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Final Environmental Impact Statement for the Four-Forest Restoration Initiative

Volume 1

Coconino and Kaibab National Forests
Coconino County, Arizona

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Final Environmental Impact Statement for the Four-Forest Restoration Initiative

Coconino and Kaibab National Forests
Coconino County, Arizona

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Abstract: This final environmental impact statement (FEIS) documents the analysis of five alternatives (including a "no action" alternative) that was developed for the Four-Forest Restoration Initiative on the Coconino and Kaibab National Forests (NFs). Alternative C is the preferred alternative. The project proposes to conduct restoration activities over a 10-year period. Alternatives B through E would mechanically treat up to 431,049 acres of vegetation and treat up to 586,110 acres with prescribed fire. Alternatives B through D propose nonsignificant forest plan amendments that would amend the 1987 Coconino National Forest Plan. Alternative E, which does not propose forest plan amendments, was developed in response to public comments on the DEIS.

This final EIS and the draft record of decision are subject to objection pursuant to 36 CFR 218.8, Subparts A and B. For more information on how to comment/file objections see the project website at: http://www.fs.usda.gov/main/4fri/planning or contact Annette Fredette, project team leader at 928-226-4684.

List of Acronyms

4FRI	Four-Forest Restoration Initiative
ACHP	Advisory Council on Historic Preservation
ADEQ	Arizona Department of Environmental Quality
AGFD	Arizona Game and Fish Department
AUM	Animal Unit Month
BA	Basal area
BAER	Burned Area Emergency Response
BCC	Birds of Conservation Concern
BCR	Bird Conservation Region
BE	Biological evaluation
BMP	Best management practice
CCF	Hundred cubic feet
CEQ	Council on Environmental Quality
CFLR	Collaborative Forest Landscape Restoration
CFLRP	Collaborative Forest Landscape Restoration Program
CFR	Code of Federal Regulations
CHU	Critical habitat unit
CNF	Coconino National Forest
CO	Carbon monoxide
CWD	Coarse woody debris
d.b.h.	Diameter at breast height
DEIS	Draft environmental impact statement
dPFA	Dispersal post-fledging area
d.r.c.	diameter at root collar
EIS	Environmental impact statement
EMA	Ecosystem management area
EPA	Environmental Protection Agency
EIS	Environmental impact statement
FEIS	Final Environmental Impact Statement
FLEA	Flagstaff/Lake Mary Ecosystem Analysis
FRCC	Fire regime condition class
FSH	Forest Service Handbook
FSM	Forest Service Manual
FVS	Forest Vegetation Simulator
FWS	United States Fish and Wildlife Service
GIS	Geographic information system
HUC	Hydrologic unit code
IBA	Important bird area
IMPLAN	Impact Analysis for Planning
IT	Intermediate thin
KNF	Kaibab National Forest
LANL	Los Alamos National Laboratory
LOPFA	Landscapes outside post-fledging family area
LTIP	Large tree implementation plan
LTRS	Large tree retention strategy
MA	Management area
MAUM	Thousand animal unit month
MIS	Management indicator species
ML	Maintenance level
MRNG	Management Recommendations for the Northern Goshawk in the Southwestern United States
MSO	Mexican spotted owl
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NF	National Forest
NFMA	National Forest Management Act
NHPA	National Historic Preservation Act
NMED	New Mexico Environment Department
NRV	Natural Range of Variability
PAC	Protected activity center
PFA	Northern goshawk post-fledging family area
PJ	Pinyon-juniper
PM	Particulate matter
PNVT	Potential natural vegetation type
ROS	Recreation opportunity spectrum
ROW	Right-of-way
RU	Restoration unit
SDI	Stand density index
SHPO	State Historic Preservation Office
SI	Stand improvement
SIO	Scenery integrity objectives
SWCP	Soil and water conservation practice
TAP	Travel analysis process
TCP	Traditional cultural properties
TES	Threatened, endangered and sensitive
TMR	Travel Management Rule
TPA	Trees per acre
UEA	Uneven-aged
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
VMS	Visual Management System
VSS	Vegetation structural stages
WEPP	Water Erosion Prediction Project
WFLC	Western Forest Leadership Coalition
WUI	Wildland-urban interface

Summary

The Four-Forest Restoration Initiative (4FRI) is a planning effort designed to restore ponderosa pine forest resiliency and function across four national forests in Arizona including the Coconino, Kaibab, Apache-Sitgreaves, and Tonto National Forests. The EIS project area is approximately 988,764 acres (figure 1) and includes the Coconino National Forest (hereafter referred to as Coconino NF) and Kaibab National Forest (hereafter referred to as Kaibab NF). This analysis is independent of any preceding or subsequent environmental analysis that may occur across northern Arizona.

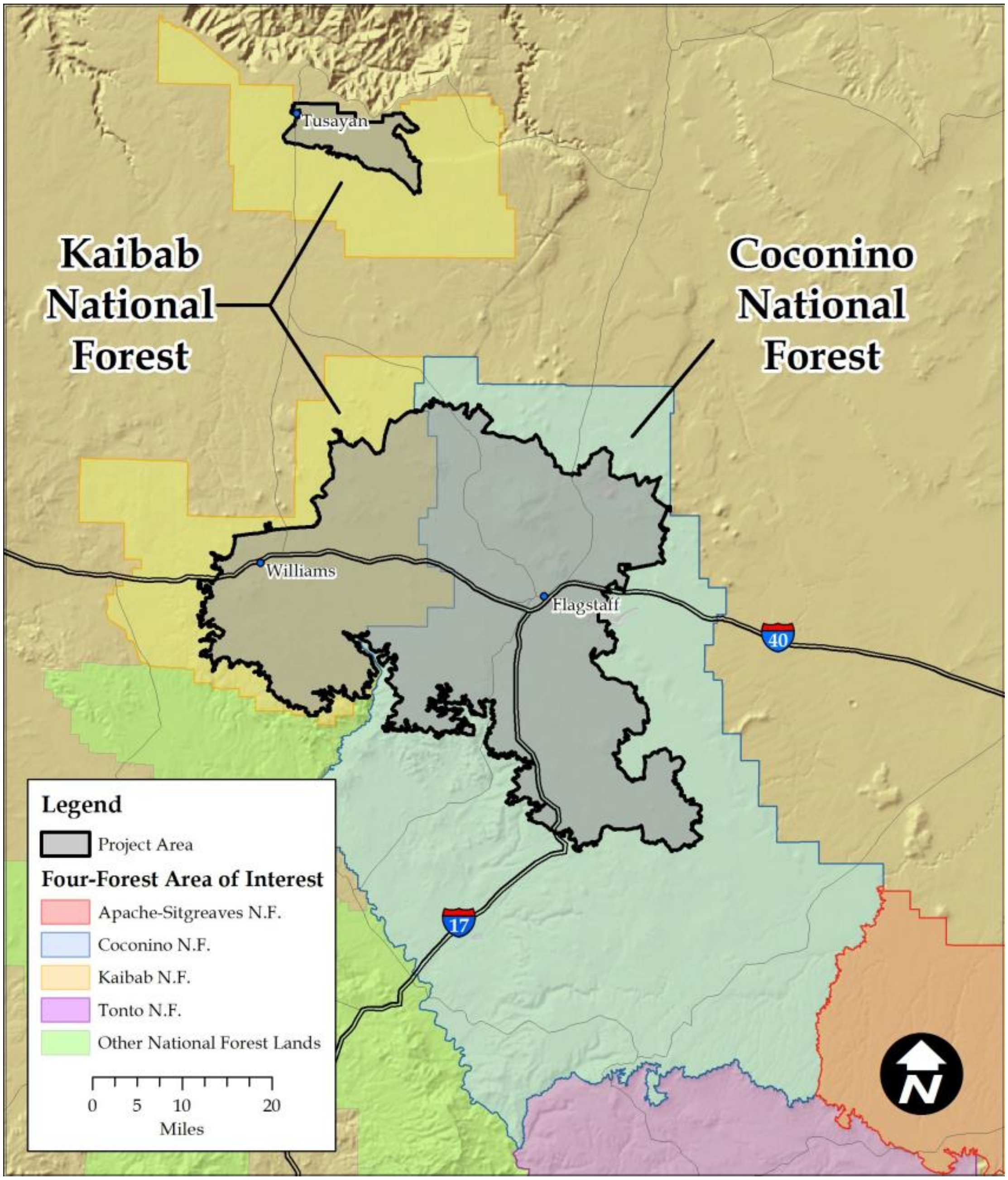

Figure 1. Four-Forest Restoration Initiative (4FRI) project area

This proposal is a result of several years of planning and collaboration among interested parties, groups and organizations, and Federal, State and local government agencies. The focus has been to restore forest landscapes and reduce the potential for severe fire effects in a manner that benefits the local economy. This proposal was selected to receive Collaborative Forest Landscape Restoration Act (CFLRA) funding. CFLRA supports landscape restoration on National Forest System lands.

In 2010, stakeholders developed a comprehensive landscape restoration strategy for the Coconino and Kaibab NFs, which documented existing conditions, potential treatment areas, and desired post-treatment conditions. The stakeholders also developed other products including the Large Tree Retention and Old Growth Protection Strategy. The Forest Service used the stakeholder's Landscape Restoration Strategy for the first analysis area (4FRI Stakeholders 2010) to inform the purpose and need and proposed action for this project. The large tree and old growth strategy was used to inform alternatives and the implementation plan.

In response to the purpose and need for action, the Coconino and Kaibab National Forests are proposing to conduct a suite of restoration activities on approximately 586,110 acres over a period of 10 years. The area affected by the proposal includes approximately 355,708 acres on the Flagstaff, Mogollon, and Red Rock Ranger Districts of the Coconino NF and 230,402 acres on the Williams and Tusayan Ranger Districts of the Kaibab NF.

The purpose of this 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, and climate change (FSM 2020.5). This action is needed because:

- Over 50 percent of the ponderosa pine is even-aged and lacks age-class diversity. The single-age forest structure has reduced the health of the ponderosa pine forest. Large, old ponderosa pine trees are rare across the landscape. The remaining old pines are at risk of dying from the increased overcrowding of trees (stand density-related mortality) and the potential for severe fire effects.
- In contrast to having a ponderosa pine ecosystem consisting of groups of trees mixed with interspaces, approximately 74 percent of the ponderosa pine forest type within the project area is departed from desired conditions. Non-forested openings have been invaded by ponderosa pine since fire exclusion and this has changed the natural (and desired) spatial pattern.
- The dense, single-age forest structure combined with the lack of nonforested openings has affected function related to the presence of grass, forbs, and shrubs (vegetation composition and diversity). There is reduced understory productivity and function throughout the forest and within grasslands and meadows where trees have grown in. Ephemeral stream function has been affected by reduced ground cover, the presence of noxious weeds, increased numbers of trees, and the lack of fire. Spring function has been affected by drought, the lack of fire, and closed forest canopies, which increase evapotranspiration.
- The existing forest structure is in poor forest health. This has affected resiliency, or the ability of ponderosa pine to withstand natural disturbances including fire, insects and disease, and changing climatic conditions, such as drought. About 191,000 acres (38 percent) are at risk from crown fire. Additional acres, primarily within or next to Mexican spotted owl habitat are at risk from high-intensity surface fire that can result in high-severity effects.

- Approximately 72 percent of the ponderosa pine in the project area has a high hazard rating for bark beetle. About 34 percent of the ponderosa pine is moderately to heavily infected with dwarf mistletoe (see silviculture report). The current deficiency in resiliency is attributed to closed forest conditions and the associated buildup of forest fuels.

The 4FRI Project has been published in the Coconino and Kaibab NFs' Schedule of Proposed Actions since January of 2011. The notice of intent to prepare an environmental impact statement was published in the Federal Register on January 25, 2011 (76 FR 4279–4281). A draft proposed action was sent to the project mailing list (paper copies and electronic mail), consisting of 1,331 individuals, local governments, State governments, Federal and State agencies, and organizations that encompassed both national forests. Fifty-four (54) scoping responses (emails and letters) were received through May 5, 2011. A scoping report that included a summary of the scoping process was posted on the 4FRI website on June 29, 2011. On March 11, 2011, the Arizona Game and Fish Department (AGFD) was designated a cooperating agency. The agency provided a habitat specialist to serve as an interdisciplinary team member and assist with the wildlife analysis.

A revised proposed action was sent to a refined mailing list (based on scoping responses) of 213 parties (169 electronic mail and 44 paper copy recipients), and a second 14-day informal scoping period began with the publication of a second revised notice of intent in the Federal Register on August 19, 2011 (76 FR 51936–51938). Not counting duplicates, 42 scoping responses (emails and letters) were addressed in content analysis (for the revised proposed action).

Four issues including prescribed fire emissions, conservation of large trees, post-treatment canopy cover and landscape openness and increased research and restoration focused the analysis or contributed to alternative development. See chapter 1 for information on how other public concerns and recommendations were addressed.

On February 26, 2013, a preview of the draft environmental impact statement (DEIS) was posted on the project's website at http://www.fs.usda.gov/main/4fri/planning, and interested parties were notified via email or phone call. On March 29, 2013 a notice of availability was published in the Federal Register (78 FR 19261). The notice of availability began a 60-day public comment period.

The DEIS documented five alternatives that were considered but eliminated from detailed study (see chapter 2) and the environmental consequences associated with three alternatives that would meet the purpose and need for action, and a no action alternative. Alternative C was identified as the preferred alternative.

Approximately 213 letters and emails were received on the DEIS. About 1,000 individual comments were received. The Forest Service analyzed comments to identify issues that required further or updated analysis and to identify analyses that required further clarification. See chapter 1 for further information on how comments were categorized and addressed. Appendix I (volume 2) of this FEIS contains responses to comments received on the DEIS.

Changes from the DEIS to the FEIS

Since the publication of the DEIS, the Forest Service:

(1) addressed two procedural concerns raised by the public;

(2) added language to the purpose and need and implementation plan to clarify the need to conserve large trees;

(3) developed a new alternative (alternative E) that proposes no forest plan amendments;

(4) considered but eliminated an evidence-based full restoration alternative;

(5) revised treatment acres for all “action” alternatives (alternatives B through E) 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);

(6) removed treatment acres which overlapped with other ongoing National Environmental Protection Act (NEPA) analyses (such as the Flagstaff Watershed Protection Project);

(7) corrected technical errors;

(8) clarified methodology; updated environmental consequences (including cumulative effects);

(9) revised, further developed, and analyzed or corrected appendix sections B through G;

(10) conducted additional analyses (as appropriate) based on public comments on the DEIS in the preparation of this FEIS;

(11) removed all forest plan amendments on the Kaibab NF and updated forest plan direction as a result of having a revised forest plan (see chapter 2; forest plan consistency section);

(12) completed the monitoring and adaptive management plan, including the incorporation of U.S. Fish and Wildlife Service (FWS) mitigation and monitoring items for Mexican spotted owl;

(13) addressed changed conditions from a 2014 wildland fire on the Coconino NF; and

(14) modified how canopy cover would be measured on about 38,256 acres in alternatives C and E in response to comments.

The incremental changes to the proposed action and alternatives is documented in the project record and incorporated by reference in accordance with 40 CFR 1502.21 (36 CFR 220.5(e)(1)).

Issues

Issues 1 through 4 were edited to reflect public comments on the DEIS related to canopy cover, post-treatment openness and the conservation of old and large trees. 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-E) to provide sharp contrast and comparison to the proposed action.

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 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 of this FEIS 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).

Issue 1: Prescribed Fire Emissions

This issue relates to the emissions from prescribed fire activities and the impact on air and water quality, public health, quality of life, and the economy of northern Arizona. In response to comments on the DEIS, emissions include, but are not limited to, radionuclide particles and mercury.

An alternative that would eliminate all prescribed fire was considered but eliminated from detailed study as it did not adequately meet the purpose and need for restoring the fire-adapted southwestern ponderosa pine ecosystem. Alternatives B, C, and E propose using prescribed fire across the entire project area and alternative C adds acres where prescribed fire would be used to restore additional acres of grasslands. Alternative D was developed to respond to the emissions issue by decreasing the acres proposed for prescribed fire by 69 percent (when compared to alternative B). This equates to removing fire on about 404,889 acres. All action alternatives include design criteria aimed at reducing impacts to air quality (as practicable) and increasing coordination efforts among neighboring national forests.

Issue 2: Conservation of Large Trees

This issue focuses on the conservation of large trees and the inclusion into the action alternatives of a strategy produced by the 4FRI stakeholders, the “Old Growth Protection and Large Tree Retention Strategy”[1] (also referred to as the “Large Tree Retention Strategy” or the “Old Tree Retention Strategy”). Large post-settlement trees, as defined by a socio-political process, are those greater than 16 inches d.b.h.

Commenters stated alternatives B (proposed action alternative) and D do not incorporate the Large Tree Retention Strategy. Alternative C and E respond to this issue by incorporating key components of the strategy and focusing on ecological desired conditions. In response, an implementation plan that is integral to all action alternatives was developed. The plan identifies ecological conditions where large, post-settlement trees may be removed to move toward or meet desired conditions. The intent of the Large Tree Retention Strategy has been incorporated into alternative C and E’s design criteria, the monitoring and adaptive management plan, and the project implementation plan. All resource reports have analyzed and disclosed how the modified Large Tree Retention Strategy (the Large Tree Implementation Plan) has been addressed in the environmental consequences section of this FEIS.

Issue 3: Post-treatment Canopy Cover and Landscape Openness

This issue focuses on retaining closed canopy conditions for species including, but not limited to, goshawk and Mexican spotted owl. Commenters stated measuring canopy cover in goshawk habitat at the group level would not meet forest plan stand-scale canopy requirements. Commenters stated a reduction in canopy and large tree densities have never been analyzed under the National Environmental Policy Act and National Forest Management Act and could have deleterious effects to goshawk, its prey species, and those wildlife species that are dependent on that cover. Because natural openings would no longer be included within the vegetation structural stage (VSS) classification, it would result in significantly more lands being in an open condition

[1] 4FRI Stakeholders 2010

or outside of the VSS 4 to 6 classifications. This could substantially increase the logging of mature and old trees and negatively affect wildlife, including goshawk and its prey species.

Alternatives B through E are designed to provide closed canopy conditions and comply with the forest plans. The vegetation analysis addresses the interrelationship between canopy cover and old and large trees. To address post-treatment openness and canopy cover, a nonsignificant forest plan amendment for the Coconino NF was developed for alternatives B, C, and D. Alternative E does not propose a forest plan amendment.

Issue 4: Increased Restoration and Research

This issue focuses on recommendations to increase the acres and type of restoration treatments. Commenters recommended including additional acres of grassland restoration. The U.S. Fish and Wildlife Service recommended increasing prescribed fire and mechanical treatments within Mexican spotted owl habitat (to improve the quality of the habitat and be in alignment with the revised Mexican Spotted Owl Recovery Plan (USDI FWS 2012)). Commenters recommended including a paired watershed study and small mammal research to evaluate the impact of landscape-scale restoration. Alternative C was developed to respond to this issue.

Procedural Concerns

Range of Alternatives and Comparison of Alternatives

This procedural concern was raised in comments to the DEIS. There is a concern that the action alternatives proposed in the DEIS were virtually identical except for the variation in acreages. Some commenters stated there is no (action) alternative where a plan amendment would not take place. Commenters stated it is not possible to understand the environmental effects and tradeoffs for resources that result from the amendments themselves.

Alternative E may address this concern. In alternative E, no forest plan amendment would occur and treatments would comply with the current Coconino NF forest plan. In summary, the FEIS includes 11 alternatives including no action, 4 action alternatives and 6 alternatives that were considered but eliminated from detailed study.

Significant Forest Plan Amendments

This procedural concern is based on comments on the DEIS. Commenters stated the plan amendments are significant because they may bring about changes that may have an important effect on the entire land management plan (or affect land and resources throughout a large portion of the planning area) see FSM 1926.52 (Jan. 31, 2006). Some commenters stated the plan amendments are significant because the two national forests are including identical plan amendments in similar projects.

In the FEIS, the analysis has been updated to clarify methodology and data used for the significance evaluation. Alternative E, which proposes no forest plan amendments, provides a point of comparison to alternatives B, C and D which do include plan amendments. In the FEIS, no plan amendment is proposed for the Kaibab NF in alternatives B, C and D because the treatments are in alignment with the plan’s objectives, desired conditions, and standards and guidelines (see chapter 2, “Forest Plan Consistency” section). Also see appendix I, “DEIS Response to Comments.”

Summary of Alternatives

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).[2] 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** 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 in diameter (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. 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 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 to mechanically treat trees up to 17.9 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, 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, but the protected activity centers 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.

[2] http://www.nepa.gov/nepa/regs/ceq/1502.htm#1502.14

- **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 a paired watershed study and small mammal research. It proposes to mechanically treat 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 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 2).
- 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 action alternatives include adaptive management actions that would be taken as needed to restore springs, ephemeral channels, and naturalize decommissioned and unauthorized roads (table 22). Temporary roads will be decommissioned by the purchaser/contractor immediately after use using adaptive management actions (FEIS, chapter 2) and BMPs for the rehabilitation of ground disturbed sites (FEIS, appendix C).

All action 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 1. FEIS summary 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
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 BA. 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.

MSO PAC = Mexican spotted owl protected activity center; BA = basal area

Table 2. 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.					

Alternatives Considered but Eliminated from Detailed Study

The DEIS included five alternatives considered but eliminated from detailed study. Public comments 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. In response to comments on the DEIS, a sixth alternative (evidence-based full restoration) was considered but eliminated from detailed study.

Design Features, Best Management Practices and Mitigation

Project design features, best management practices and mitigation measures that are designed to minimize or avoid impacts of the proposed actions have been included in the analysis of this FEIS (see appendix C). Some mitigation measures have been refined or added since the release of the DEIS. Chapter 3 of this FEIS summarizes, by resource, changes to design features and mitigation measures (with rationale) as appropriate.

Implementation Plan

The implementation plan (appendix D) is designed to be integral to the selected alternative and record of decision. It must be considered in conjunction with appendix C, which provides the design criteria, best management practices, and mitigation measures. The implementation plan provides direction that would be used by personnel to ensure that implementation meets the purpose and need and forest plan standards and guidelines. It is the foundation for the formal silvicultural prescriptions. The silvicultural prescriptions would document the desired conditions presented in the analysis, incorporate design features and mitigation (appendix C), and provide the course of action needed to move toward those desired conditions. In response to comments on the DEIS, the implementation plan has been corrected and revised.

Monitoring and Adaptive Management

Appendix E includes the adaptive management, biophysical and socioeconomic monitoring plan. This plan is designed to be integral to the selected alternative and record of decision. The monitoring and adaptive management plan details the framework and process for monitoring selected actions. The 4FRI stakeholders and the Forest Service coordinated on the design of the monitoring and adaptive management plan. In response to comments on the DEIS, the plan has been corrected and revised. Appendix E also includes the Mexican spotted owl and Arizona bugbane monitoring plan as approved (through formal consultation) by the FWS.

Forest Plan Consistency

The 4FRI Project was reviewed for consistency with the 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). Consistency evaluations can be found by resource in chapter 3 of this FEIS, in each specialist report, and the project record. Appendix D (implementation plan) documents how treatment design meets Coconino NF and Kaibab NF forest plan direction and desired conditions.

Coconino NF: Three nonsignificant amendments for the Coconino NF were evaluated in the FEIS. The amendments are authorized via 36 CFR 219, the Forest Service Planning Rule. Section 219.17(b)(3) of the Rule provides the transition language that allows this project to propose amendments to the Coconino NF forest plan using the provisions of the 1982 Planning Rule. 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 FWS biological opinion that is specific to this project. Amendment 2 clarifies existing direction related to managing canopy cover and interspace in the forest plan. The purpose of amendment 2 is to bring the project into alignment with the best available science (Reynolds et al. 2013) that provides desired conditions for restoring fire-adapted ponderosa pine in the Southwest. Amendment 3 resolves a forest plan error related to the management of heritage resources and is specific to this project. The detailed significance analysis for each amendment is located in appendix B of this FEIS.

The significance of each amendment was evaluated in accordance with Forest Service Handbook (FSM) 1926.51 and FSM 1926.52. 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 (Reynolds et al. 2013). The amendments bring the alternatives into alignment with the revised Mexican Spotted Owl Recovery Plan, although the degree of alignment varies by alternative. No amendment would 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).

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. All forest plan amendments for the Kaibab NF were removed from the FEIS because the alternatives are consistent with the revised Kaibab NF forest plan. The project's desired conditions for ponderosa pine were based on the best available science for the restoration of southwestern fire-adapted ecosystems (Reynolds et al. 2013). These desired conditions informed the Kaibab NF's plan revision process. The amendments for Mexican spotted owl were removed because the project is consistent with the 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 (Kaibab NF forest plan, p. 51).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. Kaibab NF forest plan consistency evaluations are located in each resource report. A consolidated evaluation is in the project record (see chapter 2 for additional details).

Major Conclusions

In response to public comments received on the DEIS, the FEIS presents additional information to display a sharper contrast and comparison of effects between the alternatives (table 35). See chapter 3 for the complete effects analysis.

Prescribed Fire Emissions (Issue 1)

Emissions would be highest in alternative A, approaching 80,000 pounds per acre. After treatment, there would be the least emissions potential from alternatives B and C with emissions projected at about 31,000 pounds per acre. Alternative E would be the next lowest amount of emissions, and would be closer to alternatives 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.

From a quality of life perspective, smoke emissions would be inevitable under all alternatives, whether from prescribed burns or wildfire. However, the intensity and duration of emissions would be variable. With prescribed burns, burn plans would be developed to minimize adverse effects to quality of life in nearby communities. The Forest Service would work with the Arizona Department of Environmental Quality to ensure that smoke impacts to human health are avoided or minimized. This issue remains unresolved and controversial with those members of the public who oppose any use of prescribed fire.

Large and Old Trees (Issue 2, Purpose and Need)

The conservation of large trees was identified as issue 2. The need to retain large trees was identified in the purpose and need. In alternative A, the sustainability of the large and old tree component across the landscape may be impaired by density related mortality and forest health issues. When compared to alternative A, the sustainability of the large and old tree component across the landscape would be improved (see “Forest Health” later in this section).

The goshawk analysis indicates the mature and old forest structural stages would be underrepresented in the post-fledging area (PFA) habitat and lands outside post-fledging area (LOPFA) even-aged stands. Projections show a trend toward improved representation in all habitats. In 2050, all restoration units (RUs) are very close to or exceed desired conditions for the number of trees per acre larger than 18 inches with the exception of RU 6.

In alternative D, 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. Also see the “Mexican Spotted Owl Habitat” large and old tree discussion. 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. However, this issue likely remains unresolved and controversial with those members of the public who oppose cutting any tree larger than 16 inches d.b.h.

Mexican Spotted Owl Habitat (Issue 3, Purpose and Need)

How treatments could potentially affect Mexican spotted owls and their habitat is part of Issue 3. The need to improve the quality of Mexican spotted owl habitat is part of the purpose and need for the project.

