THINNING CERTAIN OREGON FORESTS TO RESTORE ECOLOGICAL FUNCTION

by Andy Kerr

ABSTRACT

Politics makes for strange bedfellows and that is particularly the case today with the restoration of Oregon's public forests. Conservationists must work with cooperative elements of the timber industry to achieve ecological restoration of certain forest types exhibiting certain stand conditions. Significant amounts of this forest restoration will require some commercial logging—"thinning"—albeit only for a few decades and taking much smaller diameter trees than in the past. Logging for ecological restoration will produce much less timber than was historically removed from federal forests, but significantly more timber than has been removed in recent years. Carefully controlled thinning projects in certain forest types with certain stand conditions must be a part of a scientifically justified program of forest restoration that includes protecting all old growth trees, creating more old growth trees, preserving roadless areas, removing roads, removing livestock and/or reintroducing natural fire to forest ecosystems.

OREGON WILD/Larry Olson

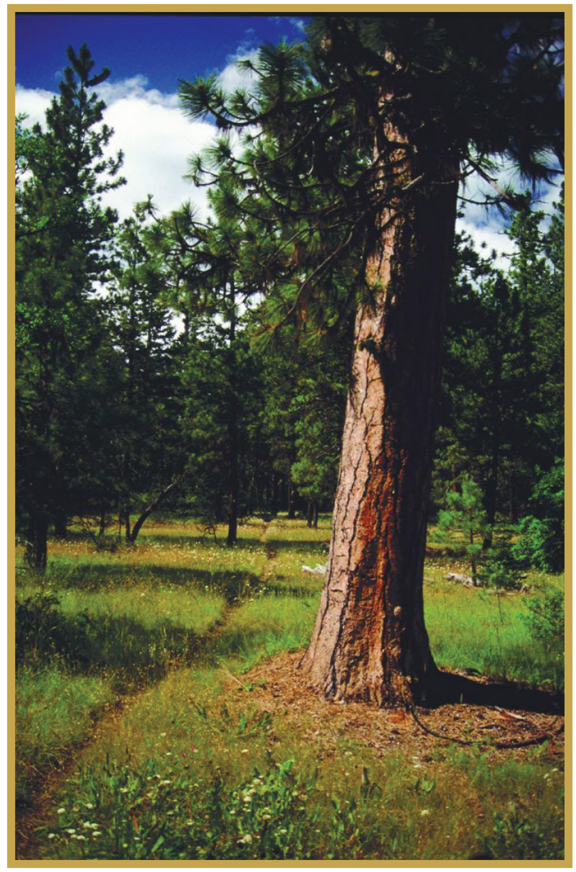
A dry old-growth ponderosa pine stand near Lookout Mountain on the Ochoco National Forest. Due to a deficiency of fire and an excess of livestock, young ponderosa pines are beginning to fill in the forest understory. It's time to underburn this stand, and thinning first is unnecessary due to the small size of the saplings.

Table of Contents

Tough Love for Tree Huggers

To thin or not to thin: that is the question:
Whether 'tis nobler to let this forest suffer
The slings and arrows of fire suppression,
Or to drop a match against this forest of troubles,
And by burning restore them? To log: to stump:
Yes sometimes; and by these stumps that will be seen
It is better than heart-ache of the thousand unnatural shocks
That big old trees are heir, 'tis a restoration.[1]

The timber industry has long bragged of planting five trees for every one they log. In this case, the industry is not lying. The problem, of course, is that industry has targeted and logged mostly old trees, often older than our nation's Constitution, and replaced them with trees that won't live as long as it will take you to pay off your house. The newly planted trees will likely be logged again long before they ever develop into an older and ecologically diverse forest.



Oregon Wild/Elizabeth Feryl

This park-like stand of dry mixed conifer forest in the Cascade-Siskiyou National Monument would benefit from a restorative surface fire.

Conservationists have succeeded in reducing the timber cut on federal public lands in Oregon by approximately 80-90 percent of historic levels. Of course, this is measured against an unsustainable frenzy of logging and roading and not against any rational calculation of the replacement rate of old growth nor consideration for any balance between a forest's provision of wood products and other forest products, such as water, wildlife, recreation, biodiversity, scenery and sequestered carbon.

The age of trees cut on Oregon's federal forests has declined somewhat proportionally to the amount of logging, although too many large, old trees are still being logged. It is also the case that not enough small trees are being cut. For ecological restoration purposes, it is often desirable to thin overstocked monoculture tree plantations[2] that have replaced many wet (westside) and some dry (eastside) forests.

Oregon Wild/Sandy Lonsdale

Old-growth Douglas-fir forest on the Willamette National Forest. No need for any kind of restoration in this low-elevation westside forest. Some very hot, dry and windy day, this forest will be replaced naturally. Such stand-replacing burns are inevitable, foreseeable and ecologically essential.

In some dry forests—particularly dry ponderosa pine and dry mixed-conifer forest types (see Map 1)—the lack of fire, presence of livestock and/or past high-grade logging of large fire-resistant trees have created a thick and undesirable understory of small, young trees that pose a significant fire hazard

1 Sorry, Willie—if indeed you were the *real* author.
2 A "plantation" is a stand of trees, generally all of the same age, size, spacing and species that have been planted, usually after clearcut logging or a stand-replacing fire. A selectively logged forest stand or a clearcut that regenerates naturally is not a "plantation."

to residual old trees. The thinning of these small trees is often necessary before reintroducing fire into these fire-dependent forests.

In many cases, the reintroduction of fire—either by prescribed burning or allowing wildfires to burn—is all that is required to "thin" overgrown forests. *Logging is not needed in all cases.* However in other cases, logging of certain forest types exhibiting certain stand conditions in Oregon must increase—but it must be ecologically and hydrologically sensitive, strictly controlled and restorative in nature—should will only be necessary for a few decades.

Oregon Wild/David Stone, Wildland Photography

For millennia, periodic fire (by lightning and Indians) maintained this meadow on Chucksney Mountain on the Willamette National Forest. Recent fire suppression is allowing young conifers to march into the meadow. Unchecked, the meadow will be lost.

My thinking about the appropriateness of active restoration in public forests, including thinning (a.k.a. logging) has evolved from initial opposition ("just let nature handle it") to conditioned support to address *certain* stand conditions in *certain* forest types. Many conservationists and scientists have influenced my thinking, in most particular the work of Rick Brown of Defenders of Wildlife. His *Thinning, Fire and Forest Restoration: A Science-Based Approach for National Forests in the Interior West* is critical reading on the subject.[3]

James Johnston/Northforkphotos.com

A plantation in the Fall Creek drainage of the Willamette National Forest. While most Forest Service and Bureau of Land Management plantations are not planted in straight rows, this plantation offends not only one's ecological sense of what is a forest, but also one's aesthetic sense. Ecologically, a plantation is more akin to a cornfield than a forest.

Brown has also published a paper with Dr. James Agee and Jerry Franklin that suggests prioritizing restoration based on fire-severity regime and other factors.

The authors also suggest that the goal of forest restoration should not be a return to conditions prior to European invasion, but rather toward a forest resistant and resilient to climate change.[4]

Five distinguished scientists have also published a peer-reviewed paper on the appropriate management of fire-dependent forests in the western United States that is a very important contribution to the understanding of the role of fire and our role in returning fire to forest ecosystems. *Managing Fire-Prone Forests in the Western United States*[5] appeared in the journal *Frontiers of Ecology and Environment* in 2006, a publication of the Ecological Society of America. It is based

3 Brown, R. 2000. Thinning, Fire and Forest Restoration: A Science-Based Approach for National Forests in the Interior West. Defenders of Wildlife. Portland, OR. 40 pp. Available at www.biodiversitypartners.org/reports/Brown/brown01.shtml.
4 Brown, Richard T., James K. Agee and Jerry F. Franklin. 2004. Forest Restoration and Fire: Principles in Context of Place. Conservation Biology 18:903-912.
5 Noss, R. F., J. F. Franklin, W. L. Baker, T. Schoennagel, P. B. Moyle. 2006. Managing fire-prone forests in the western United States. Frontiers in Ecology and the Environment 4(9): 481-487. (Ecological Society of America. Washington, D.C.). With the permission of the lead author, this paper is available for download for limited educational purposes only at www.andykerr.net/downloads.

on an unpublished report from the Society for Conservation Biology. I have known two of the authors for decades and have often sought their counsel on ecological issues. All the authors are excellent and respected scientists. In their article, Noss, et al. caution us to remember that forests are not all the same.

> *Fire exclusion and other human activities led to significant deviations from historical variability in some, but not all, forests. Restoration treatments are warranted, sometimes urgently, only where such activities have resulted in major alterations in ecosystem structure, function, or composition.*[6]

While only some—though still a very large amount—of Oregon forests are in urgent need of active restoration, most are not. This paper focuses on those forests that can benefit from human intervention.

Oregon Wild/Elizabeth Feryl

Dense regrowth in forests following a natural disturbance such as fire or an unnatural disturbance such as clearcutting resulting from tree planting is one of several pathways to an old-growth forest. However, most tree plantations, such as this one, could benefit from variable density thinning to accelerate the onset of late-successional forest characteristics.

REVIEWS REVIEWS REVIEWS

481

Managing fire-prone forests in the western United States

Reed F Noss[1], Jerry F Franklin[2], William L Baker[3], Tania Schoennagel[4], and Peter B Moyle[5]

The management of fire-prone forests is one of the most controversial natural resource issues in the US today, particularly in the west of the country. Although vegetation and wildlife in these forests are adapted to fire, the historical range of fire frequency and severity was huge. When fire regimes are altered by human activity, major effects on biodiversity and ecosystem function are unavoidable. We review the ecological science relevant to developing and implementing fire and fuel management policies for forests before, during, and after wildfires. Fire exclusion led to major deviations from historical variability in many dry, low-elevation forests, but not in other forests, such as those characterized by high severity fires recurring at intervals longer than the period of active fire exclusion. Restoration and management of fire-prone forests should be precautionary, allow or mimic natural fire regimes as much as possible, and generally avoid intensive practices such as post-fire logging and planting.

Front Ecol Environ 2006; 4(9): 481–487

The management of fire-prone forests, especially within the national forests of the west, is one of the most contentious natural resource issues in the US today. One recent response to the controversy is the Healthy Forests Restoration Act (HFRA) of 2003 (Public Law 108-V148). This law has potentially profound consequences for forests and their biodiversity and must therefore be implemented on the basis of the best scientific information and guidance. Towards this end, the North American Section of the Society for Conservation Biology convened a scientific panel to review issues related to the ecology and management of fire-prone forests of the western US. This article is adapted from the unpublished report of that panel (Noss *et al.* 2006a).

The vegetation of North America has been shaped by recurring fires over millions of years. Fossils of pines (*Pinus* spp), which are closely associated with fire, date from the Cretaceous Period, more than 100 million years ago (Millar 1998). Fire remains the primary natural disturbance influencing plant and animal communities across much of the continent today (Habeck and Mutch 1973; Agee 1993). Many forests, however, have been degraded over the past century by misguided fire management, as well as other impacts such as logging and livestock grazing. Uncharacteristic fuel loads contribute to altered fire regimes in some forest types (Covington and Moore 1994; Schoennagel *et al.* 2004). Key structural elements (eg old "veteran" trees), terrestrial and aquatic biodiversity, and habitats of many threatened and endangered species are already greatly diminished and at continuing risk of loss. Increased human habitation of wildlands has intensified problems of managing fire, especially at the wildland–urban interface (Dombeck *et al.* 2004).

