Chapter 2. Alternatives

This chapter describes and compares the alternatives considered for the Four Forests Restoration Initiative. It presents the alternatives in comparative form, defining the differences between each alternative, and providing a clear basis for choice by the decision makers. 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).

Changes from the Draft Environmental Impact Statement

Council on Environmental Quality (CEQ) regulations (40 CFR 1503.4) direct an agency to review, analyze, evaluate and respond to substantive comments on a draft EIS. It directs an agency preparing a final environmental impact statement to assess and consider comments both individually and collectively and to respond by one or more of the means listed below, stating its response in the final statement. Possible responses are to:

1. Modify alternatives including the proposed action.
2. Develop and evaluate alternatives not previously given serious consideration by the agency.
3. Supplement, improve, or modify its analyses.
4. Make factual corrections.
5. Explain why the comments do not warrant further agency response, citing the sources, authorities, or reasons which support the agency's position and, if appropriate, indicate those circumstances which would trigger agency reappraisal or further response.

Since the publication of the DEIS, the Forest Service:

- Addressed two procedural concerns raised by the public;
- Added language to the purpose and need and implementation plan to clarify the need to conserve large trees;
- Developed a new alternative (alternative E) which proposes no forest plan amendments;
- Considered but eliminated an evidence-based full restoration alternative;
- Revised treatment acres for all action alternatives based on monitoring results that identified new Mexican spotted owl protected activity centers (PACs), modified existing PAC boundaries, and identified new northern goshawk post-fledging family areas (PFAs);
- Removed treatment acres that overlapped with other ongoing NEPA analyses (such as the Flagstaff Watershed Protection Project);
- Corrected technical errors;
- Clarified methodology and updated environmental consequences (including cumulative effects);
- Revised, further developed and analyzed or corrected DEIS appendices A through G;
- Conducted additional analyses (as appropriate) based on public comments on the DEIS in the preparation of this FEIS;

- Removed all forest plan amendments on the Kaibab NF and updated forest plan direction as a result of having a revised forest plan;
- Completed the monitoring and adaptive management plan (including the incorporation of the U.S. Fish and Wildlife Service biological opinion mitigation and monitoring items for Mexican spotted owl);
- Addressed changed conditions from a 2014 wildland fire on the Coconino NF; and,
- Modified how canopy cover would be measured on about 39,856 acres in alternatives C and E in response to feedback and comments on the DEIS.

See the project record for the complete list of changes between the DEIS and the FEIS.

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, "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 to the proposed action 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 in the DEIS (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.

The DEIS documented five alternatives that were considered but eliminated from detailed study, the environmental consequences associated with three action alternatives that would meet the purpose and need for action, and a no action alternative. Alternative C was identified as the preferred alternative. In response to comments on the DEIS, alternative E was developed. No forest plan amendments are proposed in alternative E. A sixth alternative (evidence-based full restoration) was considered but eliminated from detailed study.

In response to comments on the DEIS, two procedural concerns related to the range of alternatives and plan amendments were added to chapter 1 to highlight concerns raised by the public. Public concerns that are routine disclosures (see chapter 3) were not considered to be key issues. For example, consultation with the U.S. Fish and Wildlife Service on endangered species is a requirement. Therefore, comments that stated consultation needed to occur were not considered a key issue. Appendix I provides a summary of comments as well as individual responses to comments received on the DEIS. Many public comments submitted during the scoping period suggested alternatives that were either considered in detail or eliminated from detailed analysis (see chapter 2).

In summary, this final environmental impact statement responds to four issues and evaluates five alternatives: the no action alternative (alternative A) required by the regulations, the proposed

action (alternative B), and three alternatives (alternative C, D, and E) to provide sharp contrast and comparison to the proposed action:

Alternative A is the no action alternative as required by 40 CFR 1502.14(c). There would be no changes in current management and the forest plans would continue to be implemented. Approximately 166,897 acres of current and ongoing vegetation treatments and 195,076 acres of prescribed fire projects would continue to be implemented within and next to the project area. Approximately 43,041 acres of vegetation treatments and 58,714 acres of prescribed fire and maintenance burning would be implemented next to the project area by the Coconino and Kaibab NFs in the foreseeable future (within 5 years). Activities such as road maintenance, recreation, firewood gathering and authorized livestock grazing would continue. Activities that have been authorized in separate decisions such as the control of non-native invasive plants and implementation of travel management would continue. Alternative A is the point of reference for assessing alternatives B through E.

Alternative B, the proposed action alternative, reflects incorporating comments received during scoping and collaborative efforts from January 2011 to August 2011. Changes from the DEIS to the FEIS are described on page 51.

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 by increasing prescribed burning treatments within protected Mexican spotted owl habitat (to improve the quality of owl roosting and nesting habitat). It aligns treatments with the "Mexican Spotted Owl Recovery Plan, First Revision" (USDI FWS 2012). The alternative also adjusts treatments (decreases acres of mechanical treatment and increases the acres of prescribed fire) to incorporate two research opportunities including a small mammal and bird study and a paired watershed study.

Alternative D was developed to respond to **Issue 1**—prescribed fire emissions—by decreasing the acres where prescribed fire would be used by 69 percent (when compared to alternative B). This equates to removing fire on about 404,889 acres. Other attributes of alternative D, with the exception of the use of prescribed fire, are similar to alternative B.

Alternative E was developed in response to comments on the DEIS. Alternative E responds to **Issue 3** (post-treatment landscape openness and canopy cover), and may resolve concerns the public had related to the range of alternatives and forest plan amendments. It is similar to alternative C in that it adds acres of grassland treatments on the Kaibab NF and incorporates wildlife and watershed research on both forests. It proposes mechanically treating trees up to 9 inches d.b.h. in 18 Mexican spotted owl protected activity centers and includes low-severity prescribed fire within 70 Mexican spotted owl protected activity centers, excluding 54 core areas. Key components of the stakeholder-created large tree retention strategy are incorporated into the alternative's implementation plan. No forest plan amendments are proposed.

All action alternatives (B through E) 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, and mitigation measures

(appendix C), an implementation plan (appendix D), and an adaptive management, biophysical and socioeconomic monitoring plan (appendix E). All action alternatives protect and conserve old trees and the implementation plan includes specific direction for managing old trees. A modified version of the original stakeholder-developed large tree retention strategy (included in the implementation plan) is included in alternatives C and E.

Forest Plan Consistency

Forestwide and management area or geographic area-specific standards and guidelines have been incorporated into the design of alternatives B through E as displayed in appendix C of this FEIS. Other applicable forest plan requirements that have been incorporated by resource are in the resource specialist reports.

The project was reviewed for compliance with direction in the current "Coconino National Forest Plan" (forest plan), as amended (USDA FS 1987), the "Land and Resource Management Plan for the Kaibab National Forest, as revised" (USDA FS 2014) and the Forest Service Planning Rule (36 CFR 219.17(b)(3)). Consistency evaluations can be found by resource in chapter 3 of this FEIS and the project record.

Forest Plan Amendments

Appendix B addresses the Coconino NF nonsignificant forest plan amendments that are proposed in alternative B through D. Appendix D (implementation plan) documents how treatment design meets Coconino NF and Kaibab NF forest plan direction and desired conditions.

Coconino NF: The proposed forest plan amendments are authorized by the Forest Service Planning Rule. Section 219.17(b)(3) of the Rule provides transition language that allows this project to propose amendments to the Coconino NF forest plan using the provisions of the 1982 Planning Rule.

Amendments 1 through 3 were evaluated in accordance with the significance amendment criteria in FSM 1926.51 and FSM 1926.52. The purpose of amendment 1 is to bring the selected alternative in alignment with the revised Mexican Spotted Owl Recovery Plan and defer monitoring to the U.S. Fish and Wildlife Service biological opinion that is specific to this project. Amendment 2 clarifies existing direction in the forest plan. Amendment 3 resolves a forest plan error and is specific to this project. The significance analysis for each amendment is located in appendix B of this FEIS.

The proposed amendments are consistent with FSM 1926.51 nonsignificance criteria because no amendment alters multiple-use forest plan goals and objectives, adjusts management area boundaries or management prescriptions. The changes in standards and guidelines are considered to be minor because they reflect the latest, best available science including the revised Mexican Spotted Owl Recovery Plan. The amendments do not alter the long-term relationship between levels of multiple-use goods and services originally projected for the Coconino NF. These outputs were specific to a planning period ranging from 10 to 15 years (as identified in 1987):

- Amendment 1: The amendment would affect 6,906 acres or 18 percent of the protected activity center habitat on the Coconino NF.
- Amendment 2 is a clarification amendment. The canopy cover portion of the amendment would affect 137,313 acres (17 percent) of all goshawk habitats on the Coconino NF.

Managing 28,952 acres of ponderosa pine for an open reference condition would affect approximately 4 percent of all suitable goshawk habitats on the Coconino NF.

- Amendment 3 is specific to the 355,707 acres of proposed treatments in this project. The amendment would affect about 20 percent of the Coconino NF (which totals 1,821,495 acres).

For these reasons, the amendments would not result in an important effect to the entire land management planning area. Each amendment is a specific, one-time variance for this restoration project. The best available science for management in southwestern forests and the (Coconino NF) forest plan revision process are affecting ongoing and future analyses. The plan amendments that are specific to this project do not impose direction on ongoing or future analyses.

With the proposed nonsignificant forest plan amendments (see appendix B) alternatives B, C, and D are consistent with the current 1987 Coconino NF forest plan direction. Alternative E is consistent with the current forest plan with one exception. Attaining no effect for heritage resources would not be possible unless 100 percent of the project area was surveyed and avoided.

Kaibab NF: The revised forest plan for the Kaibab NF became effective in April of 2014. The project's desired conditions were based on the best available science for the restoration of southwestern fire-adapted ecosystems (Reynolds et al. 2013). The direction in Reynolds et al. has informed all forest plan revisions processes in the Southwestern Region. With design features and mitigation, alternatives B through E are consistent with forest plan objectives, desired conditions, standards, and guidelines, although movement toward desired conditions varies by alternative.

The project is consistent with the revised forest plan in that a guideline for threatened, endangered and sensitive species directs projects to integrate management objectives and protection measures from approved recovery plans (revised KNF forest plan, p. 51). The revised Mexican Spotted Owl Recovery Plan (USDI FWS 2012) does not limit tree removal from within protected activity centers to a specific d.b.h., nor does it require a specific method for habitat monitoring. Although restricted habitat is referred to as "recovery habitat" and "nest/roost habitats" in the 2012 revised recovery plan (USDI FWS 2012, pp. 3-4), the project's desired conditions for nesting and roosting habitat is consistent with the revised recovery plan. The revised recovery plan still recommends that a percentage (10 to 25 percent) of recovery habitat be managed as nesting and roosting habitat (USDI FWS 2012, p. VIII). Designating habitat in the project area with the best potential would move toward desired percentages in recovery habitat. Also see appendix D in this FEIS (Implementation Plan).

Forest plan desired conditions for ponderosa pine, a major vegetation type, would be achieved because the project (1) at the fine scale provides for managing crowns of trees within the mid-aged to old groups as interlocking or nearly interlocking (revised Kaibab NF forest plan, p. 17); (2) at the mid-scale manages forest conditions in some areas contain 10 to 20 percent higher basal area in mid-aged to old tree groups than in the general forest (e.g., goshawk post-fledging family areas (PFAs), Mexican spotted owl nesting/roosting habitat, drainages, and steep north-facing slopes) (revised Kaibab NF forest plan p. 18); and, (3) at the landscape scale the ponderosa pine forest is a mosaic of conditions composed of structural stages that range from young to old trees. The forest is generally uneven-aged and open, and old growth occurs throughout the landscape (revised Kaibab NF forest plan, p. 18). Treatment design in ponderosa pine also meets the wildlife guideline of having goshawk nest areas that are multi-aged and dominated by large trees with interlocking crowns and are generally denser than the surrounding forest (Kaibab NF forest plan,

p. 51). See appendix D in the FEIS (Implementation Plan), which provides specific treatment design for alternatives.

The project's use of the term "interspaces" with treatment design is consistent with the forest plan's desired condition at the midscale for interspace (revised Kaibab NF forest plan, p.17). Treatments and site-specific analysis indicates interspace would typically range from 10 to 70 percent and be based on site productivity (see silviculture forest plan consistency evaluations).

The project is consistent with soil and watershed desired conditions and guidelines (revised Kaibab NF forest plan, pp. 44-46) in that the project is designed to maintain or improve water quality and quantity. The project incorporates best management practices and design features that would control erosion and protect and improve watershed condition (see appendix C). The project would improve stream channel stability and spring function and move water levels and flow rates toward reference conditions (see chapter 3). The project is consistent with the desired conditions for fire behavior (risk) and fire regime in ponderosa pine by promoting the return of low-severity fire into the landscape (revised Kaibab NF forest plan, p. 18). The project is consistent with narrow and rare endemic species guidelines in that it incorporates measures to protect and provide for rare and narrow endemic species where they are likely to occur (revised Kaibab NF forest plan, p. 52). The silviculture analysis documents the project will not alter timber suitability.

Additional detail can be found in the forest plan consistency evaluations which have been made part of each resource report. With design features and mitigation, alternatives B through E are consistent with the forest plan. As noted above, movement toward desired conditions varies by alternative.

Alternatives Considered but Eliminated from Detailed Study

The range of alternatives considered by the responsible officials in this FEIS includes five alternatives (including no action) analyzed in detail and six alternatives that were considered but eliminated from detailed study. Public comments received in response to the proposed action suggested five alternative methods for achieving the purpose and need, including an alternative that would: (1) use mechanical treatments limited to trees no larger than 8 inches d.b.h., (2) use prescribed fire as the sole treatment method, (3) eliminate the use of prescribed fire, (4) use the original large tree retention strategy, and (5) limit mechanical treatments to 16 inches d.b.h.

All alternatives were evaluated to determine how well the proposal would accomplish the purpose and need for action. 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).

Analysis of the comments received on the DEIS resulted in a sixth alternative (evidence-based full restoration) considered but eliminated from detailed study. Only a summary of key findings for this alternative are included in this section. The complete analysis conducted for the evidence-based full restoration alternative is in the project record and will be made available on the project website. In this FEIS, numbers have been updated or corrected as needed since the DEIS was released for public comment. See the project record for the complete list of updates and corrections.

Limit Mechanical Treatments to 8 Inches D.B.H.

This alternative was based on the assertion that crown fire can be effectively addressed with mechanical treatments that do not cut trees larger than 8 inches 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 review, it was determined that it would not meet various elements of the purpose and need, as described below.

- Nonforested openings (interspaces), tree group size, and shape would be determined by the location of trees less than 8 inches d.b.h.. In situations where the existing condition is dominated by trees greater than 8 inches 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 143,850 acres of vegetation structural stage (VSS) 3 stands (with an average diameter larger than 8 inches) and 216,691 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 507,839 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 terms (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) (see chapter 2).
- Even-aged stand conditions apply to 56 percent (46 percent within ponderosa pine as a whole) of landscapes outside of post-fledging 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 trees 8 inches d.b.h. would result in over 74 percent of these acres remaining even-aged (VSS 3 with an average diameter greater than 8 inches, all VSS 4, 5, and 6). This would be contrary to moving toward improved forest structure and pattern desired conditions, which affect habitat.
- Uneven-aged stand conditions apply to 44 percent (54 percent within ponderosa pine as a whole) 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 trees 8 inches d.b.h. and smaller would result in no movement toward a balance of age classes within over 73 percent of the uneven-aged LOPFA habitat (VSS 3 with an average diameter greater than 8 inches, all VSS 4, 5, and 6).

- 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 (silviculture report, page 45). 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 presettlement trees (old forest). This inter-tree 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 inches 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 197,459 acres (39 percent) of VSS 3 and 220,359 acres (43 percent) of VSS 4 (see the 3A to 4C rows in table 6 of the silviculture report). This condition would be contrary to moving toward forest structure and pattern desired conditions.

- Approximately 87,553 acres of VSS 3 and 98,905 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 190,832 acres in areas dominated by trees greater than 8 inches d.b.h. with an SDI greater than 55 percent of maximum SDI. This condition would be contrary to improving forest resiliency and sustainability.

- **Gambel oak –** Ponderosa pine trees are the primary factor inhibiting Gambel oak development within 64,065 acres of Mexican spotted owl restricted other habitat. Sixty-two (62) percent of these acres are dominated by trees greater than 8 inches with a SDI greater than 55 percent.[10] Mechanical treatment constrained by an 8-inch d.b.h. 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 Mexican spotted owl restricted other habitat.

- **Aspen –** Mechanical treatments of trees up to 8 inches 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 inches 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.

[10] 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 or more of maximum stand density. See chapter 1 of this FEIS and the silviculture report for additional information on stand density.

- **Pine-sage –** Within the 5,261 acres of pine-sage proposed for mechanical treatment, 4,457 acres (85 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 inches 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 507,839 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 0 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.

Use Prescribed Fire as the Sole Treatment Method

In response to public comments and recommendations received during scoping, we considered an alternative that 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 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 review, it was determined that it would not meet various elements of the purpose and need, as described below.

Protected activity centers (PACs) can be representative of old age, old forest structure within the project area. Figure 25 shows uncharacteristically 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 Protected Activity Center (2001), Coconino NF

Using fire as a thinning agent in these conditions (that represent extreme fuel loadings) could cause undesirable high-severity effects or result in uncontrollable fire behavior. This represents extreme fuel loading and is a hazardous condition that can produce high-severity effects. If a wildfire burned though this PAC (even under moderate conditions), it is likely the effect would include a lot of 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 high-severity fire effects, the prescribed fire treatments proposed (alternative C) 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 Mexican Spotted Owl Recovery Plan objectives) would occur on 10,319 acres (acres to be mechanically treated up to 17.9 inches d.b.h.) of Mexican spotted owl 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). To avoid excessive old tree damage and mortality, any treatment in those acres that contribute to old growth (192,819 acres of 586,110 acres or 33 percent of the treatment area) would likely be deferred 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 achieved 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 26 percent (155,061 acres of 586,110 acres) of the treatment area, a prescribed fire-only alternative would achieve forest structure desired conditions because there is little need for changing forest structure on these acres. On the remaining 431,049 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 achieve 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 achieve forest structure and pattern desired conditions and would not improve resiliency in goshawk habitat.

- Fires in areas dominated by dense, even-aged VSS 3 and VSS 4 that produced effects 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 (299,634 acres) of goshawk LOPFA and PFAs 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 to avoid undesirable 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 45,142 acres of historic (mollic-integrade) savanna, about 51,444 acres (91 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 encroaching trees prior to using prescribed fire. Moving toward forest structure, spatial pattern and vegetation composition and diversity desired conditions would not likely to be achieved 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 encroaching trees 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 Mexican spotted owl 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) the potential for uncharacteristically severe fire effects would remain high and there would be no improvement in terms of resiliency in and around Mexican spotted owl protected activity centers; (2) treatment on 192,819 acres or 33 percent of the treatment area would likely be deferred 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 achieved 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 (equates to 9,435 acres of grassland in VSS 3+) and 45,142 acres of historic mollic-integrade savanna (equates to 42,009 acres in VSS 3+); 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

Some public comments recommended eliminating all prescribed fire to remove project nuisance smoke and its resulting emissions. Recommendations include using livestock (cattle, goats) in lieu of prescribed fire to reduce fuels. This alternative assumes that approximately 90 percent of all treatment-related slash (biomass) would be moved offsite and considers grazing and a variety of mechanical treatment methods to reduce fuels.

This alternative was not analyzed in detail. After an initial review, it was determined that it would not meet various elements of the purpose and need, as described below:

- Eliminating the use of prescribed fire would negatively affect forest structure in terms of moving toward age and size class diversity and forest health desired conditions. Without the thinning effects of fire on canopy fuels, seedlings, and young saplings, 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 that would sanitize dwarf mistletoe infections and reduce densities (due to the thinning effect of fire) would not occur. No change in canopy characteristics would occur. 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 431,049 acres in the project area would be effective at restructuring most of the canopy bulk density, canopy base heights, tree density, and the arrangement of trees in the short term (immediately after 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. 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 killing 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 (such as

flooding, debris flows, and erosion). 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 and duff that have 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 is 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 evenly distributed throughout a pasture and the herbaceous vegetation and shrubby fuels normally regrow within the same year.
- To replace the use of prescribed fire, livestock (cattle and goats) would have to be used on 586,110 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) 48,703 acres of existing grasslands, (2) over 56,000 acres of ponderosa pine with a savanna or grassland reference condition, (3) grassland inclusions within 507,839 acres of ponderosa pine forested areas, (4) 5,261 acres of

pine-sage, (5) 1,469 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), (3) maintain desired canopy base heights, canopy bulk densities, and reduced ladder fuel conditions (that were attained through mechanical treatment), and (4) thin seedlings and small saplings to maintain a mosaic of age classes, 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 some surface 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)

Comments recommended incorporating the LTRS as written by the 4FRI stakeholders. This alternative was not analyzed in detail. After an initial review, it was determined that incorporating and 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 alternatives C and E. 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. Comments on the DEIS requested the original LTRS be made readily available. The original LTRS document is available in the project record and is available on the 4FRI web site.

