of past fires. Collection of sediment cores, microscopic examination of soil samples and detection of charcoal fragments is required (see photo at right). Carbon dating techniques can also be used to estimate approximate age; however, this method is based on estimating the time since the tree was growing, <u>not</u> the time of the fire. Charcoal records generally allow analysis of longer time frames than other methods (hundreds to millions of years) but with less resolution.

Source of image on right: www.landcareresearch.co.nz



While the natural fire regime is a general classification of fire frequency and intensity in the absence of modern human activity, a fire regime condition class (FRCC) is a classification of the amount of departure from the historical natural regime. Three classes are identified based on the degree of departure:

FRCC 1 – low departure, within the natural (historical) range of variability and risk of losing key ecosystem components is low

FRCC 2 – moderate departure; risk of losing key ecosystem components is moderate

FRCC 3- high departure; risk of losing key ecosystem components is high

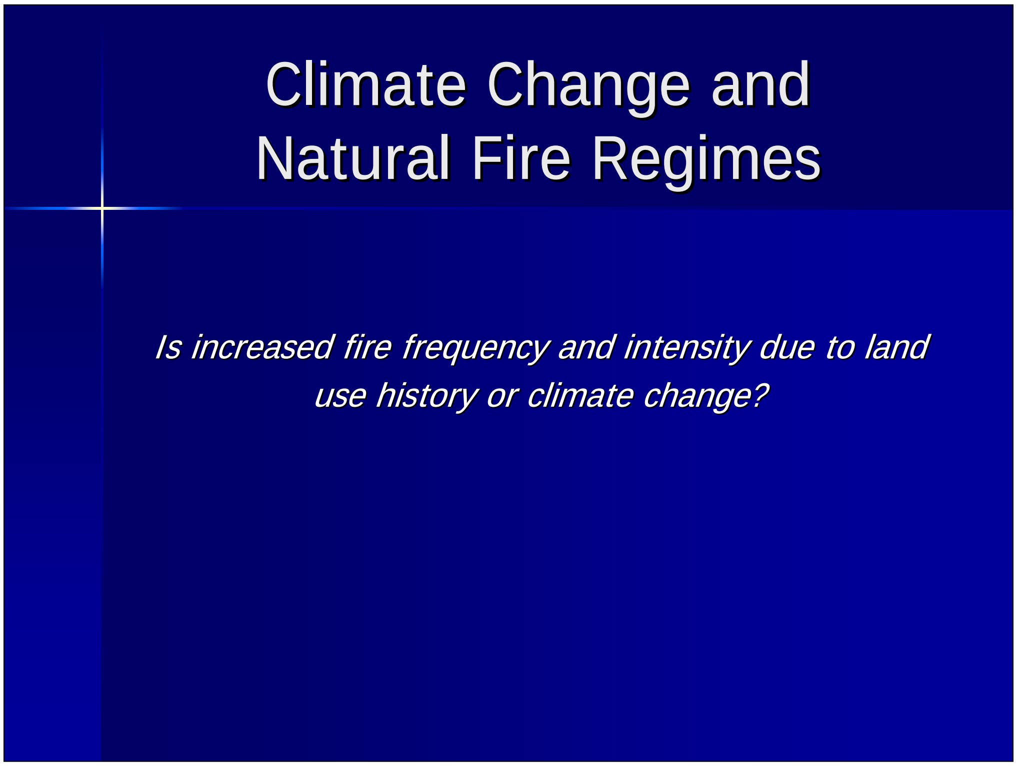
Note regions where departures are most severe include much of the western and southeastern United States. Large regions in southern California, Arizona and New Mexico, the Pacific Northwest, and the Greater Yellowstone ecosystem are particularly affected. Not coincidentally, these areas have all been affected by uncharacteristically intense and widespread fires in recent years.

SOURCE: http://tncfire.org/images/RA_FRCC.jpg

A number of factors may contribute to departures from historical fire regimes and result in altered fire behavior. **Fire exclusion and suppression** with resulting changes in stand structure and fuel loads is probably the most common contributing factor, but it is not the only one. Some **forest management practices** such as high-grading (removal of the largest trees in a stand) and even reforestation efforts may alter fire regimes by changing the species composition, density or structure of stands in a landscape. **Population growth and urban development** also alter fire regimes by increasing the "wildland-urban interface" where human-caused fires are likely to increase.

The establishment and proliferation of **invasive species** may also alter fire regimes particularly when these species have different growth characteristics or flammability when compared to native species. In the Pinyon-juniper woodlands of the Great Basin, cheat grass (*Bromus tectorum*) is an example. Cheat grass out-competes native vegetation and produces tremendous amounts of fine fuels, creating a more volatile fire regime. Also in pinyon-juniper forests, **overgrazing** may result in removal of competing vegetation for trees creating overly dense stands that are more prone to stand replacing fires. **Climate change** may alter fire regimes by changing temperature and precipitation patterns, resulting in either an increase or decrease in the frequency and intensity of fires.

Departures result in changes to any number of ecosystem characteristics including vegetation characteristics (e.g., species composition, structure, stand age and canopy closure), fuel composition, fire frequency and severity, insect pest outbreaks.



The relationship between climate change and natural fire regimes warrants further analysis.