For this paper we evaluated the scientific literature that is relevant to conservation, restoration, and management of forests in the western US (excluding Alaska). Our review addresses ecological science relevant to developing and implementing fire and fuel management policies, including activities conducted before, during, and after wildfires. Our focus is primarily on wildlands, rather than the wildland–urban interface, where ecological values may be secondary to fire-risk mitigation to protect people and homes (DellaSala *et al.* 2004). In wildlands especially, sustainable forest management must be based on well-grounded ecological principles.

In a nutshell:

- The complexity created by variability in fire regimes defies a one-size-fits-all management prescription
- Restoration is warranted where fire exclusion has led to substantial alterations in ecosystem qualities
- Post-fire logging usually has no ecological benefits and many negative impacts; the same is often true for post-fire seeding
- Although many forests will require continued management, a common sense conservation goal is to achieve forests that are low maintenance and require minimal repeated treatment

[1]Department of Biology, University of Central Florida, Orlando, FL 32816 (rnoss@mail.ucf.edu); [2]College of Forest Resources, University of Washington, Seattle, WA 98195; [3]Ecology Program and Department of Geography, University of Wyoming, Laramie, WY 82071; [4]Department of Geography, University of Colorado, Boulder, CO 80309; [5]Department of Wildlife, Fish, and Conservation Biology, University of California, Davis, CA 95616

■ **Fire in western forests**

Fire provides fundamental services, including recycling nutrients, regulating the density and composition of

© The Ecological Society of America www.frontiersinecology.org

Wendell Wood, Oregon Wild

Restoring fire into a ponderosa pine forest that is deficient of large standing trees, both live and dead.

In my opinion, the policy and political import of this paper prescribing management of forests before, during and after fire will be comparable in policy impact as to that of a 1981 U.S. Forest Service research publication that challenged conventional thinking about the importance of old-growth forests.[7]

---

6 Noss et al. (2006): 483.

7 Franklin, J. F., K. Cromack, W. Denison, A. McKee, C. Maser, J. Sedell, F. Swanson, G. Juday. 1981. Ecological characteristics of old-growth Douglas-fir forests. Gen. Tech. Rep. PNW-118. USDA-Forest Service, Pacific Northwest Forest and Range Experiment Station. Portland, OR.

Passive Versus Active Restoration

As our understanding of ecological processes and restoration improves, the conservation community is increasingly faced with a choice of whether to support *active* restoration of abused ecosystems. Of course, conservationists have always supported *passive* restoration, which means ending activities harmful to native ecosystems (logging, roading, grazing, mining, drilling, spraying, plowing, mining, fire suppression, certain types of recreation, etc.) and allowing nature to heal itself. A philosophical—and to some, moral—dilemma arises when conservationists must consider whether to support active ecological restoration, either to speed natural healing or prevent nature from irreversibly converting the abused ecosystem to a new and ecologically undesirable state.

Oregon Wild/Elizabeth Feryl

While forests may naturally reclaim logging roads, active restoration is often desirable to remove culverts, restore slopes and other measures to make roads hydrologically invisible.

There are many cases where active restoration—sometimes involving significant human intervention—has succeeded in achieving ecological goals. The California condor and peregrine falcon still fly today thanks to captive breeding and reintroduction programs. The coastal western snowy plover owes its continued existence to vigorous predator control (and also activities that restored its maritime habitat). Some conservationists support controlling (i.e., killing) barred owls that are encroaching into the range and driving off the northern spotted owl. The National Park Service is presently thinning trees that have encroached into giant sequoia groves, because they fear that prescribed fire of any size could jeopardize the last 70 to 85 remaining groves of giant sequoia unless the ladder fuel is removed first.

Active restoration may not always be the preferred long-term solution to an environmental problem, but may be critical to short-term strategies to conserve sensitive native species. For many conservationists, it is much easier to support active restoration to conserve an individual species of imperiled plant or animal than to manage an entire ecosystem. Ecosystems are infinitely more complex than the life history of an individual species.

If one objects to active restoration for philosophical reasons, based on the belief that nature always knows best how to manage itself, then further human intervention in an ecosystem is never justified—even if nature has never confronted anything like the set of unnatural human-caused irritants set upon it and the even more unnatural resulting conditions.

There are also moral objections to active ecosystem or species restoration. This view holds that commercial extraction of natural resources on public lands is morally wrong. I generally agree with this view and still adhere to it as a long-term goal for public lands. However, there are cases where active restoration is ecologically justified and also the only practical way to achieve it is by commercial means.

There is also a social, if not psychological, aspect that affects conservationists when it comes to trees. All conservationists congenitally hug trees, many of us are conditioned to plant trees, and few of us feel good about cutting trees—at least not native species.

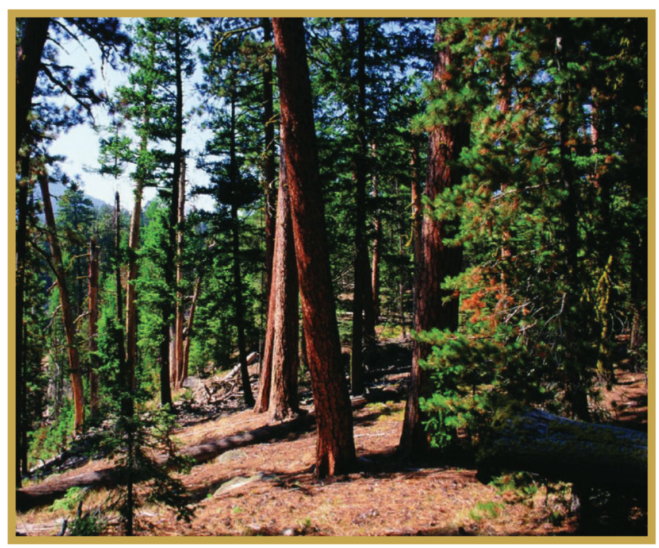
Active restoration should always be pursued carefully, with forethought and a willingness to either stop or adjust course based on nature's feedback. As a rationalist, I prefer to follow prevailing science. While it is possible that the current science is incorrect (science pursues truth, but by its nature will never reach absolute truth), if most of the best qualified scientists agree that certain forest stands with certain stand conditions are (1) unhealthy; (2) the prognosis with just passive restoration is poor; and (3) active management will likely improve the situation, then I'm going with the science. Today, most forest scientists support active restoration of certain western forests in certain cases (see below).

Joseph Vaile, KS Wild

80-90 year-old conifer trees have invaded and overtopped what was previously an Oregon white oak savannah.

Separating the Good Science from the Bad Science

The science of ecology is often conflated with the "science" (pronounced "art") of natural resource management. Failing to distinguish the two can leave one believing that all science concerning an issue is controversial and conflicting. Ecological science never agreed that killing predators, stocking streams with alien and/or hatchery fish, removing large woody debris from streams, or replacing old-growth forests with clearcuts were good for wildlife and watersheds. Natural resource "science" made those recommendations because those "scientists" believed that nature could be "improved." Ecological science explains nature, and the scientific discipline of conservation biology seeks to conserve and restore nature. Natural resource "science" seeks to manipulate nature to achieve certain ends.



Oregon Wild/Sandy Lonsdale

This dry mixed conifer stand on the Wallowa-Whitman National Forest is dominated by ponderosa pine, but has a fir understory, which developed following the introduction of livestock grazing and suppression of fire. The risk of an otherwise beneficial surface fire moving into the canopy by these "ladder" fuels is moderate. However, the stand is in a roadless area, which requires special consideration in management. This might be a case where the appropriate active restoration is a backpack flamethrower operated by a person wearing snowshoes.

While it is important to ascertain whom a scientist works for, doing so offers no definitive information about potential bias or the perspective of the researcher. Before and after I dropped out of Oregon State University, I witnessed university scientists—willing to bite the hand that fed them, in this case the U.S. Forest Service—produce excellent, ecologically based and sound science on old-growth forests. In other cases, I saw horrible "science" coming out of the university's Department of

Rangeland Resources and Management. Although the department has changed its name to Rangeland Ecology and Management, most of their "science" still errs because it presumes (if not exalts) the presence of livestock in native forests, grasslands and deserts. Nonetheless, there are scientists in western universities, and in federal and state agencies, who produce excellent science in spite of where their desk is located—including the OSU REM Department.

All ecological science and management "science" needs to be read critically. The science that I rely on to formulate my policy recommendations—that carefully controlled thinning of certain forests exhibiting certain stand conditions should be part of a comprehensive restoration program—may turn out to be wrong. However, while new science occasionally proves old science wrong (and sometimes astoundingly so), new science usually confirms and builds upon old science.

The End Objectives for Active Forest Restoration

In many cases, the degree of human manipulation necessary to restore an ecosystem to a more natural state would be more acceptable to conservationists if the ultimate objective for the treated area is the complete restoration of ecological structure and function. In the case of forests, *if* the long-term objectives for a site are to:

- (1) conserve and restore (and never again log, even under the guise of salvage logging) late-successional and old-growth forests (with natural episodic stand replacement);
- (2) allow, if not reintroduce, (and never again suppress) wildfire;
- (3) remove livestock from the area (and never again allow grazing); and
- (4) remove unnecessary roads (and never again allow roading)

then conservationists are more likely to accept and the general public to support more active (i.e., lots of stumps) ecosystem restoration activities in the short-term.

Oregon Wild/Sandy Lonsdale

A controlled burn on the Deschutes National Forest that is burning "cool" along the ground, reducing the build-up of understory vegetation.

The goal of forest restoration should not be a return to pre-settlement conditions, but the establishment of forests that are both resistant and resilient in a future affected by climate change.

Conservationists are not interested in supporting a perpetual thinning program by a federal forest bureaucracy looking to sustain and expand itself, and which is afraid to reintroduce wildfire, remove livestock, remove unnecessary roads, and inform imprudent house owners that building in the path of periodic fire is as dumb as building in the path of periodic floods. Such policy is not good for forests or taxpayers. Noss, et al. state:

> *Restoration plans should systematically incorporate fire to maintain restored forests. Forests are dynamic; therefore, any restoration program must provide for sustained fire management to maintain the desired condition. Low-maintenance forests, which can often be achieved through managed natural fire, are an appropriate restoration goal in many cases; where this is not possible, prescribed fire should mimic the characteristic fire regime as closely as possible. Because fire regimes vary tremendously on a regional scale, managers should allow for a range of fire severities.*[8]

---

8 Noss, Reed F., Edward T. LaRoe, J. Michael Scott. 1995. Endangered Ecosystems of the United States: A Preliminary Assessment of Loss and Degradation. Biological Report 28. USDI-National Biological Service. Washington, DC: (unpaginated) (citations omitted) (available at biology.usgs.gov/pubs/ecosys.htm).

Box 1: Save the Ponderosas

*Ponderosa Pine (***Pinus ponderosa***).*

When considering whether to pursue active restoration of a forest, it is logical and prudent to ask what the consequences may be of not acting. In the case of dry ponderosa pine and dry mixed conifer types, not acting will likely result in the eventual loss of significant areas of old-growth ponderosa pine and other fire-resistant trees to fire and/or insects and diseases aided and abetted by moisture stress. While ponderosa pine trees still comprise much of Oregon's eastside forests, old-growth ponderosa is in severe short supply. For example, scientists have estimated a 92-98% loss of old-growth ponderosa pine forests on the Deschutes, Fremont, and Winema national forests in south central Oregon.[9] Comparable losses of old-growth ponderosa are also the case on the Ochoco, Malheur, Umatilla and Wallowa-Whitman national forests in northeastern Oregon.

