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 C) 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 extensive collaboration 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."

Minor modifications included incorporating the stakeholder developed old tree protection strategy (OTPS) (with some modifications) into alternative B, correcting vegetation, habitat, old growth, and road acreages or miles, finalizing forest plan amendments, and developing the adaptive management and monitoring, and implementation plan. See the "Proposed Action Development" section in chapter 1 for additional information.

Those concerns that could not be addressed through minor modifications to the proposal were considered key issues and drove the development of two additional alternatives (see the "Issues" section in chapter 1). The minor modifications incorporated into the final proposed action (alternative B) were carried forward into the other alternatives.

Alternative C responds to **Issue 2**—conservation of large trees—by incorporating key components from the original 4FRI stakeholder created large tree retention strategy (4FRI stakeholders 2011) into the alternative's implementation plan. The alternative also responds to **Issue 4**—increased restoration and research. The alternative adds acres of grassland restoration treatment on the Kaibab NF. It includes recommendations from the U.S. Fish and Wildlife Service (FWS) by increasing prescribed burning treatments within protected Mexican spotted owl (MSO) habitat (to improve the quality of owl roosting and nesting habitat), and aligning treatments in threshold habitat with the "Mexican Spotted Owl Recovery Plan, First Revision" (USDI 2012). The alternative also adjusts treatments (decreases acres of mechanical treatment and increases the acres of prescribed fire) in order to incorporate two research opportunities including a small mammal and bird study and a water yield study.

Alternative D was developed to respond to **Issue 1**—prescribed fire emissions—by decreasing the acres on which prescribed fire would be utilized. Other attributes of alternative D, with the exception of the use of prescribed fire, are similar to alternative B.

All action alternatives (B–D) address **Issue 2**—post-treatment canopy cover and landscape openness—through quantitative and qualitative analysis and with a forest plan amendment for both forests. All action alternatives (B–D) propose additional activities including restoring springs and ephemeral channels, constructing protective fencing in select aspen stands, constructing (and decommissioning) temporary roads, reconstructing and improving roads, relocating a minimal number of road miles, and decommissioning existing roads and unauthorized routes. All action alternatives include design features, best management practices (BMPs), and mitigation measures

(appendix C), an implementation plan (appendix D), and a monitoring and adaptive management plan (appendix E). The implementation plan includes direction for managing old trees. A modified version of the original stakeholder developed large tree retention strategy is only applicable to the implementation plan in alternative C.

Forest Plan Consistency

Forestwide and management/geographic area-specific standards and guidelines have been incorporated into the design of alternatives B, C, and D as displayed in appendix C. Other applicable forest plan requirements that have been incorporated by resource are in the resource specialist reports. With the proposed nonsignificant forest plan amendments (see appendix B), alternatives B, C, and D are consistent with the Coconino and Kaibab NFs forest plan direction. As discussed in chapter 1 (pages 7–8), the Coconino and Kaibab forest plans are currently under revision. Depending on the timing of the release of final documents, the final 4FRI analysis will be consistent with the plans in effect at that time.

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, including an alternative that would: (1) utilize mechanical treatments limited to 8-inch d.b.h., (2) utilize prescribed fire as the sole treatment method, (3) eliminate the use of prescribed fire, (4) utilize the original large tree retention strategy, and (5) limit mechanical treatments to 16-inch d.b.h.

Limit Mechanical Treatments to 8-inch d.b.h.

This alternative was based on the assertion that crown fire can be effectively addressed with mechanical treatments that do not exceed 8-inch d.b.h. Small diameter mechanical tree cutting would be used to establish tree groups, nonforested openings (interspaces), and move toward a balance of tree age and size classes. Prescribed fire would be used to reduce litter and other surface fuels, stimulate herbaceous understory vegetation, prepare sites for natural ponderosa pine regeneration, and maintain interspaces.

This alternative was not analyzed in detail. After an initial analysis, it was determined that it would not meet various elements of the purpose and need, as described below. The purpose and need statement is displayed below in **bold** text.

The purpose of the project is to reestablish and restore forest structure and pattern, forest health, and vegetation composition and diversity. There is a need to increase forest resiliency and sustainability, protect soil productivity, and improve soil and watershed function. Resiliency increases the ability of the ponderosa pine forest to survive natural disturbances such as fire, insect and disease, fire, and climate change (FSM 2020.5).

- Nonforested openings (interspaces), tree group size, and shape would be determined by the location of less than 8-inch d.b.h. trees. In situations where the existing condition is dominated by trees greater than 8-inch d.b.h., the post-treatment condition would result

in large, continuous tree groups with very little variety in size or shape and very little interspace. The post-treatment condition would not move the project area toward forest structure and pattern desired conditions.

- Treatment of approximately 147, 947 acres of VSS 3 stands (with an average diameter larger than 8 inches) and 227,042 acres of VSS 4 to VSS 6 (all stands identified for mechanical treatment) would be constrained by an 8-inch d.b.h. limit. These stands would not be treated or would have minimal treatment. Approximately 73 percent of the 512,178 acres of ponderosa pine within the project area would not move toward desired conditions for forest structure and pattern. In both the short (up to 10 years) and long term (20-plus years) these areas would continue on a trajectory away from the desired forest structure.
- In northern goshawk habitat, the project area currently 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 population 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).
- Even-aged stand conditions apply to 46 percent of landscapes outside of post-fledgling area (LOPFA) habitat (see chapter 1). Forest plan direction is to move these areas toward an uneven-aged condition. Constraining treatments within even-aged LOPFA habitat to 8-inch d.b.h. would result in over 80 percent (VSS 3 with an average diameter greater than 8 inches, all VSS 4, 5, and 6) of these acres remaining even-aged. This would be contrary to moving toward improved forest structure and pattern desired conditions which affect habitat.
- Uneven-aged stand conditions apply to 54 percent of the LOPFA habitat (see chapter 1 and the silviculture report). In those portions of the habitat that are currently uneven-aged, VSS 3 (35 percent) and VSS 4 (32 percent) are overrepresented and VSS 1 (0 percent), VSS 2 (2 percent), VSS 5 (14 percent), and VSS 6 (17 percent) are underrepresented (relative to a balanced age/structure uneven-aged condition). In uneven-aged stands, concentrating all treatment to 8-inch d.b.h. and less would result in no movement toward a balance of age classes within over 90 percent (VSS 3 with an average diameter greater than 8 inches, all VSS 4, 5, and 6) of the uneven-aged LOPFA habitat.
- In ponderosa pine (analysis area extent), young and mid-age structural stages (VSS 3 and VSS 4) account for approximately 82 percent of the ponderosa pine project area while the grass/forb and seedling/saplings stages (VSS 1 and VSS 2) are approximately 2 percent, the mature tree stage (VSS 5) is 10 percent, and the old forest stage (VSS 6) is 6 percent. The low representation in the seedling/sapling, mature, and old classes indicates limited structural stage diversity across the landscape (silviculture report, page 27). In many situations, VSS 3 and VSS 4 are in direct competition with the remaining pre-settlement trees (old forest). This intertree competition has a negative effect on old tree growth and vigor resulting in density-related mortality, decreased resilience, and an unsustainable condition. This would be contrary to the need to improving resiliency and sustainability.

Removal of the younger trees competing with the old trees would be determined by the location of trees less than 8-inch d.b.h. 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. Movement toward the desired condition is not likely to occur in 199,536 acres (39 percent) of VSS 3 and 221,101 acres (43 percent) of VSS 4 (see the 3A to 3C rows in table 6 of the silviculture report). This condition would be contrary to moving toward forest structure and pattern desired conditions.

- Approximately 374,989 acres of VSS 3 and 191,715 acres of VSS 4, 5, and 6 currently have a stand density index (SDI) greater than 55 percent of maximum SDI, the threshold for density-related mortality in ponderosa pine. There would be limited ability to reduce the potential for density-related mortality on 566,704 acres in areas dominated by trees greater than 8-inch d.b.h. with an SDI greater than 55 percent of maximum SDI. This condition would be contrary improving forest resiliency and sustainability.
- **Gambel oak –** Ponderosa pine trees are the primary factor inhibiting Gambel oak development within 65,024 acres of MSO restricted other habitat. Sixty-two percent of these acres are dominated by trees greater than 8 inches with a SDI greater than 55 percent[6]. Mechanical treatment constrained by an 8-inch limit would not move Gambel oak toward (vegetation composition and diversity) desired conditions in terms of increasing oak growth rates and reducing density-related mortality on approximately 40,315 acres of MSO restricted other habitat.
- **Aspen –** Mechanical treatments up to 8-inch d.b.h. that reduce pine-aspen competition would maintain the aspen overstory and promote aspen regeneration. However, in areas that are dominated by trees greater than 8-inch d.b.h., mechanical treatment constrained to an 8-inch d.b.h. would have very little ability to increase the aspen growth rate or stimulate regeneration and move aspen toward desired conditions for vegetation composition and diversity.
- **Grasslands –** In 11,230 acres of historic (mollisol soils) grassland within the ponderosa pine cover type, 9,435 acres (84 percent) are dominated by trees greater than 8 inches d.b.h. Mechanical treatment constrained by an 8-inch limit would not adequately move grasslands toward (vegetation composition and diversity) desired conditions by restoring historic tree pattern and density.
- **Pine-sage –** Within the 5,261 acres of pine-sage proposed for mechanical treatment, 5,187 acres (99 percent) are dominated by trees greater than 8 inches. Mechanical treatment constrained by an 8-inch limit is not expected to adequately move pine-sage toward (vegetation composition and diversity) desired conditions by restoring the historic tree pattern and density.

Summary: This alternative would partially address Issue 2, conservation of large trees, since mechanical treatments would be curtailed at 8-inch d.b.h. It would not achieve restoration desired conditions. It would resolve Issue 3, post-treatment canopy cover and landscape openness, since only small-diameter trees would be removed. However, approximately 73 percent of the 512,178

[6] Based upon established forest density/vigor relationships, density-related mortality begins to occur once the forest reaches 45 to 50 percent of maximum stand density and mortality is likely at density levels of 60 percent+ of maximum stand density. See chapter 1 of the DEIS and the silviculture report for additional information on stand density.

acres of ponderosa pine within the project area would not move toward forest structure and pattern desired conditions. Of all the even-aged stands, 47 percent (VSS 4), 8 percent (VSS 5), and 1 percent (VSS 6) would remain even-aged. There would be zero percent movement toward desired conditions in uneven-aged VSS 4 through VSS 6. For these reasons, this alternative was considered but eliminated from detailed study.

Utilize Prescribed Fire as the Sole Treatment Method

In response to public comments and recommendations, we considered an alternative which only uses prescribed fire to move toward restoration desired conditions. 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. This alternative was not analyzed in detail. After an initial analysis, it was determined that it would not meet various elements of the purpose and need, as described below. The purpose and need statement is displayed in **bold** text.

The purpose of the project is to reestablish and restore forest structure and pattern, forest health, and vegetation composition and diversity. There is a need to increase forest resiliency and sustainability, protect soil productivity, and improve soil and watershed function. Resiliency increases the ability of the ponderosa pine forest to survive natural disturbances such as fire, insect and disease, fire, and climate change (FSM 2020.5).

PACs are representative of old age, old forest structure within the project area. Figure 25 shows heavy fuel loading within a PAC. This is representative of conditions within some PACs in the project area that are proposed for treatment. 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.

Figure 25. High surface fuel loadings in Mormon Mountain PAC (2001), Coconino NF

Using fire as a thinning agent in these conditions would cause high-severity effects to the surface and/or result in uncontrollable fire behavior. This represents extreme fuel loading and is a hazardous condition which can produce high-severity effects. If a wildfire burned though this PAC (even under moderate conditions), the effect would be high tree mortality, loss of soil productivity, and the total loss of nesting and roosting habitat. This would be contrary to the need to improve resiliency and sustainability in the project area.

Based on the potential for severe fire effects, using prescribed fire in 18 PACs (without the ability to mechanically protect old and large trees) would likely be deferred. No movement toward reducing fire risk or improved quality in nesting and roosting habitat (as described in the desired conditions from forest plans and from MSO recovery plan objectives) would occur in 10,741 acres (acres to be mechanically treated up to 18-inch d.b.h.) of MSO habitat. Movement toward a forest that is resilient to natural disturbances would be diminished. Without resiliency, forest sustainability would be affected:

- 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 order to avoid excessive old tree damage and mortality, any treatment in those acres that contribute to old growth allocation (194,804 acres of 593,211 acres or 33 percent of the treatment area) would likely be deferred in order to avoid a further reduction in pre-settlement trees, which are currently uncommon across the landscape. In this alternative, movement toward having a sustainable forest structure with age and size class diversity would not be met as there would be continued overrepresentation in the VSS 3 and 4 age classes and continued underrepresentation in the VSS 5 and VSS 6 age classes.
- Within 27 percent (159,211 acres of 593,211 acres) of the treatment area, a prescribed fire only alternative would meet forest structure desired conditions because there is little need for changing forest structure on these acres. On the remaining 434,000 acres, analysis indicates mechanical treatment would be needed to move toward forest structure desired conditions.
- The project area is currently deficit in VSS 1 and VSS 2 (2 percent of the project area). Using prescribed fire only would not provide the adequate regeneration opening necessary to move toward the desired condition of a balance of age classes without producing high mortality in VSS 5 and VSS 6. The project area is currently deficit in mature tree stage (VSS 5) and the old forest stage (VSS 6) is 10 and 6 percent of the project area respectfully. Using prescribed fire only would not increase growth in mid-aged stands to move sites toward mature and old forests. It would not meet forest structure and pattern desired conditions.
- The use of prescribed fire without mechanical treatment could result in undesirable fire effects in goshawk habitat as stand density increases over time. In 2020, both even-aged and uneven-aged stands that occur in LOPFAs are projected to be dominated by the young and mid-aged forest structural stage, approximately twice the desired condition (see the silviculture report). Trends in goshawk PFAs are similar as described for LOPFAs. This would not meet forest structure and pattern desired conditions and would not move improve resiliency in goshawk habitat.

- Fires in areas dominated by dense, even-aged VSS 3 and VSS 4 severe enough to thin trees are likely to result in crown fires and would be difficult to manage under any circumstances (Miller and Urban 2000). Under these conditions, there is an elevated potential for fire to be carried into the overstory canopy or for fire to damage tree cambium to the point of overstory mortality beyond what is acceptable (Battaglia, Smith, and Shepperd 2009).
- Up to 76 percent (303,721 acres) of goshawk LOPFA would not be expected to move toward the desired condition of having a forest structure with age class diversity. In areas dominated by VSS 3 and VSS 4, the tree size would be greater than what could be safely and effectively treated with fire. Due to the likelihood of severe fire effects, prescribed fire treatments are likely to be deferred in the larger VSS classes. The post-treatment condition would result in large, continuous tree groups with very little variety in size or shape and very little interspace. A lack of groups with interspaces would increase the likelihood of having future 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 would be unpredictable.
- In pine-sage, prescribed fire would need to be deferred in areas where pine cover is highest in order to avoid severe effects to the surface vegetation community. Movement toward the (vegetation composition and diversity) desired condition by restoring the historic pattern within the pine-sage mosaic and managing fire in sage would not be achieved in the deferred acres or in areas where treatments led to severe effects to surface vegetation.
- Within 11,230 acres of historic (mollisol soils) grassland within the ponderosa pine cover type, and the 45,469 acres of historic (mollic-integrade) savanna, about 48,332 acres (85 percent) are dominated by trees in the VSS 3 and larger classes. On these acres, there would very little ability to restore the historic tree pattern and density without removing the encroachment prior to using prescribed fire. Moving toward forest structure, spatial pattern and vegetation composition and diversity desired conditions would not likely to be met under a prescribed fire only scenario. On 48,161 acres of grasslands (grassland cover type), prescribed fire only would not accomplish the objective of removing tree encroachment of other than seedling size trees; fire only would likely produce effects that simulate regeneration and growth of native herbaceous vegetation.
- Areas deferred because of dense forest conditions would maintain closed canopies and prevent understory development, limiting vegetation diversity and composition, particularly for MSO and goshawk prey species.

