

Jemez CFRP Pre-treatment Assessment Report

I. Introduction

The Jemez Collaborative Forest Restoration Project is a small ecological restoration demonstration experiment situated on Santa Fe National Forest Land in Northern New Mexico. This project is funded by the Collaborative Forestry Restoration Program (CFRP), a federally funded program intended to fund collaboratively designed forest restoration projects on federal lands throughout the state of New Mexico.

The Jemez CFRP project area is split between the Redondo and East Fork project sites. The Redondo site is comprised of approximately 120 acres of mixed conifer and ponderosa pine forest just north of the USFS Redondo Campground between the Valles Caldera Preserve and Highway 4. The East Fork Project site is roughly 3 miles southwest of the Redondo site and is composed of approximately 36 acres of ponderosa pine dominated forest near the East Fork trailhead parking area just east of Highway 4. See figure 1.

Both sites are situated in highly visible and visited areas. The area surrounding the Redondo campground is heavily used by recreationists during the summer months and the East Fork trailhead is used by hikers and bikers from the surrounding area and beyond year round (personal observation).

While differing in species composition and structure, both sites exhibit conditions typical of degraded, fire-adapted forests. In general, tree density, basal area and canopy cover in these sites is high as compared to historical levels. These conditions have been linked to epidemic bark beetle outbreaks and severe stand replacing wildfires, among other ecologically damaging phenomena. In addition, understory diversity and cover is sparse, providing relatively little hiding cover or forage for wildlife species.

The Jemez CFRP project's intent is to demonstrate and assess three different ecologically sound forest restoration options within both the Redondo and East Fork Project areas. Treatment options include: 1.) No treatment ("experimental control") 2.) a historical forest evidence-based thinning treatment developed by the Ecological Restoration Institute (ERI) followed by prescribed burning and 3.) a goshawk post fledgling area guidelines¹ based treatment. Each project site is divided into three approximately equally sized treatment units randomly assigned one of these three treatment designations.

¹ Based upon guidelines described in RM-217, Reynolds et. al. 1992.

