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Working Papers in Southwestern Ponderosa Pine Forest Restoration

Treating Slash after Restoration Thinning

August 2005

NORTHERN ARIZONA UNIVERSITY

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Ecological restoration seeks to heal degraded ecosystems by reestablishing native species, structural characteristics, and ecological processes. The Society for Ecological Restoration International defines restoration as "an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability. . . . Restoration attempts to return an ecosystem to its historic trajectory" (Society for Ecological Restoration International 2004).

In the southwestern United States, most ponderosa pine forests have been degraded during the last 150 years; many areas are now dominated by dense thickets of small trees and have lost their once diverse understory. Forests in this condition are highly susceptible to damaging, stand-replacing fires and increased insect and disease epidemics. Restoration of these forests centers on reintroducing frequent, low-intensity surface fires—often after first thinning dense stands—and reestablishing productive understory plant communities. The Ecological Restoration Institute at Northern Arizona University is a pioneer in researching, implementing, and monitoring ecological restoration of southwestern ponderosa pine forests. 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 funding from the USDA Forest Service. 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.

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Introduction

Restoration thinning of ponderosa pine forests often results in large quantities of slash that can be challenging to treat. As is true of most aspects of forest restoration, there is no one-size-fits-all approach for dealing with slash. In fact, there are several options commonly used in southwestern forests, each with its own advantages and disadvantages. It is important for land managers to understand the long-term implications of slash removal methods on ecosystem processes. This paper presents standard methods for disposing of slash, as well as the ecological and logistical tradeoffs associated with each method.

Slash Disposal: Points to Consider

1. How much slash will be produced?
2. Will the slash increase wildfire hazard or prescribed fire intensity?
3. How much has been budgeted for slash removal?
4. How much slash should be left onsite to enhance ecosystem functions?
5. Have the ecological consequences of each slash disposal method been considered?

Ecosystem Considerations

Soil

Healthy soil is the building block for all other ecosystem processes. The use of mechanized equipment for thinning a restoration site and piling slash can cause soil compaction and degrade the overall quality of the soil (Elseroad et al. 2003). High-intensity fires, whether broadcast burns or in slash piles, can also severely damage soils, leaving them sterile and unproductive.

Fungi

Mycorrhizal fungi are part of the natural biota in southwestern forest ecosystems and often serve as a good indicator of ecosystem health. Found in the soil, these fungi promote the growth and diversity of native plants, bind soil particles, and inhibit the growth of invasive plant species (Marler et al. 1999). Approximately eighty percent of vascular plants form a mutualistic relationship with arbuscular mycorrhizae (Korb and Springer 2003). Research suggests that mycorrhizal fungi can be disrupted when slash is burned, even at temperatures as low as 80°C (Selmants et al. 2003).

Seed bank

Existing seeds in the soil are important for the recolonization of a restoration site. If the seed bank has adequate numbers of viable native seeds, a plant community may be able to reestablish itself without manual seeding (Korb and Springer 2003). Seed banks vary according to location, site history, and the degree of disturbance. Low-intensity short-duration burns generally do not severely impact the seed bank; in fact, such fires appear to stimulate the germination and growth of many native herbaceous plants (unpublished data, Scott Abella, Ecological Restoration Institute). However, invasive plants are likely to colonize both areas disturbed by mechanized equipment and areas where high-intensity fires have burned, resulting in reduced regeneration of native plants.

Plants

The method by which slash is treated directly influences understory plants. Low-intensity broadcast burns of slash release nitrogen and can result in rapid plant growth. High-intensity burns and heavy use of mechanized equipment can disturb soils and result in widespread colonization by invasive plant species (Korb et al. 2004; Haskins and Gehring 2004).