Summary: This issue would not resolve **Issue 2**, conservation of large trees. This alternative was considered but eliminated from detailed study because: (1) fire risk would remain high and there would be no improvement in terms of resiliency in and around MSO PACs; (2) treatment on 194,804 acres or 33 percent of the treatment area would likely be deferred in order to avoid a further reduction in pre-settlement trees; (3) movement toward having a sustainable forest structure with age and size class diversity would not be met as there would be continued overrepresentation in the VSS 3 and 4 age classes and continued underrepresentation in the VSS 5 and VSS 6 age classes; (4) forest structure and pattern and overall function would not be restored on 11,230 acres of grasslands and 45,469 acres of historic mollic-integrade savanna; and (5)

movement toward the desired condition of restoring the historic pattern within the pine-sage mosaic would not be achieved in areas where treatment was deferred.

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 in order 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 offsite and considers grazing and a variety of mechanical treatment methods to reduce fuels.

This alternative was not analyzed in detail. After an initial analysis, it was determined that it would not meet various elements of the purpose and need, as described below. The purpose and need statement is displayed in **bold** text.

The purpose of the project is to reestablish and restore forest structure and pattern, forest health, and vegetation composition and diversity. There is a need to increase forest resiliency and sustainability, protect soil productivity, and improve soil and watershed function. Resiliency increases the ability of the ponderosa pine forest to survive natural disturbances such as fire, insect and disease, fire, and climate change (FSM 2020.5).

- Without the use of prescribed fire, forest structure could be affected in terms of moving toward age and size class diversity and forest health desired conditions. Without the thinning effect of fire, denser conditions could affect the VSS distribution trend by slowing stand development and growth. This would result in more of the landscape being maintained in the young forest stage. Contrary to the restoration purpose and need, development of the mature and old forest stages could be impeded.
- Mechanical treatments would address the majority of conditions associated with density-related mortality, bark beetle hazard, and dwarf mistletoe infections. However, the pruning effect of fire sanitizing dwarf mistletoe infections would not be realized nor would reduced densities due to the thinning effect of fire be realized. This could lead to slight increases in bark beetle hazard and density-related mortality, contrary to resiliency and sustainability desired conditions.
- Without the use of prescribed fire, patterns of surface vegetation would continue to deteriorate as fire-adapted shrubs and herbaceous species decline (Huffman and Moore 2008, Moir 1988). Eliminating fire would also have an effect on Gambel oak growth forms and densities. Currently, the Gambel oak population throughout the project area is dominated by seedlings and saplings. Without fire as a regulator of these smaller size classes, both the variety of oak growth forms and densities of seedlings and saplings would continue to be outside the range of oak's evolutionary environment. This would be contrary to forest structure, pattern, and vegetation composition and diversity desired conditions.
- Mechanical treatment on 434,001 acres in the project area would be effective at restructuring canopy bulk density, canopy base heights, tree density, and the arrangement of trees in the short term (immediately post-treatment). However, mechanical treatments alone would not be sufficient to produce effects that simulate regeneration and growth of native herbaceous understory vegetation (vegetation

composition and diversity desired condition) or reduce the natural surface fuels that have accumulated since the interruption of fire on the landscape. Refer to the alternative D effects analysis in chapter 3 for a detailed example of the effects of eliminating prescribed fire as a restoration treatment.

- In this alternative, accumulations of litter, duff, existing dead and down woody debris, seedlings, and small saplings would not be reduced by mechanical thinning. These accumulations, in addition to the debris from logging (even with most biomass moved offsite), could result in surface fires that burn at high intensities and lethally scorch tree crowns.
- Excessive surface fuels would promote surface fires that are likely to 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. In the project area, the potential to compromise water resources such as Oak Creek, Upper Lake Mary, or Mormon Lake would exist as second order fire effects occur (flooding, debris flows, erosion, etc.). This would be contrary to the need to reduce the potential for severe fire effects and move toward having a forest that is resilient to wildfire.
- Other types of mechanical fuels treatments considered include:
    - Debris from chipping and shredding of trees and woody surface fuels would either remain on the forest floor or would be piled and moved offsite. 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 of trees and woody surface fuels 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 that was suggested in public comment. Grazers would remove the herbaceous vegetation that helps carry a fire across the majority of the project area, but the herbaceous layer is only a minor contributor to fire effects when compared to needle cast, tree debris, and the trees themselves. Grazing to reduce fuel loading is much more effective in chaparral and scrubland habitats, which are rare within the project area.
    - Within the larger 988,764-acre 4FRI project area, 791,250 acres are within grazing allotments. There are 47 active livestock (cattle and sheep) allotment management plans in place. 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 and 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 regrow, normally within the same year.

- To replace the use of prescribed fire, livestock (cattle and goats) would have to be used on 593,211 acres (alternative C). 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. There would likely be a decline in herbaceous species production and diversity, and possibly an increase in soil compaction across the project area. This is contrary to the purpose and need which is designed to increase the herbaceous understory and move toward improved function in soils, watersheds, grasslands, and forested areas.

Summary: This issue would resolve **Issue 1**, prescribed fire emissions. It would be possible to use mechanical treatments to move biomass offsite and reduce surface fuels that would have been burned and produced smoke. However, mechanical treatment would not replace the role fire has in improving vegetation composition and diversity on: (1) 59,391 acres of existing grasslands, (2) over 56,000 acres of ponderosa pine with a savanna or grassland reference condition, (3) grassland inclusions within 308,000 acres of ponderosa pine forested areas, (4) 5,261 acres of pine-sage, (5) 1,471 acres of aspen, and (6) thousands of acres where Gambel oak exists within the pine forest.

Without the ability to use prescribed fire to: (1) stimulate understory vegetation growth, (2) reduce the natural surface fuels (that have accumulated since the interruption of fire on the landscape), and (3) maintain desired canopy base heights, canopy bulk densities, and reduced ladder fuel conditions (that were attained through mechanical treatment), it is estimated the project area would begin to move away from forest structure and pattern and resiliency desired conditions within 10 years of the mechanical treatment. The use of alternative fuels treatment methods in lieu of prescribed fire could provide reductions in fuels but would not meet the ecological need of a fire-adapted landscape. In the case of grazing, the level that would be needed to maintain the project area without fire would exceed forest plan allowable thresholds. Using grazing as a surrogate for prescribed fire would be contrary to the purpose and need which is designed to increase vegetation composition and diversity, and move toward improved soil productivity and watershed function.

Incorporate the Original Large Tree Retention Strategy (LTRS)

Overview: This alternative was not analyzed in detail. After an initial analysis, it was determined that incorporating/implementing the original LTRS would not meet various elements of the purpose and need. A modified version of the original strategy, the large tree implementation plan (LTIP), was included in alternative C. The "background" section summarizes how the original LTRS was modified. Table 15 displays a few excerpts from the original LTRS, the location of the excerpts in the LTRS, a crosswalk to the modified LTIP, and rationale why the original language was not accepted as written. The complete crosswalk document is in the project record and will be made available on the 4FRI Web site.

Background: The large tree retention strategy (hereafter referred to as LTRS) was developed by the four-forest restoration stakeholders in 2011 through a collaborative process. The intent of the LTRS exception process is to increase landscape heterogeneity and conserve biodiversity. The LTRS represents social agreement between parties and was developed to reduce conflict and enhance the chance of successfully implementing restoration at the landscape scale. The original LTRS defines large post-settlement trees as those greater than 16-inch diameter-at-breast height (d.b.h.). The LTRS provides direction for retaining large trees throughout the 4FRI landscape, except:

- As necessary to meet community protection and public safety goals, and
- Where best available science and stakeholder agreement identify sites where ecological restoration and biodiversity objectives cannot otherwise be met. This specifically applies to several exception categories including wet meadows, seeps, springs, riparian areas, encroached grasslands, aspen groves or oak stands, within stand openings, and heavily stocked stands with high basal area generated by a preponderance of large, young trees.

Rationale for Considering but Eliminating the Original LTRS from Detailed Study:

- The original LTRS did not provide the ability to create regeneration openings using a group selection treatment method within the large, young tree (LTRS, pp. 23–24) and the within stand openings category (LTRS, pp. 21–22). We found that in the short term (0 to 10 years), this would result in a continued imbalance of size classes that would be contrary to the forest plan desired conditions in non-PFA goshawk habitat outside of nest stands. There would be no movement toward sustaining the older, larger trees into the future. The ability to provide for tree recruitment into the largest size classes would be hindered. For this reason, the implementation plan includes the ability to create regeneration openings.
- The original LTRS would have required the Forest Service to consult with stakeholders should a new exception category be found during implementation (LTRS, page 25). To resolve the potential for Federal Advisory Committee Act (FACA) violations, this consultation requirement was removed. The modified version includes language to address the concern without potentially violating FACA: During implementation (prescription development), if a condition exists that does not the meet the desired conditions included in the large tree implementation plan, no large trees would be cut until the National Environmental Policy Act (NEPA) decision is reviewed by the Forest Service implementation team. The team would decide whether the action is consistent with the analysis and the decision made. This information would be made part of the annual implementation plan checklist/compliance review that is recommended by the team and approved by the forest supervisor.
- In the original LTRS, movement toward the desired condition in pine-oak was constrained to MSO habitat. This would preclude moving toward desired conditions in non-MSO habitat (LTRS, pp. 19–20). For this reason, the ability to move all pine-oak within the project area toward desired conditions was included in the large tree implementation plan.
- The exception categories were translated into resource-specific desired conditions. This was completed because we found that the exception categories represented the majority of the landscape. An exception, by definition, is something that is not included in, or

does not fit into, a general rule. We spatially mapped the exception categories and found that true exceptions were a minor component of the desired condition strategy for managing post-settlement trees. For example, the geospatial mapping exercise found that around 54,358 acres of the proposed treatment area did not fit an existing resource (formally exception) category. Most acreage could be classified within the large, young tree category. The 54,358 acres noted above do not necessarily mean a new category has to be developed. Either the vegetation and geospatial data was not able to determine what category these acres should be placed in or it was expected, based on the vegetation data, that these acres could be moved toward desired conditions without needing to cut trees larger than 16-inch d.b.h. On-ground review and validation is planned to rectify the lack of information on these acres. Desired conditions were easier to translate into treatment design (see "Alternative C – Implementation Plan"). See table 15 which provides two examples of exception categories modified into desired conditions.

- Other minor additions or variations are disclosed in the January 23, 2012, Summary LTRS Crosswalk to desired conditions document (see project record).

Limit Mechanical Treatments to 16-inch d.b.h. as a Means to Preserve Large Trees

Background: This alternative originated over the impression that there are relatively few large trees remaining on the landscape and that the removal of large trees is a return to commercially-focused forest management.

In the past, within the Southwestern Region of the Forest Service, diameter caps have been used to preserve large trees, often those over 16-inch d.b.h., leading to a so-called "16-inch cap." In many cases, project level agreements were negotiated with local stakeholders to implement diameter caps. Diameter caps have since become a common practice on some national forests within the region. Recent projects on the Coconino NF with some form of diameter caps include Upper Beaver Creek and East Clear Creek. Many other recent projects on the Coconino NF and the southern part of the Kaibab NF have consider but eliminated a "16-inch cap" alternative due to it not meeting these specific projects' purpose and need.

An alternative limiting mechanical harvest to trees less than 16-inch d.b.h. was not analyzed in detail for two reasons:

1. The 4FRI collaborative group developed and submitted to the Forest Service for consideration a large tree retention strategy (LTRS). The LTRS identifies situations where removing post-settlement trees larger than 16-inch d.b.h. would be ecologically beneficial. Key components from the 4FRI stakeholder strategy have been incorporated into alternative C's implementation plan.
2. Land managers and researchers throughout the Southwest have concerns that such a policy is unsustainable, and that constraining restoration treatments to 16-inch d.b.h. and less would limit achievement and maintenance of desired conditions for long-term forest structure, composition, and forest dynamics unique to the open tree canopy/multistoried conditions in the frequent fire forests of Arizona and New Mexico.

Fire-adapted forest systems typical within the Southwestern Region of the Forest Service were historically driven by frequent fire burning through an herbaceous understory. This maintained open, uneven-aged conditions in ponderosa pine and dry mixed conifer forests. The purpose of the project is to reestablish and restore forest structure and pattern, forest health, and vegetation composition and diversity. There is a need to increase forest resiliency, protect soil productivity, and improve soil and watershed function. Resiliency increases the ability of the ponderosa pine forest to survive natural disturbances such as fire, insect and disease, and climate change (FSM 2020.5). In meeting desired conditions, restoration treatments proposed in the 4FRI project are designed to lower the overstory density and canopy continuity, and reestablish forest openings to provide for recruitment of younger age classes.

The publication "Diameter Caps and Forest Restoration" (USDA 2011) documents an evaluation of a 16-inch d.b.h. cut limit on achieving desired conditions and reports on the results of related studies. This publication synthesizes the concerns land managers and researchers throughout the Southwest have regarding a projectwide (programmatic) diameter cap. The main conclusion from that publication is that when managed using a 16-inch d.b.h. cut limit, the plurality of stands would trend toward a large diameter, single story, closed-canopy condition. The ponderosa pine/grassland and the ponderosa pine/Gambel oak potential natural vegetation types (PNVTs) considered in the USDA 2011 study are prevalent throughout the 4FRI project area and some of the forest inventory assessment (FIA) datasets used in the study are from the southern Kaibab NF and Coconino NF.

The following discussion relates how a trend toward a large diameter, single story, closed-canopy forest condition would not meet many of the project's desired conditions:

- A trend toward a large diameter, single story, closed-canopy forest condition would result in homogeneous vegetation structure at the landscape scale. Structural characteristics would lack a mosaic of interspace, tree groups of varying sizes and forest structure with all age and size classes represented. Forest management under a diameter cap would result in a narrow range of forest structure and composition, thereby limiting future ability to manage for a restored forest condition. For these reasons, the purpose and need would not be met on most of the project area.
- Closed-canopy forests do not allow for the sustainable vigor/growth of old age trees. Under these conditions, old trees would be subject to density-related mortality, higher bark beetle hazard, and would be more susceptible to high-severity fires.
- Closed canopy, single-storied forests are more susceptible to density-related mortality, successful bark beetle attack, and provide conditions conducive to dwarf mistletoe spread and intensification.
- A trend toward single story, closed-canopy forest conditions would result in landscape scale homogeneity lacking diversity. Closed-canopy forest conditions do not allow for the sustainable growth of shade intolerant tree species (Gambel oak and aspen). Closed-canopy forest conditions do not provide canopy gaps to support robust understory vegetation for plant diversity.
- Closed-canopy, single-storied forest stands are more susceptible to crown fires and changes to fire regimes, as well as long-term conversion from forested plant communities to shrub- and herbaceous-dominated vegetation types (Savage and Mast 2005).