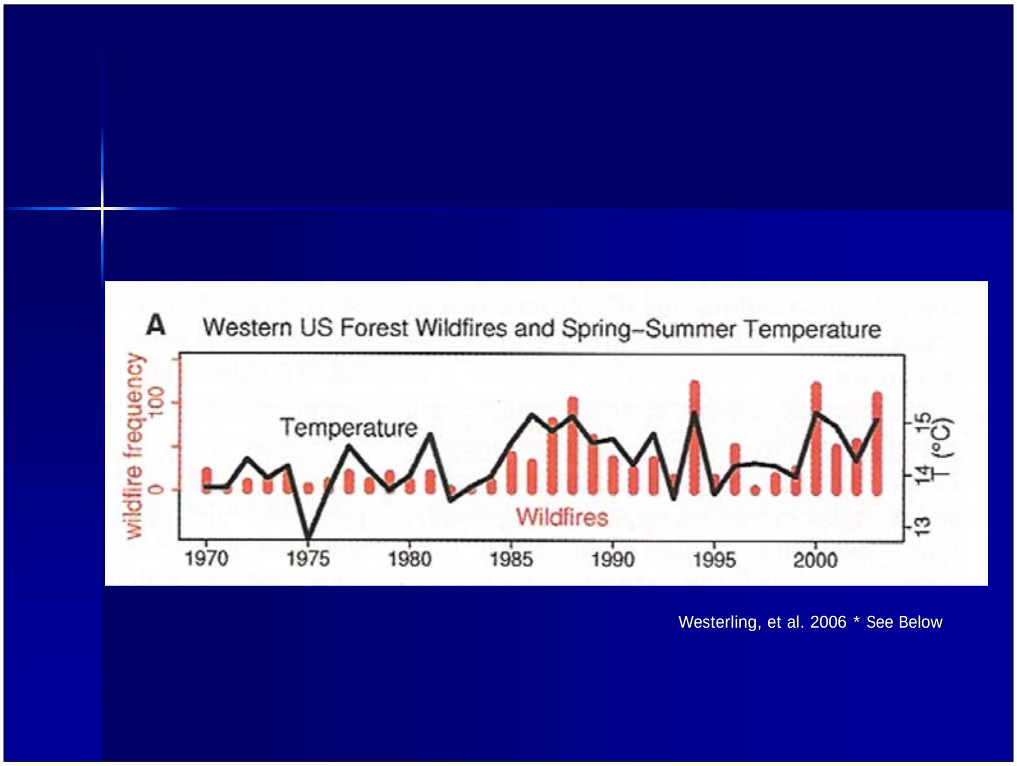
Determination of the actual cause for departures from historical fire regimes is important because it may have a profound effect on the success of management interventions:

1. If departures are due to **land use history** (i.e, fire suppression, forest management practices, etc.), then fuel reduction and ecological restoration make the most sense.

But,

2. If **climate change** is the main driver, then fuel reduction and ecological restoration efforts may be ineffective. A climate-based explanation contends that increased fire frequency and intensity is due to increased variability in moisture conditions, increased drought frequency and increased temperatures.

These explanations, of course, are not mutually exclusive. They may be complementary with increased fire frequency and intensity due to a combination of extreme droughts and an excess of fuel in forests.

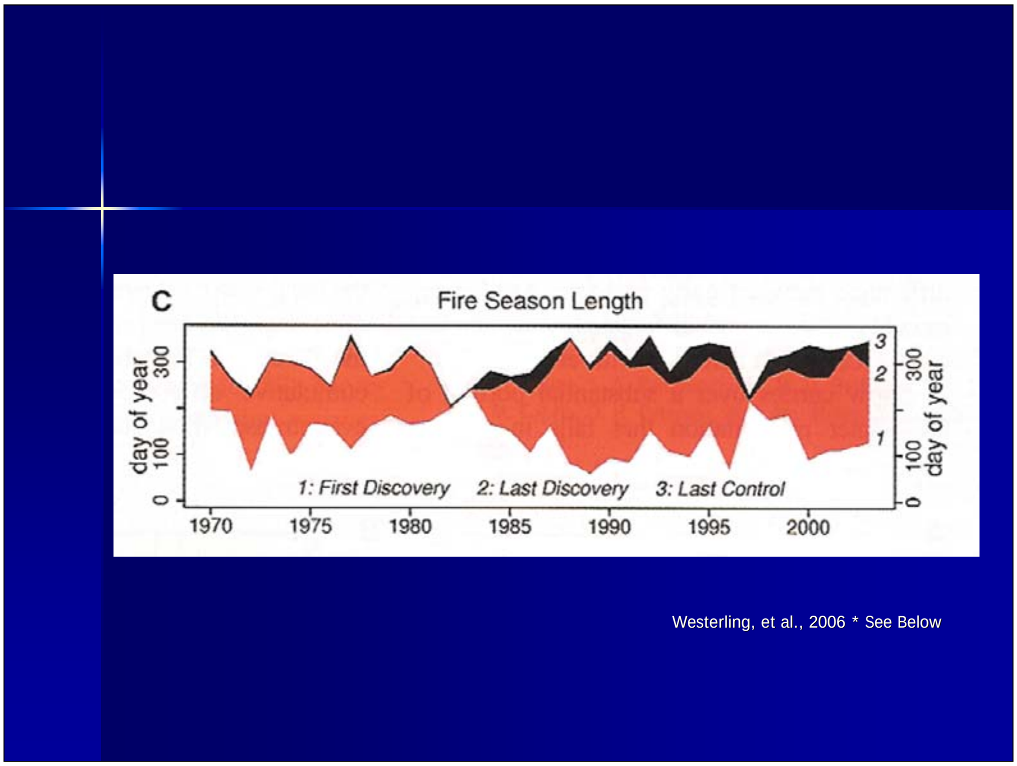


A recent study examines the relationship between climate and the occurrence of major wildfires in the western U.S.:

Westerling, A.L., et al. 2006. Warming and earlier spring increase western U.S. wildfire activity. Science 313:940-943.

The authors examined 1166 large wildfires for 1970-2003 on federal lands in the western U.S. Historical wildfire observations illustrate a rapid increase in frequency and duration beginning in the mid-1980s. This change was correlated with a shift towards warmer spring temperatures, longer summer dry seasons, drier vegetation and longer fire seasons. Reductions in winter precipitation and an earlier snow melt also played a role.

This figure shows some of the data that support these conclusions. The graph illustrates the relationship between the frequency of large wildfires (vertical bars) and spring-summer (March-August) mean temperatures for western United States. Wildfire frequency is strongly correlated ($r=0.76$, $P<0.001$) with spring-summer temperatures, suggesting a climate-wildfire relationship.



Fire season length also increased in the 1980s. Lower value (“1”) on graph indicates date of discovery of first fire that season, “2” indicates date of discovery of last fire that season and “3” indicates date of control of last fire that season. When comparing the time period from 1970-1986 to 1987-2003, fire seasons increased by 78 days (64%). Annual length of fire season was moderately correlated with regional spring and summer temperatures.