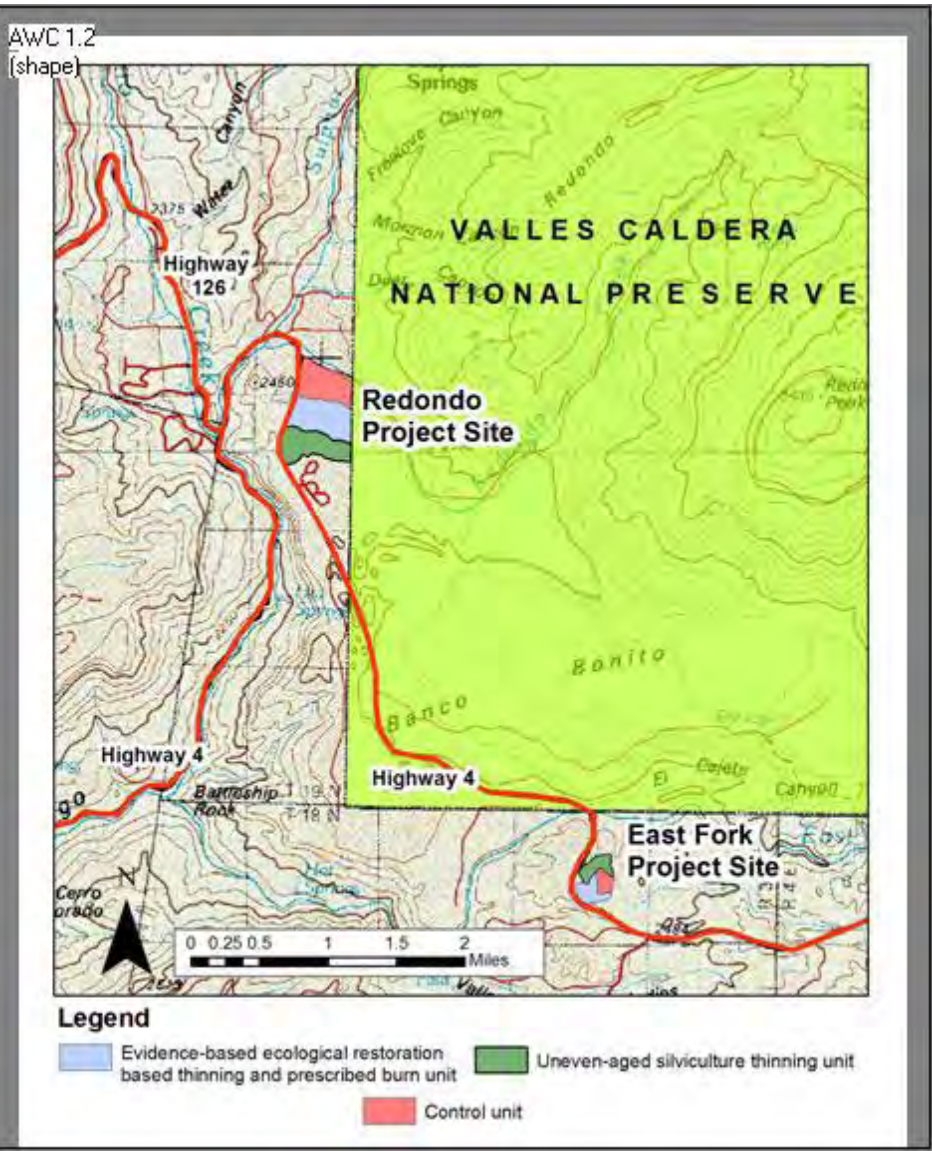


Figure 1: Location of the Jemez CFRP project sites.

Following initiation of fieldwork associated with the Jemez CFRP project it was learned that both project sites are contained within designated Northern Goshawk Post-fledgling areas (PFAs). PFAs are defined by the Northern Goshawk Management Recommendations (Reynolds et. al. 1992) and consist of 420 acres surrounding documented Northern Goshawk nests. The Goshawk Management Guidelines have been an obligatory component of official region 3 forest management for almost 10 years now, but there is currently little region-wide consensus on their technical implementation and few documented descriptions of successful goshawk guideline-based management activities. The desired result of goshawk guidelines based management activities is an uneven-

aged forest landscape comprised of even-aged tree groups that approximates the composition, structure and pattern of Southwestern forest landscapes prior to the alteration of natural fire regimes during the late 19th to early 20th century (Smith and Long 2000).

This contrasts with evidence-based ecological restoration methods. These treatments rely on an understanding of forest reference conditions, or conditions known to be within the range of healthy ecosystem variability, in order to guide ecosystems back to healthy conditions where forest structure and functions such as low intensity fire are maintained over time (Moore 1999). The location, presence or absence and species composition of stumps, snags, downed logs and old trees are reference conditions that provide a degree unequivocal evidence of historical forest structure. The prescription applied at both evidence based ecological restoration treatment units at both project areas is as follows: each historical forest evidence encountered is replaced a ratio of 3 post-settlement trees to 1.5 stumps established after Euro-American settlement. In addition to these replacement trees all trees established prior to Euro-American settlement, typically trees having old age characteristics (i.e. large diameters, yellow bark, large branches), were marked for retention.

In Southwestern ponderosa pine ecosystems it has been repeatedly demonstrated that frequent, low intensity fires were primarily responsible for the maintenance of ecosystem conditions during historical times. The application of some form of prescribed or natural wildland fire following thinning treatment is an essential component of all ecological restoration-based treatments in southwestern ponderosa pine forests (Moore 1999).

The Jemez CFRP project provides excellent opportunity to investigate the quantitative impacts of evidence-based ecological restoration treatments within a goshawk PFA area. Using expert opinion, monitoring and assessment data collected at the project sites and the results of similar treatments in the Southwest, the following questions regarding evidence-based ecological restoration treatments can be addressed prior to the completion of thinning treatments: 1.) What is the current condition of the forest, and are these conditions compatible with Northern Goshawk guidelines forest structure requirements for post fledgling areas? 2.) What do we know about the historical forest structure at the project sites from historical forest structure evidence (stumps, downed trees, snags, old trees)? Finally, 3.) Based upon published examples and pre-treatment data collected at the Jemez CFRP sites, how will forest conditions following the completion of ecological restoration-based thinning compare to the conditions mandated by the goshawk post-fledgling area guidelines?

