Pacific Northwest Research Station

Science Update

FIRE RISK IN EAST-SIDE FORESTS

Tom Iraci

IN SUMMARY

Wildfire was a natural part of ecosystems in east-side Oregon and Washington before the 20th century. The fire regimes, or characteristic patterns of fire—how often, how hot, how big, what time of year—helped create and maintain various types of forests.

Forests are dynamic, and fire interacts with other ecological processes. Fires, forests, and their interactions are closely studied by scientists from the USDA Forest Service Pacific Northwest (PNW) Research Station and their partners.

Over the past century, land use and land management practices changed fire regimes in east-side forests, particularly in dry, low-elevation forests that were historically dominated by large, widely spaced ponderosa pines.

Now, in the 21st century, the extent of high-severity fire regimes exceeds that of low-severity fire regimes in east-side forests. The forests most likely to have changed from low- to high-severity regimes are also those forests near human communities.

Fires can pose risks to people and their communities, even though fires may be a natural part of the ecosystem in which those people happen to live.

A variety of passive and active restoration options can be used to manage—but not eliminate—fire risk. Scientists offer information about the outcomes of these choices.

See inside for scientific perspectives on fire risk in east-side forests.

United States Department of Agriculture

Forest Service

Pacific Northwest Research Station

www.fs.fed.us/pnw

Issue 2

September 2002

What was the historical fire risk in eastern Oregon and eastern Washington?

The concept of fire risk includes human values. Fire risk to people will exist even if fire is a completely natural part of the ecosystem where some people happen to live.

And, in fact, fire is natural. Wildfire was a normal part of most east-side ecosystems before the 20th century and helped to create and maintain those ecosystems. Forests have always burned. The proof is in the ways that trees and shrubs have adapted to fire. Trees die, but forests don't.

Andy Youngblood

Large ponderosa pines have a thick, corky bark that insulates better than asbestos of equal thickness. A mature ponderosa pine can survive an hour of moderate-intensity fire at its base—the type of surface fire that was most common in ponderosa pine forests for hundreds and, perhaps, thousands of years.

Purpose of PNW Science Update

The purpose of the *PNW Science Update* is to contribute scientific knowledge for pressing decisions about natural resource and environmental issues.

PNW Science Update is published several times a year by:

Pacific Northwest Research Station
USDA Forest Service
P.O. Box 3890
Portland, Oregon 97208
(503) 808-2592

The Pacific Northwest Research Station mission is to generate and communicate scientific knowledge that helps people understand and make informed choices about people, natural resources, and the environment.

Send comments to:

Valerie Rapp, writer and editor
vrapp@fs.fed.us

Send change of address information to
pnw_pnwpubs@fs.fed.us

Fire regimes varied in the diverse ecosystems of eastern Oregon and Washington (see table 1). Historically in the ponderosa pine forests, fires were frequent, which kept fuel loads low, and most fires were low-severity surface fires. Although large pines often survived surface fires, some young trees were killed in each fire. The result was an open forest with large trees, scattered small trees, and an open understory of native grasses and a few shrubs. Large ponderosa pines often survived for hundreds of years. These dry, ponderosa pine

Seward and Todd. From private collection of Senator Gordon McKay.

Frequent, low-severity fires helped create old-growth ponderosa pine forests, such as this one near Bend, Oregon, in the early 20th century.

Key Findings

- Over the past century, land use and land management activities have changed disturbance regimes in east-side forests, particularly in dry, low- and mid-elevation forests that were historically dominated by large, widely spaced ponderosa pines.
- The extent of high-severity fire regimes now exceeds that of low-severity fire regimes in east-side forests. The forests that are most likely to have changed from low- to high-severity regimes are also the forests near human communities.
- Computer models estimate that if dry forest areas of equal size with the same fuel loading were burned by wildfire and prescribed fire, the wildfires would produce nearly double the amount of particulate emissions.
- Under an active restoration approach, with the most optimistic assumptions, east-side forests with large, widely spaced ponderosa pines and Douglas-firs could at best be increased to about two-thirds of their historical abundance over the next century.
- Introduced diseases such as white pine blister rust, introduced nonnative plant species such as cheatgrass and spotted knapweed, and possible climate changes, among other factors, make it impossible to exactly replicate historical forest ecosystems.