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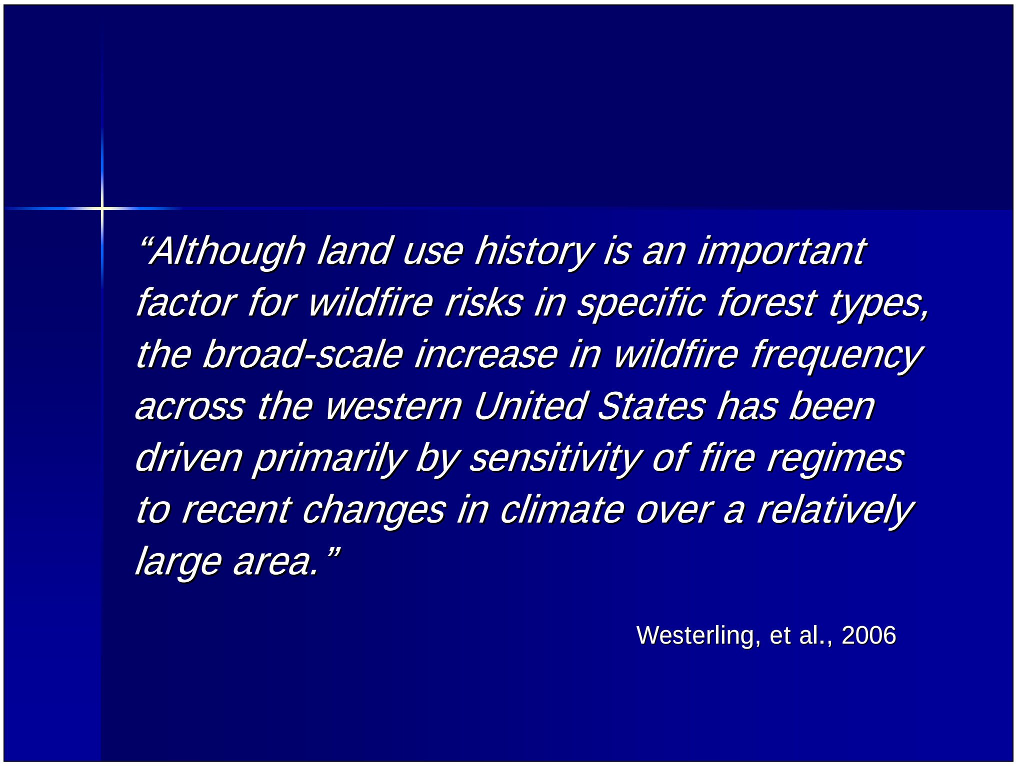


The best predictor of the future is what has happened in the past. This study suggests a relationship between climate and fire frequency in the recent past. If climate change plays out in the West, as predicted by scientists, it is reasonable to assume that drier forests in a warmer environment will experience an increase in fire frequency.

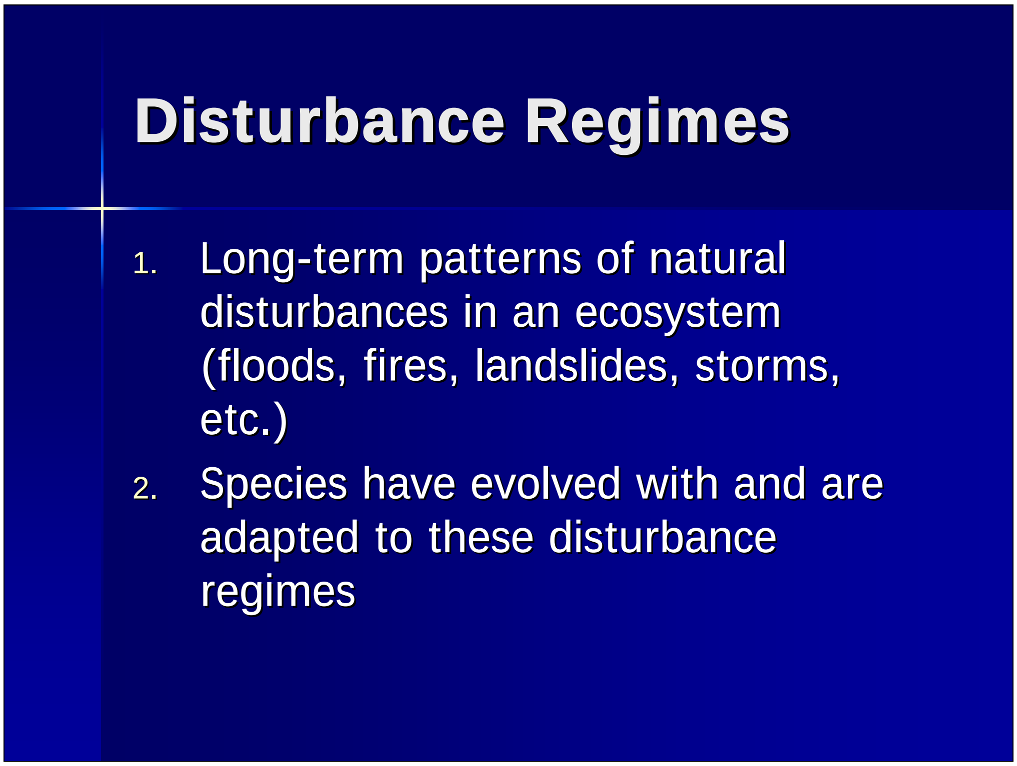
However, the relative impact of climate change and fire suppression varies with region.

For example:

N. Rockies – fire exclusion has not significantly influenced natural fire regimes. Rather, extended summer drought caused by earlier springs and warmer summers creates a greater moisture deficit in vegetation resulting in increased fire risk.

N. California – a combination of both fire exclusion and climate change . Fire exclusion and other activities have created an overabundance of fuels.