II. Methods

The assessment and monitoring design of the Jemez CFRP project consists of grouped ecological restoration, goshawk guidelines treatments and control units at both the Redondo and East Fork project sites. Treatment units at the Redondo and East Fork sites are approximately 40 acres and 14 acres in size respectively. Because of differences in project site area, 20 monitoring plots were established within each Redondo treatment unit and 7 within each East Fork unit.

Forest Structure

Plot centers were GPS surveyed and plots were permanently monumented with a marked iron rebar stake. Two photos of the current forest structure were taken in north and east directions at each plot center and one hemispheric photo of the forest canopy was taken at each center to estimate tree canopy cover. Forest structure at each plot was measured with a combination of a fixed radius plot to measure regeneration, pole and sapling sized trees and a variable-radius plot (using a 10 basal area factor prism) for mature trees. Condition, species, diameter, crown base height and total height were measured for each standing tree. Coarse woody debris and forest floor fuels were estimated at each plot using a permanently monumented 50 foot transect using the methodology described in Brown 1974.

Understory Plant Community

Understory data was collected at a sub-sample of the overstory monitoring plots: 8 plots per treatment unit at the Redondo site, for a total of 24 plots; 4 plots per treatment at the East Fork site, for a total of 12 plots (pre-monsoon: June 23-28, 2006). Quadrat sampling was used to obtain cover estimates functional plant groups (trees under breast height, shrubs, graminoids, forbs), exotic plant species, and of various substrates cover (plant basal area, litter, wood, bole, stump, soil, rock). Data was collected using 2m x 0.5m quadrats placed at specified intervals along a 50 meter transect running through plot center. In conjunction with quadrat sampling, a species list was compiled for each plot from a belt transect (10m x 50m).

In addition to collecting data at permanent monitoring plots, a systematic survey was conducted at each project site (post-monsoon: July 21-25, 2006) in order to make a voucher collection of all plant species present and to map species of concern (exotics, sensitive species) using a GPS unit. The Redondo control unit was not surveyed due to time constraints. The scope of the survey included recently treated areas adjacent to the project site in order to check for populations of exotics which could potentially invade the project site. Voucher specimens will be donated to the herbarium at the University of New Mexico upon completion of this project. The USDA Plants Database was used as the authority for plant species referred to in this document. Appendix B includes synonymy with the "Working Index of New Mexico Vascular Plant Names" (Allred 2006).

Forest Reference Conditions

Two approximately 5 acre macroplots were established within easily accessed areas at both the Redondo and East Fork project sites to provide examples of presettlement forest conditions. All live and dead trees, stumps and downed trees within each plot thought to have existed at the site 120 years before present were marked and located with a GPS unit. Age determination of trees and stumps was estimated in the field and is based upon age related characteristics such as: diameter, presence of yellow platy bark and large branches on live trees and snags and the diameter, degree of decomposition and presence of decay resistant heartwood in downed trees and stumps. Following tree marking an approximately 1.4 acre subplot was established near or within each macroplot. The exact location condition, species, diameter and mark (i.e. cut or leave tree) of all standing trees and historical forest evidences within this subplot were recorded. This mapping effort was accomplished using a network of survey tapes, resulting in a relative positional accuracy of less than 1 meter for mapped features.

III. Current Conditions

Forest Structure

Conifer Tree Density, Basal Area and Diameter Distributions

- Current conditions at both project sites do not meet forest structure guidelines for goshawk Post-Fledgling areas; forest composition is dominated by fire-intolerant and small diameter coniferous trees.

High average tree densities were observed at both project sites, although tree densities observed at the East Fork site were an order of magnitude greater than those seen at the Redondo site (Table 1).

At both project areas large diameter tree classes (> 16" diameter) are dominated by ponderosa pine and to a lesser extent Douglas fir (Table 1).

At both project areas tree densities are driven by large number of trees in the smallest classes.