Landscape-Level and Forest Stand-Level Conservation and Restoration

While this paper addresses forest restoration at the forest stand-level, any ecologically viable forest restoration plan depends on the development and implementation of a broader landscape-level conservation plan. Landscape-level conservation and restoration plans are complex and beyond the scope of this paper. In short, a landscape-level forest conservation plan will include a system of late-successional and riparian reserves that ensure for the continued viability of all species native to the landscape, additional protections and restrictions to conserve soil, hydrologic and other forest functions, and create conditions where the forest landscape is both resistant to and resilient in a future affected by climate change.[10]

Restoration in Planted Versus Unplanted Forests

Most forest plantations established in most forest types (wet or dry; high to low fire-severity) following clearcutting become extensive stands of a single monoculture tree species of the same age and similar spacing. Plantations in mostly any forest type can often be made more biologically diverse by variable density thinning.[11]

---

9 Noss et al. (2006): 484.

10 Noss, Reed F. and Allen Cooperrider. Saving Nature's Legacy: Protecting and Restoring Biodiversity. Defenders of Wildlife and Island Press. Washington, DC; Lindenmayer, D. B. and J. F. Franklin. 2002. Conserving Forest Biodiversity: A Comprehensive Multiscaled Approach. Island Press. Washington, DC.

11 Carey, A. B. 2003. Biocomplexity and restoration of biodiversity in temperate coniferous forest: inducing spatial heterogeneity with variable-density thinning. Forestry 76(2): 127-136; M. G. Hunter. 2001. Management in Young Forests. Communiqué No. 3. Cascade Center for Ecosystem Management. Corvallis, OR. 28 pp.; P. S. Muir, R. L. Mattingly, J. C. Tappeiner, J. D. Bailey, W. E. Elliott, J. C. Hagar, J. C. Miller, E. B. Peterson, E. E. Starkey. 2002. Managing for biodiversity in young Douglas-fir forests of western Oregon. Biological Science Report USGS/BRD/BSR–2002-0006. U.S. Geological Survey, Biological Resources Division. Washington, DC. 76 pp.; S. S. Chan, D. J. Larson, K. G. Maas-Hebner, W. H. Emmingham, S. R. Johnston, D. A. Mikowski. 2006. Overstory and understory development in thinned and underplanted Oregon Coast Range Douglas-fir stands. Can. J. For. Res./Rev. 36(10): 2696-2711; V. Rapp. 2002. Restoring Complexity: Second-Growth Forests and Habitat Diversity *in* Science Update. USDA-Forest Service, Pacific Northwest Research Station. Portland, OR; J. F. Franklin, D. R. Berg, D. A. Thornburgh, J. C. Tappeiner. 1997. Alternative silvicultural approaches to timber harvesting: variable retention harvest systems. Pages 111-139 *in* K. Kohm and J. F. Franklin (eds.). Creating a Forestry for the 21st Century. Island Press. Washington, DC.

Variable-density thinning regimes in which thinning intensity and tree marking rules are varied within the stand of interest are a useful approach to increasing heterogeneity in stand density and canopy cover. Variable-density thinning is sometimes referred to as the "skips-and-gaps" approach. In such a prescription, some portions of the stand are left lightly or completely unthinned ("skips") providing areas with high stem density, heavy shade, and freedom from disturbance while other parts of the stand are heavily harvested ('gaps"), including removal of some dominant trees providing more light for subdominant trees and understory plants. Intermediate levels of thinning area also applied in a typical variable-density prescription.

Variable-density thinning addresses a variety of stand development objectives, although it is generally more difficult to apply than uniform thinning. However, tools, such as global positioning systems, can make spatially variable stand management relatively straightforward and cost effective.

Physical removal of trees that are felled or girdled may not be necessary in thinnings aimed at enhancing biodiversity conservation. Some or all of the thinned material may be retained to contribute to stand structural complexity and organic matter. However, where trees have commercial value, they probably will be removed; this can provide financing for additional stand treatments to further enhance conservation of biodiversity.[12]

Doug Heiken, Oregon Wild

Doug Heiken, Oregon Wild

Before variable density thinning, trees are denser and there is relatively little understory vegetation. After variable density thinning, trees are less dense and there is relatively more understory vegetation.

12 Lindenmayer, D. B. and J. F. Franklin. 2002. Conserving Forest Diversity: A Comprehensive Multiscaled Approach. Island Press. Washington, DC. 184. (internal citations omitted for clarity).

Identifying and Addressing the Causes of Forest Un-Health in Eastside Forests[13]

Historically, the most valuable trees removed in dry forest types were large, old trees that had evolved to resist (and even prosper following) fire.[14] The trees not taken were smaller in diameter and usually of species or ages more susceptible to fire. Younger and smaller trees are more susceptible because they have thinner bark and branches closer to the ground. In addition, younger and smaller trees can out-compete larger and older trees for site moisture, resulting in the death of the older, fire resistant trees. Large, old trees must be preserved in any restoration program.

Oregon Wild/Jeremy Hall

Restoring forests isn't just about the trees. Countless miles of forest roads are failing and must be repaired or, preferably, removed. It is often the case that the only money for such removals will come from commercial thinning as part of a comprehensive restoration plan.

Fire suppression must also be eliminated as part of an ecologically sound restoration program. Fire "prevention" (wildfire can only be delayed, not "prevented") and suppression only became marginally effective after World War II with the availability of heavy equipment and the establishment of the fire-industrial complex. Finally—and although they receive less attention than logging and fire suppression—the historic and current impacts of roading and livestock grazing must be addressed to achieve true forest restoration. Roads fragment forests, compact soils, increase erosion, pollute streams, serve as vectors for alien species, and more.[15]

Andy Kerr, The Larch Company

Bovine bulldozers grazing in a previously logged dry mixed conifer stand on the Fremont National Forest.

Livestock grazing is equivalent to the annual clearcutting of the forest understory and historically represents the first human assault on most dry forests. The introduction of livestock to western forests in the late 19th century shifted the composition of the forest understory from grass and forbs (which livestock found more palatable) toward less palatable shrubs and small trees. This interrupted the cycle of frequent surface fires that were previously carried by understory grass and allowed small trees, shrubs and dense understory to become ladder fuels to the forest canopy above.[16]

The reintroduction of fire (sometimes, but not always, preceded by carefully controlled thinning of certain forest types with certain stand conditions) can help restore natural forest *structure*, but only the removal of livestock and unnecessary roads can fully restore natural forest *function*—including hydrological function.

---

13 "Eastside" forests are those federal forestlands in Oregon and Washington that are not within the range of the northern spotted owl, which inhabits "westside" forests. Eastside forests should not be confused with "eastern" forests of the United States, as they are a subset of "western" forests of North America.

14 Brown, R. (2000).

15 Noss, R. F. 1990. The ecological effects of roads, or the road to destruction. Available at www.wildlandscpr.org/resourcelibrary/reports/ecoleffectsroads.html (originally published as Diamondback. 1990. The Ecological Effects of Roads, or the Road to Destruction. Special Paper. Earth First! Tucson, AZ).

16 Belsky, A. and D. Blumenthal. 1997. Effects of livestock grazing on stand dynamics and soils in upland forests of the Interior West. Cons. Biol. 11: 315–327.

Box 2: The Sacrifice Zone that is the Wildlands-Urban Interface

The Wildlands-Urban Interface (WUI; "woo'-ee") is (unfortunately) an expanding zone of land the separates developed from undeveloped landscapes and our economic infrastructure from our natural infrastructure. This zone is misnamed as rarely do truly urban lands interface with true wildlands. Usually the interface is characterized by isolated buildings (e.g., exurban houses) inappropriately located in a somewhat "wild" landscape (defined by a lack of buildings and supporting infrastructure).

This paper does not address forest "restoration" in the WUI because the forests of the WUI are not likely to be managed for ecological health, but rather for reduced fire risk and protection of buildings and other private property. Fuels reduction implemented in WUI zones to reduce fire risk is not forest restoration. Ecologically, the WUI is a sacrifice zone.

Of course, the WUI is usually larger than it needs to be, so more forestland is sacrificed than is necessary. Wildland fire is not prevented, but only delayed. Buildings located in the WUI can protected from fire through proper construction and maintenance of the building and proper management of the vegetation near the building. If property owners follow a few simple rules, their buildings are highly unlikely to burn.[17] It is more efficient and better forest policy to focus resources on making buildings in the WUI fire resistant (or removing them) than to expend resources trying to create forest conditions that are less unsafe for firefighters to fight inevitable fires in an attempt to protect buildings that should not be there in the first place. Putting non-rich young people employed as forest firefighters in harm's way to protect misplaced vacation houses of the rich is a misguided social priority.

The WUI cannot be depended upon for a sustainable supply of timber. Even if fire is not again allowed to regulate forest biomass near homes, it will not be desirable from a fire safety standpoint to allow the trees to grow again to a commercial size. It is better to use mowers or goats or the like to control growth, if either prescribed wild fires or fireproofing buildings are otherwise socially unacceptable to accomplish the task.

Restoration in Wet versus Dry Forests and High- versus Low-Severity Fire Types

The restoration needs of forests differ depending on the dominant fire type and fire frequency that they evolved with. In general, fire frequency is higher in low-severity fire type forests and lower in high-severity fire type forests (see Table 1).

Never-logged high-severity/low frequency forest fire types are generally the least appropriate for active restoration as fire suppression has historically had minimal impacts on forest structure and function. Previously logged stands with remnant old-growth overstories in low-severity/high frequency fire types are generally the most appropriate for active restoration when fire suppression has drastically altered the structure and function of these forests.

Low-Severity Fire Types

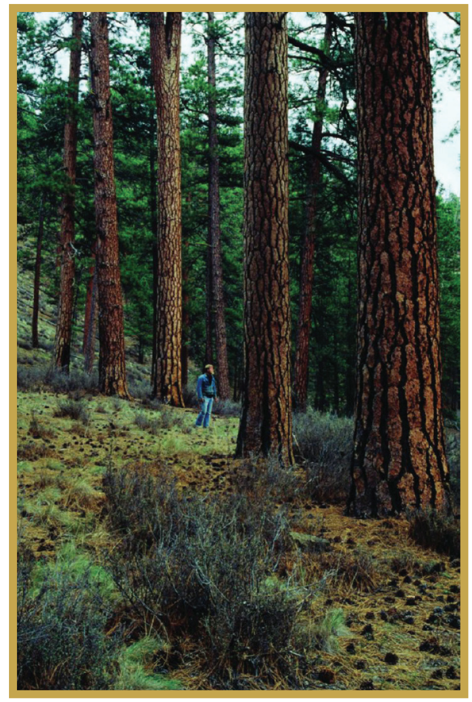
The forest types that are of most concern and most often in need of active thinning before the reintroduction

---

17 Nowicki, B. and T. Schulke. 2006. The Community Protection Zone: defending homes and communities from the threat of forest fire. Pages 265-267 *in* G. Wuerthner (ed.). Wild Fire: A Century of Failed Forest Policy. Foundation for Deep Ecology. Sausalito, CA; Island Press. Washington, DC. 252 pp.

of fire are dry ponderosa pine and dry mixed-conifer forests (both low-severity dominant fire forest types).[18] For these particular forest types, Noss et al. advise:

> *Restoration of dry ponderosa pine and dry mixed-conifer forests — where low severity fires were historically most common — is ecologically appropriate on many sites. Active (e.g., mechanical thinning of small stems, prescribed fire) or passive (e.g., wildland fire use, livestock removal) management can restore stand densities to the levels that existed prior to fire exclusion, livestock grazing, logging, and plantation establishment. Retention of old live trees, large snags, and large logs in restoration treatments is critical. Also, restoring other key components of these ecosystems, such as native understory plants is essential for full recovery of natural conditions, including the characteristic fire regime.*[19]



Oregon Wild/Elizabeth Feryl

Thinning is unnecessary in this dry ponderosa pine stand on the Deschutes National Forest before allowing a wildfire or prescribing a management fire to restore the stand.

