Working Papers in Southwestern
Ponderosa Pine Forest Restoration

Restoring the Uinkaret Mountains: Operational Lessons and Adaptive Management Practices

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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, like the restoration treatments being implemented in the Uinkaret Mountains, 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.

Introduction

Since 1995, the Ecological Restoration Institute (ERI) at Northern Arizona University (NAU) has been working with the Bureau of Land Management (BLM) and Arizona Game and Fish Department (AGFD) to implement and monitor large-scale ponderosa pine forest ecosystem restoration in northwest Arizona (*Figure 1*). This work has already produced many valuable lessons that have been applied to restoration in the Uinkaret Mountains on the Arizona Strip, but many of those lessons may also be useful elsewhere. This document summarizes operational lessons learned during more than five years of intensive research, and suggests how it may be applied at other ponderosa pine restoration sites in the Southwest.

Why Restoration?

Since the onset of Euro-American settlement in the late nineteenth century, fire exclusion, livestock grazing, road building, and logging have caused southwestern forests to become dense with small trees and heavy fuel loads. Open stands of primarily large pines have been converted into thickets of small trees that compete for limited light, moisture, and nutrients (Mast et al. 1999). Instead of frequent, low-intensity surface fires, current fuel loads support stand-replacing crown fires. These conditions are not sustainable and lead to fires of increasing size and severity. They degrade biodiversity, recreational values, and possibly water supplies. Extensive research suggests that active restoration is needed to regain natural ecological structure, composition, and function (Moore et al. 1999).

Forest restoration can take many different forms. In the Uinkaret Mountains, the goal of restoration practice is to recreate forest structural and compositional characteristics similar to those of the reference historical condition that existed prior to late nineteenth-century Euro-American settlement (Covington et al. 1997). This will allow ecosystem processes, in particular frequent, low-intensity fires, to resume sustainable patterns.

Project Overview

The Ecological Restoration Institute and its collaborators have examined forests at a number of locations in the Southwest and northern Mexico in order to determine a range of variability in forest types and disturbance history. They have also established experimental studies of ecological restoration treatments in the Uinkaret Mountains in the Grand Canyon-Parashant National Monument. These studies have been and will continue to be used to examine ecosystem responses, including those of plants, arthropods, birds, reptiles, and mammals, to ponderosa pine restoration treatments.

Other experimental study areas at which ERI has been active are located in Grand Canyon National Park, the Flagstaff urban/wildland interface, and several southwestern national forests. As in the Uinkarets, these areas generally include large (250- to 10,000-acre) operational restoration experiments linked to smaller (25- to 50-acre) replicated experimental blocks. A mix of dense forest, open parks, and edges allows useful comparisons of wildlife use. Monitoring protocols in these restoration experiments are standardized and documented for comparison with other sites elsewhere.

Researchers continue to monitor forest and fuel conditions, as well as wildlife responses to restoration treatment, in the Uinkarets. Observations from this monitoring are continually used to improve restoration treatments and techniques through an adaptive management process. After five years, restoration is really only beginning; the research is designed for long-term study with permanent monitoring systems and designated control areas. Implementation of initial restoration treatments in the Uinkaret Mountains is expected to conclude in 2004, but ongoing monitoring will continue for years to come.