East Fork Site: tree densities are highly influenced by dense, sapling-sized (0-4 inch diameter) pure ponderosa pine thickets interspersed throughout the project area (See Appendix A, Figure 1).

Redondo Site: highest tree densities are in the sapling and pole sized (0-8 inch in diameter) classes. Overall, this diameter class is dominated by ponderosa pine, but tree species such as Douglas fir, white fir and blue

spruce comprise a sizable proportion of the density in these diameter classes (See Appendix A, Figure 2).

Tree basal area is similar at both project sites. The extremely high tree densities at the East Fork site together contribute a small amount to basal area. At the Redondo site much smaller numbers of large trees contribute to a similar basal area.

Table 1: Tree Density ,Basal Area and Canopy Cover Estimates

	Tree Density/Acre	Std. Dev.	Sq. Ft. Basal Area/Acre	Std. Dev.	Mean Canopy Cover	Std. Dev.
East Fork						
<i>Fiedler</i>	4297.8	4424.0	117.8	31.2	66.7	6.3
<i>ERI</i>	684.8	844.3	97.4	24.4	63.9	6.2
<i>Control</i>	2059.6	3037.5	98.4	31.0	61.5	8.8
Redondo						
<i>Fiedler</i>	353.9	398.3	113.4	56.3	62.3	10.7
<i>ERI</i>	248.5	182.8	117.7	42.7	64.3	9.4
<i>Control</i>	384.2	210.3	135.6	54.5	70.4	5.8

Canopy Cover

- Canopy cover values at both project sites both well exceed values stated within the goshawk guidelines.

Canopy cover at the both sites was assessed with computer analysis of digital hemispherical photos taken at monitoring plot centers. Average canopy cover estimates were consistently in the 60-70 percent cover range for all treatment units at both East Fork and Redondo project sites (Table 1). This value is not comparable to within group canopy cover requirements stated within the Goshawk Guidelines.

Deciduous Tree Density and Regeneration

Stands of quaking aspen (*Populus tremuloides*) and Gambel oak (*Quercus gambelii*) are considered to be desirable elements within goshawk PFAs, since both provide food and nest sites for goshawk prey species (Reynolds *et al.* 1992). Aspen and oak are the two most prevalent deciduous tree species found within the project areas.

Aspen

- No aspen were encountered in the East Fork project site. Aspen comprised a small component of the tree composition of the Redondo site. An average of 7 live aspen trees per acre was measured in the Redondo site on 9 out of 60 monitoring plots (Table 2).
- Roughly twice as many dead aspen were encountered in the Redondo unit as live aspen trees (14 per acre).
- While not measured quantitatively, large dead and down aspen trees were encountered in several instances throughout the Redondo site (See photo 1).
- Densities of aspen regeneration were roughly 13 times greater than tree size aspen, averaging 181 stems less than 4.5 feet tall per acre. Of this amount, 59 percent were less than 16 inches in height (Table 2).



Photo 1: Plot photo of aspen stand succeeded by conifers. Note the single live aspen at left and the dead and down aspen on the forest floor. These conditions were observed but not specifically quantified throughout the Redondo project site.

Gambel Oak

- No Gambel oak was encountered in the East Fork Unit. Approximately 3 oak stems per acre were encountered in the Redondo project site, though oak thickets were common in the surrounding area.
- In the Redondo project site, densities of regenerating oak stems were roughly 57 times greater than tree and pole size Gambel's oak densities, averaging 171 stems less than 4.5 feet tall per acre. Seventy-eight percent of the oak stems encountered on monitoring plots were less than 16 inches in height (Table 2).
- The overabundance of regenerating oak stems compared to tree sized stems is partly explained by the apparent thicket forming nature of this species in the Jemez Mountain ecoregion.