The last sentence suggests that removing domestic livestock to restore understory vegetation that carry beneficial, low-severity fire across the forest floor in dry forest types is a necessary step to restoring natural fire in these forests.

High-Severity Fire Types

The effects of past fire suppression in relatively pristine coastal temperate forests, coastal subalpine forests, pinyon pine–juniper woodlands, interior Northwest montane forests and interior subalpine forests need not concern us. Noss et al. note:

> *Fire exclusion has had little effect on fuels or forest structure in forests characterized by high severity (stand replacement) fire. High severity fires are relatively infrequent, occurring at intervals of one to many centuries, whereas active fire exclusion, especially in remote forests, began only decades ago. Because fuel structures or tree densities are usually within the historical range of variability, active restoration is ecologically inappropriate in these forests.*[20]

Oregon Wild/Sandy Lonsdale

Lodgepole pine lives fast and dies young. Snags are roosting and nesting habitat for bald eagles and other species.

A very rare coincidence of dry and windy conditions must occur for an old-growth coastal temperate forest to burn. When it does burn, the forest usually burns in a mosaic that increases biological diversity. Even in cases where old-growth forest is quite rare, actively seeking to suppress fire in these forest types is questionable in that the gross negative ecological impacts of "fighting" fires generally exceed any net ecological benefits of putting out a fire before nature does so itself. In addition, fire fighting really doesn't work anyway, as nature starts most fires (lightning) and nature ends most fires (because the fire burns all available dry fuel or is extinguished by rain and snow).

---

18 Hessburg, P. F., J. K. Agee, J. F. Franklin. 2005. Dry forests and wildland fires of the Inland Northwest, USA: contrasting the landscape ecology of the pre-settlement and modern eras. Forest Ecology and Management 211: 117-139.

19 Noss et al. (2006): 484.

20 Noss et al. (2006): 483-484.

As for interior higher elevation forests, let them burn when they want to burn. Lodgepole pine forests are an example. The destiny in life of most interior lodgepole pine is to live a relatively short time (for a tree) and then die in a stand-replacing blaze. Concerns about mountain pine beetle "infestations"—often a precursor to a cleansing fire—are generally raised by those interested in wood more than the woods.

> *The mountain pine beetle has played an historic role in the dynamics of lodgepole pine ecosystems. By periodically invading stands and creating large amounts of fuels, which are eventually consumed by fire, creating favorable conditions for regeneration, the beetle has increased the probability that lodgepole pine will reoccupy the site at the expense of other species."*[21]

If the Forest Service is concerned about an interior high elevation forest burning when the agency doesn't want it to burn, then the agency should burn such a forest when it wants it to burn.

Wendell Wood, Oregon Wild

A social problem that must be resolved is how to regulate smoke that results from burning forests. If the smoke comes from a wildfire, it is deemed a natural event and air quality regulations do not apply. However, if it comes from a prescribed fire, it is considered a human activity that is regulated under clean air laws.

Mixed-Severity Fire Types

I am somewhat worried about management of mixed-severity fire type forests because the conditions and health of these forest types are difficult to assess. What constitutes a natural state versus a human-caused altered state for a particular mixed-severity fire forest type? How many fire cycles can a given mixed-severity forest type miss before the forest ecology is out of whack? What are the consequences if the forest burns before it can be thinned? What are the consequences of thinning? Noss et al. state:

> *Scientific understanding of mixed severity fire regimes is limited, making it difficult to provide defensible guidelines for restoration. These are often complex landscape mosaics; it is therefore necessary to plan and conduct activities at large spatial scales. Where sufficient ecological and fire-history information is available, a combination of thinning and prescribed fire may be useful in restoration. Nevertheless, only portions of these landscapes may warrant treatment.*[22]

The Larch Company

A mixed conifer forest in the southern Oregon Cascades. Scattered old-growth trees are being encroached by 70-90 year old true firs in the understory that are stealing moisture from the old giants and will possibly serve as ladder fuel that will carry otherwise beneficial surface fire into the forest canopy. On the other hand, if this stand is burned by a cool, slow moving fire, it might only clean out the ground cover and spare most of the smaller trees to continue encroaching on the oldest trees. On yet another hand, a hot fire might replace the entire stand. While mixed-fire severity forests are complex, such is no reason to sit on our hands and not consider what management might restore natural, beneficial fire to these forest types.

---

21 Burns, R. M. and B. H. Honkala (tech. coords.). 1990. Silvics of North America: 1. Conifers. Agriculture Handbook 654. USDA-Forest Service. Washington, DC. (available at www.na.fs.fed.us/spfo/pubs/silvics_manual/Volume_1/pinus/contorta.htm).
22 Noss et al. (2006): 484.

Table 1*
Fire Regimes of Major Western Forests and Examples of Plant Association Groups

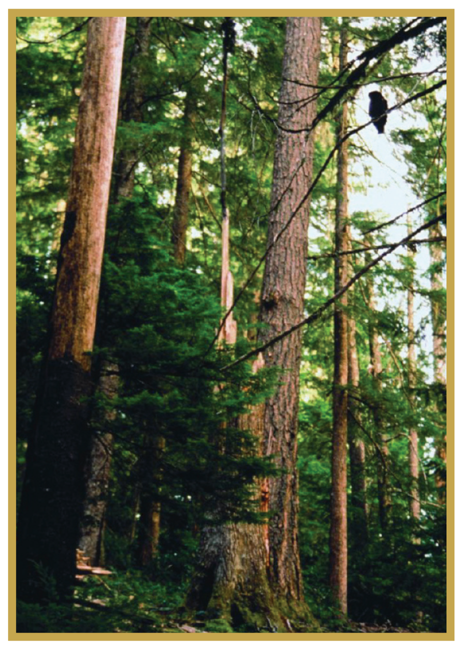
Dominant fire type	*General forest type*	*Common plant association groups*
High severity, low frequency	Coastal temperate forests	Sitka spruce, western hemlock, western redcedar, Douglas-fir
	Coastal subalpine forests	Mountain hemlock, Pacific silver fir
	Pinyon pine–juniper woodlands	Colorado pinyon, singleleaf pinyon, Utah juniper, western juniper
	Interior Northwest montane forests	White pine, western redcedar, western hemlock
	Interior subalpine forests	Engelmann spruce–subalpine fir, lodgepole pine, bristlecone pine, limber pine, whitebark pine, quaking aspen
Mixed severity, mixed frequency	Coastal oak woodlands	
	Rocky Mountain ponderosa pine– Douglas-fir forests	Ponderosa pine, Douglas-fir, western larch
	Interior mesic mixed conifer forests	Douglas-fir, white fir, aspen
	Klamath–Siskiyou mixed evergreen forests	
	Sierra Nevada red fir forests	Shasta red fir
	Sierra Nevada giant sequoia forests	Giant sequoia
Low severity, high frequency	Dry ponderosa pine forests	Ponderosa pine, Jeffrey pine
	Dry mixed conifer forests	Ponderosa pine, Douglas-fir, dry grand fir

* Noss et al. (2006): 484.

Forest Restoration Considerations for Species Dependent on Either Late- or Early-Successional Stands

Noss et al. remind us that as we restore vast landscapes, we must also consider the short- and long-term needs of individual species.

> *Species closely associated with late- or early-successional conditions in fire-prone landscapes need special management consideration. For example, managed forests are often fragmented by periodic logging and road-building, or consist only of stands of trees too small or too open to meet the needs of late-successional dependent species, such as the spotted owl (*Strix occidentalis*).*[23]



Oregon Wild/Sandy Lonsdale

A northern spotted owl in an old-growth forest on the Willamette National Forest. No need for restoration here, only protection.

[23] Noss et al. (2006): 484.

Watershed Constraints on Forest Restoration

While scientifically based restoration of Oregon forests using thinning can have significant benefits to the terrestrial component of (1) low-severity, high frequency fire types, (2) some mixed-severity varying frequency fire types and (3) monoculture tree plantations in any forest type, any restoration treatment must carefully account for and mitigate the impacts on the aquatic component of these forest ecosystems. For example, if currently commonly available logging equipment is used, thinning operations may require temporary new or rebuilt roads. Roads compact soil and increase erosion, as does the use of heavy equipment off roads, both of which detrimentally affects aquatic systems. However, if modern harvesters and forwarders (see "New Techniques and Tools for Restoration Logging" below) are properly used, additional roading may be avoided.

Forest restoration must balance the needs of both the terrestrial and watershed components of any forest. As we restore a forest, we must also restore the associated watershed by permanently removing—or at least rendering hydrologically invisible—unnecessary roads and culverts, removing impassable barriers to aquatic species, reducing water withdrawals from streams and ending livestock grazing and other activities that impair hydrologic function.[24]

Moisture Stress and Ponderosa Pine Restoration

> *In most of the pure yellow-pine forests of [Oregon] the trees are spaced rather widely, the ground is fairly free from underbrush and debris, and travel through them on foot or horseback is interrupted only by occasional patches of saplings and fallen trees.*[25]
>
> \- T. T. Munger, 1917

Oregon Wild file photo

In particular—but not exclusively—in ponderosa pine forest types, high-grade logging has removed most of the old-growth ponderosa pine, making those "yellow-bellies" remaining all the more important. Fire suppression and livestock grazing are converting open park-like ponderosa pine forests that, in Oregon, generally had 20-50 mostly large trees—often ranging from 400 to 600 years of age—per acre into dense stands of ponderosa or fir understory of 500-1,000 mostly seedlings, saplings and poles per acre. In Oregon, natural fire frequency, before the introduction of Smokey Bear and domestic livestock grazing, was generally 2-47 years.[26]

Besides the acknowledged concern that these smaller trees can serve as a ladder fuel to carry otherwise beneficial surface fire into the canopy of otherwise fire-resistant old-growth trees, conservationists must also be concerned that the new (1 to ~130± years; post-European invasion) dense little trees will out-compete the remaining older trees (~130±; pre-European invasion) for space and moisture. While old-growth trees may succumb to insect infestation or disease, the underlying cause of death is often the weakened condition of the big, old trees from