Although the modified large tree retention strategy applies only to alternatives C and E, the silvicultural analysis for Mexican spotted owl indicates good representation in the 18- to 24-inch size classes in all habitats in alternatives B, C, and E. Alternative D resembles the no action alternative with the least movement made toward desired conditions. 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. 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).

The FWS biological opinion for Mexican spotted owl found the preferred alternative (alternative C) “may effect and is likely to adversely affect Mexican spotted owls and their habitat, including critical habitat.” There is potential for short-term adverse effects to owls and their habitat from project activity disturbance outside of the nesting season (USDI FWS 2014). Potential impacts to Mexican spotted owl likely remain controversial with those members of the public who oppose any mechanical or prescribed fire treatments within Mexican spotted owl habitat. Also see the uncertainty and risk discussion in the “Mexican Spotted Owl” analysis in the “Wildlife” section of chapter 3.

Northern Goshawk Habitat (Issue 3, Purpose and Need)

How treatments could potentially affect northern goshawk habitat is part of issue 3. The need to improve the quality of goshawk habitat is part of the purpose and need for the project.

In alternatives B through E, primary benefits from these changes in forest structure are that the risks of large-scale loss of habitat from disturbances such as uncharacteristic fire, bark beetles, and density-related mortality would be reduced. In alternative A, the potential for large-scale loss of habitat from disturbances would persist and increase.

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.

In alternatives B through E, treatments in goshawk habitat would be implemented using tree stocking guidelines that would maintain interlocking or nearly interlocking tree crowns. Tree group density would meet and exceed the canopy cover requirements (Coconino NF only) and desired conditions (Kaibab NF). In response to feedback and comments received on treating less aggressively and leaving more large trees, canopy cover will 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. Although canopy cover desired conditions and requirements would be met, the retention of adequate canopy cover or closed canopies likely remains controversial with those members of the public who believe the post-treatment condition will be too open.

Soil Productivity and Watershed Function (Issue 4, Purpose and Need)

The topic of increased restoration and research and how landscape restoration affects water yield and watershed function is part of issue 4. The potential impact of treatments on soil productivity and watershed function is part of the purpose and need.

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.

Short-term impacts from soil disturbances would range from a watershed average of 2.9 percent (lowest in alternative D) to 3.4 percent (highest in alternative C). In alternatives B through E, no watershed would have soil disturbance above 11 percent (4 percent below the 15 percent threshold).

Soil disturbance includes temporary road construction and decommissioning. Disturbance to soils from about 520 miles of road construction and decommissioning would occur on about 1,645 acres. Disturbance would be short term. Most road construction and decommission actions would be located on soils with slight or moderate erosion hazard. About 22 miles of road (about 40 acres) occur on severe erosion hazard soils. Temporary roads would be decommissioned by the purchaser/contractor immediately after use using adaptive management actions (FEIS, chapter 2) and BMPs for the rehabilitation of ground-disturbed sites (FEIS, appendix C).

The project would remove approximately 860 miles of roads, or about 1,645 acres of road from future disturbance in the long-term. About 38 miles (roughly 70 acres) are on severe erosion hazard soils. BMPs, including SW BMP 38 (see appendix C), are designed to minimize impacts from decommissioning efforts. After decommissioning, there would be reduction of roads on severe erosion hazard soil type. Soil productivity and watershed function should be maintained.

On untreated slopes over 15 percent, up to 33 percent is likely to have high burn severity in alternative A. The potential for high burn severity could occur across more acres in alternative D because of the continuing accumulation of surface fuels.

In alternatives B, C and E, watershed condition would be improved on 23 percent at risk and 42 percent impaired watersheds. This would be reduced in alternative D with 18 percent improvement in at-risk watersheds and 23 percent improvement in impaired watersheds. This occurs because alternative D does not use enough prescribed fire that is necessary to maintain soil productivity and watershed function. With implementation of identified soil and water BMPs, ADEQ water quality standards would be met.

Although soil productivity and watershed function would be maintained, disturbance related to the development and decommissioning of temporary roads is likely to be remain controversial with some members of the public.

Forest Health (Purpose and Need)

In alternative A, the percent of the project area with a high bark beetle hazard rating would increase from 84 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, best meeting the desired condition of having no high hazard ratings in the project area. 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 52 (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.

In alternative A, an increase in stand density-related mortality would be expected in much of the Mexican spotted owl habitats. Alternatives B through E would decrease SDI max[3] as a result of treatments. However, regardless of alternative (B through E), most Mexican spotted owl protected habitat would be within the “extremely high density” zone. Restricted other habitat would be on the high end of the desired range. 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.

[3] SDI max represent the maximum SDI varying by species. Percent SDI max expresses the actual density in a stand relative to a theoretical maximum density possible for trees of that diameter and species. Ponderosa pine uses a maximum SDI of 450 (i.e., a stand with SDI of 200 is (200/450)*100 = 44.4% of maximum SDI).

Vegetation Composition and Diversity (Purpose and Need)

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. Alternatives B through E would result in vigorous aspen regeneration. Alternative D treats the least acres of aspen due to using less prescribed fire. Alternatives B, C, and D increase large oak in Mexican spotted owl habitat by 6 percent in the short term and 7 percent in the 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.

Alternatives B, D, and E would treat the most acres of grassland (see chapter 2, table 35), 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 owls and their prey in the short and long terms (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.

Forest Resiliency and Function – Fire (Purpose and Need)

At the landscape scale, the difference in modeled crown fire potential between alternatives B though E is minimal because the vertical and horizontal continuity of canopy fuels is broken up by mechanical treatments. Under alternative E there would likely be greater potential for crown fire than under alternative B because, without an amendment, the forest plan would require less interspace and result in more contiguous canopy fuels.

In alternative A 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.

Forest Resiliency and Function – Vegetation Structure and Composition (Purpose and Need)

In terms of establishing and maintaining composition and structure of vegetation, alternative A moves the project area away from desired conditions. In alternative A, in ponderosa pine, all trees per acre greater than 5 inches d.b.h. and all basal area would continue to increase from the historic range. In most cases, the averages exceed the historic range by 2020 and 2050. This alternative represents an increase in tree density, the slowing of tree growth, and increased risks from fire, insects, and diseases.

Alternative D would move the project toward the desired condition but leaves treated areas at higher risks of high severity fire. Alternatives B and C 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 and functions. Vegetation would have improved ability to resist, and adapt to, future disturbances and climates. In alternatives B through E, forest attributes are within the natural range of variation, except for in protected activity centers, goshawk nest areas, and Mexican spotted owl target threshold habitats.

Forest Resiliency – Climate Change (Purpose and Need)

In alternative A, there would be increased risk of stand density and insect and disease-related mortality. The ponderosa pine forest would have limited resilience to survive and recover from potential large-scale impacts. Alternatives B, C, and E increase resiliency to natural disturbances on over 500,000 acres in both the short and long terms. In alternative D (long term) over 300,000 acres would return to pretreatment conditions and would be susceptible to high-severity surface fire effects resulting in reduced resiliency to natural disturbances.

In alternative A, carbon stocks would remain high. Large-scale fire events would release significant amounts of carbon into the atmosphere. In alternatives B through E, individual tree growth would improve, resulting in larger average tree size and increased stable carbon storage over time, offsetting short-term losses of carbon removed through mechanical treatments and prescribed fire.

Socio-economics (Topic of Public Interest)

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.

Over the 10-year treatment period, assuming a 4 percent discount rate, alternatives B through E would save between $156,000,000 and $232,000,000 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.

Decision Framework

The Coconino and Kaibab NF forest supervisors are the Forest Service officials responsible for deciding whether to select the actions as proposed (alternative B); select one of the other action alternatives including alternative C, D or E; select an alternative that combines attributes from differing alternatives; or select no action (alternative A). Their decision includes determining: (1) the location and treatment methods for all restoration activities, (2) design criteria, mitigation, and monitoring requirements, (3) the components that will be included in the monitoring and adaptive management plan, (4) the components that will be included in the implementation checklist and plan, (5) the estimated products or timber volume to make available from the project, and (6) consistency with the forest plans in place at the time of the decision and whether the Coconino NF forest plan would be amended.

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Chapter 1. Purpose of and Need for Action

Document Structure

The Forest Service has prepared this final environmental impact statement (FEIS) in compliance with the National Environmental Policy Act (NEPA) and other relevant Federal and State laws and regulations. This FEIS discloses the direct, indirect, and cumulative environmental impacts that would result from the proposed action and alternatives. This document is organized into two volumes.

Volume 1

Chapter 1. Purpose and Need for Action: The chapter includes information on the history of the project proposal, the purpose of and need for the project, and the agency's proposal for achieving that purpose and need. This section also details how the Forest Service informed the public of the proposal and how the public responded.

Chapter 2. Alternatives, including the Proposed Action: This chapter provides a more detailed description of the agency's proposed action as well as alternative methods for achieving the stated purpose. These alternatives were developed based on issues raised by the public and other agencies. This discussion also includes mitigation measures. Finally, this section provides a summary table of the environmental consequences associated with each alternative.

Chapter 3. Affected Environment and Environmental Consequences: This chapter describes the environmental effects of implementing the proposed action and other alternatives. This analysis is organized by resource area.

Chapter 4. Consultation and Coordination: This chapter provides a list of preparers and agencies consulted during the development of the environmental impact statement.

References: This section provides a list of scientific literature used to inform the analysis.

Index: The index provides page numbers by document topic.

Volume 2

Appendices A through I: The appendices provide detailed information to support the analysis. Appendices include: a placeholder for a map packet (appendix A); proposed forest plan amendments (appendix B); project design features, best management practices (BMPs), and mitigation (appendix C); the implementation plan (appendix D); the adaptive management, biophysical and socioeconomic monitoring plan (appendix E); cumulative effects (appendix F); wildlife bridge habitat analysis (appendix G); glossary of terms (appendix H); and response to comments on the DEIS (appendix I).

Additional documentation, including the complete analysis for each resource, may be found in the project record located at the Coconino National Forest Supervisor's Office, 1824 South Thompson Street, Flagstaff, Arizona. All specialist reports are also posted on the 4FRI website at: http://www.fs.usda.gov/main/4fri.

Project Overview and Background

The Four-Forest Restoration Initiative (4FRI) is a planning effort designed to restore ponderosa pine forest resiliency and function across four national forests in Arizona including the Coconino, Kaibab, Apache-Sitgreaves, and Tonto (figure 2).

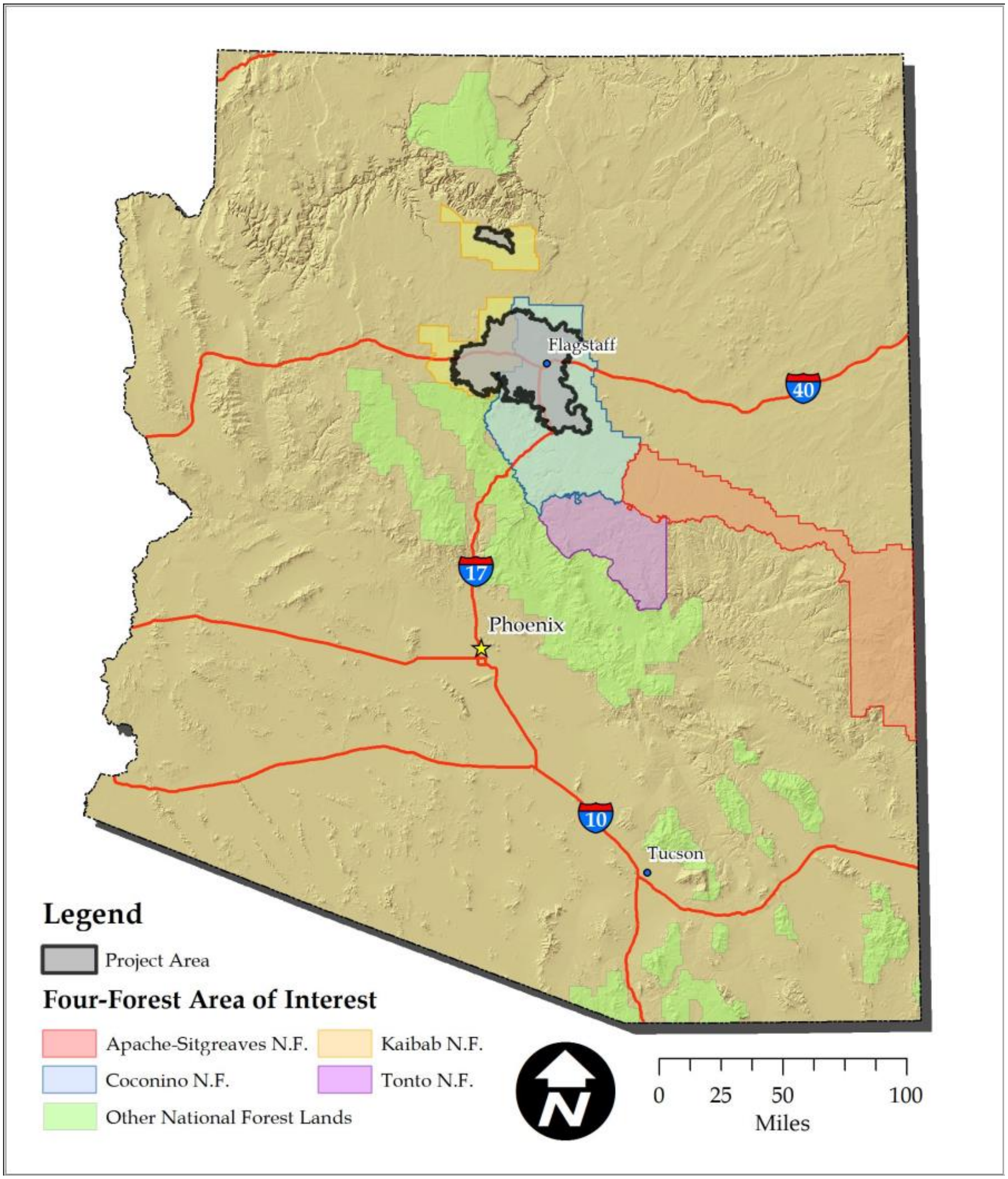

Figure 2. Four-Forest Restoration Initiative (4FRI) vicinity map

The EIS project area is approximately 988,764 acres and includes the Coconino National Forest (hereafter referred to as Coconino NF) and Kaibab National Forest (hereafter referred to as Kaibab NF) (figure 3). This analysis is independent of any preceding or subsequent environmental analysis that may occur across northern Arizona.

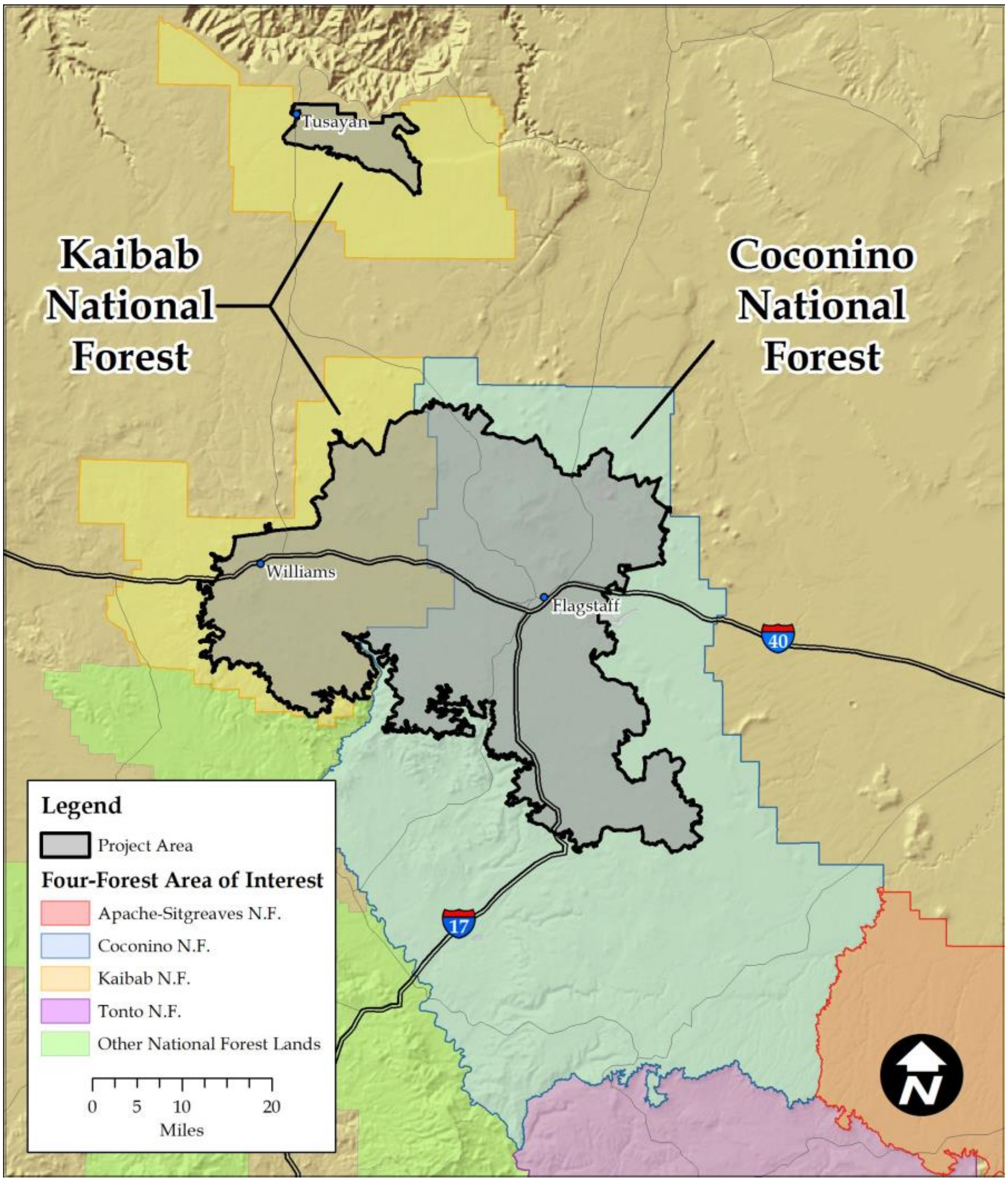

Figure 3. EIS project boundary on the Coconino and Kaibab National Forests

The Forest Service is proposing to conduct restoration activities on approximately 586,110 acres of the Coconino and Kaibab NFs. Of this total, approximately 355,707 acres would be treated on the Coconino NF and 230,402 acres would be treated on the Kaibab NF (alternative C, preferred alternative). Restoration actions would focus on the Flagstaff Ranger District with fewer acres included on the Mogollon Rim and Red Rock Ranger Districts of the Coconino NF. On the Kaibab NF, activities would occur on the Williams and Tusayan Ranger Districts (figure 4).

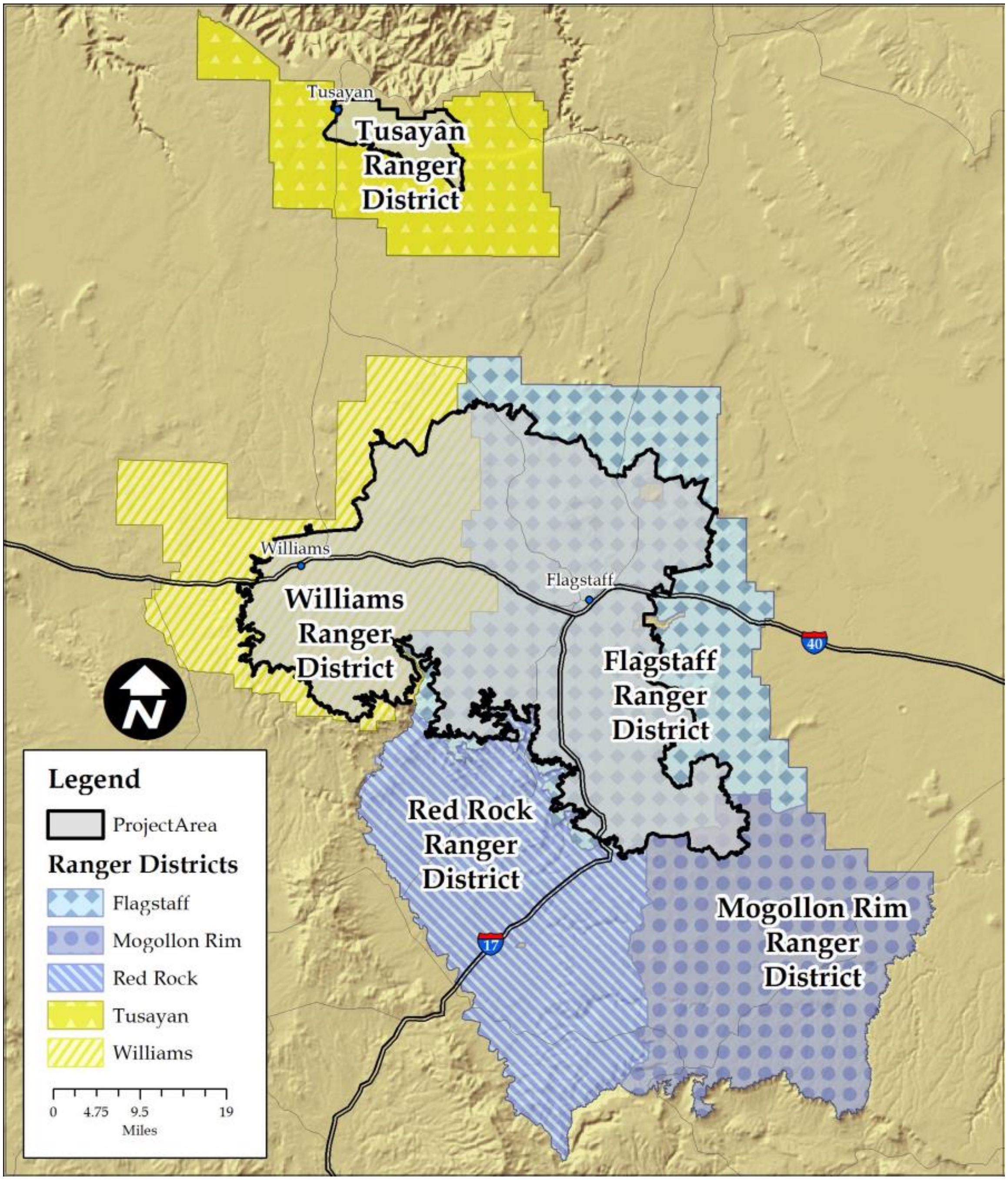

Figure 4. Restoration units (RUs) within the project area

Project Location

Within the 988,764-acre project area, approximately 390,000 acres were excluded from this proposal. Excluded areas include about 213,090 acres that are being analyzed in separate environmental analyses; approximately 30,000 acres that are located in special areas that include designated wilderness, inventoried roadless areas, wild and scenic rivers, and wilderness study areas; and over 145,000 acres that are non–Forest Service administered lands. The project area is entirely located within Coconino County.

Due to the size of the project, the Forest Service used a strategy developed by the 4FRI stakeholders and stratified the landscape into six restoration units (figure 5). A restoration unit (RU) is a contiguous geographic area that ranges from about 46,000 acres to 333,000 acres.

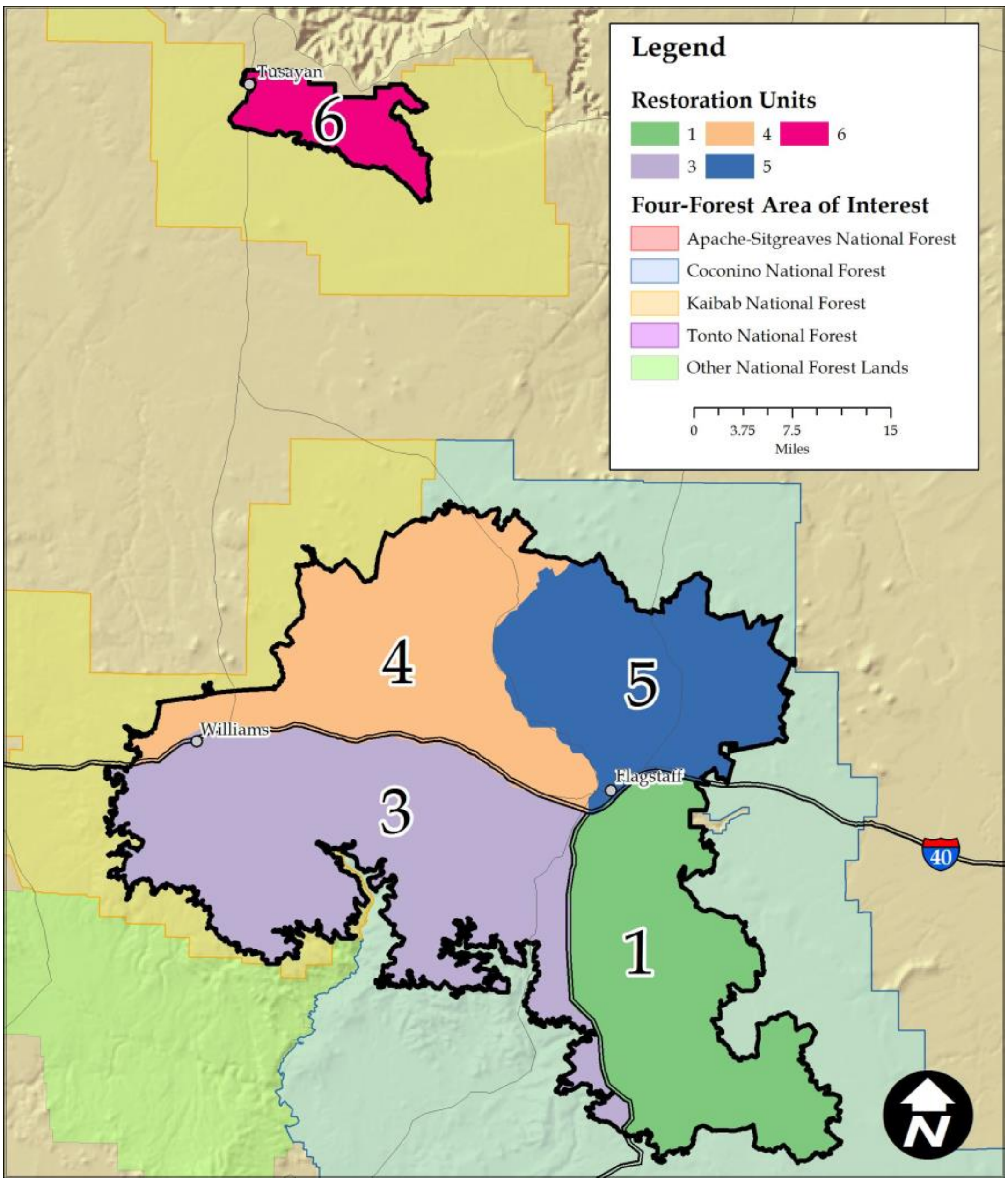

Figure 5. Restoration units within the project area

RU 1 includes portions of the Flagstaff, Mogollon, and Red Rock Ranger Districts (Coconino NF). RU 1 is generally located south of I-40 and east of I-17. RU 3 includes portions of the Williams Ranger District (Kaibab NF), Flagstaff, and Red Rock Ranger Districts (Coconino NF) and is generally located south of I-40 and west of I-17. RU 4 includes portions of the Flagstaff Ranger District and the Williams Ranger District. It is generally located north of I-40 and west of Highway 180.

