

DRAFT Chapter 2 – Alternatives

This chapter describes and compares the alternatives considered for the Coconino and Kaibab NFs restoration project and presents the alternatives in comparative form, defining the differences between each alternative and providing a clear basis for choice by the decision maker. Some of the information used to compare the alternatives is based upon the design of the alternative (appendix D) and some of the information is based upon the environmental, social, and economic effects of implementing each alternative (chapter 3).

Alternative Development Process

As a result of public comment over an 8-month timeframe and additional analysis, the proposed action was modified as allowed by 36 CFR 220.7(b)(2)(iii), which states that “the description of the proposal and alternative(s) may include a brief description of modifications and incremental design criteria developed through the analysis process to develop the range of alternatives considered.” See chapter 1 (pages 55 and 56) for details on the development of the final proposed action (alternative B).

The interdisciplinary team (IDT) used information from scoping, including the issues identified for the project (pages 53 through 54), in conjunction with database modeling and field-related resource information, to formulate alternatives to the proposed action alternative (alternative B).

Alternative C responds to issue 2, conservation of large trees, (page 53) by incorporating key components from the 4FRI stakeholder-created Large Tree Retention Strategy (LTRS) into the alternative’s design criteria, monitoring and adaptive management plan, and project implementation plan. The alternative responds to comments and recommendations provided during scoping by including additional acres of grassland restoration treatment on the Kaibab NF. The alternative responds to comments by adjusting vegetation (decreases acres) and prescribed burning (increases acres) treatments in order to incorporate two research opportunities. One study would evaluate the effect of residual tree groups and tree-less opening size on small mammals and bird species. The second study would evaluate water yield from landscape-scale restoration actions. The alternative responds to recommendations to include mechanical and prescribed fire treatments within the proposed Garland Prairie Research Natural Area (RNA) on the Kaibab NF to move this area closer to its historical reference condition. The alternative also incorporates recommendations from U.S. Fish and Wildlife Service to increase prescribed burning treatments within protected habitat to improve the quality of Mexican spotted owl (MSO) roosting and nesting habitat.

Alternative D was developed to respond to issue 1, prescribed fire emissions (pages 52 and 53), by decreasing the acres to be prescribed burned. Other attributes of the alternative, with the exception of the use of prescribed fire, are similar to alternative B.

Forest Plan Consistency

Forest-wide and management/geographic area-specific standards and guidelines have been incorporated into the design of alternative B, C, and D as displayed in appendix D. Other applicable forest plan requirements that have been incorporated by resource are in the resource specialist reports. With the proposed non-significant forest plan amendments (see appendix C), alternatives B, C, and D are consistent with relevant Coconino and Kaibab NFs forest plan direction.

Alternatives Considered but Eliminated from Detailed Study

The range of alternatives considered by the responsible officials includes alternatives to the proposed action that are analyzed in the document, as well as other alternatives considered but eliminated from detailed study. Public comments received in response to the proposed action suggested alternative methods for achieving the purpose and need. They include the following three alternatives:

Alternative That Would Utilize Mechanical Treatments Limited to 8-inch dbh To Reduce the Potential for Crown Fire

This alternative was based on the assertion that crown fire can be effectively addressed with mechanical treatments that do not exceed 8-inch dbh. How this alternative would meet the purpose and need (which focuses on affecting forest structure, composition, and pattern) to put the project area on a trajectory towards improved wildlife habitat quality, increased forest resiliency, and improved function from natural disturbances was evaluated. Mechanical tree cutting would be used as the tool to establish interspaces, thin trees, and create sites for natural regeneration. Prescribed fire would be used to reduce litter and other surface fuels, decrease canopy fuels by increasing canopy base heights and decreasing canopy bulk density, stimulate herbaceous understory vegetation, prepare sites for natural ponderosa pine regeneration, and maintain interspaces.

A project objective is to re-establish non-forested openings that have become invaded by ponderosa pine since fire exclusion and reconfigure the forests to move towards their natural spatial pattern. Interspaces, tree group size, and shape would be determined by the location of less than 8-inch dbh trees. In situations where the existing condition is dominated by trees greater than 8-inch dbh, the post treatment condition would result in large, continuous tree groups with very little variety in size or shape and very little interspace.

In review of existing data, the stands with mechanical treatments classified as VSS 3 with an average diameter larger than 8 inches (147,947 acres) and all of the stands with mechanical treatments classified as VSS 4, 5 and 6 (227,042 acres) would be constrained by an 8-inch dbh limit. These stands would not be treated or have minimal treatment, and as a result 73 percent of the 512,173 acres of ponderosa pine within the analysis area would not move towards desired conditions for forest structure and pattern. Over the long term (20 plus years), these areas would continue on a trajectory away from the desired forest structure and pattern.

A project objective is to sustain old forest structure over time across the landscape by maintaining existing old trees, providing a continuous stock of “replacement” old trees, and by promoting sustainable forest conditions across the landscape. The project area is dominated by VSS 3 and VSS 4 classes. In many situations, these trees are in direct competition with the remaining pre-settlement trees. This inter-tree competition has a negative effect on old tree growth and vigor resulting in density related mortality and an unsustainable condition. Removal of these younger trees competing with the old trees would be determined by the location of trees less than 8-inch dbh. The VSS 3 greater than 8 inches and VSS 4 classes would continue to dominate the landscape and remain in direct competition with the old trees.

The disparity between the existing and desired wildlife habitat conditions was displayed in the purpose and need. In northern goshawk habitat, the project area has an imbalance of tree size classes. In terms of landscape ecology, each size class represents specific habitat components that

are needed for goshawk prey species. An imbalance in these habitat components potentially decreases the ability of goshawks to maintain their numbers over time. Currently, the project area is deficit of mature and old forest (VSS 5 and 6) as well as seedlings and saplings (VSS 2), and even-aged stand conditions apply to 56 percent of the non- post-fledgling family area (PFA) habitat within the project area (see tables 4 and 5 on p. 30, chapter 1). This condition is only desirable in nesting stands. Constraining treatments to 8-inch dbh would result in a portion of VSS 3 remaining even-aged and over 47 percent of VSS 4, 8 percent of VSS 5, and 1 percent of VSS 6 remaining even-aged. This would be contrary to moving towards improved habitat. In those portion of the habitat that are currently uneven-aged, an intermix of vegetation structural stages are currently lacking or limited in most stands. VSS 3 (35 percent) and VSS 4 (32 percent) are over-represented; VSS 1 (0 percent), VSS 2 (2 percent), VSS 5 (14 percent), and VSS 6 (17 percent) are deficit relative to a balanced age/structure uneven-aged condition. Concentrating all treatment to 8 inch dbh and less would result in no movement towards desired condition in a portion of VSS 3, and in 100 percent of VSS 4 to VSS 6.

A project objective is to reduce the potential for stand density-related mortality and reduce the level of dwarf mistletoe infection. A population of trees with a stand density index (SDI) greater than 55 percent has a high potential for density-related mortality. Avoiding density-related mortality and maintaining forest vigor can be achieved by maintaining densities at or less than this threshold. Mechanical treatments up to 8-inch dbh that reduce the SDI below 55 percent would reduce the potential for density related mortality. In areas that are dominated by trees greater than 8-inch dbh with an SDI greater than 55 percent, a mechanical treatment up to 8-inch dbh would have very little ability to reduce the potential for density related mortality. Of the 374,989 acres with mechanical treatments classified as VSS 3 with an average diameter larger than 8 inches or with mechanical treatments classified as VSS 4, 5 and 6, 191,715 acres (51 percent) currently have a SDI greater than 55 percent. Desired conditions for vegetation diversity and composition focus on maintaining and promoting Gambel oak, aspen, grasslands and pine-sage:

- **Gambel oak** – Objectives are to maintain and promote Gambel oak by increasing development of large oak and conserving existing large oaks. Reducing pine-oak competition will accomplish these objectives. Mechanical treatments up to 8-inch dbh that reduce pine-oak competition will maintain and promote Gambel oak. In areas that are dominated by trees greater than 8-inch dbh, a mechanical treatment up to 8-inch dbh would have very little ability to increase oak growth rates and reduce mortality. The conditions in which ponderosa pine trees are inhibiting Gambel oak development is most prevalent within the 65,024 acres of MSO restricted other habitat. Of those acres, 62 percent have a SDI greater than 55 percent and are dominated by trees greater than 8 inches. Any mechanical treatment constrained by an 8-inch limit within these areas would likely not be adequate to increase oak growth rates and reduce mortality.
- **Aspen** – Objectives are to maintain and promote aspen by increasing growth and stimulating regeneration. Removal of younger cohorts of competing ponderosa pine and disturbing (mechanical or fire) the sites would accomplish these objectives. Mechanical treatments up to 8-inch dbh that reduce pine-aspen competition would maintain the aspen overstory and promote aspen regeneration. In areas that are dominated by trees greater than 8-inch dbh, a mechanical treatment up to 8-inch dbh

would have very little ability to increase aspen growth rates and stimulate regeneration.

- **Grasslands** – Objectives are to maintain and promote grasslands. Removal of ponderosa pine encroachment that has occurred since fire exclusion (post-settlement) would accomplish these objectives. Mechanical treatments up to 8-inch dbh that remove ponderosa pine from grasslands would maintain and promote grasslands. In areas that are dominated by trees greater than 8-inch dbh, a thinning treatment up to 8-inch dbh would have very little ability to maintain and promote grasslands. Within the 11,230 acres proposed for grassland mechanical treatment, 9,435 acres (84 percent) are dominated by trees greater than 8 inches. Any mechanical treatment constrained by an 8-inch limit within these areas would likely not be adequate to restore the historic tree pattern and density within the grassland.
- **Pine-sage** – Objectives are to maintain and promote pine-sage. Removal of ponderosa pine encroachment that has occurred since fire exclusion (post-settlement) would accomplish these objectives. Mechanical treatments up to 8-inch dbh that remove ponderosa pine overtopping the sage component would maintain and promote the sage. In areas that are dominated by trees greater than 8-inch dbh, a mechanical treatment up to 8-inch dbh would have very little ability to maintain the sage component. Within the 5,261 acres proposed for pine/sage mechanical treatment, 5,187 acres (99 percent) are dominated by trees greater than 8 inches. Any mechanical treatment constrained by an 8-inch limit within these areas would likely not be adequate to restore the historic tree pattern and density within the treatment area.

Analysis demonstrates that this alternative would result in 73 percent (or the majority) of the project area not moving towards forest structure and pattern desired conditions in the short (up to 20 years) and long term (20 years-plus). Without the ability to affect structure and pattern, the overall objective of increasing forest resiliency and function would not occur on a majority of the project area. For this reason, the alternative was considered but eliminated from detailed study.

Alternative That Would Utilize Prescribed Fire as the Sole Treatment Method to Move towards Restoration Objectives

A basic concept in restoration is to use a combination of mechanical treatment and prescribed fire to move towards desired conditions. Mechanical treatment provides a balance of age classes in the short term (immediately post-treatment) and increased age and size class diversity in the long term (up to 30 years post-treatment). Prescribed fire reduces surface fuel loadings, stimulates understory growth, and stimulates the growth of species that have evolved with fire. Using a combination of mechanical treatment and prescribed fire is supported by science. Fulé et al. (2012) recently conducted a systematic review of 54 studies with quantitative data and found that:

- Canopy fuels, and both fine and course surface fuels, were significantly reduced relative to controls in burn-only treatments, though the conditions under which a burn is conducted affect the efficiency of a prescribed burn.
- Fine and course surface fuels significantly increased in thin-only treatments.
- Surface fuels changed little in thin and burn treatments but had a greater effect than either thinning alone or burning alone on reducing tree density, basal area, and canopy cover.

In response to public comments and recommendations, we considered an alternative which uses prescribed burning-only (versus mechanical treatment and prescribed fire) to move towards restoration objectives. The recommendations are based on the assertion that the current high-intensity fire rotation in southwestern forests is 625 years and/or that the forests should be predominantly managed as self-regulating through the use of natural processes such as fire. How this alternative would meet the purpose and need (which focuses on affecting forest structure, composition, and pattern) to put the project area on a trajectory towards improved age and size class diversity, wildlife habitat quality, increased forest resiliency, and improved function from natural disturbances) was evaluated. How the alternative responds to a key issue, smoke, was also evaluated.

At the project (landscape) scale, approximately 34 percent of the area has the potential to sustain crown fire. Of the 34 percent, 25 percent would be active crown fire and 9 percent would be passive crown fire. All crown fire is high severity in ponderosa pine. These types of fire have the potential to alter the successional trajectories of post-burn vegetation, creating entirely different communities than those existing before such events (Savage and Mast 2005, Kuenzi et al. 2008, Strom and Fulé 2007). See figure 22 in chapter 1 which displays the existing crown (and surface) fire risk. At the restoration unit (RU) scale, the risk of crown fire varies, ranging from 19 percent RU 6 (Tusayan District, Kaibab NF) to 42 percent in RU 1. At a finer scale that reflects habitats for threatened and endangered species such as MSO, crown fire risk increases up to 55 percent.

Surface fire potential exists on about 64 percent of the project area. Even without crown fire, a high intensity surface fire burning through this area could scorch the canopy sufficiently to cause widespread mortality (Van Wagner 1973). A high-intensity surface fire has high flame lengths. High flame lengths combined with closed, dense canopy fuels (the desired condition in many wildlife habitats) can produce sufficient damage to kill trees with a combination of needle scorch, root damage, and cambium damage. Figure 32 displays the existing surface fuel loading within the project area. The darkest blue color in the legend represents areas where fuel loadings are on the high end of what is recommended for soil productivity, historic levels, soil heating, wildlife, and fire hazard (Brown et al. 2003). Yellow through red display where surface fuel loads exceed levels recommended.

Within 27 percent (159,211 acres of 593,211 acres) of the project area, a burn-only alternative would meet the purpose and need for the project in terms of forest structure and forest health as analysis has determined there is little need for change that cannot be addressed with prescribed fire.

Without a combination of mechanical treatment and prescribed fire, density expressed as basal area and SDI are expected to continue to increase and remain higher than desired in all MSO habitats. By 2050, the distribution of size classes would exceed desired conditions in the 12- to 18-inch and the 18- to 24-inch size classes and remain below desired conditions in the 24-inch plus size class (see silviculture report).