Table 2: Aspen and Oak Trees and Regeneration per Acre

	Trees per Acre	Regeneration (<1.4 m tall) per Acre	Percent Less than 16" tall
Oak Regeneration			
<i>Fiedler</i>	0.0	14.2	100
<i>ERI</i>	0.0	165.9	63
<i>Control</i>	8.1	333.9	70
Aspen Regeneration			
<i>Fiedler</i>	8	133.5	53
<i>ERI</i>	2	170.0	57
<i>Control</i>	11	242.8	66

Coarse Woody Debris

Coarse woody debris (CWD), which includes standing dead trees (snags), downed logs, and large branches, is a critical component of healthy forest ecosystems (Bull 2002), providing wildlife habitat for many species, including the prey base for the northern goshawk. Standing snags serve as roosting, perching, and nesting sites for many bird species, while downed logs provide cover, foraging, and nesting sites for small mammals (Gordon 1996). Management guidelines for the northern goshawk state that snags (>18" DBH, 30' tall), downed logs (>12" DBH, >8' long), and woody debris (>3" in diameter) be present throughout the PFA, with desired minimums for each category (Reynolds *et al.* 1992).

- Amounts of both standing and downed CWD currently existing in the Currently, the number of snags per acre suitable for wildlife habitat (appropriate diameter and height/length) is below the recommended amount at both the Redondo and East Fork project sites (Table 3).
- Dense forest stands such as are found within the Jemez CFRP create conditions of intense competition for light and nutrients, slowing the growth and development of large diameter trees, snags and logs (Roberts 2003).

Table 3. Optimal density of CWD (per acre) in northern goshawk PFAs compared to current conditions in the Jemez CFRP

	Number of Snags	Number of Downed Logs	Tons of Woody Debris*
Ponderosa Pine			
PFA	2	3	5-7
East Fork	0.51	not measured	17.77
Mixed Conifer			
PFA	3	5	10-15
Redondo	0.80	not measured	7.87

*1000 hr. fuels (>3" in diameter; includes downed logs)

Crown Fire Hazard Simulation Analysis

- No specific fire behavior or crown fire behavior thresholds or guidelines are stated within the Goshawk Guidelines. The presence of crown fire behavior and ensuing fire induced mortality of the living trees within the area would result in the loss of goshawk and goshawk prey habitat and incompatibility with desired conditions.

Background

FlamMap, a GIS based crown fire prediction model was used to assess the pretreatment crown fire hazard potential. Inputs to this model were derived from a combination of monitoring plot data, a USGS digital elevation model and canopy cover estimates derived from 1 meter resolution aerial photos of the study area.

Weather conditions and fuel moisture inputs used in FlamMap were based upon a readily available pre-formatted set of measurements for the month of June from the South Kaibab National Forest, Tusayan Ranger District. Five different windspeeds ranging from 25 to 45 miles per hour were used during FlamMap fire simulations. Weather and windspeed inputs were chosen to represent extreme fire weather events, instead of average seasonal values.

Results

Using the stated model parameters and inputs portions of both project areas will burn under all of the tested windspeeds.

There appears to be greater threat of crown fire behavior over contiguous areas at the East Fork site than the Redondo site. Thickets of extremely high tree densities (>1000 trees per acre), very low crown base heights and the effect of steep southerly slopes within this study site appear to have a great influence upon the incidence of crown fire at this site.

Expected crown fire behavior at the Redondo site comprises a smaller proportion of the overall area than the East Fork site at all windspeeds assessed. Areas of expected crown fire also appear less contiguous at the Redondo site. The influence of previous fuels treatments completed at the Redondo site can be seen in the lack of expected crown fire behavior in southwestern area of this site at all but the highest windspeeds.

Understory Plant Community

Desired conditions for northern goshawk Post-fledging Family Areas (PFAs) include a well developed herbaceous and shrub understory throughout, dominated by native species, and especially grasses. Species richness is low on monitoring plots, though slightly greater at Redondo than at the East Fork project site. Increased shading from dense regeneration within the Jemez CFRP has also reduced cover of understory forb and shrub layers that provide important food and hiding cover for goshawk prey base species (Reynolds *et al.* 1992).