Table 15. Large tree retention strategy and large tree implementation plan crosswalk

Original LTRS Statement	LTRS Reference Location	Rationale for Excluding Statement as Written in the (Modified) Large Tree Implementation Plan
Comparison Between Original and (modified) Large Tree Implementation Plan		
The intention of the exception process is to increase landscape heterogeneity and conserve biodiversity. Thus, we do not support implementing any exceptions where removing the trees would conflict with existing recovery/conservation plan objectives for managing sensitive, threatened, or endangered species or their habitat. We also recognize there may be additional areas and/or circumstances where large trees need to be removed to achieve restoration. These circumstances should be identified through a site specific, agreement based, collaborative process as described in the 4FRI Charter.	Page 4 of I. Old Growth Protection and Large Tree Retention Strategy (OGP and LTRS) Overview	This statement in the LTRS requires agreement-based exceptions for categories overlooked in the LTRS. This statement implies the Forest Service (FS) will need to seek approval for every tree cut that may be in an exception not currently covered. The FS cannot relinquish its decisionmaking authority. Additionally; when mapped, the exception categories described in the LTRS are shown to be common occurrences on the ground (they are the norm).
III. Exception Process for Large Post-Settlement Tree Retention The following section outlines a problem statement, specific identifying circumstances, ecological objectives, and selection criteria for instances in which large post-settlement trees may be cut to meet restoration objectives. At specific locations, large trees may need to be removed, felled, or girdled for purposes of ecological restoration and biodiversity conservation. The purpose of this section is to provide sufficient specificity to translate those exception categories where stakeholder agreement exists to do so into management actions and tree marking guidelines. For eight of the nine exception categories, programmatic recommendations describe the circumstances and criteria in which large post-settlement trees may need to be removed. For the "Heavily Stocked Stands with High Basal Area Generated by a Preponderance of Large Young Trees (or Large Young Tree)" exception category, getting to a higher level of social and scientific agreement entails more complexity and challenges, so we propose the initiation of additional collaborative discussion and planning that we hope will bolster restoration efforts by increasing confidence and knowledge sharing, maximizing agreement, and minimizing disagreement.	Exception Process, III. p. 8, also see pp. 9, 11, 13, 15, 17, 19, 21, and 23	The intent of this section (criteria for removing large trees) is addressed in design features (designed to meet forest plan requirements) and the alternative C implementation plan. These pages imply the Forest Service would need to seek approval for every tree cut that may be in an exception category not currently defined. The Forest Service cannot legally give its decisionmaking authority to an individual or group. On a project of this size, it would not be reasonable or practical to seek agreement on all marking when this requires silvicultural expertise. However, the implementation plan in the DEIS reflects collaboration with interested parties. It has been field tested with interested parties from the stakeholder group and with Agency foresters who routinely mark and administer vegetation projects. Modifications were made to the implementation plan as a result of the field reviews. In addition, the implementation plan reflects the incorporation of the stakeholder developed old growth protection strategy. This strategy is presented as the "Old Tree Implementation Plan" and was incorporated into all action alternatives.

Original LTRS Statement	LTRS Reference Location	Rationale for Excluding Statement as Written in the (Modified) Large Tree Implementation Plan
Within Stand Openings Exception Category: **Ecological Objectives** 1. Conserve and restore openings within stands to provide natural spatial heterogeneity for biological diversity. 2. Break up fuel continuity to reduce the probability of torching and crowning. 3. Restore natural heterogeneity within stands. 4. Promote snowpack accumulation and retention to benefit groundwater recharge and watershed processes at small scale. **Criteria** Large (>16″ d.b.h.) post-settlement ponderosa pine trees may be removed to restore the unique biophysical attributes of within stand openings according to these criteria: 1. When the presence of such trees would prevent the reestablishment of sufficient within-stand openings to emulate natural vegetation patterns based on current stand conditions, pre-settlement evidences, desired future conditions, or other restoration objectives, and 2. Where desired openings are tentatively identified as ≥0.05 acre (these openings should be established wherever possible by enlarging current within stand openings or where small diameter trees are predominant), and 3. Where removing the trees does not conflict with existing recovery/conservation plan objectives for managing sensitive, threatened, or endangered species or their habitat. NOTE: It is not necessary that within-stand openings and groups be located in the same location that they were in before settlement. That is, trees might be retained in areas that were openings before settlement, and openings might be established in areas that had previously supported pre-settlement trees.	pp. 21–22	This exception category does not allow cutting trees greater than 16 inches for regeneration openings. Accepting this as written would violate the forest plans and the concept of a balance of age classes and sustained yield. The modified LTIP includes language that allows for regeneration openings and includes desired conditions related to implementing pre-settlement tree conservation measures. For an opening that is equivalent to 3/10 to 8/10 per acre, there could be a situation where you cannot provide the opening without cutting a tree that is greater than 16-inch d.b.h., because group selection is missing from the LTRS. It could force the placement of tree groups in sub-standard locations. The desired conditions for this category are as follows: **Modified Within-Stand Openings Desired Conditions** • The pattern of openings within stands that provide natural spatial heterogeneity for biological diversity are conserved. • Openings break up fuel continuity to reduce the probability of torching and crowning and restore natural heterogeneity within stands. • Openings promote snowpack accumulation and retention which benefits groundwater recharge and watershed processes at the fine (1 to 10 acres) scale. • The presence of such trees does not prevent the reestablishment of sufficient within-stand openings to emulate natural vegetation patterns based on current stand conditions, pre-settlement evidences, desired future conditions, or other restoration objectives. • Groups of trees typically range in size from 0.1 acre to 1.0 acre. Canopy gaps and interspaces between tree groups or individuals are based on site productivity and soil type and range from 10 percent on highly productive sites to as high as 90 percent on those soil types that have an open reference condition. • Suitable openings for successful natural regeneration in this project would range in size from 3/10 to 8/10 of an acre.

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 (alternatives C and D). Alternatives C and D respond to recommendations and issues raised by the public. A brief summary of the alternatives is provided below.

Alternative A is the no action alternative as required by 40 CFR 1502.14(c). There would be no changes in current management under the forest plans. Approximately 82,592 acres of ongoing vegetation treatments and 96,125 acres of ongoing prescribed fire projects would continue to be implemented adjacent to the treatment area. Approximately 86,771 acres of vegetation treatments and 142,869 acres of prescribed fire and maintenance burning would be implemented adjacent to the treatment area by the forests in the foreseeable future (within 5 years). Alternative A is the point of reference for assessing action alternatives B–D.

Alternative B is the proposed action**.** This alternative would mechanically treat 388,489 acres of vegetation and utilize prescribed fire on 587,923 acres. It incorporates comments and recommendations received during 8 months of collaboration with individuals, agencies, and organizations. It proposes mechanically treating up to 16-inch d.b.h. in 18 MSO PACs and includes low-severity prescribed fire within 72 MSO PACs, including 56 core areas. Three nonsignificant forest plan amendments on the Coconino NF and two nonsignificant forest plan amendments on the Kaibab NF would be required to be in compliance with the plans.

Alternative C is the **preferred alternative.** This alternative would mechanically treat 434,001 acres of vegetation and utilize prescribed fire on 593,211 acres. It responds to Issue 2 (conservation of large trees) and Issue 4 (increased restoration and research). It 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 Research Natural Area on the Kaibab NF. It proposes mechanically treating up to 18-inch d.b.h. in 18 MSO PACs and includes low-severity prescribed fire within 72 MSO PACs, including 56 core areas. Key components of the stakeholder created LTRS are incorporated into the alternative's implementation plan. Three nonsignificant forest plan amendments on the Coconino NF and three nonsignificant amendments on the Kaibab NF would be required to be in compliance with the plans.

Alternative D would mechanically treat 388,489 acres of vegetation and utilize prescribed fire on 178,790 acres. This alternative was developed in response to Issue 1(prescribed fire emissions). It decreases the acres that would receive prescribed fire by30 percent when compared to alternative B (proposed action). It proposes mechanically treating up to 16-inch d.b.h. in 18 PACs MSO PACs but the PACs would not be treated with prescribed fire. Three nonsignificant forest plan amendments on the Coconino NF and two amendments would be required on the Kaibab NF to be in compliance with the plans.

Actions Common to Alternatives B–D

- All action alternatives (B–D) propose additional actions including restoring springs and ephemeral channels, constructing protective fencing in select aspen stands, constructing (and decommissioning) temporary roads, reconstructing and improving roads, relocating a minimal number of road miles, and decommissioning existing roads and unauthorized routes (see table 1 in chapter 1).

- Design features, best management practices (BMPs), and mitigation to be used as part of alternatives B–D are located in appendix C.
- All action alternatives incorporate key components of the old tree protection strategy into the alternative's design features (appendix C), implementation plan (appendix D), and monitoring and adaptive management (appendix E). The Forest Service worked collaboratively with stakeholders to develop the monitoring and adaptive management and implementation plan.
- All action alternatives include adaptive management actions that would be taken as needed to restore springs, ephemeral channels, and naturalize decommissioned and unauthorized roads (table 16).
- All action alternatives address Issue 3, post-treatment canopy cover and landscape openness. Alternatives B–D are designed to meet canopy cover in VSS 4 to VSS 6 in compliance with the forest plans (except in areas managed for an open reference condition). Each alternative addresses the interrelationship between canopy cover and old and large trees.

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. Up to 45,000 acres of vegetation would be mechanically treated annually. Up to 40,000 acres of prescribed fire would be implemented annually across the forests. Two prescribed fires[7] would be conducted on all acres proposed for treatment over the 10-year period. Restoration activities would:

- Mechanically cut trees and apply prescribed fire on approximately 388,489 acres. This includes: (1) mechanically treating up to 16-inch d.b.h. within 18 MSO PACs, (2) cutting 99 acres of trees by hand on slopes greater than 40 percent, and (3) using low-severity prescribed fire within 72 MSO PACs (excluding core areas).
- Utilize prescribed fire only on approximately 199,435 acres.
- Construct 517 miles of temporary roads for haul access and decommission when treatments are complete (no new permanent roads would be constructed).
- Reconstruct up to 40 miles of existing, open roads for resource and safety concerns (no new permanent roads would be constructed). Of these miles, approximately 30 miles would be improved to allow for haul (primarily widening corners to improve turn radiuses) and about 10 miles of road would be relocated out of stream bottoms. Relocated roads would include rehabilitation of the moved road segment.
- Decommission 770 miles of existing system and unauthorized roads on the Coconino NF.
- Decommission 134 miles of unauthorized roads on the Kaibab NF.
- 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.

[7] The first prescribed fire may include pile burning followed by a broadcast burn.

- 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.

Three nonsignificant forest plan amendments (see appendix B) would be required on the Coconino NF to implement alternative B:

Amendment 1 would add language to allow mechanical treatments up to 16-inch d.b.h. to improve habitat structure (nesting and roosting habitat) in 18 MSO PACs. The amendment would remove language that limits PAC treatments in the recovery unit to 10 percent increments and language that requires the selection of an equal number of untreated PACs as controls. The amendment would remove language referencing monitoring (pre- and post-treatment, population, and habitat). Replacement language would defer final project design and monitoring to the FWS biological opinion specific to MSO for the project.

The amendment, which is specific to restricted habitat in pine-oak, would allow for designating less than 10 percent of restricted habitat on the Coconino NF as target or threshold (i.e., future nesting and roosting habitat) based on the quality of the habitat. Definitions of target and threshold habitat would be added.

Amendment 2 would add the desired percentage of interspace within uneven-aged stands to facilitate restoration in goshawk habitat (excluding nest areas), add the interspace distance between tree groups, add language clarifying where canopy cover is and is not measured, allow 29,017 acres to be managed for an open reference condition, and add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.

Amendment 3 would remove the cultural resource standard that requires achieving a “no effect” determination and would add the words “or no adverse effect” to the remaining standard. In effect, management would strive to achieve a “no effect” or “no adverse effect” determination.

Two nonsignificant forest plan amendments (see appendix B) would be required on the Kaibab NF to implement alternative B:

Amendment 1 would add the desired percentage of interspace within uneven-aged stands to facilitate restoration in goshawk habitat (excluding nest areas), add the interspace distance between tree groups, add language clarifying where canopy cover is and is not measured, allow 27,637 acres to be managed for an open reference condition, and add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.

Amendment 2 would allow for designating less than 10 percent of restricted habitat in pine-oak as target or threshold (i.e., future nesting and roosting habitat) based on the quality of the habitat. The amendment would remove language that limits PAC treatments in the recovery unit to 10 percent increments and requires the selection of an equal number of untreated PACs as controls. The amendment would also remove language that references monitoring (pre- and post-treatment, population and habitat). Replacement language would defer final project design and monitoring to the FWS biological opinion specific to MSO for the project.

Table 16. Alternative B–D springs, channels, and roads adaptive management actions

Evaluation Criteria	Desired Condition	Existing Condition	Possible Management Actions*	Monitoring Measure	Trigger Indicating Additional Action is Needed (What/When)	Adaptive Options*
Roads and unauthorized routes located in upland (non-meadow) and in meadows	Soils are in satisfactory condition so that soil can resist erosion, recycle nutrients, and absorb water. Understory species (grasses, forbs, and shrubs) diversity is consistent with site potential and provides for infiltration of water and reduction of accelerated erosion. The understory has a variety of heights of cool and warm season vegetation.	Up to 904 miles of road/route are in unsatisfactory soil condition due to accelerated erosion, lack of effective ground cover, and compaction.	1. Reestablish former drainage patterns, stabilize slopes, and restore vegetation; 2. Block the entrance to a road or install water bars; 3. Remove culverts, reestablish drainages, remove unstable fills, pull back road shoulders, and scatter slash on the roadbed; 4. Eliminate the roadbed by restoring natural contours and slopes; and 5. Other methods designed to meet the specific conditions associated with the unneeded road.	• Miles of road treated • Soil condition assessment	Soil condition is impaired or unsatisfactory as defined in a soil condition assessment. Time is 5 years after treatment.	• Additional drainage • Additional revegetation efforts (including mulching) • Short-term fencing to protect revegetation • Complete removal of roadbed
Roads and unauthorized routes located in the filter strips of identified riparian and nonriparian stream courses	Soils are in satisfactory condition so that the soil can resist erosion, recycle nutrients, and absorb water. Understory species (e.g., grasses, forbs, and shrubs) diversity is consistent with site potential and provides for infiltration of water and reduction of accelerated erosion. The understory has a variety of heights of cool	All roads are in unsatisfactory soil condition due to accelerated erosion, lack of effective ground cover, and compaction.	1. Reestablish former drainage patterns, stabilize slopes, and restore vegetation; 2. Block the entrance to a road or install water bars; 3. Remove culverts, reestablish drainages, remove unstable fills, pull back road shoulders, and scatter slash on the roadbed; 4. Eliminate the roadbed by restoring natural contours and slopes; and	• Miles of road treated • Soil condition assessment	Soil condition is impaired or unsatisfactory as defined in the soil condition assessment. Time is 5 years after treatment.	• Additional drainage • Additional revegetation efforts (including mulching) • Short-term fencing to protect revegetation