Wildlife

Southwestern ponderosa pine forests are home to many birds, mammals, reptiles, and amphibians (Chambers and Germaine 2003). If left at a restoration site, larger coarse woody debris can serve as habitat for a number of species, especially small mammals (Randall-Parker and Miller 2002)

Slash Treatment Methods

Leaving some slash on a restoration site can result in ecological benefits. Course woody debris can protect forest soils and new seedlings, provide habitat for wildlife, and release valuable nutrients such as nitrogen or phosphorus into the ecosystem over time (Graham et al. 1994). Some research suggests that leaving 8 to 13 tons per acre of course woody debris is appropriate in southwestern ponderosa pine forest ecosystems; however, this value is only a guideline and will not be suitable for every restoration site (Graham et al. 1994).

Unfortunately, leaving too much slash can increase fire risk and lock up nitrogen. In dealing with slash managers must balance fire risk with the ecological benefits of leaving some slash in place. They also must assess what is logistically and financially feasible. Each of the following slash treatment methods has advantages and disadvantages.

Pile and Burn

Unmarketable wood and debris can be mechanically or manually gathered and piled in small stacks throughout the restoration site. The piles are then burned when conditions are acceptable – usually when overall fire risk is low.

- **Advantages**. Piles can be burned in a controlled manner. This method is relatively inexpensive.
- **Disadvantages**. Piled slash can provide habitat for beetles that attack pine trees (Parker 1991). Slash pile fires can burn as hot as 700°C at the soil surface and at 250°C four inches under the surface (DeBano et al. 1998). Heated soils experience changes to pH, total nitrogen, and organic carbon. The physiochemical modifications become permanent when soil temperatures reach 180°C (Giovanni et al. 1988). Burning slash piles with high-intensity fire significantly reduces densities of arbuscular mycorrhizal propagules (Korb et al. 2004); in fact, these fungi are disrupted at temperatures as low as 80°C (Selmants et al. 2003). Slash pile scars often remain unvegetated for a long time unless seeds are manually distributed. In some cases, invasive species take hold at slash pile sites and spread from them (Korb et al. 2004).
- **Recommendations**. Build small slash piles on existing roads or disturbed areas to minimize damage to undisturbed soils. If it is not possible to build piles on an existing road, revegetate pile sites with native seeds and inoculate them with arbuscular mycorrhizal propagules. This can be done by scooping some nearby soil onto them; avoid soil from areas infested with invasive plants. Research suggests that these linked efforts greatly minimize slash pile scars (see box).

Broadcast Burn

If funding is limited or a minimal amount of slash has been produced, scattering and broadcast burning the slash can be a viable option.

- **Advantages**. Low-intensity fires release nitrogen into the ecosystem and can stimulate understory plant growth. Prescribed burns reduce the risk of catastrophic wildfire by decreasing the overall forest fuel load.
- **Disadvantages**. Broadcast burns feeding on heavy loads of slash can be destructive to soils, fungi, the seed bank, and plants, and can kill trees remaining after thinning. Smoke from large broadcast fires may be burdensome to the public.
- **Recommendations**. Scatter slash away from leave trees in order to protect them during prescribed fire. If large amounts of slash remain, broadcast burn during cooler, wetter periods when the slash is damp. Ensure that slash quantities are small enough to retain some open burn windows.

Chip or Grind

Not regularly used in southwestern forests, this method uses machinery to chip or grind the slash into small pieces.

- **Advantages**. Small amounts of chipped slash spread around a restoration site can protect soil and seedlings. Chips can also hold moisture.
- **Disadvantages**. Broadcast burning of chips substantially increases the heat of subsequent fire and can damage soils. If chips are not burned they increase the risk of fire, suppress herbaceous vegetation, and lock up valuable nitrogen. Using a chipper increases project costs.
- **Recommendation**. Reduce fire risk by transporting chips to areas where they can readily be used as mulch, such as hiking trails, playgrounds, or subdivisions.

Lop and Scatter

The slash is lopped to within 2 or 3 feet of the ground. It naturally compresses over time and then can be broadcast and burned at a later date. Alternatively, a bulldozer can also be used to compress the slash.