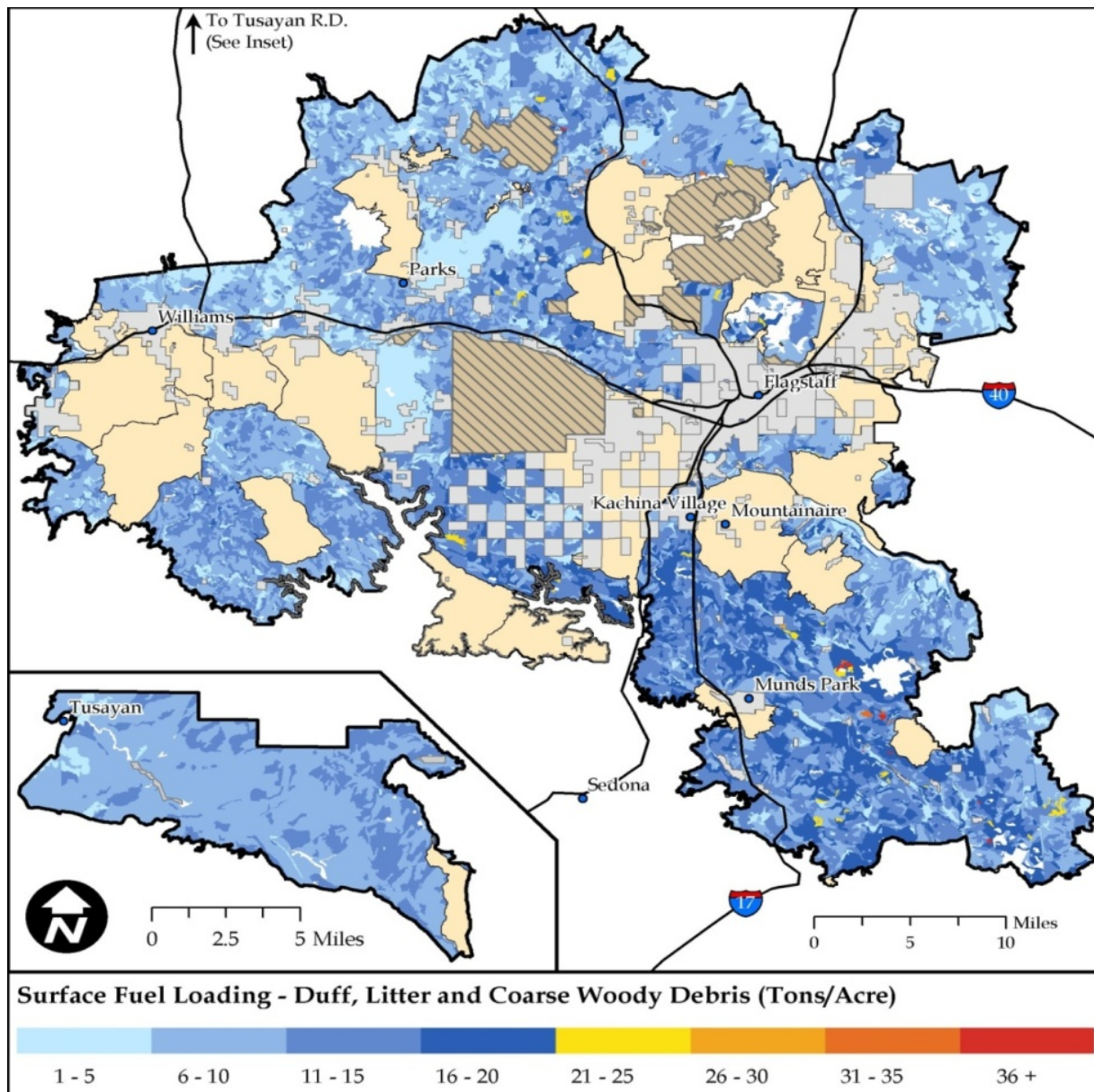


Figure 32. Existing Surface Fuel Loading within the Project Area (tons/acre)

In MSO habitat, applying prescribed fire (as the primary thinning agent) without mechanical treatment is likely to remove key habitat components including large and old trees that are needed for quality roosting and nesting habitat. Exactly how much mortality and which trees would be killed would be unknown for a few years following the fire. Mortality from the fire would leave a residual fuel load that would have to be managed. The residual fuel load, when combined with snags that are created from fire-related tree mortality, would increase the tons per acre of coarse woody debris (CWD), exceed desired conditions, and pose a risk for severe effects if high-severity surface fire occurred.

Figure 33 (below) shows heavy fuel loading within in the Mormon Mountain PAC in 2011. This is representative of conditions within some PACs in the project area. In this location, litter is 8 to 12 inches deep. There are several inches of duff beneath the litter and large logs scattered about. Some logs are buried in the litter. There is a preponderance of young trees, with sufficient canopy fuels to carry active crown fire. In areas like this, it would be difficult to reduce surface fuels by thinning with fire without killing large and old trees. Using fire as a thinning agent in these conditions would cause high severity effects to the surface and/or result in uncontrollable fire behavior. While this represents extreme fuel loading, it is a hazardous condition in terms of fire behavior and fire effects. If a wildfire burned through this PAC (even under moderate conditions) the effect would be high tree mortality, loss of soil productivity, and total loss of habitat.



Figure 33. High Surface Fuel Loading in Mormon Mountain PAC (2011), Coconino NF

For this reason, treatment in 18 MSO PACs (11,272 acres), where analysis has demonstrated mechanical treatment is needed, would likely be deferred. Without the ability to mechanically reduce fuel loadings around PACs prior to applying prescribed fire, prescribed burning in 56 cores areas would likely be deferred. Deferring treatment in 18 PACs and 56 core areas (up to 600 acres) would result in no movement towards reducing fire risk or improved quality in nesting and roosting habitat. The potential for using silviculture as a tool for meeting objectives such as maintaining and developing MSO habitat and enhancing various ecological factors is specifically identified in the Recovery Plan (USDI 1995). Because fire risk would remain high in PACs and forest structure (quality of nesting and roosting habitat) would not meet desired conditions in all habitats (112,546 acres total), no movement towards MSO Recovery Plan objectives and forest plan (fire risk and forest structure) desired conditions in MSO habitats would occur in this alternative.

Forest resiliency is dependent on the distribution of age and size classes and the ability of the forest structure to withstand natural disturbances, such as fire. A balance of age and size classes across the landscape allows for a sustainable balance of regeneration, growth, mortality, and decomposition (Oliver and Larsen 1990, Franklin et al. 2002, Thomas et al. 1979). Currently, over 50 percent of the project area lacks age and size class diversity and is in an even-aged structure. A lack of age and size class diversity (see table 2 and tables 4 to 7, chapter 1) results in reduced resiliency (i.e. much higher risk of high intensity and severity fire. In terms of moving towards desired conditions for forest structure, fire is indiscriminate, and it is not at all certain that the structure left after thinning with fire would set the burned area on a trajectory towards restoration. The project area is currently deficit in VSS 1 (2 percent of the project area) and VSS 2 (4 percent of the project area). Increasing the deficit in VSS 1 and 2 and potentially affecting site productivity for regrowth after a high-severity fire does not meet the purpose and need of having age and size class diversity and a forest structure that is resilient to fire.

The use of prescribed fire without mechanical treatment could result in undesirable fire effects on the overstory trees of larger age and size classes as stand density increases over time. In 2020, both even-aged and uneven-aged stands that occur outside of goshawk PFAs are projected to be dominated by the young and mid-aged forest structural stages with a combined overall distribution of 84 percent in uneven-aged stands and 70 percent in even-aged stands. This is over twice the desired condition (see silviculture report). Trends in goshawk PFAs are similar as described for non-PFA areas. Fires severe enough to thin 10-inch to 14-inch dbh pines are likely to crown in unthinned stands and would be difficult to manage under any circumstances (Miller and Urban 2000). The risk of fire being carried into the overstory canopy and escaping or high cambium damage, resulting in overstory mortality could occur (Battaglia, Smith, and Shepperd 2009).

Approximately 194,804 acres meet old growth conditions in the project area. Old tree and large trees (with old growth characteristics) that are scattered across the treatment area would not receive mechanical treatment prior utilizing prescribed fire. Old ponderosa pines are often more susceptible to mortality after fire (even low intensity fires) than younger mature trees (Kolb et al. 2007). The increasing size and severity of wildfires and the ensuing death of old and/or large ponderosa pines has been linked to fuel accumulation resulting from a century of fire exclusion (Covington et al. 2001, Hood 2010, and Kolb et al. 2007). In this alternative, the potential for more extreme fire behavior would exist. With little to no opportunity to effectively prepare old or large trees (with old growth characteristics) to minimize the effects of a high-intensity wildfire, there would be much greater potential for high severity effects than if it could be thinned and/or a

low-intensity fire occurred first. Recent research indicates that scorch is one of the primary factors in large and old tree mortality (Jerman et al. 2004) and is influenced by the vertical arrangement of fuels. Prescribed fire, when combined with mechanical treatment (in the vicinity of old and large trees), decreases fuel loading in the immediate vicinity of these trees, which decreases the potential for crown scorch.

Currently, the old growth allocation acres are attributed to: (1) 100 percent of MSO protected habitat, (2) 100 percent of MSO target/threshold, (3) 40 percent of MSO restricted habitat that is uneven-aged with low dwarf mistletoe infection, (4) 80 percent of MSO restricted habitat that is even-aged and mid-aged to old with low dwarf mistletoe infection, (5) 100 percent of goshawk nest stands, (6) 40 percent of goshawk PFA and non-PFA areas that are uneven-aged with low dwarf mistletoe infection, and (7) 80 percent of goshawk PFA and non-PFA areas that are even-aged and mid-aged to old with low dwarf mistletoe infection. In order to avoid excessive old tree damage and mortality (even with mitigation), any treatment in those acres that contribute to old growth allocation (194,804 acres or 33 percent of the project area) would likely be deferred because a key project objective is to improve age and size class diversity, particular in VSS 5 and 6 which are rare across the landscape. In this alternative, movement towards age and size class diversity would not be met as there would be continued deficits in VSS 5 and VSS 6.

Another project objective is to re-establish non-forested openings that are being invaded by ponderosa pine due to fire exclusion, and reconfigure the forests for movement toward their natural spatial pattern. In situations where the existing condition is dominated by trees (VSS 3 and VSS 4) greater than those that can be safely and effectively treated with fire, the post treatment condition would result in large, continuous tree groups with very little variety in size or shape and very little interspace. This means that up to 76 percent of goshawk non-PFA habitat, which accounts for 62 percent of the total project area acreage (of 369,033 acres), is not likely to move towards the desired condition of having age class diversity. A lack of spatial pattern (groups with interspaces) increases the likelihood of having overstory mortality as a result of using prescribed-fire only. Compliance with forest plan goshawk habitat requirements that restrict the width and acre-size of openings may not occur.

Currently, big sage and ponderosa pine co-occur on approximately 16,000 acres of the Tusayan District (Kaibab NF, RU 6) portion of the project area. Without mechanically treating these acres first, ponderosa would continue to increase in density and sage would be at risk of being shaded out. Pine, sage, and other components that make up this vegetative community would be at risk of high severity fires which could eliminate sage and other shrubs locally. In addition, it could change the site potential because of high severity effects to the soil (chemical and physical changes). Where pine cover is higher, prescribed burning would need to be deferred in order to avoid severe effects to the surface vegetation community. Movement towards the desired condition of having a shifting mosaic of sagebrush (with a mix of age classes) that is largely regulated by fire would not be achieved in those areas where pine cover is highest.

Of the 59,391 acres of grasslands that are departed from historic conditions, 11,230 acres have conifer encroachment exceeding the 0 to 9 percent tree cover desired condition. About 9,435 acres (84 percent) of these grassland acres are dominated by trees in the VSS 3 category (a young forest ranging from 5- to 12-inch dbh). In these acres, there would very little ability to restore the historic tree pattern and density within the grasslands without removing the encroachment prior to using prescribed fire. The purpose and need would not likely to be met on 84 percent of this

grassland vegetation. The desired condition would be met in 48,161 acres where prescribed fire-only is needed to restore grassland function.

A key public issue in this analysis is smoke and the associated emissions from the use of prescribed fire. Emission production is limited to what the allowed by the Arizona Department of Environmental Quality. However, public tolerance effectively sets a social limit to how many acres are treated with fire. Initial entry burns into areas that have not burned for a long time (100 percent of the project area) would produce a great deal more smoke from the first and second burns than in subsequent burns. Stands that have burned more recently and frequently would produce lower emissions. See figure 34 and figure 35 which displays emissions from various treatments including wildfire, prescribed fire-only, and mechanical treatment combined with prescribed fire. The first prescribed fire following mechanical treatment produced slightly over 30,000 pounds per acre of emissions. The first prescribed fire without mechanical treatment produced slightly over 40,000 pounds per acre of emissions. Without the ability to utilize mechanical treatment to reduce smoke emissions as possible and practicable, there would likely be a reduced and ineffective rate of treatment that goes well beyond the 10-year life of this project. Less than 30,000 acres would be treated per year and the majority of the project area would remain at risk from uncharacteristic fire and in a degraded forest health condition. This alternative would not respond to prescribed fire emissions (smoke), a key issue.

In summary, this alternative was considered but eliminated from detailed study because: (1) fire risk would remain high in PACs, forest structure (quality of nesting and roosting habitat) would not meet desired conditions in all habitats (112,546 acres total), and there would be no movement towards MSO Recovery Plan objectives and forest plan (fire risk and forest structure) desired conditions in MSO habitats, (2) continued deficit in VSS 1, 2, 5, and 6 would occur and moving towards age and size class diversity would not be attained, (3) historic tree pattern, density, and overall function would not be restored on 11,000 acres of grasslands, (4) movement towards the desired condition of having a shifting mosaic of sagebrush (with a mix of age classes) that is largely regulated by fire would not be achieved in those areas where pine cover is highest, and (6) the alternative does not respond to prescribed fire emissions, a key issue.