Table 1—Summary of east-side fire regimes

Zone	Forest type	Historical fire regime[a]	Missed fire-return intervals (average)	Summary of ecological changes
Low elevation, dry climate	Ponderosa pine dominant	Frequent to very frequent, low-severity—burned some or most forest floor plants and litter, some small trees killed, most overstory trees survived	Several to many	Decline in area and connectivity of late-seral (old or mature), openly spaced forests. Increase in densely spaced multilayer forests. Fire regime is generally high severity. Increased competition for moisture and nutrients because of increased tree densities. Changes in species composition.
Mid elevation, transitional climate	Mixed conifers, many variations	Mixed fire regimes resulted in various forests—varying amounts of understory and overstory trees killed	Variable	Increase in area and connectivity of mid-seral (intermediate-aged) forests. Area of late-seral forests well below historical levels. Some changes in species composition. Fire regime is generally high severity.
High elevation, cold, moist climate	Lodgepole pine dominant	Infrequent return; high-severity, stand-replacement fires—all or most trees killed in both overstory and understory	One or more	Increased insect and disease mortality in old lodgepole pine forests. Higher fuel levels and increased fire susceptibility.
High elevation, cold, moist climate	Subalpine fir	Infrequent return; high-severity, stand-replacement fires—all or most trees killed in both overstory and understory	Less than one	Slight to significant shift from early-seral (young) stages to late-seral forests, depending on geographic area.

[a] Some publications describe fire severity classes as nonlethal, mixed, and lethal. These terms can be misleading. The nonlethal, or low-severity, fire in fact kills some trees, plants, and animals. The lethal, or high-severity, fire does not kill all trees and animals; some trees resprout, patches of trees often survive, and many animals flee or take refuge underground.

forests were extensive at low to mid elevations in the Blue Mountains, eastern and southeastern Oregon Cascade Range, upper Klamath area, Ochoco Mountains, eastern Washingon Cascade Range, and the Okanogan Plateau.

A variety of mixed-conifer forests grew in the moister, transitional zone between dry forests and high-elevation forests. Douglas-fir, white fir, and grand fir dominated forests in this zone. Fire-return intervals ranged from 40 to 100 years, and fire intensities ranged from crown fires to low-intensity surface fires. A mosaic of fire effects covered the landscape. Some fires killed most or all trees, whereas others left patches of living and dead trees behind.

In a few places, mostly at higher elevations, intense fires at 100- to 200-year intervals perpetuated extensive lodgepole pine forests. When no major fires occurred for more than 200 years, much of the lodgepole pine succumbed to mountain pine beetle attacks, and more shade-tolerant species such as grand fir and white fir became dominant.

At high elevations, Englemann spruce, subalpine fir, western larch, and other species became dominant. The climate was cold and fires infrequent. When fires did occur, they often killed most or all trees across large areas.

Fire was just one disturbance process in east-side forests. Other ecological processes also affected forest development, and these forces interacted with each other. Of all the factors that have affected forests, both in the past and now, one of the most important is people.

Fire Terminology

Fire frequency—Return interval.
0-25 years—Very frequent.
26-75 years—Frequent.
76-150 years—Infrequent.

Fire intensity—Heat released per unit length of fireline, during a fire.
Low intensity—Average flame length of less than 3 feet.
Intermediate intensity—Average flame lengths between 3 and 9 feet.
High intensity—Average flame lengths above 9 feet, or flames enter tree crowns extensively, or both.

Fire regime—Characteristic combination of fire frequency, intensity, seasonal timing, and fire size in an ecosystem.

Fire severity—Damage to ecosystems. Assessed in many ways, such as percentage of trees killed and soil char.

USDA Forest Service

Fire-resistant ponderosa pine and western larch had the greatest commercial value and were most likely to be removed.

Have the disturbance regimes changed in eastern Oregon and Washington?

Yes. Although people have been a factor in east-side disturbance regimes for thousands of years, their influence changed. Native Americans set fires to clear brush and produce forage, and the historical regimes included these fires. In the 1800s, early settlers brought a different culture into east-side ecosystems, changing disturbance regimes dramatically.

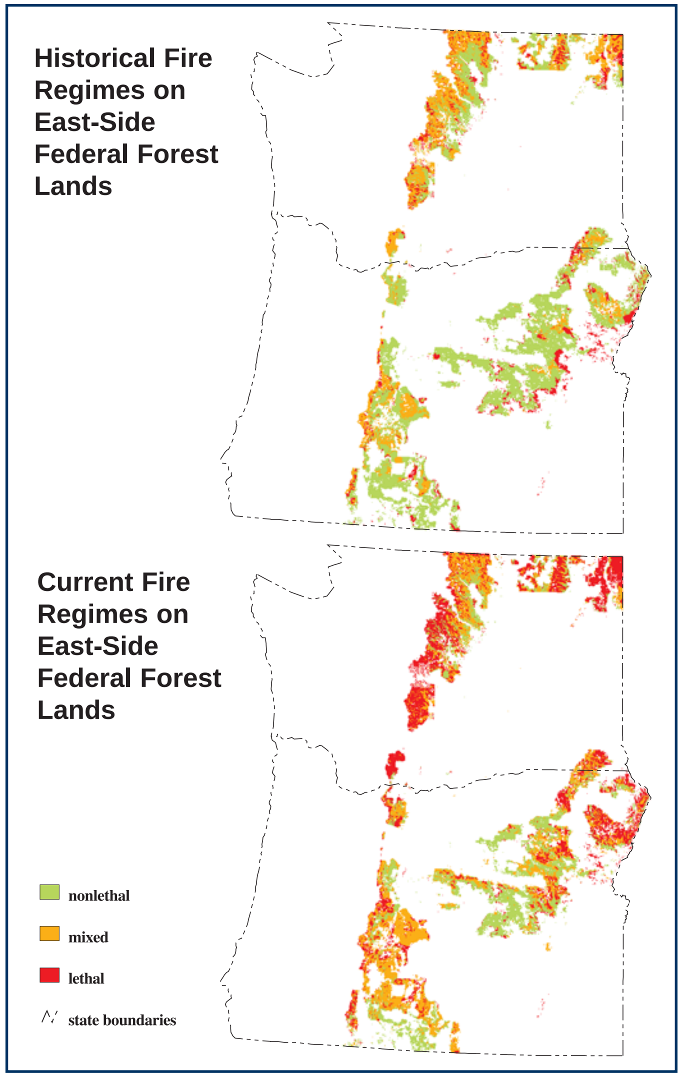
The main changes occurred over the past century.