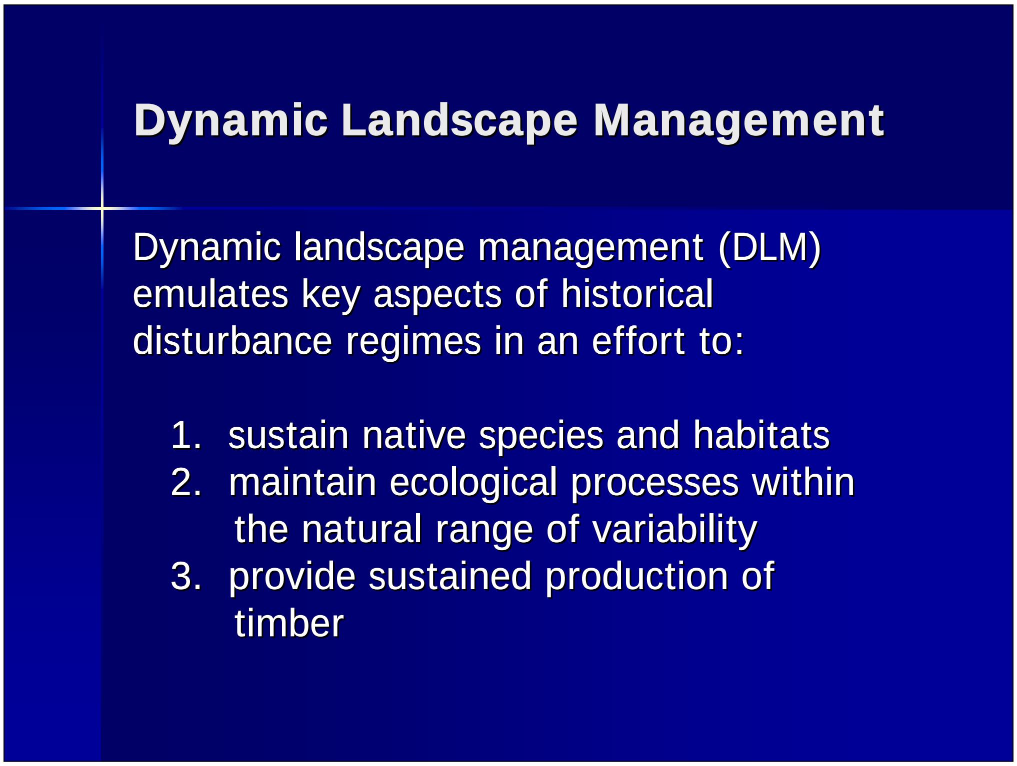
We will now examine how our understanding of historical fire regimes has been incorporated into forest management.



Forests and all of the species they harbor have evolved with disturbance (fires, floods, landslides, storms). Long-term patterns (especially frequency and intensity) of these events are called **disturbance regimes**, which vary significantly from region to region. The historical landscape patterns that we see in forests today are the products of these disturbance regimes (e.g., the distribution of different forest age classes in a landscape). The species that occupy forests are adapted to this disturbance regime.

With the application of ecosystem-based management to public forests, a broader view of forests was required. Many important ecosystem processes such as carbon storage or nutrient cycling occur as a result of an accumulation of events that occur over a network of individual "patches". Each patch is relatively homogeneous (e.g., same age, same species composition, etc.), but different from the area that surrounds it. Individual patches are interconnected by various networks such as the stream network or the road network into a patchwork that is called a **landscape**. Landscapes are usually tens of thousands of acres in size and often are defined by a particular watershed. In simplest terms, a landscape is what you might see from a high vantage point such as in the two photographs seen here in the Oregon Cascade Range. The landscape model of forests has allowed scientists to investigate questions on a much broader scale than previous investigations, which emphasized individual patches or forest stands.

Forest management practices over the past 50 years have created new landscape patterns that are largely unfamiliar to the species that occupy them (e.g., smaller patch sizes, more highly fragmented landscapes, highly roaded landscapes, dominance of early stages of ecological succession, higher edge density). Management activities such as logging, road building, fire suppression, planting and thinning all change landscape patterns. In some areas this has disrupted ecological processes and contributed to the loss of biodiversity in forest ecosystems.

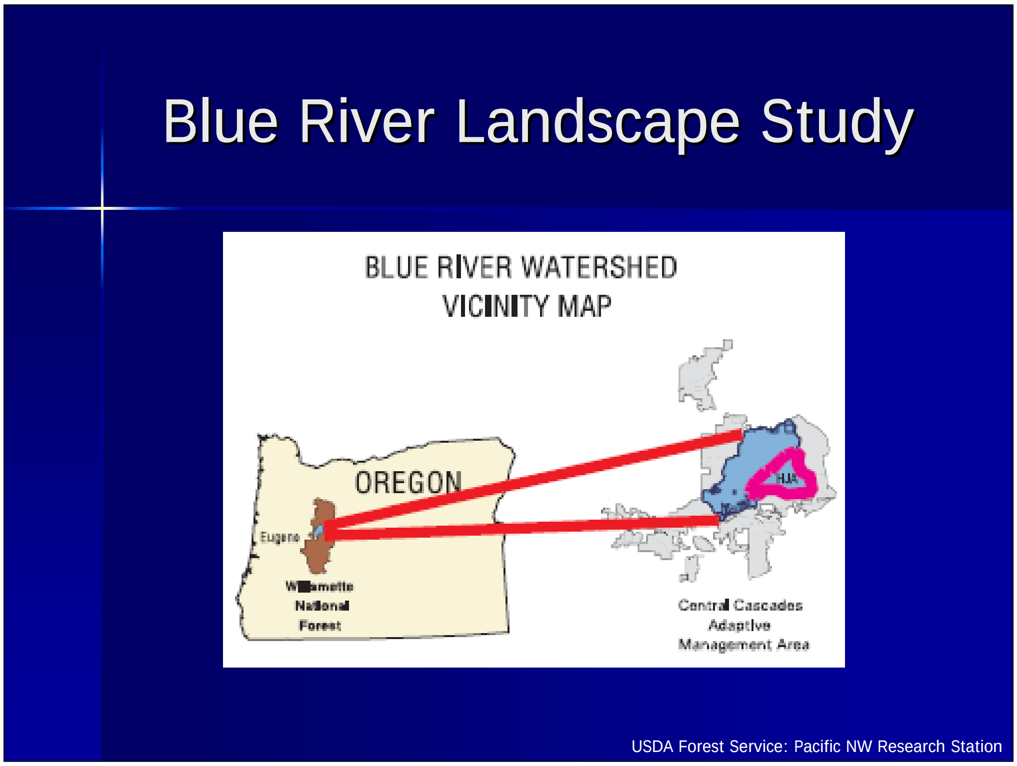


As an alternative, some scientists and natural resource managers are recommending a different approach that recognizes the importance of historical disturbance regimes. The approach has been labeled **dynamic landscape management**. Dynamic landscape management (DLM) emulates key aspects of historical disturbance regimes in an effort to:

1. sustain native species and habitats
2. maintain ecological processes within the natural range of variability
3. provide sustained production of timber

Note that DLM does not attempt to mimic historical disturbance regimes. In many cases, disturbance on this scale (e.g., large, stand-replacement fires) would be unacceptable.