---

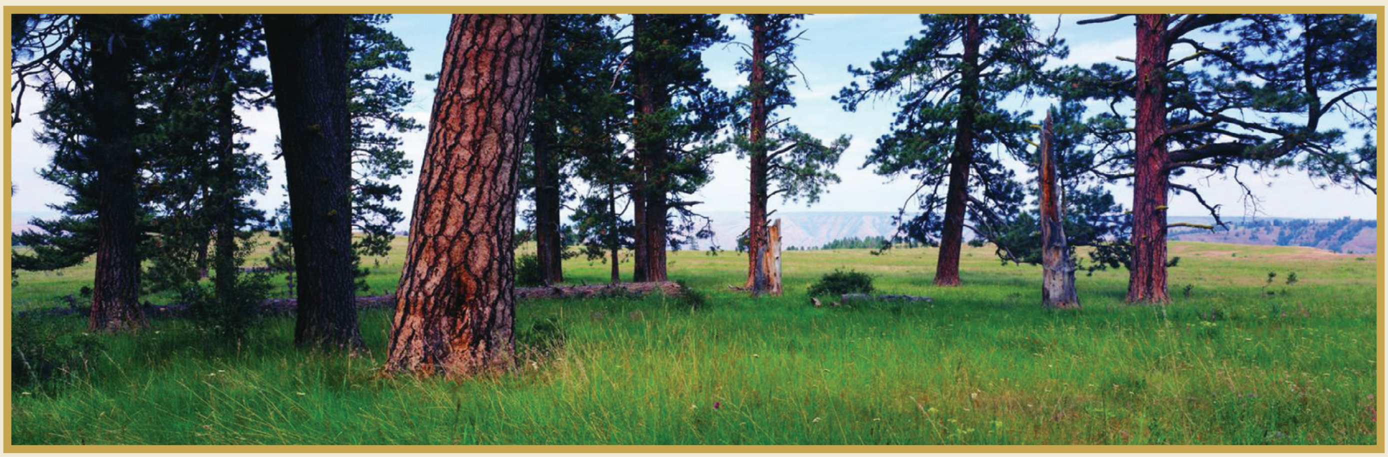
24 Rhodes, J. J. 2007. The Watershed Impacts of Forest Treatments to Reduce Fuels and Modify Fire Behavior. Pacific Rivers Council. Eugene, OR.
25 Munger, T. T. 1917. Western Yellow Pine in Oregon. Bulletin 418. U.S. Department of Agriculture. Washington, DC. 48 pp.
26 Fitzgerald, S. A. 2005. Fire ecology of ponderosa pine and the rebuilding of fire-resilient ponderosa pine ecosystems. Pages 197-226 *in* M. W. Ritchie, D. A. Youngblood, A. Youngblood (tech. coords.). Proc. Symposium on Ponderosa Pine: Issues, Trends, and Management; Oct. 18-21, 2004; Klamath Falls, OR. Gen. Tech. Rep. PSW-198. USDA-Forest Service, Pacific Southwest Research Station. Albany, CA.

stress caused by a lack of moisture.[27] In the case of old-growth ponderosa pine in particular, so few big old trees remain that they need our special attention in the short-term. These survivors need relief from overcrowding from numerous little trees.

While we are removing those small trees we must remember to leave enough of them behind to provide wildlife cover and to someday replace the large snags and old trees that make up the old-growth forest. We must also often leave behind more old trees per acre than perhaps traditionally occupied a site because of a general shortage of old trees in the area.

Box 3: The Dirt Under Overgrown Ponderosa Pine Forests

On the Fremont National Forest in Oregon, many of the dense stands of ponderosa pine growing at lower elevations are growing on Mollisols.[28] "Mollisols are soils that have a dark surface horizon and are commonly found in *grasslands*"[29] (emphasis added). What is often characterized as "park-like" stands of ponderosa pine *forest* may be more accurately described as park-like stands of ponderosa pine *savannah*. Naturally, there was more area covered by grass than by trees. One should not misinterpret this as an argument to essentially clearcut forests on mollisols. One must factor in today's conditions where it may be desirable to leave a heavier density of forest, at least for some period of time, to account for forest loss elsewhere in the area.



Oregon Wild/Ellen Bishop

Many ponderosa pine "forests" are more accurately characterized as "parklands" or "savannah," like this one in the Hells Canyon National Recreation Area on the Wallowa-Whitman National Forest.

Forest Change Versus Forest Expansion

Conservationists are most familiar with natural forests being converted to unnatural landscapes due to livestock grazing, fire suppression and high-grade logging. However, there is also a case where livestock grazing and fire exclusion in the sagebrush steppe is facilitating the expansion of western juniper into previously tree-free landscapes and quaking aspen stands. Aggressive intervention is often needed in this case, though it must be done primarily on a non-commercial basis, as few economic opportunities coincidental to conservation exist in this case.[30]

27 Perry, David, Professor, Department of Forest Science, Oregon State University, pers. comm (Nov. 29, 2006).
28 Perry, David, Professor, Department of Forest Science, Oregon State University, pers. comm (Nov. 29, 2006).
29 Natural Resources Conservation Service. 1989. Percent of Land in Mollisols. Map m4034. USDA-Natural Resources Conservation Service, Resource Assessment Division. Washington, DC.
30 Kerr, A. and M. N. Salvo. 2007. Managing Western Juniper to Restore Sagebrush Steppe and Quaking Aspen. Sagebrush Sea Campaign. Chandler, AZ.

Forest Restoration Can Look Like Hell — But It Doesn't have To

Not unlike a multiple heart-bypass patient just after surgery, forest restoration by thinning can initially look awful. Thinning is logging. Soil can be disturbed. Stumps are created. Some trees large enough to hug are cut. But if nature is given time to heal, livestock are removed, and fire is reintroduced, after a few to several years (the more productive the ecosystem, the less time needed for recovery) the area will begin to look much better. Much of this unsightliness can be dramatically reduced by the use of modern logging equipment (see "New Techniques and Tools for Restoration Logging" below).

Doug Heiken, Oregon Wild

Recently completed plantation thinning on the Siuslaw National Forest.

Doug Heiken, Oregon Wild

Thinning on the Trove Project on the Willamette National Forest. It still doesn't look much like a real forest, but it started as a tree plantation, after all.

New Techniques and Tools for Restoration Logging

Where it is determined appropriate to thin forests by mechanical means, that should not mean business as usual for logging companies to use existing techniques and heavy equipment favored by most operators for logging, such as bulldozers and rubber-tired skidders. State-of-the-art harvesters (cuts log to length and limbs log at stump site) and forwarders (hauls logs to landing area without requiring roads)—while capital intensive—are very efficient to cut small diameter trees and have significantly less impact on forest soil, resulting in significantly less compaction and erosion.

John Deere

John Deere

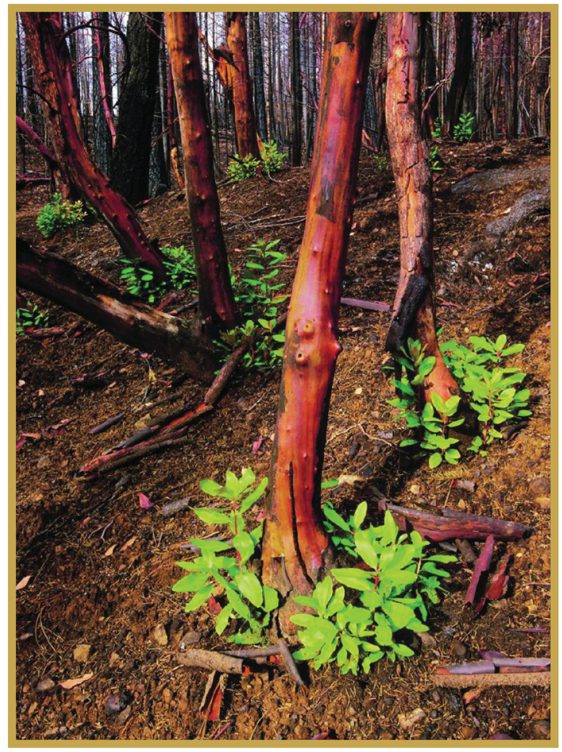
A state-of-the-art harvester and forwarder, though capital intensive, are efficient and can be financially viable, and result in less compaction of soils and damage to remaining vegetation and the watershed.

The use of lower impact logging equipment can be made even less harmful to forests depending on the method and timing of their operation. For example, to minimize soil impacts, restoration thinning should be done when the ground is frozen, covered in snow, or dry. For example, the use of tire chains to help the equipment move on deep snow is acceptable, but not to get around in the mud.

Conservationists should support government incentives to encourage the widespread use of this kind of equipment.

The Salvage Logging Racket

Conservationists support for scientifically based thinning of certain forest types with certain forest conditions *before* reintroduction or restoration of fire (wild or prescribed) does not in any way imply support for logging *after* a fire (of any kind). While there are ecological benefits to thinning certain fire-suppressed forest types with certain stand conditions and then introducing prescribed fire before inevitable wildfire, there are no such benefits to logging after a fire in any type of forest. Noss et al. are quite specific as to the consequences of post-fire logging.



Oregon Wild/Ken Crocker

As soon as rain extinguished the 2002 Biscuit Fire (the millions of dollars spent on firefighting were wasted), new madrone sprouts were seen even before the onset of winter.

> *First, post-burn landscapes have substantial capacity for natural recovery. Re-establishment of forest following stand-replacement fire occurs at widely varying rates; this allows ecologically critical, early-successional habitat to persist for various periods of time.*
>
> *Second, post-fire (salvage) logging does not contribute to ecological recovery; rather, it negatively affects recovery processes, with the intensity of impacts depending upon the nature of the logging activity. Post-fire logging in naturally disturbed forest landscapes generally has no direct ecological benefits and many potential negative impacts. Trees that survive fire for even a short time are critical as seed sources and as habitat that sustains biodiversity both above- and belowground. Dead wood, including large snags and logs, rivals live trees in ecological importance. Removal of structural legacies, both living and dead, is inconsistent with scientific understanding of natural disturbance regimes and short- and long-term regeneration processes.*
>
> *Third, in forests subjected to severe fire and post-fire logging, streams and other aquatic ecosystems will take longer to return to historical conditions or may switch to a different (and often less desirable) state altogether. Following a severe fire, the biggest impacts on aquatic ecosystems are often excessive sedimentation, caused by runoff from roads, which may continue for years.*
>
> *Fourth, post-fire seeding of non-native plants is often ineffective at reducing soil erosion and generally damages natural ecological values, for example by reducing tree regeneration and the recovery of native plant cover and biodiversity. Non-native plants typically compete with native species, reducing both native plant diversity and cover.*

> *Fifth, the ecological importance of biological legacies and of uncommon, structurally complex early-successional stands argues against actions to achieve rapid and complete reforestation. Re-establishing fully stocked stands on sites characterized by low severity fire may actually increase the severity of fire because of fuel loadings outside the historical range of variability.*
>
> *Finally, species dependent on habitat conditions created by high severity fire, with abundant standing dead trees, require substantial areas to be protected from post-fire logging.*[31]

Salvage logging after a fire is part of a racket that is the fire-industrial complex.[32]

OREGON WILD/Ken Crocker.

Salvage logging after a forest fire is akin to mugging a burn victim.

OREGON WILD/Ken Crocker.

Much of the area within the perimeter of the 2002 Biscuit Fire on the Siskiyou National Forest burned lightly or not at all.

OREGON WILD/Elizabeth Feryl

The infamous 1991 Warner Creek Fire was caused by arson and Willamette National Forest officials eagerly sought to salvage the "dead" trees (the recent fire scars may be seen at the base of the trees), but were prevented from doing so by intense citizen opposition and their superiors higher up the Forest Service.

---

31 Noss et al. (2006): 485-86

32 Wuerthner, G. (ed.). 2006. WILDFIRE: A CENTURY OF FAILED FOREST POLICY. Foundation for Deep Ecology. Sausalito, CA; Island Press. Washington, DC. 252 pp.