Evaluation Criteria	Desired Condition	Existing Condition	Possible Management Actions*	Monitoring Measure	Trigger Indicating Additional Action is Needed (What/When)	Adaptive Options*
	and warm season vegetation.		5. Other methods designed to meet the specific conditions associated with the unneeded road.			
Undeveloped spring in a forested setting. Vegetation and soils range from satisfactory condition (waterflow is occurring) to vegetation/ soils are below potential or are impaired/ unsatisfactory (there is no evidence of waterflow from spring).	Springs and associated streams and wetlands have the necessary soil, water, and vegetation attributes to be healthy and functioning at or near potential. Waterflow patterns, recharge rates, and geochemistry are similar to historic levels and persist over time. Water quality and quantity maintain native aquatic and riparian habitat and water for wildlife and designated beneficial uses, consistent with water rights and site capability. Plant distribution and occurrence are resilient to natural disturbances. Soils are in satisfactory condition.	Undeveloped springs occur on both forests in a forested setting. There are six springs on the Coconino NF that are located in forested areas, but the status of development is unknown.	If vegetation/soils are satisfactory options include: • Remove tree canopy to pre-settlement condition within 2–5 chains of the spring; • Apply for water right if none exists; • Prescribe burn, or • No action. If vegetation/soils are below potential or are impaired/unsatisfactory options include: • Remove tree canopy to pre-settlement condition within 2–5 chains of the spring; • Apply for water right if none exists; • Remove noxious weeds; • Prescribe burn; or • Identify stressor and provide protection	Properly functioning condition (PFC), Museum of Northern Arizona level 1 monitoring, waterflow (possible new direction for spring monitoring from FS), photo points	Drop in PFC class, monitoring displays a dropping trend. Monitoring every 1–10 years	• ID stressor, protect from stressor (fence/ jackstraw, close road, relocated road, etc.) • No action

Evaluation Criteria	Desired Condition	Existing Condition	Possible Management Actions*	Monitoring Measure	Trigger Indicating Additional Action is Needed (What/When)	Adaptive Options*
			measure for the stressor (fence, jackstraw, remove/relocate road/trail etc.) and/or • Other methods designed to meet the desired conditions.			
Developed springs in a forested setting. Vegetation and soils range from satisfactory condition (waterflow is occurring) to vegetation/ soils are below potential or are impaired/ unsatisfactory (there is no evidence of waterflow from spring).	Springs and associated streams and wetlands have the necessary soil, water, and vegetation attributes to be healthy and functioning at or near potential. Waterflow patterns, recharge rates, and geochemistry are similar to historic levels and persist over time. Water quality and quantity maintain native aquatic and riparian habitat and water for wildlife and designated beneficial uses, consistent with water rights and site capability. Plant distribution and occurrence are resilient to natural disturbances. Soils are in satisfactory condition.	There are 26 springs on the Kaibab NF that are located in forested areas and the status of development is unknown. There are 40 developed springs on the Coconino NF that are located in forested areas. There are six springs on the Coconino NF that are located in forested areas and the status of development is unknown.	Negotiate with holders of water rights that are non-Forest Service at Alto, Chimney, Dairy, Double, Garden, Griffiths, Howard, Little Elden, Lower Hull, Mud, Pat, Sawmill, Seven Anchor, and Upper Hill Springs on the Coconino National Forest and springs on the Kaibab NF to explore the possibility of releasing water above their water right for riparian conditions. If vegetation/soils are below potential or are impaired/unsatisfactory: • Remove tree canopy to pre-settlement condition within 2–5 chains of the spring, • Prescribe burn, • Remove existing water right (see list above) to expand current riparian	PFC, Museum of Northern Arizona level 1 monitoring, waterflow (possible new direction for spring monitoring from FS), photo points	Drop in PFC class, monitoring displays a dropping trend. Monitoring every 1–10 years	• ID stressor, protect from stressor (fence/ jackstraw, close road, relocated road, etc.) • No action

Evaluation Criteria	Desired Condition	Existing Condition	Possible Management Actions*	Monitoring Measure	Trigger Indicating Additional Action is Needed (What/When)	Adaptive Options*
			conditions, • Identify stressor and provide protection measure for the stressor (fence, jackstraw, remove/relocate road/trail etc.), and/or • Apply other methods designed to meet the desired conditions.			
Undeveloped spring in a meadow setting. Vegetation and soils range from satisfactory condition (waterflow is occurring) to vegetation/ soils are below potential or are impaired/ unsatisfactory (there is no evidence of waterflow from spring).	Springs and associated streams and wetlands have the necessary soil, water, and vegetation attributes to be healthy and functioning at or near potential. Waterflow patterns, recharge rates, and geochemistry are similar to historic levels and persist over time. Water quality and quantity maintain native aquatic and riparian habitat and water for wildlife and designated beneficial uses, consistent with water rights and site capability. Plant distribution and occurrence are resilient to natural	Springs occur on the two national forests that are not developed and occur in a meadow setting. There is one spring on the Coconino NF (Scott Spring) that is located in meadow areas, but the status of development is unknown. There is one spring on the Kaibab NF that is located in meadow areas, but the status of	If vegetation/soils are satisfactory: • Apply for water right if none exists, • Prescribe burn, and/or • Take no action. If vegetation/soils are below potential or are impaired/unsatisfactory: • Apply for water right if none exists, • Remove noxious weeds, • Prescribe burn, • Identify stressor and provide protection measure for the stressor (fence, jackstraw, remove/relocate road/trail etc.), and/or	PFC, Museum of Northern Arizona level 1 monitoring, waterflow (possible new direction for spring monitoring from FS), photo points	Drop in PFC class, monitoring displays a dropping trend. Monitoring every 1–10 years	• ID stressor, protect from stressor (fence/ jackstraw, close road, relocate road, etc.) • No action

Evaluation Criteria	Desired Condition	Existing Condition	Possible Management Actions*	Monitoring Measure	Trigger Indicating Additional Action is Needed (What/When)	Adaptive Options*
	disturbances. Soils are in satisfactory condition.	development is unknown.	select • Other methods designed to meet the desired conditions.			
Developed spring in a meadow setting. Vegetation and soils range from satisfactory condition (waterflow is occurring) to vegetation/ soils are below potential or are impaired/ unsatisfactory (there is no evidence of waterflow from spring).	Springs and associated streams and wetlands have the necessary soil, water, and vegetation attributes to be healthy and functioning at or near potential. Waterflow patterns, recharge rates, and geochemistry are similar to historic levels and persist over time. Water quality and quantity maintain native aquatic and riparian habitat and water for wildlife and designated beneficial uses, consistent with water rights and site capability. Plant distribution and occurrence are resilient to natural disturbances. Soils are in satisfactory condition.	Springs occur on the two national forests that are developed and occur in a meadow setting. There are four springs on the Coconino NF that are located in meadow areas and are developed.	If vegetation/soils are satisfactory: • Prescribe burn, • Re-plumb spring to allow for water above existing water right to be released to expand current riparian conditions, and /or • Other methods designed to meet the specific conditions associated. If vegetation/soils are below potential or are impaired/unsatisfactory: • Prescribe burn, • Remove noxious weeds, • Re-plumb spring to allow for water above existing water right to be released to expand current riparian conditions, • Identify stressor and provide protection	PFC, Museum of Northern Arizona level 1 monitoring, waterflow (possible new direction for spring monitoring from FS), photo points	Drop in PFC class, monitoring displays a dropping trend. Monitoring every 1–10 years	• ID stressor, protect from stressor (fence/ jackstraw, close road, relocated road, etc.) • No action

Evaluation Criteria	Desired Condition	Existing Condition	Possible Management Actions*	Monitoring Measure	Trigger Indicating Additional Action is Needed (What/When)	Adaptive Options*
			measure for the stressor (fence, jackstraw, remove/relocate road/trail etc.), and/or • Other methods designed to meet the desired conditions.			

*Adaptive actions will need to be assessed to evaluate whether they are consistent with the NEPA analysis and decision made.

Alternative B Tables and Figures

Table 17 describes treatments and provides treatment acres. Figure 26 displays the general locations of mechanical and prescribed fire treatments.

Table 18 provides acres by road treatment type and restoration unit. Figure 27 displays the general locations of road treatments.

Table 19 provides acres of springs, channels, and aspen treatments by restoration unit. Figure 28 displays the general locations for these treatments.

Table 20 and table 21 provide treatment type and acres in goshawk and MSO habitat. Figure 29 displays the general treatment locations.

Table 22 and table 23 display the old growth allocation acres by forest, restoration unit, and vegetation type. Figure 30 displays the general location of the old growth allocation.

The map packet in appendix A provides all treatment maps at a larger scale for easier viewing.

Table 17. 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. Accompanied by prescribed fire.	1,229
Prescribed Fire Only	Prescribed fire would be applied exclusively to move treated areas toward desired vegetation conditions.	199,435
Grassland Restoration	Mechanical treatment that removes encroaching post-settlement conifers and manages for up to 90 percent of the treatment area as grass/forb/shrub using pre-settlement tree evidence as guidance. Accompanied by prescribed fire.	11,185
Intermediate Thin (IT) 10 (10 to 25% interspace)	Mechanical treatment that thins tree groups and establishes interspace adjacent to tree groups to an average of 70–90 square feet of basal area and manages for improved tree vigor and growth by retaining the best growing dominant and codominant trees with the least amount of mistletoe; interspace would occupy 10–55 percent of the treatment area, respectively. Accompanied by prescribed fire.	7,766
Intermediate Thin (IT) 25 (25 to 40% interspace)		11,871
Intermediate Thin (IT) 40 (40 to 55% interspace)		39,189
MSO Threshold	Same as MSO Target	1,894
MSO Target	Intermediate thinning (IT) designed to improve forest health, reduce fire risk, and meet forest density, structure, and species composition requirements. Accompanied by prescribed fire.	6,518
MSO Restricted	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, irregular tree spacing, a mosaic of interspaces and tree groups of varying sizes. Accompanied by prescribed fire.	65,024
MSO PAC	Mechanical treatment designed to increase tree vigor and health and create canopy gaps to reduce fire risk. Accompanied by prescribed fire.	10,741

Treatment Type	Treatment Description/Objective	Acres
Pine-Sage	Mechanical treatment that restores pre-settlement tree density and pattern using pre-settlement tree evidence as guidance. Accompanied by prescribed fire.	5,261
Savanna (70 to 90% interspace)	Mechanical treatment that restores pre-settlement tree density and pattern, and manages for a range of 70–90 percent of the treatment area as interspace (grass/forb) between tree groups or individual trees using pre-settlement tree evidence as guidance. Treatment would be accompanied by prescribed fire.	45,469
Stand Improvement (SI) 10 (10 to 25% interspace)	Mechanical treatment that establishes tree groups and interspace adjacent to tree groups and manages for improved tree vigor and growth by retaining the best growing dominant and codominant trees within each group; interspace would occupy 10–55 percent of the treatment area, respectively. Treatments would be accompanied by prescribed fire.	1,914
Stand Improvement (SI) 25 (25 to 40% interspace)		6,824
Stand Improvement (SI) 40 (40 to 55% interspace)		12,309
Uneven-aged (UEA) 10 (10 to 25% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 10–25 percent of the treatment area. Accompanied by prescribed fire.	18,204
Uneven-aged (UEA) 25 (25 to 40 % interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 25–40 percent of the treatment area. Accompanied by prescribed fire.	39,244
Uneven-aged (UEA) 40 (40 to 55% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 40–55 percent of the treatment area. Accompanied by prescribed fire.	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) objective. Accompanied by prescribed fire.	535
Wildland-Urban Interface (WUI) (55 to 70% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 55–70 percent of the treatment area. Accompanied by prescribed fire.	2,268

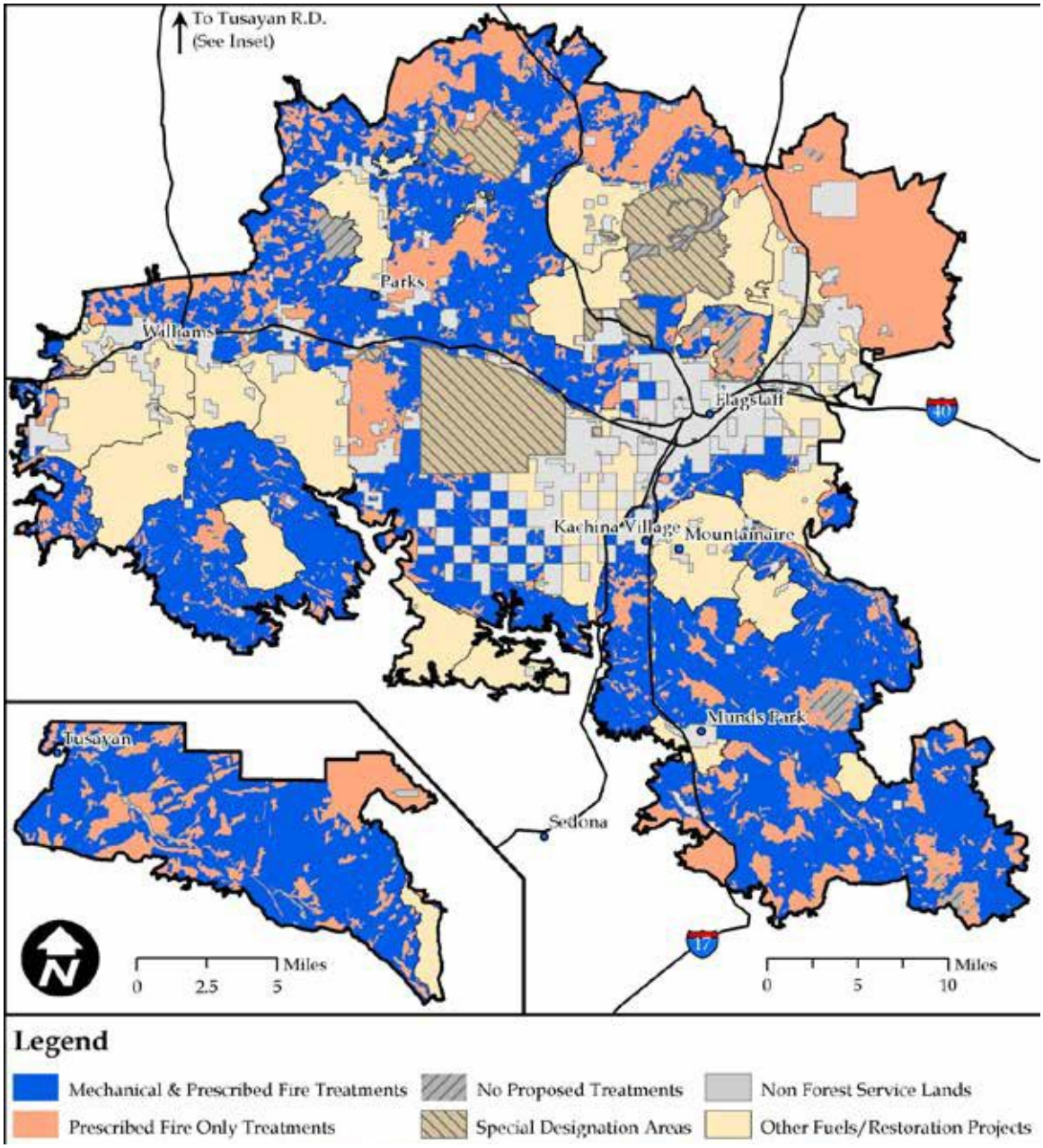

Figure 26. Alternative B general locations of mechanical and prescribed fire treatments

Table 18. Alternative B through D road activity miles by restoration unit (RU)

RU	Decommission		Temporary Road Construction and Decommission	Reconstruction –Relocation	Reconstruction –Improvement[8]
	Closed Roads	Unauthorized Roads	Temporary Roads		
1	205	0	110	2.2	8
3	100	77	166	2.8	9
4	185	33	198	1.1	9
5	280	0	27	0	3
6	0	24	15	3.3	1
Total	**770**	**134**	**517**	**10**	**30**

*Temporary roads that are constructed would be decommissioned once implementation is complete. Gates or other devices would be used as needed to manage motorized access during implementation.