Also, note that dynamic landscape management is consistent with the broader ideals of “ecosystem management.”

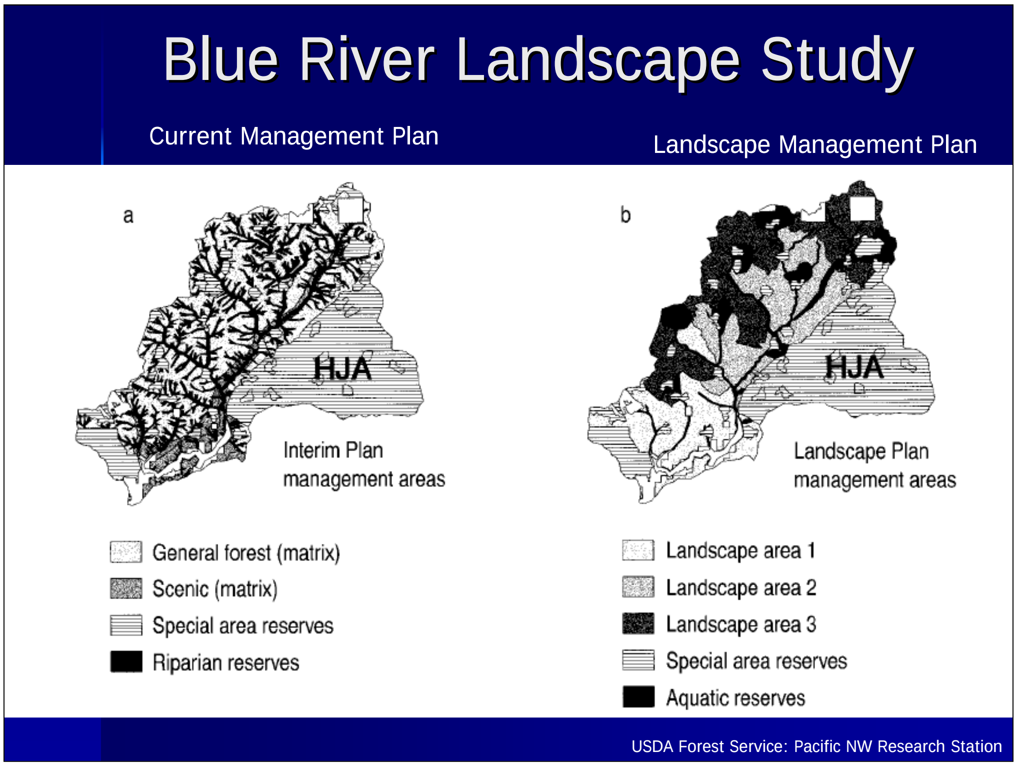


The DLM approach has been implemented at several sites in Oregon. For example:

1. Middle McKenzie Landscape Design (BLM, Eugene District)
2. Middle South Umpqua Vegetation Management Project
3. Blue River Landscape Study – USDA Forest Service

The Blue River Landscape Study will be described as an example of how this approach might be implemented.

The study is being conducted on approximately 57,000 acres of national forest land, including the 15,700-acre H.J. Andrews Experimental Forest ("HJA" in the figure).

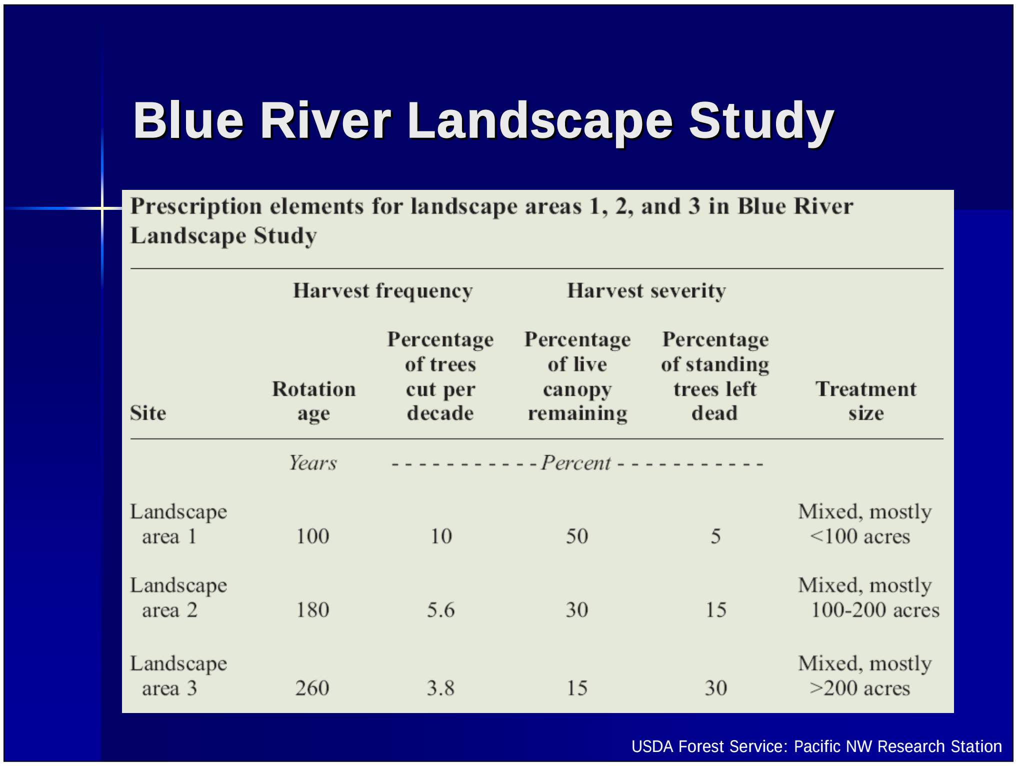


The purpose of the Blue River Landscape Study was to compare the future impacts at a landscape level of two management plans:

1. The Current Management Plan that was designed primarily to protect streams (by establishing riparian reserves) and spotted owls (by establishing late successional reserves)
2. The Landscape Management Plan that was based on historical fire regimes

Fire was the primary historical disturbance agent influencing the distribution of various stand ages in the western Cascade Range. Three landscape areas were identified by researchers based on historical fire regimes. Each area is characterized by a different fire frequency, intensity and amount of area burned.

These three landscapes are illustrated in map “b” in this figure. Map “a” illustrates the landscape resulting from the management plan currently in place for comparison.