Background: The LTRS was developed by the 4FRI 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 inches 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 Large Tree Retention Strategy from Detailed Study:

- The original Large Tree Retention Strateg (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, p. 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 4FRI record of decision. This information would be made part of the annual implementation plan checklist and 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 Mexican spotted owl habitat. This would preclude moving toward desired conditions in non-Mexican spotted owl 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 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. The exception categories were spatially mapped and it was discovered 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 inches 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).

Table 15. Large Tree Retention Strategy (LTRS) and Large Tree Implementation Plan (LTIP) 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 decision-making 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 pages 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 decision-making 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 (greater than 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.	pages 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 inches 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.

Limit Mechanical Treatments to 16 Inches D.B.H. as a Means to Preserve Large Trees

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 inches 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 considered 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 inches 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 inches 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 trees 16 inches d.b.h. and smaller 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. 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 FS 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 considered in the 2011 Forest Service study are prevalent throughout the 4FRI project area and some of the forest inventory assessment 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 and 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 high severity 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).

Evidence-Based Full Restoration Alternative

This alternative was considered as a result of comments on the DEIS. Commenters stated the DEIS did not include an evidence-based, full-restoration alternative, which looks at the outcomes and impacts of applying science-based ecological restoration on this landscape. Science that supports ecological restoration includes (but is not limited to) Woolsey (1911), Cooper (1960), White (1985), Pearson (1950), Covington et a1. (1997), and Abella and Denton (2009).

Commenters stated that designing treatments based on the goshawk guidelines (forest plan) is not ecologically based restoration. Without developing an evidence-based, full restoration analysis, there is no way to adequately compare the tradeoffs between: a restoration alternative that replicates the natural range of variability (NRV) and restores forests to pre-fire exclusion conditions, or an analysis that is designed to address restoration and issues associated with forest openness, closed canopy species, and canopy cover/closure.

This alternative would meet the objective of increasing forest resiliency and sustainability. It would address **Issue 4** (DEIS, pp. 38-39). However, the full restoration alternative would compromise closed and moderately closed forest structure in Mexican spotted owl and goshawk habitat. The alternative would remove much of the closed canopy (bridge) habitat for wildlife (appendix G) thereby removing refugia for closed canopy-dependent species. Desired conditions and forest plan direction specific to vegetation composition and diversity in Gambel oak (DEIS, p. 19), Mexican spotted owl (DEIS, p. 14) and goshawk habitat (DEIS, pp. 12-13, 637-638) would not be met. The desired condition of a having moderate-to-closed canopy conditions widely distributed on the landscape would not be achieved. There would be insufficient moderate-to-closed conditions that would provide habitat connectivity (DEIS, p. 11, appendix G).

For these reasons, this alternative was considered but eliminated from detailed study. For additional details, see the project record.

Evidence-Based Full Restoration Treatment Implications to Mexican Spotted Owl Protected Habitat

In Mexican spotted owl habitat, approximately 43,711 acres of habitat would receive evidence-based full restoration treatments that include grassland, savanna and uneven-aged methods. Of these acres, 100 percent of Mexican spotted owl protected (35,019 acres) habitat would be treated.

The protected activity centers (PACs) provide the best possible owl habitat available with the nest or activity center located near the center. The restricted habitats are managed to ensure a sustained level of owl nest/roost habitat distributed across the landscape. The average conditions within the restricted target/threshold Mexican spotted owl forest habitats currently have the minimum structural components with the exception of percent density within the 24-inch and larger size class and trees per acre in the 18-inch and larger size class. The average condition within the restricted other Mexican spotted owl forest habitats are also lacking in trees greater than 18 inches and percent density of trees 24 inches and larger. The Gambel oak component in both habitats is close to or above the minimum of greater than or equal to 20 percent and they are providing the key habitat components of coarse woody debris greater than 12 inches and snags greater than or equal to 18 inches (silviculture report, page 40).

Summary of Effects

In the full restoration alternative, the residual basal area in Mexican spotted owl protected habitat would range from 38 to 84 whereas in alternative B the residual basal area would be 155. From strictly a forest structure and forest health perspective, the reduced basal area would create conditions that result in less risk to natural disturbances including fire, insect and disease. As a result, forest resiliency would be improved. In alternative B, a basal area of 155 would meet or exceed the nesting and roosting criteria for Mexican spotted owl. Providing this habitat is necessary for species recovery. The full restoration alternative would not meet the minimum nesting and rooting criteria (DEIS, p. 14). Resident territories for Mexican spotted owl could be lost. This would move the species further away from recovery objectives.

The average Gambel oak basal area would range from 14 to 36 percent in alternative B and 7 to 10 percent in the full restoration alternative. To achieve the target basal area, the full restoration alternative may decrease large-diameter oak trees, a major nesting substrate used by Mexican spotted owl in ponderosa pine. Retention of medium-sized oak (primary mast producers that support prey species) and large oak (nesting) is key and provided for in alternatives B through E. Reducing oak would not be in alignment with the purpose and need, which to maintain and promote oak for several species of wildlife in general including Mexican spotted owl (DEIS, p. 14). Decreasing oak may result in Mexican spotted owl abandonment of its habitat which would reduce their range. Actions that reduce the quality and quantity of the habitat are not consistent with recovery objectives (Wildlife Report, pp. 26-29).

In the full restoration alternative the post-treatment percent maximum stand density index (max SDI) in Mexican spotted owl protected habitat (full restoration alternative) would range from 71 to 87 whereas in alternative B the percent max SDI would range from 16 to 34. The low percent max SDI in the full restoration alternative illustrates the decrease in forest density and increased resiliency to natural disturbances. Alternatives B through E result in high and very high densities

(reduced resiliency) due to treatments designed to meet forest plan direction and Mexican Spotted Owl Recovery Plan objectives.

In Mexican spotted owl protected habitat, the full restoration alternative would produce more trees greater than 18 inch d.b.h. However, these trees would be spatially arranged as individuals or in groups within an open landscape, contrary to the habitat needs of Mexican spotted owls. The resultant forest structure in alternative B is a direct result of conservative mechanical treatments designed to meet Mexican spotted owl habitat requirements. While large trees would be lower in alternative B, large-diameter trees would exist in a forested environment versus the open landscape produced by the full restoration alternative. While percentages and number increases can appear "better" or "more beneficial" the spatial arrangement would be lacking.

Mexican Spotted Owl Target and Threshold Habitat

There are approximately 8,692 acres of Mexican spotted owl target and threshold habitat in the project area. The average conditions within the restricted target/threshold Mexican spotted owl forest habitats currently have the minimum structural components with the exception of percent density within the 24 inch and larger size class, and trees per acre in the 18 inch and larger size class. The Gambel oak component is close to or above the minimum of greater than or equal to 20 percent and is providing the key habitat components of coarse woody debris greater than 12 inches and snags greater than or equal to 18 inches.

Treatments in target and threshold habitat are to be designed to maintain existing elements of Mexican spotted owl habitat where they exist and move forests toward those habitat features where they are lacking. Treatments are to be designed to be in accordance with Mexican Spotted Owl Recovery Plan objectives by retaining oak and large trees, increasing tree growth rates, increasing stand resiliency, improving prey habitat, and reducing risk of undesirable fire behavior and effects.

Summary of Effects

In the full restoration alternative the residual basal area in Mexican spotted owl restricted target and threshold habitat would range from 38 to 84 whereas in alternative B the residual basal area would range from 139 to 171. From a strictly forest structure and forest health perspective, the reduced basal area would create conditions that result in less risk to natural disturbances including fire, insect and disease. As a result, forest resiliency would be improved. However, the low basal area would delay or prevent the development of future nesting and roosting habitat. This would limit recovery potential. The full restoration alternative would move the species further away from recovery objectives.

The residual percentage of maximum stand density index (max SDI) in Mexican spotted owl restricted target and threshold habitat would range from 16 to 34 whereas in alternative B the residual percentage of max SDI would range from 71 to 87. The low percentage of max SDI in the full restoration alternative illustrates the decrease in forest density and increased resiliency to natural disturbances. Alternatives B through E result in higher densities (reduced resiliency) due to treatments designed to meet forest plan direction and Mexican Spotted Owl Recovery Plan objectives.

Mexican Spotted Owl Restricted Threshold and Target Habitat

Summary of Effects

In the full restoration alternative the post-treatment condition for trees in the smallest size class indicates a substantial decrease in the 12-inch to 17.9-inch d.b.h. category. The full restoration

alternative would result in a greater percentage of trees in the 24-inch d.b.h. and larger category. However, these trees would be spatially arranged as individuals or in groups within an open landscape, contrary to the objective for this habitat, which is supposed to provide future nesting and roosting habitat. The resultant forest structure in alternative B is a direct result of the conservative mechanical treatments designed to meet future nesting and roosting habitat requirements. While trees in the 24-inch d.b.h. and larger category would be lower in alternative B, large-diameter trees would exist in a forested environment versus the open landscape produced by the full restoration alternative. While percentages and number increases can appear "better" or "more beneficial" the spatial arrangement would be lacking.

In alternative B, the understory index would range from 24 to 47. In the full restoration alternative, the understory index would range from 148 to 287. The significant difference in understory response illustrates the openness of the landscape in the full restoration alternative when compared to the conservative nature of the mechanical treatments in alternatives B through E. The intensive grassland and savanna treatments would provide the greatest benefits for a wide range of species. There would be direct improvements to small and large mammals that use grasses, forbs, and shrubs. There would be increased habitat for nesting birds, including increased cover and seed production. However, this outcome is not in alignment with the objectives for target and threshold habitat (future nesting and roosting habitat).

Mexican Spotted Owl Restricted Other Habitats

The average condition within the restricted other Mexican spotted owl forest habitats are lacking in trees greater than 18 inches and percent density of trees 24 inches and larger. The Gambel oak component in is close to or above the minimum of greater than or equal to 20 percent and is providing the key habitat components of coarse woody debris greater than 12 inches and snags greater than or equal to 18 inches.

Summary of Effects

In the full restoration alternative the residual basal area in Mexican spotted owl restricted other habitat would range from 38 to 84 whereas in alternative B the residual basal area would be 78. While the differences in basal area do not seem measurable, there would be a different post-treatment spatial pattern. Alternative B is designed to meet the intent of the Mexican Spotted Owl Recovery Plan. In the full restoration alternative, the habitat would include interspersed savanna and grassland. Mexican spotted owls have not been documented using meadows 10 acres or larger (Gainey et al. 2011). The full restoration alternative is likely to decrease the quantity and quality of owl habitat even though the basal area averages are similar.

In the full restoration alternative, the average Gambel oak basal area would be 25 percent in alternative B and range from 7 to 10 percent in the full restoration alternative. This represents a substantial decrease in Gambel oak. This is likely a result of decreasing large-diameter oak trees, a major nesting substrate used by Mexican spotted owl in ponderosa pine, to meet the target basal area. Retention of medium-sized oak (primary mast producers that support prey species) and large oak is a key objective in the purpose and need and is provided for in alternatives B through E. Reducing oak would not be in alignment with purpose and need which to maintain and promote oak for several species of wildlife in general including Mexican spotted owls (DEIS, pp. 19, 616-617). Actions that reduce the quality and quantity of the habitat are not consistent with recovery objectives.

In the full restoration alternative the residual percentage of maximum stand density index (max SDI) in Mexican spotted owl restricted other habitat would be 37 in alternative B whereas the

residual percentage of max SDI in the full restoration alternative would range from 16 to 34. The lower percentage of max SDI range in the full restoration alternative illustrates the decrease in forest density and increased resiliency to natural disturbances. Alternatives B through E result in higher densities (reduced resiliency) due to treatments designed to meet forest plan direction and Mexican Spotted Owl Recovery Plan objectives.

In the full restoration alternative, the post-treatment condition (mid-range) would be relatively similar for trees in the 12-inch and 18-inch categories. The full restoration alternative would result in a greater percentage of trees in the 24-inch d.b.h. and larger category. However, these trees would be spatially arranged as individuals or in groups within an open landscape, contrary to the objective for this habitat which is supposed to provide future nesting and roosting habitat. The resultant forest structure in alternative B is a direct result of the conservative mechanical treatments designed to meet future nesting and roosting habitat requirements. While trees in the 24-inch d.b.h. and larger category would be lower in alternative B, large-diameter trees would exist in a forested environment versus the open landscape produced by the full restoration alternative. While percentages and number increases can appear “better” or “more beneficial” the spatial arrangement would be lacking.

In alternative B, the understory index would be 141. In the full restoration alternative, the understory index would range from 148 to 287. In comparison to the no action alternative, alternative B provides a significant increase in understory response which increases food and cover for Mexican spotted owl prey species. However, when compared to the full restoration alternative, the understory response in alternative B is much less. The significant difference in understory response illustrates the openness of the landscape in the full restoration alternative when compared to the conservative nature of the mechanical treatments in alternatives B through E. The intensive grassland and savanna treatments would provide the greatest benefits for wide range of species. There would be direct improvements to small and large mammals that use grasses, forbs, and shrubs. There would be increased habitat for nesting birds, including increased cover and seed production.

Evidence-based Full Restoration Treatment Implications to Northern Goshawk Post-fledging Nest Areas

The project area contains approximately 8,816 acres of goshawk post-fledging nest areas.

Summary of Effects

The residual basal area in goshawk nest areas would be 98 in alternative B whereas the residual basal area in the full restoration alternative would range from 38 to 84. The full restoration alternative represents a significant departure in basal area. Approximately 75 percent of nest habitat would be compromised by converting the forested environment to an open landscape interspersed with individual trees or tree groups. Although goshawk habitat use is variable across its range, goshawk consistently seek larger trees and higher canopy cover for nesting (Reynolds et al. 1992).

The residual percentage of max SDI in goshawk nest habitat would be 38 in alternative B whereas the residual percentage of max SDI in the full restoration alternative would range from 16 to 34. The lower percentage of max SDI range in the full restoration alternative illustrates the decrease in forest density and increased resiliency to natural disturbances.

There would be little difference in coarse woody debris (CWD) greater than 12 inches in diameter in the alternatives. However, the residual CWD greater than 3 inches in the full restoration alternative would reverse the upward trend found in alternative B. In the full restoration

alternative, CWD greater than 3 inches would range from 1.5 to 2.5 tons per acre, a decrease from the projected 3.3 tons per acre in alternative B. The downward trend is not in alignment with forest plan desired conditions for managing CWD between 3 to 10 tons per acre.

In alternative B, snags would increase from 0.4 snags per acre (current condition) to 1.6 snags per acre. This approaches the desired condition of 2 snags greater than 18 per acre (DEIS, p. 13, table 6). The full restoration alternative would reverse the upward trend found in alternative B to a range of 0.6 to 0.8 snags greater than 18 per acre. The downward trend is not in alignment with desired conditions.

Evidence-Based Full Restoration Treatment Implications to Northern Goshawk PFA/dPFA

About 38,987 acres of goshawk post fledging and dispersal post-fledging areas (PFA/dPFA) would be treated.

Summary of Effects

The residual basal area in goshawk PFA/dPFA would be 92 in alternative B whereas the residual basal area in the full restoration alternative would range from 38 to 84. The full restoration alternative represents a significant departure in basal area as a result of the grassland and savanna treatments. Approximately 68 percent (26,380 acres) of PFA/dPFA habitat would be compromised by converting the forested environment to an open landscape interspersed with individual trees or tree groups. Although goshawk habitat use is variable across its range, goshawk consistently seek larger trees and higher canopy cover for nesting (Reynolds et al. 1992).

The residual percentage of max SDI in goshawk nest habitat would be 39 in alternative B whereas the residual percentage of max SDI in the full restoration alternative would range from 16 to 36. The lower percentage of max SDI range in the full restoration alternative illustrates the decrease in forest density and increased resiliency to natural disturbances.

There would be little difference in CWD greater than 12 inches in diameter in the alternatives. However, the residual CWD greater than 3 inches in the full restoration alternative would reverse the upward trend found in alternative B. In the full restoration alternative, CWD greater than 3 inches would range from 1.5 to 2.5 tons per acre, a decrease from the projected 3.1 tons per acre in alternative B. The downward trend is not in alignment with forest plan desired conditions for managing CWD (5 to 7 tons per acre for Coconino NF and 3 to 10 tons per acre for Kaibab NF).

In alternative B snags would increase from 0.4 snags per acre (current condition) to 1.0 snags per acre. This approaches the desired condition of 2 snags greater than 18 per acre (DEIS, p. 13, table 6). The full restoration alternative would reverse the upward trend found in alternative B to a range of 0.6 to 0.9 snags greater than 18 inches d.b.h. per acre. There would be less movement toward achieving desired conditions.

Rationale for Considering But Eliminating Evidence-based Full Restoration Alternative from Detailed Study

Mexican Spotted Owl Habitat

The evidence-based full restoration alternative would adversely affect the quality and quantity of 100 percent (35,019 acres) of Mexican spotted owl protected habitat. In target and threshold habitat, forest resiliency and the understory grass/forb/shrub matrix would be improved. However, the low basal area would delay or prevent the development of 8,692 acres of future nesting and roosting habitat. This would limit recovery potential. The full restoration alternative

would move the Mexican spotted owl further away from recovery objectives. The full restoration alternative would not be compliant with the Coconino National forest plan or the revised Mexican Spotted Owl Recovery Plan. Because it is not compliant with the revised Mexican Spotted Owl Recovery Plan, it would also not be compliant with the Kaibab Land and Resource Management Plan. The full restoration alternative is not consistent with the purpose and need for the project.

In Mexican spotted owl restricted other habitat, due to the low basal area, the full restoration alternative is likely to decrease the quantity and quality of owl habitat even though the basal area averages are similar. There would be a substantial decrease in oak in the full restoration alternative. Reducing oak would not align with the purpose and need, which is to maintain and promote oak for several species of wildlife in general, including Mexican spotted owl (DEIS, pp. 19, 616-617). Actions that reduce the quality and quantity of Mexican spotted owl habitat are not consistent with recovery objectives. The full restoration alternative would provide the most understory response (benefit to Mexican spotted owl prey species) and increase the resiliency of the habitat the most to unanticipated events such as bark beetle outbreak and climate-influenced changes. However, due to the post-treatment basal area and oak, the full restoration alternative would not be consistent with the forest plans or the revised Mexican Spotted Owl Recovery Plan.

Goshawk Habitat

In goshawk PFA nest areas and in PFA/dPFA, the lower percentage of max SDI range in the full restoration alternative would increase resiliency to natural disturbances. However, approximately 75 percent of nest habitat and 68 percent of PFA/dPFA would be compromised by converting the forested environment to an open landscape interspersed with individual trees or tree groups. Although goshawk habitat use is variable across its range, goshawks consistently seek larger trees and higher canopy cover for nesting. The downward trend in coarse woody debris would not align with forest plan desired conditions for managing coarse woody debris between 3 to 10 tons per acre on the Kaibab NF and 5 to 7 tons per acre on the Coconino NF. The full restoration alternative would reverse the upward trend found in alternative B to a range of 0.6 to 0.8 snags greater than 18 per acre. The downward trend would not align with desired conditions. The full restoration alternative would result in less movement toward achieving desired conditions for large snags, prolonging poorer habitat conditions.

Alternatives Considered in Detail

This FEIS documents the analysis of five alternatives, including no action (alternative A), the final proposed action (alternative B), and three additional alternatives (alternatives C, D, and E). Alternatives C and D respond to recommendations and issues raised by the public during the extended scoping period. These issues were addressed in the DEIS. Alternative E was developed in response to comments on the DEIS. 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 and the forest plans would continue to be implemented. Approximately 166,897 acres of current and ongoing vegetation treatments and 195,076 acres of prescribed fire projects would continue to be implemented within and next to the project area. Approximately 43,041 acres of vegetation treatments and 58,714 acres of prescribed fire and maintenance burning would be implemented within and next to the project area by the Coconino and Kaibab NFs in the foreseeable future (within 5 years). Activities such as road maintenance, recreation, firewood gathering and authorized livestock grazing would continue. Activities that have been authorized in separate decisions such as the control of

non-native invasive plants and implementation of travel management would continue. Alternative A is the point of reference for assessing action alternatives B through E.