Communities in the vicinity of the proposed treatments include Flagstaff, Munds Park, Mormon Lake, Tusayan, and Williams, Arizona. RU 5 is located north of the I-40 and east of Highway 180 and includes landmarks such as Mount Elden. RU 6 lies immediately south of and next to Grand Canyon National Park. RU 6 entirely encompasses the Tusayan Ranger District on the Kaibab NF. RU 2 is located west of I-17 and south of the Mogollon Rim (figure 5). RU 2 was removed from this analysis (and subsequent maps) because the vegetation is not contiguous pine.

The project area was further stratified into several subunits that range in size from 4,000 to 109,000 acres (figure 6, page 7). Both units (RU and subunits) are based on 6th-code watershed boundaries, State and national forest transportation systems, and national forest administrative boundaries. Each resource specialist determined how best to use the restoration units and subunits in their analysis. Some analysis scales were selected to meet forest plan requirements (see individual resource sections in chapter 3).

4FRI Background

The 4FRI proposal is a result of several years of planning and collaboration among interested parties, groups and organizations, and Federal, State, and local government agencies. The focus has been to restore forest landscapes and reduce the potential for severe fire effects in a manner that benefits the local economy. In 2007, the Arizona Forest Health Council completed the Statewide Strategy to Restore Arizona's Forests. The strategy's vision integrates knowledge and experience from science, community collaboration, and economics to identify the necessary steps to increase the rate and effectiveness of forest restoration across Arizona.

The communities that surround the four national forests engaged in the 4FRI project are economically and social diverse. Apache, Coconino, Gila, Graham, Navajo, and Yavapai counties have economic bases in consumptive industries, agriculture, tourism and services to retirees. With this diversity has come an increasingly divergent vision of how to manage public lands and how to respond to the threat of uncharacteristic wildland fires. While the stakeholders may not always agree, there is strength in having stakeholders who can provide a wide range of potential solutions when working with the Forest Service.

In February 2008, based on recommendations within the statewide strategy, the "Analysis of Small Diameter Wood Supply in Northern Arizona" report (Hampton et al. 2008) was completed. This process demonstrated a level of "social agreement" on how much, where, and under what basic parameters mechanical treatment, as one restoration tool, could be used to accelerate restoration of the 2.4 million-acre ecosystem. In 2008, the Kaibab NF launched the Kaibab Forest Health Focus, a science-based, collaborative effort to guide future landscape-level forest restoration efforts.

To further advance collaborative efforts and secure the necessary assistance, the Forest Service created a task force to work with the Forest Health Council. The purpose of the task force was to identify alternative approaches to accelerating forest restoration in northern Arizona. To move into on-the-ground implementation as quickly as possible, stakeholders representing individuals, State and Federal agencies, local governments, the four national forests in northern Arizona, and the Forest Service's Southwestern Regional Office moved forward with the four-forest initiative.

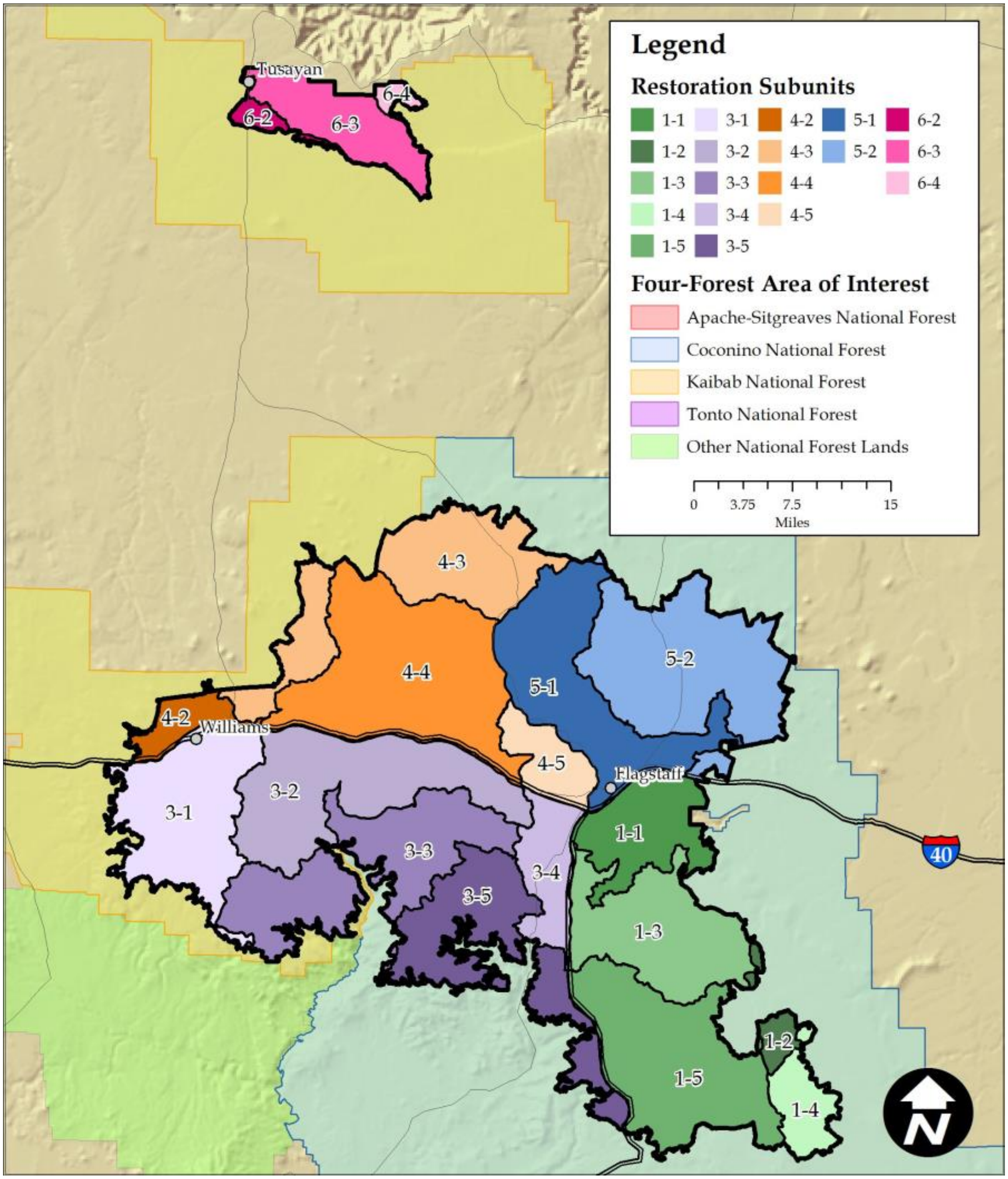

Figure 6. Restoration subunits within the project area

In 2009, Title IV of the Omnibus Public Land Management Act (P.L. 111-11) authorized funding for the Collaborative Forest Landscape Restoration (CFLR) Fund to support landscape-scale restoration on National Forest System lands. In 2010, the initiative received funding via the

CFLR Act. The CFLR Act objectives include reducing uncharacteristic wildfire and the associated management costs, supporting local and collaborative partnerships, supporting monitoring of restoration efforts, and supporting efforts that utilize forest products that benefit communities and offset treatment costs. Among other types of guidance, the CFLR Act requires that restoration treatments maintain or contribute to the development of old growth stands, maximize the retention of large trees, focus on small-diameter tree thinning, do not require the establishment of permanent roads, and require decommissioning of all temporary roads built for treatment purposes.

Also in 2010, stakeholders began refining their vision for ponderosa pine forest restoration. Stakeholders developed a comprehensive landscape restoration strategy for the Coconino NF and Kaibab NF, which documented existing conditions, potential treatment areas, and desired post-treatment conditions. The stakeholders also developed other products including the "Old Growth Protection and Large Tree Retention Strategy" (4FRI Stakeholders 2010). The Forest Service used the stakeholder's "Landscape Restoration Strategy for the First Analysis Area Report" (4FRI Stakeholders 2010) to inform the purpose and need and proposed action for this project. The large tree and old growth strategy was used to develop alternatives and the implementation plan.

While the 4FRI analysis has been in development, other broad-scale planning efforts have been underway. The Forest Service requires that the forest plans for individual national forests be revised every 10 to 15 years. Efforts began to revise the forest plans in 2006. In February of 2014 the Regional Forester for the Southwestern Region signed the Record of Decision for the Kaibab NF forest plan. The Coconino NF forest plan was issued in 1987. Although the Coconino NF forest plan is 25 years old, Congress has provided exemptions for older plans and the plan is being revised. The Coconino Draft Revised Plan and DEIS was released for comment in early 2014.

This 4FRI final EIS is consistent with the current Coconino NF forest plan as amended, including the project-specific amendments proposed in appendix B of this document. This final EIS is consistent with the revised Kaibab NF forest plan (USDA FS 2014). Consistency evaluations are included in each resource report. The record of decision for this project will further address consistency with the Kaibab NF revised forest plan.

Since the 4FRI EIS and plan revision documents have been developed essentially concurrently, consistent coordination and a great deal of alignment existed between the desired conditions and drivers of the three efforts. The timing of the release of the final Coconino NF documents will determine the description of how the 4FRI will achieve the consistency requirements. To the extent there is any inconsistency with a current or revised plan adopted prior to the final decision on the 4FRI project, appropriate project-specific plan amendments consistent with those proposed in appendix B of this document will be made at the time of the final decision.

Likewise, the Mexican Spotted Owl Recovery Plan was revised. The recovery plan was first issued in 1995. The Mexican Spotted Owl Recovery Plan, First Revision (USDI FWS 2012) was released in December 2012. While the FEIS uses terminology and recommendations specific to the former (1995) recovery plan, it was also designed to meet the criteria and recommendations of the 2012 recovery plan. Throughout the analysis process, there was continuous coordination with the U.S. Fish and Wildlife Service (FWS). The FWS has reviewed the project solely on the criteria of the 2012 Mexican Spotted Owl Recovery Plan and has determined the FEIS is in alignment with it and in compliance with the Endangered Species Act.

Purpose and Need for Action

The purpose and need for proposing an action was determined by comparing the objectives and desired conditions in the Coconino NF and Kaibab NF Land and Resource Management Plans (forest plans) to the existing conditions related to forest resiliency and forest function. Where plan information was dated or not explicit, local research and the best available science were used. The purpose and need also was developed using the landscape restoration criteria found in the Omnibus Public Land Management Act of 2009 (P.L. 111-11). The results of the comparison are displayed in narrative, tables, and photographs in this chapter.

The purpose of the project is to reestablish and restore forest structure and pattern, forest health, and vegetation composition and diversity to conditions similar to the natural range of variability. 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, insects and disease, fire, and climate change (FSM 2020.5). A key objective is to comply with the Omnibus Public Land Management Act of 2009 criteria for landscape-scale restoration, and achieve community, wildlife and forest protection while retaining as many large trees (greater than 16 inches d.b.h.) as possible.

The project is expected to move almost 600,000 acres toward comprehensive, landscape-scale restoration with benefits that include improved forest function and health, vegetation biodiversity, wildlife habitat, soil productivity, watershed function, and reduced risk of severe fire effects.

Existing and Desired Conditions

Forest Structure and Spatial Pattern

This analysis uses canopy density and openness; the relationship of vegetation structural stage (VSS) to age and size class and diversity; stand density and key habitat components; large trees; and old growth as criteria to describe existing and desired conditions for forest structure and spatial pattern in the project area.

Tree Density and Canopy Openness

A characteristic of historic southwest ponderosa pine forests was the grass/forb/shrub (interspace) interspersed among small groups of trees (Reynolds et al. 2013) This interspace typically comprised a large portion of the landscape (Woolsey 1911, Cooper 1960, White 1985, Pearson 1950, Covington et a1. 1997, Abella and Denton 2009). Low-severity fires occurred every 2 to 22 years and maintained an open canopy structure (Weaver 1951, Cooper 1960, Swetnam 1990, Swetnam and Baison 1990, Fulé et al. 1997a, Covington et al. 1997, Heinlein et al. 2005, Fulé et al. 2003). Typical historical tree groups ranged from 0.1 to 0.75 acre in size and were comprised of 2 to 72 or more trees per group (White 1985, Fulé et al. 2003, Covington et al. 1997, Reynolds et al. 2013). Reference conditions for openness ranged from 52 to 90 percent open (Reynolds et al. 2013). Others (including Fulé and Woolsey) have described historical ponderosa pine forests as having low tree-density, open, savanna-like stands consisting of groups of pine trees interspersed with grassy or shrubby openings (White 1985, Fulé et al. 2003, Woolsey 1911). For this analysis, the term "openness" is used to convey the percentage of the forested area that is grass/forb/shrub interspace. It is often used interchangeably with the term "canopy density."

In contrast to having a ponderosa pine ecosystem consisting of groups of trees mixed with interspaces, approximately 74 percent of the ponderosa pine forest type within the project area is departed from historical reference conditions.[4] Table 3 displays the existing percent of interspace (openness) in the project area by restoration unit.[5] Openness ranges from very open/open to closed. Stand data was used to generate figure 7 on page 11; the figure was updated in the FEIS to improve clarity.

Table 3. Canopy openness (classification percent of interspace) by restoration unit

Restoration Unit	Acres	Very Open (percent)	Open (percent)	Moderately Closed (percent)	Closed (percent)
1	144,114	1	14	28	57
3	129,225	1	14	25	60
4	134,278	4	22	35	39
5	59,033	11	57	23	9
6	41,189	2	30	39	29
All ponderosa pine	507,839	3	22	29	46

Overall, the desired condition is to reestablish nonforested openings that have been invaded by ponderosa pine since fire exclusion and reconfigure the forests toward their natural spatial pattern. At the fine scale, groups of trees would typically range in size from 0.1 acre to 1 acre.

Tree group size would exceed 1 acre as needed to respond to site-specific conditions including the presence of pre-settlement trees or mature and mid-aged trees that are developing old-tree characteristics. Tree groups in the mid-age and older structural stages (VSS 4, 5, and 6) would have canopies that provide moderate-to-closed conditions and where canopies are touching, or nearly touching, to provide connectivity for wildlife that are dependent on this type of habitat.

There would be a mix of very open, open, moderately closed, and closed canopy conditions at the landscape (ponderosa pine vegetation) scale. Moderate-to-closed canopy conditions would be widely distributed on the landscape. Habitat for goshawk and Mexican spotted owl, steep slopes, and buffers for resources such as bald eagle roosts, other raptor nests, caves, and special designations that would not be treated (including wilderness and most research natural areas) provide connectivity with moderate-to-closed canopy conditions. At the landscape scale (extent of ponderosa pine vegetation), openness would range from very open (up to 90 percent) within the savanna and grassland matrix to closed (as low as 10 percent) on the highly productive forest areas to achieve a heterogeneous condition across the landscape.

There is a need to use management strategies that move tree group pattern, interspaces, and canopy density toward the natural range of variation (sum of reference conditions) and provide a mix of open, moderately closed, and closed canopy conditions at the fine (group) to landscape (ponderosa pine vegetation) scale. There is a need to amend the Coconino NF forest plan to provide for grass/forbs/shrubs (interspace) interspersed among tree groups.

[4] Reference condition is defined as the condition due to site, ecology, and natural disturbance regime.

[5] Determining openness is best accomplished through aerial imagery analysis. At present, this analysis is only available for a small portion of the project area. In the absence of a detailed aerial imagery analysis it was determined that stand data was an appropriate substitute to classify the continuous canopy conditions that currently exist within the project area. Therefore, the current openness within the project area was determined using the canopy density measurements described in the silviculture specialist report.

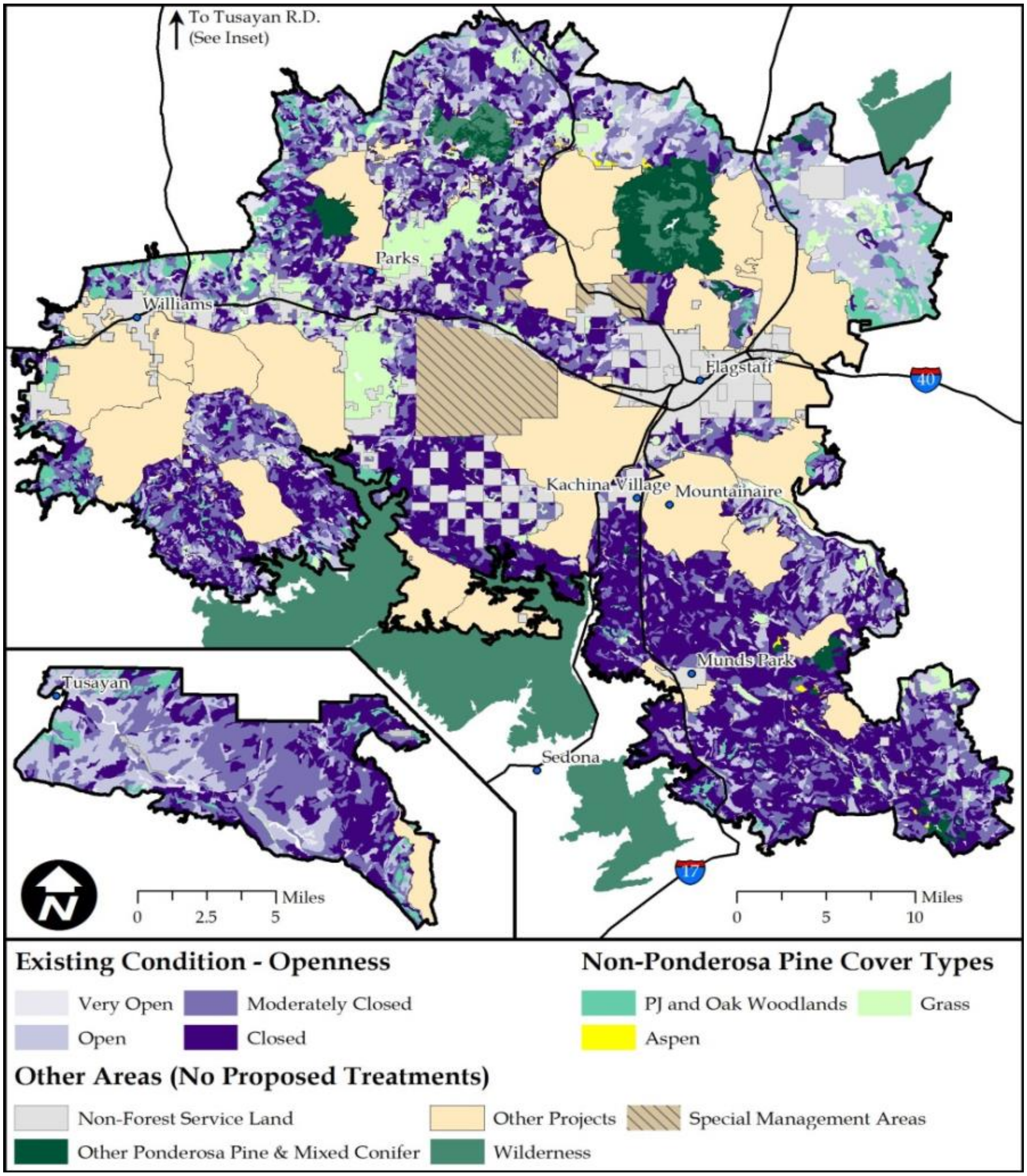

Figure 7. Existing canopy openness within the project area

Vegetation Structural Stage – Age and Size Class Diversity

Vegetation structural stage (VSS) is a method of describing forest age and tree size from seedlings to old forests. The VSS classification is based on the tree size class with the highest square foot of basal area and is an indication of the dominant tree diameter distribution. A group of trees with a single age class is considered even-aged while a group of trees with multiple age classes is uneven-aged.

Forest resiliency and diversity is dependent on the distribution of age and size classes and the capacity of an area. Currently, over 50 percent of the ponderosa pine type in the project area lacks age and size class diversity and is in an even-aged structure. This has resulted in a homogenous landscape with reduced resiliency. Reduced resiliency is expressed as the increased potential for severe effects from wildfire, increased stand density-related mortality, reduced resiliency to bark beetle attack, increased dwarf mistletoe spread, and reduced understory productivity. Figure 8 displays a dense, even-aged forest structure that is common throughout the project area.

Figure 8. Even-aged forest structure common throughout the project area

Goshawk Habitat

The project area (minus excluded acres[6]) has approximately 367,452 acres of goshawk habitat outside of post-fledging family areas (PFAs). Forest plan direction for lands outside post-fledging family areas (LOPFA) is to have uneven-aged conditions with a diversity of VSS distributed across the landscape (see table 4). Diversity in age and size classes (VSS) represents specific habitat components that are needed for goshawk prey species. An imbalance potentially decreases the ability of goshawks to maintain their numbers over time.

Table 4. Existing VSS distribution within goshawk LOPFA habitat

Vegetation Structural Stage (VSS)	Even-Aged Stands Existing Percent of Area	Uneven Aged Stands Existing Percent of Area	Forest Plan Desired VSS Percent Distribution	Habitatwide Percent Distribution
1 – Grass/Forb/Shrubs	7	0	10	4
2 – Seedling/Sapling	0	2	10	1
3 – Young Forest	37	35	20	36
4 – Mid-age Forest	47	32	20	41
5 – Mature Forest	8	14	20	10
6 – Old Forest	1	17	20	8

[6] The project area boundary of 988,765 acres less excluded areas equals 588,716 acres

Even-aged stand conditions occur on approximately 56 percent (46 percent of all the ponderosa pine) of the LOPFA habitat with approximately 44 percent (54 percent of all ponderosa pine) in uneven-aged stand conditions (see silviculture report, table 80). Although the uneven-aged stand condition partially meets forest plan direction, the desired balance of VSS classes is lacking as displayed in table 4. In all stands, the young and mid-aged forest structural stages are surplus, and the grass/forb/shrub, seedling/sapling, mature, and old forest stages are deficit relative to forest plan direction. The desired condition is to move even-aged stands to an uneven-aged structure and move all stands toward the forest plan's VSS percent distribution. There is a need to increase grass/forb/shrub, seedling/sapling, and mature and old forest components.

Forest Structure – Post-fledging Family Areas (PFA)

There is approximately 30,014 acres of goshawk PFA habitat in 588,716 acres of the project area. PFAs consist of nest sites and adjacent habitat most likely to be used by fledglings during their early development. This category also includes dispersal PFAs (or dPFA) which is unoccupied suitable habitat within a 2 to 2.5-mile range of a PFA.

VSS 3 and 4 are over-represented and VSS 1, 2, 5 and 6 are deficit (table 5). Outside of nest stands, the desired condition is to have an uneven-aged forest structure that represents all age classes (USDA FS 1987). While the Kaibab NF forest plan no longer describes a desired distribution of VSS classes, VSS is still a useful concept for describing and managing for uneven-aged conditions over time.

Table 5. VSS distribution within goshawk PFA habitat

Vegetation Structural Stage (VSS)	Even-Aged Stands Percent of Area	Uneven-aged Stands Percent of Area	Coconino Forest Plan Desired Percent Distribution	Habitat Wide Percent Distribution
1 – Grass/Forb/Shrubs	3	0	10	2
2 – Seedling/Sapling	1	1	10	1
3 – Young Forest	35	34	20	34
4 – Mid-age Forest	52	39	20	47
5 – Mature Forest	8	15	20	11
6 – Old Forest	1	11	20	5

Stand Density and Key Habitat Components

One of the major factors affecting forest structure and development is inter-tree competition. High forest densities result in increased inter-tree competition. Measures of forest density include basal area, trees per acre, and stand density index. Basal area is the cross-sectional area of all trees, measured in square feet per acre, and trees per acre are simply a count of the total number of trees on an acre. Stand density index is a relative measure of stand density based on the number of trees per acre and the mean diameter (Reineke 1933). It is a good indicator of tree competition. Based upon established forest density/vigor relationships, density-related mortality from competition begins to occur once the forest reaches 45 to 50 percent of maximum stand density. Mortality is likely to occur at density levels over 60 percent of maximum stand density (Long 1985).

Table 6 displays that both stand density index and basal area are above the desired condition, which means much of the goshawk habitat is currently at risk from density-related tree mortality. The table also displays existing and desired conditions for snags and coarse woody debris, two key components of wildlife habitat. Approximately 588,716 acres within the project area is deficit in snags and does not meet desired conditions for coarse woody debris. The desired condition is to reduce the potential for density-related mortality and have stand densities at levels that facilitate forest health. Stand densities allow for overall forest development, tree vigor, and resilience to characteristic disturbances. In addition to stand density, there is a need to move toward forest plan desired conditions for snags, coarse woody debris, and forest structural stages that are currently in deficit.

Table 6. Existing and desired conditions for goshawk habitat components

Habitat Type and Acres	Basal Area Average		Stand Density Index Percent of Maximum		Snags > 18 in. d.b.h. per Acre		Coarse Woody Debris Total Tons per Acre	
	Existing	Desired	Existing	Desired	Existing	Desired	Existing	Desired
PFA (30,014)	107	70-80	56	25-40	0.4	2.0	3.9	5-7
LOPFA (367,452)	96	50-70	52	15-35	0.4	2.0	3.5	5.7

Mexican Spotted Owl Habitat

Forest Structure, Stand Density, and Key Habitat Components

Table 7 displays the existing and desired conditions for structural attributes and habitat components within Mexican spotted owl habitats. The components (which include stand density index, number of trees per acre, coarse woody debris, and snags) are indicators of nesting and roosting characteristics as outlined in the forest plans. These components are necessary to maintain a suite of prey species for Mexican spotted owls.

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 over 60 percent of maximum stand density (Long 1985). Table 7 on page 15 displays that all Mexican spotted owl habitats exceed the 60 percent-plus maximum stand density. In all Mexican spotted owl habitats, trees greater than 18 inches d.b.h. and large snags are deficit from forest plan and Mexican Spotted Owl Recovery Plan desired conditions and coarse woody debris requirements are met on less than 10 percent of the habitat.

The desired condition is to improve the quality of Mexican spotted owl nesting and roosting habitat by reducing the potential for density-related mortality and to move toward forest plan desired conditions for trees greater than 18 inches d.b.h., snags, and coarse woody debris. There is a need to implement uneven-aged management strategies that improve nesting and roosting habitat and reduce the potential loss of habitat. There is a need to amend the Coconino NF forest plan to allow treatments that would most effectively improve nesting and roosting habitat.