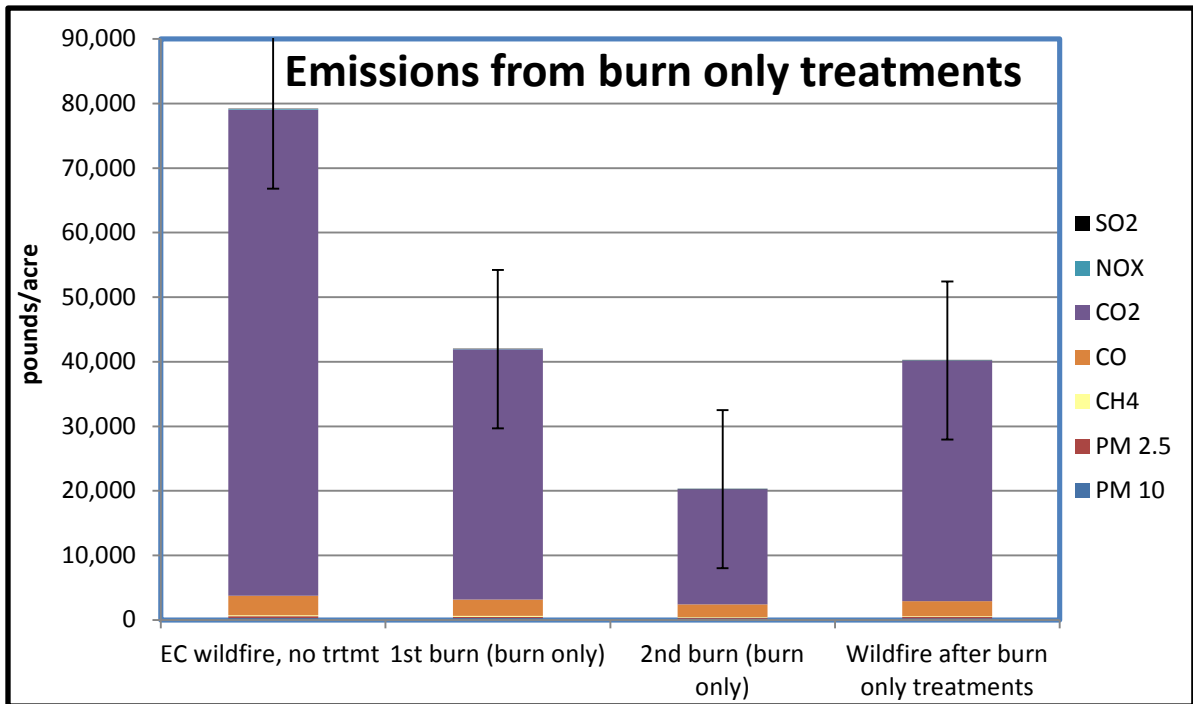


Figure 34. Projected Emissions (pounds/acre) from Various Burn-only Treatments

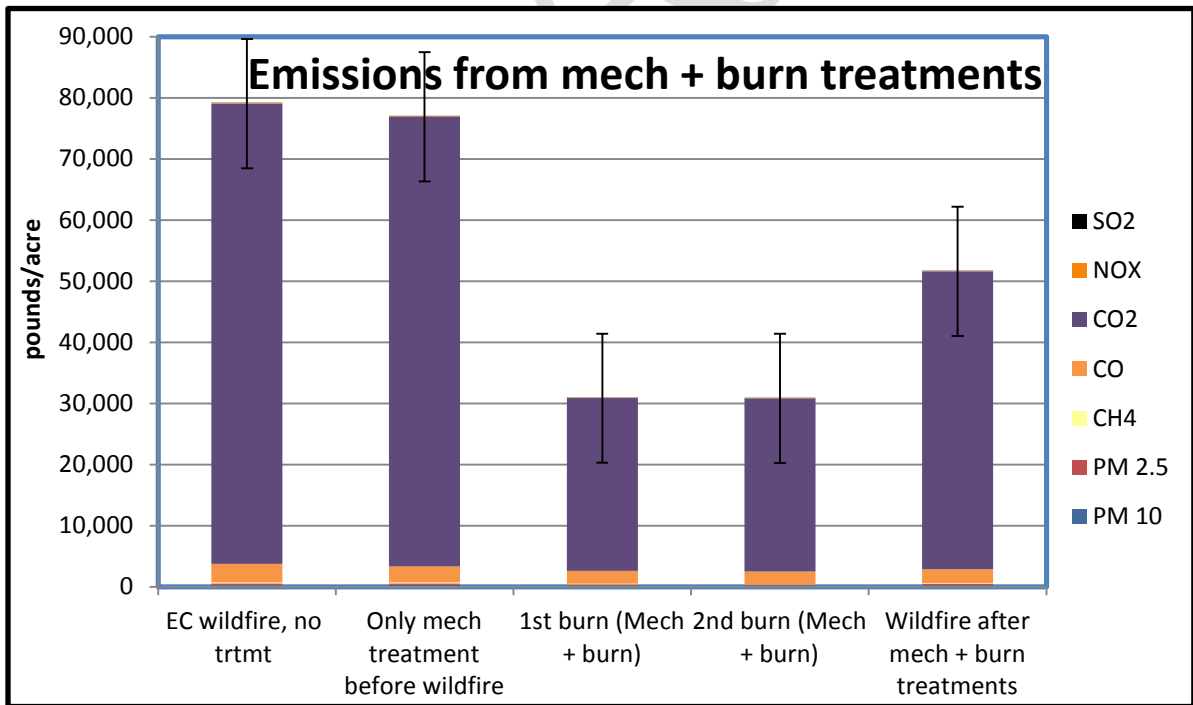


Figure 35. Projected Emissions (pounds/acre) from Wildfire and Mechanical and Prescribed Burning

Alternative That Would Eliminate the Use of Prescribed Fire

The purpose of this alternative is to respond to public comment and the recommendation to eliminate all prescribed fire to remove project nuisance smoke and its resulting emissions. Recommendations include using livestock (cattle, goats) in lieu of prescribed fire to reduce fuels. This alternative assumes that approximately 90 percent of all treatment-related slash (biomass) would be moved off-site, considers a variety of mechanical treatment methods, and considers grazing. How this alternative would meet the purpose and need (which focuses on affecting forest structure, composition, and pattern) to put the project area on a trajectory towards improved wildlife habitat quality, increased forest resiliency, and improved function from natural disturbances was evaluated.

Mechanical treatment on 434,001 acres in the project area would be effective at quickly resetting the trajectory of a forest that has become overly dense by restructuring tree canopy characteristics, tree density, and the arrangement of trees. However, landscape patterns and mosaics that would have been created or maintained with fire would have to be maintained mechanically. Fire in ponderosa pine promotes groupy/clumpy arrangements with interspaces. Groups and interspaces are natural to the ponderosa pine ecosystem and fundamental to its adaptation to fire. Patterns of surface vegetation would continue to deteriorate, as shrubs and other species adapted to fire declined (Huffman and Moore 2008, Moir 1988). In order to avoid forest re-growth that would support extreme fire behavior, the project area would need to be thinned at a rate of approximately 50,000 acres year over a period of at least 20 years. Covington et al. (2001) found that continuous disturbance over long duration could negatively affect soil and habitat.

While mechanical treatment would create openings, interspaces, and would reduce competition amongst trees, it would not replace the ecological role that fire plays in ponderosa pine and grasslands. A key project objective is to increase the herbaceous understory. A productive and diverse understory protects soil from erosion, creates forage and cover for wildlife, provides fuels to carry low-severity surface fires, and is the repository for much of the biodiversity in ponderosa pine ecosystems (Moore et al. 2006). Approximately 300 to 600 plant species occur beneath the canopies of ponderosa pine forests in northern Arizona (Daniel Laughlin, personal communication 2011). In a rare long-term study on overstory manipulation, species richness did not differ among treatments for 10 years (Laughlin et al. 2008). Mechanical treatment alone did not increase species richness, but mechanical treatment plus repeated use of prescribed fire increased species richness 11 and 12 years after initial treatment (Laughlin et al. 2008). Fifteen new species were present in years 12 and 13 that were not present at the beginning of the study (Laughlin et al. 2008).

A review of the best available science was conducted and synthesized into table 14. The table summarizes understory response to forest disturbances including mechanical treatment, mechanical treatment and prescribed fire, and high-severity wildfire. The expected understory responses are directly linked to specific literature.

Table 14. Understory Response to Various Treatments

Understory Characteristic	Change Relative To Control Plots			Citation(s)
	Mechanical Treatment	Mechanical and Prescribed Fire	High Severity Wildfire	
Species Richness	Increase	Increase	Increase (but includes a higher percentage of exotic species)	Stoddard et al. 2011
Total Biomass	Increase	Increase	Increase (but includes a higher percentage of exotic species)	Moore et al. 2006
Graminoids	Increase	Greatest Increase	Decrease	Griffis et al. 2001; Stoddard et al. 2011
Forbs	Increase	Greatest Increase	Increase	Griffis et al. 2001; Laughlin et al. 2004, 2005, and 2006; Moore et al. 2006
Shrubs	Increase	Increase/Decrease	Decrease	Huffman and Moore 2004; Griffis et al. 2001
Gambel Oak	Increase	Decrease in small diameter trees/Increased growth rates of larger oak	Decrease	Abella and Fulé 2008
Soil Nutrients	Increase	Greatest Increase	Increase (greater pulse in magnitude, but with lower potential to affect plant growth over time)	Meyer et al. 2001; Gundale et al. 2005; Hart et al. 2005; Covington and Sackett 1992; Abella 2004
Actinomycete	Increase (after herbaceous vegetation increases)	Increase	Decrease (patchy response depends on site-specific severity)	Gundale et al. 2005; Hart et al. 2005
Arbuscular Mycorrhizae	Increase (after herbaceous vegetation increases)	Increase	Decrease (patchy response depends on site-specific severity)	Covington and Sackett 1984; Abella 2004
Community Composition	Increase	Increase		Covington and Sackett 1992; Abella 2004; Laughlin et al. 2008
Litter	Decreased Rate of Accumulation	Decrease	Decrease	Scudieri 2009

Understory Characteristic	Change Relative To Control Plots			Citation(s)
	Mechanical Treatment	Mechanical and Prescribed Fire	High Severity Wildfire	
Native Species	Increase	Increase	Increase (in the long term)	Griffis et al. 2001; Laughlin et al. 2004, 2005, and 2006; Moore et al. 2006
Exotic Species	Increase	Increase (in short-term)	Greatest Increase	Griffis et al. 2001; Sabo et al. 2009; Stoddard et al. 2011

Without the use of prescribed fire, forest structure would be affected in terms of moving towards age and size class diversity desired conditions. There would be an increase in VSS 3 (would not meet desired condition), a decrease in VSS 4 (would meet desired condition), a slight decrease in VSS 5 in 2020 followed by a slight increase in 2050, and an overall decrease in VSS 6 (would not meet desired condition). These differences can be attributed to the lack of prescribed fire mortality, especially in the VSS 3 class. The denser conditions also would affect the VSS distribution trend by slowing stand development and growth. This results in maintaining more of the landscape in the young forest stage and impeding development of the mature and old forest stages, which is contrary to the purpose and need of the project. See the silviculture report for additional information.

Overall, movement towards the desired condition of maintaining pine regeneration in grasslands (59,391 acres), pine-sage (5,261 acres), and ponderosa pine with an open reference condition (56,692 acres) could be achieved with frequent cutting and/or mowing. Regeneration would need to be addressed every 5 years.

Habitat for the northern goshawk and MSO evolved with fire. Fire, along with bunch grass competition, keeps pine from out-competing Gambel oak (Abella 2008, Reynolds et al. 1992), an important forage plant for many wildlife species. Fire is a recommended management tool for improving goshawk habitat, and fire suppression is credited with degrading goshawk habitat by changing forest structure and composition (Reynolds et al. 1992). By year 2020 in MSO habitats, basal area density would approach the high end threshold of the desired range within the restricted other (target/threshold) habitat and would be within desired range for the other habitats. SDI would be higher than desired in all habitats with the exception of restricted other in RU 5 and protected habitat in RU 4. By year 2050, basal area and SDI density would exceed desired conditions in all habitats. The distribution of size classes would be at or exceed desired conditions in the 12- to 18-inch and the 18- to 24-inch size classes in all habitats. Stocking in the 24 inch plus size class would exceed desired conditions in the restricted other habitat and would remain below desired conditions in 8,713 acres of target/threshold habitat. The short and long term effects are largely due to the limited mechanical and fire treatments in 11,630 acres of protected habitat and the high oak stocking and lack of post mechanical treatment burning in 67,378 acres of restricted habitat.

By year 2020 in goshawk habitat, all habitats would be within the desired density range with the exception of RU 6 PFA (due to these stands being dominated by young forest structural stage).

With the exception of RU6 and non-PFA acres in RU 5, tons of coarse woody debris would be at or above desired conditions due to the lack of prescribed fire reducing this attribute. Snags per acre would be below desired conditions at all scales. In year 2050 (at the habitat and RU scale) all habitats would remain within the desired SDI range. Basal area would be above desired with the exception of RU 6 PFA and corresponding canopy cover would remain above the desired threshold. Total tons of coarse woody debris would exceed the minimum desired with the exception of RU 6 PFA and outside of PFA. Snags would increase but would remain below desired levels.

Movement towards having a forest that has increased resilience to undesirable fire behavior and its effects would be reduced. Mechanical treatment would move thinned fuels offsite and decrease the potential for crown fire and emissions. Though the potential for crown fire may be low or non-existent as a result of thinning, surface fire intensity may increase (Omi and Martinson 2002). Surface fire potential currently exists on about 62 percent of the project area (see figure 32). In this alternative, accumulations of litter, duff, existing dead and down woody debris, and seedlings and small saplings would not be reduced by mechanical thinning. These accumulations, in addition to the debris from logging (even with most biomass removed off-site), could result in surface fires that burn at high intensities and lethally scorch tree crowns. Fires that burn or smolder for long periods of time (also referred to as fires that have long residence times) would consume or kill roots, seeds, and other organic matter in the top layers of soil. Mortality rates would be higher than what is predicted from using prescribed fires across the project area. Tree mortality would include large and old trees that typically have decades of debris built up around their base and on top of their roots. Even though crown fire is not present, fires that have long residence times can have detrimental effects across large areas, including unburned areas adjacent to or downstream/downslope from the burned area. In the project area, the potential to compromise water resources such as Oak Creek, Mormon Lake, or Stoneman Lake would exist as second order fire effects occur (flooding, debris flows, erosion, etc.).

Should fire occur in the project area, it would be wildfire. Wildfire can be beneficial or detrimental, depending on environmental conditions at the time of the fire, and the condition of the forests in which they burn. A key objective of reducing the risk of wildfire to human and resource values would not be met. Excessive surface fuels would promote surface fires that burn at high intensities and have effects that include the mortality of large and old trees on 62 percent or greater of the project area. Meeting objectives and movement towards the desired condition would not be met.

Alternative types of treatment considered:

Chipping and shredding (a form of mechanical treatment) material would either remain on the forest floor or would be piled and moved off site. Shredded or chipped wood at the surface has been shown to augment the already-negative effects of excessive litter/duff that has accumulated, decreasing surface vegetation cover, particularly for native species (Miller and Seastedt 2004). Therefore, most materials would need to be piled and moved off the forests.

Mastication produces a much wider variety of debris sizes. When the mastication debris is left on the forest floor, it does not cover the forest floor as completely as using the chipping method. Nonetheless, as with chipping, when the size of the project and the potential quantity of material to be masticated is considered, mastication would only be viable if debris is consolidated and removed.

Raking is a time consuming method that is a way to treat the buildup of litter and duff. Leaf blowing would be a time consuming method that would not be effective at removing a buildup of litter and duff. This method could be combined with raking as it may facilitate moving litter into piles which are then transported off the forests.

Grazing as another method to reduce fuel loading was suggested in public comment. Herbaceous vegetation would help to carry a fire in the majority of project area, but is only a minor contributor compared to needle cast, tree debris and trees themselves. However, this is not true in grassland and shrubland areas.

Within the 988, 764 acre 4FRI analysis area, 790,985 acres are within grazing allotments. There are 47 active livestock (cattle and sheep) allotment management plans in place that permit over 20,000 animals (see range specialist report) to utilize the forests. Grazing allotments are currently authorized on 100 percent of the project area. The allotment plans address suitable forage areas and are designed to maintain or improve forest resources. These plans have conservative grazing utilization standards that range between 30 to 40 percent. Grazing systems include both rest and deferred rotation. The use of these grazing systems can temporarily reduce herbaceous fine fuels where grazing occurs. However, this use is not even throughout a pasture and the herbaceous vegetation and shrubby fuels re-grow, normally within the same year.

To use livestock (authorized livestock and goats was recommended in a public comment) as a tool to reduce the threat of wildfire in this area, utilization rates would need to be greatly increased along with the length of graze periods within each pasture. This type of increased use would exceed what is currently permitted in the existing allotment management plans. This type of use would not contribute to the long-term health of the area. It would lead to a decline in herbaceous species production and diversity, and possibly an increase in soil compaction across the project area. This equates to impacting over 500,000 acres where treatments are planned. This is contrary to the purpose and need of the project which seeks to increase the herbaceous understory and move towards improved function in soils, watersheds, grasslands, and forested areas.