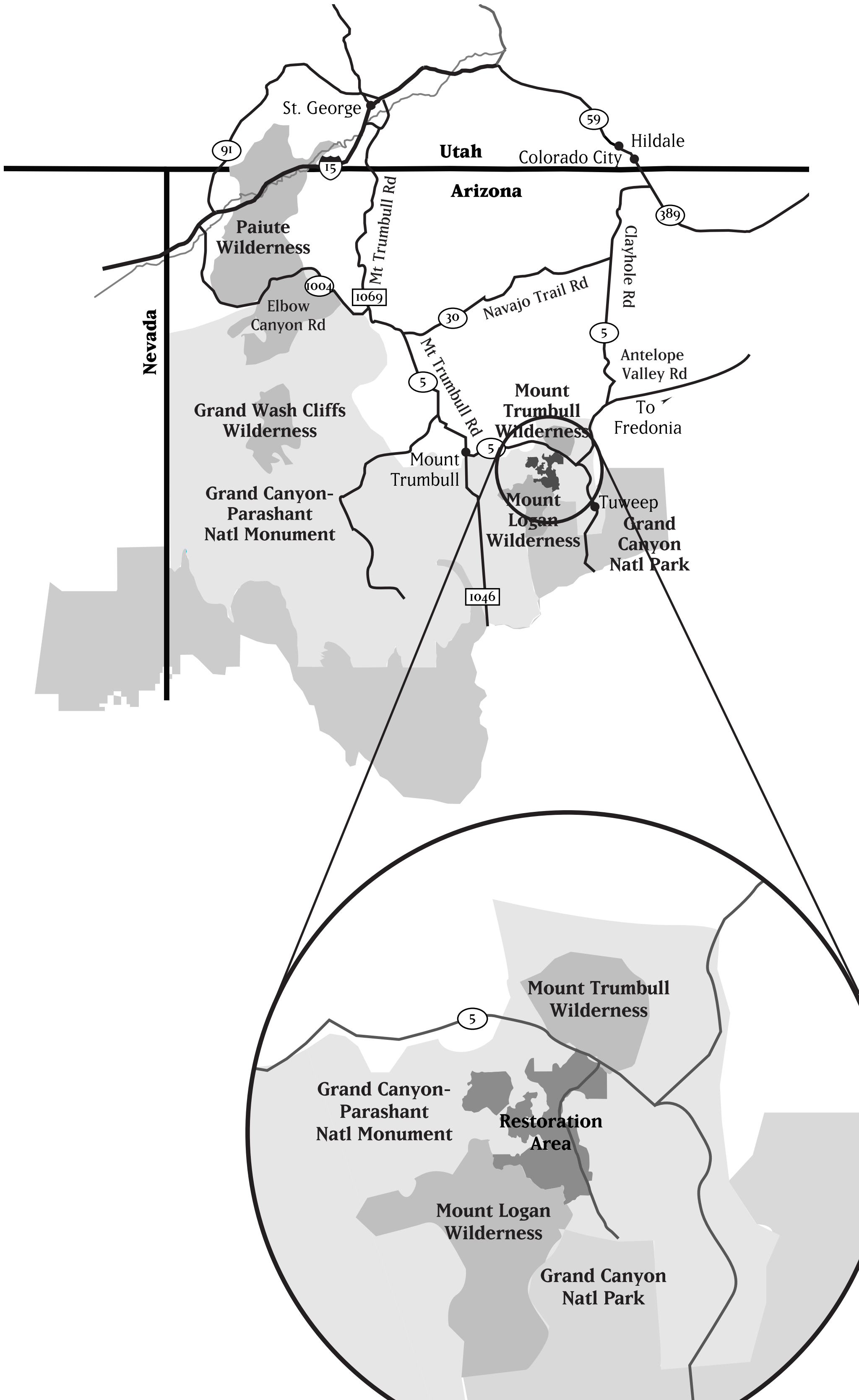

Figure 1. Uinkaret Mountains forest restoration site

Project Goals

ERI's research has had three primary goals:

- Systematically analyze the changes in southwestern forests since disruption of the natural regime of frequent, low-intensity fires in the second half of the nineteenth century.
- Compare the effects of disturbances such as intense wildfires to see if disturbed forest ecosystems can return to health.
- Initiate carefully planned and monitored ecological restoration treatments in cooperation with land-management agencies.

These three goals may be further broken down into these specific actions:

- Measure historic changes in forest structure.
- Design landscape-level restoration treatments.
- Measure and integrate social and cultural considerations in restoration.
- Implement landscape-level experiments and monitoring.
- Monitor vegetation response to restoration treatments.
- Monitor wildlife response to restoration treatments.
- Implement adaptive management strategies that are quickly able to integrate new research data and needs.