Young Forests More Rare than Old-Growth Forests

Restoring forests is not just about favoring old-growth trees. The goal must be to conserve and restore fully functioning forests, which will be more old than young, as that is the natural way of things. However, Noss et al. remind us to also account for young forests in restoration plans.

> *Forest landscapes that have been affected by a major natural disturbance, such as a severe wildfire or wind storm, are commonly viewed as devastated. Such perspectives are usually far from ecological reality. Overall species diversity, measured as number of species – at least of higher plants and vertebrates – is often highest following a natural stand replacement disturbance and before redevelopment of closed-canopy forest. Important reasons for this include an abundance of biological legacies, such as living organisms and dead tree structures, the migration and establishment of additional organisms adapted to the disturbed, early-successional environment, availability of nutrients, and temporary release of other plants from dominance by trees. Currently, early-successional forests (naturally disturbed areas with a full array of legacies, i.e. not subject to post-fire logging) and forests experiencing natural regeneration (i.e. not seeded or planted), are among the most scarce habitat conditions in many regions.*[33]

It is not only unnecessary to log to create young forests, but impossible. All one has to do is avoid "salvage logging" after a natural disturbance (fire, wind, insect infestation, disease event, etc.). The legacy of large woody material (both live and dead standing trees, downed trees, etc.) is a fundamental component of a healthy young forest stands.

Where and How to Restore

Table 2 summarizes restoration needs, if any, and appropriate restoration strategies for major Oregon forest types (Map 1). In general:

• Westside Douglas-fir, lodgepole pine, mountain hemlock, silver fir, Sitka spruce and subalpine fir dominated forest types are of high fire-intensity and low fire-frequency and are in no need of restoration by fire with or without thinning first.

• Oregon white oak, ponderosa pine dominated forest types are of low fire-intensity and high fire-frequency and are often in need of restoration by fire with or without first thinning commercially or non-commercially.

• Eastside Douglas-fir, Jeffrey pine, redwood, Siskiyou mixed, true fir and western larch dominated forest types are of mixed fire-intensity and medium fire-frequency and may or may not be in need of restoration by fire with or without thinning first. The drier the forest, the more likely.

• Quaking aspen and western juniper are high fire-intensity and of widely varying fire-frequency that are mostly in need of restoration by fire with or without thinning first.

---

33 Noss et al. (2006): 485.

Table 2
Restoration Parameters for Major Oregon Forest Types[34]

Dominant Tree Species on Map 1-1	*Forest Types*	*Dominant Fire Type Severity**	*Restoration Needs for Non-Plantation Stands***	*Restoration Strategies If Needed*
Douglas-fir	Douglas-fir/ Broadleaf Deciduous; Douglas-fir/Oregon White Oak; Douglas-fir/ Ponderosa/Incense Cedar; Douglas-fir/Ponderosa/ True Fir; Douglas-fir/Western Hemlock; Douglas-fir/True Fir/ Ponderosa Pine/ Western Larch	High	Generally none. As a high severity fire type, human-caused interruption of natural fire cycles has been minimal to none, especially in the wetter forest types (associated with broadleaf deciduous or western hemlock trees). The drier forest types, in certain circumstances, may be appropriate for active restoration.	Reintroduction of fire into drier sites. In certain circumstances, some thinning (noncommercial and possibly commercial in application) before fire reintroduction may be appropriate.
Jeffrey Pine	Siskiyou Jeffrey Pine	Mixed	"*Scientific understanding of mixed severity fire regimes is limited, making it difficult to provide defensible guidelines for restoration. These are often complex landscape mosaics; it is therefore necessary to plan and conduct activities at large spatial scales.*" (Noss et al. [2006])	"*Where sufficient ecological and fire-history information is available, a combination of thinning and prescribed fire may be useful in restoration. Nevertheless, only portions of these landscapes may warrant treatment.* (Noss et al. [2006])
Lodgepole Pine	Lodgepole; Lodgepole/ True Fir; Lodgepole/ Western Larch; Subalpine Lodgepole	High	Generally none. As a high severity fire type, human-caused interruption of natural fire cycles has been minimal to none.	If you don't want lodgepole pine to burn when lodgepole pine wants to burn, then burn lodgepole pine when you want it to burn. The important thing to never forget is that lodgepole pine is going to burn.
Mountain Hemlock	Mountain Hemlock; Mountain Hemlock/ Parklands; Mountain Hemlock/Red Fir; Mountain Hemlock/Red Fir/Lodgepole	High	Generally none. As a high severity fire type, human-caused interruption of natural fire cycles has been minimal to none.	Let it burn when it wants to burn.
Oregon White Oak	Oregon White Oak/ Douglas-fir; Oregon White Oak/Pacific Madrone; Oregon White Oak/Ponderosa	Low	Very site dependent, though encroachment by Douglas-fir and invasive weeds is common.	In cases where fire suppression has favored evergreen trees at the expense of Oregon white oak, it may be desirable to thin (non-commercially or commercially) the conifers before reintroducing fire. Remove invasive weeds and the vectors such as off-road vehicles and livestock that spread them.
Ponderosa Pine	Ponderosa, Ponderosa/ Douglas-fir/True Fir; Ponderosa/Douglas-fir/Western Larch/ Lodgepole; Ponderosa/ Grasslands; Ponderosa/ Lodgepole; Ponderosa/ White Oak; Ponderosa on Pumice; Ponderosa/Scrub	Low	Generally high on all forest types.	The cessation of livestock grazing is necessary to restore full forest function, as is the reintroduction of fire. In many cases, the (noncommercial or commercial) thinning of trees is desirable before the reintroduction of fire. In roadless areas, it is generally desirable to avoid the creation of stumps and can generally be avoided with intensely careful restoration of fire under appropriation conditions (which may involve a backpack flamethrower and snowshoes.)

34 Major Oregon forest types derived from W. Loy (ed.). 2001. "Biotic Systems" *in* Atlas of Oregon (2nd ed.).University of Oregon Press. Eugene, OR: 175-185 (which is based on J. Kagan and S. Caicco. 1992. Manual of Oregon Actual Vegetation. Oregon Natural Heritage Program, Idaho Cooperative Fish & Wildlife Research Unit. Oregon Geospatial Data Clearinghouse. GAP vegetation, 1:250,000).

Quaking Aspen	Quaking Aspen	High	If grazed by livestock and fire has been suppressed, restoration is likely necessary.	Remove the livestock permanently and reintroduce fire. In some cases, it may be necessary to cut the emerging conifer understory first, but it may be just best to torch the entire stand and let the young aspens return. ***
Redwood	Redwood	Mixed	Generally none. Human-caused interruption of natural fire cycles has been minimal to none at most locations.	Periodic burning of the understory to mimic historic burning of certain sites by Native Americans may be justified on social, but not ecological, grounds.
Silver Fir	Silver Fir/Western Hemlock/Noble Fir	High	Generally none. As a high severity fire type, human-caused interruption of natural fire cycles has been minimal to none.	
Siskiyou Mixed	Siskiyou Mixed Conifer (High Elevation); Siskiyou Mixed Conifer; Siskiyou Mixed Evergreen	Mixed	"*Scientific understanding of mixed severity fire regimes is limited, making it difficult to provide defensible guidelines for restoration. These are often complex landscape mosaics; it is therefore necessary to plan and conduct activities at large spatial scales.*" (Noss et al. [2006])	"*Where sufficient ecological and fire-history information is available, a combination of thinning and prescribed fire may be useful in restoration. Nevertheless, only portions of these landscapes may warrant treatment.* (Noss et al. [2006])
Sitka Spruce	Sitka Spruce	High	Generally none. As a high severity fire type, human-caused interruption of natural fire cycles has been minimal to none.	
Subalpine Fir	Subalpine Fir/ Engelmann Spruce Parklands	High	Generally none. As a high severity fire type, human-caused interruption of natural fire cycles has been minimal to none.	
True Firs	True Fir/Douglas-fir; True Fir/Lodgepole; True Fir/Lodgepole/ Western Larch/ Douglas-fir	Mixed	The drier forest types (generally more associated with ponderosa and western larch trees), may be appropriate for active restoration.	Reintroduction of fire into drier sites. In certain circumstances, some thinning (noncommercial and possibly commercial in application) before fire reintroduction may be appropriate.
Western Juniper	Juniper/Big Sage; Juniper/Bitterbrush; Juniper/Grasslands; Juniper/Low Sage; Juniper/Mountain Big Sage; Juniper/Ponderosa	High	First determine if the area in question was naturally (pre-livestock grazing and pre-fire suppression) a western juniper forest or woodland or is a case of western juniper invading sagebrush steppe.	If naturally a western juniper forest or woodland, no restoration is likely necessary, other than remove the livestock and reintroduce fire. If it is the case of western juniper invading sagebrush steppe aggressive restoration to restore sagebrush steppe may be necessary. ***
Western Larch	Western Larch/Douglas-fir/True Fir; Western Larch/Douglas-fir/ Ponderosa/Lodgepole	Mixed	It all depends on the site and the stand conditions. North-facing slopes are less in need of active restoration, while south-facing slopes are more so.	Restore natural fire regime. Thinning may be appropriate in certain circumstances.

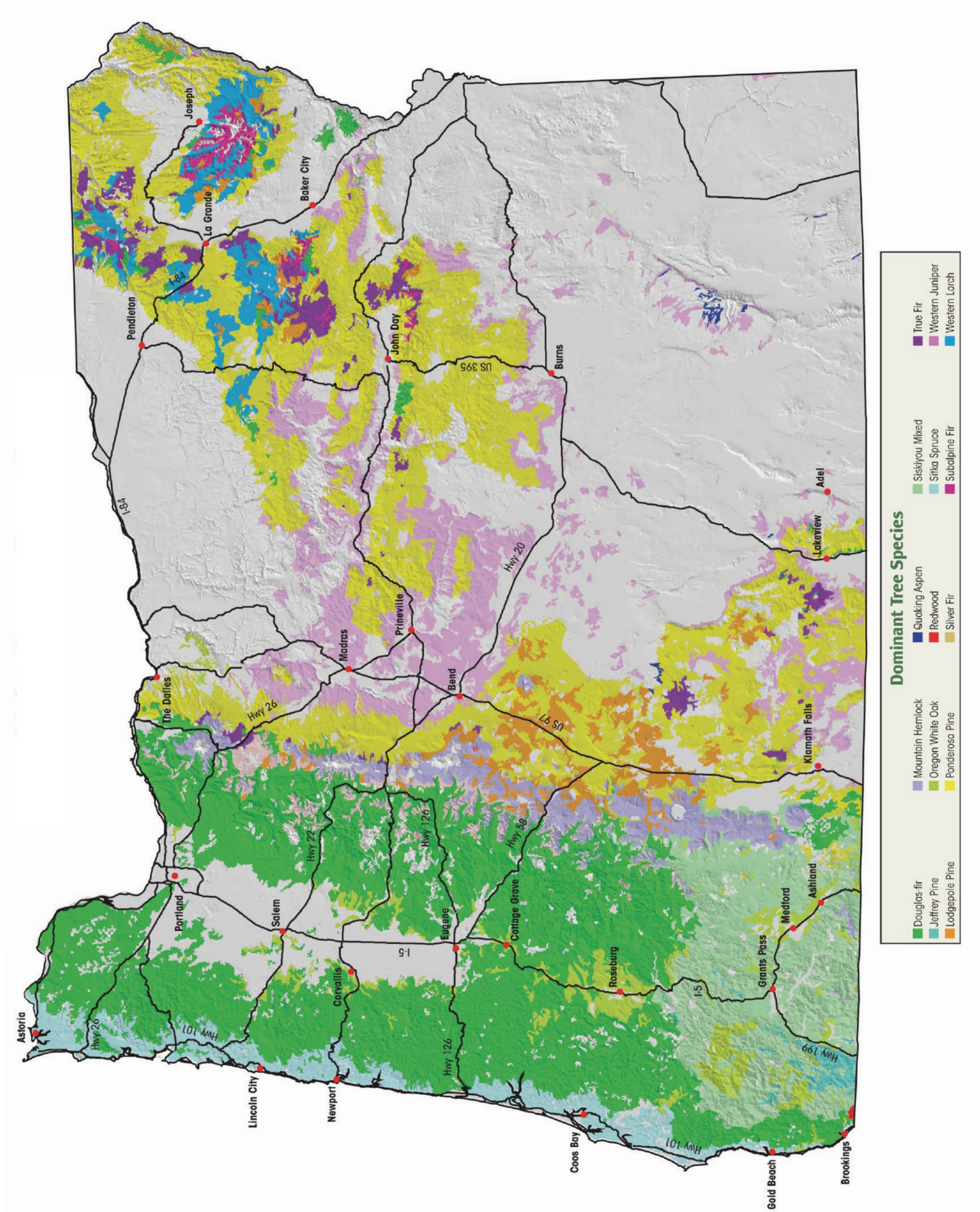
* Generally adapted from Noss, et al. (2006).