In summary, it is possible to use mechanical treatments (including chipping, shredding, mastication, raking, and leaf blowing) or remove most biomass offsite that would otherwise be burned and produce smoke. However, without fire, the effects of using only mechanical treatments would eliminate many of the ecological roles that fire provides that are necessary and beneficial to healthy forests and watersheds in the 4FRI project area. Mechanical treatment could not replace the role fire has in increasing vegetation composition and diversity in 59,391 acres of historic grasslands and over 45,000 acres of ponderosa pine with an open reference condition. In 5,261 acres of pine-sage, a shifting mosaic of shrubs species with an intermix of age classes (that provides for vegetation diversity) would not occur as fire is the process that maintains this diversity. Without the ability to use prescribed burning to maintain the desired canopy base heights, canopy bulk densities, and reduced ladder fuel conditions that have been attained through mechanical treatment, the risk to losing key components of the ecosystem would increase unless approximately 60,000 acres is annually treated over the course of 20 years.

Alternatives Considered in Detail

The Forest Service developed four alternatives, including the no action (alternative A), the final proposed action (alternative B) and two additional alternatives (alternative C and D) that respond to recommendations and issues raised by the public.

Alternative A – No Action

As required by 40 CFR 1502.14(c) the no action alternative (alternative A) has been analyzed to contrast the impacts of the action alternatives with the current condition and expected future condition if the proposed action were not implemented.

This alternative proposes no restoration treatments including those for vegetation, prescribed fire, springs, seeps, ephemeral channels, and road decommissioning in the project area. Alternative A would not increase forest resiliency to natural disturbances and would not improve function. It does not meet the purpose and need for the project as it would not move the project area towards forest plan vegetation (forest structure, forest health, composition, and diversity), fire behavior (percent of the landscape with the potential for uncharacteristic fire behavior and effects), soils (soil function/productivity and understory species) and watershed (riparian ecosystem and channel function) desired conditions.

Design Criteria, Mitigation Measures, and Best Management Practices Common to Alternatives B-D

The Forest Service developed and/or incorporated design features, best management practices (BMPs), and mitigation to be used as part of alternatives B-D, see appendix D.

Implementation Plan Common to Alternatives B through D

The Forest Service used comments and recommendations from the public and stakeholders to develop documents that would guide implementation. See appendix E for the implementation plan which is part of alternatives B, C, and D.

Monitoring and Adaptive Management Plan

The Forest Service worked collaboratively with stakeholders to develop a monitoring and adaptive management plan that is to be used as part of alternatives B, C, and D, see appendix F.

Alternative B – Proposed Action

The Coconino and Kaibab NFs propose to conduct approximately 587,923 acres of restoration activities over approximately 10 years or until objectives are met. Approximately 20,000 to 30,000 acres of vegetation would be treated annually and up to 40,000 acres would be prescribed burned annually across the forests. Restoration activities would:

- Mechanically cut trees on approximately 388,489 acres, including mechanically treating up to 16-inch dbh within 18 MSO PACs and cutting 99 acres of trees by hand on slopes greater than 40 percent

- Utilize mechanical treatment and prescribed fire on approximately 388,489 acres, including prescribed burning within 72 MSO PACs (excluding core areas) and on 99 acres of slopes greater than 40 percent
- Utilize prescribed fire-only on approximately 199,435 acres
- Decommission 770 miles of existing system and unauthorized roads on the Coconino NF
- Decommission 134 miles of unauthorized roads on the Kaibab NF
- Construct 245 miles of temporary roads for haul access and decommission when treatments are complete
- Open (construct) approximately 272 miles of existing, decommissioned road and return to decommissioned status when treatments are complete
- Reconstruct up to 10 miles of existing, open roads for resource and safety concerns
- Restore 74 springs and construct up to 4 miles of protective fencing
- Restore 39 miles of ephemeral channels
- Construct up to 82 miles of protective (aspen) fencing
- Allocate as old growth 40 percent of ponderosa pine and 77 percent of pinyon-juniper woodland on the Coconino NF and 35 percent of ponderosa pine and 58 percent of pinyon-juniper on the Kaibab NF

Two non-significant forest plan amendments (see appendix C, alternative B) would be required on the Coconino NF to implement the proposed action. A variance would be provided to: (1) use mechanical treatments to improve habitat structure and treat up to 16-inch dbh within 18 MSO PACs, (2) clarify that canopy cover would be measured and met at the group level, (3) add language to define/describe interspace and describe the relationship between interspaces, openings, and vegetation structural stage (VSS) classes, and (4) manage 29,017 acres of goshawk non-PFA habitat for less than 40 percent canopy cover and less than 3 to 5 reserve trees per acre.

One non-significant forest plan amendment (see appendix C, alternative B) would be required on the Kaibab NF to implement the proposed action. A variance would be provided to: (1) clarify that canopy cover would be measured and met at the group level, (2) add language to define/describe interspace and describe the relationship between interspaces, openings, and vegetation structural stage (VSS) classes, and (3) manage 27,637 acres of goshawk non-PFA habitat for less than 40 percent canopy cover in VSS 4 to 6 and less than 3 to 5 trees per acre.

Table 15 provides acres to be mechanically treated by treatment type. Please refer to the glossary (appendix H) for treatment definitions. Individual resource sections in chapter 3 describe how actions were evaluated at various scales. Figure 36 displays alternative B's vegetation and prescribed fire treatments at a course scale. Table 16 provides information on road treatment acres by restoration unit for alternative B, C, and D and figure 37 provides the course-scale overview. Table 17 provides information on acres of springs, ephemeral channels, and aspen treatments for alternative B, C, and D, and figure 38 provides the course scale overview. Table 18 and table 19 display vegetation and prescribed burning treatment acres in goshawk and MSO habitat specific to alternative B and figure 39 provides a course-scale map for treatments in these habitats. Table 20 and table 21 display the old growth allocation for alternative B, C, and D and figure 40 provides the course-scale overview (map).

Table 15. Alternative B Mechanical and Prescribed Fire Treatment Descriptions and Acres

Treatment Type	Treatment Description/Objective	Acres
Aspen	Mechanical treatment that removes post-settlement conifers within 100 feet of aspen clone, stimulates suckering, and includes prescribed fire	1,229
Prescribed Fire Only	No mechanical treatment accompanies prescribed fire	199,435
Grassland Restoration	Mechanical treatment that remove encroaching post-settlement conifers	11,185
Intermediate Thin (IT) 10	Mechanical treatment designed to thin tree groups and establish interspace adjacent to group to an average of 70 to 90 square feet of basal area and manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees with the least amount of mistletoe	7,766
Intermediate Thin (IT) 25		11,871
Intermediate Thin (IT) 40		39,189
MSO Restricted	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, irregular tree spacing, and various patch size	65,024
MSO Target	Intermediate thinning (IT) designed to improve forest health, reduce fire risk, and meet basal area requirements	6,518
MSO Threshold	Same as MSO Target	1,894
MSO PAC	Mechanical treatment designed to increase tree vigor and health and create canopy gaps to reduce fire risk	10,741
Pinesage	Mechanical treatment that restores pre-settlement tree density and pattern using evidence as guidance	5,261
Savanna	Mechanical treatment that restores pre-settlement tree density and pattern and manages for a range of 70 to 90 percent of the treatment area as interspace (grass/forb) between tree groups or individuals	45,469
Stand Improvement (SI) 10	Mechanical treatment that establishes tree groups and interspace adjacent to the groups and manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees within each group	1,914
Stand Improvement (SI) 25		6,824
Stand Improvement (SI) 40		12,309
Uneven-aged (UEA) 10	Mechanical treatment that is designed to have interspaces between tree groups and clumps that occupy 10 percent of the landscape	18,204
Uneven-aged (UEA) 25	Mechanical treatment designed to have interspaces between tree groups and clumps occupy that up to 25 percent of the landscape	39,244
Uneven-aged (UEA) 40	Mechanical treatment designed to have interspaces between tree groups and clumps that occupy up to 40 percent of the landscape	101,044
Wildland Urban Interface (WUI) Pinyon-juniper	Mechanical treatment around the community of Tusayan designed to reduce fire risk and meet Community Wildfire Protection Plan (CWPP) objectives	535
Wildland Urban Interface (WUI) 55	Mechanical treatment in the WUI designed to have interspaces that occur between tree groups and clumps occupy up to 55 percent of the landscape	2,268

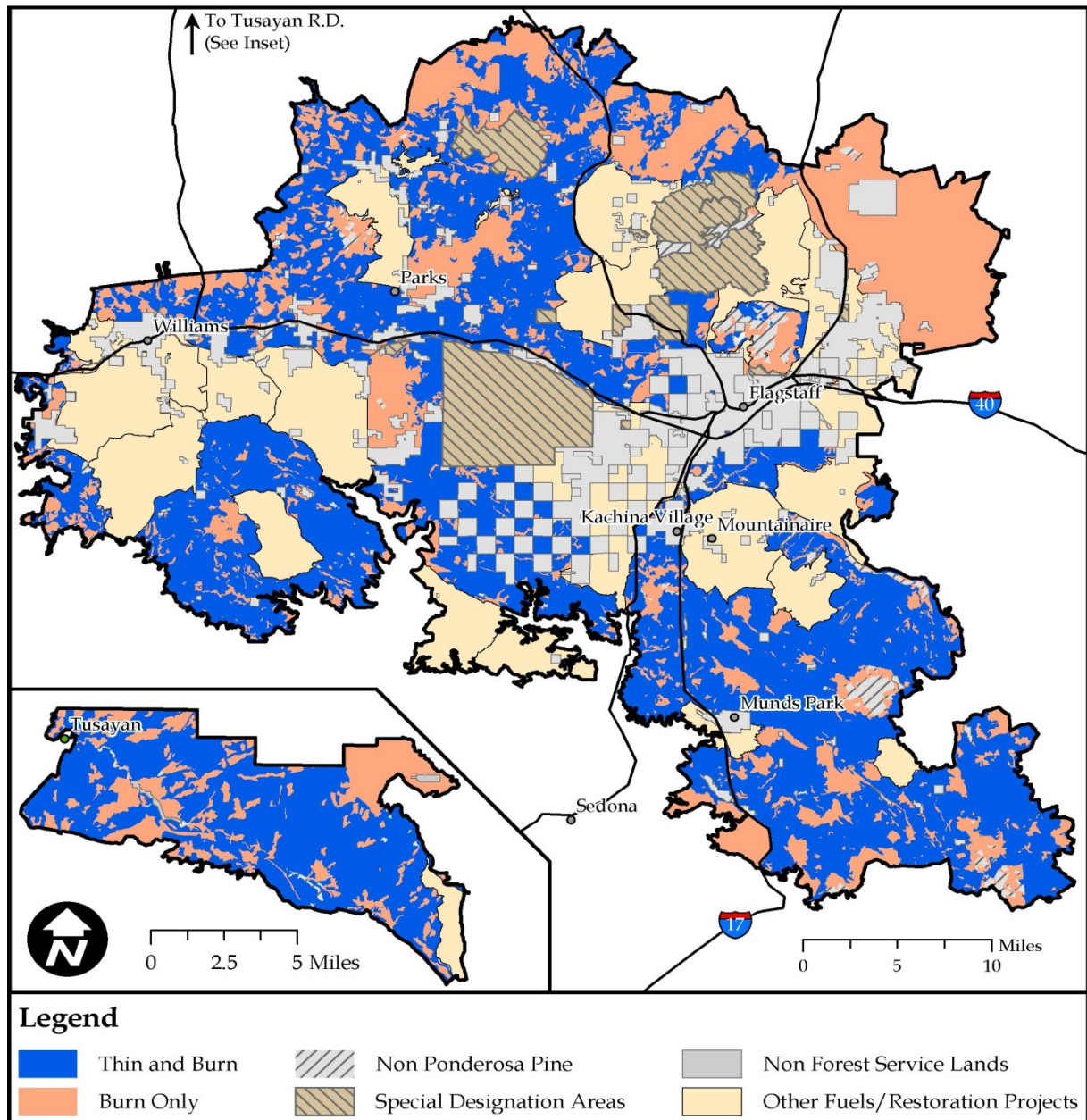


Figure 36. Alternative B General Locations of Mechanical and Prescribed Fire Treatments

Table 16. Alternative B through D Road Activity Miles by Restoration Unit (RU)

Alternative B Road Activities (Miles)					
RU	Decommission		Temporary Road Construction and Decommission		Reconstruction
	Closed Roads	Unauthorized Roads	New Roads	Previously Decommissioned Roads	
	1	205	0	69	
3	100	77	96	70	2.8
4	185	33	56	142	1.1
5	280	0	8	19	0
6	0	24	15	0	3.3
Total	770	134	245	272	10

*Temporary road construction would be followed by decommission once implementation is complete. Gates or other devices would be used as needed to manage motorized access during implementation.

Table 17. Alternative B through D Springs, Riparian, Ephemeral Streams, and Aspen Activities by Restoration Unit (RU)

RU	Springs Restoration (Number)	Riparian Habitat and Ephemeral Stream Restoration (Miles)	Aspen Restoration		
			Mechanical Treatment (Acres)	Prescribed Fire (Acres)	Protective Fencing* (Miles)
1	32	24	182	167	11
3	24	7	201	0	17
4	14	5	453	46	41
5	4	2	392	10	14
6	0	<1	0	0	0
Total	74	39	1,229	223	82

*See appendix D for details on aspen treatment design.

