

# 3

Working Papers in Southwestern  
Ponderosa Pine Forest Restoration

## Protecting Old Trees From Prescribed Fire



Ecological Restoration Institute  
Northern Arizona University  
P.O. Box 15017  
Flagstaff, AZ 86011-5017  
[www.eri.nau.edu](http://www.eri.nau.edu)



## **Working Papers in Southwestern Ponderosa Pine Forest Restoration**

The Ecological Restoration Institute at Northern Arizona University is a pioneer in researching, implementing, and monitoring ecological restoration of southwestern ponderosa pine forests. These forests have been significantly altered through more than a century of fire suppression, livestock grazing, logging, and other ecosystem changes. As a result, ecological and recreational values of these forests have decreased, while the threat of large-scale fires has increased dramatically. The ERI is helping to restore these forests in collaboration with numerous public agencies. By allowing natural processes such as fire to resume self-sustaining patterns, we hope to reestablish healthy forests that provide ecosystem services, wildlife habitat, and recreational opportunities.

Every restoration project needs to be site-specific, but the detailed experience of field practitioners may help guide practitioners elsewhere. The Working Papers series presents findings and management recommendations from research and observations by the ERI and its partner organizations.

This publication would not have been possible without significant staff contributions and funding from the Bureau of Land Management. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the U.S. Government. Mention of trade names or commercial products does not constitute their endorsement by the U.S. Government.

Today's southwestern ponderosa pine forests are much different from those that grew prior to Euro-American settlement. Forests that once burned at frequent intervals have been prevented from burning, often for more than a century, by direct fire suppression and the results of heavy livestock grazing. Fire exclusion has created crowded "doghair thickets" of growth-suppressed trees and accumulated fuels. When fire strikes these forests, as it inevitably will, they are primed to burn hot and fast and often experience dangerous and damaging crown fires. Damage from high-intensity fires often leads to tree mortality and other undesirable ecological effects, such as severe soil erosion.

Due to logging and other ecological changes, old trees have grown scarce in most southwestern ponderosa pine forests. Many of those that remain are under increased stress due to competition from overcrowded younger trees, as well as from fire and insects. One of the primary aims of forest restoration is to preserve old trees—and to reduce competition around younger trees so that they grow large more quickly.

### **Values of large, old trees in ponderosa pine forests**

- The increased structural diversity provided by large, old trees improves habitats for birds, insects, and other animals. For example, bats can roost under loose slabs of bark on older trees.
- Large, old trees often become long-lasting snags when they die, benefiting birds and other wildlife.
- Old trees, when not surrounded by large amounts of ground fuels or "ladder fuels" that can carry fire into their canopy, are largely resistant to low-intensity surface fires.
- Old trees have greater genetic diversity than even-aged groups of young trees, and provide forests a better chance of adapting to changing climatic conditions and other environmental factors.
- The presence of old trees, especially "yellow pines," enhances the aesthetics and overall success of restoration projects.

### **Large, old trees at risk**

In 1994 forest scientists estimated that there were only 15 to 30 years remaining during which forest managers might remediate ponderosa pine forests before large tracts succumbed to crown fires, large-scale insect outbreaks, or competition (Covington and Moore 1994). Crown fires have continued to grow in extent since then, underlining the need for forest restoration. A "hands-off" forest management strategy means that many large, old trees will die prematurely.



## Not by fire alone

Frequent low-intensity fires are an essential part of restoration treatments in southwestern ponderosa pine forests. They cycle nutrients, reduce woody fuel loads, maintain an open forest structure, and promote the growth of numerous understory plant species. Such fires produce a cascade of positive effects up the food chain, including insects, birds, and mammals that feed on the plants.

While prescribed fire by itself can reduce the risk of wildfire damage because it reduces fuel surface loads under certain circumstances, it can also cause high mortality of remaining old trees. This may not be quickly apparent, as foliage can remain green for a long time because of moisture stored in the stem. Evidence of harm to old trees from prescribed burns has begun to show on several study plots north of Flagstaff, where experiments have been ongoing since the 1970s. Without previous manipulation of forest fuel loads (such as raking duff away from trunks), up to 60 percent of old trees died within 20 years following controlled burns (Sackett et al. 1996). As a result, burning often needs to be combined with other treatments to maximally benefit ponderosa pine forests—and to prevent widespread fire-caused tree mortality.