- **Fire suppression.** The Forest Service and other agencies began fighting fires early in the 20th century. Early suppression efforts were limited. As the century advanced, firefighting included retardant planes, smokejumpers, and helitack crews; water tenders, pumps, and hoses; and better road access, allowing crews and equipment to reach fires faster, thereby suppressing most fires while they were small.

- **Fire exclusion.** Traditional Native American burning was eliminated. In some areas, the loss of native grasses from livestock grazing eliminated fine fuels that helped fires spread. Road networks and irrigated fields created fire breaks.

- **Timber harvest.** The most common approach was to log the biggest and best trees and leave smaller trees to grow.

- **Livestock grazing.** Cattle and sheep were moved on to the rangelands in greater numbers than the native deer, elk, and antelope had ever reached, and stayed for extended periods. When overgrazed native grasses could not grow back successfully, shrubs and nonnative grasses were likely to grow. These plants presented a different fuel loading and different fire regime from native grasses.



PNW Research Station

Before settlement by nonindigenous people 150 years ago, most fires in low- and mid-elevation forests were nonlethal or low severity (green areas on map of historical fire regimes). Lethal (high-severity) and mixed-effects fire regimes (red and orange areas on map of current fire regimes) now exceed low-severity fire regimes on federal forest land in eastern Oregon and Washington.

- **Introduction of nonnative plant species.** Nonnative plants such as knapweed and cheatgrass changed ecosystems and are now irrevocably established. An accidentally imported tree disease, blister rust, killed most five-needled pines, changing the species composition of many east-side forests.

Early settlers intended for their changes to improve the land. Foresters wanted younger and more vigorous forests, and ranchers wanted more grass. Fire suppression and selective logging were meant as conservation measures. But all these individual activities, and the synergy of these actions, led to major changes in disturbance regimes across the landscape.

The two maps above show the magnitude of the changes in east-side fire regimes; the maps do not predict where fires will actually occur. The widespread change to more severe regimes, however, indicates that the potential for large, stand-replacement fires is far greater than the estimated conditions a century ago.

Bill Hopkins

This contemporary dry forest still has big pines, but mid-sized and small trees create multiple layers. Native shrubs such as bitterbrush are prevalent over grasses.

What are the consequences of the changes in fire regimes?

Changed disturbance regimes have moved east-side forests to new trajectories in forest development. "Fire regimes that exist today are uncharacteristic for the east-side and related climate regimes," comments Paul Hessburg, a research plant pathologist for PNW Research Station.

With heavy ground fuels and high tree densities, these dry forests are now much more likely to have severe fires—and they are also the most common forest type near people's homes on the east side.

Of all east-side forests, dry forests have changed the most. In old or mature (late-seral) ponderosa pine forests, multilayered, mixed-conifer understories are now more widespread than historically. Tree densities are much higher, and the mix of dominant tree species changed in many places. Timber harvest reduced the number of large ponderosa pine and larch. Branches, fallen trees, and ground litter have accumulated. Less of the forest floor is covered by grasses and herbs.