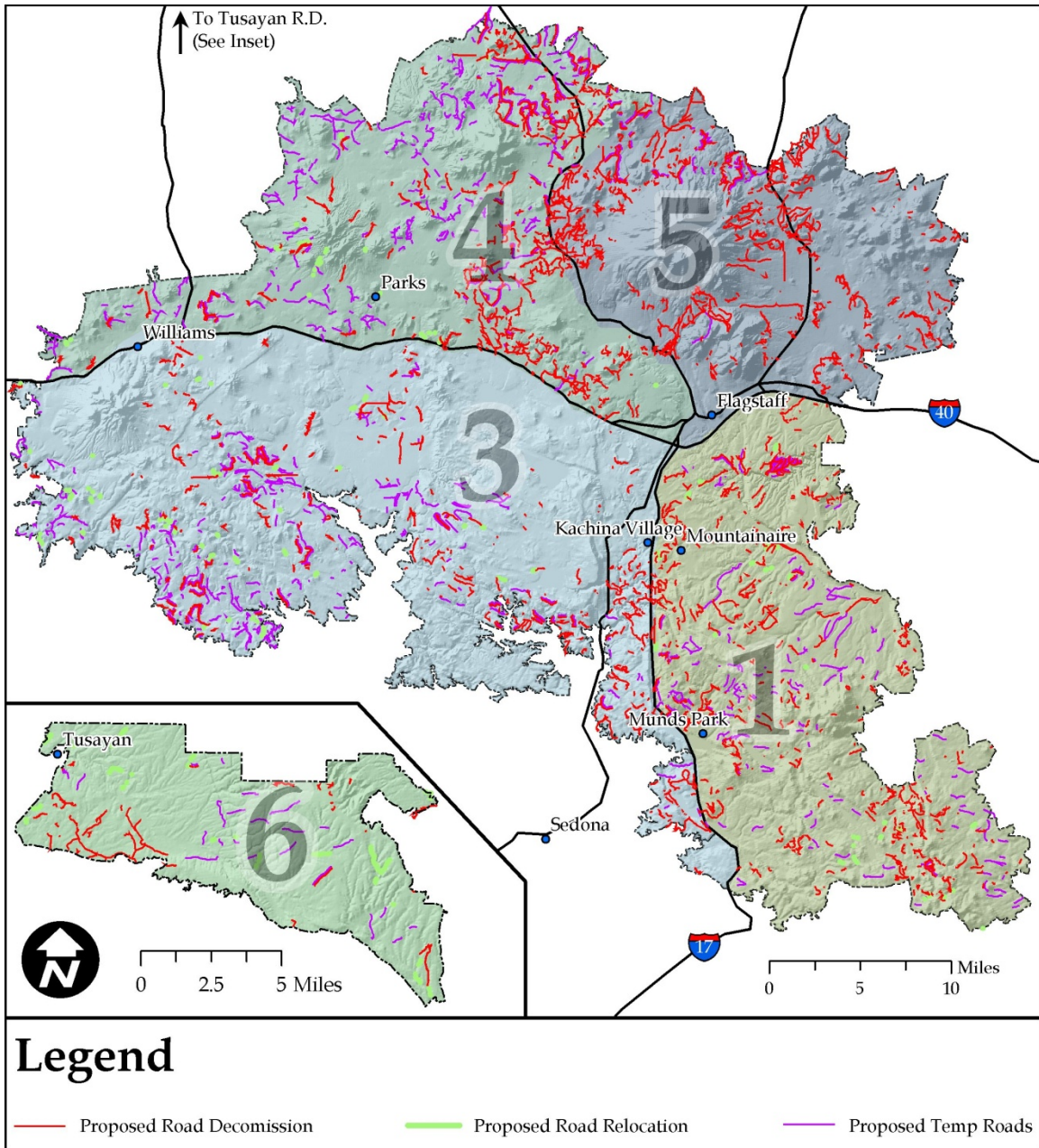


Figure 37. Alternative B and D General Locations of Road Treatments

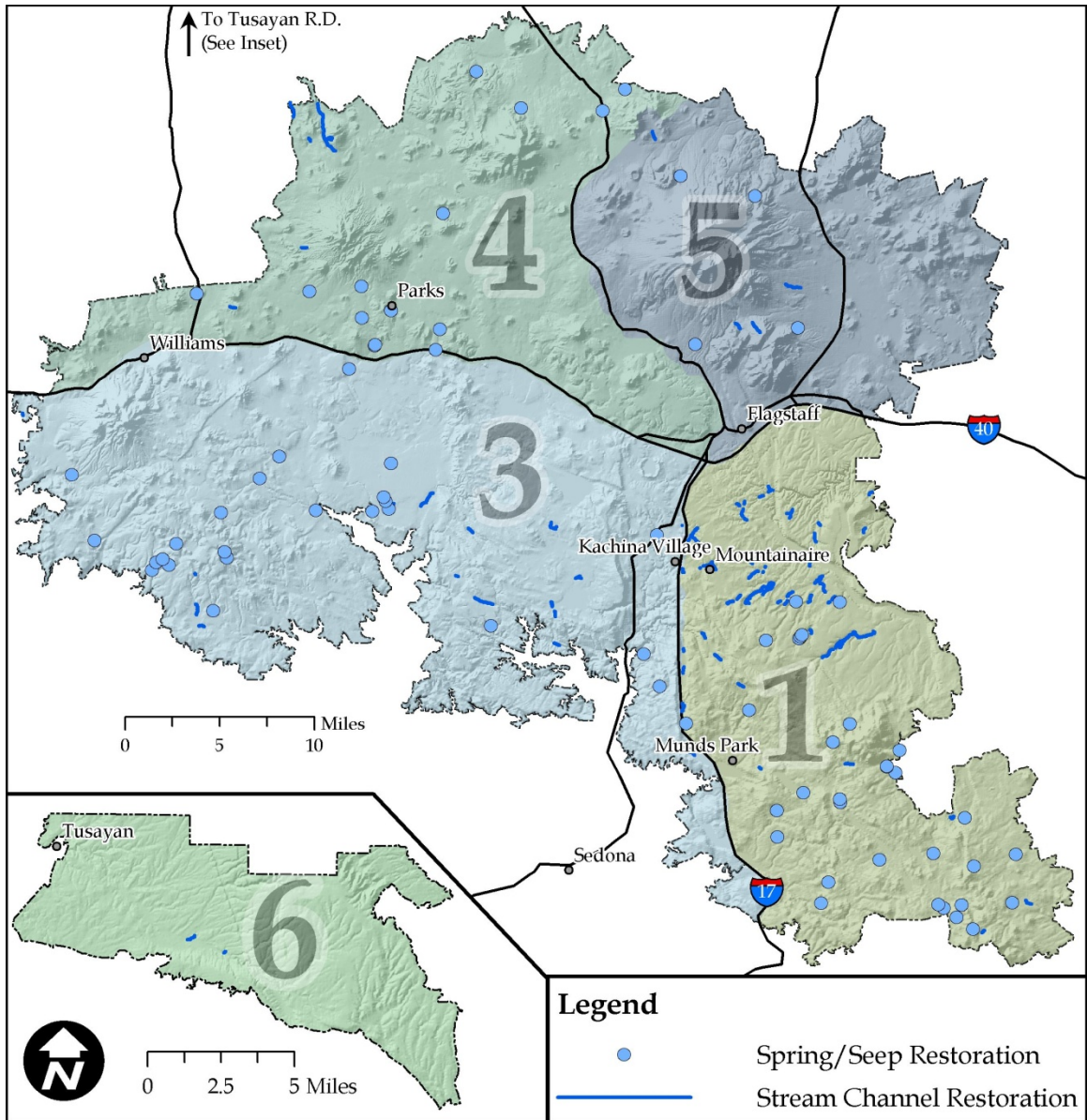


Figure 38. Alternative B and D General Locations of Spring and Stream Treatments

Table 18. Alternative B Treatments in Goshawk Habitat

Treatment by Goshawk Habitat Type (Acres)				
Treatment Type	Landscapes outside of PFA	Post-Fledgling Family Area (PFA)	Dispersal Post-Fledgling Family Area (dPFA)	Total Acres by Treatment Type
Uneven-aged (UEA)*	146,674	9,639	4,446	160,760
Intermediate Thinning (IT)	53,997	3,807	1,022	58,825
Stand Improvement (SI)	19,980	991	76	21,047
Savanna	45,469	0	0	45,469
Grassland	11,185	0	0	11,185
Pine-Sage	4,674	392	196	5,261
Prescribed Fire-Only	86,933	8,733	1,299	96,965
Total mechanical treatment acres	281,979	14,828	5,740	302,548
Total prescribed fire treatment areas	368,912	23,561	7,039	399,512

*See appendix D for details on design features and mitigation for treatments within goshawk habitat.

Table 19. Alternative B Summary of Treatments in MSO Habitat

MSO Habitat Type				
Treatment Type*	Protected	Restricted	Target/Threshold	Total Acres by Treatment Type
Prescribed Fire-Only	20,864	2,354	301	23,519
MSO Restricted	0	65,024	0	65,024
MSO Target	0	0	6,518	6,518
MSO Threshold	0	0	1,894	1,894
PAC -Mechanical	10,741	0	0	10,741
Total	31,605	67,378	8,713	107,696

* See appendix D for details on design features and mitigation for treatments within MSO habitat.

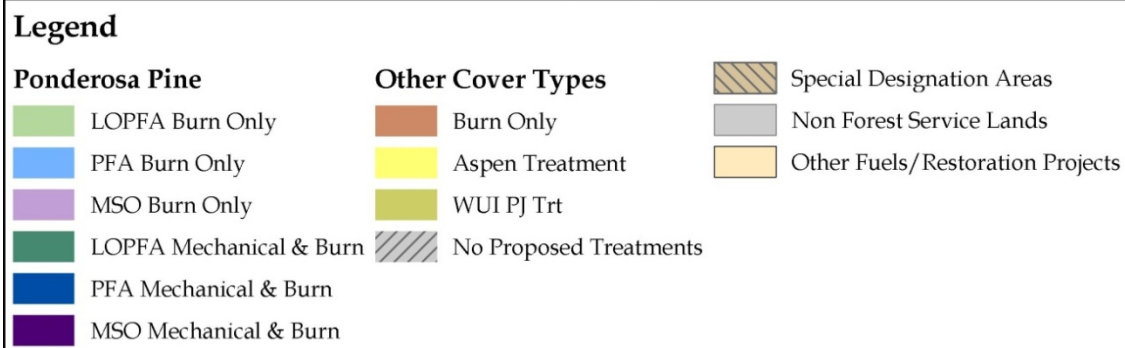
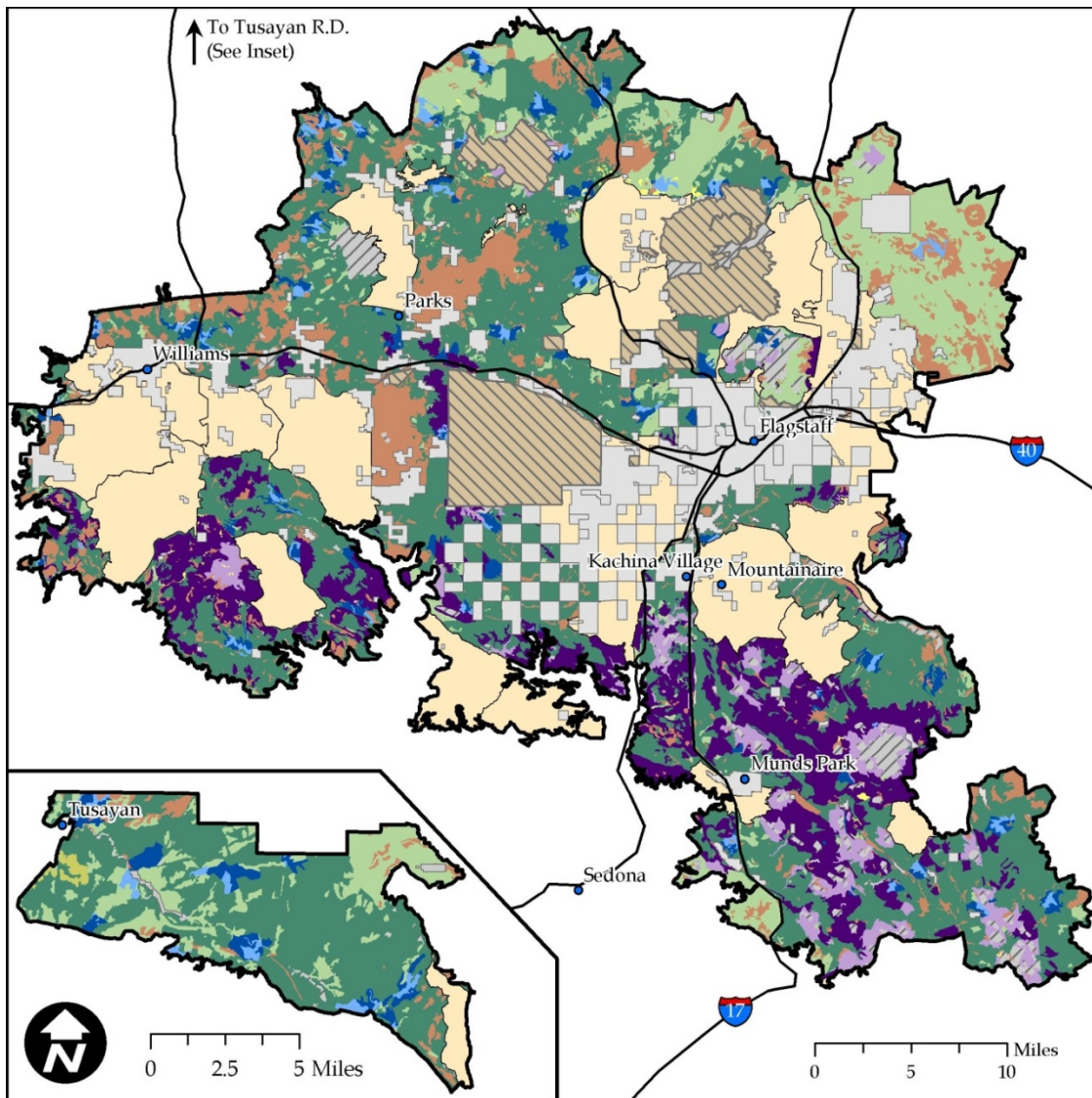


Figure 39. Alternative B Mechanical and Prescribed Fire Treatments in Goshawk and MSO Habitat

*LOPFA – Landscapes outside of PFAs.

Table 20. Alternative B Ponderosa Pine Old Growth Allocation Acres and Percent by Forest and Restoration Unit

Restoration Unit	Ponderosa Pine Total Acres		Ponderosa Pine Old Growth Acres		Old Growth Percent (%)	
	Coconino NF	Kaibab NF	Coconino NF	Kaibab NF	Coconino NF	Kaibab NF
1	145,793	0	65,189	0	45	0
3	58,327	70,898	21,341	25,177	37	36
4	56,981	77,320	17,718	30,342	31	39
5	61,671	0	24,745	0	40	0
6	0	41,188	0	10,291	0	25
Total	322,772	189,407	128,994	65,810	40	35

Table 21. Alternative B Pinyon-Juniper Old Growth Allocation Acres and Percent by Forest

Restoration Unit	Pinyon-Juniper Total Acres		Pinyon-Juniper Old Growth Acres		Pinyon-Juniper Old Growth Percent (%)	
	Coconino NF	Kaibab NF	Coconino NF	Kaibab NF	Coconino NF	Kaibab NF
1	1,141	0	611	0	54	0
3	832	3,201	356	1,747	43	55
4	42	7,123	42	4,116	100	58
5	8,771	0	7,302	0	83	0
6	0	2,206	0	1,452	0	66
Total	10,786	12,530	8,311	7,315	77	58