Table 7. Existing and desired conditions of Mexican spotted owl habitat components

Habitat Type	Basal Area		SDI (% of Maximum)		Trees ≥ 18 in. (per acre)		Snags ≥ 18 in. (per acre)		CWD >12 in. (tons per acre)	
	Existing	Desired	Existing	Desired	Existing	Desired	Existing	Desired	Existing	Desired
Restricted Target/ Threshold (8,692) acres)	162	150–170	85	≤55	16.3	≥20	0.5	≥2.0	1.2	≥ 1
Restricted Other (66,419 acres)	137	70–90	69	25–40	11.5	≥ 20	0.4	2.0	0.4	≥ 1
Protected (35,262 acres)	155	NA	78	≤ 55	15.0	NA	0.6	≥ 2.0	0.8	≥ 1

CWD = coarse woody debris

Forest Structure – Large Trees

The Omnibus Public Land Management Act[7] outlines criteria for landscape-scale restoration on National Forest System lands. The Act directs landscape restoration projects funded under this authority to focus on the removal of small diameter trees. Tables 4 through 7 (see previous pages) display that large trees (VSS 5 and 6) are currently under-represented within the project area. The desired condition is to balance community, wildlife, and forest restoration into treatment design. While some large trees would be removed to accomplish ecological objectives or public safety objectives around communities, there is a need to retain as many large trees (larger than 16,inches d.b.h.) as possible. There is a need to recognize the rarity and ecological and socio-political importance of large trees in the Southwest and to develop a process that addresses large tree retention during project implementation.

Forest Structure – Old Growth

The old growth standards for the Coconino NF state, “Until the forest plan is revised, allocate no less than 20 percent of each forested ecosystem management area to old growth as depicted in table 8. In the long term, manage old-growth in patterns that provide for a flow of functions and interactions at multiple scales across the landscape through time. Allocations will consist of landscape percentages meeting old-growth conditions and not specific acres.” The old growth guideline for the Coconino NF state, “All analyses should be at multiple scales—one scale above and one scale below the ecosystem management areas” (USDA FS 1987, p. 70-1).

To be consistent with the Coconino NF forest plan, scales of analysis based on existing divisions of the landscape were developed specifically for this project. The smallest scale is represented at the stand level with stand size averaging less than 100 acres. The ecosystem management area (EMA) is the restoration subunit. Subunits range in size from 4,000 to 109,000 acres. The scale above the EMA is the restoration unit, which ranges in size from 46,000 to 335,000 acres.

In the Kaibab forest plan, the desired condition at the landscape scale (over 10,000 acres) is to have old growth occur throughout the landscape as a component of uneven-aged management

[7] Title IV, Section 4003, subpart c

with the location of old growth shifting on the landscape as a result of succession and disturbance (USDA FS 2014).

There are approximately 507,839 acres of ponderosa pine in the 4FRI project area. Of this total, 160,816 acres (36 percent) are the closest to meeting old growth conditions. Currently, all restoration units meet or exceed the 20 percent minimum Coconino NF forest plan requirement. Currently, the Kaibab NF has old growth occurring throughout the landscape (consistent with forest plan desired conditions). Approximately 31 percent (83,186 acres) of the Kaibab NF in the 4FRI treatment area has the desired older size classes and old growth components are well represented.

Table 8 displays acres of ponderosa pine old growth by restoration unit and national forest for all ponderosa pine within the 4FRI project area, as well as ponderosa pine (within the project area) that have been analyzed in separate vegetation analyses (see silviculture report). For the Coconino NF, the acres displayed in table 8 are the acres allocated and managed as old growth (consistent with forest plan direction). The acres listed in table 8 for the Kaibab NF represent the areas currently closest to having, or attaining the desired old growth components, dominated by trees in the largest size classes.

Table 8. Ponderosa pine old growth acres and percent by national forest and restoration unit

	Ponderosa Pine Total Acres (4FRI / Other Projects) Total		Ponderosa Pine Old Growth Acres (4FRI / Other Projects) Total		Ponderosa Pine Old Growth Percent	
RU	Coconino NF	Kaibab NF	Coconino NF	Kaibab NF	Coconino NF	Kaibab NF
1	(144,114 / 48,876) 192,990	This RU does not occur on Kaibab NF	(64,090 / 12,507) 76,597	This RU does not occur on Kaibab NF	40	This RU does not occur on Kaibab NF
3	(58,327 / 29,176) 87,503	(70,898 / 57,886) 128,784	(21,486 / 10,894) 32,380	(25,177 / 13,746) 38,923	37	30
4	(56,957 / 5,941) 62,898	(77,321 / 14,089) 91,410	(17,717 / 1,965) 19,682	(30,342 / 2,140) 32,482	31	36
5	(59,033 / 45,022) 104,055	This RU does not occur on Kaibab NF	(23,716 / 8,441) 32,157	This RU does not occur on Kaibab NF	31	This RU does not occur on Kaibab NF
6	This RU does not occur on Kaibab NF	(41,189 / 7,450) 48,639	This RU does not occur on Kaibab NF	(10,291 /1,490) 11,781	This RU does not occur on Kaibab NF	24
Total	(318,431 / 129,015) 447,446	(189,408 / 79,425) 268,833	127,009 / 33,807) 160,816	(65,810 / 17,376) 83,186	36	31

Most sites on the Coconino NF currently do not fully meet the minimum criteria for old growth conditions. However, the acres displayed in table 8 and table 9 are currently the closest to meeting old growth conditions. This approach is consistent with Coconino NF forest plan direction, which states: “strive to create or sustain as much old growth compositional, structural, and functional flow as possible over time at multiple-area scales…and seek to develop or retain old-growth function on at least 20 percent of the naturally forested area by forest type in any landscape" (USDA FS 1987).

The old growth acreage percentage for ponderosa pine includes 100 percent of Mexican spotted owl protected habitat, 100 percent of Mexican spotted owl target/threshold habitat, 40 percent of Mexican spotted owl restricted habitat that is uneven-aged with low dwarf mistletoe infection, and 80 percent of Mexican spotted owl restricted habitat that is even-aged and mid-aged to old with low dwarf mistletoe infection. In goshawk habitat, the old growth acreage percentage for ponderosa pine includes 100 percent of goshawk nest stands, 40 percent of goshawk post-fledging family and foraging areas that are uneven-aged with low dwarf mistletoe infection, and 80 percent of goshawk post-fledging family and foraging areas that are even-aged and mid-aged to old with low dwarf mistletoe infection.

There are approximately 29,534 acres of pinyon-juniper within 588,716 acres of the project area. Of this total, 8,758 acres (68 percent) are closest to meeting old growth conditions as described by the Coconino NF forest plan. Currently, all restoration units meet or exceed the 20 percent minimum Coconino NF forest plan requirement. Currently, the Kaibab NF has old growth occurring throughout the landscape (consistent with forest plan desired conditions), with approximately 58 percent of the Kaibab NF in the 4FRI treatment area dominated by trees in the largest size-classes and having or attaining old growth components. Table 9 displays acres of pinyon-juniper old growth by restoration unit and national forest for all pinyon-juniper within the 4FRI project area as well as pinyon-juniper (within the treatment area) that have been analyzed in other vegetation analyses (see silviculture report). For the Coconino NF, the acres displayed in table 9 represent the acres allocated to old growth (per forest plan direction). For the Kaibab NF, the acres listed in table 9 represent the areas currently having, or attaining, the desired conditions associated with old growth.

Table 9. Pinyon-juniper old growth acres and percent by national forest

	Pinyon-Juniper Total Acres (4FRI / Other Projects) Total		Pinyon-Juniper Old Growth Acres (4FRI / Other Projects) Total		Pinyon-Juniper Old Growth Percent	
RU	**Coconino NF**	**Kaibab NF**	**Coconino NF**	**Kaibab NF**	**Coconino NF**	**Kaibab NF**
1	(1,141 / 2,135) 3,276	This RU does not occur on Kaibab NF	(611 / 447) 1,058	This RU does not occur on Kaibab NF	32	This RU does not occur on Kaibab NF
3	(832 / 0) 832	(3,201 / 3,533) 6,734	(356 / 0) 356	(1,747 / 2,245) 3,992	43	59
4	(42 / 0) 42	(7,123 / 0) 7,123	(42 / 0) 42	(4,116 / 0) 4,116	100	58
5	(8,771 / 0) 8,771	This RU does not occur on Kaibab NF	(7,302 / 0) 7,302	This RU does not occur on Kaibab NF	83	This RU does not occur on Kaibab NF
6	This RU does not occur on Kaibab NF	(2,206 / 550) 2,756	This RU does not occur on Kaibab NF	(1,452 / 110) 1,562	This RU does not occur on Kaibab NF	57
Total	(10,786 / 2,135) 12,921	(12,530 / 4,083) 16,613	(8,311 / 447) 8,758	(7,315 / 2,355) 9,670	68	58

Figure 9 displays the general locations of ponderosa pine and pinyon-juniper in the treatment area that are closest to meeting old growth conditions and components. In both ponderosa pine and pinyon-juniper, the desired condition is to allocate sites on the Coconino NF and manage for old growth components on the Kaibab NF. Where management occurs within ponderosa pine and pinyon-juniper cover types, there is a need to maintain the old growth characteristics and components.

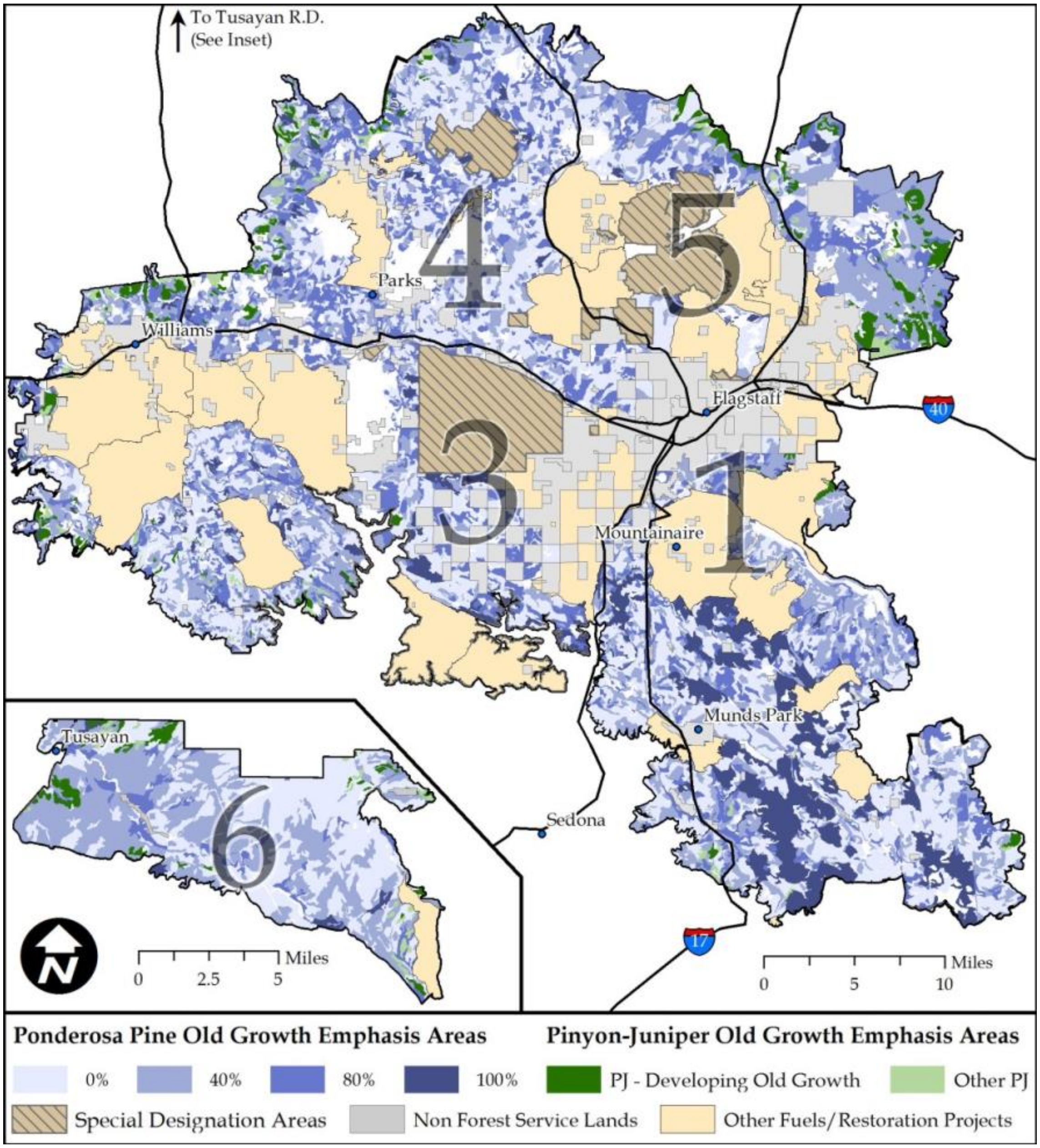

Figure 9. Ponderosa pine and pinyon-juniper that best meets old growth conditions

Forest Health – Insect and Disease

Bark Beetle

Forest health is defined by the vigor and condition of the forest stands (see previous discussion on stand density) and the presence of insects and disease that affect the sustainability of the forest. Ponderosa pine is attacked and killed by several different bark beetles in the genera *Dendroctonus* and *Ips*. Approximately 7 percent of the ponderosa pine in the project area has a low bark beetle hazard rating, while 21 percent has a moderate rating, and the remaining 72 percent has a high bark beetle hazard rating (table 10). Areas with a low or moderate hazard rating would be expected to be resistant to successful bark beetle attack and large-scale mortality.

Table 10. Existing ponderosa pine beetle hazard rating (percent of area in each RU)

Hazard Rating	RU 1	RU 3	RU 4	RU 5	RU 6	Analysis Area Acres / Percent of Total
Low	3	6	8	26	0	37,993 / 7
Moderate	12	11	27	46	25	106,131 / 21
High	85	83	65	28	75	363,775 / 72

Dwarf Mistletoe

Dwarf mistletoe infection in ponderosa pine is common throughout 588,716 acres of the project area. Mistletoe infected trees slowly weaken, experience growth loss, and eventually die (Lynch et al. 2008).

Approximately 66 percent of the area is not infected or has a low infection level (with less than 20 percent of the trees infected). Thirty-four percent of the area is moderately infected (20 to 50 percent of the trees infected) or heavily infected (50 to 80 percent of the ponderosa pine infected). The average range of infection is from 4 to 10 percent in the none/low infection level group and 33 to 42 percent in the moderate/high infection level group (table 11). Several stands have an extreme infection rating where 80 percent or more of the trees are infected.

Table 11. Existing dwarf mistletoe infection level by restoration unit (RU)

Infection Level Average Percent of Tree Infected	RU 1	RU 3	RU 4	RU 5	RU 6	Percent of Analysis Area
None/Low	53	57	74	92	82	66
None/Low	5	6	4	10	5	6
Moderate/High Percent of Area	47	43	26	8	18	34
Moderate/High	38	33	38	41	42	36
Extreme Percent of Area	<1	<1	<1	0	0	<1
Extreme Percent of Area	86	86	85	–	–	86

The desired condition is for a forest structure that would allow beetles and dwarf mistletoe to function at naturally occurring or historic levels. There is a need to manage insect and disease in a manner that reduces, but does not eliminate bark beetle or dwarf mistletoe to provide nesting, resting, foraging, and catching sites for birds and mammals, including Abert's and tassel-eared squirrels.

Vegetation Diversity and Composition

Gambel Oak

Vegetation diversity throughout 588,716 acres of the project area has declined. Gambel oak, a subtype within ponderosa pine, is important to many wildlife species as it provides important nesting and foraging habitat. A lack of fire led to increased stand densities of pine and resulted in Gambel oak becoming overtopped by ponderosa pine (figure 10) (Abella and Fulé 2008).

The desired condition is to develop and maintain a variety of oak size classes and forms where they occur. Oak should range from shrubby thickets and pole-sized clumps to large trees across the landscape to provide habitat for a large number and variety of wildlife species (Brown1958, Kruse 1992, Rosenstock 1998, Abella and Springer 2008, Abella 2008a, Neff et al. 1979, USDA FS 2014). There is a need to stimulate new growth, maintain growth in large-diameter trees, and use management strategies that provide for a variety of shapes and sizes across the landscape.

Figure 10. Ponderosa pine overtopping of Gambel oak in the Bar-M (Coconino NF) portion of the project area

Aspen

There are approximately 1,522 acres of aspen within 588,716 acres of the project area. Aspen is dying or rapidly declining on both national forests due to the combined effects of conifer encroachment (ingrowth), browsing by animals, insects, disease, severe weather events, and lack of fire disturbance (Lynch 2008, USDA FS 2008, 2009). A study by Fairweather et al. (2007) on the Coconino NF indicates that aspen on low-elevation dry sites (less than 7,500 feet) has sustained 95 percent mortality since 2000. Aspen mortality on these sites is expected to continue as many live trees currently have only 10 to 30 percent of their original crown. Figure 11 displays an unhealthy aspen stand within the project area. The desired condition is to maintain and regenerate aspen. Where possible, there is a need to stimulate growth and increase individual recruitment of aspen.

Figure 11. Aspen near Government Prairie, Kaibab NF

Grasslands

There are approximately 48,703 acres of montane/subalpine and Colorado Plateau/Great Basin grasslands within 588,716 acres of the project area. Only 2 percent of the Great Basin grasslands on the Coconino NF were historically composed of very large shrubs, closed canopies, and very large trees. Currently, this percentage is 19 percent (USDA FS 2009). Within montane/subalpine grasslands, conifer encroachment has increased from 0 to 33 percent (USDA FS 2009). On the Kaibab NF, conifers have invaded at least 8 percent of grasslands (USDA FS 2008).

Figure 12 displays conifer encroachment within the project area over a 100-year period. On both national forests, the desired condition for grasslands is to move toward the natural range of variation. Tree cover would range from 0 to 9 percent, grasses and forbs would dominate, and fire return intervals would average 10 years (Weaver 1951, Cooper 1960, Swetnam 1990, Swetnam and Baison 1996, Fulé et al.1997a, Fulé et al.1997c, Heinlein et al. 2005, Diggins 2010). Fire would function within in its natural fire regime across the landscape without causing loss to ecosystem function, human safety, lives, and values. When fire does occur, it typically replaces more than 75 percent of the dominant vegetation type (USDA FS 2009). There is a need to reduce or remove tree encroachment, which has decreased the size and function of landscapes that were historically grasslands.

Figure 12. Fern Mountain (Hart Prairie) Grassland circa 1880s (left); the same area circa 1980s (right)

Pine-Sage

Based on review of the project area, ponderosa pine trees are encroaching and shading out sage on about 5,261 acres. Without treatment, pine density is likely to increase and entirely shade-out the sage component. The desired condition is to restore the pattern within the pine-sage mosaic and manage fire to enhance sage. There is a need to remove post-settlement pine that is currently overtopping and shading sage. Figure 13 displays the post-treatment desired condition. This figure portrays an area just south of the town of Tusayan, Arizona approximately 6 years after a low-severity prescribed fire.

Figure 13. Post-treatment pine-sage desired condition (Kaibab NF)

Forest Resiliency

Fire Behavior

Currently, about 191,000 acres (38 percent) of the project area has crown fire potential. Crown fire generally produces 100 percent mortality in ponderosa pine by consuming the crowns of trees. Additional acres, primarily within or next to Mexican spotted owl habitat, are at risk from high-intensity surface fire that can result in high-severity effects. A high-intensity surface fire burning through this area could scorch the canopy sufficiently to cause widespread mortality (Van Wagner 1973). Figure 14 displays the current crown and surface fire potential within the project area. Figure 15 displays locations of potential resources at risk from fire.

Wildland-urban interface areas are spread across the project area and are located within or next to the communities of Flagstaff (RUs 1, 3, 4, 5), Williams (RUs 3, 4), Tusayan (RU 6), Parks (RUs 3, 4), Belmont (RUs 3, 4), and scattered developments such as Doney Park (RU 5), Munds Park (RU 1), and Kachina Village (RU 3). Although past fuel treatments have been implemented in the WUI closest to the major population centers, much of the landscape is still vulnerable to fire or to second order fire effects such as flooding, erosion, weed infestations, and damaged infrastructure.

In addition to wildland-urban interface, areas at risk include water resources, such as the Lake Mary, Rio de Flag, and Bill Williams watersheds. The Lake Mary and Rio de Flag watersheds are a source of water for the city of Flagstaff, Arizona. The Bill Williams watershed provides water for the city of Williams, Arizona. Other resources at risk from crown fire include a diverse assemblage of wildlife that are known to occur or have habitat within or adjacent to the project area. Figure 15 provides a visual comparison between fire risk and some (not all) at-risk resources. Figure 15 displays the location of some resources at risk including the city of Flagstaff, the town of Tusayan, other lands outside national forest, watersheds, and Mexican spotted owl PACs, for reference with figure 14, which displays fire potential.

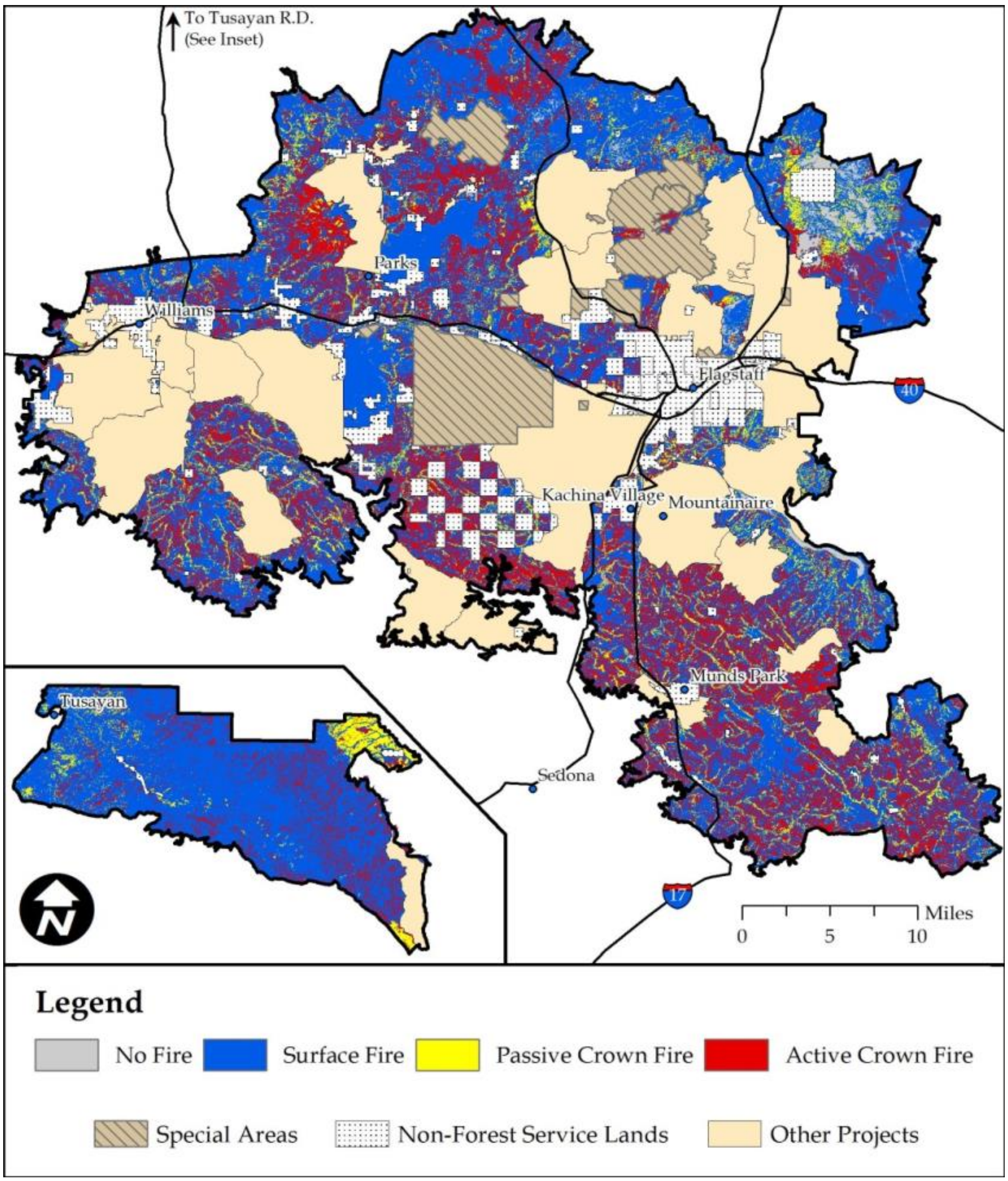

Figure 14. Current crown and surface fire potential in the project area

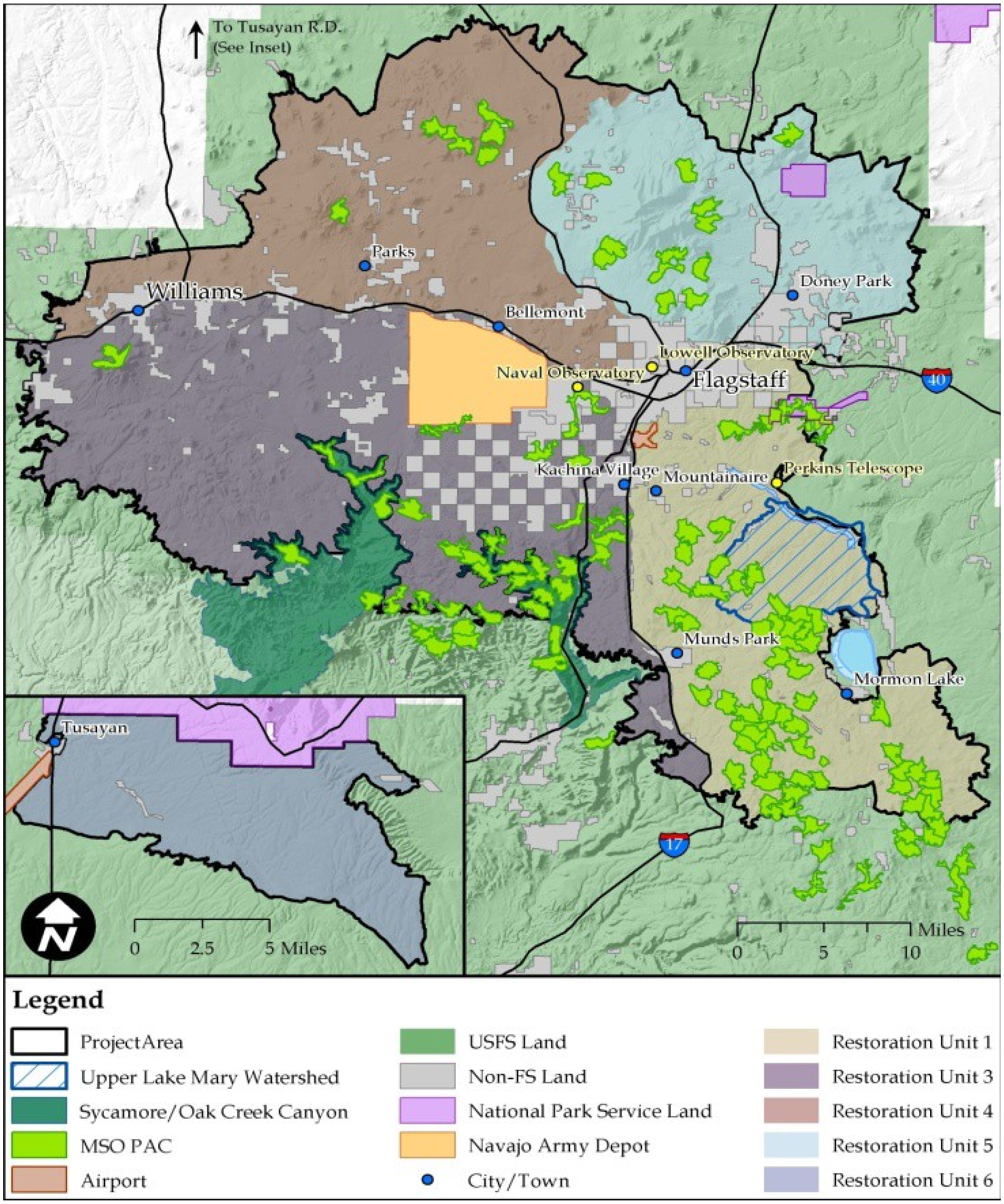

Figure 15. Locations of resources at risk (for reference with figure 14)

Canopy Characteristics and Surface Fuels Affecting Fire Behavior

Canopy bulk density and canopy base height are characteristics used to measure the potential for crown fire. Higher canopy bulk densities means that fire can easily move through the crowns of trees. Higher canopy bulk densities mean there are more fuels to burn. With more fuels, fire intensity can increase. Approximately 61 percent of the ponderosa pine in the project area has a canopy bulk density rating greater than 0.05 kg per cubic meter (kg/m^3). The desired condition in ponderosa pine is to reduce the potential for crown fire and have canopy bulk density below 0.05 kg/m^3. No more than 10 percent of the project area should have the potential for crown fire.

