Proposal for Forest Restoration Experiment on the Mineral EMA, Springerville District, Apache-Sitgreaves National Forests, Arizona

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Introduction

The Ecological Restoration Institute (ERI) has cooperated with the Apache-Sitgreaves (A-S) National Forests in terms of technical assistance and information for several years. Expanding on this relationship, the ERI proposes to develop the following experiment.

This proposal is for a replicated ecosystem management experiment to take place in ponderosa pine forests of the Springerville Ranger District. The experiment would test three treatments: (1) control (no action); (2) ecological restoration treatment consisting of tree thinning to emulate patterns of forest structure that existed prior to fire-regime disruption (circa 1880), treatment of accumulated fuels, and reintroduction of surface fire in prescription; and (3) another treatment involving thinning and burning, to be developed in conjunction with forest managers (possibilities are suggested on the next page).

The purpose of the experiment is to provide accurate scientific information for the National Forests on the ecological effects of treatments, including no-action. Information will include measurements of change in forest structure, fire hazard, and understory plant community responses. The scientific value of the experiment extends far beyond the A-S because this study site is one in a series of long-term ecological restoration experiments in northern Arizona. Other sites include Mt. Trumbull (BLM Arizona Strip), Flagstaff (Coconino National Forest and Rocky Mountain Research Station), Grand Canyon (Kaibab National Forest and Grand Canyon National Park), Camp Navajo (Arizona Army National Guard), and Centennial Forest (Northern Arizona University). The research design proposed here will also be comparable to companion studies on the Kaibab and Gila National Forests as well as the nationwide Fire/Fire Surrogates experiment.

Methods

Meeting and field tour

The Mineral EMA along the Mogollon Rim was previously identified as the logical location for the experiment because of its position in A-S management planning. On December 6, 2001, Doug Beal and Tom Beddow from the A-S Supervisor’s Office met with Charlie Denton, Doc Smith, and Pete
Fulé from the ERI and Mike Rabe from the Arizona Game and Fish Department. We discussed the feasibility and logistics of the experiment. The notes from our discussion follow:

Experimental Design

- The experiment is designed in 4 blocks of approximately 100 acres each, each block representing one complete replicate. Within each block would be units of about 33 acres in size. The 3 treatments would be randomly assigned to the 3 units in each block.
- A tentative set of potential block locations were identified in a field tour (Figure 1). These blocks are square in shape, but the actual treatment units to be identified on the ground will be laid in with irregular outlines and will follow existing stand boundaries or fuelbreaks as much as possible.
- The blocks should be located in areas representative of a range of broader forest conditions, so that results could be useful over larger areas of forest.
- The blocks should be accessible in order to accommodate treatment operations and to facilitate tours of the sites. Tours serve an important purpose of demonstrating and explaining management alternatives to the public and to other managers.
- Wherever possible, existing fuelbreaks such as roads, skid trails, or natural openings should be used as treatment unit boundaries to minimize new fireline construction.
- Thinning treatments should be done by the same operator, same methods, and within a narrow time frame insofar as possible. It would be logical to break out the experimental blocks as a separate contract within the larger Mineral EMA. The timing of thinning treatments depends on the progress of the environmental documentation process (see below) and the contracting process, but the earliest that thinning or any other treatment activity would begin is September 1, 2002, to permit the collection of pre-treatment data in the summer of 2002.
- Slash treatments should also be as uniform as possible in terms of methods and timing. A number of options were discussed, including chipping, whole-tree harvesting with large piles at landings, dispersed piles, or slash removed to be burned in a power plant.
- Burning treatments should also be as uniform as possible in terms of methods and timing. A broadcast burn would be part of the ecological restoration treatment and probably also the third treatment. If piles are used for slash disposal, they presumably would be burned before the broadcast burn. Either spring or fall burning is acceptable but burning should be done on all blocks in a single narrow time frame. Fire must be kept out of the control units.
- Grazing affects post-treatment recovery. Our understanding is that the current draft EA for the Mineral EMA treatments calls for deferring grazing for 1 year. A longer period of livestock grazing deferment would be desirable for the experiment in order to be comparable with data from other experimental sites (6 years deferred grazing). This could be accomplished either by preventing grazing in the pastures where the blocks are located (all are in the Harris Lake allotment) or by fencing out the experimental blocks with a regular barbed wire fence. Another option discussed was to apply a proposed grazing easement to the region, using funds that are currently being requested from the Rocky Mountain Elk Foundation.
- The environmental assessment for the overall Mineral EMA is in draft form and undergoing the final editing process. The four experimental blocks would be incorporated in the EA. The experimental blocks could also serve as a part of the monitoring scheme for the larger project. Clearances for cultural and biological resources would presumably be carried out for the blocks in conjunction with the larger project.