- **Advantages**. Compressed slash breaks down faster than undisturbed course woody debris. Mechanical compression can reduce the intensity of prescribed burns (Jerman et al. 2004). Compressed slash holds less oxygen and is not in a vertical arrangement, resulting in lower tree mortality when broadcast burned.
- **Disadvantages**. If slash is mechanically compressed, increased use of machinery and operator time results in higher expense. Soil compaction and disturbance can result. Tightly packed slash can cause high soil temperatures during fire.
- **Recommendation**. Rake slash away from old-growth trees to further ensure that they are not damaged by broadcast burning (see *Working Paper 3: Protecting Old Growth from Prescribed Fire* for more information).

Haul It Away

This method is generally used only if the restoration project is small and minimal slash has been produced. The slash is loaded on trucks and taken to another location, where it is usually burned.

- **Advantages**. Since the slash is not piled or burned on the restoration site, damage to the soil, fungi, or seed bank will be minimal.
- **Disadvantages**. This can be a very expensive method for removing slash.
- **Recommendation**. Try to limit soil impacts at the restoration site by driving and parking trucks only in designated areas.

General Recommendations

- To minimize buildup of pine engraver beetle (*Ips pini*) populations, try to avoid creating slash from January until the summer monsoon season begins. If slash is created during the late winter through early summer, treating it within 6 weeks will reduce the risk of beetle-caused pine mortality.
- Remove as much slash from a restoration site as the budget allows, while still taking into account the ecological value of retaining some on site. Removing most or all material over 4 inches in diameter can help mitigate beetle outbreaks (Parker 1991).
- Minimize soil damage by understanding what soil type is present and adjusting the season of treatment and use of mechanized equipment accordingly (see *Working Paper 5: Limiting Damage to Forest Soils During Restoration*).
- Use native plant seeds to reseed slash pile scars and, if necessary, areas where slash has been broadcast burned.
- In areas of severe soil disturbance – such as slash pile sites – inoculate the soil with arbuscular mycorrhizal propagules or undisturbed soils (see *Working Paper 12: Restoring Forest Roads*).

Restoring Slash Pile Scars: Experimental Results

An experiment was conducted in the ponderosa pine forests of northern Arizona to evaluate the best methods for increasing the abundance and diversity of native plants and arbuscular mycorrhizal (AM) propagules within slash pile scars (Korb et al. 2004). In this study, several plots located within the fire gradient of slash pile scars were tested to see which treatments produced the best ecological responses. Each plot was randomly assigned to one of the following five treatments. All of the topsoil used was collected from a road construction site close to the restoration area.

Treatment 1: Control. The slash pile scar did not receive any treatment.

Treatment 2: Sterilized soil addition. Soil was steam-sterilized for 48 hours to remove all living organisms and then added at a depth of 2 centimeters.

Treatment 3: Live soil addition. Soil containing microorganisms and plant propagules and inoculated with AM fungi was added at a depth of 2 centimeters.

Treatment 4: Native seed addition (without soil). Approximately 11 grams of 19 different native seeds were added directly to the plot. The seeds were selected to match native vegetation growing near the slash pile scar.

Treatment 5: Native seed and live soil addition. Soil containing microorganisms, plant propagules, AM fungi, and the same seed amendment mixture in treatment 4 was added at a depth of 2 cm.

Plant density results

Plots that received native seed and live soil amendments (treatment 5) had the greatest native understory richness and fewest invasive plants among any of the treatment groups. Two years after the treatments, plots that received this treatment had approximately 11.9% understory cover, similar to areas adjacent to the slash pile scar. Plots that received only native seeds (treatment 4) had more understory growth than treatments 1, 2, or 3, but less understory growth than treatment 5. The control plots (treatment 1) and those that received only sterilized soil (treatment 2) had less then .01% understory cover two years after treatment.

Arbuscular mycorrhizae results

Plots that received native seed and live soil amendments (treatment 5) also had the highest density of effective arbuscular mycorrhizal root colonization. The control and sterilized soil plots (treatments 1 and 2, respectively) had the lowest densities of understory cover and effective arbuscular mycorrhizal propagules. Higher densities of arbuscular mycorrhizae result in more growth of native understory plants.

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For More Information

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NAU Printing Services/G57xxxx/2500/07-05

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