- **Alternative B** is the proposed action. This alternative would mechanically treat 384,966 acres of vegetation and use prescribed fire on 583,330 acres. It incorporates comments and recommendations received during eight months of collaboration with individuals, agencies, and organizations. It proposes mechanically treating trees up to 16 inches d.b.h. in 18 Mexican spotted owl protected activity centers (PACs) and includes low-severity prescribed fire within 70 Mexican spotted owl PACs, excluding 54 core areas. Three nonsignificant forest plan amendments on the Coconino NF would be required to comply with the plans (see table 2). No forest plan amendments are proposed on the Kaibab NF.
- **Alternative C** is the **preferred alternative.** This alternative would mechanically treat 431,049 acres of vegetation and use prescribed fire on 586,110 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 paired watershed research on both national forests, and mechanically treats trees and uses prescribed fire within the proposed Garland Prairie management area on the Kaibab NF. It proposes mechanically treating up to 17.9 inches d.b.h. in 18 Mexican spotted owl PACs and includes low-severity prescribed fire within 70 Mexican spotted owl PACs, including 54 core areas. Key components of the stakeholder-created Large Tree Retention Strategy are incorporated into the alternative's implementation plan. Three nonsignificant forest plan amendments on the Coconino NF would be required (see table 2). No forest plan amendments are proposed on the Kaibab NF.
- **Alternative D** would mechanically treat 384,966 acres of vegetation and use prescribed fire on 178,441 acres. This alternative was developed in response to **Issue 1** (prescribed fire emissions). It decreases the acres that would receive prescribed fire by 69 percent (when compared to alternative B, the proposed action). This equates to removing fire on about 404,889 acres. It proposes mechanically treating trees up to 16 inches d.b.h. in 18 Mexican spotted owl protected activity centers (PACs), but the PACs would not be treated with prescribed fire. Three nonsignificant forest plan amendments on the Coconino NF would be required (see table 2). No forest plan amendments are proposed on the Kaibab NF.
- **Alternative E** was developed in response to comments on the DEIS. This alternative would mechanically treat 403,218 acres of vegetation and use prescribed fire on 581,020 acres. Alternative E responds to **Issue 3** (post-treatment landscape openness and canopy cover), and may resolve concerns the public had related to the range of alternatives and forest plan amendments. It is similar to alternative C in that it adds acres of grassland treatments on the Kaibab NF and incorporates wildlife and watershed research on both forests. It proposes mechanically treating trees up to 9 inches d.b.h. in 18 Mexican spotted owl PACs and includes low-severity prescribed fire within 70 Mexican spotted owl PACs, excluding 54 core areas. Key components of the stakeholder-created large tree retention strategy are incorporated into the alternative's implementation plan. No forest plan amendments are proposed on either forest.

Actions Common to Alternatives B, C, D, and E

- Alternatives B through E 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 (table 16).
- On those acres proposed for prescribed fire, two fires would be conducted over the 10-year period.
- Design features, best management practices (BMPs), and mitigation to be used as part of alternatives B through E are located in volume 2, appendix C.

All these alternatives incorporate into each alternative's design features key components of the Old Tree Retention Strategy (volume 2, appendix C), the implementation plan (volume 2, appendix D), and the adaptive management, biophysical and socioeconomic monitoring plan (volume 2, appendix E). The Forest Service worked collaboratively with stakeholders to develop the final monitoring and adaptive management and implementation plan. Appendix E also includes the Mexican spotted owl and Arizona bugbane monitoring plan as approved (through formal consultation) by the U.S. Fish and Wildlife Service.

Table 16. Alternatives B through E 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 uplands (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 roads/routes 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. Apply 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 and warm season vegetation.	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 5. Apply 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 the soil condition assessment. Time is 5 years after treatment.	1. Additional drainage 2. Additional revegetation efforts (including mulching) 3. 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*
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 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; • Conduct prescribed burn, or • No action. If vegetation/soils are below potential or are impaired or 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; • Conduct prescribed burn; or • 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.	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.	1. ID stressor, protect from stressor (fence/ jackstraw, close road, relocated road, etc.) 2. No action

Evaluation Criteria	Desired Condition	Existing Condition	Possible Management Actions*	Monitoring Measure	Trigger Indicating Additional Action is Needed (What/When)	Adaptive Options*
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 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.	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.	1. ID stressor, protect from stressor (fence/ jackstraw, close road, relocated road, etc.) 2. No action

Evaluation Criteria	Desired Condition	Existing Condition	Possible Management Actions*	Monitoring Measure	Trigger Indicating Additional Action is Needed (What/When)	Adaptive Options*
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 disturbances. Soils are in satisfactory condition.	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 development is unknown.	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, • Conduct prescribed burn, • Identify stressor and provide protection measure for the stressor (fence, jackstraw, remove/relocate road/trail etc.), and/or select • Apply other methods designed to meet the desired conditions.	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	1. ID stressor, protect from stressor (fence/ jackstraw, close road, relocated road, etc.) 2. No action

Evaluation Criteria	Desired Condition	Existing Condition	Possible Management Actions*	Monitoring Measure	Trigger Indicating Additional Action is Needed (What/When)	Adaptive Options*
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: • Conduct prescribed 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 measure for the stressor (fence, jackstraw, remove/relocate road/trail etc.), and/or • Apply other methods designed to meet the desired conditions.	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	1. ID stressor, protect from stressor (fence/ jackstraw, close road, relocated road, etc.) 2. No action

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

Alternative A

Alternative A is the no action alternative as required by 40 CFR 1502.14(c). There would be no changes in current management and the forest plans would continue to be implemented. Approximately 166,897 acres of current and ongoing vegetation treatments and 195,076 acres of prescribed fire projects would continue to be implemented within and next to the project area. Approximately 43,041 acres of vegetation treatments and 58,714 acres of prescribed fire and maintenance burning would be implemented within and next to the project area by the Coconino and Kaibab NFs in the foreseeable future (within 5 years). Activities such as road maintenance, recreation, firewood gathering and authorized livestock grazing would continue. Activities that have been authorized in separate decisions such as the control of non-native invasive plants and implementation of travel management would continue. Alternative A is the point of reference for assessing action alternatives B through E.

Alternative B – Proposed Action

The Coconino and Kaibab NFs propose to conduct approximately 583,330 acres of restoration activities over approximately 10 years or until objectives are met. On average, 45,000 acres of vegetation would be mechanically treated annually. On average, 40,000 to 60,000 acres of prescribed fire would be implemented annually across the national forests (within the treatment area). Up to two prescribed fires would be conducted on all acres proposed for treatment over the 10-year period. Restoration actions would:

- Mechanically cut trees on approximately 384,966 acres. This includes mechanically treating up to 16 inches d.b.h. within 18 Mexican spotted owl protected activity centers (PACs).
- Apply prescribed fire on approximately 384,966 acres where mechanical treatment occurs and use low severity prescribed fire within 70 Mexican spotted owl PACs (excluding core areas).
- Use prescribed fire only on approximately 198,364 acres.
- Construct approximately 520 miles of temporary roads for haul access and decommission them 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 726 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 and manage as old growth 40 percent of the ponderosa pine type and 77 percent of the pinyon-juniper woodland on the Coconino NF.
- Manage and develop uneven-aged stands with a representation of old growth components across most of the project area on the Kaibab NF.

No forest plan amendments would be needed on the Kaibab NF. The proposed actions are consistent with forest plan objectives, desired conditions, and standards and guidelines (see forest plan consistency section). Three nonsignificant forest plan amendments (see vol. 2, 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 inches d.b.h. to improve habitat structure (nesting and roosting habitat) in 18 Mexican spotted owl 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 pre- and post-treatment population and habitat monitoring. Replacement language would defer final project design and monitoring to the FWS biological opinion specific to Mexican spotted owl for the project. The amendment, which is specific to restricted habitat in pine-oak, would add definitions of target and threshold habitat.

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 28,952 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.

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 Mexican spotted owl habitat. Figure 29 displays the general treatment locations.

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

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.	1,227
Prescribed Fire Only	Prescribed fire would be applied exclusively to move treated areas toward desired vegetation conditions.	198,364
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 to 90 square feet of basal area and manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees with the least amount of mistletoe; Interspace would occupy 10 to 55 percent of the treatment area, respectively. Accompanied by prescribed fire.	7,565
IT 25 (25 to 40% interspace)		11,871
IT 40 (40 to 55% interspace)		38,713
Mexican spotted owl (MSO) Threshold	Same as MSO Target (see below)	1,894
MSO Target	Intermediate thinning designed to improve forest health, reduce fire risk, and meet forest density, structure, and species composition requirements. Accompanied by prescribed fire.	6,497
MSO Restricted	Uneven-aged 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.	64,065
MSO PAC	Mechanical treatment designed to increase tree vigor and health and create canopy gaps to reduce fire risk. Accompanied by prescribed fire.	10,284
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 to 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.	45,405
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 co-dominant trees within each group; Interspace would occupy 10 to 55 percent of the treatment area, respectively. Treatments would be accompanied by prescribed fire.	1,914
SI 25 (25 to 40% interspace)		6,618
SI 40 (40 to 55% interspace)		12,303
Uneven-aged (UEA) 10 (10 to 25% interspace)	Uneven-aged mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 10 to 25 percent of the treatment area. Accompanied by prescribed fire.	18,082

Treatment Type	Treatment Description/Objective	Acres
UEA 25 (25 to 40 % interspace)	Uneven-aged mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 25 to 40 percent of the treatment area. Accompanied by prescribed fire.	39,190
UEA 40 (40 to 55% interspace)	Uneven-aged mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 40 to 55 percent of the treatment area. Accompanied by prescribed fire.	100,133
Wildland-urban Interface Pinyon-juniper	Mechanical treatment around the community of Tusayan designed to reduce fire risk and meet Community Wildfire Protection Plan objective. Accompanied by prescribed fire.	535
Wildland-urban Interface (55 to 70% interspace)	Uneven-aged mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 55 to 70 percent of the treatment area. Accompanied by prescribed fire.	2,224

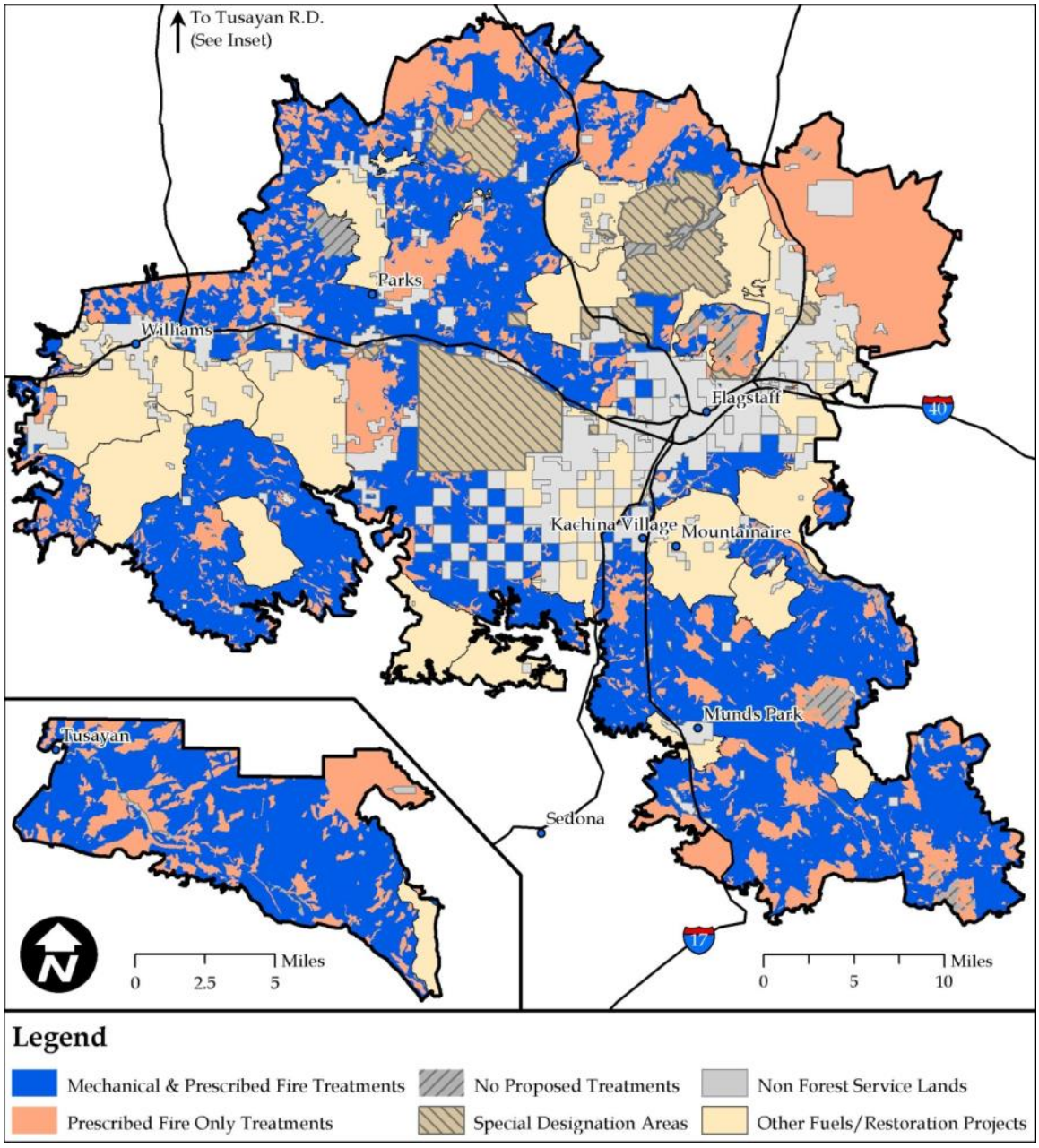

Figure 26. Alternative B general locations of mechanical and prescribed fire treatments

Table 18. Alternatives B through E road activity miles by restoration unit (RU)

RU	Closed Road Decommission	Unauthorized Road Decommission	Temporary Road Construction and Decommissioning*	Reconstruction –Relocation	Reconstruction –Improvement**
1	190	0	111	2.2	8
3	100	77	172	2.8	9
4	184	33	197	1.1	9
5	252	0	25	0.0	3
6	0	24	15	3.3	1
Total	**726**	**134**	**520**	**<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.

** Road reconstruction improvements are estimated miles for the restoration units.

Table 19. Alternatives B through E 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 Protective Fencing* (Miles)
1	32	24	182	10
3	24	7	201	17
4	14	5	451	41
5	4	2	393	14
6	0	<1	0	0
Total	**74**	**39**	**1,227**	**82**

*See appendix D for details on aspen treatment design.

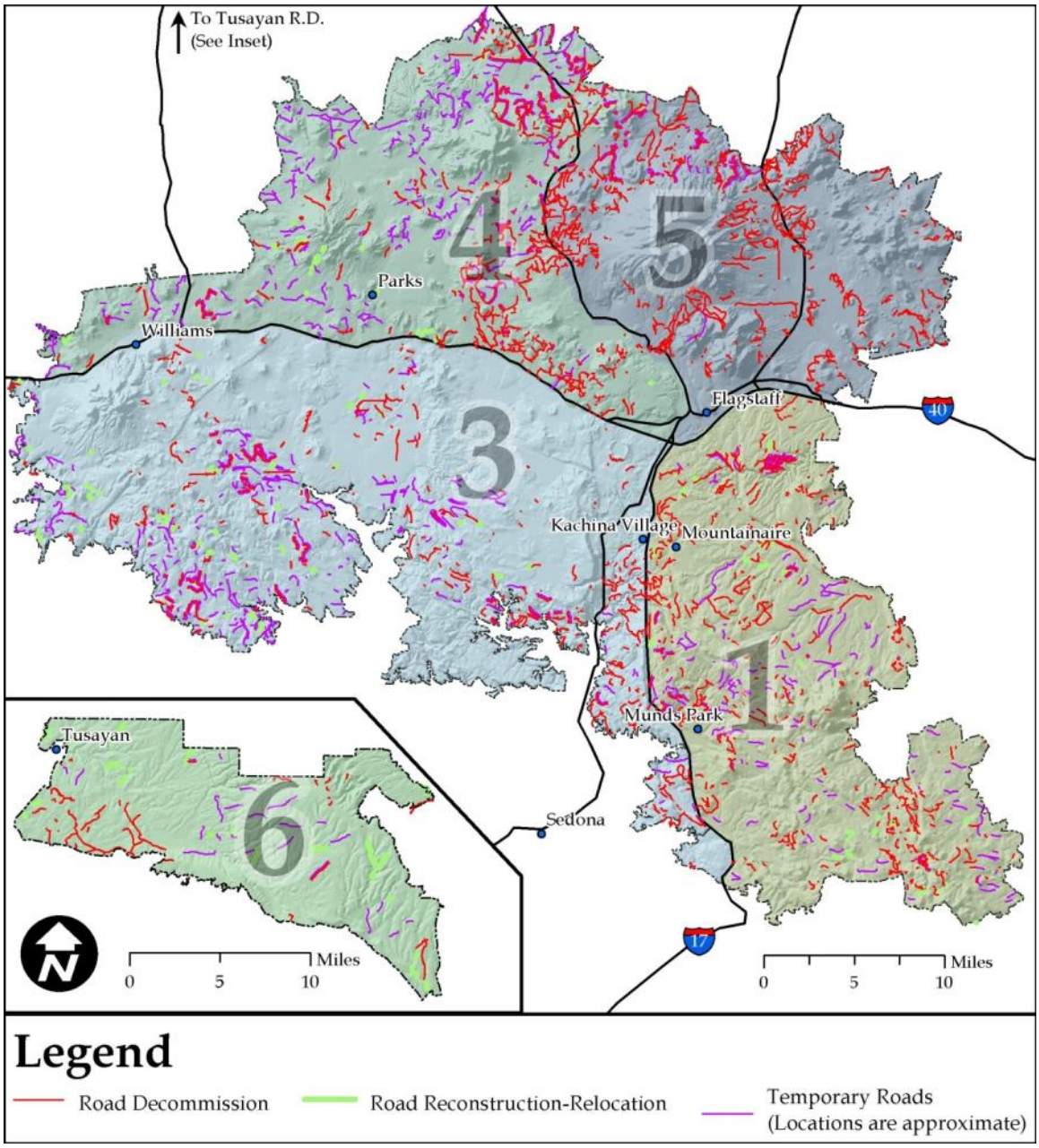

Figure 27. Alternatives B through E general locations of road treatments

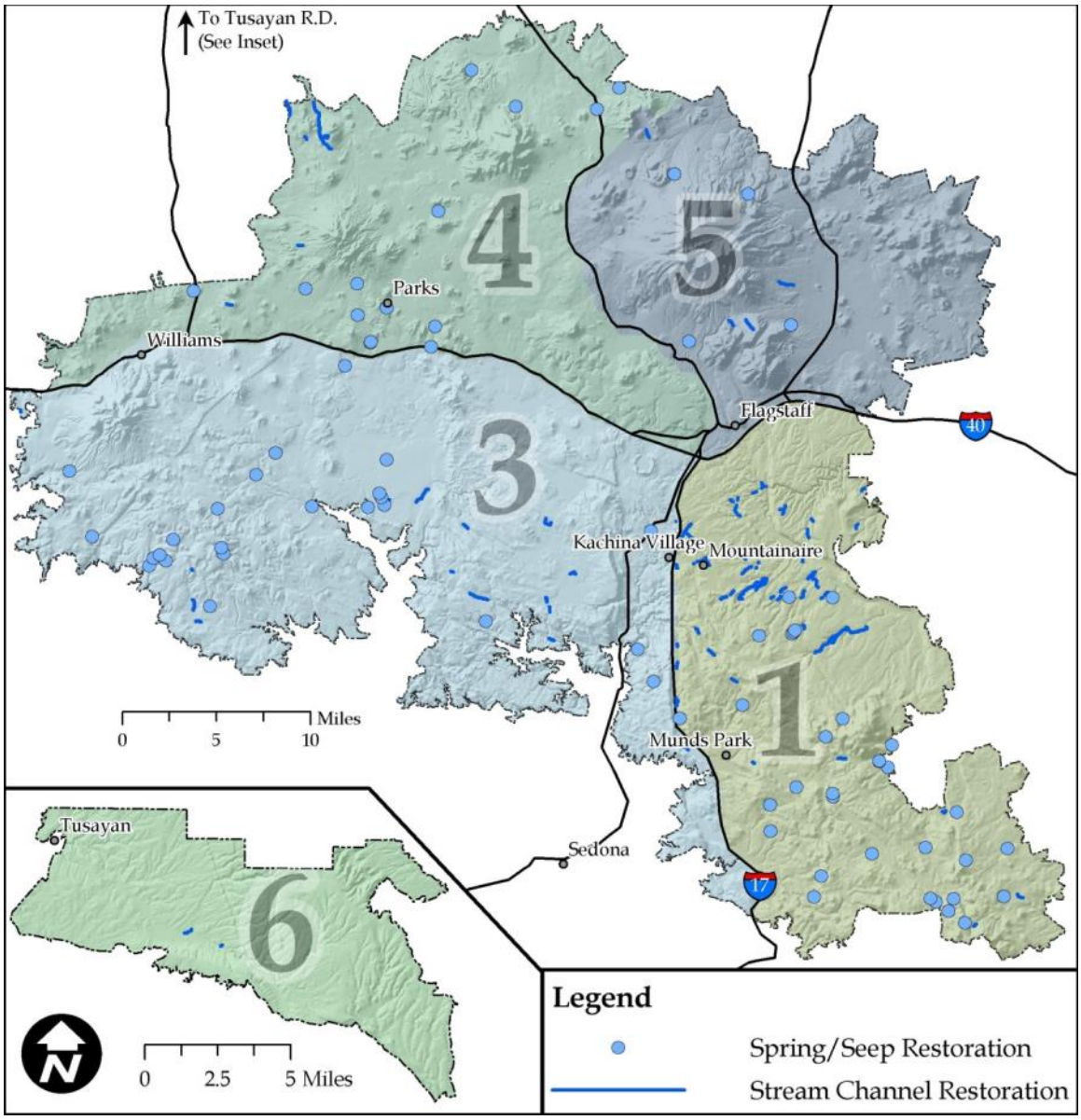

Figure 28. Alternatives B through E general locations of spring and stream treatments

Table 20. Alternative B treatments in goshawk habitat

Treatment Type	Landscapes Outside of Post-fledging Family Area (Acres)	Post-fledging Family Area (Acres)	Dispersal Post-fledging Family Area (Acres)	Total Acres by Treatment Type
Uneven-aged (UEA)*	145,511	9,672	4,446	159,629
Intermediate Thinning (IT)	53,520	3,606	1,022	58,148
Stand Improvement (SI)	20,167	592	76	20,835
Savanna	45,405	0	0	45,405
Grassland	11,185	0	0	11,185
Pine-Sage	4,674	392	195	5,261
Prescribed Fire Only	86,870	8,713	1,299	96,882
Total mechanical treatment acres	280,462	14,262	5,739	300,463
Total prescribed fire treatment areas	367,332	22,975	7,038	397,345

*See appendix, sections 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	20,083	2,354	218 (Target) 83 (Threshold)	22,738
MSO Restricted	0	64,065	0	64,065
MSO Target	0	0	6,497	6,497
MSO Threshold	0	0	1,894	1,894
PAC -Mechanical	10,284	0	0	10,284
Total	**30,367**	**66,419**	**6,715 (Target) 1,977 (Threshold)**	**105,478**

* See appendix, sections C and D for details on design features and mitigation for treatments within Mexican spotted owl habitat.