Study Sites

Four preferred experimental blocks are shown in Figure 1 (white blocks, labeled B, D, F, and G). These blocks form an elevational gradient from approximately 7,500 to 8,500 feet. If one or more of the preferred blocks is not acceptable, the alternate blocks A, C, or E could be used instead. Photos from the blocks are appended. These blocks are square in shape, but the actual treatment units to be
identified on the ground will be laid in with irregular outlines and will follow existing stand boundaries or fuelbreaks as much as possible.

A-S Preferred and Potential EB Block Locations

Figure 1. Four preferred experimental blocks are shown in white (labeled B, D, F, and G). These blocks form an elevational gradient from approximately 7,500 to 8,500 feet. If one or more of the preferred blocks is not acceptable, the alternate blocks A, C, or E could be used instead. These blocks are square in shape, but the actual treatment units to be identified on the ground will be laid in with irregular outlines and will follow existing stand boundaries or fuelbreaks as much as possible.
Photos from the potential experimental sites:
Thinning and Burning Treatments

The ecological restoration treatment tested in this experiment is the “full restoration” treatment that has been tested at the other experimental sites mentioned above (Covington et al. 1997, Fulé et al. 2001). The reference condition selected for the full restoration thinning will be the presettlement pattern of tree species composition and spatial arrangement (White 1985, Fulé et al. 1997, Covington et al. 1997, Mast et al. 1999). Living presettlement trees of all species will be retained. In addition, wherever evidence of remnant presettlement material is encountered (snags, stumps, logs), several of the largest postsettlement trees of the same species within 30 ft will be retained as replacements. If suitable trees are not found within 30 ft, the search radius will be extended to 60 ft. Each remnant will be replaced with 1.5 trees (i.e., 3 replacements per every 2 remnants) if the replacements are 16” diameter at breast height (dbh) or larger, otherwise each remnant was replaced with 3 trees. Before prescribed burning, accumulated forest floor fuels will be raked approximately 1 ft away from the base of the boles of old-growth trees in order to minimize cambial girdling by fire (Sackett et al. 1996).

The locally developed treatment will be a different thinning design. Possibilities discussed in the field on December 6 included: (1) the A-S/Mineral “goshawk” treatment, (2) the A-S/Mineral “presettlement” treatment, (3) a minimal thinning treatment, (4) a treatment similar to full restoration with different thinning levels, or (5) a fire-only treatment.

Field Methods

Twenty permanent monitoring plots will be established in each unit (total N = 4 blocks X 3 treatments X 20 plots = 240 plots). Plots will be located on a 60-m grid, corresponding to a measured experimental area of 7.2 ha per treatment unit. Plot centers will be established with tape and compass from surveyed reference points, such as section corners. Global positioning systems will be used to geo-reference plot grids. Centers will be permanently marked with iron stakes and slope and aspect will be recorded. Photos will be taken to plot center from 11.28 m N and E.

Overstory trees taller than breast height (137 cm) will be measured on a 400 m² (11.28 m radius) circular fixed-area plot. Species, condition (living or snag/log classes [Thomas et al. 1979]), diameter at breast height (dbh), dwarf mistletoe rating (0-6), and a preliminary field classification of presettlement or postsettlement origin, will be recorded for all live and dead trees over breast height, as well as for stumps and downed trees that surpassed breast height while alive. Potentially presettlement ponderosa pine trees will be identified based on size (> 40 cm diameter at “stump height” [dsh], 40 cm above ground level) or yellowed bark (White 1985). Trees of all other species, oaks, pinyons, and junipers, will be considered as potentially presettlement if dsh > 20 cm. All potentially presettlement trees, as well as a random 10% subsample of other trees, will be cored with an increment borer at 40 cm above ground level to determine age and past size, as described below. Diameter at stump height will be recorded for all cored trees. All overstory trees will be marked with aluminum tags at breast height and tree locations will be mapped.

Regeneration (trees below breast height) and shrubs will be tallied by condition class and by three height classes (0-40 cm, 40.1-80 cm, and 80-137 cm) on a nested 100 m² (5.64 m radius) subplot. The point-line intercept method (line transect) will be used to collect herbaceous and shrub data on all plots. Plant species, substrate, and overstory canopy cover (vertical projection of canopy taller than 137 cm) will be recorded every 30 cm along a 50-m line transect oriented upslope with 25 m above and 25 m below the plot center. Species will be also recorded within 5 m to either side of each transect, forming a 10 m wide belt transect on each plot. Dead woody biomass and forest floor material will be measured on a 50 ft planar transect in a random direction from each plot center.

Prescribed burning will be monitored. Variables include: ignition method, flame length, and rate of spread. Weather variables include: ambient temperature, relative humidity, and wind speed and direction.
After burning, fuels will be re-measured. Burn severity codes (5 categories, unburned to complete consumption) will be recorded at each forest floor measurement point. All variables on all permanent plots will be re-measured in the first growing season after the burn. In addition, total height, crown base height, crown scorch (height and percent), and bole char (minimum and maximum height) will be measured on all trees. Burn severity codes (4 categories, unburned to completely burned) will be assigned to vegetation and substrate (litter, rock, soil, wood, scat, bole) at each intercept point along the line transects.