Table 19. 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)	Aspen Restoration Prescribed Fire (Acres)	Aspen Restoration 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.

[8] Road reconstruction improvements are estimated miles for the restoration units.

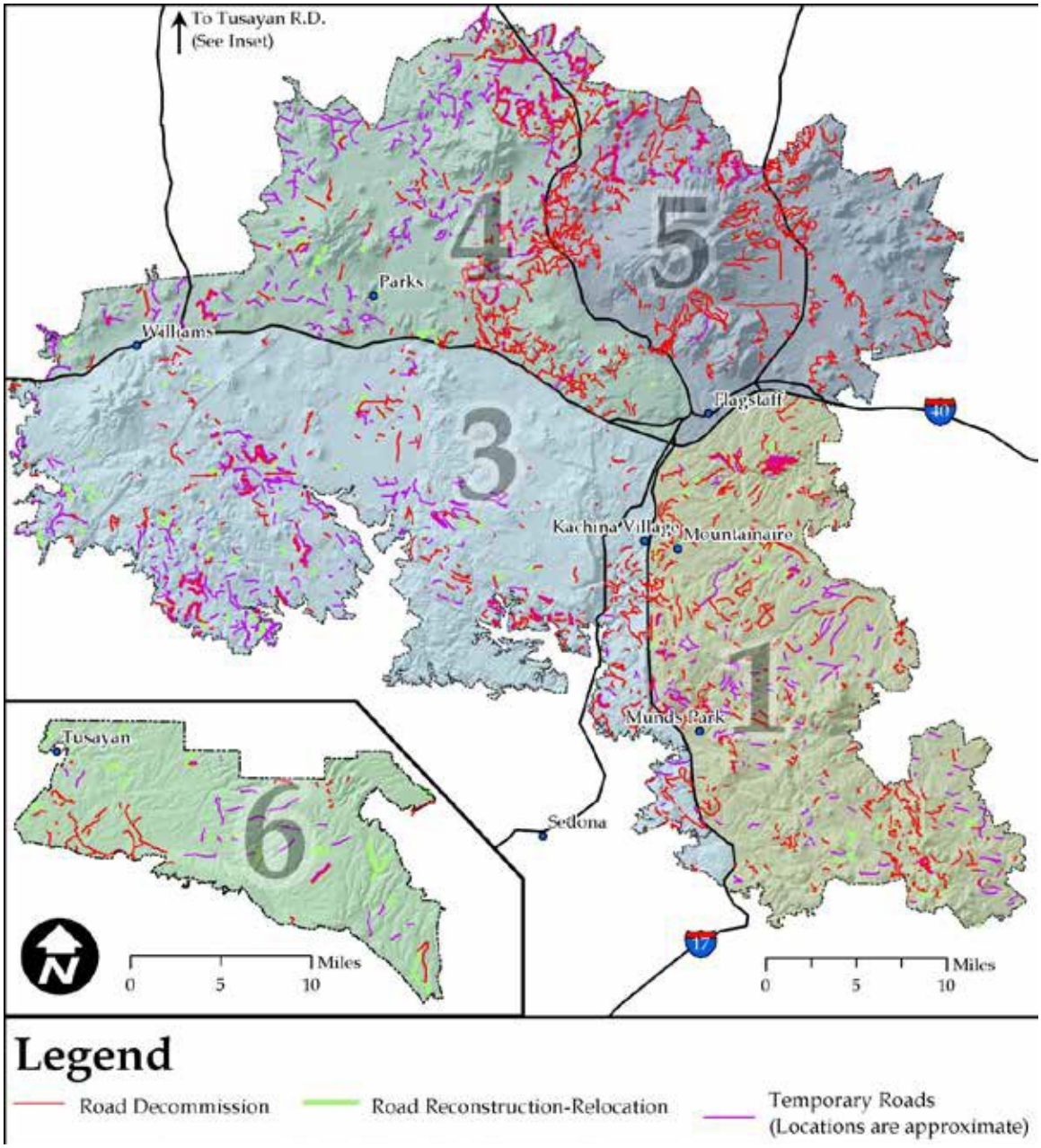

Figure 27. Alternative B–D general locations of road treatments

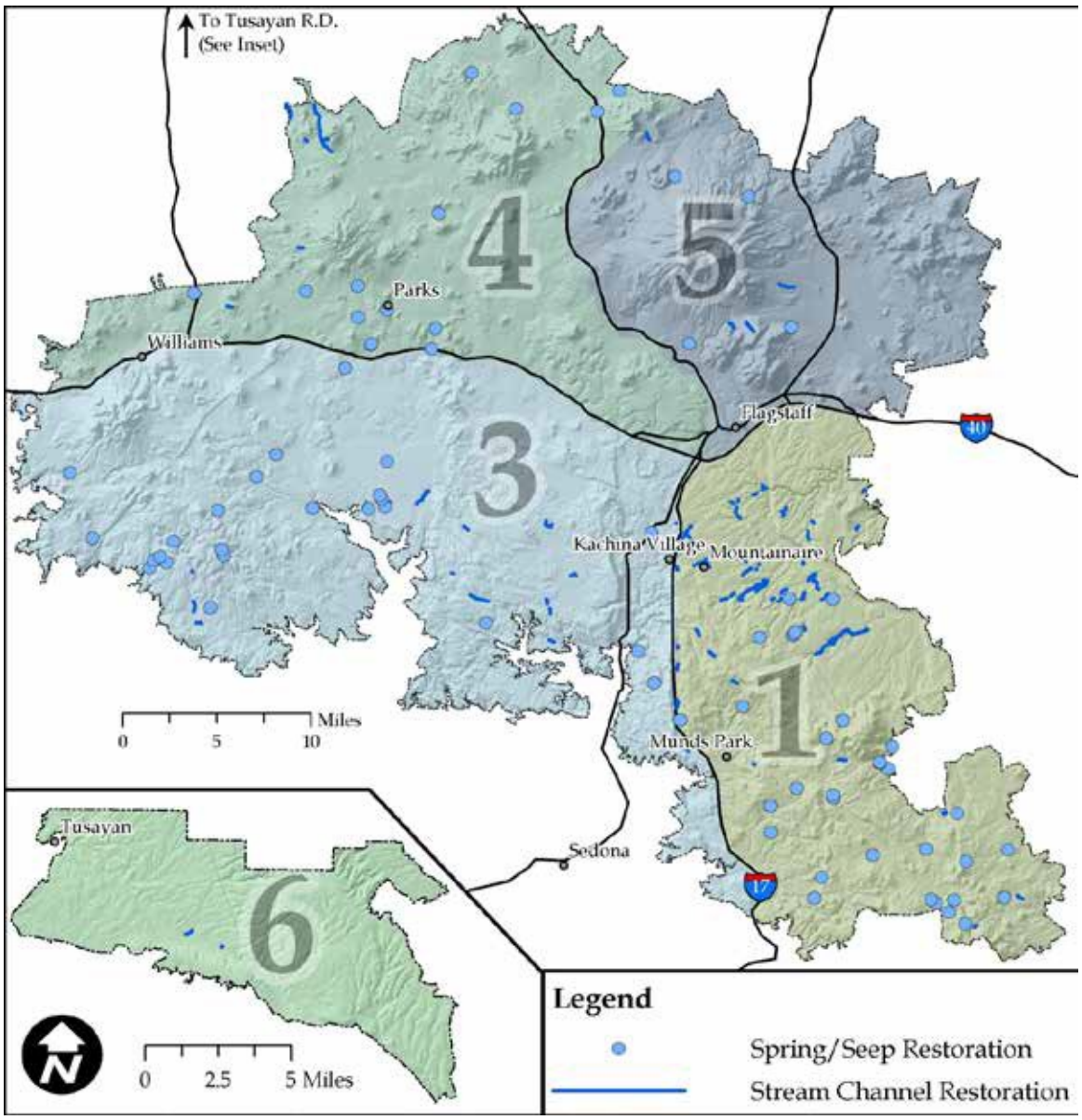

Figure 28. Alternative B–D general locations of spring and stream treatments

Table 20. Alternative B treatments in goshawk habitat

Treatment Type	Landscapes Outside of PFA (Acres)	Post-Fledgling Family Area (PFA) (Acres)	Dispersal Post-Fledgling Family Area (dPFA) (Acres)	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 C and D for details on design features and mitigation for treatments within goshawk habitat.

Table 21. Alternative B summary of treatments in Mexican spotted owl (MSO) habitat

Treatment Type*	Protected (Acres)	Restricted (Acres)	Target and Threshold (Acres)	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 C and D for details on design features and mitigation for treatments within MSO habitat.

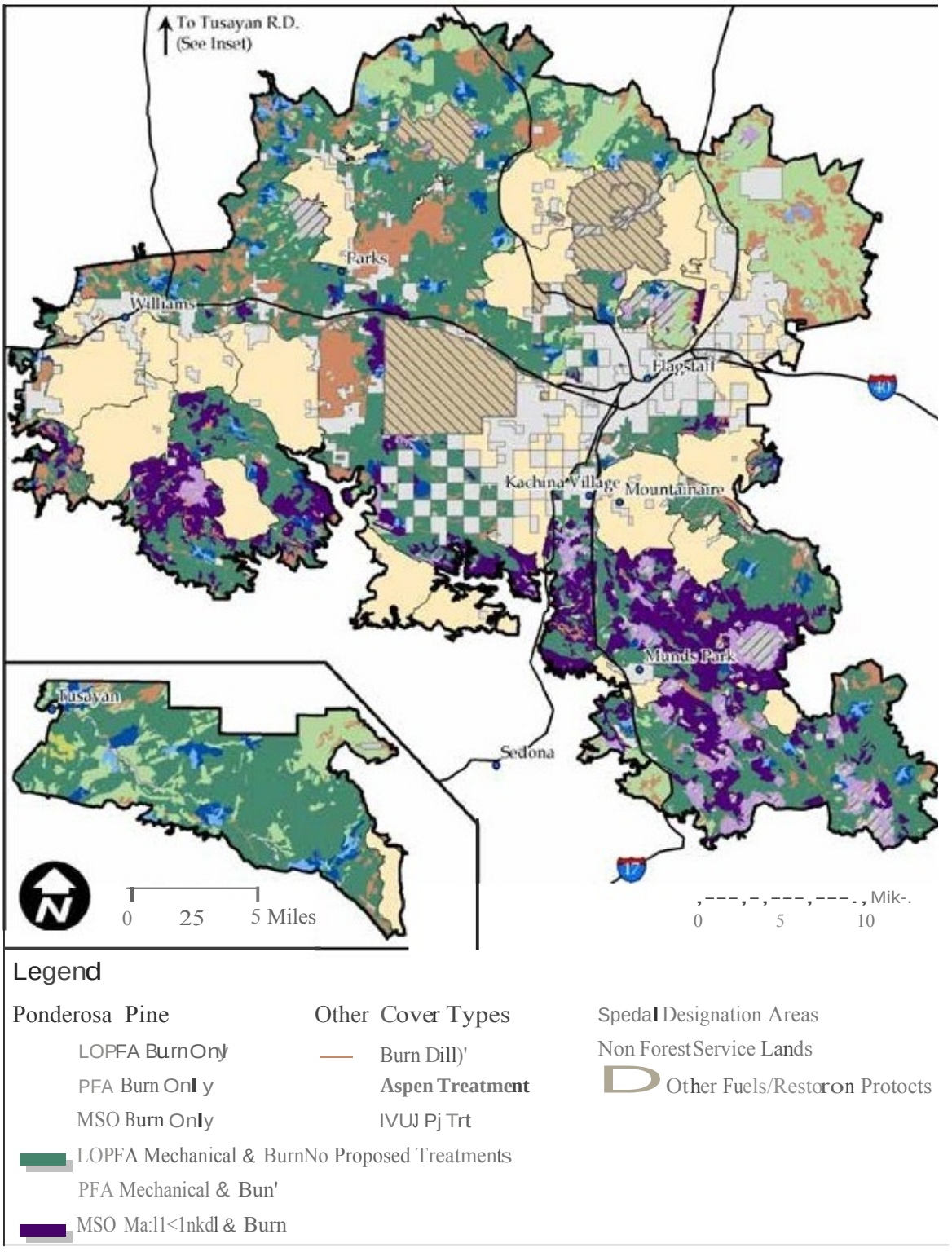

Figure:29. Alternative B mechanical and prescribed fire treatments in goshawk and MSO habitat

*LOPFA-Landscapes outside of PFAs.

Table 22. Alternative B–D 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	NA	65,189	NA	45	NA
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	NA	24,745	NA	40	NA
6	NA	41,188	NA	10,291	NA	25
Total	**322,772**	**189,407**	**128,994**	**65,810**	**40**	**35**

Table 23. Alternative B–D pinyon-juniper old growth allocation acres and percent by forest and restoration unit

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	NA	611	NA	54	NA
3	832	3,201	356	1,747	43	55
4	42	7,123	42	4,116	100	58
5	8,771	NA	7,302	NA	83	NA
6	NA	2,206	NA	1,452	NA	66
Total	**10,786**	**12,530**	**8,311**	**7,315**	**77**	**58**