**Only ponderosa pine acres within Mexican spotted owl PAC habitat is reflected in this table.

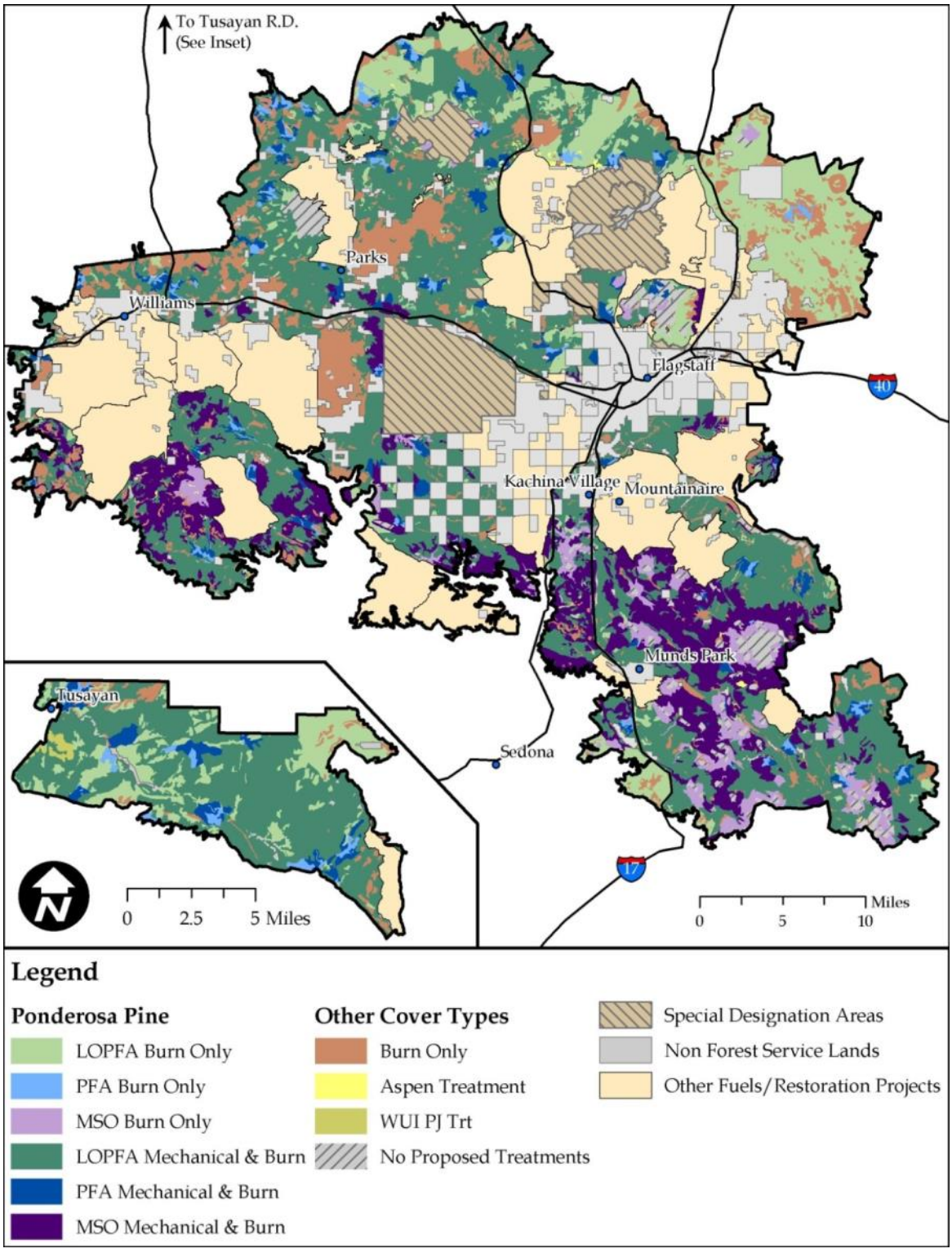

Figure 29. Alternative B mechanical and prescribed fire treatments in goshawk and Mexican spotted owl (MSO) habitat

*PFA = post-fledging areas, LOPFA = landscapes outside of PFAs; WUI PJ Trt = wildland-urban interface pinyon-juniper treatment

Table 22. Alternatives B through E; ponderosa pine old growth 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	144,114	NA	64,090	NA	44	NA
3	58,327	70,898	21,486	25,177	37	36
4	56,957	77,321	17,717	30,342	31	39
5	59,033	NA	23,716	NA	40	NA
6	NA	41,189	NA	10,291	NA	25
Total	**318,431**	**189,408**	**127,009**	**65,810**	**40**	**35**

Table 23. Alternatives B through E; pinyon-juniper old growth 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**

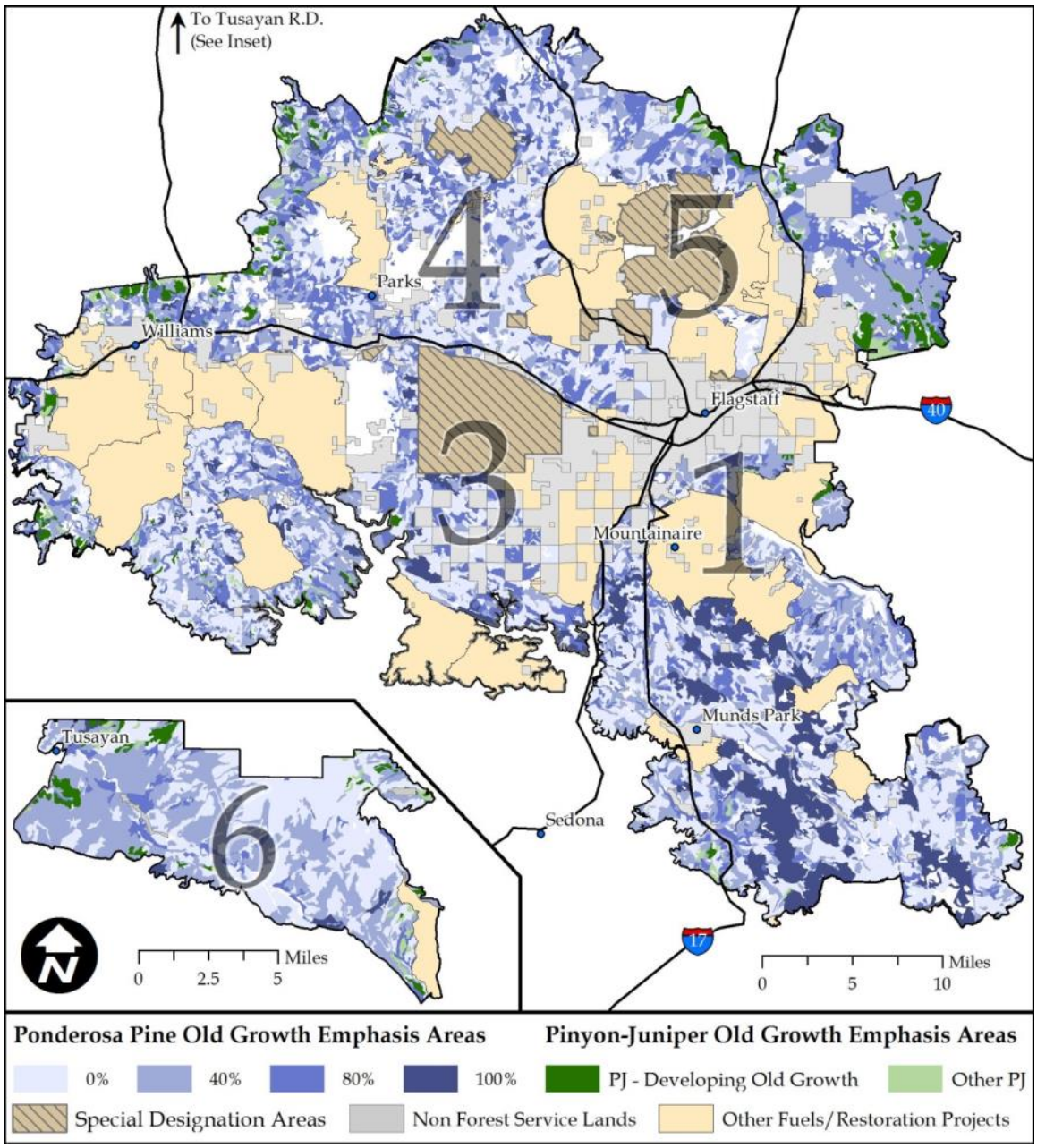

Figure 30. Alternatives B through E; ponderosa pine and pinyon-juniper old growth management (PJ = pinyon-juniper)

Alternative C (Preferred Alternative)

The Coconino and Kaibab NFs would conduct restoration activities on approximately 586,110 acres over a period of 10 years or until objectives are met. On average, 45,000 acres of vegetation would be mechanically treated annually. On average, 40,000 to 60,000 acres of prescribed fire would be implemented annually across the national forests (within the treatment area). Up to two prescribed fires[11] would be conducted on all acres proposed for treatment over the 10-year period. Restoration activities would:

- Mechanically cut trees on approximately 431,049 acres. This includes: (1) mechanically treating up to 17.9 inches d.b.h. within 18 Mexican spotted owl protected activity centers.
- Apply prescribed fire on approximately 431,049 acres where mechanical treatment occurs; this includes using low-severity prescribed fire within 70 Mexican spotted owl protected activity centers (including 54 core areas).
- Use prescribed fire only on approximately 155,061 acres.
- Construct approximately 520 miles of temporary roads for haul access and decommission them 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 726 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 12 flumes and 12 weather stations and associated instrumentation (up to 3 total acres of soil disturbance) to support the paired watershed study.
- Allocate and manage as old growth 40 percent of the ponderosa pine type and 77 percent of the pinyon-juniper woodland on the Coconino NF.
- Manage and develop uneven-aged stands with a representation of old growth components across most of the project area on the Kaibab NF.

No forest plan amendments would be needed on the Kaibab NF. The proposed actions are consistent with forest plan objectives, desired conditions, and standards and guidelines. 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 17.9 inches d.b.h. to improve habitat structure (nesting and roosting habitat) in 18 Mexican spotted owl PACs. These PACs would be managed for a minimum basal area of 110. It would allow low-intensity prescribed fire within 54

[11] A single prescribed fire may include burning piles and a follow-up broadcast burn. Prescribed fire would be implemented as indicated by monitoring data to augment wildfire acres, with the expectation that desired conditions would require a fire return interval of about 10 years.

Mexican spotted owl 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 pre- and post-treatment population and habitat monitoring. Replacement language would defer final project design and monitoring to the U.S. Fish and Wildlife Service biological opinion specific to Mexican spotted owls for the project.

The amendment, which is specific to restricted habitat in pine-oak, would add definitions of target and threshold habitat. It would allow 6,299 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 28,653 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.

An exception to this amendment applies to about 38,256 acres of goshawk habitat. In response to feedback and comments received on treating less aggressively and leaving more large trees, canopy cover would be measured at the stand level on about 38,256 acres of goshawk habitat where there is a preponderance of VSS 4, 5 and 6.

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.

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, table 19, figure 27, and figure 28).

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

Old growth is the same as described in alternative B (see table 22, table 23 and figure 30).

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.	1,227
Prescribed Fire Only	Prescribed fire would be applied exclusively to move treated areas toward desired vegetation conditions.	155,061
AZ Game & 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 to 90 square feet of basal area and manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees with the least amount of mistletoe; Interspace would occupy 10 to 55 percent of the treatment area, respectively. Accompanied by prescribed fire.	7,565
IT 25 25 to 40% interspace)		11,871
IT 40 (40 to 55% interspace)		38,616
Mexican spotted owl (MSO) Threshold	Same as MSO Target (below)	1,892
MSO Target	Intermediate thinning designed to improve forest health, reduce fire risk, and meet forest density, structure, and species composition requirements. Accompanied by prescribed fire.	6,495
MSO Restricted	Uneven-aged 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.	62,785
MSO PAC	Mechanical treatment designed to increase tree vigor and health and create canopy gaps to reduce fire risk. Accompanied by prescribed fire.	10,284
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
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 presettlement tree density and pattern, and manages for a range of 70 to 90 percent of the treatment area as interspace (grass/forb) between tree groups or individual trees using pre-settlement tree evidence as guidance. Treatment would be accompanied by prescribed fire.	45,142

Treatment Type	Treatment Description/Objective	Acres
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 co-dominant trees within each group; Interspace would occupy 10 to 55 percent of the treatment area, respectively. Treatments would be accompanied by prescribed fire.	1,914
SI 25 (25 to 40% interspace)		6,618
SI 40 (40 to 55% interspace)		12,270
Uneven-aged (UEA) 10 (10 to 25% interspace)	Uneven-aged mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 10 to 25 percent of the treatment area. Accompanied by prescribed fire.	17,865
UEA 25 (25 to 40% interspace)	Uneven-aged mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 25 to 40 percent of the treatment area. Accompanied by prescribed fire.	38,492
UEA 40 (40 to 55% interspace)	Uneven-aged mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 40 to 55 percent of the treatment area. Accompanied by prescribed fire.	95,730
Wildland-urban Interface Pinyon-juniper	Mechanical treatment around the community of Tusayan designed to reduce fire risk and meet Community Wildfire Protection Plan objectives. Accompanied by prescribed fire	535
Wildland-urban Interface (55 to 70% interspace)	Uneven-aged mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 55 to 70 percent of the treatment area. Accompanied by prescribed fire.	2,224
Paired Watershed Study	2,300 acres of control watersheds and infrastructure (50 ft. high towers with no guy lines, snow pillows, 12 flumes and 12 weather stations and associated instrumentation) to evaluate how restoration affects water yield and carbon. No fire treatments for 5 to 7 years in control watersheds.	Up to 3

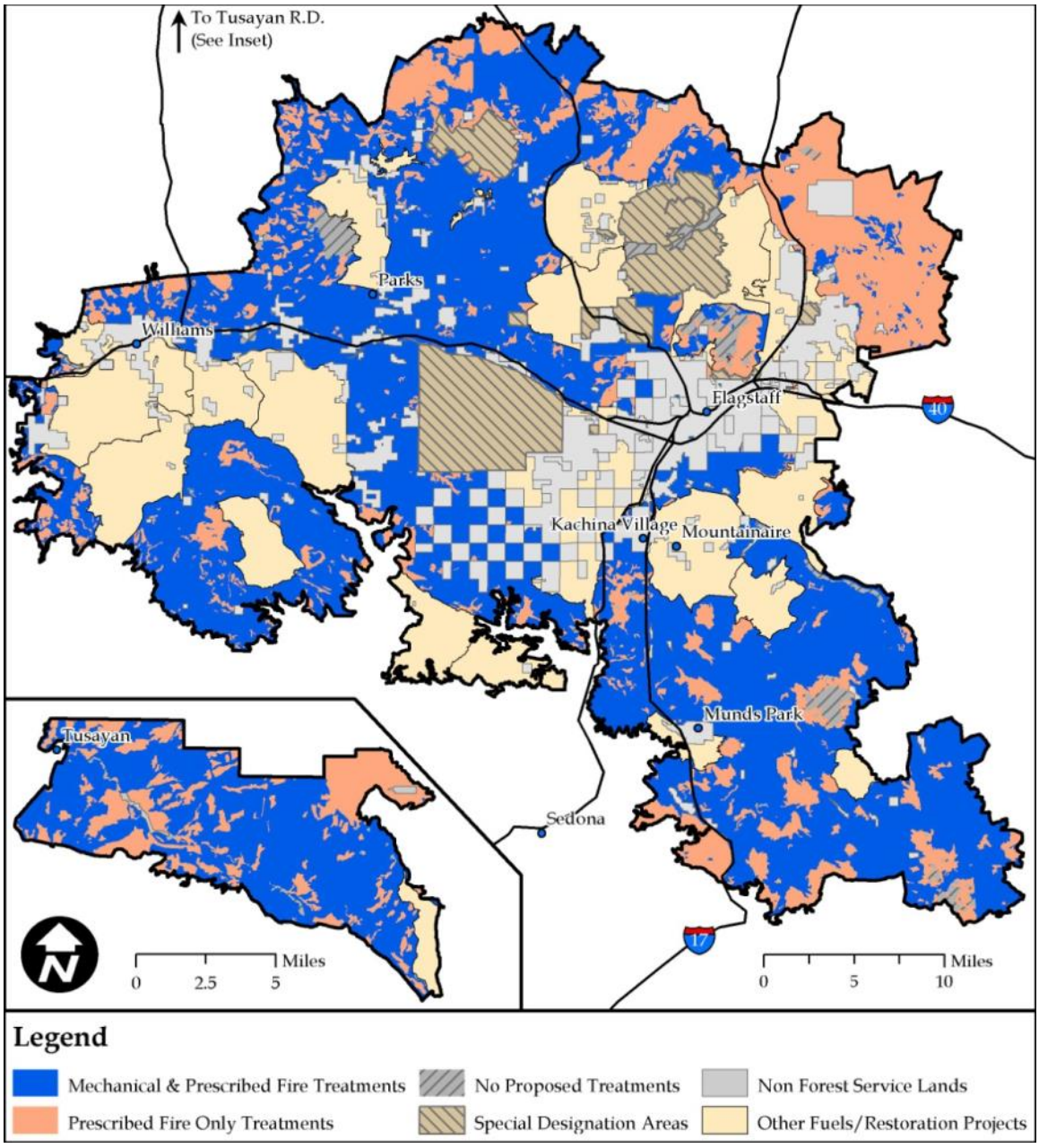

Figure 31. Alternative C mechanical and prescribed fire treatments

Table 25. Alternative C treatments in goshawk habitat

Vegetation Treatment Type	Landscapes Outside of Post-fledging Family Area (Acres)	Post-fledging Family Area (Acres)	Dispersal Post-fledging Family Area (Acres)	Total Acres by Treatment Type
Uneven-aged (UEA)*	145,122	9,579	4,447	159,148
Intermediate Thinning (IT)	53,423	3,607	1,022	58,052
Stand Improvement (SI)	20,133	592	76	20,801
Savanna	45,142	0	0	45,142
Grassland restoration within ponderosa pine	11,230	0	0	11,230
Pine-Sage	4,674	392	195	5,261
Prescribed Fire Only	86,869	8,709	1,299	96,877
Total mechanical treatment acres	279,724	14,170	5,740	299,634
Total prescribed fire treatment areas	366,594	22,878	7,039	396,511

*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	24,735	2,354	217 (Target) 84 (Threshold)	27,390
MSO Restricted	0	62,785	0	62,785
MSO Target	0	0	6,495	6,495
MSO Threshold	0	0	1,892	1,892
PAC Mechanical	10,284	0	0	10,284
Total	**35,019**	**65,139**	**6,712 (Target)** **1,976 (Threshold)**	**108,846**

* See appendix C and D for details on how treatments would be designed within Mexican spotted owl habitat.