Restoration Procedures

A combination of thinning, prescribed burning, and reseeding is used to achieve restoration goals. The goal of thinning is to emulate the spacing and density of trees as they existed prior to alteration of forest structure through grazing, logging, and fire suppression. The goal of burning is to reduce unnatural fuel loadings, dispose of thinning slash, and maintain forest structure by killing young trees and maintaining a diverse herbaceous understory, such as shrubs and grasses (Weaver 1951). Reseeding helps the understory community to recover more quickly and may aid in averting the spread of unwanted invasive species such as cheatgrass.

In the arid Southwest, where decomposition rates are slow, evidence of trees that were standing at the time of Euro-American settlement (called "presettlement trees") but that have been removed through logging or decay remains present for a long time in the form of snags, stumps, downed logs, or holes. As a result, it is possible to determine where large ponderosa pines once stood. In addition, it can be assumed that pines that have acquired yellow bark ("yellow pines") are of advanced age and generally predate Euro-American settlement.

Thinning Criteria

The thinning protocol in the Uinkarets has focused on these criteria:

- All remaining presettlement trees are left standing, including all snags, all yellow pines, and all trees over 28 inches diameter at breast height (dbh). Increment cores are taken to determine whether questionable trees are of presettlement origin.
- Where evidence of missing presettlement trees is present in the form of snags, stumps, fallen logs, or decay holes, nearby live trees are left standing as replacements.
- To compensate for mortality and reduced biomass of young trees as compared to missing large trees, replacement trees are left standing at a ratio greater than 1:1.
- All Gambel oak is retained, as well as pinyon and juniper over 12 inches dbh.
- Excess trees are cut and woody material is removed both by contractors and by a BLM fuels reduction crew that focuses especially on unmerchantable trees.

Preparing for Prescribed Burns

Prescribed burns are conducted following thinning treatments. Areas are first prepared for fire through these steps:

- Fire lines are placed around units to be burned.
- "Ladder fuels" that would allow ground fires to rise into the canopy are removed.
- Accumulated duff is raked away from old-growth trees, snags, and oaks.
- Slash may be lopped, compacted with a tractor, or allowed to naturally disintegrate over a few years in order to reduce the height of the fuel base. At other sites, slash has been gathered into piles that can be safely burned during winter or at other times.

Reseeding

After burning, some treatment areas are reseeded with a mix of native plant seed and kept ungrazed by livestock for at least three or four years. Appropriate seed mixes have often been expensive. Finding mixes and ensuring that they do not alter the genetic diversity of the native plant community remains a concern, as does the spread of invasive species.

Treatment Issues and Adaptive Practices

Cooperation between the ERI, BLM, AGFD, and other interested parties has allowed quick, practical application of research results in restoration treatments. The BLM has been highly accommodating in adjusting treatment plans and schedules to meet research concerns. As problems have arisen, they have been evaluated and attempts have been made to correct them. Following are some of the issues that have arisen during the course of carrying out restoration treatments, and the adaptive practices that have been used to resolve them. These issues will be explored more closely in other working papers.

Issue: Initially, in an attempt to emulate natural tree clumping, only replacement trees within 15 feet of presettlement tree evidence (e.g., snags, stumps, downed logs, or root holes) were left standing. This often meant small trees were left while large trees located more than 15 feet from presettlement evidence were removed.
Adaptation: The search radius around presettlement tree evidence was adjusted to 60 feet, allowing the retention of larger replacement trees.

Issue: “Leave trees,” those trees not removed during thinning, are smaller and have considerably less biomass than the large trees they are intended to replace.
Adaptation: Either 3 or 1.5 trees are left for each missing presettlement tree evidence site, depending upon the size of the replacement trees (3 trees when below 16 inches dbh, an average of 1.5 when larger). Some practitioners have recommended leaving more trees than this in order to compensate for post-thinning mortality.

Issue: Clumps of Gambel oak, a species of particular importance to wildlife as a source of food and nesting or roosting cover, and to humans for aesthetics, were thinned and then burned, resulting in high mortality.
Adaptation: Thinning of oaks was discontinued. Instead, accumulated duff and other debris, especially slash from thinning operations, is removed from the ground around the trunks of large trees in order to minimize mortality of old trees.