** Plantation stands in any forest type are generally benefited from variable density thinning to accelerate the onset of late-successional characteristics, subject to appropriate restraints to project and restore soil and hydrological functions.

*** *See*: Kerr, A. and M. N. Salvo. 2006. Managing Western Juniper to Restore Sagebrush Steppe and Quaking Aspen. Sagebrush Sea Campaign. Chandler, AZ

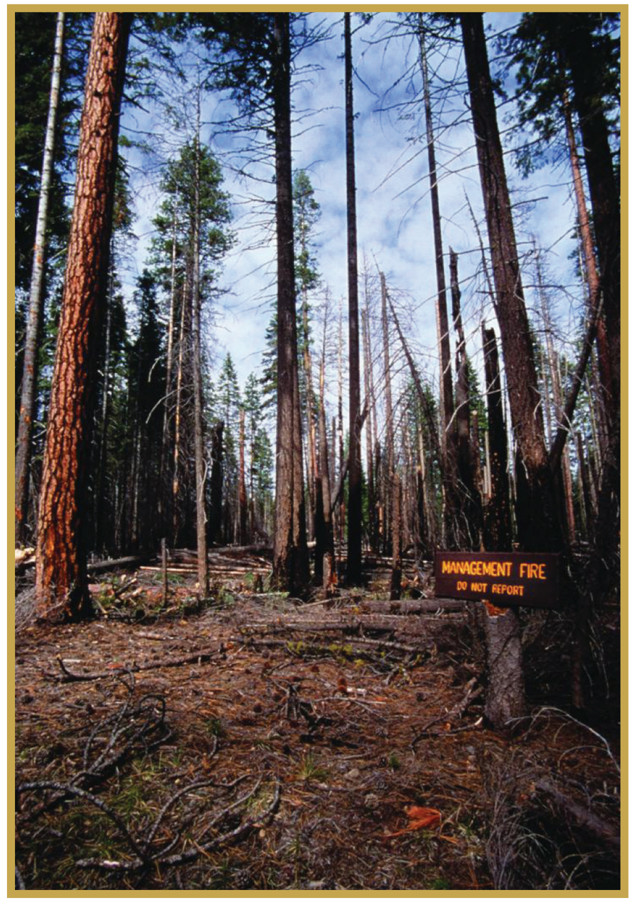
**** Applies to true western juniper forest or woodland type, not where western juniper is invading sagebrush steppe.

Map 1. Major Oregon Forest Types



A Matter of Money

Livestock grazing, roading, logging and fire suppression on federal forestlands have produced a massive ecological debt. While it would be ideal if the federal government would simply pay for ecologically justifiable forest thinning, road restoration, and watershed rehabilitation as part of a comprehensive and scientifically rational forest restoration program, that is not likely to happen. The money is not politically available and the scale of restoration needed on federal forests is immense. In one of life's bemusing ironies, the conservation community needs—for the next few decades—the timber industry to log more, not less, on Oregon public lands—although of smaller-diameter trees. The ecological backlog of problematic small trees has economic value and can pay—or nearly pay—for its own removal, as well as the removal of non-commercial problematic trees and unnecessary roads, if mills invest in state-of-the-art microlog log processing facilities (as small as a 12-foot log with a 4-inch top).



Oregon Wild/Elizabeth Feryl

The National Park Service has a positive attitude toward restoration of fire-suppressed stands in Crater Lake National Park.

Letting It Burn

To achieve passive restoration, or to realize the full benefits of active restoration, public land agencies must embrace wildland fire as a management strategy. The National Park Service is very enlightened in this regard, as are certain regions of the Forest Service (Region 1, Northern and Region 2, Southwestern). The Pacific Southwest Region (Region 5, California) is catching up. However, Region 6, the Pacific Northwest Region, for the most part believes the only way to "fight" a fire is with a blank check.[36]

Box 4: Forest Restoration and Climate Change

While forest restoration plans need to factor in climate change, climate change should not be used as an excuse not to restore forests. Biodiversity, watershed and recreation benefits of restored forests are generally consistent with carbon sequestration goals. The more forestlands that are restored to full ecological health and function, the more likely that forests will be both resistant and resilient to the occurrence of climate change. Also, as more forests are restored, more atmospheric carbon will be safely returned to biospheric carbon.[35]

---

35 Heiken, D. 2007. The Straight Facts on Forests, Carbon and Global Warming. Oregon Wild. Eugene, OR.
36 Kerr, A.. 2006. The ultimate firefight: changing hearts and minds. Pages 273-277 *in* G. Wuerthner (ed.). Wild Fire: A Century of Failed Forest Policy. Foundation for Deep Ecology. Sausalito, CA; Island Press. Washington, DC. 252 pp.

Learning to Trust Federal Forest Agencies

The historic distrust and antipathy of the conservation community toward federal forest agencies is well founded. In the past, our public agencies were terrible stewards of public forests. Today, while still far from perfect, the Forest Service is now beginning to do more good than bad to the national forests. A major reason for the agency's evolution is that it has become increasingly difficult to log old trees on federal forests (although, unfortunately, still not difficult enough). However, another reason (and probably a result of the first reason) is that the Forest Service bureaucracy is transitioning from a timber-beast support bureaucracy to a forest-stewardship bureaucracy (whether true stewardship is actually possible in a self-serving bureaucracy is another discussion). This transition is not occurring fast enough for conservationists and not without glitches, reversals and diversions. One does not train dogs, children or bureaucracies in a day. Nonetheless, reform in Forest Service is occurring—even under the George W. Bush Administration—and deserves recognition and encouragement from the conservation community (unfortunately, the same cannot be said for the Bureau of Land Management[37]). By partnering with the Forest Service, conservationists can assist this positive trend rather than risk leaving a vacuum that competing interests would no doubt fill.

Oregon Wild/Jay Lininger

Fire has sculpted this mixed-severity fire-regime stand near the Rogue River and it could use another fire. However, the Bureau of Land Management plans to clearcut this area and calls it an "old-growth regeneration" project. BLM is the last refuge of unreconstructed federal timber beats and should be run out of western Oregon and be replaced by the Forest Service.

Oregon Wild/Umpqua Watersheds

*This Douglas-fir (*Pseudotsuga menzeisii*) in the Bunker Hill Unit of the proposed North Umpqua Wilderness is perhaps 1,000 years old. The only way to know for sure is to cut it and count rings. Counts on nearby stumps showed over 600 rings on trees that were three feet in diameter. In the name of forest "health," the Forest Service is contemplating cutting down this tree to make more room for a younger (but still rather old) ponderosa pine (*Pinus ponderosa*) nearby. It is cases like this for which conservationists must be eternally vigilant.*

37 *See* Kerr, Andy. 2007. Transferring Western Oregon Bureau of Land Management Forests to the National Forest System. Ashland, OR: The Larch Company. Occasional Paper #2.

The Art of Forest Restoration

While science should always guide forest restoration at both the landscape and forest stand level, the details of whether a particular tree should be logged or not is often a matter of judgment. Management prescriptions that are appropriate to the forest type and stand condition can only provide so much guidance. Absolute limits, be they measured by age, in diameter at breast height (dbh), basal area, or in other ways, do not allow for sometimes desirable exceptions to the rule. Today, on the eastside national forests of Oregon and Washington, the Forest Service is generally prohibited from cutting a live tree over 21 inches dbh. This is generally a good thing, especially for rare old-growth ponderosa pine. In most cases, but not always, 21 inches is a good retention minimum for large white fir. But there are exceptions to the rule.

For example, consider the case of a 26-inch dbh ponderosa pine, a 22-inch white fir, and a 20-inch ponderosa pine, the latter two growing in the canopy "drip line" (roughly the reach of roots) of the former. A strict reading of the current rule is that the white fir would not be cut, but the smaller ponderosa pine would be. However, coring the trees reveal that the white fir, though large, is only about 110 years old, having become established after livestock invaded the stand and consumed the fine fuels that naturally carried low-intensity surface fires. It also turns out that the larger ponderosa pine is 350 years old and the smaller one is 340 years old. In this example, I would favor logging the white fir, even though it is over 21 inches dbh and keeping the smaller ponderosa pine even though it is smaller than 21 inches dbh. The pines have lived together for 230 years before human disturbance, so worked out how to share the site long before the invasion of livestock and the white fir.

While it is critically important to know a stand of trees "originally" looked like, such should not be all controlling in making management decisions. It may be that a 22-inch dbh white fir is an interloper, but that all the big old ponderosa pines have been logged already. In this case, any big tree is important to leave in the stand. As restoration activities proceed, those marking the project should be more concerned with stand and tree character, than a particular age, basal area, or diameter. If conservationists don't trust the Forest Service employee to always exercise good judgment, then conservationists better be involved in marking which trees should stay and which trees should go.

The Timber Industry: Trust But Verify

The timber industry has lost its social license to log merely for commercial purposes roadless areas, old-growth trees and riparian areas on federal lands and has generally conceded this fact—which is why the timber industry now couches all current public lands logging as fire salvage, "forest health," and fire prevention projects. As the West continues to urbanize, the timber industry will lose its social license to commercially log federal forestlands for any purpose. However, for now, conservationists need a timber industry that logs certain smaller trees on certain Oregon federal forests to aid ecologically sound forest restoration.

The timber industry, like the federal forest agencies, is in transition. In fact, speciation has occurred. What once were all and quite numerous unreconstructed timber beasts (*Sylvanus horribilis*) has largely been replaced by a new kind of timber operator (*S. adaptus*) that is adapting to logging small trees and is more properly scaled to the capacity of the forest to sustainably produce wood. Unfortunately, *S. horribilis* is not yet extinct; fortunately they are not reproducing. Conservationists need to encourage speciation of the new kind of timber operator at least as much as we encourage the extinction of the old type. By partnering with the adapting timber operators, conservationists can help their evolution in ways we like.