Species Richness and Cover

- Approximately 160 species were identified within the Jemez Collaborative Forest Restoration Project (Jemez CFRP) area during the course of a systematic survey, (Appendix B) 115 of which were recorded on monitoring plots.
- Species richness is slightly greater at Redondo than at the East Fork project site, ranging from 25-32 species per treatment unit (avg. 29 species) versus 18-26 species per (avg. 22 species). Frequently encountered species are listed in Appendix B.
- Cover of understory plants (forbs, grasses, and shrubs) is extremely low, averaging 2% on monitoring plots within the Jemez CFRP. In contrast, total plant cover has been estimated at over 30% at reference sites for ponderosa pine forests located on the north rim of the Grand Canyon (Friederici 2002).
- Cover of trees under breast height consists solely of ponderosa pine (*Pinus ponderosa*) at East Fork, while species composition of regen is diverse at Redondo, including Gambel oak (*Quercus gambelii*), aspen

(*Populus tremuloides*), white fir (*Abies concolor*), Rocky Mountain juniper (*Juniperus scopulorum*), blue spruce (*Picea pungens*), limber pine (*Pinus flexilis*), as well as ponderosa pine (*Pinus ponderosa*) and Rocky mountain Douglas-fir (*Pseudotsuga menziesii* var. *glauca*).

Exotics

- Thirteen exotic plant species were observed in the project area (Appendix B), though only two species, smooth brome (*Bromus inermis* ssp. *inermis* var. *inermis*) and common mullein (*Verbascum thapsus*), were recorded on monitoring plots.
- Smooth brome is easily the most common exotic in the project area and was pervasive along access roads, dominating the understory in adjacent aspen stands within the Redondo site. The species is ubiquitous throughout the East Fork site, especially in small clearings adjacent to ponderosa pine stumps and along trails, open meadows, and with sparse cover in the understory of doghair thickets (Photo 2).



Photo 2: Smooth brome dominating the understory of an aspen grove along a service road within the Redondo unit.

- Burning slash piles is known to have adverse effects such as soil sterilization, promoting exotic species establishment, and causing severe

reductions of viable native seed populations (Korb *et al.* 2004). A suite of exotics including common mullein (*Verbascum thapsus*), Canadian horseweed (*Conyza canadensis*), smooth brome (*Bromus inermis* ssp. *inermis* var. *inermis*) and cheatgrass (*Bromus tectorum*) were observed in previously treated areas where slash had been piled and burned (Photo 3).



Photo 3: Burn pile sites at previously treated areas within Redondo. a.) Cheatgrass and other non-native species. b.) Bare soil and non-native species

Forest Reference Conditions

- A departure from historical forest structure conditions is cited within RM-217 as a prime reason for goshawk population and reproduction declines. Presettlement evidence in the form of stumps, old trees and woody debris provide an example of forest conditions before the disruption of natural fire regimes, and provide a point of reference for the planning of restoration based management activities.

Mapping of old stumps and trees on macroplots established within both project sites indicates that historical densities of trees were far lower than current levels (See stand data table and macroplot figures). A recent study indicates that 81 to 100% of old trees, downed logs and stumps are capable of being relocated after 84 to 90 years (Moore et. al. 2004).

Historical forest composition in both areas was nearly entirely dominated by ponderosa pine. At the Redondo site this contrasts with the current species composition which includes high densities of small diameter fire intolerant species including white fir, blue spruce and to a lesser extent Douglas fir.

It seems likely from field observations that historical evidence of white fir, blue spruce and Douglas fir are less persistent, possibly due to the lack of weather-resistant heartwood and the typically smaller diameter of remaining spruce stumps. In this case, density estimates of these species are probably lower than historical levels.

IV. Expected Outcomes

Forest Structure

Tree Density and Basal Area

- No specific tree density or basal area target is specified within RM-217. These attributes are site specific and can be generally predicted from the densities of presettlement forest evidences found within the project sites.

Post-treatment stand densities can be estimated using presettlement forest evidence densities determined from macroplots within each project area and a replacement rate of 1.5 post settlement trees for every dead presettlement evidence, a density of 49.5 trees per acre is expected within the Redondo unit, and a density of 56.9 trees per acre is expected within East Fork unit (See appendix A: “Redondo and East Fork Stem Mapped Macroplots”).

These estimates are likely lower than the true density to be expected in these areas based upon the findings of similar ecological restoration experiments completed in ponderosa pine forests.

The application of evidence based ecological restoration treatments will produce site specific post-treatment forest densities and tree distributions. The forest at each project site following treatment will be related to the historical conditions present at that particular site.