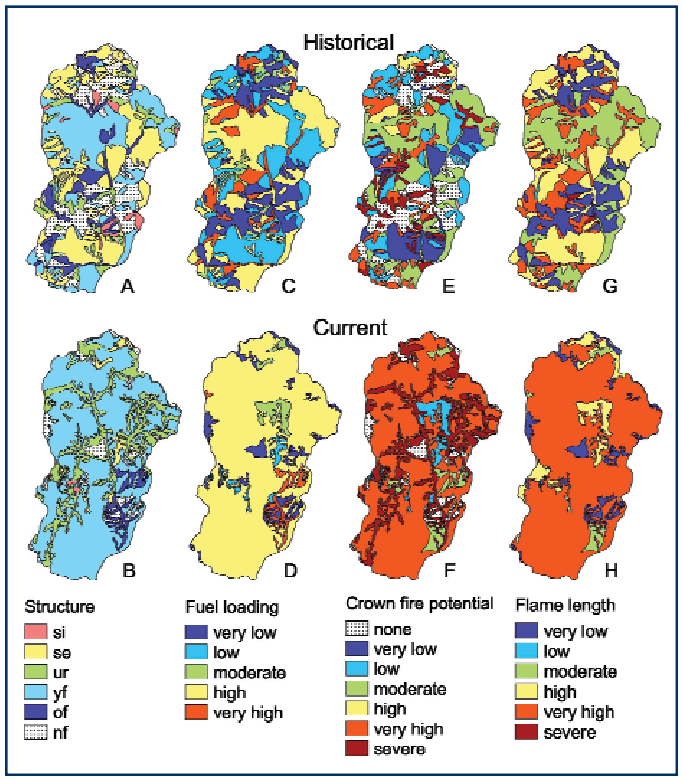
Many dry forests have now missed 7 to 10 fire-return intervals, compared to their historical fire regimes. With heavy ground fuels and high tree densities, these dry forests are now much more likely to have severe fires—and they are also the most common forest type near people's homes on the east side.

Ponderosa pine cover has decreased in many dry forests, and Douglas-fir cover has increased in the Blue Mountains, Columbia Plateau, and northern Cascade Range. Grand fir cover has increased in some areas. In the eastern Cascade Range, dry forests changed from white-headed woodpecker and flammulated owl habitat to spotted owl habitat. Multilayered spotted owl habitat used to be uncommon on the eastern slope of the Cascade Range, found only in scattered fire refugia among the dry forests.

At high elevations, cold, moist forests had long fire-return intervals. Many of these forests have not yet missed one complete fire cycle, and their development has not yet diverged significantly from historical trajectories.

New fire regimes will be unlike those of either the historical past or the 20th century.

Enough east-side forests have changed so that new patterns are becoming apparent across large landscapes. In general, the area covered by old forests has declined across much of the east side, with the greatest declines in the Blue Mountains, northern Cascade Range, and upper Klamath Basin. Mature forests of large, widely spaced trees have declined more than 50 percent from historical levels, as estimated on Forest

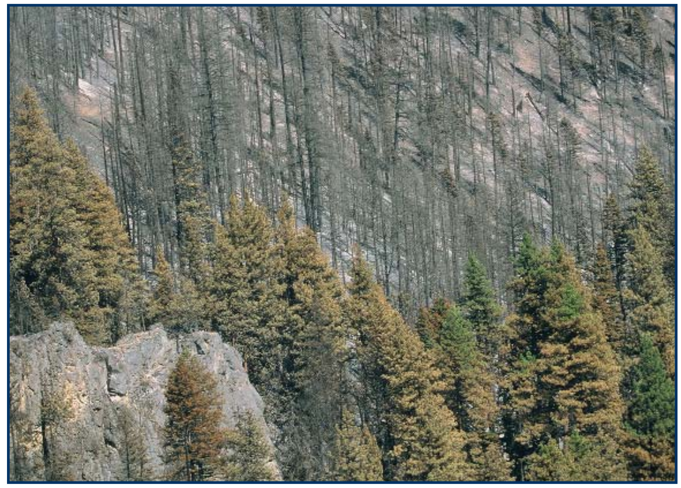


Paul Hessburg and Brion Salter

Changes between historical and current conditions in subwatershed 55, Lower Grand Ronde subbasin, in the Blue Mountains.
A & B: Structural classes. *Abbreviations are si = stand initiation; se = stem exclusion (both open and closed canopies); ur = understory reinitiation; yf = young multistory forest; of = old multistory and single-story forest; nf = nonforest.*
C & D: Fuel loading. *Classes are very low 0-10.0 tons/acre; low = 10.1-20.0 tons/acre; moderate = 20.1-25.0 tons/acre; high = 25.1-30.0 tons/acre; and very high = >30.0 tons/acre.*
E & F: Crown fire potential. *A comparative index.*
G & H: Flame length. *Classes are very low < 2 feet; low = 2-3.9 feet; moderate = 4-5.9 feet; high = 6-7.9 feet; very high = 8-11 feet; and severe > 11 feet.*

Tom Iraci

Extreme fire behavior is dangerous for firefighters and the public. Hash Rock Fire, Ochoco National Forest, August 2000.



Tom Iraci

Hot fires can damage soils, sometimes with substantial effects on long-term productivity.

Service and Bureau of Land Management land in the interior Columbia basin. Middle-aged forests, less than 100 years old, are substantially more common than they were historically.

These changes, set in motion partially by changed fire regimes, are gathering their own momentum. New fire regimes will be unlike those of either the historical past or the 20th century.