The canopy base height of a stand is the lowest height above the ground at which there is a sufficient amount of canopy fuel to spread fire vertically into the canopy (Scott and Reinhardt 2001). The lower the canopy base height, the easier it is for crown fire to initiate (Van Wagner 1977). Currently, canopy base heights in the project area average approximately 16 feet. To minimize the potential for crown fire initiation, the desired condition is to have average stand canopy base height above 18 feet. Table 12 summarizes existing and desired conditions for fire risk.

Table 12. Existing and desired fire potential in ponderosa pine in the project area

Evaluation Criteria	Existing Condition	Desired Condition
Potential crown fire (%)	38	Up to 10
Canopy Base Height (ft.)*	16	>18
Canopy Bulk Density (kg/m3)*	0.06	<0.050

*Stand average across the project area

Surface fuels (as analyzed for fire behavior and effects) include litter, duff, and coarse woody debris greater than 3 inches diameter. High surface fuel loading can result in high-severity effects because they can smolder in place for long periods, transferring more heat into soil and tree cambiums. Mechanical treatments generally do not remove surface fuels from a treatment area, so they remain a potential source of heat (fire effects) and emissions.

Currently, litter, duff, and coarse woody debris average 11 tons per acre. When averaged, the existing surface fuels do not exceed recommended surface fuel loading (Brown et al. 2003). However, there are areas that exceed desired surface fuel loadings. Most of these areas are near, or associated with, Mexican spotted owl habitat (see the fire ecology report).

Overall, the desired condition is to have fire maintain a mosaic of diverse native plant communities. In ponderosa pine, no more than 10 percent of the project area should be prone to crown fire under modeled conditions, with high-severity acres spatially distributed (Swetnam and Baison 1996, Roccaforte et al. 2008). In grasslands, no more than 3 percent should be prone to crown fire (in this analysis, crown fire in grasslands is a reference to crown fire in trees growing in the grasslands). In both vegetation types, when crown fire does occur, it should be mostly passive crown fire, occurring in single trees, groups, clumps, or areas where there has been mortality (e.g., from wind throw or insects). High-intensity surface fire should be rare with surface fuel loadings (including coarse woody debris, litter, and duff) ranging between 5 and 20 tons per acre (Brown et al. 2003).

Overall, the desired condition is to have fire function as a natural disturbance within the ecosystem without causing loss to ecosystem function or to human safety, lives, and values. Over time, conditions would allow managers to use fire to maintain the area as a functioning ecosystem. There is a need to reduce canopy bulk density and raise canopy base height to reduce the potential for crown fire. No more than 10 percent of the project area should have the potential for crown fire. To reduce the potential for high-severity surface fire, there is a need to maintain surface fuel loadings that meet desired conditions and reduce excessive surface fuel loadings in areas next to and within Mexican spotted owl habitat.

Fire Regime Condition Class

Fire regime condition class (FRCC) is a coarse-scale evaluation protocol developed to support planning and risk assessments (Schmidt et al. 2002, Hann et al. 2004). Fire regime condition class assessments determine how departed a landscape's fire regime is from its historic fire regime. It is scaled from 1 to 3, with 3 being the most departed and 1 being the least departed.

The fire regime is significantly departed from historical ranges on about 66 percent of the project area. The project area is classified as FRCC 3 (table 13). In FRCC 3, the risk of losing key ecosystem components is high. Approximately 25 percent of the project area is in FRCC 2, indicating the ecosystem is moderately departed from its historical range. The departure in fire frequency has resulted in dramatic changes to fire size, intensity, severity, landscape patterns, and vegetation attributes.

The desired condition is to have 100 percent of the project area in FRCC 1and 2. In FRCC 1 and 2, fire regimes would be within historical ranges and the risk of losing key ecosystem components would be low. Vegetation, fuels, and natural disturbances would be intact and functioning within historical ranges. There is a need to reduce the percent of ponderosa pine and grassland vegetation in FRCC 3 and move the fire regimes toward FRCC 1and 2.

Table 13. Existing and desired fire regime condition class for ponderosa pine

Fire Regime Condition Class (FRCC) Indicators	Existing Condition (% of total area)	Desired Condition (% of total area)
Vegetation Condition Class 1	14	100
Vegetation Condition Class 2	25	
Vegetation Condition Class 3	61	
FRCC of Treatment Area	3	1-2

Soil Productivity and Watershed Function

Soils

Approximately 85 percent of soils and strata (soil layers) in the 988,764-acre project area are in satisfactory soil condition and have the ability to resist accelerated erosion. Most strata in the ponderosa pine vegetation type currently are underneath a closed stand structure with high canopy covers and densities. This has reduced understory forage productivity although there is generally sufficient vegetative ground cover to reduce accelerated erosion. Due to the closed stand structure, most soils and strata are at risk from the relatively high potential for crown fire (about 86 percent in FRCC 2 and 3). This also poses a high risk of moderate or high burn severity effects to the watersheds under normal or extreme fire behavior conditions. Fires resulting in moderate or high burn severity pose substantial risk to soil productivity, watershed function, and downstream water quality in connected streamcourses where there are soils with moderate or high erosion hazard following storm events.

The desired condition is to protect long-term soil productivity by maintaining or improving soil condition and function (toward satisfactory). The vegetative ground cover would be adequate to protect against accelerated erosion, and would help maintain soil stability and vegetation productivity. Soil loss would be below tolerance, and no visible signs of excessive erosion would be present. Surface soil hydrologic function would be in satisfactory condition with well-aggregated, granular surface soil structure and tubular pores with sufficient porosity to effectively infiltrate water. Soil nutrient cycling would be in satisfactory condition. Vegetative ground cover, including surface litter, plant basal cover, and herbaceous understory would approach natural conditions identified in "Terrestrial Ecosystem Survey Potential Plant Community Ecological Processes and Function" (USDA FS 1984).

Watersheds at the 6th Hydrologic Unit Code (6th-code) Scale

The project lies within 82 6th-code watersheds. The watershed condition framework protocol (USDA FS 2010a, 2010b) was used to classify watershed conditions at the 6th-code level including 12 watershed indicators. Overall, ponderosa pine vegetation types are dominated by functional-at-risk 6th-code watersheds (about 451,500 acres, or 46 percent of the analysis area); with several impaired watersheds (about 316,800 acres, or about 32 percent of the analysis area) and a few properly functioning watersheds (about 220,400 acres, or about 22 percent of the analysis area).

The desired condition is to have watershed function maintained or improved toward functioning properly. Watersheds would exhibit high geomorphic, hydrologic, and biotic integrity relative to their natural potential condition. Fire regime condition class and tree densities would be reduced and moving toward FRCC 1 (historical range). Soil and riparian condition and function would be improved and moving toward satisfactory and properly functioning.

Figure 16 is a photo of Babbitt Spring, which has an impaired function. Babbitt Spring is located in the Lake Mary watershed on the Flagstaff Ranger District (Coconino NF) and is an example of spring conditions within the project area. The headcut in the spring outflow, the encroachment of ponderosa pine into the spring site, and the lack of riparian vegetation normally associated with a functioning riparian site are indicators of impaired function.

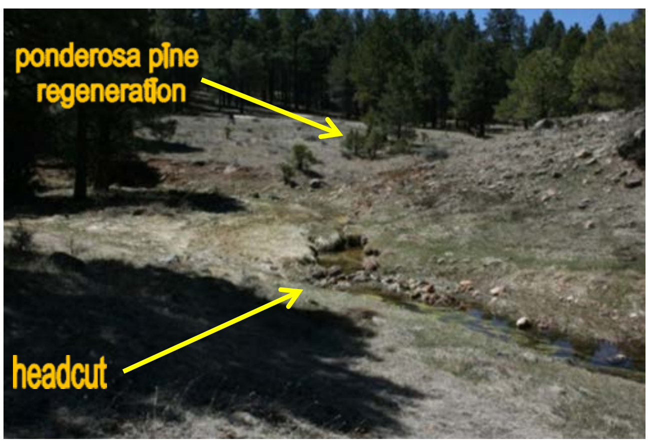

Figure 16. Example of a degraded (Babbitt) spring on the Coconino NF

Figure 17 displays Hoxworth Spring in a restored condition. This figure provides an example of successfully meeting restoration desired conditions. Vegetative composition and spring outflow has improved. Bank headcutting in the spring's outflow has been addressed and tree encroachment that affected spring function has been removed. The purpose of figure 18 is to display protective measures (fencing) that have been successfully used in the past to attain restoration desired conditions.

Figure 17. Example of Restored (Hoxworth) Spring

Figure 18. Example of protective measures for spring restoration

The desired condition for springs is to have the necessary soil, water and vegetation attributes to be healthy and functioning at or near potential. Water flow patterns, recharge rates, and geochemistry would be similar to historic levels and persist over time. Water quality and quantity would 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 would be resilient to natural disturbances (USDA FS 1987).

There is a need to improve the condition and function of 74 springs to sustain these features on the landscape. On some springs, this means maintaining and promoting existing vegetation. On others, there is a need to reduce tree encroachment, reduce the presence of noxious weeds, and limit the potential for future disturbance. On all springs there is a need to return fire, a natural disturbance process, to the system.

Ephemeral Streams

Ephemeral streams are those that flow only briefly during and following a period of rainfall. They are important for hydrological function of watersheds and provide important seasonal habitat for a variety of wildlife, in particular, migratory birds and dispersing amphibians. Ephemeral streams are categorized as riparian or nonriparian. On the Coconino NF, approximately 32 miles of ephemeral streams are heavily eroded with excessive bare ground, denuded vegetation, and head cuts. Of the total miles, approximately 6 miles are riparian streams and 26 miles are nonriparian.

The Kaibab NF has approximately 7 miles (total) of degraded nonriparian streams. Figure 19 shows an active headcut and lateral bank cutting that resulted in accelerated erosion rates. This condition is common in the project area.

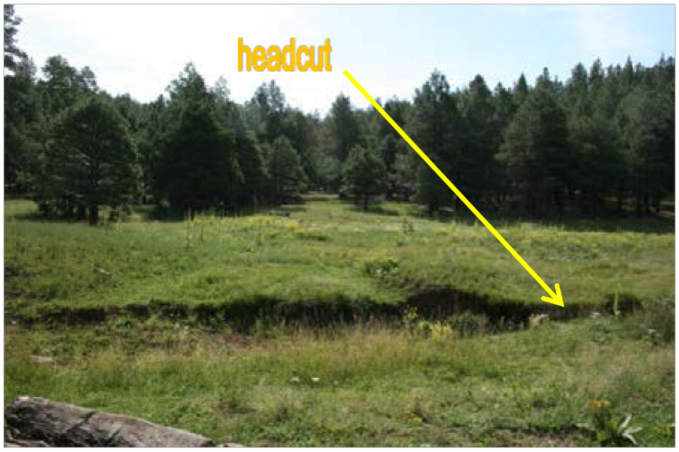

Figure 19. Example of a degraded ephemeral/riparian stream (Coconino NF)

The desired condition is to restore the functionality of ephemeral streams (USDA FS 1987). On some of the total miles of stream, there is a need to maintain and promote existing vegetation. On others, there is a need to reduce tree encroachment and the presence of noxious weeds, and to limit the potential for future disturbance. On all ephemeral streams, there is a need to return fire, a natural disturbance process, to the system.

The left photo in figure 20 is an example of a restored ephemeral stream. The figure displays what an ephemeral stream could look like immediately after recontouring treatments are completed. The right-hand photo displays what the restored ephemeral stream would look like about 1 year after treatment. This figure displays the desired condition for ephemeral stream restoration.

Figure 20. Example of a restored (Hoxworth Spring) drainage immediately after treatment (left photo) and 1 year after treatment (right photo)

Roads and Unauthorized Routes

The Coconino and Kaibab NFs have identified the needed road system for public and administrative motorized use through the Travel Management Rule process (see the transportation specialist report for details on forestwide transportation analyses). The Travel Management Rule process identified a need to decommission approximately 726 miles of existing system and unauthorized roads on the Coconino NF. On the Kaibab NF, approximately 134 miles of unauthorized roads (often referred to as user-created routes) were recommended for decommissioning.

The desired condition is to restore decommissioned road prisms to their natural condition (USDA FS 1987, 1988). Soils would be in satisfactory condition so that the soil can resist erosion, recycle nutrients, and absorb water. Understory species (e.g., grasses, forbs, and shrubs) diversity would be consistent with site potential and provide for infiltration of water and reduction of accelerated erosion. The understory would have a variety of heights of cool and warm season vegetation. Impacts to wildlife and habitat would be minimized.

About 2,787 miles of road (within the 988,764-acre project area) would be needed to implement the 4FRI Project. Of this total, approximately 2,267 miles are existing, open roads. However, portions of these existing roads have resource concerns, which require maintenance or reconstruction prior to using them. In some parts of the project area there are no existing roads that could provide access to treatments, or records and field review indicate the roads have been decommissioned in previous projects. For additional information, see the transportation inventory in the project record.

The desired condition is to minimize soil and vegetation disturbance from roads. There is a need to have adequate access to the project area for implementation while being consistent with the Omnibus Public Land Management Act of 2009 (which does not allow for the establishment of permanent roads). Adequate access includes using existing roads and temporarily creating roads that would be returned to their natural state (decommissioned) at the completion of project activities. Maintenance, reconstruction, and restoration actions would be designed to meet the site-specific condition as possible and practicable.

Decision Framework

The Coconino and Kaibab NF Supervisors are the Forest Service officials responsible for deciding whether to select the actions as proposed (alternative B); select one of the other action alternatives including alternative C, D and E; select an alternative that combines attributes from the alternatives; or select no action (alternative A). Their decision includes determining: (1) the location and treatment methods for all restoration activities, (2) design criteria, mitigation, and monitoring requirements, (3) the components that will be included in the monitoring and adaptive management plan, (4) the components that will be included in the implementation checklist and plan, (5) the estimated products or timber volume to make available from the project, and (6) consistency with the forest plans in place at the time of the decision and whether the Coconino NF forest plan would be amended.

Other Planning Efforts

See pages 7 to 8 for discussion on the relationship between the forest plans and the revised Mexican Spotted Owl Recovery Plan (USDI FWS 2012) to this analysis. Other restoration activities (actions on the national forests, or private, State, and other non-National Forest System lands) that influence or are complementary to this analysis are addressed in cumulative effects analyses.

Relationship to the Forest Plans

The project was reviewed for consistency 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 36 CFR 219.17(b)(3).[8] Consistency evaluations can be found for each resource in chapter 3 of the this document and the project record. Appendix B provides details for the nonsignificant forest plan amendments that are proposed in alternatives B through D. With the proposed nonsignificant forest plan amendments, alternatives B, C, and D are consistent with the current 1987 Coconino NF forest plan direction. Alternative E is consistent with the current Coconino NF 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.

With design features and mitigation, alternatives B through E are consistent with the Kaibab NF forest plan's objectives, desired conditions, standards, and guidelines. Movement toward desired conditions varies by alternative. Appendix D (implementation plan) documents how treatment design meets Coconino NF and Kaibab NF forest plan direction and desired conditions. See chapter 2 for additional discussion.

Management Direction

The project area includes 23 management areas as described in the Coconino National Forest Plan (pp. 46 to 206–113). Table 14 displays the management areas located within the project area, forest plan management area emphasis, and the relationship between each management area's approximate total acreage to the project. The management area direction for the Flagstaff/Lake Mary Ecosystem Analysis Area (FLEA) is displayed throughout the 10 management areas that make up the FLEA.

Kaibab NF Forest Plan

The revised forest plan for the Kaibab NF became effective in April of 2014. The 4FRI FEIS has been updated to reflect new management direction in the revised forest plan. On the Kaibab NF, the project area is within the ponderosa pine major vegetation type and the following management and/or designated areas: Wildland-urban Interface (60,273 acres), Grand Canyon Game Preserve (2,395 acres), Developed Recreation Sites (1,857 acres), Garland Prairie Management Area (402 acres),Bill Williams Mountain (20 acres), and 19 miles of the Arizona National Scenic Trail.

Table 14 displays the acreage associated with the management areas in the project area where the majority of restoration actions are proposed. Figure 21 displays the general location of the management areas in the project area.

For additional information, see chapter 4 of the Coconino National Forest Plan (pp. 98 to 206) and pages 85 to 107 of the revised Kaibab National Forest Land Management Plan where detailed descriptions of forestwide resource direction specific to the management areas is located.

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[8] 36 CFR 219 is the Forest Service Planning Rule. This section of the Rule provides the transition language that allows this project to propose amendments to the Coconino NF forest plan using the provisions of the 1982 planning rule.

Table 14. Forest plan management areas (MA) within the project area

Forest Plan Management Areas within the Project Area*	Description	Forest Plan Emphasis	Forestwide MA Acres	MA Acres within Project Area	Acres / Percent of Forestwide MA Proposed for Treatment*
Coconino National Forest					
MA 3	Ponderosa pine and mixed conifer on less than 40% slope	Sustained yield of timber and firewood, wildlife habitat, grazing, high quality water, dispersed recreation	511,015	236,245	190,687 / 37
MA 8	PJ woodlands > 40 %	Firewood production, watershed condition, wildlife habitat, and livestock grazing	273,815	451	248 / <1
MA 10	Transition grassland/sparse PJ above Mogollon Rim	Range management, watershed condition, and wildlife habitat	160,494	8,544	8,011 / 5
MA 6	Unproductive timber lands	Wildlife habitat, watershed condition, grazing	67,146	12,115	11,628 / 17
MA 35	Lake Mary Watershed	Maintenance and/or improvement of soil condition and watershed function, reduced fire risk in urban/rural influence zone	62,536	59,301	35,994 / 58
MA 32	Deadman Wash	Grasslands, un-roaded landscape, grazing, hunting	58,133	11,659	11,380 / 20
MA 4	Ponderosa pine and MC above 40%	Wildlife habitat, watershed condition, and dispersed recreation	46,382	11,793	8,145 / 18
MA 33	Doney	Reduced fire risk in urban/rural influence zone, recreation, grasslands, scenic quality	40,530	25,779	14,024 / 35
MA 38	West	Reduced fire risk in urban/rural influence zone, recreation, scenic quality	36,298	36,134	19,538 / 54
MA 31	Craters	Restore natural grasslands, re-establish or maintain fire in pinyon-juniper woodland	29,940	8,969	8,969 / 30
MA 36	Schultz	Reduce wildfire risk, maintain watershed health and water quality	21,289	21,130	4,393 / 21

Forest Plan Management Areas within the Project Area*	Description	Forest Plan Emphasis	Forestwide MA Acres	MA Acres within Project Area	Acres / Percent of Forestwide MA Proposed for Treatment*
MA 37	Walnut Canyon	Reduce fire risk in urban/rural interface zone, progress toward desired forest structure including Mexican spotted owl and goshawk habitats	20,566	18,030	6,420 / 31
MA 12	Riparian and open water	Wildlife habitat, visual quality, fish habitat, watershed condition on the wetlands, riparian forest, and riparian scrub, dispersed recreation on the open water portions	20,490	653	609 / 3
MA 7	PJ woodlands < 40%	Firewood production, watershed condition, wildlife habitat, grazing	19,077	3,206	3,203 / 17
MA 13	Cinder Hills	OHV recreation opportunities and amenities, scenic integrity, geologic features	13,711	13,711	13,670 / 99
MA 9	Mountain grasslands	Livestock grazing, visual quality, wildlife habitat	9,049	7,102	5,385 / 60
MA 20	Highway 180 corridor	Scenic attraction, access to year-round recreation and Grand Canyon NP	7,608	6,213	4,237 / 56
MA 14	Oak Creek Canyon	Scenery, recreation, wildlife habitat, healthy streams, clean air and water, manage fire hazards and risk	5,388	7	7 / <1
MA 28	Schnebly Rim	Seasonal gateway, conserve winter range for deer, elk, turkey	5,090	2,455	2,455 / 48
MA 5	Aspen	Wildlife habitat, visual quality, sustain yield of firewood production, watershed condition, dispersed recreation	3,450	2,761	695 / 20
MA 34	Flagstaff	Reduce risk of catastrophic wildfire, recreation, scenic quality	1,781	1,675	1,417 / 80
MA 18	Environmental Study Areas (Griffith's Springs ESA)	Visual resource management, watershed condition, manage for low fire potential with fire re-established	1,577	1,577	325 / 21

Forest Plan Management Areas within the Project Area*	Description	Forest Plan Emphasis	Forestwide MA Acres	MA Acres within Project Area	Acres / Percent of Forestwide MA Proposed for Treatment*
MA 15	Developed recreation sites	Developed recreation	874	805	48 / 6
Kaibab National Forest					
Grand Canyon Game Preserve	Game preserve	Range of habitats for native and desired nonnative wildlife species, including predators	612,736	2,395	2,395 / <1
Wildland-urban Interface	Areas surrounding human development	Wildland fires are low intensity surface fires	389,720	117,272	60,273 / 51
Bill Williams Mountain	Multiple uses	High natural, cultural and economic value	17,745	17,745	20 / <1
Kendrick Mountain Wilderness	Designated Wilderness	Manage for natural processes	6,660	6,660	0/0
Developed Recreation Sites	Recreation sites, trailheads,	Developed Recreation	1,556	1,556	1,556 / 100
Arizona Bugbane Botanical Area	Designated Area	AZ bugbane habitat protection	490	490	0/0
Garland Prairie	Former proposed research natural area	Serves as reference for study of ecological changes	340	340	340 / 100
Arizona National Scenic Trail	Non-motorized scenic trail	Manage for high scenic values and primitive recreation settings	90 Miles	19 miles	19 miles / 21

*Acres based on alternative C. Acres and percentages are approximate as many mapping inconsistencies were found when we compared the management area boundary maps to vegetation stand data. Forest plan MA mapping was conducted at a very coarse scale whereas the numbers associated with our vegetation stand data is much more precise. The FLEA MA on the Coconino NF is comprised of MA 3, 4, 5, 8, and 9 which are included in the table.

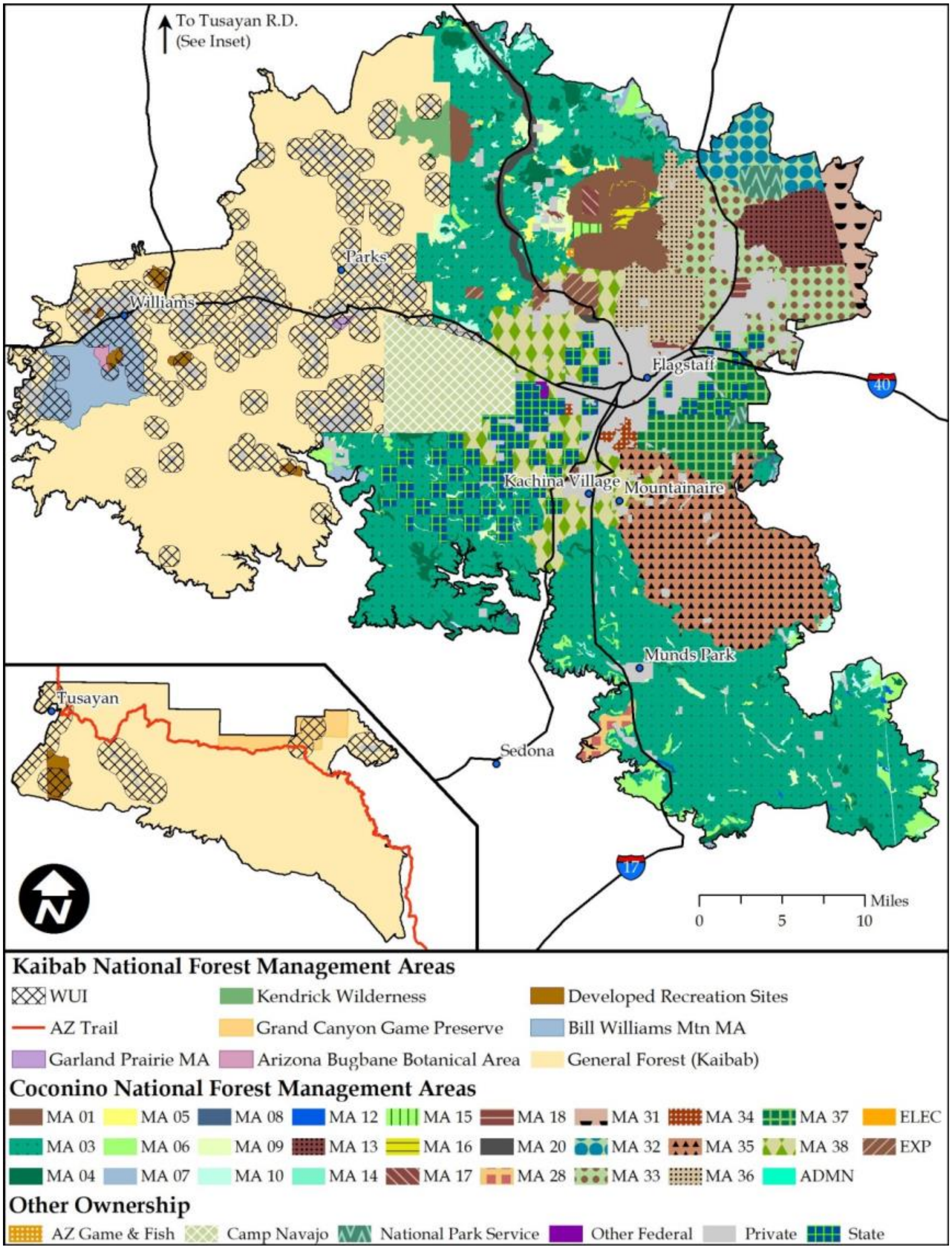

Figure 21. Forest plan management areas within the project area

Public Involvement

Collaboration

Collaboration has been integral to moving forward with a landscape restoration proposal. In 2010, stakeholders began refining their vision for ponderosa pine forest restoration across 2.4 million acres on four national forests in Arizona including the Apache-Sitgreaves, Coconino, Kaibab, and Tonto.