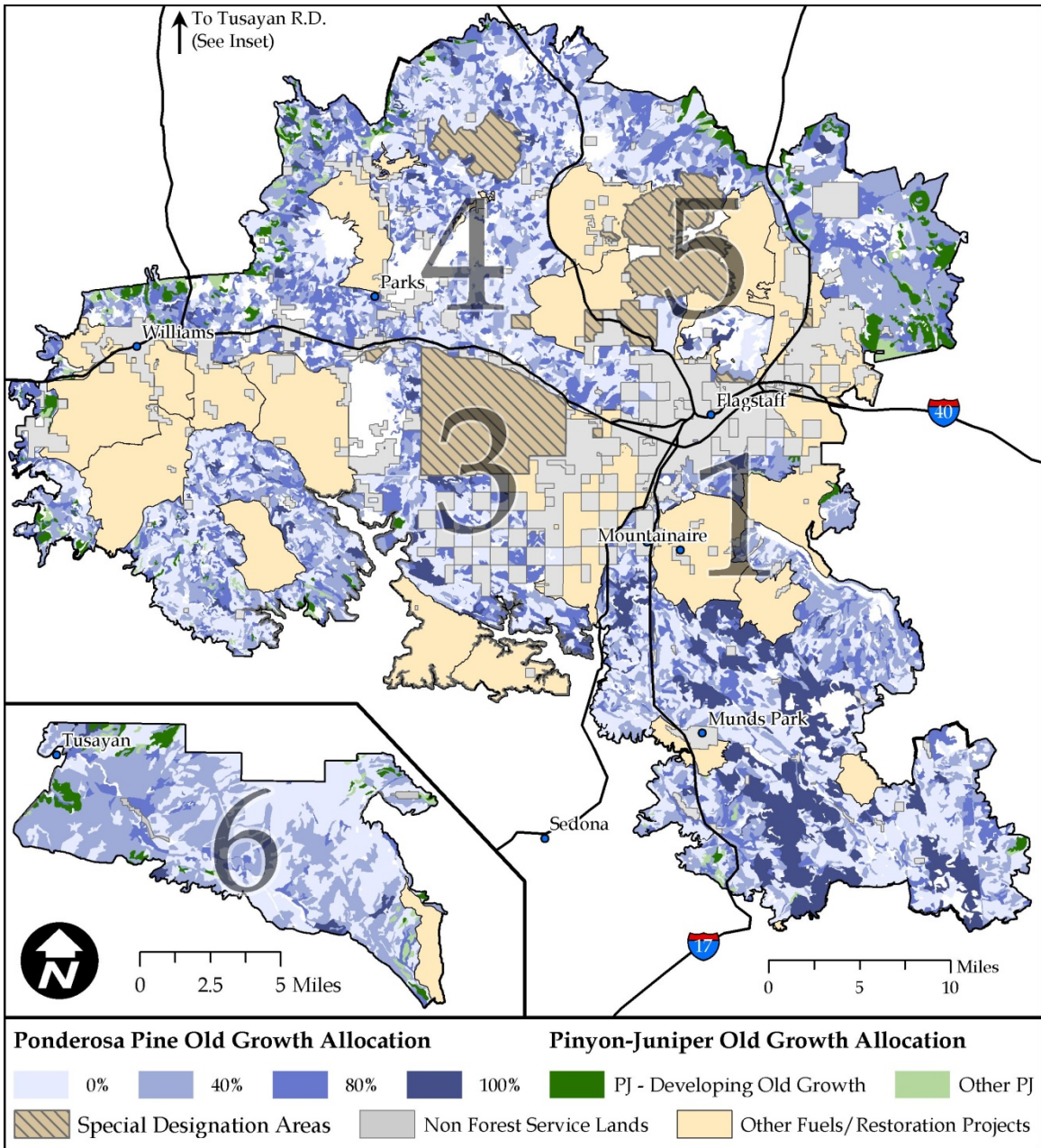


Figure 40. Alternative B through D Ponderosa Pine and Pinyon-Juniper Old Growth Allocation

Alternative C

Alternative C responds to issue 2 (conservation of large trees), adds acres of grassland treatments on the Kaibab NF, incorporates wildlife and watershed research on both forests, and mechanically treats and uses prescribed fire within the proposed Garland Prairie RNA on the Kaibab NF. It proposes mechanically treating up to 18-inch dbh in 18 MSO PACs and includes prescribed fire within 72 MSO PACs, including 56 core areas (see “Alternative Development Process” in chapter 1 for additional information).

The Coconino and Kaibab NFs would conduct restoration activities on approximately 593,211 acres over a period of 10 years or until objectives are met. Approximately 20,000 to 30,000 acres of vegetation would be treated annually and up to 40,000 acres would be prescribed burned annually on the forests. Restoration activities would:

- Mechanically cut trees on approximately 434,001 acres, including mechanically treating up to 18-inch dbh within 18 MSO PACs and cutting trees by hand on 99 acres on slopes greater than 40 percent
- Utilize mechanical treatment and prescribed fire on approximately 434,001 acres including prescribed fire within 72 MSO PACs (including 56 core areas)
- Utilize prescribed fire-only on approximately 159,211 acres
- Decommission 770 miles of existing system and unauthorized roads on the Coconino NF
- Decommission 134 miles of unauthorized roads on the Kaibab NF
- Construct 245 miles of temporary roads for haul access and decommission when treatments are complete
- Open (construct) approximately 272 miles of existing, decommissioned road and return to decommissioned status when treatments are complete
- Reconstruct up to 10 miles of existing, open roads for resource and safety concerns
- Restore 74 springs and construct up to 4 miles of protective fencing
- Restore 39 miles of ephemeral channels
- Construct up to 82 miles of protective (aspen) fencing
- Construct up to 15 weirs and 20 weather stations (up to 3 total acres of disturbance) to support watershed research
- Allocate as old growth 40 percent of ponderosa pine and 77 percent of pinyon-juniper woodland on the Coconino NF and 35 percent of ponderosa pine and 58 percent of pinyon-juniper on the Kaibab NF

Two non-significant forest plan amendments (see appendix C) would be required on the Coconino NF to implement alternative C. A variance would be provided to: (1) use mechanical treatments to improve habitat structure and mechanically treat up to 18-inch dbh within 18 MSO PACs, use prescribed fire within 56 MSO PAC no-treatment areas, and manage 6,321 acres of MSO restricted habitat at a minimum basal area of 110 square feet per acre, (2) clarify that canopy cover would be measured and met at the group level, (3) add language to define/describe interspace and describe the relationship between interspaces, openings, and vegetation structural stage (VSS) classes, and (4) manage 29,017 acres of goshawk non-PFA habitat for less than 40 percent canopy cover and less than 3 to 5 reserve trees per acre.

Two non-significant forest plan amendments (see appendix C) would be required on the Kaibab NF to implement the proposed action. A variance would be provided to: (1) clarify that canopy cover would be measured and met at the group level, (2) add language to define/describe

interspace and describe the relationship between interspaces, openings, and vegetation structural stage (VSS) classes, (3) manage 27,637 acres of goshawk non-PFA habitat for less than 40 percent canopy cover in VSS 4 to 6 and less than 3 to 5 trees per acre, and (4) mechanically treat and prescribe burn approximately 400 acres in the proposed Garland Prairie RNA.

Table 22 provides acres to be mechanically treated by treatment type. Please refer to the glossary appendix H) for treatment definitions. Individual resource sections in chapter 3 describe how actions were evaluated at various scales. Figure 41 displays alternative C’s vegetation and prescribed fire treatments at a course scale. Proposed road, springs, ephemeral channels, and aspen treatments are the same as described in alternative B (see table 16 and table 17, and figure 37 and figure 38). Table 23 and table 24 display mechanical and prescribed fire treatment acres in goshawk and MSO habitat specific to alternative C and figure 42 provides a course-scale map for treatments in these habitats. The old growth allocation for alternative C is the same as described in alternative B (see table 20, table 21, and figure 40).

Table 22. Alternative C Mechanical and Prescribed Fire Treatment Descriptions and Acres

Treatment Type	Treatment Description/Objective	Acres
Aspen	Mechanical treatment that removes post-settlement conifers within 100 feet of aspen clone, stimulates suckering, and includes prescribed fire	1,229
Prescribed Fire Only	No mechanical treatment accompanies prescribed fire	159,211
AGFD Treatment (Research)	Mechanical treatment designed to create groups of various sizes ranging from 1 to 15 acres in size, prescribed fire	4,837
Grassland restoration	Mechanical treatment that remove encroaching post-settlement conifers, prescribed fire	11,230
Grassland mechanical	Mechanical treatment in grassland vegetation types, prescribed fire	48,161
Intermediate Thin (IT) 10	Mechanical treatment designed to thin tree groups and establish interspace adjacent to group to an average of 70 to 90 square feet of basal area and manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees with the least amount of mistletoe, prescribed fire	7,766
Intermediate Thin (IT) 25		11,858
Intermediate Thin (IT) 40		39,039
MSO Restricted	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, irregular tree spacing, and various patch size, prescribed fire	63,191
MSO Target	Intermediate thinning (IT) designed to improve forest health, reduce fire risk, and meet basal area requirements, prescribed fire	6,516
MSO Threshold	Same as MSO Target	1,894
MSO PAC	Mechanical treatment designed to increase tree vigor and health and create canopy gaps to reduce fire risk, prescribed fire	10,741

Treatment Type	Treatment Description/Objective	Acres
MSO PAC Grassland Mechanical	Mechanical treatment designed to re-establish the historic meadow edge as defined by the current forest structure of young trees encroaching around the meadow edge and retain large trees with long-lived characteristics, prescribed fire	35
Pine-sage	Mechanical treatment that restores pre-settlement tree density and pattern using evidence as guidance, prescribed fire	5,261
Savanna	Mechanical treatment that restores pre-settlement tree density and pattern; manages for a range of 70 to 90 percent of the treatment area as interspace (grass/forb) between tree groups or individuals, prescribed fire	45,469
Stand Improvement (SI) 10	Mechanical treatment that establishes tree groups and interspace adjacent to the groups and manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees within each group, prescribed fire	1,914
Stand Improvement (SI) 25		6,824
Stand Improvement (SI) 40		12,244
Uneven-aged (UEA) 10	Mechanical treatment that is designed to have interspaces between tree groups and clumps that occupy 10 percent of the landscape, prescribed fire	18,109
Uneven-aged (UEA) 25	Mechanical treatment designed to have interspaces between tree groups and clumps occupy that up to 25 percent of the landscape, prescribed fire	39,176
Uneven-aged (UEA) 40	Mechanical treatment designed to have interspaces between tree groups and clumps that occupy up to 40 percent of the landscape, prescribed fire	95,712
Wildland Urban Interface (WUI) Pinyon-juniper	Mechanical treatment around the community of Tusayan designed to reduce fire risk and meet Community Wildfire Protection Plan (CWPP) objectives, prescribed fire	535
Wildland Urban Interface (WUI) 55	Mechanical treatment in the WUI designed to have interspaces that occur between tree groups and clumps occupy up to 55 percent of the landscape, prescribed fire	2,268