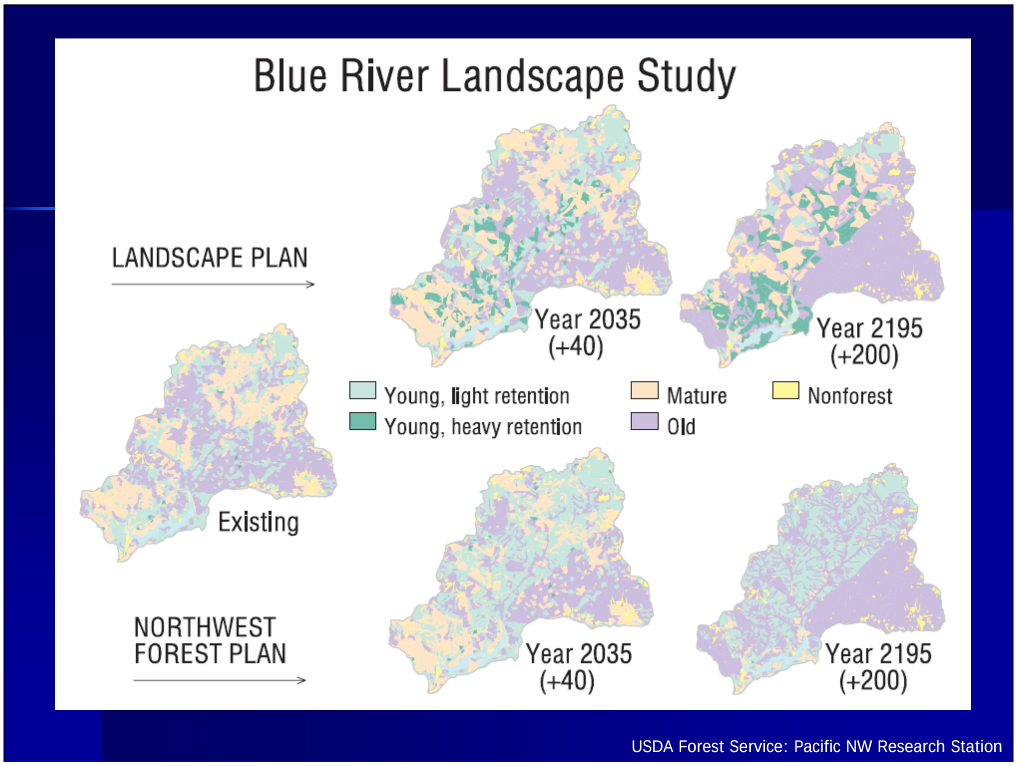


Prescription elements for landscape areas 1, 2, and 3 in Blue River Landscape Study

Site	Rotation age	Percentage of trees cut per decade	Percentage of live canopy remaining	Percentage of standing trees left dead	Treatment size
	Harvest frequency		Harvest severity		
	Years	*Percent*			
Landscape area 1	100	10	50	5	Mixed, mostly <100 acres
Landscape area 2	180	5.6	30	15	Mixed, mostly 100-200 acres
Landscape area 3	260	3.8	15	30	Mixed, mostly >200 acres

Prescriptions (harvest frequency and severity) were then developed for each of the three landscape areas that matched the fire regime for that landscape area. The various rotation ages and corresponding harvest levels in different blocks approximate the historical frequency, severity and extent of fires.

The details of each prescription are given in the table. Note the various elements of these prescriptions (see table).



The map at the left shows the current landscape, which is then compared to implementation of the dynamic landscape plan (top) and the current plan – the Northwest Forest Plan (bottom).

The two result in very different landscapes. How would you characterize these differences?

Comparison of Blue River Landscape Study (BRLS) with Northwest Forest Plan (NWFP), as modeled for 200 years of implementation

Landscape characteristic	BRLS	NWFP[a]
	Percent	
Mature and old forests	71	59
80- to 200-year-old forests	19	3
Live overstory canopy cover in young stands	15-50	15
	Acres	
Mean patch size	119	64

[a] NWFP—matrix lands with 80-year rotation, riparian reserves, and special area reserves such as late-successional habitat reserves.

USDA Forest Service: Pacific NW Research Station

This table quantifies the differences between a DLM plan ("BRLS" in table) and the existing plan ("NWFP" in table) after 200 years of implementation. The Northwest Forest Plan was implemented after the Endangered Species Act listing of the Northern spotted owl in 1990. It was primarily designed to recover owl populations by protecting late successional forests, spotted owl's primary habitat.

Several landscape characteristics are compared after 200 years of implementation of the two plans. The DLM plan results in a higher proportion of the landscape in mid- and late-successional forests and larger patch sizes. Thus, fragmentation and edge effects would be diminished under this scenario. The DLM plan would also provide for more "mature" age-class forests, which would nearly disappear under the NWFP. The NWFP, on the other hand, provides more extensive protection for riparian forests .

The resulting landscape under the DLM plan over the long run will be historically unprecedented, but will be closer to historical conditions than current plans in place. Thus, the stated goals of dynamic landscape management are more likely to be met:

1. sustain native species and habitats
2. maintain ecological processes within the natural range of variability
3. provide sustained production of timber

The approach is representative of a number of current efforts that attempt to manage forest resources by restoring to some degree, historical disturbance regimes. It is hoped by implementing these new approaches, a broader range of values in forest ecosystems will be enhanced.

Photo Credits

- Brown and Smith 2000
- Laboratory of Tree-Ring Research University of Arizona www.ltrr.arizona.edu
- Landcare Research www.landcareresearch.co.nz
- Millennium Ecosystem Assessment www.millenniumassessment.org
- Morrison and Swanson 1990
- NCSR www.ncsr.org
- Science 313:940-943: Westerling, et al. 2006
- The Nature Conservancy www.tncfire.org
- USDA Forest Service www.fs.fed.us
- USDA Forest Service: Pacific NW Research Station / HJ Andrews Experimental Forest www.fs.fed.us/pnw/

Supplemental Lecture Support

NASA World Wind Yellowstone Fires Simulation

NASA World Wind is open source software that provides access to high resolution aerial and satellite imagery. Imagery is available for the entire Earth's surface and layers may be applied for elevation, terrain, vegetation and a number of other features. *World Wind* can be downloaded for free at http://worldwind.arc.nasa.gov. (See NCSR module entitled, "Human Impacts" for details). The user interface features the ability to "search", "navigate", "zoom", "tilt" and "rotate" and to run some canned simulations. One of these simulations depicts the progression of the 1988 Yellowstone National Park fires.