The 4FRI stakeholders developed a comprehensive restoration strategy for the Coconino and Kaibab NFs (4FRI Stakeholders 2010). The landscape strategy documented existing conditions, identified potential treatment areas, and desired post-treatment conditions. The Forest Service used the stakeholder's landscape strategy to inform the purpose and need and proposed action.

Scoping

The project was posted in the Coconino and Kaibab NF's Schedule of Proposed Actions in January of 2011 and the notice of intent to prepare an EIS was published in the Federal Register on January 25, 2011 (76 FR 4279–4281).

A draft proposed action was sent to the project mailing list (paper copies and electronic mail) consisting of 1,331 individuals, local governments, State governments, Federal and State agencies, and organizations. Fifty-four (54) responses were received through May 5, 2011. A scoping report that included a summary of the scoping process was posted on the 4FRI website on June 29, 2011 (http://www.fs.usda.gov/main/4fri).

In addition to a pre-scoping public meeting and workshop held on January 20, 2011, meetings and workshops were held on the Coconino NF on February 2, 2011, February 16, 2011, and February 24, 2011. A meeting and workshop was held on the Kaibab NF on February 9, 2011. The purpose of these meetings was to receive comments that would be used to develop a revised proposed action. The sixth public meeting was held at the Coconino NF Supervisor's Office on April 27, 2011 for the purposes of providing a project update. A seventh public meeting was held on June 7, 2011 for the purposes of receiving comments on edits made to the proposed action. On average, meeting and workshop attendance ranged from 10 to 20 participants.

A revised proposed action was sent to a refined mailing list (based on scoping responses) of 213 parties (169 electronic mail and 44 hard copy recipients) and a second 14-day informal scoping period began with the publication of a second revised notice of intent in the Federal Register on August 19, 2011 (76 FR 51936–51938). Not counting duplicates, 42 scoping responses (emails and letters) were addressed in content analysis (for the revised proposed action).

Prior to the onset of the August 19, 2011 comment period, an open house was held on August 17, 2011 at the Coconino NF Supervisor's Office. Six people attended the open house. During the comment period, an open house was held on August 25, 2011 at the Williams Ranger District (Kaibab NF). As part of coordination with local governments and residents, project updates were provided to the Coconino City Council and City of Flagstaff on September 12, 201l and again on December 5, 2011. The Tusayan and Camp Verde City Council received a project update on October 5, 2011.

The Sedona and Williams City Council was updated on October 25, 2011.Updates to local residents and communities were provided at the Mountainaire Community Picnic (at the invitation of the Coconino County Supervisor) on September 17, 2011 and via an educational booth at the Flagstaff Festival of Science in September of 2011 and 2012.

In the fall of 2011, meetings were held with commenters to clarify comments received on the revised proposed action. This included hosting meetings to discuss comments on large trees on October 14, 2011 and on canopy cover (in relation to forest plan goshawk guidelines) on December 15, 2011 (Coconino NF Supervisor's Office).

In 2012, monthly public meetings were hosted from March through July to discuss the status of the environmental analysis. Draft (working) documents shared at the public meetings and made available on the 4FRI website (http://www.fs.fed.usda.gov/main/4fri/planning) included: issues, alternatives, draft forest plan amendments, cumulative effects, the scoping report (August 2011 scoping period), and version 5 of the modified large tree retention implementation strategy (alternative C). Only a sampling of the public involvement effort is included in this summary. See the project record for complete documentation. The project has been continuously posted on the Coconino and Kaibab NFs' Schedule of Proposed Actions since January of 2011 and public involvement and analysis-related documents have been posted on the 4FRI website, http://www.fs.usda.gov/main/4fri since January, 2011.

Public Review of the Draft Environmental Impact Statement

On February 26, 2013, a preview of the "Four-Forest Restoration Initiative, Coconino and Kaibab National Forests Draft Environmental Impact Statement" (DEIS) was posted on the project's website at http://www.fs.usda.gov/main/4fri/planning and interested parties were notified via e-mail or phone call. On March 29, 2013 a notice of availability was published in the Federal Register (78 FR 19261). The notice of availability began a 60-day public comment period. Documentation of the formal DEIS comment process is contained in the project record. A legal notice announcing the availability of the DEIS for review and comment was published in the Arizona Daily Sun on April 4, 2013 and posted to the project website.

The DEIS documented five alternatives that were considered but eliminated from detailed study (see chapter 2) and 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.

On January 23, 2013, a public meeting focusing on the wildlife "bridge" habitat analysis was held in Pinetop, Arizona. Public meetings were held during the formal DEIS comment period on April 15, April 16, April 17, and May 15 of 2013.

Comments were received from individuals; tribal governments; Federal, State, and local agencies; organized interest groups; and businesses. Approximately 213 letters and emails were received on the DEIS. About 1,000 individual comments were received. The Forest Service analyzed comments to identify issues that required further or updated analysis and to identify analyses that required further clarification. Appendix I contains the Forest Service responses to comments received on the DEIS.

Cooperating Agencies

On March 11, 2011, the Arizona Game and Fish Department (AGFD) became a cooperating agency. AGFD provided a habitat specialist to assist with the wildlife management indicator species effects analysis.

Tribal Consultation

The following tribes and tribal chapters who have historic ties and an interest in the Coconino and Kaibab National Forests were consulted and include: Hopi, Kaibab Band of Paiute Indians, Navajo Nation including Coppermine, Coalmine, Naness, Lechee, Leupp, Bodaway, Cameron, Tuba City, Dilkon and Tolani Lake Chapters, San Juan Southern Paiute, White Mountain Apache, Yavapai-Apache Nation, San Carlos Apache, Hualapai, Yavapai- Prescott Indian Tribe, Havasupai, Tonto Apache, Pueblo of Zuni, Pueblo of Acoma, and Fort McDowell Yavapai Nation.

Consultation began September 10, 2009 with the Kaibab NF Supervisor sending an invitation to seven federally recognized tribes to discuss 4FRI and other national forest projects. On January 27, 2011, the forests sent a letter to tribes and tribal chapters providing information and seeking involvement and comments. Two written scoping responses were received. The White Mountain Apache responded on February 17, 2011 and indicated no concern with the project. A response from the Havasupai Tribe on March 7, 2011 asked for additional information on what the expected outcome of the proposals would be. The Hopi Tribe provided comments on treatments and the heritage survey strategy on March 21, 2011. On August 22, 2011, a second scoping letter was sent to the tribes. Tribes responded and provided additional input and voiced concerns during consultation meetings. Concerns include the following:

- Traditional cultural properties are at risk to catastrophic fire.
- Springs and plant collection areas are at risk to catastrophic fire.
- Overstocked stands are reducing the sunlight available for cultural and medicinal plants.
- Springs that are important to tribal ceremonies are drying up.
- A lack of low-intensity fire is reducing regeneration of plant collection areas.
- Smoke may affect some tribal communities.
- Tribes need access to sites for ceremonies and traditional gathering.
- Tribes are concerned with the preservation of cultural resources.

One written comment was received from the Hopi Tribe in response to the DEIS (see appendix I of this FEIS). Since consultation began in 2011, continuous updates on the project have been provided to tribes. The “Tribal Relations” section in chapter 3 of this FEIS and the tribal relations specialist report provides complete consultation documentation.

Tribes that had not participated in tribal consultation continued to receive information via email and hand-delivered mail. Information will continue to be shared unless a tribe asks specifically to not be informed.

Issues

Issues 1 to 4 were edited to reflect public comments on the DEIS related to canopy cover, post-treatment openness, and the conservation of old and large trees. 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 (alternatives C, D, and E) to provide sharp contrast and comparison to the proposed action.

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. Many public comments submitted during the scoping period suggested alternatives that were either considered in detail or eliminated from detailed analysis (see chapter 2).

Some comments were determined to be outside the scope of this analysis for one or more of the following reasons: they did not reflect a cause-and-effect relationship supported by scientific evidence; they were not relevant to the decision to be made; they were outside the Forest Service's authority; or they were already decided by law, regulation, or policy. The issues raised in these comments were dismissed from further consideration. Appendix I provides a summary of comments as well as individual responses to comments received on the DEIS.

Each specialist analyzed: (1) issues raised by the public (next section), (2) how the proposed alternatives addressed the purpose and need, (3) topics required by law, regulation or policy, and, (4) additional resource topics/concerns they felt were important for their resource (see specialist reports).

Issue 1: Prescribed Fire Emissions

Commenters stated emissions resulting from prescribed fire activities would occur continuously over a 10-year period. Emissions include but are not limited to radionuclide particles and mercury. Commenters were concerned that project emissions would degrade air quality and the health of northern Arizona residents, particularly residents of the Verde Valley and Snowflake, Arizona. There was a concern that emissions could degrade water quality. There was a concern that this project, when combined with prescribed fires that other national forests conduct, would negatively impact northern Arizona residents: Residents would experience constant smoke (an emission) over a long period of time; reduced visibility and air quality from smoke would negatively affect the quality of life for residents and would reduce tourism in the area; and the reduction of tourism would result in long- term impacts to the local and regional economy of northern Arizona. Commenters were concerned the volume of smoke and the emissions that are part of smoke could affect public health. An alternative was suggested that: (1) eliminates all use of prescribed fire, (2) eliminates most prescribed fire use and relies on other methods to dispose of biomass, and (3) improves coordination among all national forests that use prescribed fire in the vicinity of the Verde Valley and Snowflake is needed. Some felt there needs to be smoke-free periods for residents downwind of the project.

Response

An alternative that would eliminate all prescribed fire was considered but eliminated from detailed study as it did not adequately meet the purpose and need for restoring the fire-adapted southwestern ponderosa pine ecosystem. Alternatives B, C and E propose using prescribed fire across the entire project area and alternative C adds acres where prescribed fires would be used to restore additional acres of grasslands. Alternative D was developed to respond to the emissions issue by decreasing the acres proposed for prescribed fire by 69 percent (when compared to alternative B). This equates to removing fire on about 404, 889 acres. All action alternatives include design criteria aimed at reducing impacts to air quality (as practicable) and increasing coordination efforts among neighboring national forests. The fire ecology, air quality, recreation, and social-economics environmental consequences disclose the potential impacts to air quality, quality of life, the local and regional economy, and public health and safety.

The indicators used to evaluate this issue are:

- Quantitative emission modeling and qualitative interpretation to evaluate the potential for emissions (including mercury) within communities that are within or in close proximity to the project area;
- Modeling of principal pollutants including carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter less than 10 microns in size (PM 10), particulate matter less than 2.5 microns in size (PM 2.5), ozone (O_2), and sulfur dioxide (SO_2) pollutants that pose potential health hazards to evaluate compliance with the Clean Air Act as regulated by Arizona Department of Environmental Quality (ADEQ); and
- Social and economic evaluation of impacts to quality of life and tourism.

Issue 2: Conservation of Large Trees

Commenters were concerned that the “Old Growth Protection and Large Tree Retention Strategy” (also referred to as the “Large Tree Retention Strategy” or LTRS), which was developed by the 4FRI stakeholders, was not included in the proposed action. Large post-settlement trees, as defined by the stakeholders’ socio-political process, are those greater than 16 inches d.b.h. The LTRS was designed to increase landscape heterogeneity and conserve biodiversity. Commenters stated the LTRS represents social agreement between parties that greatly enhances the chance for landscape restoration to succeed and reduces the risk of conflict. Commenters stated if the LTRS is not incorporated, the current social support for landscape-scale restoration may be withdrawn. Commenters stated that without the LTRS the project may remove too many large trees. There was also concern the removal of large trees may adversely impact nesting and roosting habitat and large woody debris that is important for wildlife.

Response

The vegetation analysis will evaluate how proposed treatments affect vegetation structural stages, including those trees that are 16 inches d.b.h. or larger. This analysis will be used to inform the wildlife effects analysis. Alternatives B (proposed action alternative) and D do not incorporate the LTRS. However, alternative C responds to this issue by incorporating the key components of the LTRS and focusing on ecological desired conditions. It identifies ecological conditions where large, post-settlement trees may (or should) be removed to move toward or meet desired conditions. The intent of the LTRS has been incorporated into alternative C and E’s design criteria, the monitoring and adaptive management plan, and the project implementation plan. In the FEIS, vegetation and wildlife evaluate how treatments may impact large trees as components of forest structure and wildlife habitat.

The indicators used to evaluate this issue are:

- Quantitative pre-treatment and post-treatment three-level analysis for Mexican spotted owls on the Coconino NF,
- Goshawk, old growth, and vegetation structural stage for goshawk habitat at the landscape scale (ponderosa pine vegetation type) to gauge movement toward restoration desired conditions, and
- Qualitative analysis of pre-treatment and post-treatment nonmarket social values that include large trees, public safety, and other biodiversity objectives that may conflict with the protection of large trees.

Issue 3: Post-treatment Canopy Cover and Landscape Openness

Commenters stated measuring canopy cover in goshawk habitat at the group level will not meet forest plan stand-scale canopy requirements. Commenters stated a reduction in canopy and large tree densities have never been analyzed under NEPA and NFMA and could have deleterious effects to goshawk, its prey species, and those wildlife species that are dependent on that cover; because natural openings would no longer be included within the vegetation structural stage (VSS) classification, it would result in significantly more lands being in an open condition or outside of the VSS 4 to 6 classifications. Commenters stated this could substantially increase the logging of mature and old trees and negatively affect wildlife, including goshawk and its prey species. Commenters stated the Forest Service has not adequately explained how using a silvicultural tool designed to project forest structure at the stand level can be accurately applied to model structure at smaller group scales (i.e., less than 1 acre). Commenters stated the Forest Service has not explained how restricting the retention of closed canopy forest structure to small tree groups will avoid negatively impacting canopy-dependent species.

Response

All action alternatives (B, C, D and E) are designed to be consistent with the direction in both forest plans including the canopy cover in VSS 4 to VSS 6 in the Coconino NF forest plan. The vegetation analysis addresses the inter-relationship between canopy cover and old and large trees.

To address post-treatment openness and canopy cover where the desired condition is to move toward an open ponderosa pine (savanna/grassland) reference condition, a nonsignificant forest plan amendment was developed for the Coconino NF in alternatives B, C, and D. The amendment describes how canopy cover will be measured and met at the group level, includes language that defines and describes interspaces, and describes the relationship between interspaces, openings, and VSS classes. It would also allow select acres to be managed for less than 40 percent canopy cover in VSS 4 to VSS 6 and less than 3 to 5 reserve trees per acre. Alternative E does not include forest plan amendments. Openings and canopy cover would follow current forest plan direction. Since neither forest plan provides specific direction on how canopy cover will be measured, it would be determined at the project level using the best available information.

The analysis discloses tree group stocking guides that would be used to meet tree group canopy cover requirements and evaluates the following within goshawk habitat: pre- and post-treatment distribution of habitat structure, overall habitat structure (VSS class), forest density metrics, and openness.

Issue 4: Increased Restoration and Research

Commenters recommended additional acres of grassland restoration treatments in the vicinity of Government Prairie and the Garland Prairie Management Area on the Kaibab NF. Commenters noted the historic grasslands are being encroached upon by pine. The U.S. Fish and Wildlife Service (FWS) recommended increasing prescribed fire and restoration treatments within Mexican spotted owl protected habitat (to improve the quality of the habitat and be in alignment with the revised Mexican Spotted Owl Recovery Plan (USDI FWS 2012)).

Commenters, including the Arizona Department of Game and Fish, recommended adding research that evaluates the effect of residual tree groups and tree-less opening size on small mammals and bird species should be included in project of this scale. Commenters stated research that evaluates the impact of landscape-scale restoration actions should be incorporated via a paired watershed study. Commenters noted that outcomes from watershed and wildlife research can inform future restoration projects.

Response

Alternative C responds to comments and recommendations by including additional mechanical and/or prescribed fire treatments in the vicinity of Government Prairie and the Garland Prairie management area on the Kaibab NF. The intent is to move these areas closer to historic reference conditions. The alternative responds to recommendations from FWS to increase prescribed fire and mechanical treatments within Mexican spotted owl habitat. In alternative C, prescribed fire would be applied to 70 protected activity centers, including 54 core areas. In target threshold habitat, the desired basal area is adjusted to be in alignment with the revised Mexican Spotted Owl Recovery Plan. In alternative C, the mechanical treatment d.b.h. limit would be increased to 17.9 inches in Mexican spotted owl protected activity centers.

Alternative C adjusts vegetation (decreases acres) and prescribed fire (increases acres) treatments to incorporate two research opportunities. One study would evaluate the effect of residual tree groups and opening size on small mammals and bird species. The paired watershed study would evaluate water yield from landscape-scale restoration actions.

The indicators used to evaluate this issue are:

- Acres of grassland vegetation moving toward desired conditions
- Acres of improved Mexican spotted owl nesting and roosting habitat
- Qualitative assessment of alignment with the Mexican Spotted Owl Recovery Plan
- Potential change in water yield

Procedural Concerns

Range of Alternatives and Comparison of Alternatives

This procedural concern was raised in comments to the DEIS. There is a concern that the action alternatives proposed in the DEIS are virtually identical except for the variation in acreages. Some commenters stated there is no action alternative where a plan amendment would not take place. Commenters stated it is not possible to understand the environmental effects and tradeoffs for resources that result from the amendments themselves.

Response

The phrase "range of alternatives" refers to the alternatives discussed in environmental documents. It includes all reasonable alternatives, which must be rigorously explored and objectively evaluated, as well as those other alternatives, which are eliminated from detailed study with a brief discussion of the reasons for eliminating them (40 CFR Section 1502.14).

The DEIS (pp. 8 to 104) included nine alternatives including no action, three action alternatives, and five alternatives that were considered but eliminated from detailed study. The alternatives responded to the issues received from the public (2011 Scoping Report, project record). In response to comments received on the DEIS, a fourth action alternative that would propose no forest plan amendments was analyzed in the FEIS. This increased the number of fully analyzed alternatives to five (four action alternatives and the no action alternative), and increased the number of alternatives considered but eliminated from detailed study to six.

Significant Forest Plan Amendments

Some commenters stated the DEIS (alternatives B through D) failed to support a finding that the plan amendments are nonsignificant. Some commenters stated the public cannot use the data in the analysis to determine the acres affected and to understand how these acres are related to other anticipated uses. Some commenters stated the proposed amendments are significant because they may bring about changes that may have an important effect on the entire land management plan or affect land and resources throughout a large portion of the planning area, see FSM 1926.52 (January 31, 2006).

Some commenters stated the plan amendments are significant because the Forest Service is including identical plan amendments in similar vegetation projects; therefore, providing direction that must be followed by other projects. Some commenters asked for examples of other projects with nonsignificant plan amendments. Some commenters suggested wording to improve clarity. The environmental cause-and-effect relationship is the perceived dramatic change in management for Mexican spotted owl that may result in harm to the owl.

Response

In the DEIS, three forest plan amendments were proposed for the Kaibab NF. The forest plan was revised in April of 2014. As a result, all forest plan amendments were removed in the FEIS. No forest plan amendments are needed on the Kaibab NF because the proposed actions are consistent with forest plan objectives, desired conditions, and standards and guidelines (FEIS, chapter 2, “Forest Plan Consistency” section).

Three nonsignificant amendments for the Coconino NF were evaluated in the FEIS. The amendments are authorized via 36 CFR 219, the Forest Service Planning Rule. Section 219.17(b)(3) of the Rule provides the transition language that allows this project to propose amendments to the Coconino NF forest plan using the provisions of the 1982 Planning Rule. The significance of each amendment was evaluated in accordance with Forest Service Manual (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 FWS biological opinion that is specific to this project. Amendment 2 clarifies existing direction related to managing canopy cover and interspace in the forest plan. The purpose of amendment 2 is to bring the project into alignment with the best available science (Reynolds et al. 2013) that provides desired conditions for restoring fire-adapted ponderosa pine in the Southwest. Amendment 3 resolves a forest plan error related to the management of heritage resources and is specific to this project. The detailed significance analysis for each amendment is located in appendix B of this FEIS.

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 (Reynolds et al. 2013). The amendments bring the alternatives into alignment with the revised Mexican Spotted Owl Recovery Plan, although the degree of alignment varies by alternative. No amendment would 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 Mexican spotted owl protected activity center habitat on the Coconino NF.
- Amendment 2 is a clarification amendment. The canopy cover portion of the amendment would generally affect 137,242 acres (15 percent) of all goshawk habitat on the Coconino NF. Managing 28,653 acres of ponderosa pine for an open reference condition would affect approximately 3 percent of all suitable goshawk habitats on the Coconino NF.
- Amendment 3 is specific to approximately 355,707 acres of proposed treatments in this project. In alternative C this 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 (RMRS GTR 310), 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.

Some commenters stated the plan amendments are significant because the Forests are including identical plan amendments in similar vegetation projects; therefore, providing direction that must be followed by other projects. The list of vegetation projects that were included in comments on the DEIS were reviewed. Overall, the forest plan amendments that have been proposed in other vegetation projects reflect the ongoing Coconino NF forest plan revision process, using the best available scientific information (Reynolds et al. 2013), and being compliant with the revised Mexican Spotted Owl Recovery Plan (USDI FWS 2012). A complete analysis of other proposed forest plan amendments by project is located in the project record.

Proposed Action Development

During the initial phase of scoping (January 2011 to June 2011), meetings and workshops were held for the purpose of refining the draft proposed action. We recorded many comments requesting additional detail on what vegetation and prescribed fire treatments would look like once implemented. Many commenters provided input and recommendations on identifying and prioritizing resources and infrastructure at risk from high-severity fire. Treatment in these locations is reflected in the proposed action (and subsequent alternatives).

Another topic that emerged was the conservation of old trees. In response to recommendations, key concepts from the stakeholder-developed Old Tree Protection Strategy (OTPS) were incorporated into the purpose and need (4FRI Stakeholders 2011). Treatment design criteria and mitigation (which are consistent with the OTPS) was developed and the OTPS was made integral to the revised proposed action as an attachment (appendix E in the August 2011 proposed action document). An old tree implementation plan was developed and made part of the final proposed action alternative (and all subsequent alternatives).

As the analysis progressed, the need to better describe treatments within Mexican spotted owl protected activity centers (PACs) was raised by the U.S. Fish and Wildlife Service. In response, the language in the proposed action was revised to clarify that mechanical treatment was proposed in 18 select PACs and the use of prescribed fire was proposed in 72 PACs, excluding core areas.

As the proposed action was refined, the concept of adaptive management was incorporated into the proposal to provide flexibility to account for inaccurate initial assumptions, to adapt to changes in environmental conditions, and to respond to subsequent monitoring information that indicates that desired conditions are not being met (USDA FS 2011, 2012). With this objective in mind, vegetation treatments were designed to have a range of treatment types and intensities. Having a range of treatment options helps to implement a treatment that best responds to the site-specific resource condition and most effectively allows movement toward desired conditions.

Related documents that were part of the final proposed action alternative (and subsequent alternatives) include the implementation plan (appendix D) and the monitoring and adaptive management plan (appendix E) developed in collaboration with the 4FRI stakeholders. The purpose of the implementation plan is to ensure that actions taken under adaptive management are consistent with the predicted effects and the decision. The incremental changes to the proposed action and alternatives is documented in the project record and incorporated by reference in accordance with40 CFR 1502.21 (36 CFR 220.5(e)(1)).

Summary of Final Proposed Action

A summary of the final proposed action (alternative B) is presented here. See chapter 2, alternative B for additional details.

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 two national forests (within the treatment area). Up to two prescribed fires[9] would be conducted on all acres proposed for treatment over the 10-year period.

[9] 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.

Restoration activities would:

- Mechanically cut trees on approximately 384,966 acres. This includes: (1) mechanically treating trees up to 16 inches d.b.h. within 18 Mexican spotted owl PACs and, (2) using low-severity prescribed fire within 70 Mexican spotted owl PACs (excluding core areas).
- Apply prescribed fire on approximately 384,966 acres where mechanical treatment occurs.
- Use prescribed fire only on approximately 198,364 acres.
- Construct approximately 520 miles of temporary roads for haul access and decommission the roads 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 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 U.S. Fish and Wildlife Service 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

Figure 22 through figure 24 provide a coarse-scale overview of restoration treatment locations. Please refer to the description of alternative B (proposed action alternative) in chapter 2 for details that include tables and maps that display proposed treatments.