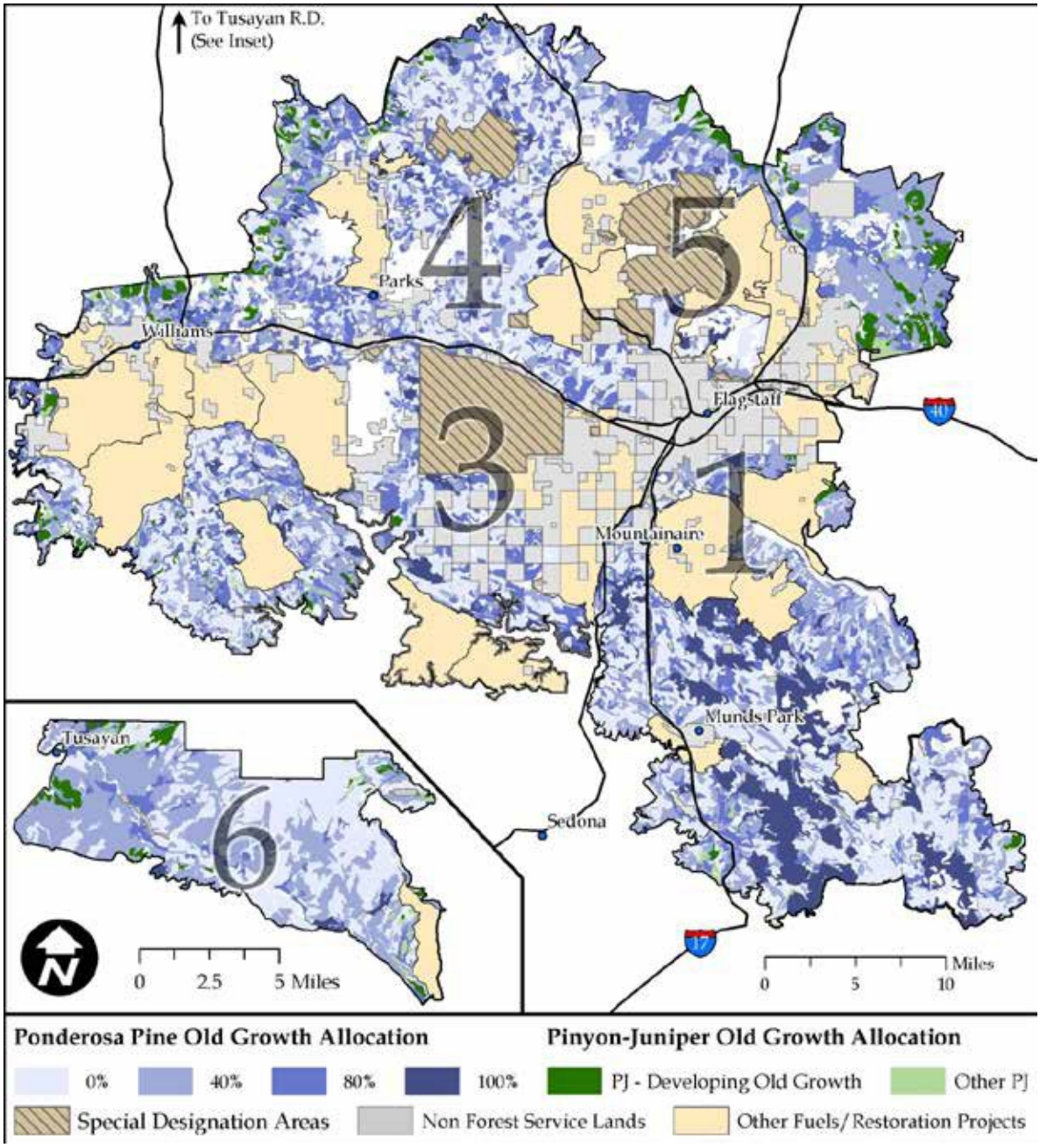

Figure 30. Alternative B–D ponderosa pine and pinyon-juniper old growth allocation

Alternative C (Preferred Alternative)

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. Up to 45,000 acres of vegetation would be mechanically treated annually. Up to 40,000 acres of prescribed fire would be implemented

annually across the forests. Two prescribed fires[9] would be conducted on all acres proposed for treatment over the 10-year period. Restoration activities would:

- Mechanically cut trees on approximately 434,001 acres. This includes: (1) mechanically treating up to 18-inch d.b.h. within 18 Mexican spotted owl protected activity centers, (2) cutting trees by hand on 99 acres on slopes greater than 40 percent, and (3) using low-severity prescribed fire within 72 Mexican spotted owl protected activity areas (including 56 core areas).
- Utilize prescribed fire only on approximately 159,211 acres.
- Construct 517 miles of temporary roads for haul access and decommission when treatments are complete (no new permanent roads would be constructed).
- Reconstruct up to 40 miles of existing, open roads for resource and safety concerns (no new permanent roads would be constructed). Of these miles, approximately 30 miles would be improved to allow for haul (primarily widening corners to improve turn radiuses) and about 10 miles of road would be relocated out of stream bottoms. Relocated roads would include rehabilitation of the moved road segment.
- Decommission 770 miles of existing system and unauthorized roads on the Coconino NF.
- Decommission 134 miles of unauthorized roads on the Kaibab NF.
- 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 woodland on the Kaibab NF.

Three nonsignificant forest plan amendments (see appendix B) would be required on the Coconino NF to implement alternative C:

Amendment 1 would allow mechanical treatments up to 18-inch d.b.h. to improve habitat structure (nesting and roosting habitat) in 18 MSO PACs. It would allow low-intensity prescribed fire within 56 MSO PAC core areas. The amendment would remove language that limits PAC treatments in the recovery unit to 10 percent increments and language that requires the selection of an equal number of untreated PACs as controls. The amendment would remove language referencing monitoring (pre- and post-treatment, population, and habitat). Replacement language would defer final project design and monitoring to the FWS biological opinion specific to MSO for the project.

The amendment, which is specific to restricted habitat in pine-oak, would allow for designating less than 10 percent of restricted habitat on the Coconino NF as target or

[9] The first prescribed fire may include pile burning followed by a broadcast burn.

threshold (i.e., future nesting and roosting habitat) based on the quality of the habitat. Definitions of target and threshold habitat would be added. It would allow 6,321 acres of restricted target and threshold habitat to be managed for a minimum range of 110 to 150 basal area.

Amendment 2 would add the desired percentage of interspace within uneven-aged stands to facilitate restoration in goshawk habitat (excluding nest areas), add the interspace distance between tree groups, add language clarifying where canopy cover is and is not measured, allow 29,017 acres to be managed for an open reference condition, and add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.

Amendment 3 would remove the cultural resource standard that requires achieving a "no effect" determination and would add the words "or no adverse effect" to the remaining standard. In effect, management would strive to achieve a "no effect" or "no adverse effect" determination.

Three nonsignificant forest plan amendments (see appendix B) would be required on the Kaibab NF to implement alternative C:

Amendment 1 would add the desired percentage of interspace within uneven-aged stands to facilitate restoration in goshawk habitat (excluding nest areas), add the interspace distance between tree groups, add language clarifying where canopy cover is and is not measured, allow 27,675 acres to be managed for an open reference condition, and add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.

Amendment 2 would allow for mechanically treating and using prescribed fire within approximately 400 acres of the proposed Garland Prairie Research Natural Area.

Amendment 3 would remove language that limits PAC treatments in the recovery unit to 10 percent increments and language that requires the selection of an equal number of untreated PACs as controls. The amendment would remove language referencing monitoring (pre- and post-treatment, population, and habitat). Replacement language would defer final project design and monitoring to the FWS biological opinion specific to MSO for the project.

The amendment, which is specific to restricted habitat in pine-oak, would allow for designating less than 10 percent of restricted habitat on the Kaibab NF as target or threshold (i.e., future nesting and roosting habitat) based on the quality of the habitat. Definitions of target and threshold habitat would be added. In restricted pine-oak habitat, it would allow 2,090 acres of restricted target and threshold habitat to be managed for a minimum range of 110 to 150 basal area.

Alternative C Tables and Figures

Table 24 describes mechanical and prescribed fire treatments and provides treatment acres. Figure 31 displays the general locations of mechanical and prescribed fire treatments.

Proposed roads, springs, ephemeral channels, and aspen treatments are the same as described in alternative B (see table 18 and table 19, and figure 27 and figure 28).

Table 25 and table 26 provide treatment type and acres in goshawk and MSO habitat. Figure 32 displays the general treatment locations in goshawk and MSO habitat.

Table 22 and table 23 display the old growth allocation acres by forest, restoration unit, and vegetation type. Figure 30 displays the general location of the old growth allocation.

The map packet in Appendix A provides all treatment maps at a larger scale for easier viewing

Table 24. 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. Accompanied by prescribed fire.	1,229
Prescribed Fire Only	Prescribed fire would be applied exclusively to move treated areas toward desired vegetation conditions.	159,211
Arizona Game and Fish Research	Mechanical treatment designed to create groups of various sizes ranging from 1 to 15 acres in size. Accompanied by prescribed fire.	4,837
Grassland Restoration	Mechanical treatment that removes encroaching post-settlement conifers and manages for up to 90 percent of the treatment area as grass/forb/shrub using pre-settlement tree evidence as guidance. Accompanied by prescribed fire.	11,230
Grassland Mechanical	Mechanical treatment in grassland vegetation types. Accompanied by prescribed fire.	48,161
Intermediate Thin (IT) 10 (10 to 25% interspace)	Mechanical treatment that thins tree groups and establishes interspace adjacent to tree groups to an average of 70–90 square feet of basal area and manages for improved tree vigor and growth by retaining the best growing dominant and codominant trees with the least amount of mistletoe; interspace would occupy 10–55 percent of the treatment area, respectively. Accompanied by prescribed fire.	7,766
Intermediate Thin (IT) 25 (25 to 40% interspace)		11,858
Intermediate Thin (IT) 40 (40 to 55% interspace)		39,039
MSO Threshold	Same as MSO Target	1,894
MSO Target	Intermediate thinning (IT) designed to improve forest health, reduce fire risk, and meet forest density, structure, and species composition requirements. Accompanied by prescribed fire.	6,516
MSO Restricted	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, irregular tree spacing, a mosaic of interspaces, and tree groups of varying sizes. Accompanied by prescribed fire.	63,191
MSO PAC	Mechanical treatment designed to increase tree vigor and health and create canopy gaps to reduce fire risk. Accompanied by prescribed fire.	10,741
MSO PAC Grassland Mechanical	Mechanical treatment designed to reestablish the historic meadow edge as defined by the current forest structure of young trees encroaching around the meadow edge; retain large trees with long-lived characteristics. Accompanied by prescribed fire.	35

Treatment Type	Treatment Description/Objective	Acres
Pine-Sage	Mechanical treatment that restores pre-settlement tree density and pattern using pre-settlement tree evidence as guidance. Accompanied by prescribed fire.	5,261
Savanna (70 to 90% interspace)	Mechanical treatment that restores pre-settlement tree density and pattern, and manages for a range of 70–90 percent of the treatment area as interspace (grass/forb) between tree groups or individual trees using pre-settlement tree evidence as guidance. Treatment would be accompanied by prescribed fire.	45,462
Stand Improvement (SI) 10 (10 to 25% interspace)	Mechanical treatment that establishes tree groups and interspace adjacent to tree groups and manages for improved tree vigor and growth by retaining the best growing dominant and codominant trees within each group; interspace would occupy 10–55 percent of the treatment area, respectively. Treatments would be accompanied by prescribed fire.	1,914
Stand Improvement (SI) 25 (25 to 40% interspace)		6,824
Stand Improvement (SI) 40 (40 to 55% interspace)		12,244
Uneven-aged (UEA) 10 (10 to 25% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 10–25 percent of the treatment area. Accompanied by prescribed fire.	18,109
Uneven-aged (UEA) 25 (25 to 40% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 25–40 percent of the treatment area. Accompanied by prescribed fire.	39,176
Uneven-aged (UEA) 40 (40 to 55% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 40–55 percent of the treatment area. Accompanied by 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. Accompanied by prescribed fire.	535
Wildland-Urban Interface (WUI) (55 to 70% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 55–70 percent of the treatment area. Accompanied by prescribed fire.	2,268

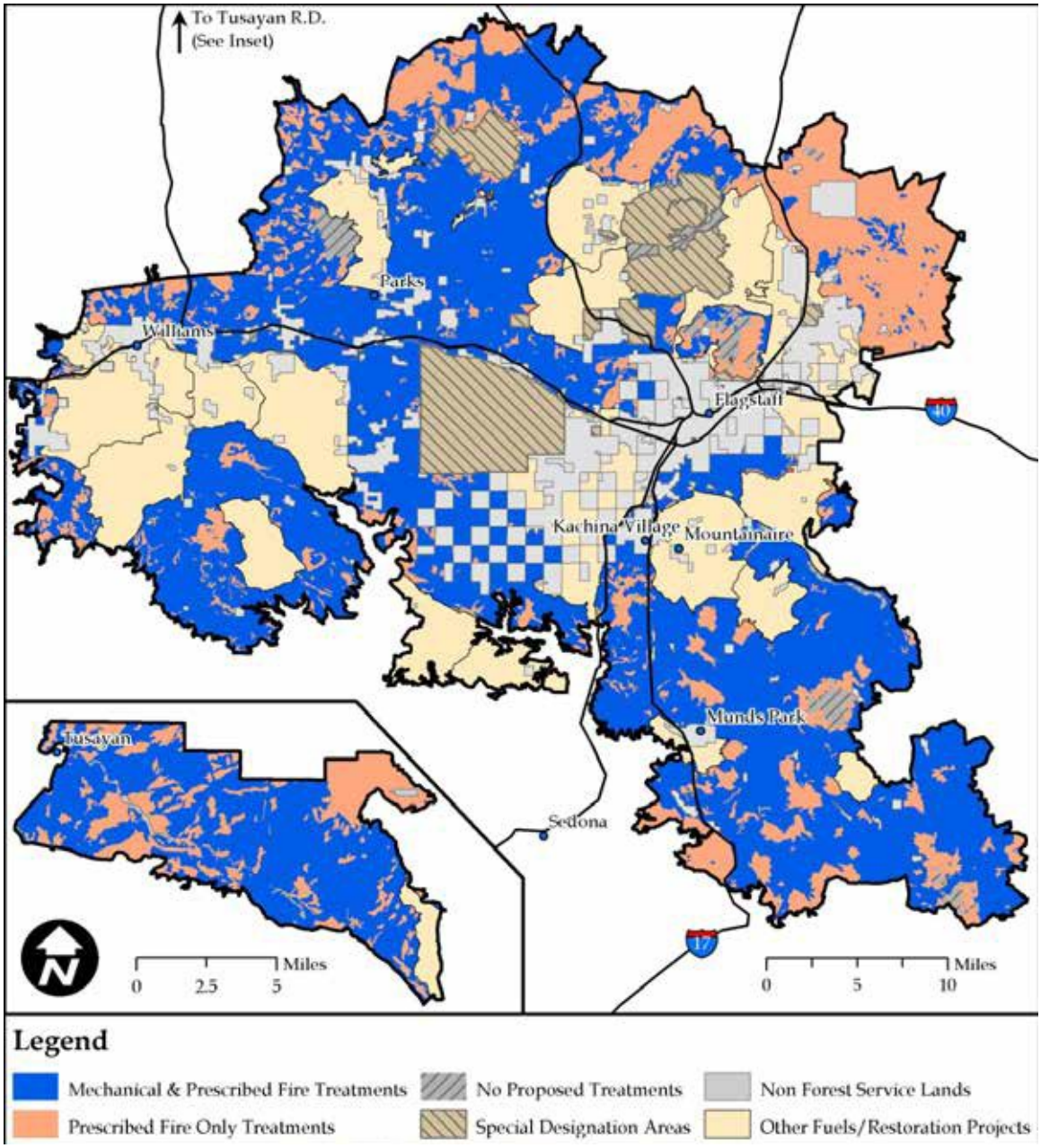

Figure 31. Alternative C mechanical and prescribed fire treatments

Table 25. Alternative C treatments in goshawk habitat

Vegetation Treatment Type	Landscapes Outside of PFA (Acres)	Post-Fledgling Family Area (PFA) (Acres)	Dispersal Post-Fledgling Family Area (dPFA) (Acres)	Total Acres by Treatment Type
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	45,462	0	0	45,462
Grassland restoration within ponderosa pine	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 C and D for details on how treatments would be designed within goshawk habitat.

Table 26. Alternative C Treatments in Mexican spotted owl (MSO) Habitat

Treatment Type*	Protected Habitat (Acres)	Restricted Habitat (Acres)	Target/Threshold Habitat (Acres)	Total Treatment Acres
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 C and D for details on how treatments would be designed within MSO habitat.