** Only ponderosa pine acres within Mexican spotted owl PAC habitat is reflected in this table.

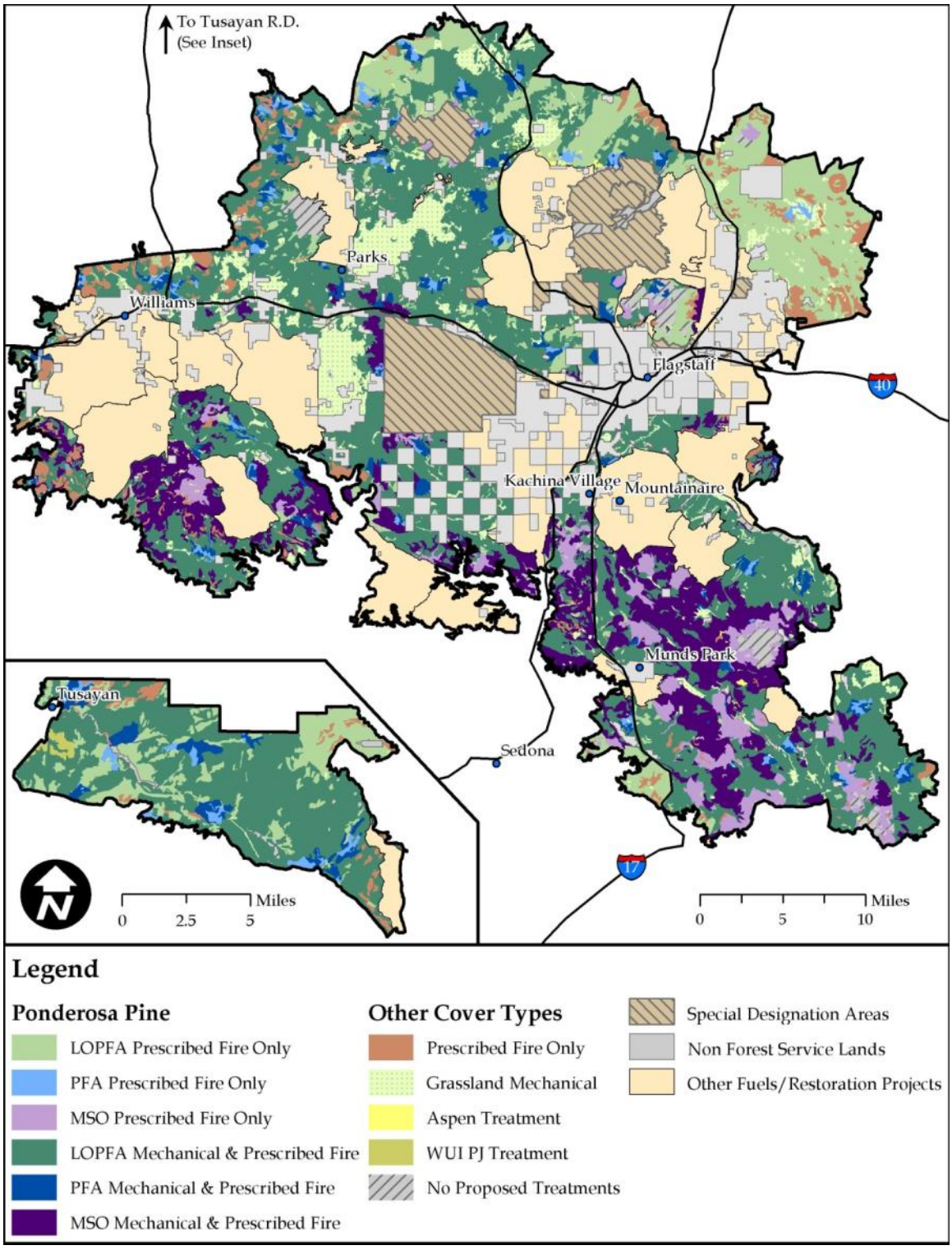

Figure 32. Alternative C mechanical and prescribed fire treatments in goshawk and Mexican spotted owl (MSO) habitat

*PFA = post-fledging areas, LOPFA = landscapes outside of PFAs; WUI PJ = wildland-urban interface pinyon-juniper

Alternative D

Alternative D responds to Issue 2 (prescribed fire emissions) by decreasing prescribed fire acres by 69 percent (when compared to alternative B, proposed action). This equates to removing fire on about 404,889 acres. A select number of Mexican spotted owl 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 563,407 acres over a period of 10 years or until objectives are met. On average, 45,000 acres of vegetation would be mechanically treated annually. On average, 40,000 acres of prescribed fire would be implemented annually across the national forests (within the treatment area). Two prescribed fires would occur over the 10-year treatment period. Restoration activities would:

- Mechanically cut trees on approximately 384,966 acres. This includes: (1) mechanically treating up to 16 inches d.b.h. within 18 Mexican spotted owl PACs, and (2) disposing of slash through various methods including chipping, shredding, mastication, and removal of biomass off-site.
- Use prescribed fire only on approximately 178,441 acres.
- Construct 520 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 726 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 and manage as old growth 40 percent of the ponderosa pine type and 77 percent of the pinyon-juniper woodland on the Coconino NF.
- Manage and develop uneven-aged stands with a representation of old growth components across most of the project area on the Kaibab NF

No forest plan amendments would be needed on the Kaibab NF. The proposed actions are consistent with forest plan objectives, desired conditions, and standards and guidelines. 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 inches d.b.h. to improve habitat structure (nesting and roosting habitat) in 18 Mexican spotted owl PACs. These PACs would be managed for a minimum basal area of 110. 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 pre- and post-treatment population and habitat monitoring.

Replacement language would defer final project design and monitoring to the U.S. Fish and Wildlife Service biological opinion specific to Mexican spotted owls for the project.

The amendment, which is specific to restricted habitat in pine-oak, would add definitions of target and threshold habitat.

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 28,952 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.

Alternative D Tables and Figures

Table 27 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 acres by forest, restoration unit, and vegetation type. Figure 30 displays the general location of existing and developing old growth.

Table 28 and table 29 provide treatment type and acres in goshawk and Mexican spotted owl habitat, respectively. 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.	1,227
Prescribed Fire Only	Prescribed fire would be applied exclusively to move treated areas toward desired vegetation conditions.	178,441
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.	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 to 90 square feet of basal area and manages for improved tree vigor and growth by	7,565
IT 25 25 to 40% interspace)		11,871

Treatment Type	Treatment Description/Objective	Acres
IT 40 (40 to 55% interspace)	retaining the best growing dominant and co-dominant trees with the least amount of mistletoe; Interspace would occupy 10 to 55 percent of the treatment area, respectively.	38,713
Mexican spotted owl (MSO) Threshold	Same as MSO Target (below)	1,894
MSO Target	Intermediate thinning designed to improve forest health, reduce fire risk, and meet forest density, structure, and species composition requirements.	6,497
MSO Restricted	Uneven-aged mechanical treatment designed to develop uneven-aged structure, irregular tree spacing, a mosaic of interspaces and tree groups of varying sizes.	64,065
MSO PAC	Mechanical treatment designed to increase tree vigor and health and create canopy gaps to reduce fire risk.	10,284
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 presettlement tree density and pattern, and manages for a range of 70 to 90 percent of the treatment area as interspace (grass/forb) between tree groups or individual trees using pre-settlement tree evidence as guidance.	45,405
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 co-dominant trees within each group; Interspace would occupy 10 to 55 percent of the treatment area, respectively.	1,914
SI 25 (25 to 40% interspace)		6,618
SI 40 (40 to 55% interspace)		12,303
Uneven-aged (UEA) 10 (10 to 25% interspace)	Uneven-aged mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 10 to 25 percent of the treatment area.	18,082
UEA 25 (25 to 40% interspace)	Uneven-aged mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 25 to 40 percent of the treatment area.	39,190
UEA 40 (40 to 55% interspace)	Uneven-aged mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 40 to 55 percent of the treatment area.	100,133
Wildland-urban Interface Pinyon-juniper	Mechanical treatment around the community of Tusayan designed to reduce fire risk and meet Community Wildfire Protection Plan objectives.	535
Wildland-urban Interface (55 to 70% interspace)	Uneven-aged mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 55 to 70 percent of the treatment area. Accompanied by prescribed fire.	2,224

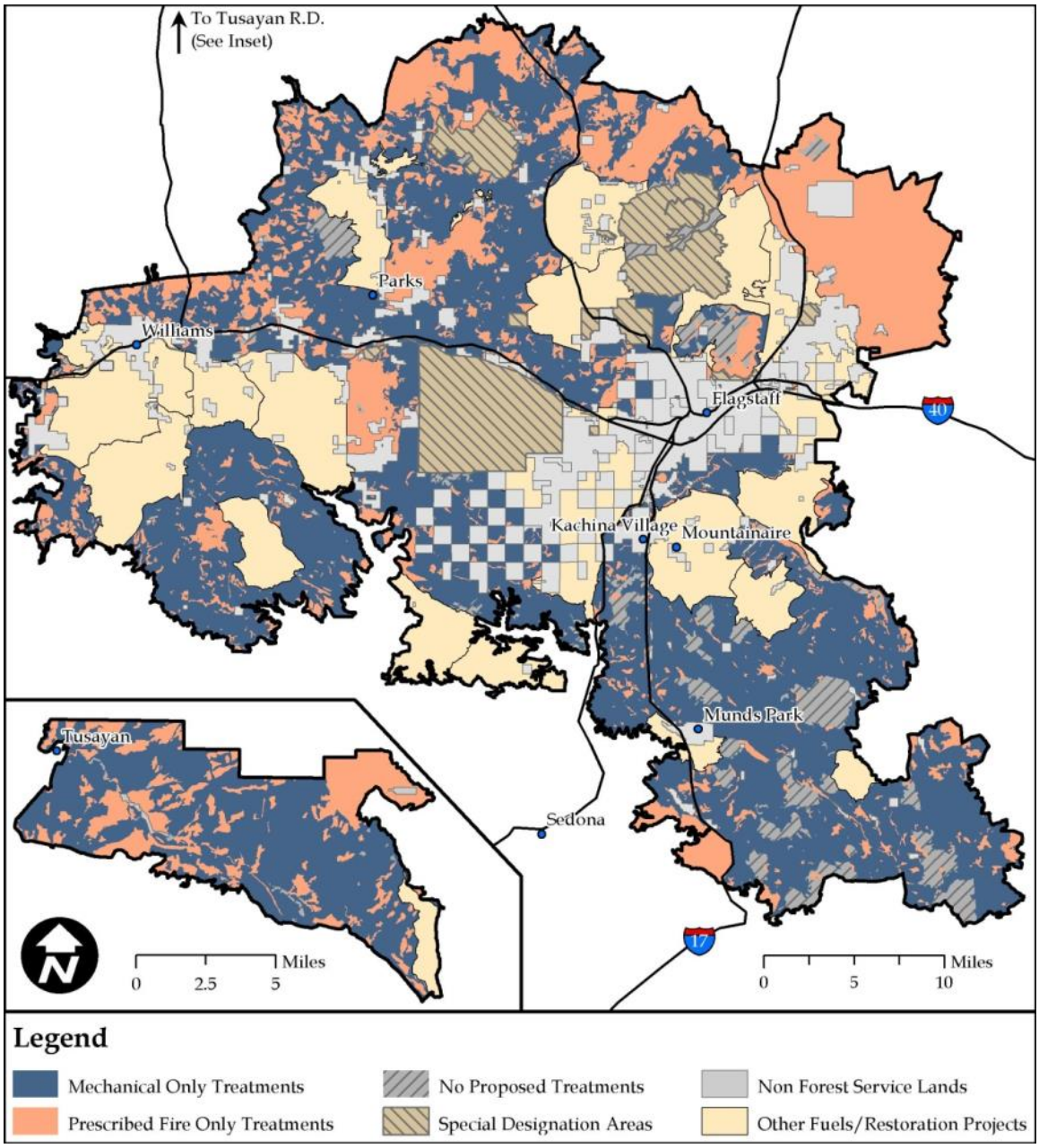

Figure 33. Alternative D mechanical and prescribed fire treatments

Table 28. Alternative D treatments in goshawk habitat

Vegetation Treatment Type	Landscapes Outside of Post-fledging Family Area (Acres)	Post-fledging Family Area (Acres)	Dispersal Post-fledging Family Area (Acres)	Total Acres by Treatment Type
Uneven-aged (UEA)*	145,511	9,672	4,446	159,629
Intermediate Thinning (IT)	53,520	3,606	1,022	58,148
Stand Improvement (SI)	20,167	592	76	20,835
Savanna	45,405	0	0	45,405
Grassland Restoration	11,185	0	0	11,185
Pine-Sage	4,674	392	195	5,261
Prescribed Fire Only	86,870	8,713	1,299	96,882
Total Mechanical Treatment Acres	280,462	14,262	5,739	300,463
Total Prescribed Fire Treatment Areas	86,870	8,713	1,299	96,882

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

Table 29. Alternative D treatments in Mexican spotted owl (MSO) habitat

Treatment Type*	Protected Habitat** (Acres)	Restricted Habitat (Acres)	Target and Threshold Habitat (Acres)	Total Treatment Acres
Prescribed Fire Only	836	2,354	218 Target 83 Threshold	3,491
MSO Restricted	0	64,065	0	64.065
MSO Target	0	0	6,497	6,497
MSO Threshold	0	0	1,894	1,894
PAC - Mechanical	10,284	0	0	10,284
Total	**11,120**	**66,419**	**6,715 Target 1,977 Threshold**	**86,231**

* See appendix C and D for details on how treatments would be designed within Mexican spotted owl habitat.

** Only ponderosa pine acres within Mexican spotted owl protected activity center (PAC) habitat is reflected in this table.

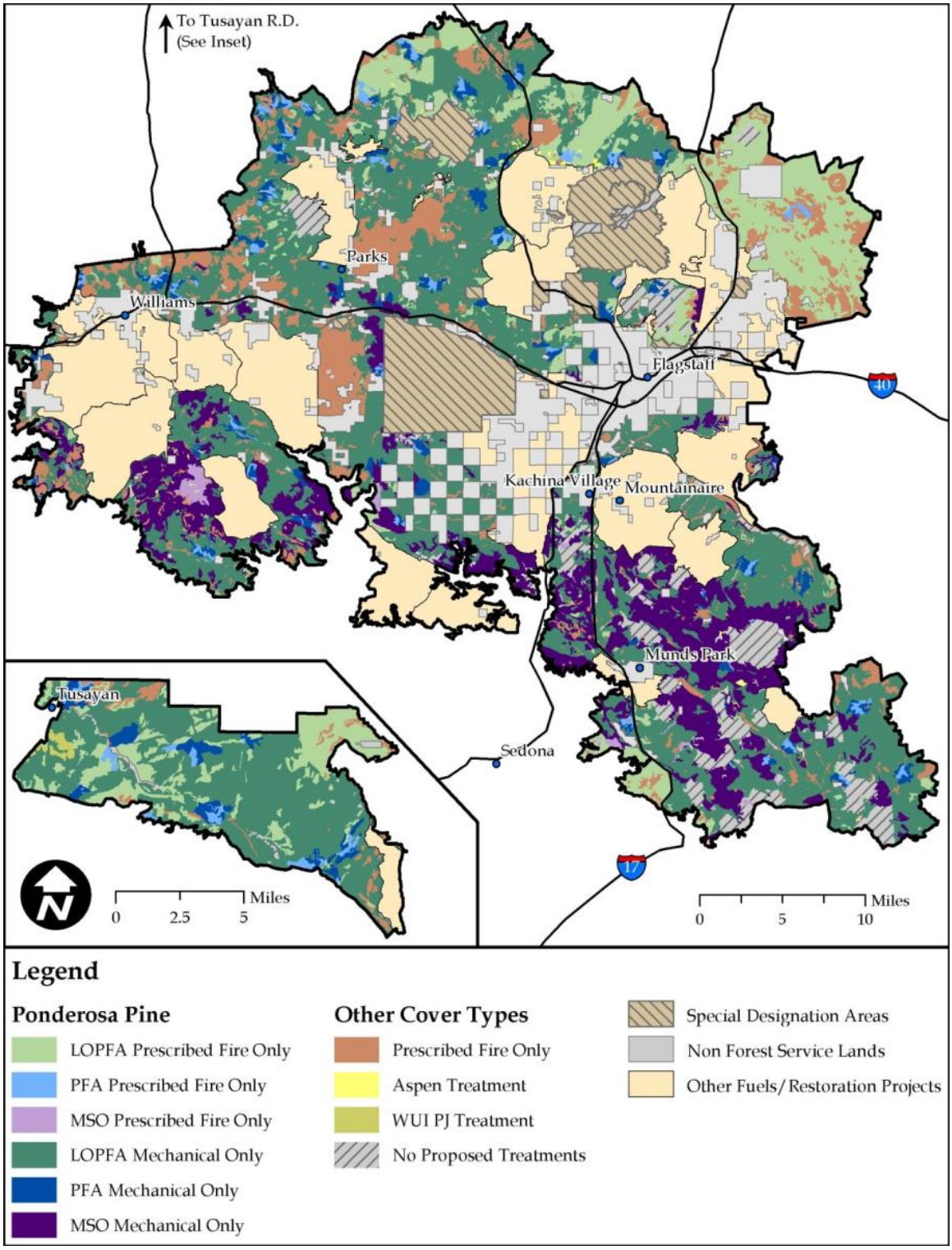

Figure 34. Alternative D mechanical and prescribed fire treatments in goshawk and Mexican spotted owl (MSO) habitat

*PFA = post-fledging areas, LOPFA = landscapes outside of PFAs; WUI PJ = wildland-urban interface pinyon-juniper

Alternative E

In alternative E 18 Mexican spotted owl PACs would be mechanically treated to 9 inches d.b.h. No prescribed fire would be utilized within PAC core areas. No acres would be managed for an open reference condition[12]. No treatments would occur within the Garland Prairie management area. Mexican spotted owl population and habitat monitoring would follow current forest plan direction and the U.S. Fish and Wildlife Service biological opinion. The paired watershed study and small mammal research would occur. Key components of the stakeholder-created Large Tree Retention Strategy are incorporated into this alternative's implementation plan.

The Coconino and Kaibab NFs would conduct restoration activities on approximately 581,020 acres over a period of 10 years or until objectives are met. On average, 45,000 acres of vegetation would be mechanically treated annually. On average, 40,000 acres of prescribed fire would be implemented annually across the Forests (within the treatment area). Two prescribed fires would occur over the 10-year treatment period.

Restoration activities would:

- Mechanically cut trees on approximately 403,218 acres. This includes: (1) mechanically treating up to 9 inches d.b.h. within 18 Mexican spotted owl PACs, and (2) disposing of slash through various methods including chipping, shredding, mastication, and removal of biomass off-site.
- Apply prescribed fire on approximately 403,218 acres where mechanical treatment occurs.
- Use prescribed fire only on approximately 177,801 acres.
- Construct 520 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 726 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 12 flumes and 12 weather stations and associated instrumentation (up to 3 total acres of soil disturbance) to support the paired watershed study.
- Allocate and manage as old growth 40 percent of the ponderosa pine type and 77 percent of the pinyon-juniper woodland on the Coconino NF.
- Manage and develop uneven-aged stands with a representation of old growth components across most of the project area on the Kaibab NF.

[12] Open reference condition is defined as forested ponderosa pine areas with mollic integrade soils to be managed as a relatively open forest with trees typically aggregated in small groups within a grass/forb/shrub matrix.

Note: Measuring canopy cover at the stand level on about 38,256 acres of goshawk habitat where there is a preponderance of VSS 4, 5 and 6 represents no change to the current Coconino NF forest plan.

Alternative E Tables and Figures

Table 30 describes treatments and provides treatment acres. Figure 35 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 acres by forest, restoration unit, and vegetation type. Figure 30 displays the general location of existing and developing old growth.

Table 31 and table 32 provide treatment type and acres in goshawk and Mexican spotted owl habitat, respectively. Figure 36 displays the general treatment locations.