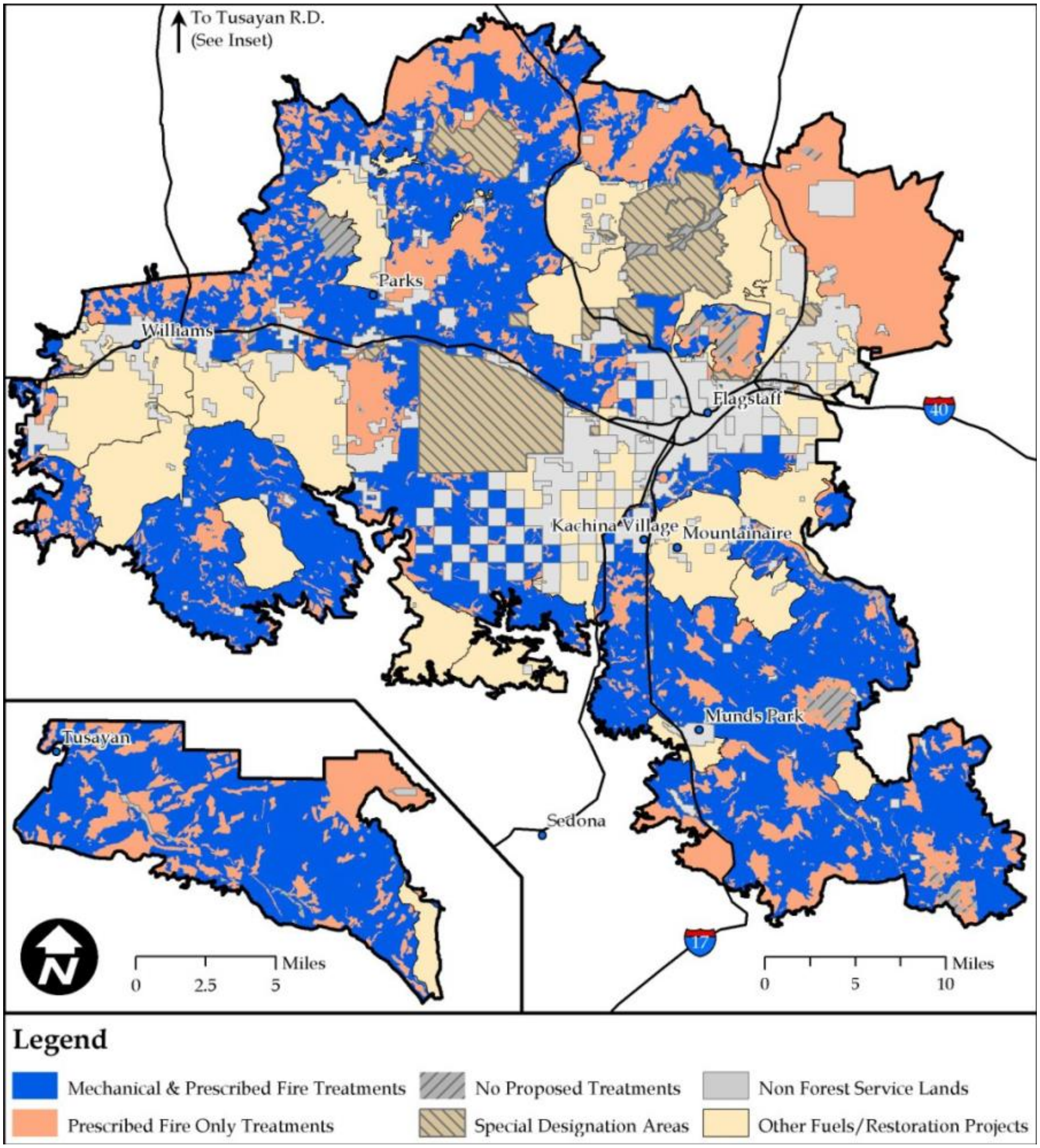

Figure 22. Final proposed action; general locations of mechanical and prescribed fire treatments

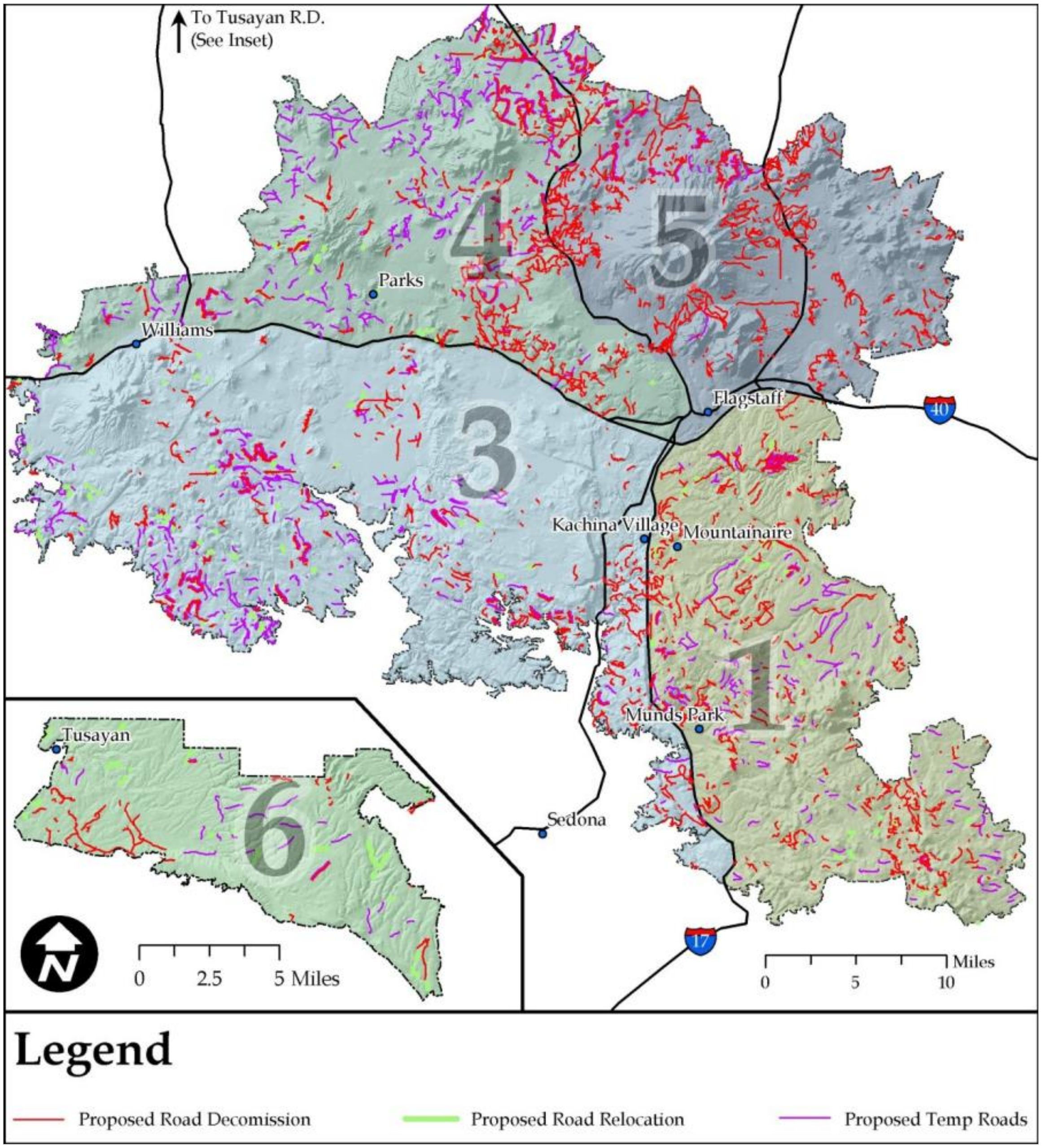

Figure 23. Final proposed action; general locations of road activities by RU

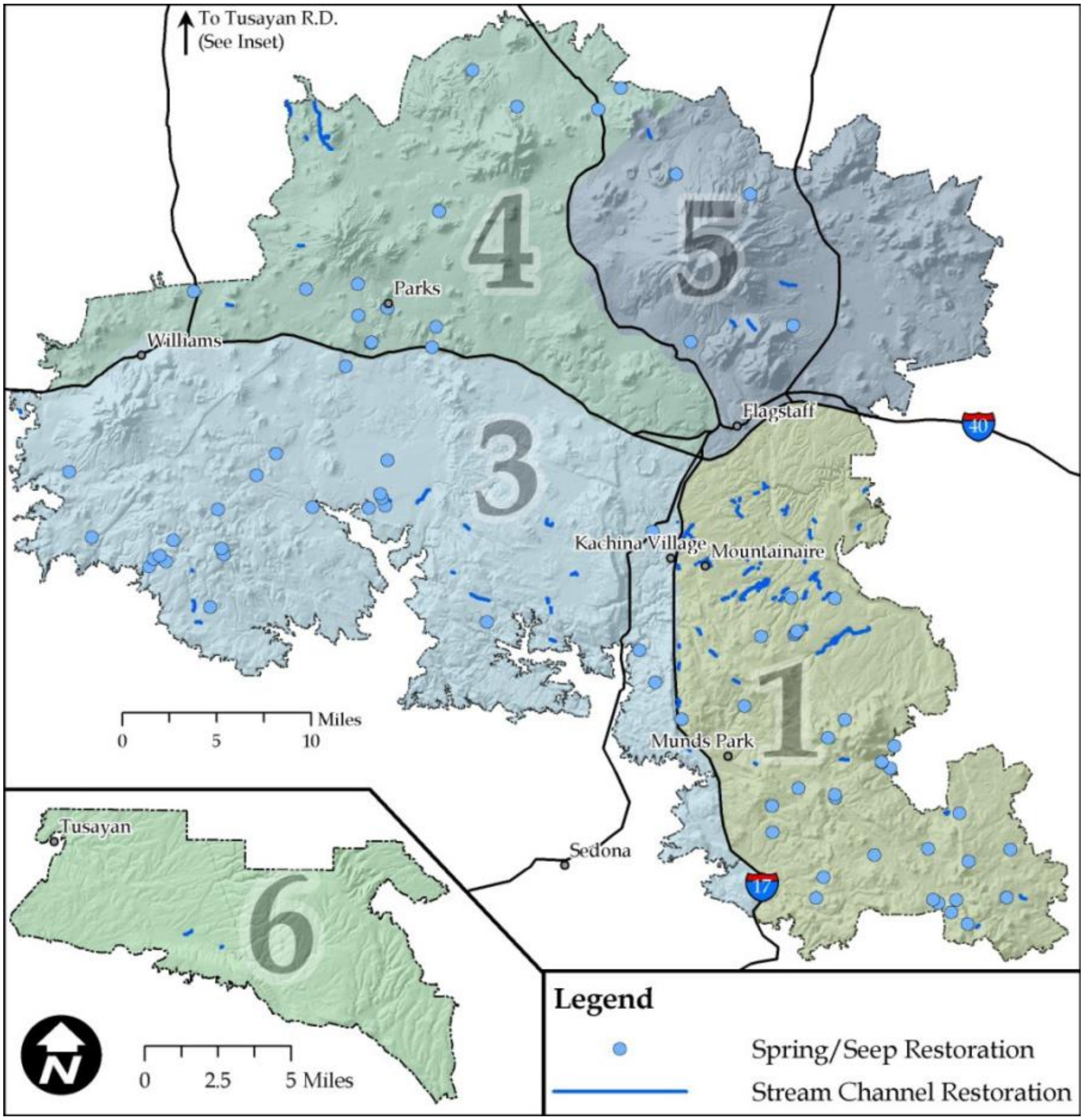

Figure 24. Final proposed action; general location of spring and ephemeral channel restoration actions by restoration unit (RU)

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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

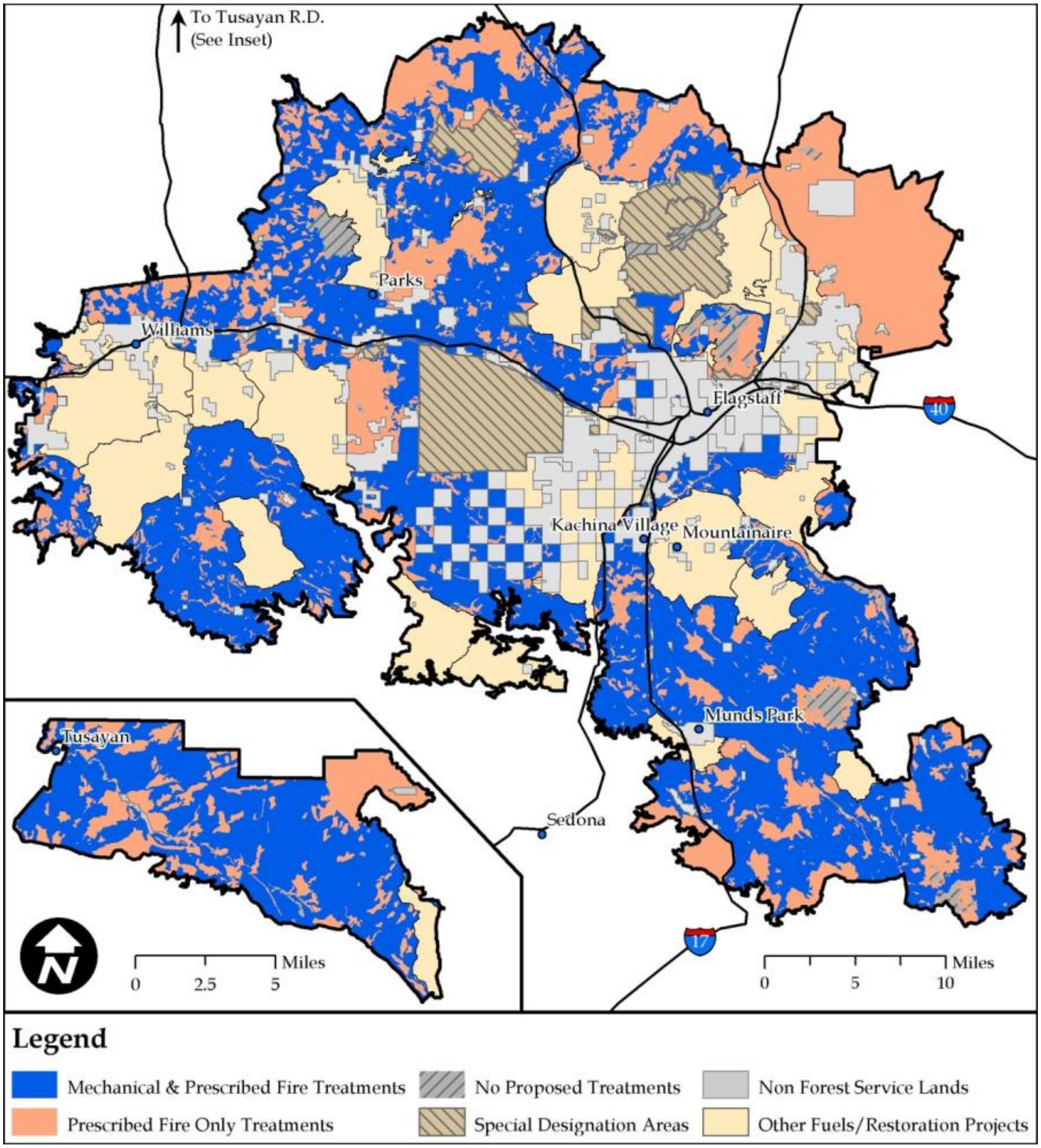


Figure 26. Alternative B general locations of mechanical and prescribed fire treatments

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.

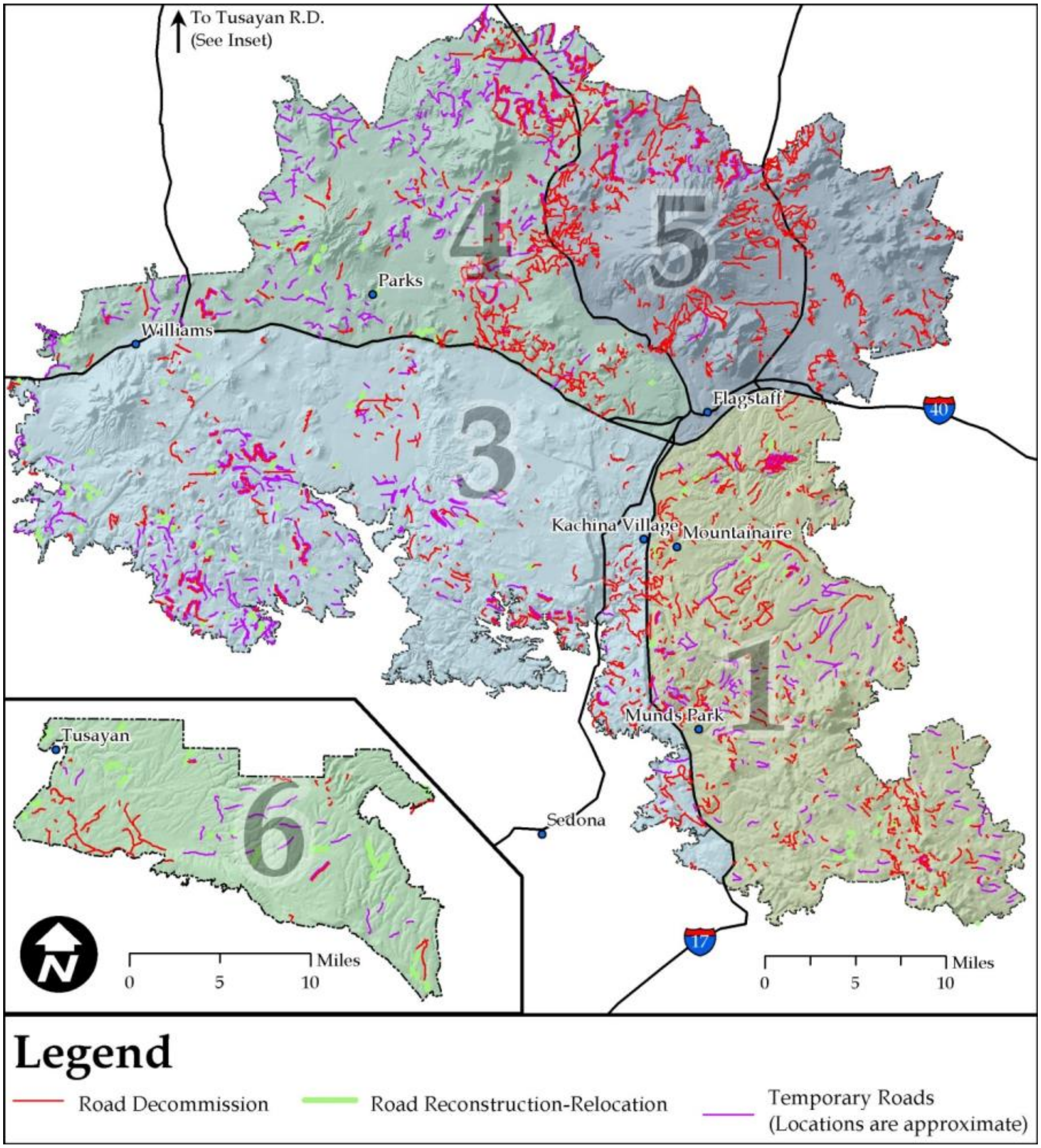


Figure 27. Alternatives B through E general locations of road treatments

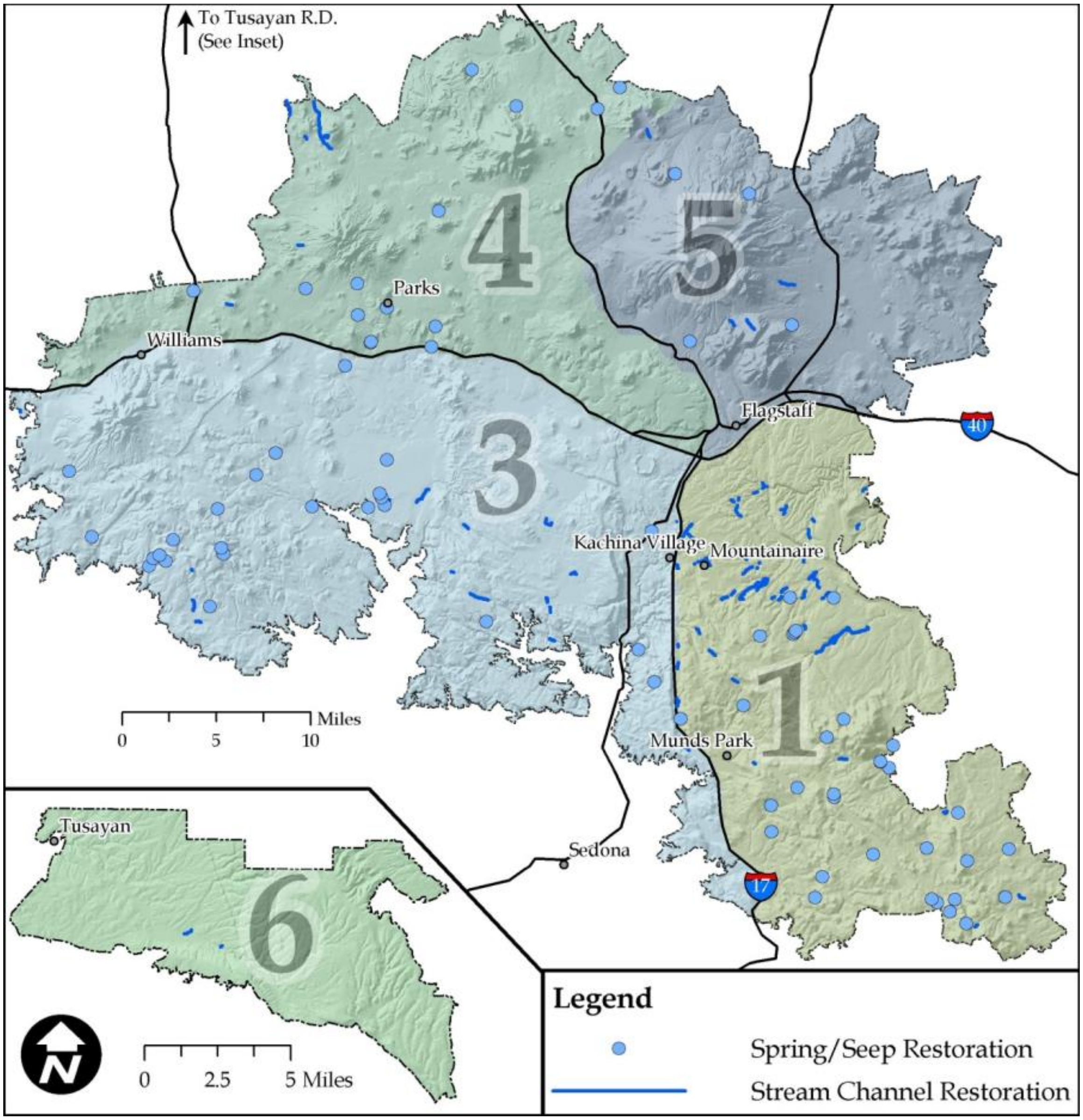


Figure 28. Alternatives B through E general locations of spring and stream treatments

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.

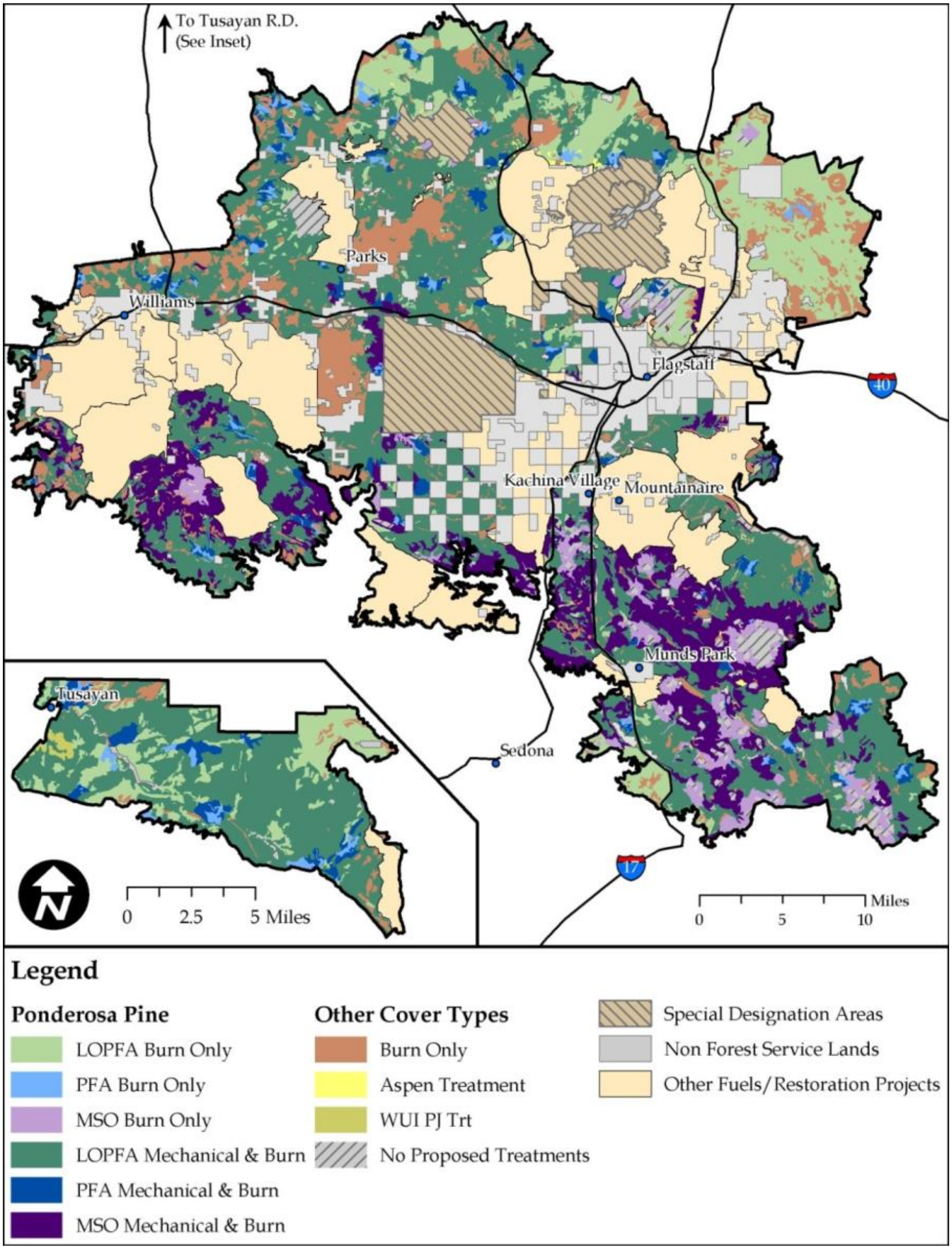


Figure 29. Alternative B mechanical and prescribed fire treatments in goshawk and Mexican spotted owl (MSO) habitat

*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**

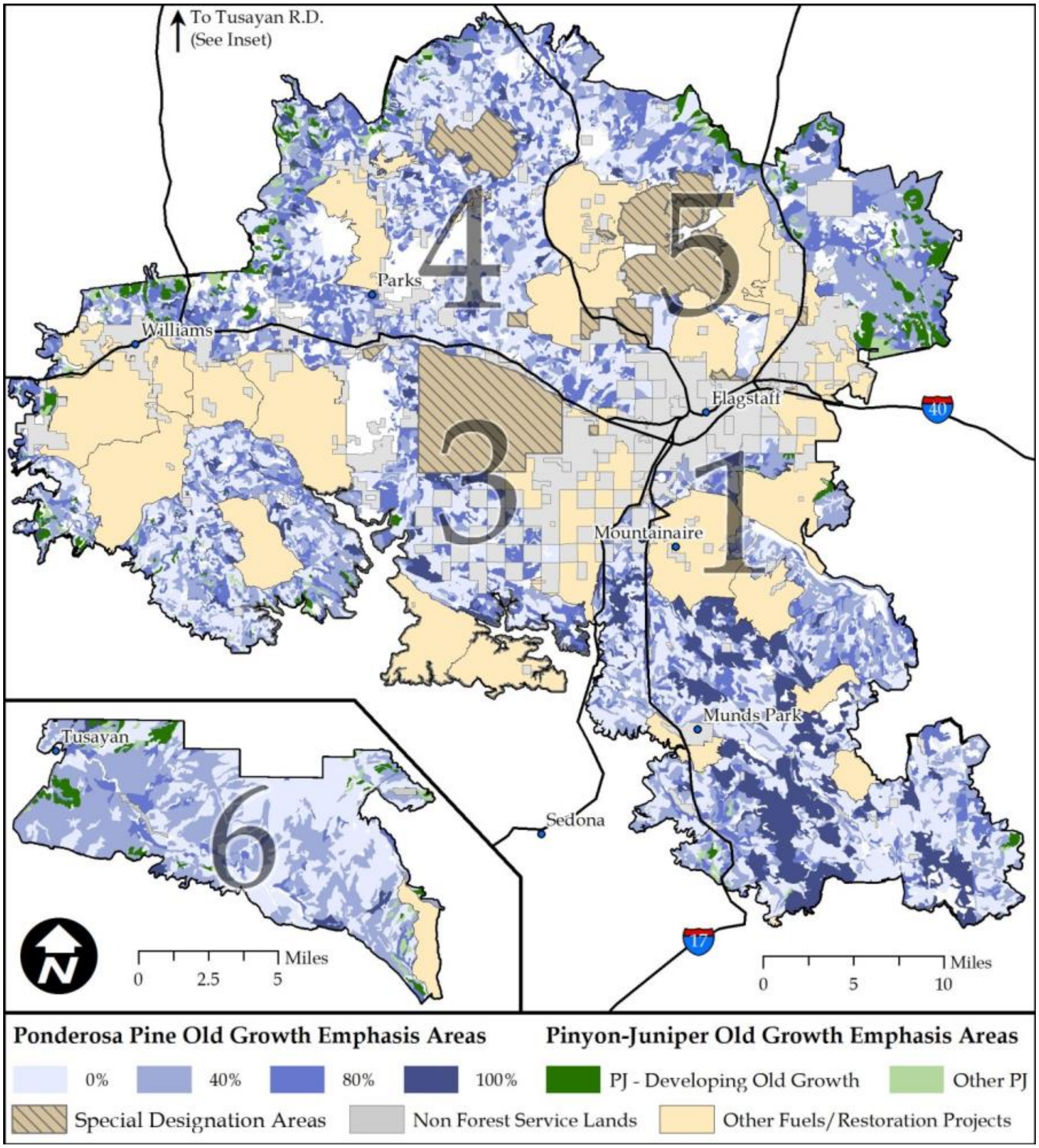


Figure 30. Alternatives B through E; ponderosa pine and pinyon-juniper old growth management (PJ = pinyon-juniper)