Monitoring of similar restoration treatments at sites in Northern Arizona have resulted in forest densities approximating or slightly greater than densities expected based upon the density presettlement structures.

Tree Diameter Distributions

- The results of ecological restoration-based treatments will result in an uneven aged (i.e. diameter) forest at both the tree grouping and stand level. This differs with goshawk guidelines based treatments which result in a mosaic of even-aged tree groupings at the stand scale.

Small diameter tree densities will be drastically reduced at both sites following treatment, but will likely result in lower, but still high proportion of small diameter trees to large diameter trees. This trend was observed at restoration sites at Mt. Trumbull and Ft. Valley, Arizona (Mast et. al. 1999, Waltz et. al. 2003).

All trees thought to be of present on the site prior to 1870-1880 were retained using the ecological restoration prescription.

Canopy Cover

While seemingly stringent, the canopy cover requirements within the Goshawk Guidelines apply to groups of mature trees with partially interlocking canopies. Since the restoration marking method results in a clumped tree structure (Covington et. al. 1997) it is highly probable that this requirement will be met following treatment (Reynolds pers. comm.).

A nearly 40 decrease in stand wide canopy cover has been documented at sites in Northern Arizona following the application of similar restoration treatment prescriptions. Caution should be taken applying these results to the Jemez CFRP study site as pretreatment conditions and canopy cover measurement methods differ between sites.

Deciduous Tree Density and Regeneration

The northern goshawk guidelines state that quaking aspen (*Populus tremuloides*) and Gambel oak (*Quercus gambellii*) regeneration should be encouraged within both ponderosa pine and mixed conifer forest types, since they provide valuable resources for woodpeckers and other prey species (Reynolds et al. 1992). Following ecological restoration treatments, a short-term decline in aspen and oak cover can be expected followed by a high density flush of new growth as the sprouting response of both species are stimulated by thinning and burning. This phenomenon has been observed at several areas in Southwest and Rocky Mountain forests (FEIS 2007).

- Aspen is highly competitive on burn sites, often increasing in cover from pre-fire levels. Mature stands of healthy trees can be expected to develop once restoration treatments are completed (FEIS 2007), providing feeding and nesting habitat for the prey base of the northern goshawk, including numerous bird species such as blue grouse, mourning dove, band-tailed pigeons, and sapsuckers (Reynolds et al. 1992)
- Mammal populations, including small prey of the northern goshawk, can be expected to increase as aspen stands regain vigor, since leaves, buds, twigs and sprouts provide forage for numerous species. The presence of deer and elk may also increase within the project area, since aspen provides palatable browse for these large ungulates, as well as summer shade and hiding cover (FEIS 2007).
- The ERI prescription can be expected to stimulate the rejuvenation of oak stands. Oak acorn crops are typically produced by trees with diameters greater than 2 inches and are an extremely plentiful and nutritious food

source for several species of mammals, from rodents to big game species (FEIS 2007). As stands mature they will provide increasing shelter, nesting sites and food availability for many wildlife species, including prey of the northern goshawk.

Coarse Woody Debris (CWD)

Prescribed burning, which is part of the ERU treatment, is the recommended method for management of woody debris in PFAs (Reynolds *et al.* 1992). However, forest managers are faced with a difficult quandary when reintroducing fire as part of a restoration prescription, while simultaneously seeking to maintain an adequate number of snags and logs as habitat for wildlife species.

- Inevitably, some logs and snags will be consumed when sites are burned, though new recruitment may also result in a net gain in the number of large snags (Roccaforte 2005).
- A majority of snags rendered unsuitable as bird habitat tend to fall over into large pieces ($\geq 6'$), providing new log habitat for small mammals (Gordon 1996).

Since post-fire suitability of snags and logs is highly correlated with fuel depth, mortality may be mitigated somewhat by creating raked buffers around selected snags, soaking logs with a water-detergent mixture or other aggressive management techniques (Gordon 1996).

Crown Fire Hazard

The application of ecological restoration based thinning and burning treatments will reduce the crown fire hazard within the project areas and minimize the potential for goshawk habitat destruction.