2

## Specific ways to prevent fire-caused tree mortality

- **Burn when trees are dormant.** Under a natural fire regime, most fires would occur in late spring and early summer. Burning the heavy fuel loads that follow restoration thinning treatments after long periods of fire exclusion, though, is more safely done when trees are dormant, in the colder times of the year. Trees survive scorch better when they are dormant than when they are allocating resources to growth. Root sensitivity to heat may be highest early in the growing season, leaving trees more vulnerable to mortality in early-season burns (Swezy and McGee 1991).
- **Burn when forests are moist.** Warm and dry weather can produce undesirable fire behavior that results in unplanned damage to large trees. In addition, researchers do not advise prescribed fire during periods of severe drought when trees are already stressed by lack of water. Burning at night can aid in keeping fire intensities low.
- **Utilize fire spread types and ignition techniques that result in low-intensity fire.** Backing fires, short run strip headfires, and spot ignition techniques assist in reducing tree mortality.



- **Avoid burning on lava and very thin soils.** Fulé et al. (in press) have raised an alarm about unexplained high tree mortality on a prescribed burn site atop lava soils near Mount Trumbull in northern Arizona. They noted that some of the dying trees bore scars from natural fires much earlier in their lives, indicating they would normally be able to withstand the effects of fire. The researchers recommend that burning on lava soils should be discontinued pending further investigation of tree mortality, and that thinning-only treatments should be considered for cinder soils.
- **Rake fuels away from old trees to increase their survival rate.** Thick piles of needles and bark flakes that have accumulated under large pines through a century or more of fire exclusion may cause higher soil and root temperatures during fires than those experienced by trees subjected to frequent, low-intensity fires. Glowing combustion of this material under large trees provides enough heat to penetrate even thick bark and soil layers, often resulting in tree mortality (Sackett et al. 1996). Raking fuels at least two feet away from the trunks of desirable trees can aid their survival.
- **Manually clear out live, dead, and downed fuel from beneath the canopy of trees to be protected.** Large, woody fuels were once sparsely distributed in southwestern ponderosa pine forests due to frequent fires. Now stumps, downed trees, and fallen branches often exceed the average of 8 tons per acre (Sackett 1979). These materials may burn at high temperatures and for long durations. Manual removal or scattering of these fuels may be necessary before prescribed burning in order to maintain low fire intensities. Thinning, lopping, and scattering small-diameter ladder fuel trees within 50 feet of old trees can prevent mortality caused by canopy scorch or ignition. Crushing forest floor fuels and slash with a small bulldozer to reduce flame height has also been shown to be effective in some cases.
- **Burn frequently to maintain healthy forests.** Once fires are established as part of treatment in a restored site, they should be repeated frequently to prevent the buildup of needles, bark flakes, and other fuels, as well as the growth of seedling thickets. Burn intervals will vary according to local needs, conditions, and restrictions. Historical fire frequencies that often ranged from two to twelve years (Covington and Moore 1994) can guide burning prescriptions, but even longer intervals may help promote open forest conditions. Ultimately, fires set by managers or by lightning may again burn in late spring and early summer, as was historically the case—and when smoke disperses more readily.



## References

Covington, W. W., P. Z. Fulé, M. M. Moore, S. C. Hart, T. E. Kolb, J. N. Mast, S. S. Sackett, and M. R. Wagner. 1997. Restoration of ecosystem health in southwestern ponderosa pine forests. *Journal of Forestry* 95(4):23-29.

Mast, J. N., P. Z. Fulé, M. M. Moore, W. W. Covington, and A. E. M. Waltz. 1999. Restoration of presettlement age structure of an Arizona ponderosa pine forest. *Ecological Applications* 9(1):228-239.

Moore, M. M., W. W. Covington, and P. Z. Fulé. 1999. Reference conditions and ecological restoration: A southwestern ponderosa pine perspective. *Ecological Applications* 9(4):1266-1277.

Weaver, H. 1951. Fire as an ecological factor in the southwestern ponderosa pine forests. *Journal of Forestry* 49:93-98.

Writer Anne Minard  
Series Editor Peter Friederici



## **For More Information**

**Ecological Restoration Institute**, <http://www.eri.nau.edu> or 928-523-7182.



Ecological Restoration Institute  
Northern Arizona University  
P.O. Box 15017  
Flagstaff, AZ 86011-5017  
[www.eri.nau.edu](http://www.eri.nau.edu)

2ERI 35AE

NON-PROFIT ORG.  
U.S. POSTAGE  
**PAID**  
NORTHERN  
ARIZONA  
UNIVERSITY