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

Table 30. Alternative E 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.	1,227
Prescribed Fire Only	Prescribed fire would be applied exclusively to move treated areas toward desired vegetation conditions.	177,801
AZ Game & 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 Mechanical	Mechanical treatment in grassland vegetation types. Accompanied by prescribed fire.	47,880
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 to 90 square feet of basal area and manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees with the least amount of mistletoe; Interspace would occupy 10 to 55 percent of the treatment area, respectively.	7,565
IT 25 25 to 40% interspace)		11,871
IT 40 (40 to 55% interspace)		40,272
Mexican spotted owl (MSO) Threshold	Same as MSO Target (below)	1,892
MSO Target	Intermediate thinning designed to improve forest health, reduce fire risk, and meet forest density, structure, and species composition requirements. Accompanied by prescribed fire.	7,059

Treatment Type	Treatment Description/Objective	Acres
MSO Restricted	Uneven-aged 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.	62,222
MSO PAC	Mechanical treatment designed to increase tree vigor and health and create canopy gaps to reduce fire risk. Accompanied by prescribed fire.	10,284
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
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
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 co-dominant trees within each group; Interspace would occupy 10 to 55 percent of the treatment area, respectively. Treatments would be accompanied by prescribed fire.	1,914
SI 25 (25 to 40% interspace)		6,618
SI 40 (40 to 55% interspace)		13,596
Uneven-aged (UEA) 10 (10 to 25% interspace)	Uneven-aged mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 10 to 25 percent of the treatment area. Accompanied by prescribed fire.	17,865
UEA 25 (25 to 40% interspace)	Uneven-aged mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 25 to 40 percent of the treatment area. Accompanied by prescribed fire.	38,492
UEA 40 (40 to 55% interspace)	Uneven-aged mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 40 to 55 percent of the treatment area. Accompanied by prescribed fire.	121,570
Wildland-urban Interface Pinyon-juniper	Mechanical treatment around the community of Tusayan designed to reduce fire risk and meet Community Wildfire Protection Plan objectives. Accompanied by prescribed fire	535
Wildland-urban Interface (55 to 70% interspace)	Uneven-aged mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 55 to 70 percent of the treatment area. Accompanied by prescribed fire.	2,224
Paired Watershed Study	2,300 acres of control watersheds and infrastructure (50-ft. high towers with no guy lines, snow pillows, 12 flumes and 12 weather stations and associated instrumentation) to evaluate how restoration affects water yield and carbon. No fire treatments for 5 to 7 years in control watersheds.	Up to 3

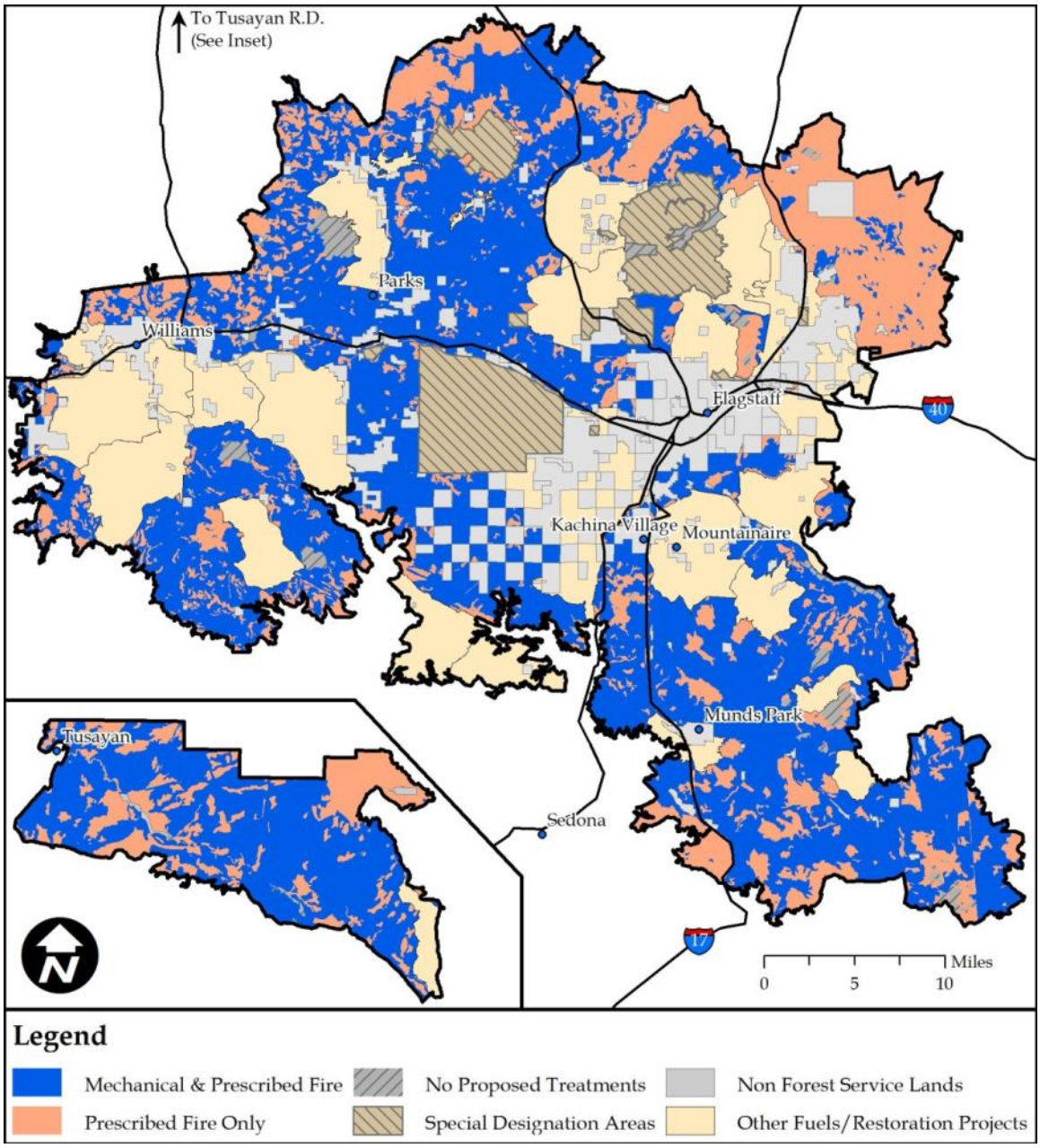

Figure 35. Alternative E mechanical and prescribed fire treatments

Table 31. Alternative E Treatments in goshawk habitat

Vegetation Treatment Type	Landscapes Outside of Post-fledging Family Area (Acres)	Post-fledging Family Area (Acres)	Dispersal Post-fledging Family Area (Acres)	Total Acres by Treatment Type
Uneven-aged (UEA)*	170,962	9,579	4,447	184,988
Intermediate Thinning (IT)	55,080	3,606	1,022	59,708
Stand Improvement (SI)	21,459	592	76	22,127
Pine-Sage	4,674	392	195	5,261
Prescribed Fire Only	114,298	8,709	1,299	124,306
Total Mechanical Treatment Acres	252,175	14,169	5,740	272,084
Total Prescribed Fire Treatment Areas	366,473	22,878	7,039	396,390

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

Table 32. Alternative E treatments in Mexican spotted owl (MSO) habitat

Treatment Type*	Protected Habitat** (Acres)	Restricted Habitat (Acres)	Target and Threshold Habitat (Acres)	Total Treatment Acres
Prescribed Fire Only	20,083	2,354	217 Target 84 Threshold	22,738
MSO Restricted	0	62,222	0	62,222
MSO Target	0	0	7,059	7,059
MSO Threshold	0	0	1,892	1,892
PAC - Mechanical	10,284	0	0	10,284
Total	**30,367**	**64,576**	**7,276 Target 1,976 Threshold**	**104,195**

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

** Only ponderosa pine acres within Mexican spotted owl protected activity center (PAC) habitat is reflected in this table.

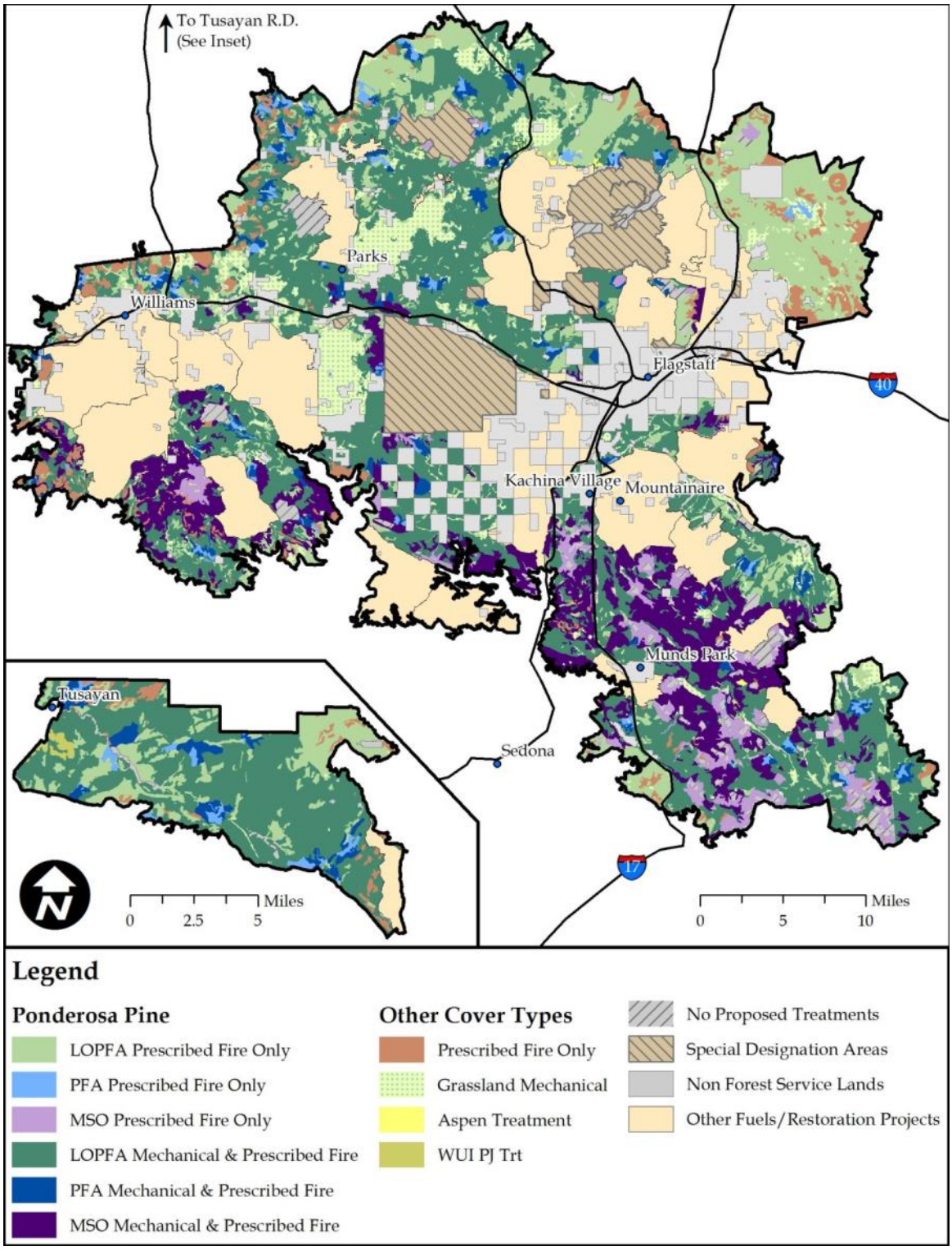

Figure 36. Alternative E mechanical and prescribed fire treatments in goshawk and Mexican spotted owl (MSO) habitat

*PFA = post-fledging areas, LOPFA = landscapes outside of PFAs; WUI PJ Trt= wildland-urban interface pinyon-juniper treatment

Comparison of Alternatives

Table 33 provides a summary of the alternatives. Table 34 provides a summary of the proposed Coconino NF forest plan amendments. Table 35 describes potential effects of implementing each alternative considered in detail. Information in table 35 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 33. Comparison of alternatives analyzed in detail

Proposed Activity	Alternative A (No Action)	Alternative B (Proposed Action)	Alternative C (Preferred)	Alternative D	Alternative E
Vegetation Mechanical Treatment (acres)	Under forest plan implementation	384,966	431,049	384,966	403,218
Prescribed Fire (acres)*	Under forest plan implementation	583,330	586,110	178,441	581,020
Mexican Spotted Owl Protected Activity Center (MSO PAC) Habitat Treatments	Under forest plan implementation	Mechanically treat up to 16 inches d.b.h. in 18 PACs (excluding core areas). Use prescribed fire in 70 MSO PACs (excluding core areas).	Mechanically treat up to 17.9 inches d.b.h. in 18 PACs and manage these PACs for a minimum of 110 basal area. Use prescribed fire in 54 MSO PACs (including core areas). Use prescribed fire in 16 MSO PACs (excluding core areas).	Mechanically treat up to 16 inches d.b.h. in 18 PACs (excluding core areas).	Mechanically treat up to 9 inches d.b.h. in 18 PACs (excluding core areas). Use prescribed fire in 70 MSO PACs (excluding core areas).
Springs Restored (number)	Under forest plan implementation	74	Same as alternative B		
Springs Protective Fence Construction (miles)	Under forest plan implementation	Up to 4	Same as alternative B		
Aspen Protective Fencing (miles)	Under forest plan implementation	Up to 82	Same as alternative B		
Ephemeral Stream Restoration (miles)	Under forest plan implementation	39	Same as alternative B		
Temporary Road Construction and Decommission (miles)	Under forest plan implementation	Up to 520	Same as alternative B		
Road Reconstruction/Improvement (miles)	Under forest plan implementation	Up to 30	Same as alternative B		
Road Relocation (miles)	Under forest plan implementation	Up to 10	Same as alternative B		
Existing Road Decommission (miles)	Under forest plan implementation	726	Same as alternative B		
Unauthorized Route Decommission (miles)	Under forest plan implementation	134	Same as alternative B		

*On those acres proposed for prescribed fire, two fires would be conducted over the 10- year period.

Table 34. Summary of forest plan amendments by alternative and theme for the Coconino NF

Alternative	Mechanical Treatments in PACs	Treatments in PAC Core Areas	Restricted Habitat Management	Basal Area in Restricted Target and Threshold Habitat	Population and Habitat Monitoring	Habitat Treatment in Incremental Percentages
Forest Plan Amendment 1: Theme - Management in Mexican Spotted Owl Habitat on the Coconino NF						
A, E	N/A					
B	Amendment 1: Allows mechanical treatment up to 16 inches d.b.h. in 18 PACs	N/A: No PAC core area treatments	Amendment 1: Adds definitions for target and threshold habitat	N/A—basal area in restricted target and threshold habitat remains 150 on both forests	Amendment 1: Defers monitoring to the project's U.S. Fish and Wildlife Service (FWS) biological opinion	Amendment 1: Defers treatment design to the project's FWS biological opinion
C	Amendment 1: Allows mechanical treatment up to 17.9 inches d.b.h. in 18 PACs and decreases the minimal basal area from 150 to 110 in the 18 PACs	Amendment 1: Allows prescribed fire in 54 core areas	Amendment 1: Adds definitions for target and threshold habitat	Amendment 1:Allows for managing 6,299 acres of restricted target and threshold habitat for a minimum range of 110 to 150 basal area	Amendment 1: Defers monitoring to the project's FWS biological opinion	Amendment 1: Defers treatment design to the project's FWS biological opinion
D	Amendment 1: Allows mechanical treatment up to 16 inches d.b.h. in 18 PACs	N/A: No PAC core area treatments	Amendment 1: Adds definitions for target and threshold habitat	N/A—basal area in restricted target and threshold habitat remains 150	Amendment 1: Defers MSO monitoring to the project's FWS biological opinion	Amendment 1: Defers treatment design to the project's FWS biological opinion
Forest Plan Amendment 2: Theme - Management of Canopy Cover and Ponderosa Pine with an Open Reference Condition within Goshawk Habitat on the Coconino NF						
A	N/A					
B-D	Amendment 2: (1) adds the desired percentage of interspaces within uneven-aged stands to facilitate restoration, (2) adds the interspaces distance between tree groups, (3) adds language clarifying where canopy cover is and is not measured, (4) allows 28,952 acres (alternatives B and D) and 28,653 (alternative C only) to be managed for an open reference condition (up to 90 percent open with less than 3 to 5 reserve trees), and (5) adds a definition to the forest plan glossary for the terms: interspaces, open reference condition, and stands.					
E	N/A: No desired percentage of interspaces would be added. No language clarifying where canopy cover is and is not measured would be added. Zero acres would be managed for up to 90 percent open with less than 3 to 5 reserve trees. No definition of interspace and stands would be added.					
Forest Plan Amendment 3: Theme - Effect Determination for Cultural Resources on the Coconino NF						
A	N/A					
B-D	Amendment 3: The amendment deletes the standard that would require achieving a "no effect" determination and adds the words "or no adverse effect" to the remaining standard. In effect, management strives to achieve a "no effect" or "no adverse effect" determination.					
E	N/A: Forest plan standard that would require achieving a "no effect" determination would remain in place.					

Table 35. Summary comparison of alternatives effects[13]

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Heterogeneity (Purpose and Need, Issue 3)							
Projectwide Landscape Scale							
Percent Openness or Interspace Percentage of the forested area that is grass-forb-shrub interspace within ponderosa pine: Very Open: 70 to 90% Open: 40-70% Moderately Closed: 25-40% Closed: <25%	Very Open: 3%	The percentage of openness ranges from very open to closed. The degree of openness is determined by soils and site potential.	3% Very Open	13% Very Open (result of grassland and savanna treatments)	13% Very Open (result of grassland and savanna treatments)	13% Very Open (result of grassland and savanna treatments)	3% Very Open (result of existing condition being very open)
	Open: 22%		22% Open	(2020) 46% Open (result of 40 to 55% interspace and WUI treatments)	(2020) 45% Open (result of 40 to 55% interspace and WUI treatments)	(2020) 46% Open (result of 40 to 55% interspace and WUI treatments)	(2020) 54% Open (result of 40 to 55% interspace and WUI treatments)
	Moderately Closed: 29%		75% Moderately Closed – mix of open and closed conditions	(2020) 28% Moderately Closed – mix of open and closed conditions	(2020) 28% Moderately Closed – mix of open and closed conditions	(2020) 28% Moderately Closed – mix of open and closed conditions	(2020) 29% Moderately Closed – mix of open and closed conditions
	Closed: 46%			(2020) 13% Closed – Large and Old Trees, interlocking crowns	(2020) 14% Closed – Large and Old Trees, interlocking crowns	(2020) 13% Closed – Large and Old Trees, interlocking crowns	(2020) 14% Closed – Large and Old Trees, interlocking crowns
Heterogeneity of Mexican Spotted Owl Protected Habitat – Subset of Landscape Scale							
Percent (%) and Acres (ac.) of Openness or Interspace	Very Open: 1% (329 ac.	Mostly closed with large and old trees and interlocking crowns	No change from existing condition	1% (329 ac.)	1% (329 ac.)	1% (329 ac.)	1% (329 ac.)
	Open: 4% (1,259 ac.)			4% (1,259 ac.)	4% (1,259 ac.)	4% (1,259 ac.)	4% (1,259 ac.)
	Moderately Closed: 19% (7,554 ac.)			21% (7,554 ac.)	21% (7,554 ac.)	21% (7,554 ac.)	21% (7,554 ac.)
	Closed: 74% (26,120 ac.)			74% (26,120 ac.)	74% (26,120 ac.)	74% (26,120 ac.)	74% (26,120 ac.)

[13] Notes: Percentages may not add up to 100 percent due to rounding errors.
The following symbols and acronyms are found throughout the summary comparison tables: * LOPFA = landscapes outside of goshawk post-fledging family areas or non-PFAs; ccf = 100 cubic feet; WUI = wildland-urban interface; % = percent; > = greater than; < = less than; ≥ = greater than or equal to; ≤ = less than or equal to

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Heterogeneity of Mexican Spotted Owl Restricted (All) Habitat – Subset of Landscape Scale							
Percent (%) and Acres (ac.) of Openness or Interspace	Very Open: <1% (342 ac.)	Percentage of interspace ranges from very open/open (prey habitat) to closed (large and old trees, interlocking crowns)	No change from existing condition	<1% (342 ac.)	<1% (342 ac.)	<1% (342 ac.)	<1% (342 ac.)
	Open: 9% (6,701 ac.)			9% (6,701 ac.)	9% (6,701 ac.)	9% (6,701 ac.)	9% (6,701 ac.)
	Moderately Closed: 24% (18,041 ac.)			80% (59,598 ac.)	78% (58,769 ac.)	80% (59,598 ac.)	78% (58,397 ac.)
	Closed: 67% (50,027 ac.)			11% (8,470 ac.)	13% (9,299 ac.)	11% (8,470 ac.)	13% (9,671 ac.)
Heterogeneity of Goshawk PFA/dPFA Habitat – Subset of Landscape Scale							
Percent (%) and Acres (ac.) of Openness or Interspace	Very Open: 2% (499 ac.) Open: 14% (4,270 ac.) Moderately Closed: 38% (11,531 ac.) Closed: 46% (13,714 ac.)	Mostly closed with large and old trees and interlocking crowns	In alternative A, all categories would be the same as the existing condition	Very Open: In alternatives B through E, the very open category remains unchanged at 2 percent (499 ac.). Open: In alternatives B through E the category ranges from 54 (16,103 ac.) in alternative C and E to 55 percent (16,441 ac.) in alternative B and D. Moderately Closed: In alternatives B through E the category would be about 27 percent with acres ranging from 8,064 to 8,163 ac. Closed: In alternatives B through E the category would be about 17 percent with acres ranging from 5,010 to 5,250 ac.			
Heterogeneity of Goshawk LOPFA Habitat –Subset of Landscape Scale							
Percent (%) and Acres (ac.) of Openness or Interspace	Very Open: 4% (14,329 ac.) Open: 27% (100,639 ac.) Moderately Closed: 31% (111,840 ac.) Closed: 38% (140,644 ac.)	Mostly closed with large and old trees and interlocking crowns	In alternative A, all categories would be the same as the existing condition.	Very Open: In alternatives B through D the category would increase from 4 to 18 percent with acres varying from 66,383 acres (alt. C) to 66,601 (alt. B, D). Alt. E is the same as alt. A with 4% (14,329 ac.). Open: In alternatives B-D the category increases and ranges from 56 percent (204,797 ac.) in alt. C to 57 percent (208,903 ac.) in alt. B and D. Alt. E increases the most to 68 percent (251,360 ac.). Moderately Closed: The category would decrease from about 31 percent (111,840 acres) to 18 percent (66,379 acres) in alt. B and D) and to 18 percent (67,045 acres) in alt. C. Alt. E decreases the least to 19 percent (70,069 acres). Closed: In alternatives B through E the category would decrease from 38 percent (140,644 ac.) to 7 percent (25,569 ac.) in alt. B and D and to 8 percent (29,228 ac.) in alt. C. Alt. E decreases the least to 9 percent (31,694 acres).			