The application of treatments will affect fire behavior predictor variables such as height to live crown, tree density and basal area, canopy cover and tree crown bulk density. This will result in a reduction of the threat of crown fire behavior at both sites following application of restoration treatments. This trend following application of restoration treatments has been documented at the Fort Valley Experimental Forest in Northern Arizona. At this site a 70 percent average reduction in the area burned by crown fire was seen at 30 mph windspeeds at the same temperatures and fuel moisture contents utilized in the Jemez CFRP fire hazard simulations (Fule *et. al.* 2001).

Understory Plant Community

Species Richness and Cover

Both bird and small mammal populations can be expected to fluctuate following thinning and/or burning, since treatments alter the distribution and types of cover, nest sites and forage available (Chambers and Mast 2005, Roberts 2003). However, the ERI prescription of thinning and burning based on pre-settlement evidence has been shown to markedly increase production and diversity of herbaceous vegetation in the understory following treatments (Moore *et al.* 2006, Huisinga *et al.* 2005). Hiding cover and forage for goshawk prey species should improve dramatically, potentially increasing food availability, one of the factors limiting northern goshawk populations (Reynolds *et al.* 2006).

- The dominant native graminoids common to both the Redondo and East Fork project sites (sedges (*Carex* sp.), Arizona fescue (*Festuca arizonica*), squirreltail (*Elymus elymoides*), mountain muhly (*Muhlenbergia montana*), prairie junegrass (*Koeleria macrantha*)) are generally resistant to fire (FEIS 2007) and will regenerate from the remaining crown or underground rhizomes even when top-killed.
- Overall cover in the shrub layer may increase due to the presence of species currently within the project area which either sprout vigorously or are reported to have good seedling establishment following fire include kinnikinnick (*Arctostaphylos uva-ursi*), New Mexico locust (*Robinia neomexicana*), wax currant (*Ribes cereum*), greyleaf red raspberry (*Rubus idaeus* ssp. *strigosus*), and prickly rose (*Rosa acicularis* ssp. *sayi*) (FEIS 2007).

Exotics

Management activities such as forest thinning and prescribed burning, while necessary for restoring forest structure, may alter ecosystems in ways that promote alien plant invasion. Prescription thinning alone or in combination with burning has been shown to increase the diversity and abundance of alien plant species (Keely 2006, Thompson 2006). Within the Jemez CFRP, smooth brome (*Bromus inermis* ssp. *inermis* var. *inermis*) and cheatgrass (*Bromus tectorum*) are two exotics of concern whose populations are likely to increase following treatment, since both species are already established and exhibit a positive response to fire (FEIS 2007, Thompson 2006).

- Smooth brome, a rhizomatous grass native to Eurasia, generally invades after disturbance and persists, which may explain the high cover values noted along old access roads within the Jemez CFRP.

The species has been extensively used for rehabilitation of disturbed sites, but can be an aggressive colonizer and may crowd out native species (FEIS 2007). Fire will top kill plants but has been only marginally successful in controlling the species and may actually stimulate growth.

- Cheatgrass, an annual, early successional species, was observed at several locations where slash had been piled and burned for a previous thinning project. Established populations tend to persist long-term in open ponderosa pine forests, since relatively low-intensity prescribed burning does not eliminate the existing pre-fire seedbank, the strongest factor controlling cheatgrass populations (Keeley and McGinnis 2007).

V. Conclusion

This document outlines the proposed objectives, methods and expected outcomes of the Jemez Collaborative Forest Restoration Project. A major component of this project is to clarify the on-the-ground application of management recommendations for the northern goshawk in southwestern fire-adapted forests. Our intent has been to state, as clearly as possible, the optimal conditions of various components stated in the guidelines and how they compare to the current condition and to expected outcomes of ecological restoration treatments as applied at the Jemez CFRP sites. After completion of restoration treatments a follow-up document will be produced by the ERI describing the resulting forest structure and composition and how it relates to the requirements outlined in the goshawk guidelines. The results, even if incompatible with expectations, will contribute valuable information to forest practitioners as they seek to manage southwestern forests for increased ecosystem health and habitat suitability for the northern goshawk and its prey base.

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