Issue: Restoration plans did not provide a sufficiently large control area to monitor bird responses to treatments.
Adaptation: Treatments were adjusted to create large control areas.

Issue: Large quantities of slash increased the risk of prescribed fire becoming too hot and killing large trees or growing out of control.
Adaptation: Cooler burning prescriptions have been implemented. Duff is raked away from large trees before burning. Experiments using a tractor to compact slash have been conducted and have resulted in a reduction of fire intensity. This treatment needs to be considered carefully, since it could result in soil compaction.

Issue: Native grasses, shrubs, and other herbaceous understory plants did not return in large numbers in some areas following tree thinning and prescribed burning.
Adaptation: Reseeding of treatment areas with native plant seed has been attempted in order to accelerate recovery. Monitoring of this effort is ongoing.

Issue: Reseeding mixtures showed a low germination rate of about 20 percent.
Adaptation: A drag towed behind an all-terrain vehicle or Bobcat was used to cover the seed mixture, increasing the germination rate to about 40 percent.

Ongoing Challenges

Numerous operational, social, and economic challenges remain before restoration of southwestern forests can successfully be carried out on a large scale. Some of the most prominent are:

- Funding and staff constraints that make it difficult to implement restoration treatments in a timely manner
- Wind, temperature, humidity, and staffing limitations make for narrow windows of opportunity for conducting prescribed burns
- Reliance on third parties, such as logging contractors, requires additional time
- Commercial sale of timber from thinning projects can be controversial
- Uncertainty about the best strategies for implementing prescribed burns, which have at times resulted in excessive mortality of yellow pines and Gambel oak
- Invasion of restored areas by nonnative herbaceous species, such as cheatgrass
- Finding adequate supplies of locally produced native seeds for seed mixes
- Livestock grazing can make it more difficult to accumulate fine fuels for future maintenance burns
- Uncertainty about effects of restoration treatments on wildlife
- Retaining all the habitat components required by wildlife during long-term and large-scale treatments
- Conducting accurate NEPA analysis, which is difficult and time-consuming
- Addressing concerns of a variety of constituents and avoiding litigation

Ongoing research projects in the Uinkarets are aimed partly at addressing these challenges. Research on wildlife responses to restoration treatments that is currently being carried out by NAU and AGFD, for example, may help delineate how future treatments can be planned on a landscape scale in order to preserve all elements of native biodiversity.

Points to Remember

Every restoration treatment needs to be site-specific. Planners have dozens of options in choosing specific treatments, and these treatments may well include alternatives such as multiple entries to a site over successive years. In addition, treatment plans at some sites must reflect such concerns as the needs of specific species, aesthetics, and recreation planning. There simply is no "one-size-fits-all" answer to restoration needs in southwestern ponderosa pine forests.

Restoration of these forests is urgently needed. Leaving these forests alone is itself a management strategy, one that will likely result in more degradation of biodiversity and ecosystem functions and increased threats to human safety. Active restoration with ongoing monitoring and adaptation, on the other hand, allows managers to improve forest conditions in a site-specific way according to the most recent research results.

Learning is ongoing. After five years, research in the Uinkaret Mountains has only begun to provide the long-term ecological data that will prove invaluable in the adaptive restoration and conservation of these forests. Adaptive planning that integrates results of this research into treatment strategies will continue to refine management work. Only through adaptive management, and extensive cooperation between agencies, will restoration treatments be able to meet the diverse needs of a wide range of people and ecological circumstances. Adaptive ecological restoration is a valuable strategy for healing degraded ponderosa pine ecosystems while probing for deeper understanding of how restoration treatments can best be improved.

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For More Information

See the ERI website at http://www.eri.nau.edu or call 928-523-7182.

For specific details about ERI's work in the Uinkaret Mountains, visit http://www.eri.nau.edu/trumbull/index.htm. Details about thinning prescriptions are available at http://www.eri.nau.edu/adaptation.htm.

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