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Spatial Arrangement Percent/acres with relative ability to attain and maintain mosaic of interspaces and tree groups ranging from very low, low, moderate to high	Continuous tree canopy with generally small interspaces	Mosaic of interspaces and tree groups of varying sizes and shapes	Similar to existing condition and trending toward a reduction of interspaces	Very Low: 10% (50,915 ac.) Low: 24% (119,956 ac.) Moderate: 24% (121,743 ac.) High: 42% (215,224 ac.)	Very Low: 10% (53,025 ac.) Low: 25% (124,577 ac.) Moderate: 24% (119,766 ac.) High: 41% (210,472 ac.)	Very Low: 10% (50,915 ac.) Low: 24% (119,956 ac.) Moderate: 24% (121,743 ac.) High: 42% (215,224 ac.)	Very Low: 11% (53,709 ac.) Low: 30% (152,005 ac.) Moderate: 23% (119,202ac.) High: 36% (182,923 ac.)

Summary of Effects – Heterogeneity (Purpose and Need, Issue 3)

In Mexican spotted owl (MSO) protected habitat, there would be no change between alternatives A through E in percent of openness. The percent openness (degree of heterogeneity) would remain the same as the existing condition. This is because thinning treatments would limit the removal of the overstory structure. In alternative A in Mexican spotted owl restricted (all) habitat, the percent of openness would remain the same as in the existing condition. Existing interspace would continue to be encroached upon by expanding tree crowns and ingrowth. In alternatives B through E there would be little change in the very open to open categories.

In restricted habitat, the wider variety of treatments to meet the multiple objectives would decrease the amount of closed conditions by about 56 percent (alternatives B and D). In alternatives C and E the decrease would be about 54 percent. In alternative A, the existing condition would persist with 67 percent of the habitat being in the closed category. The decrease in acres of closed conditions is the result of moving these acres into the moderately closed category. This is a result of creating canopy gaps and interspace, although treatments in Mexican spotted owl restricted habitat are relatively conservative. However, closed canopy conditions would remain within tree groups (see wildlife report,). Moving a significant portion of restricted habitat from closed to moderately closed conditions increases Mexican spotted owl prey habitat while developing future nesting and roosting habitat. In addition to increasing the quality of foraging habitat, treatments would decrease the risk of high-severity fire in Mexican spotted owl habitat.

In goshawk PFA/dPFA, alternatives B, C, D, and E would result in substantially more open conditions than currently exist. Alternatives B and D would result in 16,441 open acres (55 percent). This is considerably more than the 4,270 acres (14 percent) existing and about 338 acres more than Alternatives C and E (16,103 acres). Conversely, alternatives B, C, D, and E would have substantially fewer moderately closed and closed acres than existing. Alternatives B through E would result in about 13,413 acres of closed and moderately closed acres. This is considerably less than 25,245 acres in alternative A.

A wider variety of treatments would occur in LOPFA habitat than in PFA/dPFA habitat. Mechanical treatments would improve age-class diversity and move toward more open, uneven-aged conditions. Primary benefits from these changes in forest structure are that the risks of large scale loss of habitat from disturbances such uncharacteristic fire, bark beetles, and density-related mortality would be reduced. Alternative A, since there are not treatments proposed, would be at the highest risk of increasing densities, increased fire risk, increases to insect and diseases, and increased risks to PACs. Alternative D would have similar longevity and function as alternative A. Alternatives B and C would reduce densities, reduce fire risks, increase openness, and decrease risks from insects and diseases over longer periods. Alternatives B and C would be able to maintain composition, form, and structure as natural fire occurrences are reintroduced.

At the landscape scale, alternative A moves the project area away from desired conditions. It would be at highest risk of increased densities, increased fire risk, increased insect and diseases, and increased risks to PACs. Alternative D would move the project toward the desired condition but leaves treated areas at higher risks to high severity fire. Alternative D would have similar longevity and function as alternative A. Alternatives B, C and E move the project area closer to desired conditions in terms of: (1) increasing species composition; (2) increasing groups of trees; (3) maintaining scattered individual trees; (4) increasing grass-forb-shrub interspaces; (5) increasing snags, logs, and woody debris; (6) increasing variation in the arrangements of these elements in space and time; and (7) establishing ecosystem processes, functions, and fire return intervals that are within the historical range of variability. Alternatives B, C, and E would reduce densities, reduce fire risks, increase openness, and decrease risks from insects and diseases over longer periods. Alternatives B, C, and E would be able to maintain composition, form, and structure as natural fire occurrences are reintroduced. Restoration of key compositional and structural elements on a per-site basis would restore resiliency of frequent-fires in the project area, and thereby position them to better resist, and adapt to, future disturbances and climates.

Indicator	Existing Condition	Desired Condition	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
Forest Structure and Pattern (Purpose and Need, Issue 3)												
Goshawk PFA/dPFA – Vegetation Structure and Pattern												
Stand Density Index percent (%)	61	25-40	**Alt A 2020**	**Alt A 2050**	**Alt B 2020**	**Alt B 2050**	**Alt C 2020**	**Alt C 2050**	**Alt D 2020**	**Alt D 2050**	**Alt E 2020**	**Alt E 2050**
			64	69	40	49	40	49	45	54	41	49
Goshawk PFA/dPFA Even-Aged Forest Structure (VSS %)*												
VSS 1 (0.0-0.9 inches)	1	10	**Alt A 2020**	**Alt A 2050**	**Alt B 2020**	**Alt B 2050**	**Alt C 2020**	**Alt C 2050**	**Alt D 2020**	**Alt D 2050**	**Alt E 2020**	**Alt E 2050**
			1	1	8	1	8	1	8	1	8	1
VSS 2 (1.0-4.9 inches)	1	10	1	0	0	7	0	7	0	6	0	7
VSS 3 (5.0-11.9 inches)	37	20	37	6	24	3	25	3	34	5	25	3
VSS 4 (12.0-17.9 inches)	53	20	54	65	49	43	49	43	47	45	49	45
VSS 5 (18.0-23.9 inches)	7	20	6	23	12	38	12	38	9	35	12	36
VSS 6 (24.0 inches+)	1	20	1	5	7	8	6	8	2	8	6	8
Goshawk PFA/dPFA Uneven-Aged Forest Structure*												
VSS 1 (0.0-0.9 inches)	0	10	**Alt A 2020**	**Alt A 2050**	**Alt B 2020**	**Alt B 2050**	**Alt C 2020**	**Alt C 2050**	**Alt D 2020**	**Alt D 2050**	**Alt E 2020**	**Alt E 2050**
			0	0	7	0	7	0	7	0	7	0
VSS 2 (1.0-4.9 inches)	<1	10	<1	<1	<1	7	<1	7	<1	7	<1	7
VSS 3 (5.0-11.9 inches)	35	20	33	6	19	2	19	3	24	8	19	2
VSS 4 (12.0-17.9 inches)	46	20	47	48	43	27	42	26	41	23	43	28
VSS 5 (18.0-23.9 inches)	14	20	14	29	21	40	22	40	21	39	21	39
VSS 5 (18.0-23.9 inches)**	5	20	6	17	10	24	10	24	7	23	10	24
Goshawk PFA/dPFA – Prey Habitat												
Coarse Woody Debris (tons/acre)	4.11	5-7 CNF 3-10 KNF	**Alt A 2020**	**Alt A 2050**	**Alt B 2020**	**Alt B 2050**	**Alt C 2020**	**Alt C 2050**	**Alt D 2020**	**Alt D 2050**	**Alt E 2020**	**Alt E 2050**
			5.01	8.00	3.16	6.30	3.04	6.15	5.67	7.84	3.34	6.47
Understory Index (avg. lbs/acre forage)	58	Increase above current	48	32	111	67	113	68	97	57	109	66

* Note, goshawk habitat within the wildlife report includes Mexican spotted owl habitat. Within Goshawk PFA Even-aged Forest Structure, 1% is accounted for (but not displayed) as grass cover type across all alternatives and time scales.

** The goshawk analysis used 2 subsets of VSS 5.

Summary of Effects - Goshawk PFA, Forest Structure and Pattern (Purpose and Need, Issue 3):

In goshawk PFA/dPFA, alternatives B, C, D, and E would result in substantially more open conditions than currently exist (see previous discussion). Tree group density would be managed to meet the following requirements: canopy cover for mid-aged forest (VSS4) should average 1/3 60+% and 2/3 50+%. Mature forest (VSS 5) and old forest (VSS 6) should average 50+%. Immature tree groups (VSS 2 and 3) are managed to maintain tree stocking necessary to provide for desired canopy cover as the groups mature to VSS 4, 5, and 6. By following the stocking guidelines and maintaining interlocking or nearly interlocking tree crowns, tree group density would meet and exceed the canopy cover requirements. Stocking guidelines for tree groups for the dPFA/PFA mechanical thin treatments are described in appendix D (Implementation Plan).

Uneven-aged and intermediate thin are the primary PFA/dPFA mechanical treatments. These treatments would improve age-class diversity and move toward more open, uneven-aged conditions. The percent of SDI max would decrease in alternatives B through E as a result of the proposed thinning. PFA/dPFA habitat would still remain in the high density category in the short (2020) and long term (2050) in alternatives B, C, D, and E. However, alternative D would tend to have a higher max SDI than the others and would be approaching the "extremely high density" category (percent max SDI of 55 and higher) by 2050.

Trees greater than 24 inches d.b.h. in uneven-aged forest structure would increase as a result of these treatments. Alternatives B, C, and E would increase the distribution of this size class to 10 percent of the area by 2020 whereas alternative D would increase to 7 percent (from an existing distribution of 6 percent). The least increase would occur in alternative A with a 1 percent increase by 2020 and a total 12 percent increase by 2050.

In the short-term (2020), trees greater than 24 inches d.b.h. in even-aged forest structure would increase to 7 percent in alternative B; 6 percent in alternatives C and E; and only 2 percent in alternative D (from an existing level of 1 percent). In alternative A there would be no increase above 1 percent by 2020. In 2050, there would be an increase to 5 percent (alternative A).

Alternatives B, D, and E would increase the distribution of trees in the next largest size class (18 to 23.9 inches d.b.h.) in uneven-aged condition to 21 percent; alternative C would increase the distribution to 22 percent. In even-aged forest structure, the next largest size class would increase to 12 percent in alternatives B, C, and E and increase to 9 percent in alternative D, from an existing level of 6 percent. Growing trees into the largest size-classes takes time and creating more large trees would be an important contribution to habitat used for nesting and raising young. Decreasing competition around presettlement trees should enhance their survival and potentially result in more large trees than displayed in the model results. Substantial increases in the average pounds per acre of understory biomass in all action alternatives reflect more open conditions after treatment. Increases in understory would improve cover and food for birds and mammals preyed upon by goshawks as well as the invertebrates that are an important food source for goshawk prey. Alternative C would have the most improvement followed by alternatives B, then E, then D. Prey habitat would improve as coarse woody debris increases to desired conditions by 2050. In the short term, tons per acre of coarse woody debris would fall below desired in alternatives B, C, and E. Only alternative D would meet desired conditions in the short term (2020). Alternative A, since there are no treatments proposed, would be at the highest risk of increasing densities, increased fire risk, increases to insect and diseases, and increased risks to PFA/dPFA habitat.

Indicator	Existing Condition	Desired Condition	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
Goshawk LOPFA Vegetation Structure and Pattern												
Stand Density Index percent (%)	57 %	15-35%	**Alt A 2020**	**Alt A 2050**	**Alt B 2020**	**Alt B 2050**	**Alt C 2020**	**Alt C 2050**	**Alt D 2020**	**Alt D 2050**	**Alt E 2020**	**Alt E 2050**
			60	66	34	43	34	43	39	49	36	45
Goshawk LOPFA Even-Aged Forest Structure (VSS %)												
VSS 1 (0.0-0.9 inches)	1	10	**Alt A 2020**	**Alt A 2050**	**Alt B 2020**	**Alt B 2050**	**Alt C 2020**	**Alt C 2050**	**Alt D 2020**	**Alt D 2050**	**Alt E 2020**	**Alt E 2050**
			<1	<1	7	1	7	1	7	<1	9	<1
VSS 2 (1.0-4.9 inches)	1	10	1	<1	<1	6	<1	6	1	6	<1	8
VSS 3 (5.0-11.9 inches)	41	20	41	14	26	4	26	4	36	8	27	5
VSS 4 (12.0-17.9 inches)	48	20	50	52	41	35	41	35	34	36	44	39
VSS 5 (18.0-23.9 inches)	8	20	7	29	22	35	22	35	19	35	18	39
VSS 6 (24.0 inches+)	1	20	1	5	4	19	4	19	3	15	2	9
Goshawk LOPFA Uneven-Aged Forest Structure												
VSS 1 (0.0-0.9 inches)	0	10	**Alt A 2020**	**Alt A 2050**	**Alt B 2020**	**Alt B 2050**	**Alt C 2020**	**Alt C 2050**	**Alt D 2020**	**Alt D 2050**	**Alt E 2020**	**Alt E 2050**
			0	0	7	0	7	0	7	0	8	0
VSS 2 (1.0-4.9 inches)	1	10	1	<1	<1	7	<1	7	1	7	<1	7
VSS 3 (5.0-11.9 inches)	37	20	37	10	21	6	21	7	27	13	22	6
VSS 4 (12.0-17.9 inches)	36	20	37	42	23	18	22	17	22	18	24	19
VSS 5 (18.0-23.9 inches)	15	20	12	27	29	21	30	21	28	19	28	22
VSS 6 (24.0 inches+)	11	20	13	21	20	48	20	48	15	43	18	46
Goshawk LOPFA Prey Habitat												
Coarse Woody Debris (tons/acre)	3.70	5-7 CNF 3-10 KNF	**Alt A 2020**	**Alt A 2050**	**Alt B 2020**	**Alt B 2050**	**Alt C 2020**	**Alt C 2050**	**Alt D 2020**	**Alt D 2050**	**Alt E 2020**	**Alt E 2050**
			4.56	7.32	2.82	5.40	2.79	5.38	5.40	7.00	2.95	5.64
Understory Index (average pounds/acre of forage)	57	Increase above current	57	37	149	90	149	89	128	75	139	83

Summary of Effects - Goshawk LOPFA, Forest Structure and Pattern (Purpose and Need, Issue 3):

A wider variety of treatments would occur in LOPFA habitat than in PFA/dPFA habitat. Mechanical treatments in alternatives B, C, and-D would improve age-class diversity and move toward more open, uneven-aged conditions. The percent of SDI max would decrease in all action alternatives as a result of the proposed thinning. The percent of SDI max in LOPFA habitat would decrease to the high end of moderate density in alternatives B and C and decrease to high density in alternatives D and E in the short term (2020). All action alternatives would shift or remain in high density by 2050. Primary benefits from these changes in forest structure are that the risks of large scale loss of habitat from disturbances such uncharacteristic fire, bark beetles, and density-related mortality would be reduced.

Trees greater than 24 inches d.b.h. in uneven-aged forest structure would increase as a result of these treatments in all alternatives. Alternatives B and C would increase the distribution of this size class to 20 percent of the area by 2020 whereas alternative D would increase to 15 percent, and alternative E would increase to 18 (from an existing distribution of 11 percent). In alternative A increases the percent to 13 by 2020. Trees greater than 24 inches d.b.h. in even-aged forest structure would increase to 4 percent in alternatives B and C; 3 percent in alternative D; 2 percent in alternative E; and not change in alternative A (from an existing level of 1 percent).

Alternatives D and E would increase the distribution of trees in the next largest size-class (18 to 23.9 inches d.b.h.) in uneven-aged condition to 28 percent; alternative C would increase the distribution to 30 percent and would increase to 28 percent in alternative E. In comparison, alternative A decreases the percent in 2020 to 12 percent but increases by 2050 to 27 percent. In even-aged forest structure, this next largest size class would increase to 22 percent in alternatives B and C, increase to 19 percent in alternative D and increase to 18 percent in alternative E, from an existing level of 8 percent. In alternative A, there is an increase of 22 percent by 2050. Growing trees into the largest size-classes takes time and creating more large trees would be an important contribution to prey and foraging habitat.

Substantial increases in the average pounds per acre of understory biomass in all action alternatives would improve cover and food for birds and mammals preyed upon by goshawks as well as the invertebrates that are an important food source for goshawk prey. Alternatives B and C would have the most improvement followed by alternatives E, then D. This would also favor conditions conducive to the spread of low severity fire rather than crown fire. Crown fire would have more severe effects to vegetation and soil. Prey habitat would improve as coarse woody debris increases to desired conditions by 2050. In the short term, tons per acre of coarse woody debris would fall below desired in alternatives B, C, and E. Only alternative D would meet desired conditions in the short term (2020). Alternative A, since there are not treatments proposed, would be at the highest risk of increasing densities, increased fire risk, increases to insect and diseases, and increased risks to goshawk LOPFA habitat.

Indicator	Existing Condition	Desired Condition	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
Mexican Spotted Owl Protected Habitat – Forest Structure in 18 PACs												
Basal Area (BA)	148	N/A	**Alt A 2020**	**Alt A 2050**	**Alt B 2020**	**Alt B 2050**	**Alt C 2020**	**Alt C 2050**	**Alt D 2020**	**Alt D 2050**	**Alt E 2020**	**Alt E 2050**
			157	174	140	162	134	157	144	165	153	172
Stand Density Index percent (%)	78 (Extremely High)	≤ 55	76	78	61	65	57	63	63	67	67	70
Trees 12-17.9 inches d.b.h.	31	15	31	28	33	27	33	26	33	28	34	31
Trees 18-23.9 inches d.b.h.	14	15	16	23	20	28	21	29	19	27	17	25
Trees 24 inches d.b.h. and greater	8	15	9	12	10	14	21	29	10	14	9	12
Mexican Spotted Owl Protected Habitat – Forest Structure in Protected Habitat												
Active Crown Fire Risk/ Potential percent (%)	40	<10	40		20		18		34		24	

Summary of Effects – Mexican Spotted Owl Protected Habitat, Forest Structure and Pattern (Purpose and Need, Issue 3):

Several of the forest metrics are similar across alternatives in 2020 because minimal actions are proposed in PACs. Thinning, (not group selection) is proposed in PACs, in part to limit affects to overstory structure The percent of SDI max would decrease in all alternatives as a result of the proposed thinning. PACs would still remain in the highest density category ("extremely high density"), although alternative C would move the percent of SDI max to the bottom of this category in 2020, almost achieving a "high density" ranking (high density = percent SDI max of 55 and lower). The potential decrease in crown fire risk is most prominent in alternative C and alternative D makes the least change relative to the no action alternative. The change in active crown fire risk is primarily a result of two prescribed fire entries. Prescribed fire would decrease litter and increase canopy base height. Combined these actions would reduce surface fire flame length and increase the height fire would have to transition from surface into crown fire (i.e., high-severity fire). Alternative D is the only (action) alternative where at least 30 percent of the habitat would return to FRCC 3, contrary to the purpose and need.

A key result of these treatments would be increases in trees 24 inches d.b.h. and greater. By 2050, alternatives B, C, and D would increase the density of this size class to 14-15 percent of the area whereas alternatives A and E are at 12 percent. A similar pattern is evident among alternatives for trees in the next largest size-class (18 to 23.9 inches d.b.h.). Growing trees into the largest size-classes takes time and creating more large trees would be an important contribution to nesting and roosting habitat. Decreasing competition around presettlement trees should enhance their survival and potentially result in more large trees than displayed in the model results. Reducing abundant quantities of mid-sized trees and increasing areas dominated by large trees should improve Mexican spotted owl nesting and roosting habitat (USDI FWS 1995, May and Gutierrez 2002, May et al. 2004, Blakesley et al. 2005).