After opening *NASA World Wind*, click on the "**Scientific Visualization Studio"** icon on the main toolbar. Select "**Human Dimensions**" from the menu and then, "**Wildfire Growth around Yellowstone National Park in 1988**". A text box will appear that describes what is being seen in the imagery. Select the "**Background Image for Wildfire Growth around Yellowstone National Park in 1988"** and then, the animation.

The animation is a 30-second continuous loop that illustrates fire progression of the 1988 fires from 30 June to 2 October. Separate ignition points resulting in what were initially separate fires are indicated in different colors. Many of these merge into a single fire that ultimately burned approximately 1.4 million acres. On 20 August, approximately 150,000 acres burned under particularly dry and windy conditions.

The animation is a useful visual to illustrate the progression of a well-studied, catastrophic wildfire. See "Resources" for additional information on the Yellowstone Fires.

Variability of Fire Occurrence in Western Oregon, A.D. 1200 – 2000.

Berkley, E.L., C. Whitlock, P.J. Bartlein and F.J. Swanson. 2002. Temporal and spatial variability of fire occurrence in western Oregon, A.D. 1200 – 2000. Web document available on the Andrews Forest web page: http://www.fsl.orst.edu/lter/pubs/webdocs/reports/orfire.cfm?topnav=55

This document includes an interesting animation of western Oregon fire history from A.D. 1200- 2000. When the web document is loaded, Figure 4 will automatically play the animation. The visual is easily accessible and can be used to illustrate how fire histories, once determined, are displayed and analyzed. The body of the article provides a detailed explanation of what is seen in the animation.

Resources

Print and Web-based Resources

Arno, S.F. and S. Allison-Bunnell. 2002. Flames in our forest - disaster or renewal. Island Press. Washington, D.C. 227 pp.

Arno, S.F. and C.E. Fiedler. 2005. Mimicking nature's fire: Restoring fire-prone forests in the West. Island Press. Washington, D.C. 242 pp.

Agee, J.K. 1993. Fire ecology of Pacific Northwest forests. Island Press. Washington, D.C. 493 pp.

Baskin, Y. 1999. Yellowstone fires: A decade later. BioScience 49(2):93-97.

This article provides a 10-year perspective on the Yellowstone fires in 1988. It is useful as background for the NASA World Wind animation described above (see also, Romme and Despain 1989).

Berkley, E.L., C. Whitlock, P.J. Bartlein and F.J. Swanson. 2002. Temporal and spatial variability of fire occurrence in western Oregon, A.D. 1200 – 2000. Web document on the Andrews Forest web page: http://www.fsl.orst.edu/lter/pubs/webdocs/reports/orfire.cfm?topnav=55

This document includes an interesting animation of western Oregon fire history from A.D. 1200 - 2000 (see figure 4).

Brown, J.K. 1995. Fire regimes and their relevance to ecosystem management. Pages 171-178 *In* Proceedings of Society of American Foresters National Convention, Sept. 18-22, 1994, Anchorage, AK. Society of American Foresters, Wash., D.C.

Brown, J.K. and J.K. Smith (eds.). 2000. Wildland fire in ecosystems: effects of fire on flora. Gen. Tech. Rep. RMS-GTR-42-vol 2. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 257 pp.

This comprehensive review of our state-of- knowledge on the effects of fire on ecosystems is the second in a five-part series entitled "The Rainbow Series". This volume emphasizes fire regimes, the effects of fire on plants and post-fire plant community development. Other volumes evaluate other ecosystem components such as animals, cultural resources, soil, water and air. Paper copies of these documents can be ordered from:

Fort Collins Service Center
Publications Distribution
Rocky Mountain Research Station
240 W. Prospect Rd.
Fort Collins, CO 80526-2098
970-498-1392
rschneider/rms@fs.fed.us
www.fs.fed.us/rm

The 5-part series is also available on-line at:

http://www.fs.fed.us/rm/pubs/rmrs_gtr042_1.html	Effects of Fire on Flora
http://www.fs.fed.us/rm/pubs/rmrs_gtr042_2.html	Effects of Fire on Fauna
http://www.fs.fed.us/rm/pubs/rmrs_gtr042_3.html	Effects of Fire on Cultural Resources
http://www.fs.fed.us/rm/pubs/rmrs_gtr042_4.html	Effects of Fire on Soil and Water
http://www.fs.fed.us/rm/pubs/rmrs_gtr042_5.html	Effects of Fire on Air

Carr, M. 2005. Wildland Waters USDA Forest Service. Summer 2005 FS-828. 22 pp.

This special issue on fire provides an excellent general introduction to the fire issue. Most aspects are briefly addressed including fire regimes, fuels management, restoration, fire responses, salvage logging, and rehabilitation. Links to additional resources are provided.

Cissel, J.H., F.J. Swanson and P.J. Weisberg. 1999. Landscape management using historical fire regimes: Blue River, Oregon. Ecological Applications. 9(4): 1217-1231. (Pub No: 2502)

This document describes how our understanding of fire regimes is being applied to forest management in the Pacific Northwest.

DeGuenni, L.B., et al. 2005. Regulation of Natural Hazards: Floods and fires. Chap. 16 in: Current state and trends assessment. Millenium Ecosystem Assessment Document #285. www.milleniumassessment.org

This is a good source for information on global trends in wildfire frequency.

Joyce, L., R. Haynes, R. White and R. James Barbour, tech coord. 2006. Bringing climate change into natural resource management: proceedings. Gen. Tech. Rep. PNW-GTR-706. Portland, Oregon: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.150 pp.

Landscape Fire and Resource Management Tools Project (LANDFIRE) www.landfire.gov

This joint project of the USDA Forest Service, U.S. Geological Survey and the Nature Conservancy develops maps and data describing vegetation, wildland fuel, and fire regimes across the U.S. Although designed primarily for natural resource managers and planners, instructors who wish to incorporate more detailed fire regime maps into their courses will find this to be a valuable resource.

Morrsion, P.H. and F.J. Swanson. 1990. Fire history and pattern in a Cascade Range landscape. Gen. Tech. Rep. PNW-GTR-254. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 77 pp.