Not only is more of the landscape now in high-severity fire regimes, but the forests with high-severity regimes are more likely to be connected to each other. The increased continuity of fuels across the landscape means that when fires do occur, they are more likely to grow into large fires.

Miles Hemstrom, research ecologist for the PNW Research Station, comments, "These different fire regimes affect things that matter to people—like homes and property, wildlife habitat, aesthetic values, and clean water."

The changed forest conditions and fire regimes have cascading effects. Although insect and disease activity has always been part of forests, east-side forests are now vulnerable to unusually large outbreaks. Large, widely spaced trees can resist many types of insect and disease attacks, but stressed trees in dense stands, including previously resistant large trees, are more vulnerable. Dead trees are potential fuel for fires.

Fires affect every forest resource.

Forest floor. Light surface fires can make more nitrogen available in the soil, but this effect lasts only about a year. The newly available nitrogen is easily lost through leaching and erosion. Hot fires volatilize soil nutrients, especially nitrogen, and significant amounts of soil nutrients can be lost. In dry forests, soil nutrients accumulate very slowly, and losses through intense fires can have dramatic effects on forest productivity.

Soil. Severe fires often create water-repellent soils. If heavy rain falls on damaged soils, more water will flow rapidly overland instead of being absorbed. Not only is the water lost to the soil, but the overland flows are likely to erode soil and carry sediment into streams.

Tom Iraci

Severe wildfires can kill all streamside vegetation, with negative effects on water quality and aquatic life.

Waterflow regimes. Changes to waterflow regimes are difficult to quantify. Trees and ground cover slow the movement of water through a catchment, holding it for plants to use and preventing erosion. However, in dry east-side watersheds, the dense tree cover that grows in the long absence of fire can use so much of the available water that streamflows may be reduced.

Wildlife. Few large animals die in wildfires. But fires change habitats, and intense fires change habitats most dramatically. Raptors such as red-tail hawks benefit because hiding cover is reduced and their prey animals are more exposed. Insects that bore into fire-killed trees can have population explosions, providing a rich food source for insect-eating birds. Bark beetles kill some surviving trees. After a fire, grasses and other palatable plants often increase, benefiting grazing animals such as elk and deer for several years.

Tom Iraci

Hash Rock Fire, August 2000. Severe fires kill most or all trees across a large area.

Animals are best adapted to survive the fire regimes that were characteristic for their habitats over the last several thousand years.

Human communities. The forests most likely to have changed from low- to high-severity fire regimes are dry, low- or mid-elevation forests—also the forests generally near human communities. Intense wildfires can burn homes in and near the forest. If houses are saved but the surrounding area burned, the sense of place that made the area desirable can be diminished. Because of high fuel loads, these fires can be very difficult and dangerous for firefighters to control.

Are there options for reducing fire risk in the interior Columbia basin?

People tried to eliminate fire damage by fighting fires. But these well-intended efforts only succeeded in changing disturbance regimes in unforeseen ways.

The new fire regimes may threaten the diversity and long-term productivity of many east-side forests. Also, the new fire regimes may be very unstable. "Changes of this magnitude are difficult to stop or reverse," comments Hemstrom.

To restore these dynamic ecosystems, people would need to address the factors that degraded them in the first place. A variety of passive and active restoration options are possible.

Passive restoration—stop fire suppression activities and let ecological processes as they are today operate.
Passive restoration is defined as removal of the stresses that caused degradation—in this case, stop aggressive fire suppression. Under this scenario, most wildfires ignited by lightning would be allowed to burn. Firefighters would protect homes to the extent possible. On the rest of the landscape, wildfires would burn unobstructed.

However, with forests in high-severity fire regimes now widespread across the landscape, the consequences would be that many wildfires would burn big and hot. The forests are not the same as they were 150 years ago, and fires would not behave the same. Hessburg points out, "Just because lightning starts the fires in no way implies that fire behavior and fire effects will be anything like natural."

Large, high-intensity fires could severely affect people and communities in and near forests. The smoke produced would cause long periods of poor air quality.

"It's a dangerous idea that we should just let wildfires burn naturally and things would be fine," Hemstrom says. "Maybe in 200 years that would be so, but for decades it would be ugly in terms of our values."

Passive restoration, or letting some wildfires burn, is most likely to succeed ecologically (and be socially acceptable) in forests that historically had stand-replacement fires and long fire-return intervals, such as subalpine fir, western hemlock, and Pacific silver fir forests.

Active restoration—continue to manage forests, but use new approaches.
Active restoration uses a variety of management techniques. In the case of fire risk, most choices involve fuel reduction. The argument for active restoration is that passive restoration would likely be ineffective in highly degraded ecosystems. People and their communities are also at risk in many east-side locations, so passive restoration could be dangerous in these places.

Management options examined at the stand level

At the stand level, management options to reduce fire hazard include prescribed fire and various thinning treatments, and combinations of these treatments, carried out at intervals over the years. Like any disturbances, prescribed fires and thinnings will interact with other events such as grazing, floods, and insect infestations.