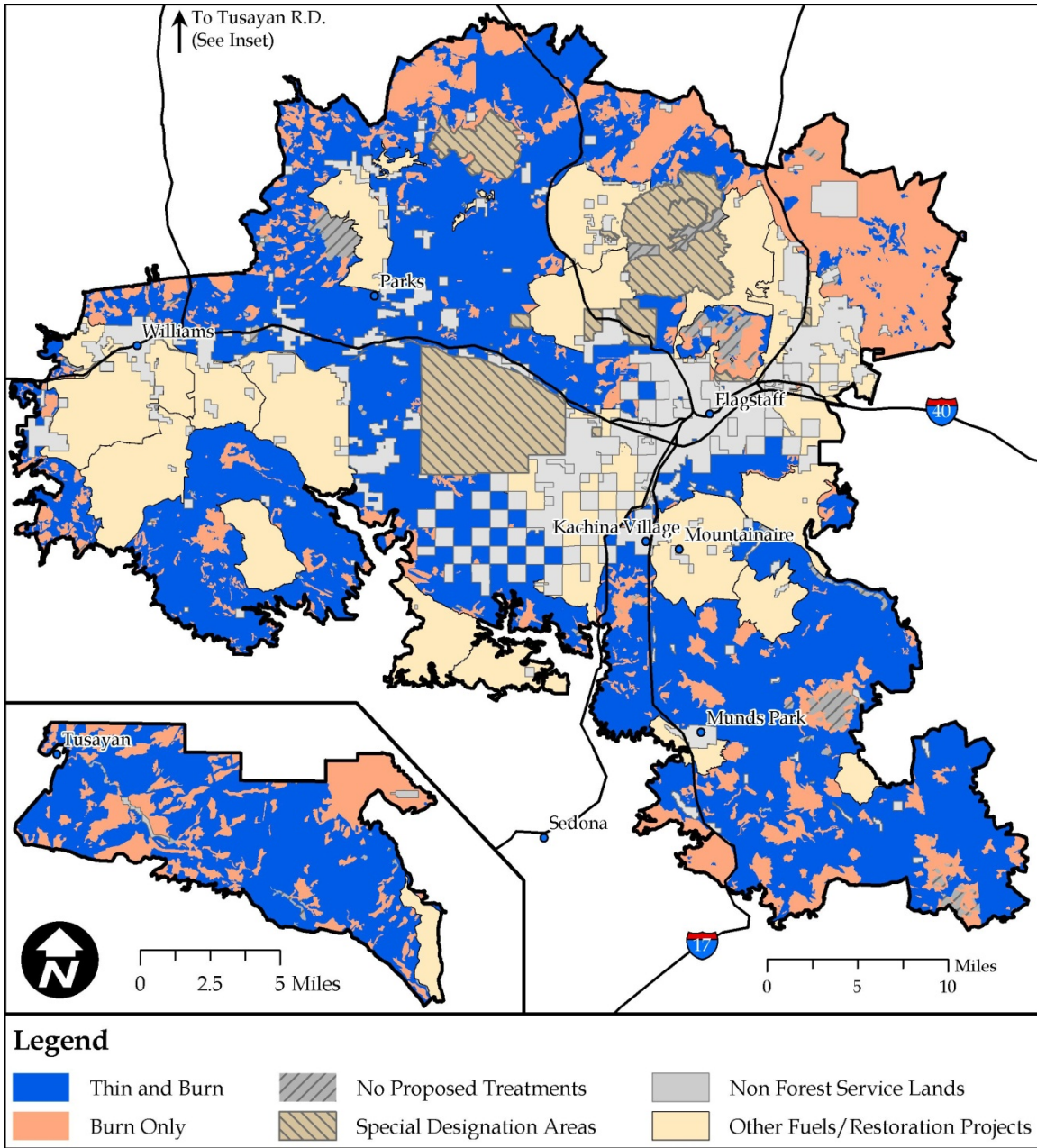


Figure 41. Alternative C Mechanical (Thin) and Prescribed Fire Treatments

Table 23. Alternative C Treatments in Goshawk Habitat

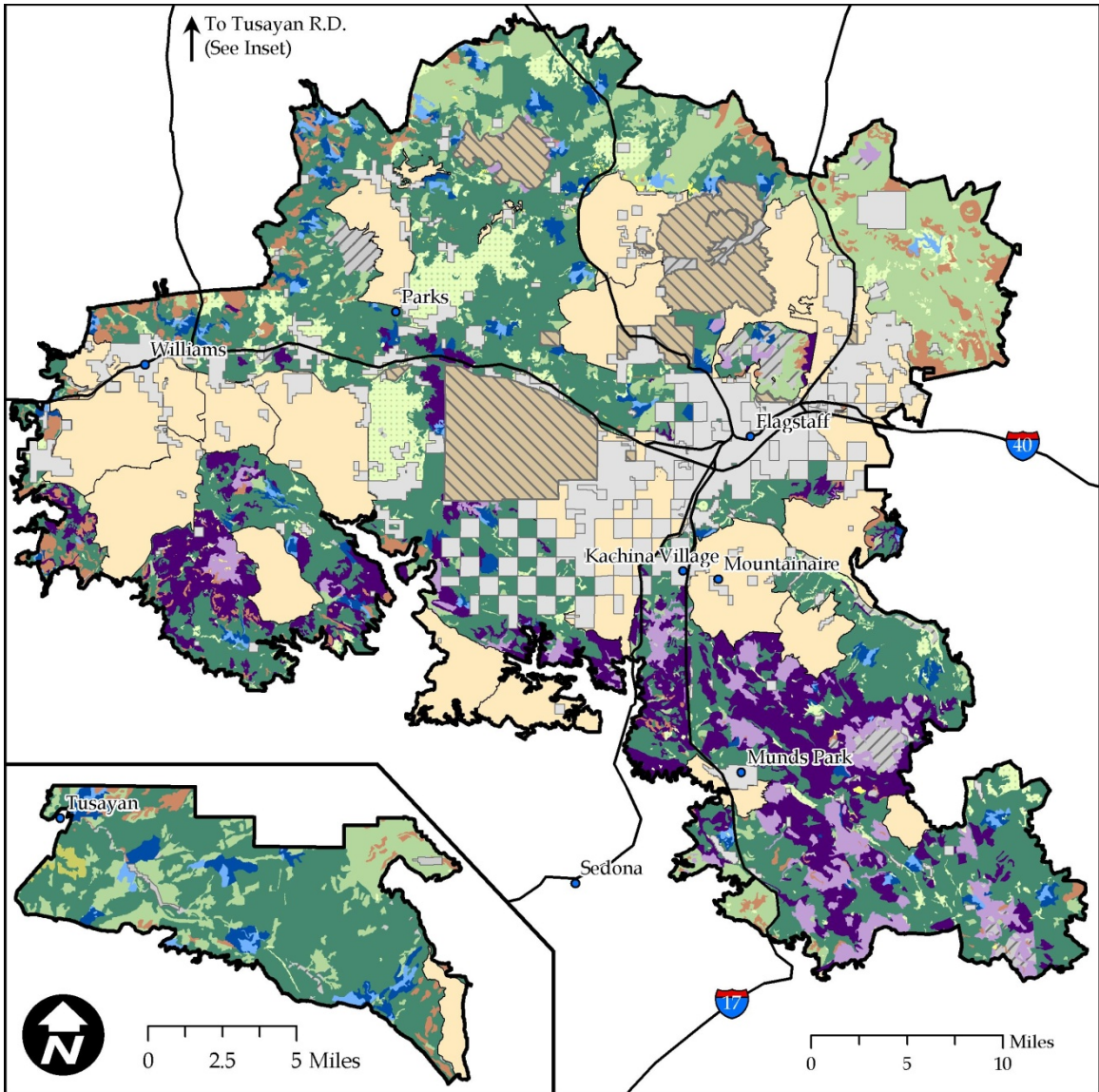
Vegetation Treatment Type	Mechanical Treatment by Goshawk Habitat Type (Acres)			Total Acres by Treatment Type
	Landscapes outside of PFA	Post-Fledgling Family Area (PFA)	Dispersal Post-Fledgling Family Area (dPFA)	
Uneven-aged (UEA)*	146,040	9,616	4,446	160,102
Intermediate Thinning (IT)	53,834	3,807	1,022	58,662
Stand Improvement (SI)	19,915	991	76	20,982
Savanna	45,469	0	0	45,469
Grassland Restoration	11,230	0	0	11,230
Pine-Sage	4,674	392	196	5,261
Prescribed Fire Only	87,879	8,755	1,299	97,934
Total mechanical treatment acres	281,154	14,805	5,740	301,699
Total prescribed fire treatment areas	369,033	23,561	7,039	399,633

*See appendix D for details on how treatments would be designed within goshawk habitat.

Table 24. Alternative C Treatments in MSO Habitat

Treatment Type*	MSO Habitat Type			Total Acres
	Protected	Restricted	Target/Threshold	
Prescribed Fire Only	25,714	4,187	303	30,204
MSO Restricted	0	63,191	0	63,191
MSO Target	0	0	6,516	6,516
MSO Threshold	0	0	1,894	1,894
PAC Mechanical	10,741	0	0	10,741
Total	36,455	67,378	8,713	112,546

* See appendix D for details on how treatments would be designed within MSO habitat.



Legend

Ponderosa Pine

- LOPFA Burn Only
- PFA Burn Only
- MSO Burn Only
- LOPFA Mechanical & Burn
- PFA Mechanical & Burn
- MSO Mechanical & Burn

Other Cover Types

- Burn Only
- Grassland Mechanical
- Aspen Treatment
- WUI PJ
- No Proposed Treatments

- Special Designation Areas
- Non Forest Service Lands
- Other Fuels/Restoration Projects

Figure 42. Alternative C Mechanical and Prescribed Fire Treatments in Goshawk and MSO Habitat

*LOPFA – landscapes outside of goshawk PFAs.

Alternative D

Alternative D responds to issue 2 (prescribed fire emissions) by decreasing the acres that would receive prescribed fire. All other components of the alternative are the same as described in alternative B (see pages 77 to 90).

The Coconino and Kaibab NFs would conduct restoration activities on approximately 567,279 acres over a period of 10 years or until objectives are met. Approximately 20,000 to 30,000 acres of vegetation would be treated annually on the forests. Restoration activities would:

- Mechanically cut trees on approximately 388,489 acres, including mechanically treating up to 16-inch dbh within 18 MSO PACs and cutting 99 acres of trees by hand on slopes greater than 40 percent. Slash would be disposed of through various methods including chipping, shredding, mastication and removal of biomass off-site
- Utilize prescribed fire-only on approximately 178,790 acres
- Decommission 770 miles of existing system and unauthorized roads on the Coconino NF
- Decommission 134 miles of unauthorized roads on the Kaibab NF
- Construct 245 miles of temporary roads for haul access and decommission when treatments are complete
- Open (construct) approximately 272 miles of existing, decommissioned road and return to decommissioned status when treatments are complete
- Reconstruct up to 10 miles of existing, open roads for resource and safety concerns
- Restore 74 springs and construct up to 4 miles of protective fencing
- Restore 39 miles of ephemeral channels
- Construct up to 82 miles of protective (aspen) fencing
- Allocate as old growth 40 percent of ponderosa pine and 77 percent of pinyon-juniper woodland on the Coconino NF and 35 percent of ponderosa pine and 58 percent of pinyon-juniper on the Kaibab NF

Two non-significant forest plan amendments (see appendix C, alternative B) would be required on the Coconino NF to implement the proposed action. A variance would be provided to: (1) use mechanical treatments to improve habitat structure and treat up to 16-inch dbh within 18 MSO PACs, (2) clarify that canopy cover would be measured and met at the group level, (3) add language to define/describe interspace and describe the relationship between interspaces, openings, and vegetation structural stage (VSS) classes, and (4) manage 29,017 acres of goshawk non-PFA habitat for less than 40 percent canopy cover and less than 3 to 5 reserve trees per acre.

One non-significant forest plan amendment (see appendix C, alternative B) would be required on the Kaibab NF to implement the proposed action. A variance would be provided to: (1) clarify that canopy cover would be measured and met at the group level, (2) add language to define/describe interspace and describe the relationship between interspaces, openings, and vegetation structural stage (VSS) classes, and (3) manage 27,637 acres of goshawk non-PFA habitat for less than 40 percent canopy cover in VSS 4 to 6 and less than 3 to 5 trees per acre.

Table 25 provides acres to be mechanically treated by treatment type. Please refer to the glossary (appendix H) for treatment definitions. Individual resource sections in chapter 3 describe how actions were evaluated at various scales. Figure 43 displays alternative D's mechanical and prescribed fire treatments at a course scale. Proposed road, springs, ephemeral channels, and aspen treatments are the same as described in alternative B (see table 16 and table 17, and figure

38 and figure 39). Table 26 and table 27 display mechanical and prescribed fire treatment acres in goshawk and MSO habitat specific to alternative D and figure 44 provides a course-scale map for treatments in these habitats. The old growth allocation for alternative D is the same as described in alternative B (see table 20, table 21, and figure 40).

Table 25. Alternative D Mechanical and Prescribed Fire Treatment Descriptions and Acres

Treatment Type	Treatment Description/Objective	Acres
Aspen	Mechanical treatment that removes post-settlement conifers within 100 feet of aspen clone, stimulates suckering	1,229
Prescribed Fire Only	No mechanical treatment accompanies prescribed fire	178,790
Grassland restoration	Mechanical treatment that remove encroaching post-settlement conifers	11,185
Intermediate Thin (IT) 10	Mechanical treatment designed to thin tree groups and establish interspace adjacent to group to an average of 70 to 90 square feet of basal area and manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees with the least amount of mistletoe	7,766
Intermediate Thin (IT) 25		11,871
Intermediate Thin (IT) 40		39,189
MSO Restricted	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, irregular tree spacing, and various patch size	65,024
MSO Target	Intermediate thinning (IT) designed to improve forest health, reduce fire risk, and meet basal area requirements	6,518
MSO Threshold	Same as MSO Target	1,894
MSO PAC	Mechanical treatment designed to increase tree vigor and health and create canopy gaps to reduce fire risk	10,741
Pine-sage	Mechanical treatment that restores pre-settlement tree density and pattern using evidence as guidance	5,261
Savanna	Mechanical treatment that restores pre-settlement tree density and pattern and manages for a range of 70 to 90 percent of the treatment area as interspace (grass/forb) between tree groups or individuals	45,469
Stand Improvement (SI) 10	Mechanical treatment that establishes tree groups and interspace adjacent to the groups and manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees within each group	1,914
Stand Improvement (SI) 25		6,824
Stand Improvement (SI) 40		12,309
Uneven-aged (UEA) 10	Mechanical treatment that is designed to have interspaces between tree groups and clumps that occupy 10 percent of the landscape	18,204
Uneven-aged (UEA) 25	Mechanical treatment designed to have interspaces between tree groups and clumps occupy that up to 25 percent of the landscape	39,244
Uneven-aged (UEA) 40	Mechanical treatment designed to have interspaces between tree groups and clumps that occupy up to 40 percent of the landscape	101,044
Wildland Urban Interface (WUI) Pinyon-juniper	Mechanical treatment around the community of Tusayan designed to reduce fire risk and meet Community Wildfire Protection Plan (CWPP) objectives	535
Wildland Urban Interface (WUI) 55	Mechanical treatment in the WUI designed to have interspaces that occur between tree groups and clumps occupy up to 55 percent of the landscape	2,268

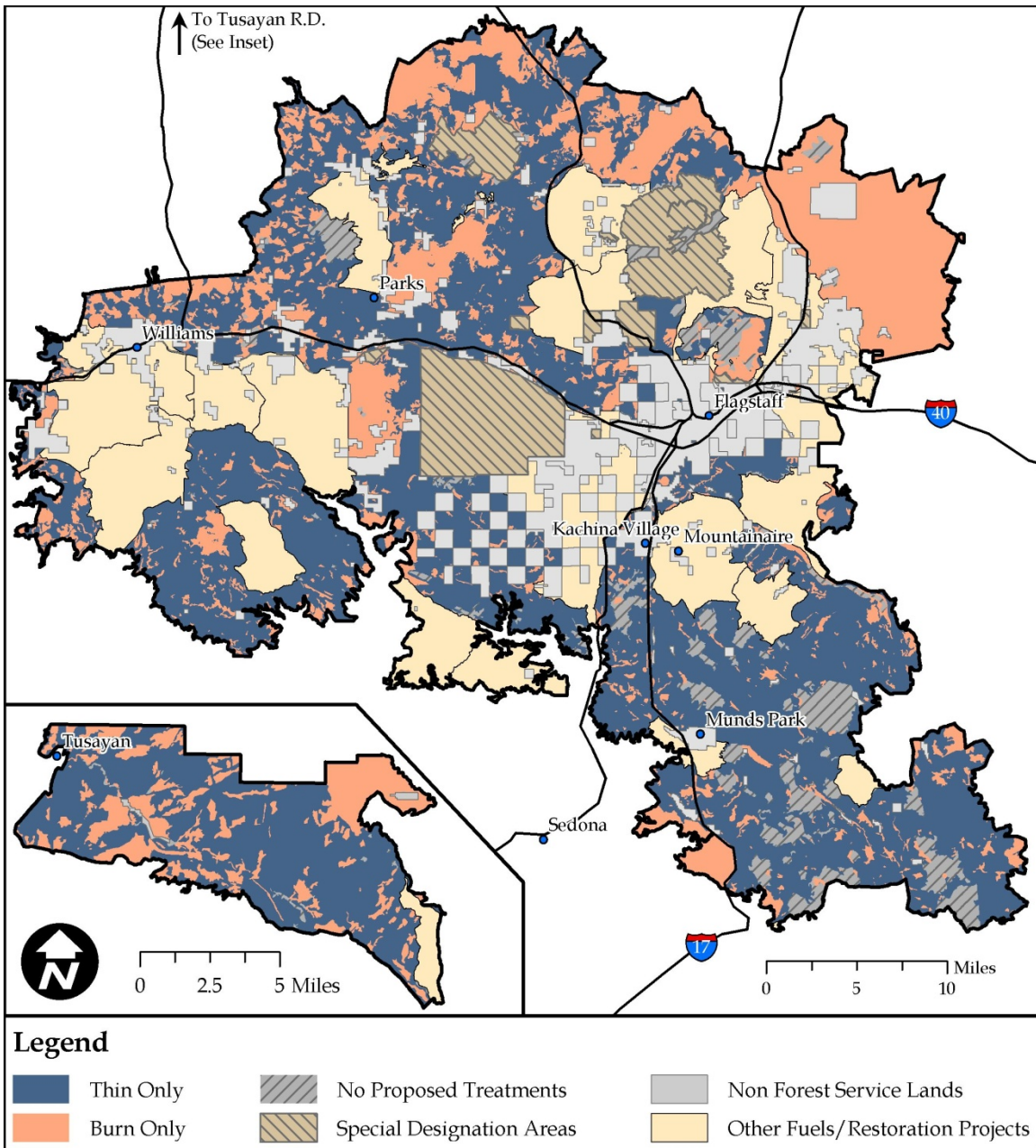


Figure 43. Alternative D Mechanical (Thin) and Prescribed Fire Treatments

Table 26. Alternative D Treatments in Goshawk Habitat

Vegetation Treatment Type	Mechanical Treatment by Goshawk Habitat Type (Acres)			Total Acres by Treatment Type
	Landscapes outside of PFA	Post-Fledgling Family Area (PFA)	Dispersal Post-Fledgling Family Area (dPFA)	
Uneven-aged (UEA)*	146,674	9,639	4,446	160,760
Intermediate Thinning (IT)	53,997	3,807	1,022	58,825
Stand Improvement (SI)	19,980	991	76	21,047
Savanna	45,469	0	0	45,469
Grassland Restoration	11,185	0	0	11,185
Pine-Sage	4,674	392	196	5,261
Prescribed Fire Only	86,933	8,733	1,299	96,965
Total Mechanical Treatment Acres	281,979	14,828	5,740	302,548
Total Prescribed Fire Treatment Areas	86,933	8,733	1,299	96,965

*See appendix D for details on how treatments would be designed within goshawk habitat.

Table 27. Alternative D Treatments in MSO Habitat

Treatment Type*	MSO Habitat Type			Total Acres
	Protected	Restricted	Target/Threshold	
Prescribed Fire Only	889	2,354	301	3,543
MSO Restricted	0	65,024	0	65,024
MSO Target	0	0	6,518	6,518
MSO Threshold	0	0	1,894	1,894
PAC - Mechanical	10,741	0	0	10,741
Total	11,630	67,378	8,713	87,721

* See appendix D for details on how treatments would be designed within MSO habitat.