Indicator	Existing Condition	Desired Condition	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
Mexican Spotted Owl – Restricted Habitat Forest structure												
Basal Area (BA)	137-193	>150	**Alt A 2020**	**Alt A 2050**	**Alt B 2020**	**Alt B 2050**	**Alt C 2020**	**Alt C 2050**	**Alt D 2020**	**Alt D 2050**	**Alt E 2020**	**Alt E 2050**
			147	169	78	101	79	112	91	127	79	112
Stand Density Index	69-100	<55	72	76	37	49	37	49	46	58	37	49
Trees 12-17.9 inches d.b.h.	25-29	15	30	28	25	20	25	21	23	20	25	21
Trees 18-23.9 inches d.b.h.	13-21	15	14	20	21	20	21	20	19	18	21	20
Trees 24 inches d.b.h. and greater	6-7	15	7	10	13	18	13	18	11	15	13	18
Active Crown Fire Risk/ Potential (%)	37-40	< 10	37		< 1 to 4		1 to 4		< 1 to 5		1 to 4	
Mexican Spotted Owl – Restricted Habitat – Prey Habitat												
Understory Index (average pounds/acre of forage)	58	Increase above current	**Alt A 2020**		**Alt B 2020**		**Alt C 2020**		**Alt D 2020**		**Alt E 2020**	
			48		32		111		67		113	

Summary of Effects – Mexican Spotted Owl Restricted Habitat, Forest Structure and Pattern (Purpose and Need, Issue 3):

Unlike protected habitat, restricted habitat is intended to provide potential nesting and roosting habitat in at least 10 percent of the restricted habitat and a diversity of stand conditions to support foraging and movements of owls across the landscape by applying principals of ecosystem management. This is evidenced in the overall decrease in SDI particularly in alternatives B, C and E. Alternative D would do the least in terms of moving toward desired conditions. The decrease in tree densities is primarily in the smaller (less than 12 inches d.b.h.) size classes as evidenced by changes by tree size-class. Similar to SDI, alternatives B, C, and E provide for more large trees (size-classes spanning from 12 to 24 inches and larger d.b.h.). Gains in the largest trees would be nearly double the results of no action. Risk of active crown fire would be markedly reduced but similar amongst action alternatives. Decreasing forest density and creating canopy gaps would increase forest understory response, thereby providing food and cover for Mexican spotted owl prey species.

Alternatives C and E would provide the strongest understory response in 2020. Overall, Mexican spotted owl restricted habitat would be improved by treatments, resulting in more large trees (greater than 18 inches d.b.h.), better prey habitat, and reduced risk of active crown fire. Understory response is not projected out till 2050 as understory response would revert back as regrowth occurs without treatment. In addition to accelerating the development of Mexican spotted owl habitat these treatments would increase the resiliency of these stands to stochastic events such as bark beetle outbreak and climate-influenced changes. In general, alternative C would move restricted habitat closer to desired conditions than the other action alternatives. Alternative A, since there are not treatments proposed, would be at the highest risk of increasing densities, increased fire risk, increases to insect and diseases, and increased risks to Mexican spotted owl restricted habitat.

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Large and Old Trees (Purpose and Need, Issues 2 and 3)							
Large and Old Tree Structure	VSS 5 and 6 (large and/or old trees) are underrepresented across the landscape.	Retain as many large trees (larger than 16 inches d.b.h.) as possible. Sustain old forest structure over time across the landscape.	See Mexican Spotted Owl and Goshawk Forest Structure Section				

Summary of Effects - Large and Old Trees (Purpose and Need, Issues 2 and 3):

In alternative A, the Mexican spotted owl analysis indicates adequate representation in the 12- to 17.9-inch size class with stocking trending toward adequate in the 18 to 23.9-inch size class and inadequate representation in 24-inch and larger size. In goshawk habitat, the trend would be toward the mid-aged and mature structural stages with overall underrepresentation in VSS 6 in the even-aged stands. Old growth structural attributes would continue to develop across the landscape. The sustainability of the large/old tree component across the landscape may be impaired by density related mortality and forest health issues as discussed in following section.

Although the modified large tree retention strategy applies only to alternatives C and E, the silvicultural analysis for Mexican spotted owl in alternatives B, C and E indicates good representation in the 18- to 24-inch size classes in all habitats. Stocking in the 24-inch and larger size class has good representation in the restricted other habitat and is underrepresented in the target/threshold habitat. The goshawk analysis above indicates the mature and old forest structural stages would be underrepresented in the PFA habitat and LOPFA even-aged stands.

Projections show a trend toward improved representation in all habitats. All treatments are designed to manage for old age trees (Old Tree Implementation Plan or OTIP) to have and sustain as much old forest structure as possible across the landscape. Over time, old growth conditions improve in terms of meeting the minimum criteria. In 2050, all restoration units are very close to or exceed the criteria for the number of trees per acre larger than 18 inches with the exception of RU 6. The sustainability of the large/old tree component across the landscape would be improved (see forest health).

In alternative D, the changes in the 18- to 24-inch and 24-inch and larger size classes in Mexican spotted owl and goshawk habitat are the same as described for alternative B and C and the LTIP is integral to alternative C. However, the reductions in prescribed fire mortality results in denser conditions that affect the VSS distribution trend by slowing stand development and growth. This results in more of the landscape being maintained in the young forest stage and impeding development of the mature and old forest stages.

Indicator	Existing Condition	Desired Condition	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
Forest Health (Purpose and Need)												
Insect and Disease and Stand Density-Related Mortality												
Beetle hazard rating (% of area rated as high)	High: 72 Moderate: 21 Low: 7	Hazard rating ranges from low to moderate with no high rating	**Alt A 2020**	**Alt A 2050**	**Alt B 2020**	**Alt B 2050**	**Alt C 2020**	**Alt C 2050**	**Alt D 2020**	**Alt D 2050**	**Alt E 2020**	**Alt E 2050**
			83% High	92% High	22% High	53% High	22% High	53% High	43% High	69% High	23% High	56% High
Percent of area with dwarf mistletoe infection level ranging from extreme to none/low	Extreme (E): < 1		**Alt A 2020**	**Alt A 2050**	**Alt B 2020**	**Alt B 2050**	**Alt C 2020**	**Alt C 2050**	**Alt D 2020**	**Alt D 2050**	**Alt E 2020**	**Alt E 2050**
			<1	1	<1	<1	<1	<1	<1	<1	<1	<1
	Moderate/High (M/H): 34		41	43	40	43	40	43	40	44	38	41
	None/Low (N/L): 66		59	56	60	57	60	57	60	56	62	59
Stand Density Index	See SDI metrics for goshawk and Mexican spotted owl.											

Summary of Effects - Forest Health (Purpose and Need):

In alternative A, the percent of the project area with a high bark beetle hazard rating would increase from 83 percent in the short term (2020) to 92 percent in the long term (2050). Alternatives B and C reduce this the most to 22 percent by 2020. In the long term, all action alternatives would result in increases of the high rating as regrowth occurs. The high hazard rating would range from 53 (alternative B) to 69 (alternative D).

When compared to no action (alternative A), alternatives B through E reduce dwarf mistletoe infection in the None/Low condition primarily as a result of being able to selectively remove lightly infected trees. However, when there is a higher infection rate it usually indicates a more extensive infection and a greater number of infected trees. Increased infection rates reduce the available opportunities to find and retain lightly infected trees. Furthermore, restoration treatments that increase the canopy spacing in heavily infected dwarf mistletoe stands has a tendency to increase the rate and intensity of infection due to the reduced interference to seed spread offered by dense canopy cover.

In alternative A, an increase in stand density-related mortality would be expected in much of the Mexican spotted owl protected and target/threshold habitat. Regardless of alternative (B through E), target/threshold and protected habitats would be within the extremely high density zone (with the exception of restoration unit 4) and on the high end of the desired range within restricted other habitat. This is largely due to the limited mechanical treatment in the protected habitat and the high oak stocking in the restricted habitat. All goshawk habitat is in the upper end of the high density zone and would continue approaching the threshold for the onset of density-related mortality. All action alternatives (B through E) would decrease max SDI as a result of treatments.

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Vegetation Diversity and Composition (Purpose and Need, Issue 4)							
Gambel oak	110,373 acres of pine-oak Mexican spotted owl (MSO) habitat	Conserve oak and improve conditions that favor oak growth and establishment	**Treatment acres that would actively reduce pine-oak competition:**				
			0	64,065	62,785	64,065	62,222
			Treatment acres within pine-oak MSO habitat that would reduce competition to large oak:				
			0	82,740	81,457	82,740	81,457
			Average Gambel oak BA (Percent of Total BA)				
			19%	**2020** 25% / **2050** 26%	Same as Alt. B	**2020** 26% / **2050** 28%	Same as Alt. B
Aspen	1,522 acres of aspen patches (within pine)	Maintain and/or regenerate aspen	0	1,450	1,469	1,249	1,450
Grasslands	48,703 acres of encroached grasslands	Restore grasslands. Enhance historic grassland inclusions within greater forested area including MSO restricted, goshawk PFA/dPFA and (LOPFA) habitats.	Restores 0 acres of encroached grasslands	Same as Alt. A	Restores 48,195 acres of encroached grasslands	Same as Alt. A	Restores 47,915 acres of encroached grasslands
	14,665 acres departed from historic grassland conditions		Restores 0 acres of historic grasslands	Restores 11,185 acres of historic grasslands.	Restores 11,230 acres of historic grasslands.	Same as Alt. B	Restores 0 acres of historic grasslands
	300,430 acres of ponderosa pine with open reference conditions (mollic-integrade soils)		Restores 0 acres of pine with an open reference condition	Restores 45,405 acres of pine with an open reference condition	Restores 45,142 acres of pine with an open reference condition	Same as Alt. B	Restores 0 acres of pine with an open reference condition
	507,839 acres of ponderosa pine		Enhances grassland inclusions on 0 acres in goshawk PFA, non PFA and MSO pine-oak habitat.	Enhances grassland inclusions on 307,939 acres in goshawk PFA, non PFA and MSO pine-oak habitat.	Enhances grassland inclusions on 306,047 acres in goshawk PFA, non PFA and MSO pine-oak habitat.	Enhances grassland inclusions on 307,939 acres in goshawk PFA, non PFA and MSO pine-oak habitat.	Enhances grassland inclusions on 334,306 acres in goshawk PFA, non PFA and MSO pine-oak habitat.
	9% crown fire	< 3% crown fire	9	8	1	12	1

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
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.	0 acres of pine-sage understory/overstory maintained and enhanced.	In alternatives B through E approximately 5,261 acres of pine-sage understory/overstory would be maintained and enhanced.			

Summary of Effects - Vegetation Diversity and Composition (Purpose and Need, Issue 4):

In alternative A, the ponderosa pine tree canopy would continue to increase, shading out understory herbaceous vegetation, understory sage and further reducing forage production and species diversity. Oak and aspen growth and vigor would continue to be stagnated due to competition with pine resulting in lowered resistance to insects and disease and eventual mortality. Alternative A does not meet fire desired conditions in grasslands.

Alternatives B through E would result in vigorous aspen regeneration free of competition from overtopping ponderosa pine. Alternative D treats the least acres of aspen due to using less prescribed fire. Alternatives B, C, D increase large oak in Mexican spotted owl habitat by 6 percent in short term and 7 percent in long term. Alternative D increases large oak the most in the long term (increase of 9 percent) as there are many acres where prescribed fire would not remove the smaller size classes of oak. Treatments in grasslands, pine-oak and pine-sage represent areas that could support dense herbaceous understories. These areas would support different species of ground cover, different arthropod assemblages, and higher densities of small mammals and birds relative to the surrounding pine forest matrix. Alternatives B, D and E would treat the most acres of grassland, but alternative C would accomplish the most restoration. Alternative E would remove encroaching trees in existing grasslands and meadows, but does nothing to restore grasslands, savannas, and meadows that are currently functioning ecologically as forest. There is a strong link between raptors and their food and restoring and enhancing prey habitat is expected to benefit Mexican spotted owl and their prey in the short- and long-term (Kalies et al. 2012, Ganey et al. 2011). Grassland desired conditions for fire would be met in alternatives C and E and would not be met in alternatives B and D.

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Forest Resiliency and Function – Fire (Purpose and Need)							
Crown Fire (2020 percent and acres)	38% 191,209	< 10% in ponderosa pine	38% 192,919	5% 26,149	5% 26,217	6% 32,367	6% 28,142
Canopy Base Height (feet)	16.5 feet	> 18 feet	16.7	25	25	23	24
Canopy Bulk Density (km/m^3)	0.059	< 0.05 kg/m^3	0.059	0.032	0.032	0.035	0.034
Fire Regime Condition Class (FRCC)	3	100% 1 and 2	3	2	2	2	2
Surface Fuel Loadings (acres with >15 tons/acre of litter, duff, coarse woody debris)*	11% 66,871	< 20** tons/acre	28% 161,405	1% 5,418	<1% 2,569	14% 77,294	2% 9,075

* Acres of >15 tons/acre are approaching or exceeding the maximum recommended average.

** Twenty tons per acre is a recommended maximum average for surface fuel loading, but is not specifically discussed in forest plans.

Summary of Effects - Forest Resiliency and Function – Fire (Purpose and Need):

At the landscape scale, the difference in crown fire potential between the alternatives is minimal because the vertical and horizontal continuity of canopy fuels would be broken up by mechanical treatments. In ponderosa pine, all restoration units (see chapter 3) would meet desired conditions for fire behavior under alternatives B, C, and E. Restoration Unit 1 would not under alternative D. There is not much difference shown in crown fire potential between alternative E and alternatives B, C, and D because Mexican spotted owl PAC treatments were designed to improve the quality and quantity of habitat through treatments that limit effects to overstory structure. However, high surface fuel loading can produce high severity fire effects without crown fire, and most of the area with high surface fuel loading would be in Mexican spotted owl habitat. From a perspective of potential control and effects, surface fuel loading is best addressed by alternatives B, C, and E.

In 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 effects to maintain the area in a FRCC 3 into the foreseeable future. There would be no movement toward the composition, pattern, and structure needed to support healthy ecological functions. Alternatives B through E would achieve desired conditions in the short term (2020) at a landscape scale for fire regime condition class, fire behavior, and canopy characteristics.

Summary of Effects - Prescribed Fire Emissions (Issue 1):

Emissions were evaluated both qualitatively and quantitatively by modeled emission quantities in pounds/acre for the most common stand condition under different treatment scenarios. Changes in those fuel components which produce the greatest percentages of emissions when they burn were modeled, and mapped. These include litter, duff, and coarse woody debris greater than 3 inches. Emissions would be highest in alternative A, where emissions would approach 80,000 pounds per acre. After treatment, there would be the least emissions potential from alternatives B and C with emissions projected at approximately 31,000 pounds per acre. Alternative E would be the next lowest, and would be closer to B and C than to D. Alternative D would have the highest potential emissions of all the action alternatives because of the lack of treatment of surface fuels, and the slight increase in surface fuels that comes from thinning. Once treatments are complete, the emissions from wildfire are projected to be slightly greater than 50,000 pounds per acre. Compared to alternative A, there would be a reduction in emissions from approximately 80,000 pounds per acre to approximately 31,000 pounds per acre.

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Soil Productivity and Watershed Function (Purpose and Need)							
Soil Productivity (percent and range of potential soil disturbance at 6th code HUC)	See chapter 3 "Soils" section and soils report for details.	Do not exceed 15% threshold	Soil disturbance could exceed threshold and range from 0 to 33 percent	In alternatives B through E, short-term impacts from soil disturbances would range from 2.9 percent (lowest in alternative D) to 3.4 percent (highest in alternative C). All action alternatives provide long term soil improvement and protection of soil productivity.			
Watershed Condition (project area)	22% functioning properly, 46% functioning at risk, 32% impaired.	Moving toward or at functioning properly.	Continuation of existing condition	Improved function on 23% of at risk and 42% of impaired watersheds.		Improved function on 18% of at risk and 23% of impaired watersheds.	Same as alt. B.
Ephemeral Channels (functional condition)	Reduced function in 39 miles of degraded channel.	Proper functioning condition.	Static to downward trend in function over time.	Alternatives B–E: At the HUC12 scale, soil disturbance would range from 2 to 108 acres in subwatersheds (1% of treatment area). Unlikely that alt. B through E would impair any downstream perennial water bodies.			
Springs (change in springe discharge and functional condition trend)	Reduced discharge in 74 springs. Static to downward trend in functional condition.	Increased spring initiation and discharge and upward trend in functional condition.	No change - static to downward functional condition trend	Alternatives B–E: Improved spring condition because discharge from springs would resume flow through historic spheres of discharge as described by Springer and Stevens (2008). At watershed scale, restored or improved hydrologic function for 74 springs that currently have reduced discharge.			
Water Yield	Reduced from historic conditions	Increased stream flow and snowpack retention	No change	Slight increase where 25 to 50 percent of overall tree canopy cover is removed	Slightly higher than under alternative B due to more forest openings and less dense forest conditions.	Similar to alternative B but with reduced potential for runoff and sediment delivery to streamcourses	Slightly lower than alternatives B and D (less acres treated) and slightly higher than Alternative C

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Surface Water Quality (based on acres of soil disturbance)	No impaired streams in the project area, one impaired stream downstream of project (Oak Creek).	Meet or exceed Arizona Department of Environmental Quality (ADEQ) water quality standards.	No change but potential for adverse effects if wildfire occurs	Minor, short term (1-2 year) changes from activities and long term improvement from increased resiliency. With application of soil and water BMPs, ADEQ water quality standards would be met.	Similar to alt. B with differences not detectable at landscape scale. With application of soil and water BMPs, ADEQ water quality standards would be met.	In short term, lowest potential for impacts but least long term improvement and protection of water quality due to due to reduced resiliency. With application of soil and water BMPs, ADEQ water quality standards would be met.	Similar to Alt. B although the distribution and types of disturbances would vary in space and would be less in Mexican spotted owl PACS. Differences not detectable at landscape scale. With application of soil and water BMPs, ADEQ water quality standards would be met.
Riparian Area and Wetland Function	Reduced function due to reduction in water yield, reduced spring discharge rates, road impacts	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 function from continuation of existing condition	Improved function from increased groundwater recharge, improved surface flows, spring restoration, and road decommission.	Same as alt. B	Improved function but to a lesser degree than alt. B and C because fewer acres would receive prescribed fire.	More acres would receive mechanical thinning than alts. B and D resulting in improved function downstream. Fewer acres of mechanical thinning than alt. C.
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 through E 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.						

Summary of Effects - Soil Productivity and Watershed Function (Purpose and Need):

In alternative A, there would be no change from current conditions. In alternatives B through E, 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. Water yield in alternative C would be expected to be slightly higher than alternatives B, D and E.

In alternative A, soil disturbance could exceed threshold and range from 0 to 33 percent due to unmitigated fire risk. Implementation of alternatives B and C is expected to maintain, improve and protect long-term soil productivity and watershed function better than D because the vast majority of D does not follow mechanical treatments with prescribed fire necessary to maintain soil productivity and watershed function processes. The absence of prescribed fire following mechanical treatments increases the risk of uncharacteristic fire that could result in areas of high burn severity which leads to accelerated erosion, runoff and sediment delivery into connected stream courses following storm events. Implementation of alternative C is likely to better restore grasslands than alternative B. Implementation of alternatives B and C would reduce the risks to life, property, soil productivity and water quality from post wildfire storm events (flooding and debris flows) much better than A and D. With implementation of identified soil and water BMPs, ADEQ water quality standards would be met.

Indicator	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Socio-Economics						
Forest Products – Timber in 100 cubic feet (ccf)	No specific desired condition	Current Condition	3,566,683	3,602,303	3,566,656	3,428,155
Forest Products - Biomass (dry tons)	No specific desired condition	Current Condition	79,218	78,095	79,218	77,909
Average Annual Forestry-Related Employment (number of jobs)	20,169	Current Condition	1,599	1,615	1,599	1,535
Average Annual Labor Income (change in income in millions of dollars)	Not applicable	Current Condition	74.9	75.6	74.9	71.9
Net Present Cost of Treatments (millions of dollars)	Not applicable	Not applicable	216	232	156	232
Annual Truck Volume	Not applicable	Current Condition	120,000	120,000	120,000	120,000

Summary of Effects - Socio-Economics:

No effects are presented under alternative A, as these reflect current conditions. The changes in employment and income under alternatives B through E reflect an increase in employment and income due to 4FRI harvesting and processing activities as well as the potential for a temporary reduction of 60 jobs and $2 million in labor income due to recreation displacement. Most visitors would engage in substitute behavior that would also contribute to the local economy (e.g., visiting an alternate site on the forest, visiting nearby national parks, state parks, or other public lands). Therefore, the probability that visitor use would be substantially disturbed is low on both forests. No reductions in grazing-related employment are expected.

Over the 10-year treatment period, assuming a 4 percent discount rate, the first stage of 4FRI would save between $156 and $232 million of cost to the taxpayer as a result of using stewardship contracts. This figure can be viewed as a proxy for the economic value of 4FRI treatments.

From quality of life perspective, smoke emissions would be inevitable under all alternatives – whether from prescribed burns or wildfire. The degree (intensity and duration) of emissions, however, are variable. With prescribed burns, burn plans are developed, which helps to minimize adverse effects to quality of life in nearby communities. The Forest Service is required to work with the Arizona Department of Environmental Quality (ADEQ) to ensure that smoke impacts to human health are avoided or minimized. In contrast, wildfires are by definition unplanned. The community smoke effects from wildfire can range from negligible to severe. The advance notice associated with prescribed burns allows individuals with acute sensitivity to smoke (e.g., asthmatics) to engage in averting behavior, which reduce the negative quality of life impacts. (See Public Health and Safety – Emissions from Prescribed Fire section for details.)

No alternative would reduce employment and income relative to current conditions, therefore, no disproportionate adverse economic effects to low-income or minority populations would occur. Smoke emissions may acutely affect vulnerable populations – children, the elderly, and individuals in poor health. Limited communications technology, language barriers, and cultural differences may also limit the effectiveness of informing nearby residents of upcoming prescribed burns. These conditions are true under all alternatives – including the no action alternative. Traditional and sacred forest uses would continue under all alternatives.