Prescribed fires can reduce fuels and fire hazard. These fires are usually carried out when fuel moistures are moderate, such as spring or late fall, and generally burn with a lower intensity than wildfires. Fine fuels are burned, but most large fuels are only charred. Because prescribed fires are less intense and less severe than most wildfires, they are less likely to damage soils and kill overstory trees.

Prescribed fires also generate less smoke and consequently fewer particulate emissions than wildfires. Wildfires burn most of their acres in summer, when fuels are very dry, and severe wildfires consume live trees, large logs, and the duff and litter layers.

In September 1995, lightning started a fire in the Mill Creek Wilderness on the Ochoco National Forest in central Oregon. The fire was allowed to burn as a prescribed natural fire and was closely monitored with some light suppression tactics over the next two weeks. The fire burned approximately 1,300 acres. In most areas, the fire burned at light to moderate intensities (mixed or low-severity effects). Flames torched some trees or made small crowning runs in places. The top photo, taken the next summer after the fire, shows an area burned by the fire. Fire effects on resource values generally were considered positive for this area.

Five years later, in August 2000, lightning ignited a fire near the old Mill Creek Fire. The new Hash Rock Fire burned intensely in very dry, windy conditions and eventually burned approximately 45,000 acres. Firefighters fought the fire aggressively, but extreme fire behavior made suppression dangerous and near impossible. The Hash Rock Fire dropped from a crown fire to a ground fire when it encountered the area previously burned in the Mill Creek Fire, most likely because of the reduced fuel loads (bottom photo). The previously burned area is on the right in the photo. Most overstory trees in the natural prescribed fire area survived both fires. Other cases have been reported in the Western United States where fuel treatment or prescribed fire reduced subsequent fire severity when wildfires occurred within 10 years. *Photos: Tom Iraci*

Tom Iraci

Firefighter lights ground fuels in prescribed underburn on the Colville National Forest, April 2001.

Because you cannot burn the same acres twice (with the same fuel load), scientists have to use computer models to compare the smoke produced by prescribed fires and wildfires. In a modeled comparison of wildfire and prescribed fire-thinning regimes in an example watershed in the Grande Ronde basin in northeastern Oregon, scientists found that wildfires would produce nearly double the amount of PM10 emissions, if these fires burned the same acres. (PM10 is particulate matter with a median diameter of 10 micrometers —a measure of the suspended particulates in smoke.)

Also, prescribed fires are ignited when weather patterns carry most smoke away from heavily populated areas. Although managers cannot eliminate all impacts of smoke, prescribed burning can greatly reduce the total emissions and minimize impacts on cities. Hessburg points out, "The question on the table is not whether there will be fire and smoke in the future, but how do citizens want their fire and smoke?"

Thinning treatments are another management option. Treatments fall into four main types: thinning from below, thinning from above, selection thinning, and free thinning. A variety of forest structures can be created, depending on existing conditions and management goals. Thinning methods can be used to lower the crown bulk density, decrease the connectivity of crowns, and remove intermediate layers that carry surface fire to tree crowns.

However, thinning does not automatically reduce fire hazard or improve forest health. In fact, with fewer trees to block wind and sun, wind speeds are higher in thinned stands, and ground fuels dry out faster. If the cut trees are left on the ground, the untreated slash raises the ground fuel load significantly.

In all types of thinning, **if the slash is not treated**, then the risk of intense or crown fire is usually increased. **If the surface fuels are treated,** then thinning will decrease potential fire intensities in the stand. Thinning can open up the stand canopy to a point where crown fires would have difficulty getting started or sustaining themselves.

Traditional salvage harvests do little to reduce crown fire hazard. In these harvests, crown bulk densities, ladder fuels, and crown base heights are little changed by the removal of a few trees, and the potential for severe fire may actually be increased, if the fuels are not reduced.

An active restoration approach provides a framework for action. The specific history of fire, logging, drought, settlement, and other activities has produced highly varied and individual forests. No one particular treatment or mix of treatments is correct for all forests. What people find acceptable differs among watersheds also.


Tom Iraci

Heavy ground fuels result in greater flame lengths. Dead branches on trees and dense understory trees become ladder fuels and carry flames to tree crowns.

When forest managers implement FireSafe principles, the risk of high-intensity, high-severity fires can be reduced in many forests.

Within an active restoration approach, managers have a variety of choices, including prescribed burning, thinning to various densities, mechanical fuel treatments, combinations of thinning and burning, and placement, timing, and frequency of treatments. Teams of resource specialists can create varied and complex treatment regimes for the widely varying conditions in forests.

Scientists James Agee (University of Washington) and Paul Hessburg have developed principles for FireSafe forests (see table 2). When forest managers implement these principles, the risk of high-intensity, high-severity fires can be reduced in many forests.