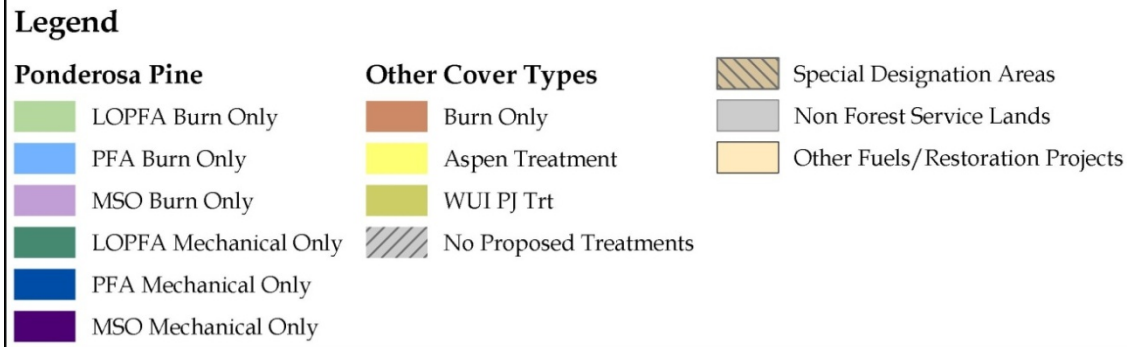
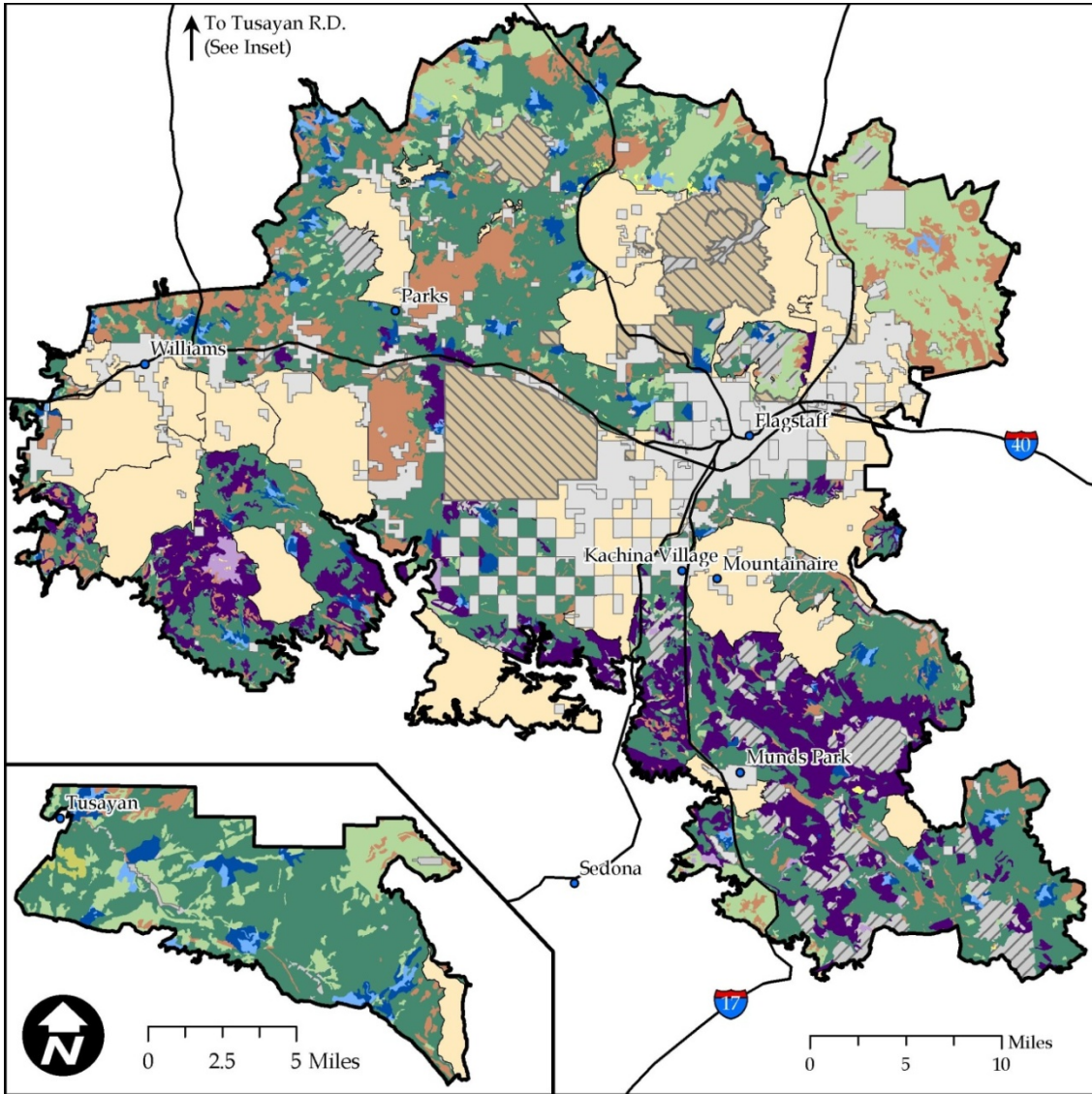


Figure 44. Alternative D Mechanical and Prescribed Fire Treatments in Goshawk and MSO Habitat

*LOPFA – landscapes outside of goshawk PFAs.

Comparison of Alternatives

Table 28 provides a summary of the alternatives and the potential effects of implementing each alternative considered in detail. Information in the table focuses on effects related to the purpose and need for the project. See chapter 3 for detailed discussion of the effects and the specialists' reports for the complete analysis.

Table 28. Comparison of Alternatives

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D	
Vegetation Structure							
Age and Size Class	Even-aged: 54 percent	<ul style="list-style-type: none"> • Uneven-aged • Distribution of age-classes that comprise a sustainable balance of structural stages 	Even-aged remains even aged	Alternatives B-D: Even-aged trending toward uneven-aged			
	Uneven-aged: 46 percent		Uneven-aged trending toward even-aged	Alternatives B-D: Uneven-aged maintained as uneven-aged			
	Dominant representation in the young and mid-aged structural stages		Alternative A-D: Dominant representation in the young and mid-aged structural stages				
	Low representation in the grass/forb/shrub, seedling/sapling, mature and old structural stages		Low representation in the grass/forb/shrub, seedling/sapling, mature and old structural stages	Alternatives B-D: Improved representation in the grass/forb/shrub, seedling/sapling, mature and old structural stages. Trending toward a balance of structural stages.			

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D
Spatial Arrangement	Continuous tree canopy with generally small interspace inclusions	Mosaic of interspaces and tree groups of varying sizes and shapes	Similar to existing. Trending toward reduction of interspace.	Treatment acres with relative ability to attain mosaic of interspaces and tree groups ranging from very low to high:		
				Very Low: 47,157	Very Low: 52,007	Very Low: 27,182
				Low: 120,363	Low: 126,074	Low: 120,363
				Moderate: 122,963	Moderate: 121,050	Moderate: 122,963
				High: 216,725	High: 211,215	High: 216,725
Heterogeneity: Openness within ponderosa pine cover type ranging from very open to closed or unknown (percent of landscape)	Very Open: 22 percent Open: 22 percent Moderately Closed: 29 percent Closed: 45 percent Unknown: 3 percent	<ul style="list-style-type: none"> Ranges from very open to closed Desired openness is determined by soils and site potential 	Similar to existing condition. Trending toward closed.	Percent of Openness ranging from Very Open to Unknown		
				Alternatives B-D: Very Open: 11		
				Open: 31	Open: 30	Open: 31
				Alternatives B-D: Moderately Closed: 42		
				Closed: 15	Closed: 17	Closed: 11
				Unknown: 1	Unknown: 0	Unknown: 5
Forest Health						
Stand Density	Percent of maximum SDI by Habitat:	Density is below the zone where density related mortality is	Percent of maximum SDI by Habitat			

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D
	MSO Protected: 78	prevalent (<56 percent of maximum SDI).	MSO Protected – 80	MSO Protected – 72	MSO Protected – 71	MSO Protected – 74
	MSO Target/Threshold: 85	Managed, uneven-aged forests range from 15-40 percent of maximum SDI.	MSO Target/Threshold: 86	MSO Target/Threshold: 75	MSO Target/Threshold: 71	MSO Target/Threshold: 76
	MSO Restricted: 69		MSO Restricted: 72	MSO Restricted: 37	MSO Restricted: 37	MSO Restricted: 46
	Goshawk Nest/PFA: 45 percent		Goshawk Nest/PFA: 47	Goshawk Nest/PFA: 27	Goshawk Nest/PFA: 27	Goshawk Nest/PFA: 30
	Goshawk non PFA (LOPFA): 40		Goshawk non PFA (LOPFA*): 43	Goshawk non PFA (LOPFA): 21	Goshawk non-PFA (LOPFA): 21	Goshawk non-PFA (LOPFA0): 24
Insect and Disease						
Beetle hazard rating (percent of landscape) ranging from low to extreme	Low: 8 Moderate: 21 High: 71	<ul style="list-style-type: none"> Forest conditions are resilient to insect and disease. Insect and disease populations are at endemic levels. 	Beetle Hazard Rating (percent):			
			Low: 4 Moderate: 13 High: 83	Low: 38 Moderate: 36 High: 26	Low: 38 Moderate: 36 High: 26	Low: 28 Moderate: 26 High: 45
Dwarf mistletoe infection level ranging from none/low to extreme	None/Low: 66 Moderate/High: 34 Extreme: <1		Dwarf mistletoe infection level (percent):			
			None/Low: 59 Moderate/High: 41 Extreme: <1	None/Low: 61 Moderate/High: 39 Extreme: <1	None/Low: 60 Moderate/High: 40 Extreme: <1	None/Low: 60 Moderate/High: 40 Extreme: <1
Vegetation Diversity and Composition						
Gambel oak	112,546 acres of pine-oak MSO habitat	Conserve oak and improve conditions	Treatment acres that would actively reduce pine-oak competition			

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D
		that favor oak growth and establishment	0	65,024	63,191	65,024
			Treatment acres within pine-oak MSO habitat that would release large oak			
			0	84,177	82,344	84,177
Aspen	1,471 acres of aspen patches (within pine)	Maintain and/or regenerate aspen patches	Acres of aspen maintained and/or regenerated			
			0	1,452	1,471	1,452
Grasslands	48,196 acres of encroached grasslands (mollisol soils)	<ul style="list-style-type: none"> Restore grasslands Enhance historic grassland inclusions within greater forested area including MSO restricted, goshawk PFA, and non-PFA (LOPFA*) habitats 	Acres of grassland enhanced and/or restored within: (1) encroached grasslands, (2) historic grasslands, (3) pine with an open reference condition, (4) goshawk PFA, non-PFA and MSO restricted habitat			
			(1) 0	(1) 0	(1) 48,196	(1) 0
			(2) 0	(2) 11,185	(2) 11,230	Same as Alternative B
			(3) 0	(3) 45,469	Same as Alternative B	
	(4) 0		310,917	(4) 308,199	(5) 305,657	
	14,665 acres departed from historic grassland conditions					
	309,926 acres of ponderosa pine with an open reference conditions (mollic-integrade soils)					

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D
Pine-Sage	16,000 acres of pine-sage potential vegetation	<ul style="list-style-type: none"> Maintain and enhance the sage understory Restore the historic overstory/ understory pattern within the pine-sage mosaic 	Acres of pine-sage understory/overstory maintained and enhanced			
			0	Alternatives B-D: 5,262 acres		
Landscape-Scale Forest Resiliency and Function in ponderosa pine			Improved vegetation structure, forest health and vegetation diversity and composition (acres)			
			0	501,208	510,346	487,233
Fire Behavior						
Crown Fire	34 percent	Up to 10 percent and no more than 50 acres	35 percent, (2020)	5 percent (2020)	4 percent (2020)	7 percent (2020)
Surface fire	64 percent	90 percent +	34 percent (2020)	94 percent (2020)	94 percent (2020)	92 percent (2020)
Fire Regime Condition Class (FRCC)	14 percent FRCC 1 27 percent FRCC 2 59 percent FRCC 3	99 percent FRCC 1 0 percent FRCC 2 1 percent FRCC 3	11 percent FRCC 1 19 percent FRCC 2 70 percent FRCC 3	18 percent FRCC 1 78 percent FRCC 2 4 percent FRCC 3	19 percent FRCC 1 81 percent FRCC 2 0 percent FRCC 3	8 percent FRCC 1 82 percent FRCC 2 10 percent FRCC 3
Landscape-Scale Forest Resiliency and Function	Alternative A: The combination of abundant and continuous canopy fuels, the lack of understory vegetation, and an already high and increasing surface fuel load, would combine with high potential for high-severity fire, and maintain the area in a Fire Regime Condition Class of 3 into the foreseeable future. There would be no movement towards resiliency and improved function. Alternatives B-D move towards FRCC desired conditions in the short-term (2020). Alternative B-D meet crown and surface fire desired conditions in the short term (2020). Movement towards the desired conditions in Alternative B-D equates to movement towards improved resiliency and function.					
Watershed Function						
Ephemeral Channels	Reduced function in	proper functioning	Static to downward	Alternative B-D: disturbance ranges from 2 to 108 acres in sub-watersheds		

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D
	39 miles of degraded channel	condition	trend in function over time	(1% of treatment area) short term increase in sediment production with adverse impacts to surface water quality and riparian conditions minimized or mitigated.		
Springs	Reduced discharge in 74 springs	soil, water, and vegetation attributes are present and allow springs to be healthy and functioning at or near potential.	Static to downward trend in functional condition	Slight increase in groundwater recharge and spring discharge would be expected in year 1-3. Long-term hydrologic response is dependent on the summed effect of the changes in evaporation, transpiration, soil moisture storage, snowpack accumulation and melt processes, and presence or absence of drought conditions		
Surface Water Quality	No impaired streams within project area, segment of Oak Creek 0.25 miles outside of the project boundary and downstream of treatment area is listed as impaired	Meet ADEQ water quality standards	No change –potential for adverse effects from wildfire exists	Short term adverse impacts from soil disturbance that averages 3.3 percent at 6 th code HUC, long term improvement	Short term adverse impacts from soil disturbance that averages 3.4 percent at 6 th code HUC, long term improvement	Short term adverse impacts from soil disturbance that averages 2.9 percent at 6 th code HUC, long term improvement
Soil Productivity and Function						
Soil Erosion/Soil Productivity	See soils report – specific to watersheds and sub-watersheds	Maintain soil erosion and loss below tolerance level (15 percent)	Soil disturbance ranges from 0 to 33 percent due to fire risk	Alternative B-D: No watersheds have soil disturbance above 11 percent which is 4 percent below the 15 percent threshold and therefore, soil productivity should be maintained at the watershed level.		
Landscape-Scale Forest Resiliency and Function	Alternative A would not increase forest resiliency to natural disturbances and would not improve soil or watershed function because watersheds would be at risk of continued uncharacteristic wildfires. Alternatives B-D would maintain or improve long-term soil productivity and watershed function. Vegetation treatments at the watershed scale combined with prescribed burning could restore or improve hydrologic function of 74 springs and select channels.					

*LOPFA – landscapes outside of goshawk post-fledgling family areas or non-PFAs