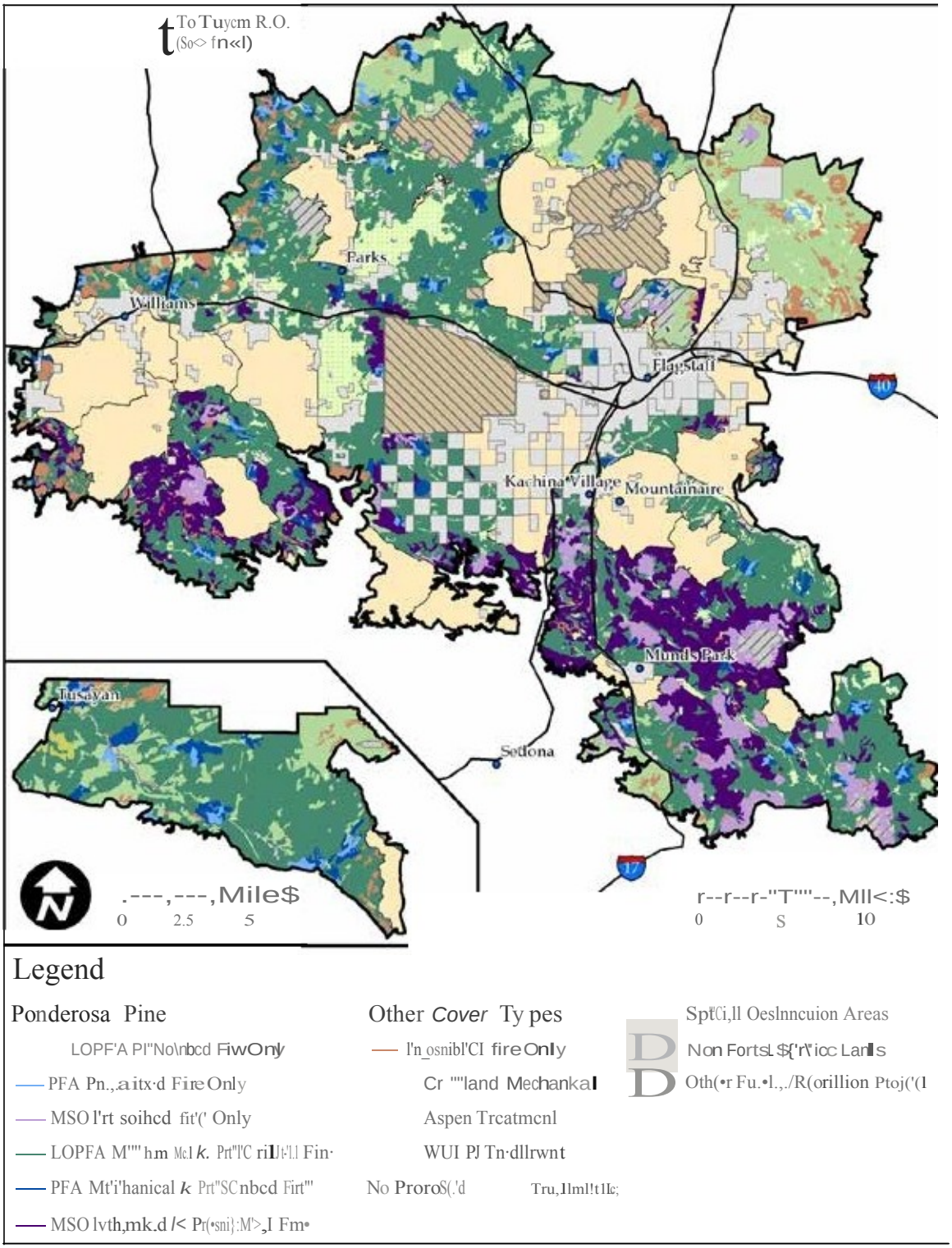

Figure32.Alternative C mechanicaland prescribed firetreatments in goshawk and MSO habitat

*LOPFA -landscapes outside of goshawk PFAs.

Alternative D

Alternative D responds to Issue 2 (prescribed fire emissions) by decreasing prescribed fire acres by 30 percent when compared to alternative B (proposed action). A select number of MSO PACs would be mechanically treated but would not be treated with prescribed fire. All other components of the alternative are the same as described in alternative B.

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. Up to 45,000 acres of vegetation would be mechanically treated annually. Restoration activities would:

- Mechanically cut trees on approximately 388,489 acres. This includes: (1) mechanically treating up to 16-inch d.b.h. within 18 Mexican spotted owl protected activity centers, (2) cutting 99 acres of trees by hand on slopes greater than 40 percent, and (3) disposing of slash through various methods including chipping, shredding, mastication, and removal of biomass offsite.
- Utilize prescribed fire only on approximately 178,790 acres. Up to 40,000 acres of prescribed fire would be implemented annually across the forests. Two prescribed fires would occur over the 10-year treatment period.
- Construct 517 miles of temporary roads for haul access and decommission when treatments are complete (no new permanent roads would be constructed).
- Reconstruct up to 40 miles of existing, open roads for resource and safety concerns (no new permanent roads would be constructed). Of these miles, approximately 30 miles would be improved to allow for haul (primarily widening corners to improve turn radiuses) and about 10 miles of road would be relocated out of stream bottoms. Relocated roads would include rehabilitation of the moved road segment.
- Decommission 770 miles of existing system and unauthorized roads on the Coconino NF.
- Decommission 134 miles of unauthorized roads on the Kaibab NF.
- 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.

Three nonsignificant forest plan amendments (see appendix B) would be required on the Coconino NF to implement alternative D:

Amendment 1 would add language to allow mechanical treatments up to 16-inch d.b.h. to improve habitat structure (nesting and roosting habitat) in 18 MSO PACs. The amendment would remove language that limits PAC treatments in the recovery unit to 10 percent increments and language that requires the selection of an equal number of untreated PACs as controls. The amendment would remove language referencing monitoring (pre- and post-

treatment, population, and habitat). Replacement language would defer final project design and monitoring to the FWS biological opinion specific to MSO for the project.

The amendment, which is specific to restricted habitat in pine-oak, would allow for designating less than 10 percent of restricted habitat on the Coconino NF as target or threshold (i.e., future nesting and roosting habitat) based on the quality of the habitat. Definitions of target and threshold habitat would be added.

Amendment 2 would add the desired percentage of interspace within uneven-aged stands to facilitate restoration in goshawk habitat (excluding nest areas), add the interspace distance between tree groups, add language clarifying where canopy cover is and is not measured, allow 29,017 acres to be managed for an open reference condition, and add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.

Amendment 3 would remove the cultural resource standard that requires achieving a "no effect" determination and would add the words "or no adverse effect" to the remaining standard. In effect, management would strive to achieve a "no effect" or "no adverse effect" determination.

Two nonsignificant forest plan amendments (see appendix B) would be required on the Kaibab NF to implement alternative D:

Amendment 1 would add the desired percentage of interspace within uneven-aged stands to facilitate restoration in goshawk habitat (excluding nest areas), add the interspace distance between tree groups, add language clarifying where canopy cover is and is not measured, allow 27,637 acres to be managed for an open reference condition, and add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.

Amendment 2 would allow for designating less than 10 percent of restricted habitat in pine-oak as target or threshold (i.e., future nesting and roosting habitat) based on the quality of the habitat. The amendment would remove language that limits PAC treatments in the recovery unit to 10 percent increments and requires the selection of an equal number of untreated PACs as controls. The amendment would also remove language that references monitoring (pre- and post-treatment, population, and habitat). Replacement language would defer final project design and monitoring to the FWS biological opinion specific to MSO for the project.

Alternative D Tables and Figures

Table 17 describes treatments and provides treatment acres. Figure 33 displays the general locations of mechanical and prescribed fire treatments.

Table 18 (see alternative B) provides acres by road treatment type and restoration unit. Figure 27 displays the general locations of road treatments.

Table 19 (see alternative B) provides acres of springs, channels, and aspen treatments by restoration unit. Figure 28 displays the general locations for these treatments.

Table 22 and table 23 (see alternative B) display the old growth allocation acres by forest, restoration unit, and vegetation type. Figure 30 displays the general location of the old growth allocation.

Table 28 and table 29 provide treatment type and acres in goshawk and MSO habitat. Figure 34 displays the general treatment locations.

The map packet in appendix A provides treatment maps at a larger scale for easier viewing.

Table 27. 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	Prescribed fire would be applied exclusively to move treated areas toward desired vegetation conditions.	178,790
Grassland Restoration	Mechanical treatment that remove encroaching post-settlement conifers and manages for up to 90 percent of the treatment area as grass/forb/shrub using pre-settlement tree evidence as guidance.	11,185
Intermediate Thin (IT) 10 (10 to 25% interspace)	Mechanical treatment that thins tree groups and establishes interspace adjacent to tree groups to an average of 70–90 square feet of basal area and manages for improved tree vigor and growth by retaining the best growing dominant and codominant trees with the least amount of mistletoe; interspace would occupy 10–55 percent of the treatment area, respectively.	7,766
Intermediate Thin (IT) 25 (25 to 40% interspace)		11,871
Intermediate Thin (IT) 40 (40 to 55% interspace)		39,189
MSO Threshold	Same as MSO Target	1,894
MSO Target	Intermediate thinning (IT) designed to improve forest health, reduce fire risk, and meet forest density, structure, and species composition requirements.	6,518
MSO Restricted	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, irregular tree spacing, a mosaic of interspaces, and tree groups of varying sizes.	65,024
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 pre-settlement tree evidence as guidance.	5,261
Savanna (70 to 90% interspace)	Mechanical treatment that restores pre-settlement tree density and pattern and manages for a range of 70–90 percent of the treatment area as interspace (grass/forb) between tree groups or individual trees using pre-settlement tree evidence as guidance.	45,469
Stand Improvement (SI) 10 (10 to 25% interspace)	Mechanical treatment that establishes tree groups and interspace adjacent to tree groups and manages for improved tree vigor and growth by retaining the best growing dominant and codominant trees within each group; interspace would occupy 10–55 percent of the treatment area, respectively.	1,914
Stand Improvement (SI) 25 (25 to 40% interspace)		6,824
Stand Improvement (SI) 40 (40 to 55% interspace)		12,309
Uneven-aged (UEA) 10 (10 to 25% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 10–25 percent of the	18,204

Treatment Type	Treatment Description/Objective	Acres
	treatment area.	
Uneven-aged (UEA) 25 (25 to 40% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 25–40 percent of the treatment area.	39,244
Uneven-aged (UEA) 40 (40 to 55% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 40–55 percent of the treatment area.	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 to 70% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 55–70 percent of the treatment area.	2,268

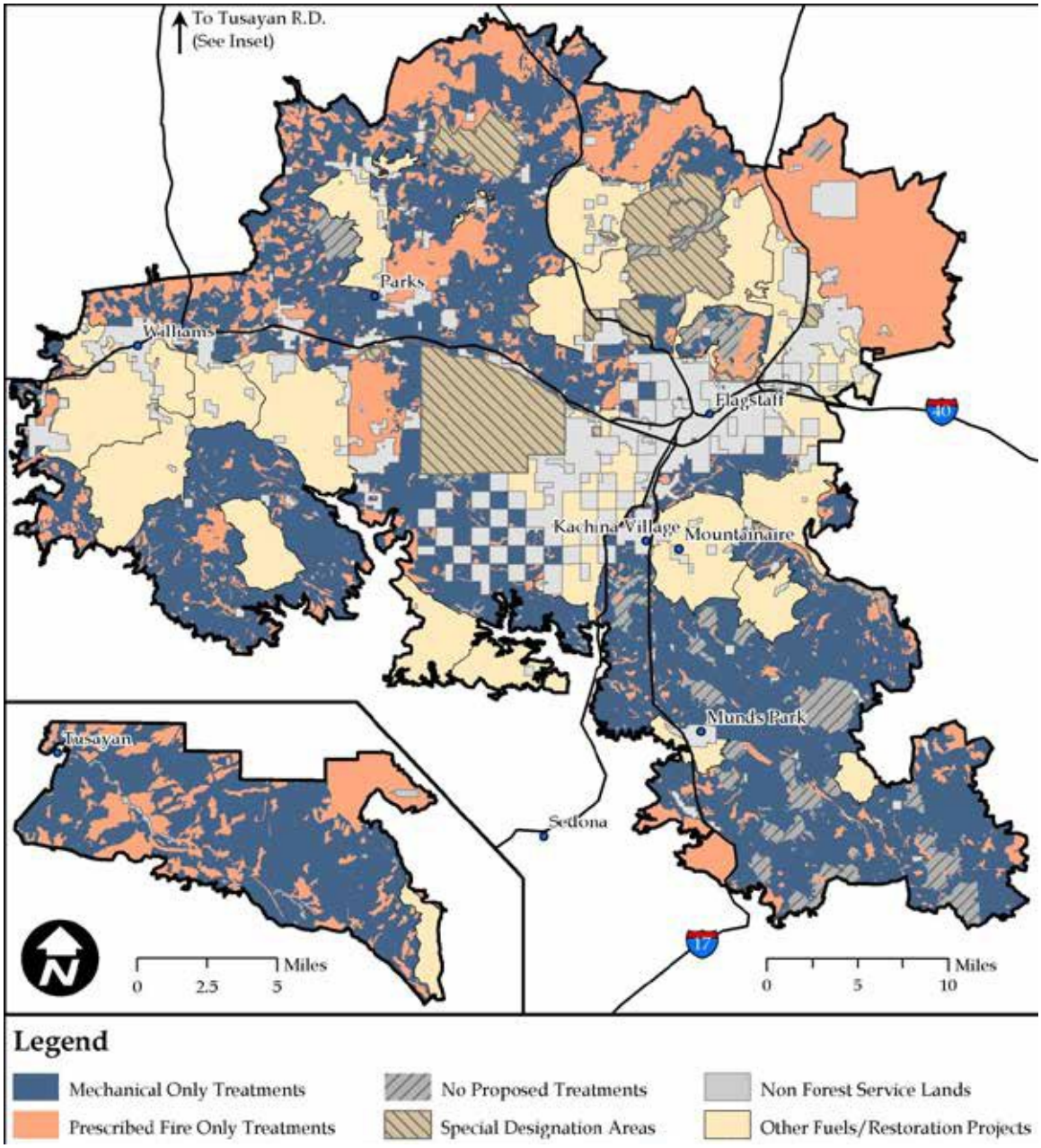

Figure 33. Alternative D mechanical and prescribed fire treatments

Table 28. Alternative D treatments in goshawk habitat

Vegetation Treatment Type	Landscapes Outside of PFA (Acres)	Post-Fledgling Family Area (PFA) (Acres)	Dispersal Post-Fledgling Family Area (dPFA) (Acres)	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 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 C and D for details on how treatments would be designed within goshawk habitat.

Table 29. Alternative D treatments in MSO habitat

Treatment Type*	Protected Habitat (Acres)	Restricted Habitat (Acres)	Target and Threshold Habitat (Acres)	Total Treatment Acres
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 C and D for details on how treatments would be designed within MSO habitat.