In thinning treatments designed for restoration, is there any compatibility with generating wood products?

If restoration were economically self-supporting, the work might more likely be carried out. If the work had to be subsidized, it would be an extra item that could be lost in budget cuts.

Current management prescriptions often call for cutting trees <8 inches in diameter, and timber sales with trees of this size generally are not commercially viable. Small-diameter material can be used as pulpwood, burned to produce energy, used to produce fuel ethanol, and for products such as posts and poles. Small-diameter timber would be more economically viable if it is used to manufacture value-added products such as window frames, doors, and mouldings.

Sawmills in eastern Oregon and Washington are more dependent on federal timber than are west-side mills, and owners of east-side mills have had trouble finding enough wood over the last decade. Many east-side mills have closed over the last few years. In some cases, the mill owners had made considerable investments to retool in order to handle smaller logs, but the supply never materialized. Other mill owners did not or could not retool their mills.

Table 2—Principles of FireSafe forests

Principle	Effect	Advantage	Concerns
Reduce surface fuels	Reduces potential flame length	Fire control is easier, less torching of individual trees	Surface disturbance: less with prescribed burning; more with other mechanical techniques
Increase height to live crown	Requires longer flame length to begin torching	Less torching of individual trees	Opens understory, may allow surface winds to increase
Decrease crown density	Makes tree-to-tree crown fire spread less probable	Reduces crown fire potential	Surface winds may increase, surface fuels may become drier
Favor fire-tolerant tree species	Reduces potential tree mortality	Improves vegetation tolerance of low- and mixed-severity fires	May be too broadly applied, resulting in overly simplified landscape patterns of composition and structure

Sources: Agee 2000, Hessburg and Agee, in press.

A few mills have retooled and are managing to find enough small-diameter logs to stay in business. To open new sawmills or redesign old ones, investors would need to see a predictable, consistent supply of material. So far that has not happened.

Some people propose an aggressive program designed to emulate the scale and intensity of historical disturbances. This also could give investors the incentives they need to establish a state-of-the-art industry.

Others fear that if restoration thinnings generate money, then economic pressures could cause managers to cut even when it is not beneficial for restoration. "Some people want us to keep thinnings below the limits of commercial viability, because they feel this gets in the way of what they see as the Forest Service's primary responsibility of good land stewardship," comments Jamie Barbour, who leads research on production technology for the PNW Research Station. "Others feel that good land stewardship means providing for people, and they think a fuels management program that supports timber-related jobs is a pretty good example."

"The jury is out on the market issue," Barbour continues. "If there's a regular thinning program, people will probably bid on the work. But if we limit the program to a couple of million cubic feet of trees <8 inches in diameter that are spread over eastern Oregon and Washington, it may still cost a lot of money to do these things." Barbour points out that in many areas, investment will be needed to carry out restoration treatments.

Active restoration would not create replications of historical forests. East-side ecosystems have been changed irrevocably.

Management options examined at the landscape level

Our knowledge of ecosystems at the landscape level is limited, but scientists can simulate the outcomes associated with various management alternatives using computer models.

Ecologist Miles Hemstrom was part of a team that projected broad-scale landscape effects for three management alternatives in the interior Columbia basin, an area including eastern Oregon and Washington. Hemstrom cautions that this work involves uncertainties because of the reliance on expert opinion, uncertainty about modeled conditions, and the integration of many variables. Despite these imperfections, the modeling outcomes do allow policymakers to evaluate how their decisions may affect long-term ecological conditions across large landscapes.

The team ran model outcomes for three alternatives:

- Alternative 1—Continue existing levels of fuel treatment, with adjustments for threatened and endangered species habitat, key aquatic and riparian species, and habitat conservation measures.
- Alternative 2—Substantial increase in fuel treatment, focusing work on high-priority subbasins; priorities would be based on analysis of biological and physical features.
- Alternative 3—Substantial increase in fuel treatment, but with less focus on multiscale analysis. Sends more resources directly to the field in the short term, but activities are spread among more subbasins and not as tightly focused on priority areas.

Under all three alternatives, significant amounts of mid-seral (maturing) forests would develop into late-seral (old or mature) conditions.

However, the three alternatives would have clearly divergent results for late-seral, single-layer forests, which include the open ponderosa pine forest type. Under alternative 1, late-seral, single-layer forests would continue to decline as a result of increased fire severity and increased insect and disease disturbance.

Under the active restoration approach of alternatives 2 and 3, by using the most optimistic assumptions, east-side forests with large, widely spaced ponderosa pines and Douglas-firs could at best be increased to about two-thirds of their historical abundance over the next century. Because it takes time to grow mature forests, even with active restoration, no more than two-thirds recovery is possible in the next 100 years. Optimistic assumptions include (1) a substantial increase over current levels in the acres receiving treatment and (2) climate trends allow success.