This Forest Service report describes the reconstruction of a fire history from the Cascade Range of Oregon. Methods based on fire scar analysis are clearly described.

Noss, R.F., J.F. Franklin, et al. 2006. Managing fire-prone forests in the western United States. Front. Ecol. Environ 4(9):481-487.

This is an excellent review of the literature on the ecology and management of fire-prone forests in the western United States. The article and the references cited within should provide faculty with a comprehensive understanding of this complex issue. It has also been posted on-line by the Ecological Society of America at: www.frontiersinecology.org.

Nowacki, G.J. and M.D. Abrams. 2008. The demise of fire and "mesophication" of forests of the eastern United States. BioScience 58(2): 123-138.

Fire issues are not restricted to the western U.S. Instructors from east of the Mississippi River will find this article on altered fire regimes of interest.

Pinchot, G. 1899. The relation of forests and forest fires. Nat. Geo. 10:363-403

This is one of the earliest accounts of the relationship between forests and wildfire by one of America's prominent foresters of the time.

Pyne, S.J. 2005. Tending fire. Island Press. Washington, D.C. 240 pp.

This book by a prominent wildfire researcher provides an in-depth evaluation of both fire suppression and "let burn" policies.

Rapp, V. 2002. Dynamic landscape management. USDA Forest Service, PNW Research Station, Portland, Oregon. Science Update #3,. 11 pp. www.fs.fed.us/pnw

This document describes how our understanding of disturbance regimes (including fire) is being applied to forest management in the Pacific Northwest.

Romme, W.H. and D.G. Despain. 1989. The Yellowstone fires. Sci. Am. 261(5):37-46.

This article provides a thorough review of the events leading up to and the immediate aftermath of the Yellowstone fires in 1988. It is useful as background for the NASA World Wind animation described above (see also Baskin, 1999).

Smith, H.Y. and S.F. Arno (eds.). 1999. Eighty-eight years of change in a managed ponderosa pine forest. Gen. Tech. Rep. RMRS-GTR-23. Ogden, Utah. USDA Rocky Mountain Research Station. 55 pp.

This Forest Service publication describes ecological changes associated with forest management and fire suppression since the early 1900s in a ponderosa pine forest. Changes are documented in a series of repeat photographs taken at 13 photopoints from 1909 to 1997. The authors discuss the effects of past management practices and recent ecosystem-based management treatments.

Selected photos included in this document were used to produce a 1996 USDA Forest Service poster designed to illustrate the impacts of fire exclusion on ponderosa pine ecosystems. In this poster, a 1909 photograph is used to illustrate the historical condition of ponderosa pine forest on the Bitterroot National Forest in Montana. The photo was later found to represent a cleanup operation after a timber sale. See module for more details.

Weisberg, P.J and F.J. Swanson. 2003. Regional synchroneity in fire regimes of western Oregon and Washington, USA. Forest Ecology and Management 172:17-28.

This study is an example of how an analysis of fire scars can be used to reconstruct fire histories.

Westerling, A.L., et al. 2006. Warming and earlier spring increase western U.S. wildfire activity. Science 313:940-943.

This study examines wildfire data from the western U.S. and finds a correlation between large wildfire frequency and duration and increased spring and summer temperatures. The results have implications for our understanding of the relationship between global climate change and wildfire risk.

Video Resources

Biscuit Fire. 2003. Oregon Field Guide. Oregon Public Broadcasting, Portland, Oregon. 30 min.

This special production by Oregon Field Guide examines wildland fire issues related to the 2002 Biscuit Fire in southwest Oregon and northern California. Several perspectives are presented including those of the USDA Forest Service, the timber industry, fire ecologists and environmental groups. Although the details may differ, most of the issues associated with the Biscuit Fire also pertain to wildfires across the West.

Fighting Fire with Fire. 2005. The Nature of Things, Canadian Broadcasting Company. Distributed by:

Bullfrog Films
P.O. Box 149, Oley, PA 19547
800-543-3764
www.bullfrogfilms.com

This 45-minute production narrated by David Suzuki provides an excellent introduction to our current thinking on fire management. Although the emphasis is on fire issues in Banff National Park and Yellowstone National Park, the concepts discussed may be broadly applied across the West. The influence of past fire fighting policy, the current condition of western forests, thinning and prescribed fire, the ecological role of fire, and the implications of global climate change are all examined.

Adaptation

Instructors are encouraged to customize NCSR modules with additional examples, issues and resources from their own geographical region. Several resources suggested for adaptation to the upper Midwest (Lake states) are cited below.

Print and Web-based Resources:

Heinselman, M.L. 1973. Fire in the virgin forests of the Boundary Waters Canoe Area, Minnesota. Quaternary Research 3:329-382.

Heinselman, M.L. 1981. Fire intensity and frequency as factors in the distribution and structure of northern ecosystems. Pages 7-57 in Proceedings of fire regimes and ecosystem properties. USDA Forest Service General Technical Report GTR WO-26.

Heinselman, M.L. 1996. The Boundary Waters Wilderness ecosystem. University of Minnesota Press, Minneapolis, Minnesota. 334 pp.

An easily readable resource with many photographs and maps of fire history of this 2 million acre wilderness area.

Franklin, J.F., R.J. Mitchell and B.J. Palik. 2007. Natural stand development and stand development principles. USDA Forest Service, Northern Research Station, NRS 19.

Franklin, J.F. , et al. 2008 (in press). Natural disturbance and stand development-based silviculture for ecological forestry. www.jones.org/education_and_outreach/defining_ecological_forestry/naturaldisturbance_draft.pdf

Minnesota Department of Natural Resources. 2003. Field guide to the native plant communities of Minnesota – Laurentian mixed forest. 352 pp. www.dnr.state.mn.us

This guide to Minnesota forest plant communities includes detailed information on the disturbance histories.

Video Resource:

Minnesota – A History of the Land – Part 5 The Northern Forest 1910s – Early 21st Century. 2007. University of Minnesota, Minneapolis, Minnesota

The History of the Land *video series is an in-depth treatment of natural resource issues in the state of Minnesota. Part 5 examines the work of Bud Heinselman, the first scientist to record a detailed fire history of a North American ecosystem. This is an excellent look at how scientists study fire history.*

Order from:

Bell Museum of Natural History
University of Minnesota
Minneapolis, MN 55455
612-626-4440
www.historyoftheland.org