If fire history cannot be adequately assessed from fire records and/or nearby fire history studies, partial cross-sections of fire-scarred catfaces will be collected from dead and living trees on the Mineral EMA for fire scar analysis.

**Laboratory, statistical, and modeling analysis.**

Increment cores will be surfaced and visually crossdated (Stokes and Smiley 1968) with local tree-ring chronologies. Rings will be counted on cores that could not be crossdated, especially younger trees. Additional years to the center will be estimated with a pith locator (concentric circles matched to the curvature and density of the inner rings) for cores that missed the pith (Applequist 1958). Fuel loadings will be calculated from the planar transect data (Brown 1974, Sackett 1980). Presettlement forest structure will reconstructed at the time of disruption of the frequent fire regime, circa 1880, following dendroecological methods described in detail by Fulé et al. (1997). Briefly, size at the time of fire exclusion will be reconstructed for all living trees by subtracting the radial growth measured on increment cores since fire exclusion. For dead trees, the date of death will be estimated based on tree condition class using diameter-dependent snag decomposition rates (Thomas et al. 1979). To estimate growth between the fire exclusion date and death date, we will develop local species-specific relationships between tree diameter and basal area increment. An analogous process of growth estimation will be used to estimate the past diameter of the small proportion of living presettlement-era trees for which an intact increment core could not be extracted due to rot.

Comparisons of forest variables between blocks, treatments, and over time (pre- and post-treatment) will be made with repeated-measures analysis of variance (anova) using Systat (SPSS Inc., Chicago, IL, 1998). Alpha level will be .05. Variables will be square-root transformed where necessary to meet anova assumptions of normality and homoskedasticity. Following a statistically significant anova result, treatment means will be compared with a post-hoc Tukey’s procedure.

Herbaceous community data analysis will include calculations of plant and substrate frequencies, species richness, Simpson’s Index (richness weighted by frequency), height classes, and cumulative species curves. PC-ORD (MjM Software, Gleneden Beach, OR, 1999) will be used for community analyses, including species area curves, cluster analyses, ordinations (non-metric multidimensional scaling, NMDS), and indicator species analysis.

To assess changes in fire hazard, fire behavior in treatment and control units will be modeled with the Nexus Fire Behavior and Hazard Assessment System (Scott and Reinhardt 1999). Crown biomass will be estimated with allometric equations for foliage and fine twigs of ponderosa pine (Fulé et al. 2001), Gambel oak (Clary and Tiedemann 1986), and pinyon and juniper (Grier et al. 1992). Crown volume will be estimated by the averages of maximum tree height (top of the canopy) and crown base height (bottom of the canopy). Crown bulk density will be calculated as crown biomass divided by crown volume. Fire weather extremes representing the 90th and 97th percentiles of low fuel moisture, high winds, and high temperature will be calculated from local data using the FireFamily Plus program (Bradshaw and Brittain 1999). Weather values will be calculated for the entire fire season (April 23 to October 16) as well as for June, historically the month with the most severe fire weather.
Schedule

A tentative schedule of activities is presented below:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Who’s Responsible</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agreement on experimental design, methods, etc.</td>
<td>ERI and A-S</td>
<td>Jan-Mar 2002</td>
</tr>
<tr>
<td>Field meeting</td>
<td>ERI field staff, A-S staff from Supervisor's Office and Springerville Ranger District</td>
<td>May 2002</td>
</tr>
<tr>
<td>Layout of treatment units</td>
<td>ERI staff</td>
<td>May-Jun 2002</td>
</tr>
<tr>
<td>Pre-treatment measurements</td>
<td>ERI staff (A-S staff are invited and welcome to participate)</td>
<td>Approximately Jun 27-Aug 15, 2002</td>
</tr>
<tr>
<td>Thinning and other treatments initiated</td>
<td>A-S staff and contractors</td>
<td>Sep 1, 2002</td>
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<tr>
<td>Burning possible</td>
<td>A-S staff (ERI will monitor burns)</td>
<td>Earliest spring 2003</td>
</tr>
<tr>
<td>Post-treatment measurements (all plots measured)</td>
<td>ERI staff (A-S staff are invited and welcome to participate)</td>
<td>Earliest summer 2003, probably 2004</td>
</tr>
<tr>
<td>Second-year measurements (plant community measured)</td>
<td>ERI staff (A-S staff are invited and welcome to participate)</td>
<td>Following year</td>
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<tr>
<td>Final report</td>
<td>ERI staff</td>
<td>One year after second-year measurements (probably 2006)</td>
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Permits

Permits are requested for the following activities:

- Research permit for the experimental activities. The permit should cover a period of at least 5 years. This proposal could serve as the study plan for the research permit.
- Camping permit for the field season, 2002 (see tentative schedule above). A temporary camp would be set up in a central location at a site approved by A-S, away from well-traveled roads. Portable toilets would be rented from a contractor.

We have prepared a SF-299 form to accompany this proposal.
References