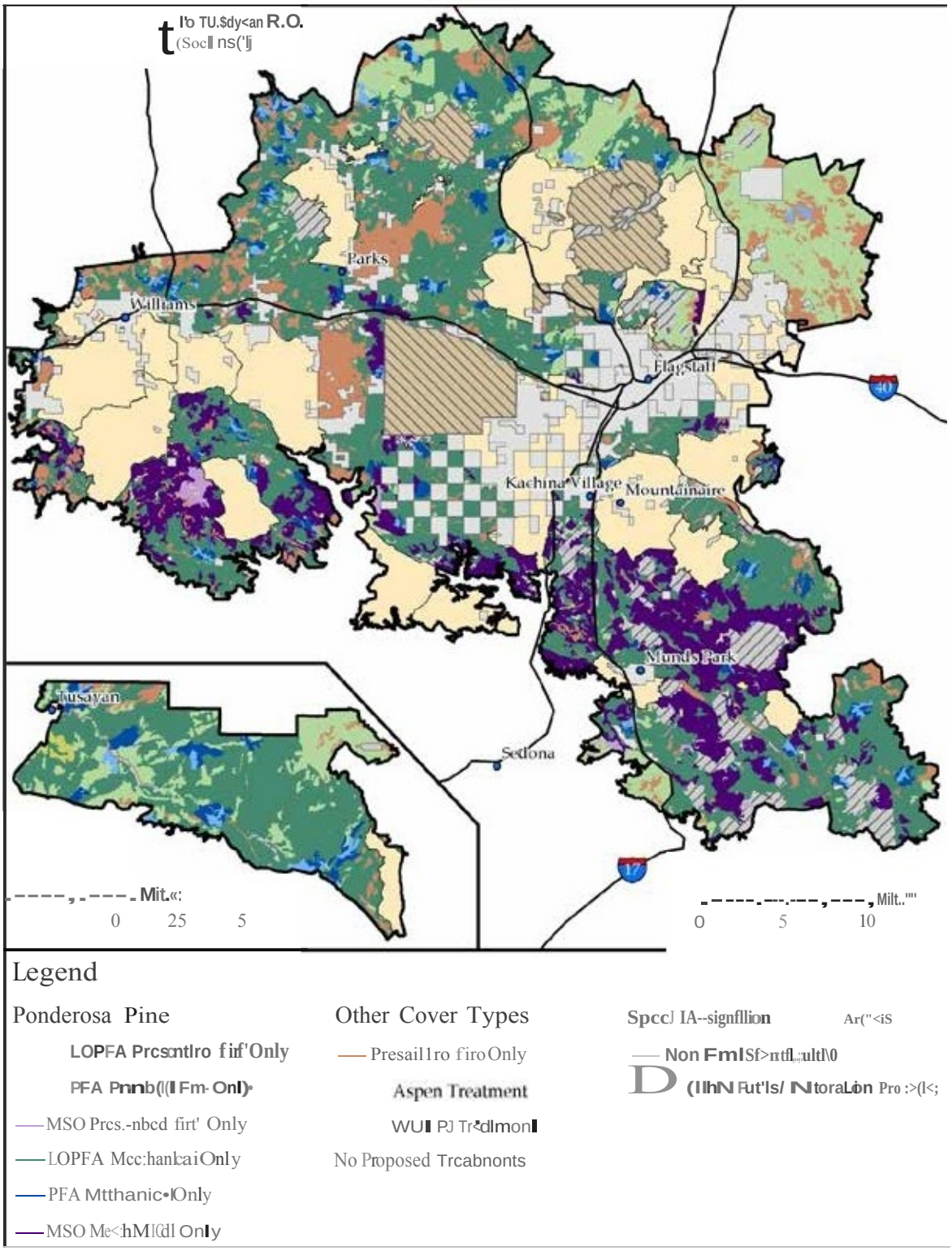

Figure34. Alternative D mechanical and prescribed fire treatments in goshawk and MSO habitat

*LOPFA -landscapes oulside of goshawk PFAs.

Comparison of Alternatives

Table 30 provides a summary of the alternatives and table 31 describes potential effects of implementing each alternative considered in detail. Information in this 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 30. Summary of alternatives analyzed in detail

Proposed Activity	Alt. A (No Action)	Alt. B (Proposed Action)	Alt. C	Alt. D
Vegetation Mechanical Treatment (acres)	0	388,489	434,001	388,489
Prescribed Fire (acres)	0	587,923	593,211	178,790
Mexican Spotted Owl (MSO) Protected Activity Centers (PACs) Habitat Treatments	NA	Mechanically treat up to 16-inch d.b.h. in 18 PACs (excluding core areas). Utilize prescribed fire in 72 MSO PACs (excluding core areas).	Mechanically treat up to 18-inch d.b.h. in 18 PACs. Utilize prescribed fire in 56 MSO PACs (including core areas). Utilize prescribed fire in 16 MSO PACs (excluding core areas).	Mechanically treat up to 16-inch d.b.h. in 18 PACs (excluding core areas). Utilize prescribed fire in 72 MSO PACs (excluding core areas).
Springs Restored (number)	0	74	Same as alternative B	
Springs Protective Fence Construction (miles)	0	Up to 4	Same as alternative B	
Aspen Protective Fencing (miles)		Up to 82	Same as alternative B	
Ephemeral Stream Restoration (miles)	0	39	Same as alternative B	
Temporary Road Construction and Decommission (miles)	0	517	Same as alternative B	
Road Reconstruction-Improvement (miles)	NA	Up to 30	Same as alternative B	
Road Relocation (miles)	NA	Up to 10	Same as alternative B	
Existing Road Decommission (miles)	NA	770	Same as alternative B	
Unauthorized Route Decommission (miles)	NA	134	Same as alternative B	

Table 31. Comparison of alternatives

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D
Vegetation Structure and Pattern						
Age and Size Class	Even-aged: 46%	Move even-aged stands toward an uneven-aged structure. There is a distribution of age-classes that comprise a sustainable balance of vegetation structural stages (VSS).	Alternative A does not meet the desired condition with even-aged stands remaining even aged.	Alternatives B–D meet the desired condition with even-aged stands trending toward uneven-aged.		
	Uneven-aged: 54%		Alternative A does not meet the desired conditions with uneven-aged stands trending toward even aged.	Alternatives B–D meet the desired condition with uneven-aged being maintained as uneven-aged.		
	Dominant representation is in the young (VSS 2) and mid-aged (VSS 3) structural stages		In all alternatives (immediately post-treatment), the dominant representation is 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 **Indicators:** **High** –Treatment acres with a high potential to attain desired conditions **Moderate** – Treatment areas with moderate potential to attain desired conditions **Low to Very Low** – Treatment acres with low or very low potential to attain desired conditions	Continuous tree canopy with generally small interspaces.	Mosaic of interspaces and tree groups of varying sizes and shapes.	Similar to existing. Trending toward a reduction of interspaces .	**Treatment acres (and percent) with relative ability to attain mosaic of interspaces and tree groups ranging from very low to high:**		
				Very Low: 47,157 (9%)	Very Low: 52,007 (10%)	Very Low: 27,182 (6%)
				Low: 120,363 (24%)	Low: 126,074 (25%)	Low: 120,327 (25%)
				Moderate: 122,963 (24%)	Moderate: 121,050 (24%)	Moderate: 122,963 (25%)
				High: 216,725 (43%)	High: 211,215 (41%)	High: 216,762 (44%)
Heterogeneity: Percent of landscape openness within ponderosa pine ranging from very open to closed or unknown	Very Open: 22% Open: 22% Moderately Closed: 29% Closed: 45% Unknown: 3%	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 closed to unknown:**		
				Very Open: 11	Very Open: 11	Very Open: 11
				Open: 31	Open: 30	Open: 31
				Moderately Closed: 42	Moderately Closed: 42	Moderately Closed: 42
				Closed: 15	Closed: 17	Closed: 11
				Unknown: 1	Unknown: 0	Unknown: 5

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D
Large/Old Tree Structure	VSS 5 and VSS 6 (large and old trees) are underrepresented across the landscape.	Uneven-aged and composed of a distribution of age classes that comprise a sustainable balance of structural stages. Manage for old age (pre-settlement) trees such that old forest structure is sustained over time across the landscape.	Over time, old growth conditions improve in terms of meeting the minimum criteria but the sustainability of large/old trees may be impaired by density-related mortality and forest health issues.	The MSO, goshawk, old growth, and forest health analysis indicates sustainability of the large/old tree component across the landscape would be improved.		
Forest Health						
Stand Density	Percent of maximum SDI by Habitat:	Density is below the zone where density-related mortality is prevalent (<56% of maximum SDI). Managed, uneven-aged forests range from 15–40% of maximum SDI.	**Percent of maximum SDI by habitat (the desired condition is to have <56 of maximum SDI—habitats meeting the desired condition is displayed in bold text):**			
	MSO Protected: 78		MSO Protected: 80	MSO Protected: 72	MSO Protected: 71	MSO Protected: 74
	MSO Target/Threshold: 85		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		**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**

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D
Insect and Disease Beetle hazard rating (percent of landscape) ranging from low to extreme	Low: 8 Moderate: 21 High: 71	Forest conditions are resilient to insect and disease. Insect and disease populations are at endemic levels. Beetle hazard ratings range from low to moderate	**Beetle hazard rating (percent) (the desired condition is to have ratings range from low to moderate—conditions meeting the desired are displayed in bold text):**			
			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 that favor oak growth and establishment	**Treatment acres that would actively reduce pine-oak competition:**			
			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).	Restore grasslands. Enhance historic grassland inclusions within greater forested area including MSO restricted, goshawk PFA, and	**Acres of grassland enhanced and/or restored within: (1) encroached grasslands, (2) historic grasslands, (3) pine with an open reference condition, and (4) goshawk PFA, non-PFA, and MSO restricted habitat:**			
			0	(1) 0	(1) 48,196	0
			0	(2) 11,185	(2) 11,230	(2) Same as alt. B
	14,665 acres departed from		0	(3) 45,469	(3) Same as alternative B	

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D
	historic grassland conditions	non-PFA (LOPFA*) habitats.				
	309,926 acres of ponderosa pine with an open reference conditions (mollic-integrade soils).		0	(4)310,917	(4) 308,199	(4) 305,657
Pine-Sage	16,000 acres of pine-sage potential vegetation	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, C, and 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
Forest Resiliency and Sustainability – Fire Behavior						
Crown Fire	34%	Up to 10%	35% (2020)	5% (2020)	4% (2020)	7% (2020)
Surface fire	64% 2% (NA – not burnable)	90%	64% (2020) 1% NA – not burnable	94% (2020) 1% NA – not burnable	94% (2020) 2% NA – not burnable	92% (2020 1% NA – not burnable
Fire Regime Condition Class (FRCC)	14% FRCC 1 27% FRCC 2 59% FRCC 3	100% FRCC 1 0% FRCC 2 0% FRCC 3	11% FRCC 1 19% FRCC 2 70% FRCC 3	18% FRCC 1 78% FRCC 2 4% FRCC 3	19% FRCC 1 81% FRCC 2 0% FRCC 3	8% FRCC 1 82% FRCC 2 10% FRCC 3

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D
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 FRCC of 3 into the foreseeable future. There would be no movement toward resiliency and improved function. Alternatives B, C, and D move toward FRCC desired conditions in the short term (2020). Alternatives B, C, and D meet crown and surface fire desired conditions in the short term (2020). Movement toward the desired conditions in Alternatives B, C, and D equates to movement toward improved resiliency and function.					
Watershed Function						
Overall Watershed Condition (within the analysis area)	22% functioning properly, 46% functioning at risk, 32% impaired.	Moving toward or at functioning properly.	Having high percentages of functioning at risk and impaired watersheds continues.	**Alternatives B and C**: 23% of functioning at risk watersheds (i.e., nearly ¼ of the 58% that are currently functioning at risk would move toward functioning properly) and 42% of impaired watersheds would improve (i.e., 42% of the current 22% impaired would move toward functioning properly). Under alternative D, 18% of functioning at-risk watersheds (i.e., nearly 1/5th of the 58% that are currently functioning at risk would move toward functioning properly) and 34% of impaired watersheds (i.e., about a 1/3rd of the 22% that are currently impaired would move toward functioning properly) would improve. **Alternative D** would not improve overall watershed condition as extensively as alternatives B and C. Approximately 496 miles of road are decommissioned in functioning at-risk watersheds and 226 miles in impaired function watersheds. Stream channel treatments improve waterflow regime on 19 miles of functioning at risk and 9 miles in impaired watersheds.		
Ephemeral Channels	Reduced function in 39 miles of degraded channel.	Proper functioning condition.	Static to downward trend in function over time.	Alternatives B–D: Disturbance would range from 2 to 108 acres in subwatersheds (1% of treatment area). Potential short-term increases in sediment production that could adversely impact surface water quality and riparian conditions are 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.	Alternatives B–D: A slight increase in groundwater recharge and spring discharge would be expected in years 1 to 3. Long-term hydrologic response would be 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.		

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D
Water Quantity	Water yield in ponderosa pine is likely reduced from historic conditions due to forest ingrowth and dense stand conditions resulting in increased yearlong evapotrans-piration rates.	Increased streamflow as measured at stream gages installed at locations downstream of proposed treatment area.	No change. There is the potential for increased storm water runoff and flooding downstream of areas burned in wildfires.	Water yield would be expected to increase only slightly in areas where vegetation treatments remove 25 to 50 percent of the overall tree canopy cover within a given watershed (Troendle et al. 2001, Burton 1997, Swank 1989, Baker 1999, 2003, Ffolliott et al. 1989, Miller 2007). Snow interception by tree canopies would be reduced, leading to increased snowpack in forest openings.	Water yield would be expected to be slightly higher than under alternative B. There would be more forest openings and less dense forest conditions. Snow interception by tree canopies would be reduced, increasing the winter snowpack.	Same as alternative B.
Surface Water Quality	There are no impaired streams within the project area. A segment of Oak Creek (0.25 mile) is outside of the project boundary, downstream of the treatment area, and listed as impaired.	Meet Arizona Department of Environmental Quality (ADEQ) water quality standards.	No change. There would be the potential for adverse effects from wildfire.	Short-term adverse impacts from soil disturbance would average 3.3% at the 6th code HUC scale. There would be long-term improvement.	Short-term adverse impacts from soil disturbance would average 3.4% at 6th code HUC scale. There would be long-term improvement.	Short-term adverse impacts from soil disturbance would average 2.9% at 6th code HUC level. There would be long-term improvement.

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D
Riparian Areas	There is reduced water yield. Ponderosa pine is compromising the integrity of riparian areas by reducing spring discharge rates and stream channel flow.	Vegetation, landforms, soil condition, and woody debris dissipate water energy, filter sediment, capture bedload, and contribute to favorable flood plain development. There is improved floodwater retention and groundwater recharge.	Reduced riparian area and wetland function are possible under alternative A.	Riparian and wetland function would improve through increased groundwater recharge, improved surface flows, and spring restoration.	Riparian and wetland function would improve slightly more than under alternatives B and D since more acres would receive mechanical vegetation treatments than in alternative B.	Riparian and wetland function would improve under alternative D, but to a lesser degree than under alternatives B and C. Fewer acres would receive prescribed fire. Fire would have reduced vegetative cover which would reduce rainfall interception, and evapotranspirational losses.

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D
Soil Productivity and Function						
Soil Erosion/Soil Productivity	See chapter 3 "Soils" section and soils report for details.	Long-term soil productivity is protected by maintaining or improving soil condition and function. Soil condition and function is maintained or improved toward satisfactory. Maintain soil disturbance below target threshold level (15%). See chapter 1 for detailed desired conditions	Soil disturbance would range from 0 to 33% due to fire risk. There would be no improvement or protection of soil condition and productivity.	Alternatives B–D: No watershed would have soil disturbance above 11%, which is 4% below the 15% threshold. Therefore, soil productivity should be maintained at the watershed level. Thinning stands and prescribed burning would increase understory response on about 388,500 acres. Using prescribed fire only on about 199,400 acres would decrease wildfire threat and improve soil condition and productivity on about 587,923 acres.		
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, C, and 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.