Box 5: Conservationists Need Capitalists

For perhaps the next 25 years, to achieve necessary large-scale variable density thinning of tree plantations (especially on the west side of Oregon) and restoration thinning of fire-suppressed dry ponderosa pine and mixed conifer forests (especially on the eastside of Oregon), will require individuals and companies with profit motive to get the restoration work done in an efficient, effective and timely manner.

As much as one may like the idea of small-scale, locally based entrepreneurs moving through the woods using horses and/or portable mills, that economic model will not meet the ecological need for forest-wide restoration. To cost-effectively remove unwanted small trees, it will be necessary to use state-of-the-art logging equipment in combination with state-of-the-art milling equipment. Both are very capital intensive and likely beyond the reach of small-scale local entrepreneurs.

To make such capital investments, capitalists must have the expectation of adequate financial returns. Supply is a critical factor in deciding whether or not to make such an investment. Since it is a good idea to remove this ecological backlog of excess wood from the woods, conservationists should be willing to support ways to ensure an adequate supply of material for these new and necessary state-of-the-art logging and milling operations. The challenge is to equally ensure that the ecological deficit of large old trees is not further increased, but turned to a surplus. It won't be easy, but it can be done. The best way is through congressional legislation that simultaneously:

(1) conserves and restores late successional and old-growth forests, roadless areas, riparian areas and other special areas;

(2) directs the federal forest agencies to conserve and restore forests so that they are both resistant and resilient to the occurrence of climate change;

(3) prioritizes the long-term stabile storage and sequestration of carbon in forest soils and biomass;

(4) provides the timber industry the assurances that their investment in ecologically compatible restoration thinning and microlog processing equipment will pay off.

Conservationists: Calibrating to New Times, Information and Circumstances

When the facts change, I change my mind. What do you do, sir?

–John Maynard Keynes[38]

Conservationists often criticize the timber industry for driving via the rearview mirror. Admittedly, driving by the review mirror can work, but only until the road curves. Too many conservationists could also be criticized for looking backward instead of forward on forest policy.

38 Bishop, M. 2004. Essential Economics. The Economist and Profile Books. Lond

Commercial resource extraction is never a highest or best use of natural or restored public lands. However, for some damaged forests, commercial extraction will be necessary for the next few decades to remove excess small diameter timber in certain forest types exhibiting certain stand conditions. The strategy of denying timber supply to the timber industry was the correct course when the industry was wholly comprised of unreconstructed timber beasts pillaging virgin old-growth timber, clearcutting to the water's edge, and roading roadless areas. Fortunately, relatively little of this activity still occurs on federal land (although any is too much). As conservationists, we must continue to mop up these pockets of resistance. However, conservationists should also come to a new understanding with those elements of the timber industry that are willing to adapt, about the need to restore certain damaged forests. Conservationists need not embrace our former enemies as friends, but merely accept certain timber industry elements as allies of convenience—for a specified purpose and limited period of time—to achieve needed forest restoration in certain specified forest types exhibiting certain specified stand conditions.

Irrational Exuberance?

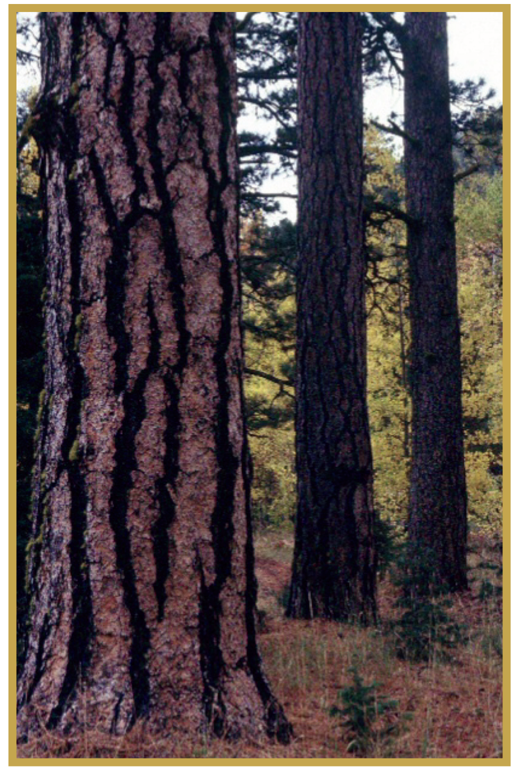
There will be a tendency by those who support the logging in public forests for purposes other than restoration to misconstrue my support for the thinning of certain forest types with certain stand conditions as unconditional and independent of other conservation goals. It is not. The commercial thinning of certain forest types with certain stand conditions can be a part of a comprehensive restoration effort that includes, but is not limited to, (a) reintroduction and maintenance of fire; (b) removal of livestock; (c) elimination of weeds; (d) removal of unnecessary roads and improvement of necessary roads to make them less damaging; and (e) widespread adoption of more environmentally sensitive logging equipment and techniques. The commercial logging for forest restoration purposes that I support is not only conditional, but also will last only for a limited time. Eventually, biomass on public forests should be regulated mostly by nature and hardly ever by chainsaws.

Joseph Vaile, KS Wild

Blue paint means remove. Conservation guidelines and principles for restoration are the first step. The second step requires conservationists getting out in the woods.

Of course, the timber industry isn't going to just magically and gracefully fade away when the work of forest restoration in public forests is done. But let's assume that restoring Oregon's forests takes 25 years. That's more than enough time for timber companies to amortize any new investments that they may need to make to log small trees. The continued urbanization and suburbanization of Oregon will only add to an electorate that increasingly will not tolerate logging merely for comemrcial gain on their local national forest. Americans living in southern California and near the Puget Sound have already succeeded in ending commercial logging in their forests. Logging companies in Oregon may not go quietly into the night, but they will have no choice but to go after Oregon's public forests have been restored.

There is an opposing tendency by those who do not support any logging on public forests for any purpose to construe my support for the thinning of certain forest types with certain stand conditions as dangerous. In some ways, it is. There is a danger that the old-guard timber industry will gets its way and not only remove small trees to aid forest restoration, but log lots of big trees as well. There is also a danger that the public and politicians are not prepared to support the reintroduction of fire on a landscape-level. There is also a danger that neither livestock nor roads will be removed from forests to achieve complete restoration. There is a danger that the environmental costs of thinning will be greater than the environmental benefits (this will certainly be the case if thinning is done badly or in excess of what is necessary to restore forests).



Wendell Wood.

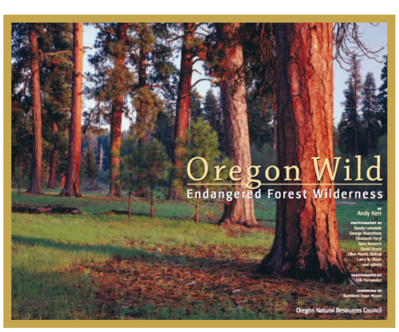
Little fir trees are taking hold under the big pines. Time to burn.

There is also danger in ignoring a consensus of the best available science and not acting. There is also the possibility that restoration thinning can be done right. The likelihood of good forest restoration is infinitely higher if the conservation community engages in the political processes that are forest policy and forest management and advocates for what it wants, rather than to oppose what it doesn't want.

Am I concerned that a revived and rejuvenated timber industry will be impossible to control? No. Here's why. The Oregon timber industry is a shadow of its former self. It has shrunk dramatically under the pressure of both economic and social forces. It will continue to downsize in the future—both in absolute and relative terms—in economic, social and political importance. What Oregon timber industry that exists in the future—its form, substance and role in society—will be beholden to a public that decides that it can exist.

Acknowledgements

In developing this paper, I am indebted to conversations and reviews from many colleagues and associates. In particular I wish to acknowledge the advice and counsel of Randi Spivak (American Lands), Dave Werntz, Mitch Friedman (both Conservation Northwest), Rick Brown (Defenders of Wildlife), Todd Schulke (Center for Biological Diversity), George Wuerthner (Foundation for Deep Ecology), Jay Lininger (Firefighters United for Safety Ethics and Ecology), Joseph Vaile (Klamath-Siskiyou Wildlands Center), Dominick DellaSala (National Center for Conservation Science and Policy), Doug Heiken, Tim Lillebo (both of Oregon Wild), Mark Salvo (Sagebrush Sea Campaign), Mike Anderson (The Wilderness Society), and Evan Frost. I'm sure I have forgotten some that I should not have, and for that I apologize. In any case, the opinions expressed herein are my own and not necessarily those who are acknowledged here.



About the Photographs

Where "*Oregon Wild*" precedes a photographer's name in a photograph credit, the image was also used in *Oregon Wild: Endangered Forest Wilderness* (2004 Timber Press). Where "*Oregon Wild*" follows a photographer's name, the person is associated with Oregon Wild (formerly Oregon Natural Resources Council).

About Andy Kerr

Andy Kerr (andykerr@andykerr.net) is Czar of The Larch Company (www.andykerr.net). A professional conservationist for three decades, he has been involved in the enactment of over 25 pieces of state and federal legislation, scores of lawsuits and endangered species listing petitions and countless administrative appeals of Forest Service and Bureau of Land Management timber sales and other decisions. He is best known for his three decades with Oregon Wild (formerly Oregon Natural Resources Council), the organization best known for having brought you the northern spotted owl. He has lectured at all of Oregon's leading universities and colleges, as well as at Harvard and Yale. Kerr has appeared numerous times on national television news and feature programs and has published numerous articles on environmental matters. He is a dropout of Oregon State University. Kerr is author of *Oregon Desert Guide: 70 Hikes* (The Mountaineers Books, 2000) and *Oregon Wild: Endangered Forest Wilderness* (Timber Press, 2004). A fifth-generation Oregonian, Kerr was born and raised in Creswell (a recovered timber town in the upper Willamette Valley). He lives in Ashland (a recovered timber town in the Rogue Valley). He lives with one wife, one dog, one cat, one horse, 20 some tropical fish and no vacancies. In his free time, Kerr likes to canoe, hike, raft, read, and work on projects that move his home and business toward energy self-sufficiency and atmospheric carbon neutrality.

About The Larch Company

The Larch Company, LLC (www.andykerr.net) is a non-membership for-profit conservation organization that represents species that cannot talk and humans not yet born, and which devotes all profits to environmental conservation. Larch has two profit centers: the Electrical Power Division and the Political Power Division. EPD owns and operates 5.1 kilowatts of photovoltaic power that provides an estimated 140% of the electric power requirements of The Larch Company and the home of its principal, Andy Kerr. PPD provides consulting services of Andy Kerr to non-profit conservation organizations and occasionally for-profit businesses (which are charged higher rates). In addition, Larch also undertakes self-initiated projects ("freelance environmental agitations"), most of which are later assumed by a non-profit conservation organization. Larch also occasionally retains other consultants to assist various conservation projects.

The Larch Company depends on clients and donations to remain in business and generate profits for environmental conservation. This Occasional Paper is a free service of the Larch Company. However, if you find the paper useful and wish to support the production of this and future Occasional Papers, (non-tax deductible) donations may be sent to The Larch Company, 1213 Iowa Street, Ashland, Oregon, 97520, USA. Thank you.

Larch Occasional Papers

This paper is a Larch Occasional Paper, a series of papers that are occasionally issued by The Larch Company on a variety of topics. Papers are available at www.andykerr.net/downloads.

#1 *Persuading Congress to Establish a Wilderness and/or Wild & Scenic River: A Checklist*
#2 *Transferring Western Oregon BLM Forests to the National Forest system.*
#3 *Thinning Certain Oregon Forests to Restore Ecological Function*