However, although the forest type (late seral, single layer) would increase, in many places it would be composed of different tree species than historical forests. Fire-intolerant species, such as Douglas-fir and grand fir, would be more prevalent, and tolerant species, such as ponderosa pine, would be less common than in historical east-side forests.

In the end, risk can only be managed, not eliminated.

Intense and severe wildfires can pose obvious risks to streams and fish. However, active restoration also can have risks. Some scientists suggest that restoration work in the next few years should minimize risk to productive streams critical to native fish, while experience is gained. They point out that although restoration techniques have been tested at the stand level, we do not really have landscape-level knowledge yet. If forest restoration results in greater watershed health, defined as the integrity of all ecological processes, it could benefit streams and fish.

Tom Iraci

In dry forest areas, many single-layer forests have developed into forests like this one, with multiple layers of small and mid-sized trees and brush in the understory of large ponderosa pine.

Active restoration would not create replications of historical forests. East-side ecosystems have been changed irrevocably. Some tenacious nonnative plant species have been added, nonnative blister rust is a permanent part of the forest, modern human settlements are part of the landscape, and the climate changes.

For all these reasons, Hemstrom says, "The historical range of variability is useful but not as a target recipe. It is a benchmark for determining the magnitude and direction of changes. It gives managers information about what directions they could take with restoration, but they're not going to make the world like it was before."

The wildland-urban interface is where people face the greatest risks from severe wildfires. Homes and communities are mingled with dry forests that have potentially high-severity fire regimes.

"The dry forests of the wildland-urban interface seem like a good place to start," comments Hessburg. "We have the best understanding of these forests and their fire regimes and the most knowledge about treatment options and effects in these types."

In relation to active restoration, Hessburg suggests, "We need to explore doing these things in areas where there are fewest downsides. Then as we learn from our successes and failures, we can take on areas that are more difficult. We also need to develop experiments that address restoration of landscape dynamics. And scientists and managers need to be partners in these experiments."

In the end, risk can only be managed, not eliminated.

For Further Reading

Agee, J.K. 1993. *Fire ecology of Pacific Northwest forests.* Washington, DC: Island Press.

Duncan, S. 2001. *Benefits of hindsight: reestablishing fire on the landscape.* Science Findings No. 36, August 2001. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Graham, R.T.; Harvey, A.E.; Jain, T.B. [et al.]. 1999. The effects of thinning and similar stand treatments on fire behavior in Western forests. Gen. Tech. Rep. PNW-GTR-463. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station; U.S. Department of the Interior, Bureau of Land Management.

Hayes, J.L.; Quigley, T.M.; Starr, L., eds. 2001. *Forest health and productivity in eastern Oregon and Washington.* Northwest Science. 75(Special issue).

Hessburg, P.F.; Agee, J.K. [In press]. An environmental narrative of inland Northwest forest, 1800-2000. Forest Ecology and Management.

U.S. Department of Agriculture, Forest Service. 1996. *Status of the interior Columbia basin: summary of scientific findings.* Gen. Tech. Rep. PNW-GTR-385. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station; U.S. Department of the Interior, Bureau of Land Management.

Resources on the Web

U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior. 2002. National Fire Plan documents. www.fireplan.gov. (26 June).

U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. www.fs.fed.us/pnw. (26 June).

U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, Bureau of Land Management. Interior Columbia Basin Ecosystem Management Project documents. www.icbemp.gov. (26 June).

Contacts

Scientists who contributed to this issue:

Jamie Barbour, jbarbour01@fs.fed.us, Focused Science Delivery Program

Miles Hemstrom, mhemstrom@fs.fed.us, Managing Disturbance Regimes Program

Paul Hessburg, phessburg@fs.fed.us, Managing Disturbance Regimes Program

John Lehmkuhl, jlehmkuhl@fs.fed.us, Managing Disturbance Regimes Program

Jim McIver, jmciver@fs.fed.us, Managing Disturbance Regimes Program

Credits:
Writer and editor – Valerie Rapp
Art director – Frank Vanni
Layout – Jenny Beranek
Photography:
Front cover photo – Tom Iraci
All other credits with photographs

PNW Science Update
U.S. Department
of Agriculture
Pacific Northwest
Research Station
333 S.W. First Avenue
Portland, OR 97208-3890

Got Science?

Science can aid in the development of informed choices and sustainable solutions by incorporating human needs and values with our best understanding of the environment.

At PNW Research Station, we generate scientific knowledge and put that knowledge into formats useful to managers, policymakers, and scientists.

The publications below and many others can be downloaded from the PNW Research Station Web site at: http://www.fs.fed.us/pnw. Publications also can be requested by calling (503) 808-2138 or e-mailing pnw_pnwpubs@fs.fed.us.

Publications from Pacific Northwest Research Station

- Quarterly list of new publications (ask for the most recent one)
- ***PNW Science Findings*** (monthly publication)
- ***Pacific Northwest Research Station Strategy for the Future*** (March 2002)