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

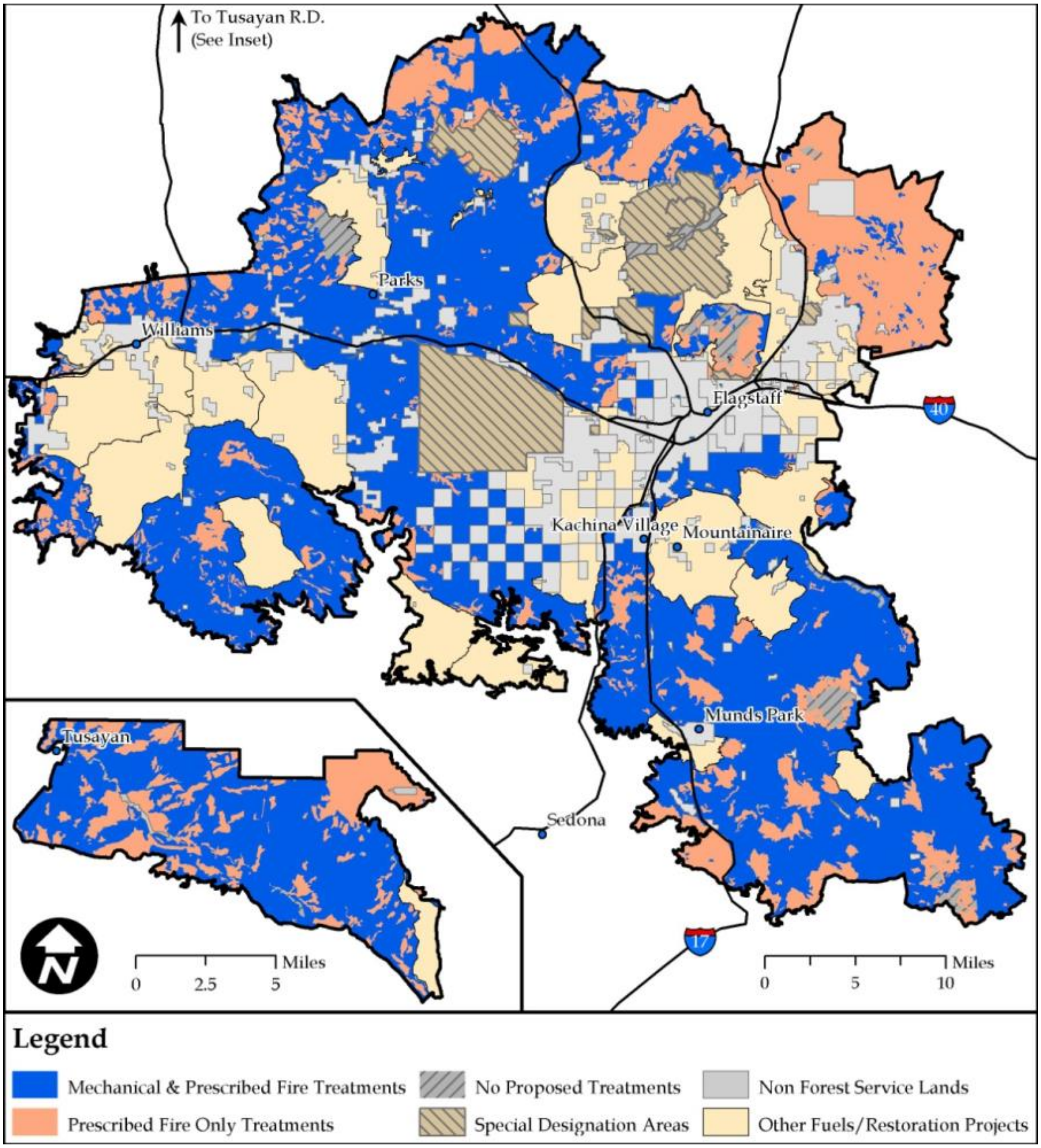


Figure 31. Alternative C mechanical and prescribed fire treatments

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.

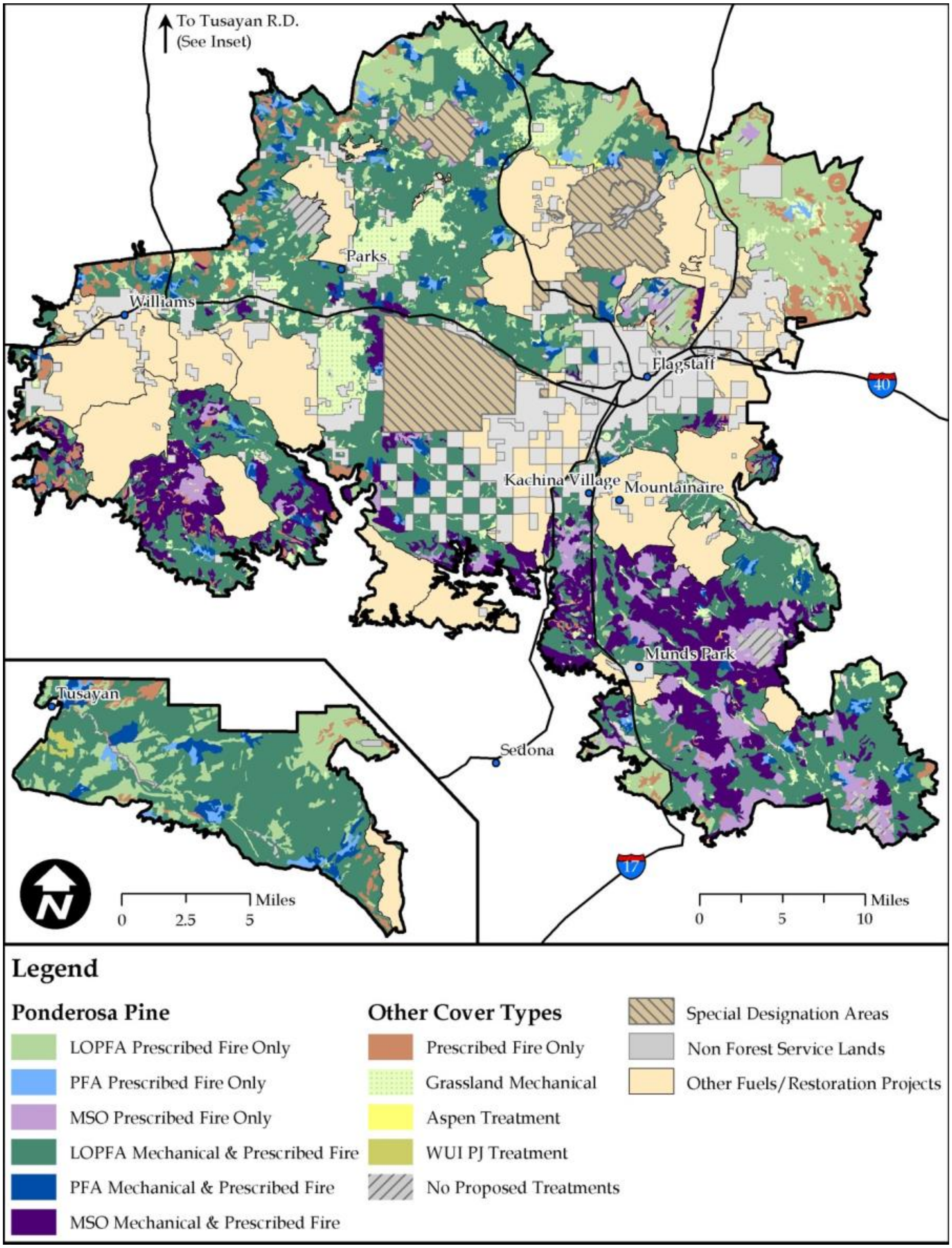


Figure 32. Alternative C mechanical and prescribed fire treatments in goshawk and Mexican spotted owl (MSO) habitat

*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

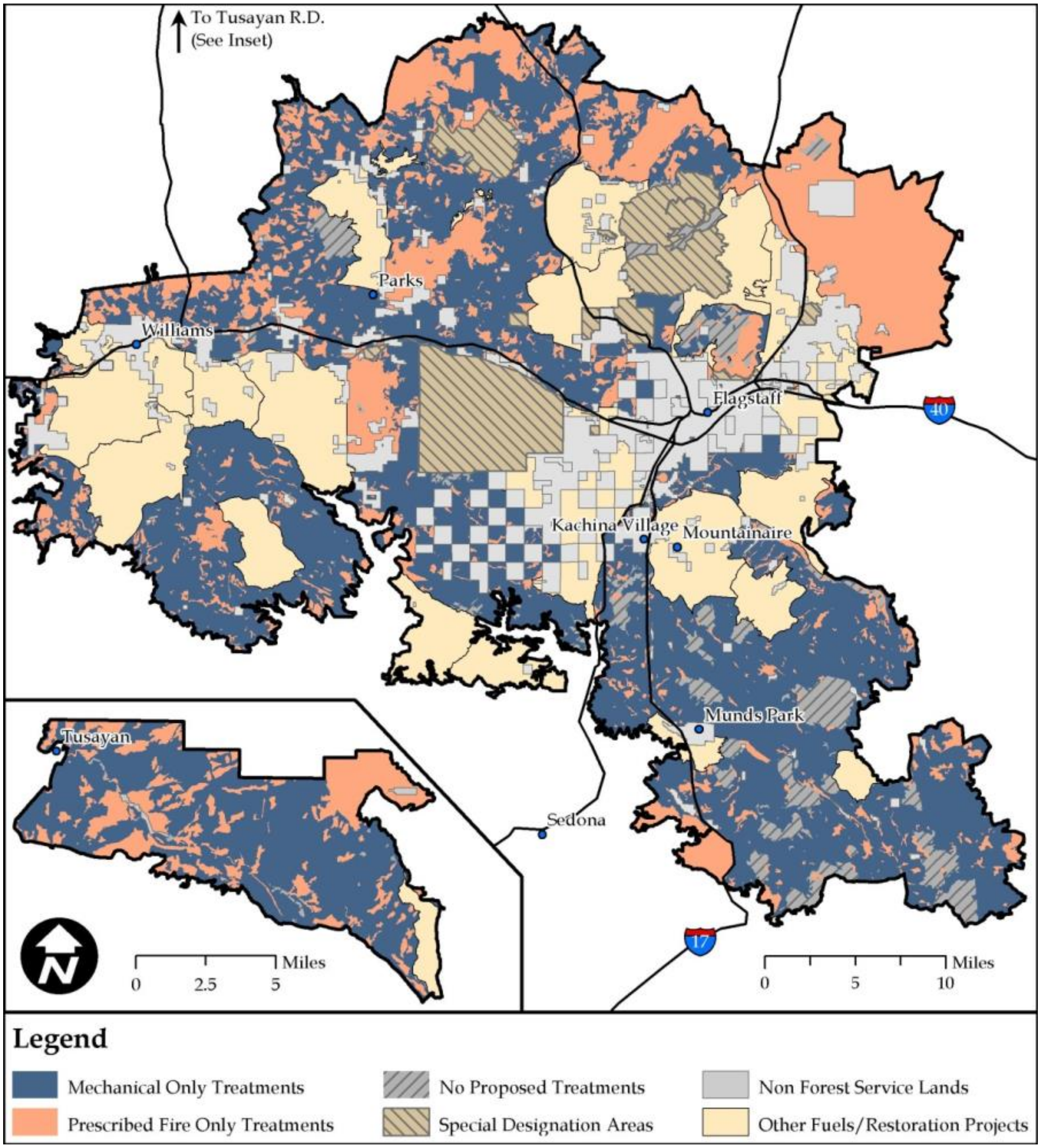


Figure 33. Alternative D mechanical and prescribed fire treatments

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.

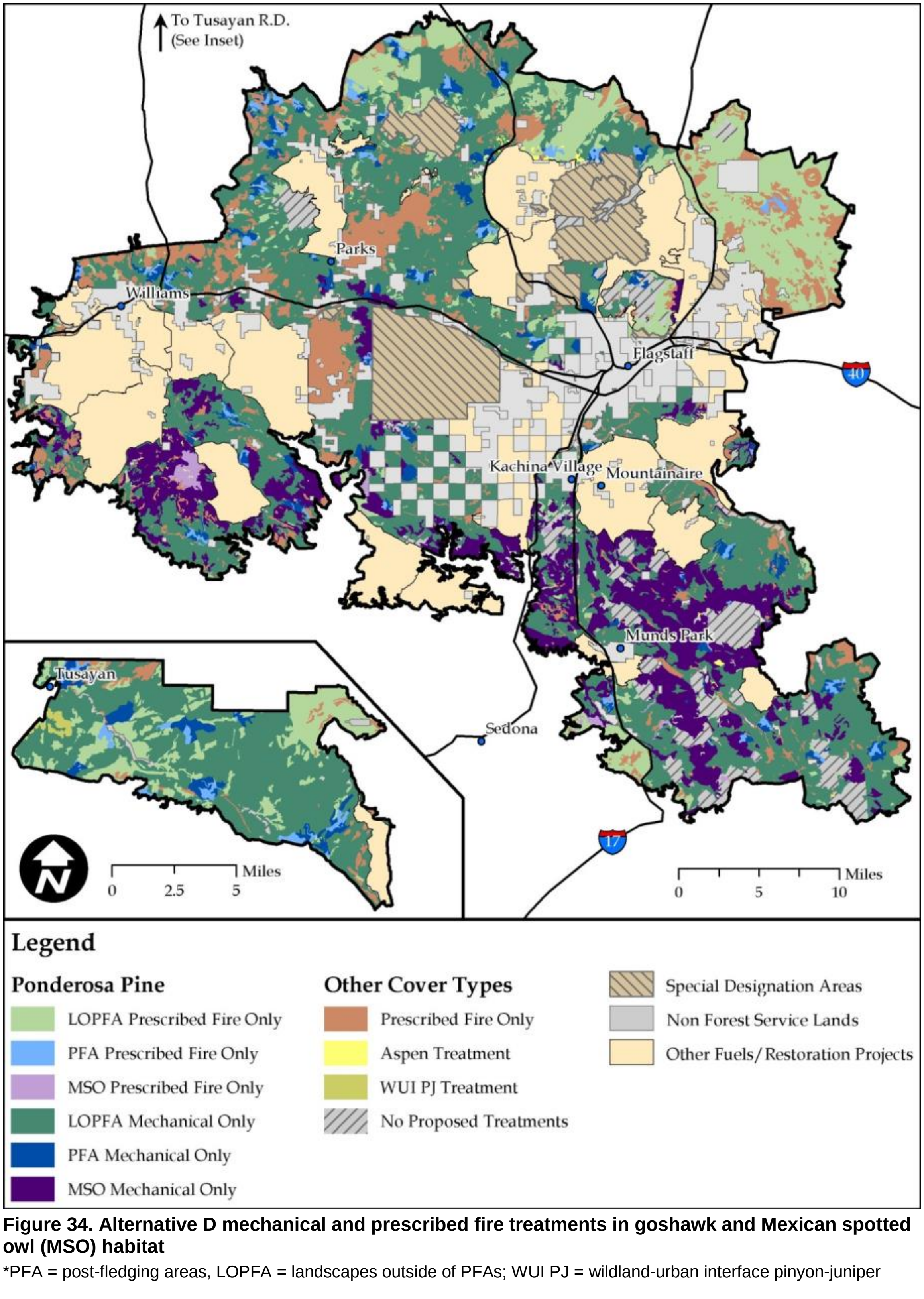


Figure 34. Alternative D mechanical and prescribed fire treatments in goshawk and Mexican spotted owl (MSO) habitat

*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

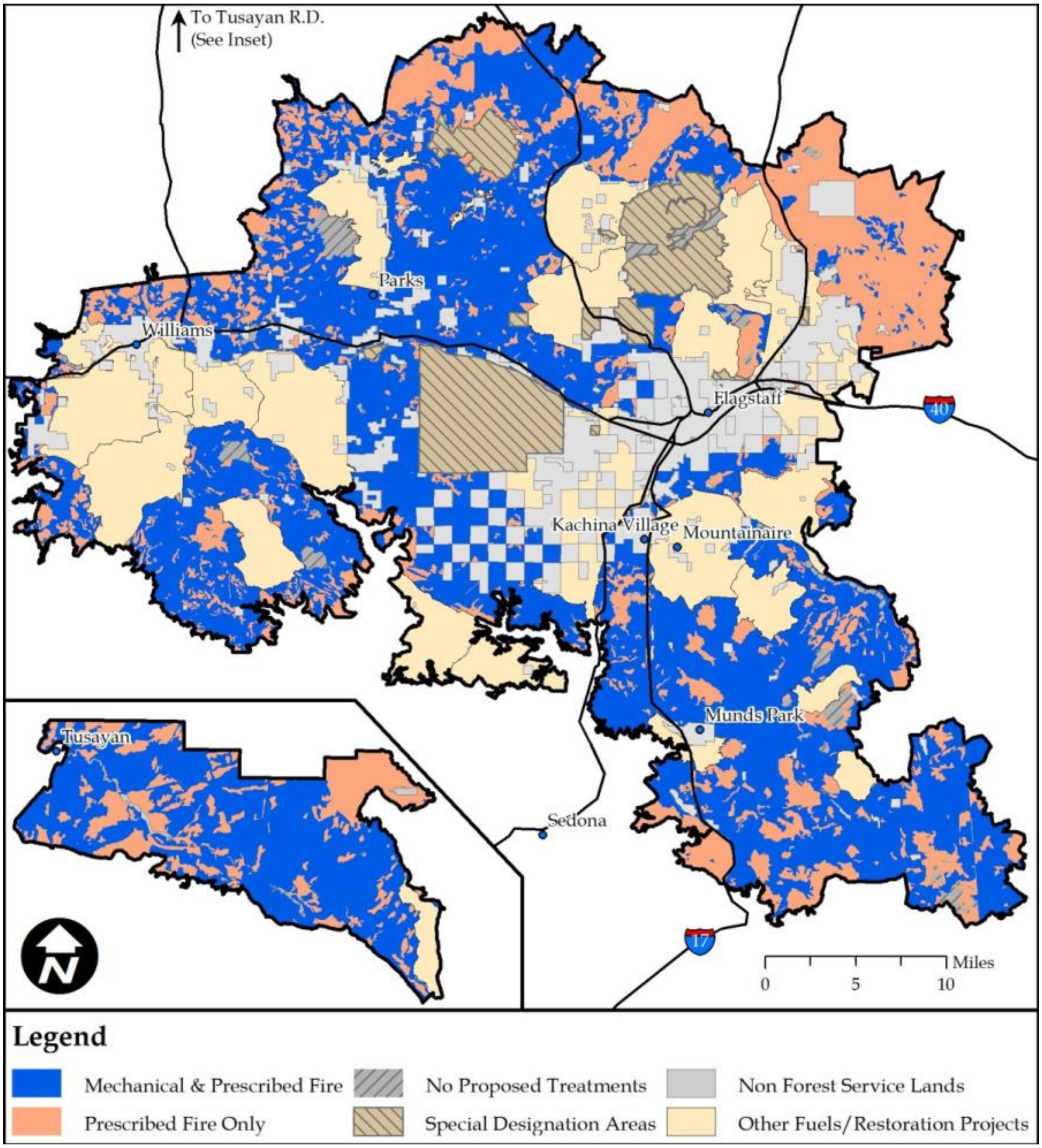


Figure 35. Alternative E mechanical and prescribed fire treatments

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.

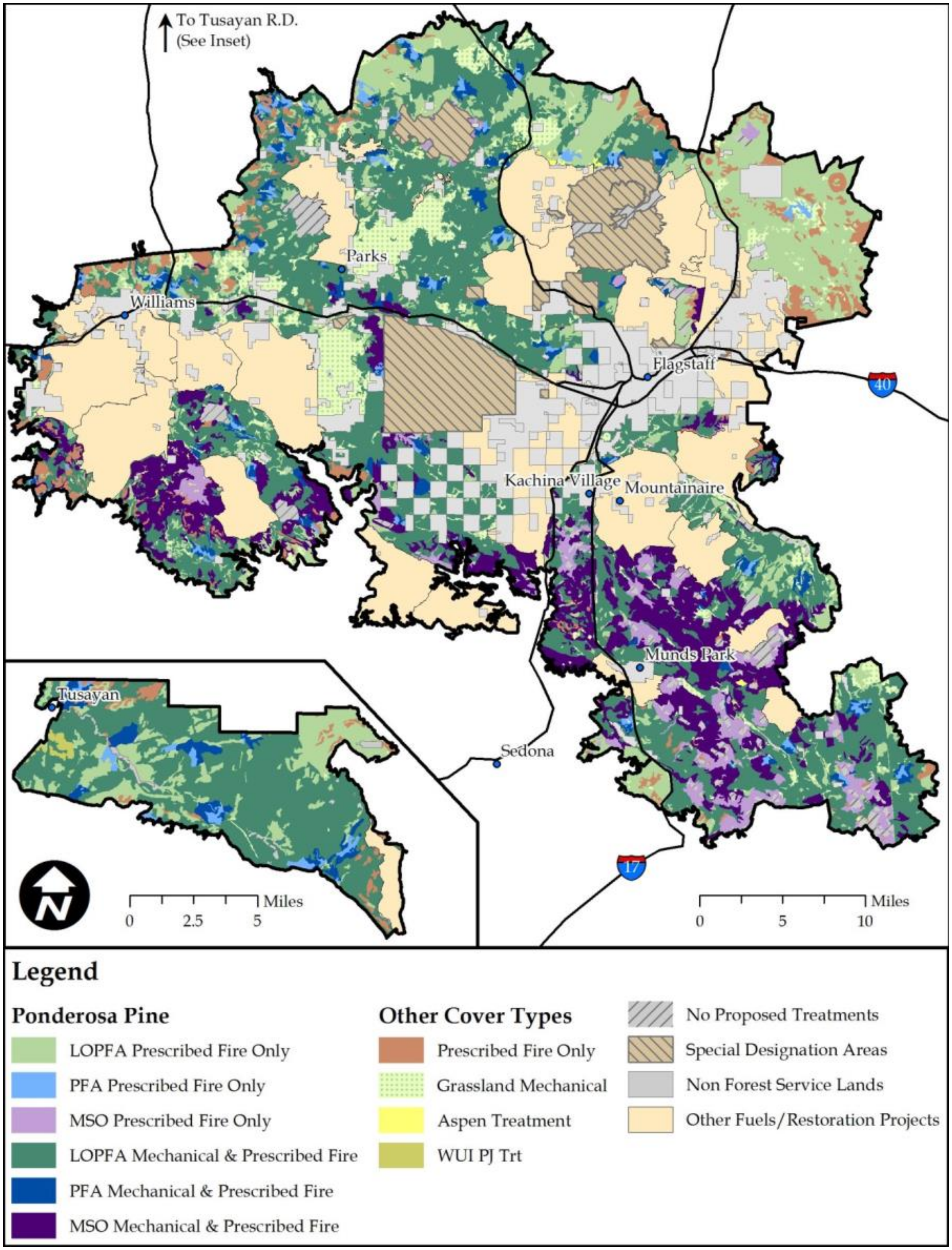


Figure 36. Alternative E mechanical and prescribed fire treatments in goshawk and Mexican spotted owl (MSO) habitat

*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.

Chapter 3. Affected Environment and Environmental Consequences

This chapter summarizes the physical, biological, social, and economic environments of the project area and the effects of implementing each alternative on that environment. It also presents the scientific and analytical basis for the comparison of alternatives presented here. Only summaries are provided for each resource and all resource reports are incorporated by reference. Complete assumptions, methodology and incomplete or unavailable information (if relevant) can be found in each resource report. Specialist reports will be available for viewing on the 4FRI website: http://www.fs.usda.gov/main/4fri.

Changes from DEIS to FEIS include updated or corrected treatment acres. The FEIS includes new analysis as a result of alternative development or changed conditions (e.g., wildfire on the Coconino NF). Some changes were in response to comments on the DEIS. For example, issues related to the conservation of large trees (VSS 4, VSS 5 and VSS 6) were addressed by modifying how canopy cover would be measured on about 38,256 acres in alternatives C and E.

Changes are documented in chapter 2 of this FEIS and summarized (as relevant) by resource.

Soils and Watershed

The soils specialist report (Steinke 2014) and watershed report (MacDonald 2014) are incorporated by reference. See the specialist report for detailed information including methodology, soil disturbance by treatment type and 6th Hydrologic Unit Code (HUC) watersheds, the Water Erosion Prediction Project (WEPP) soil erosion modeling runs, soil interpretations by 6th HUC watershed, strata, and terrestrial ecosystem survey map units, and the data used to evaluate soil disturbance cumulative effects.

Changes from the Draft Environmental Impact Statement and Opposing Science

Changes from DEIS to FEIS include updated or corrected treatment acres, updated effects analysis as a result of response to comments, new analysis as a result of alternative development or changed conditions (due to wildfire on the Coconino NF). Changes are documented in chapter 2 of this FEIS.

Numerous comments were received on the DEIS related to impacts to soil productivity or water quality. The complete response to comments is in the specialist reports and in the project record. Some comments requested that treatments be designed to maximize snowpack accumulation and water retention. This was considered to be outside the scope of the project and not meeting the purpose and need. The DEIS (and FEIS) includes an analysis of post treatment water yield. Some comments recommended no treatment in the (watershed research) control watersheds to better study the effects of water yield by treatment type. In response to these comments, the FEIS removed treatments in the control watersheds. This change does not hinder movement toward desired conditions. The analysis in the FEIS was updated to include new information from NAU on the instruments that may be used to conduct the paired watershed study (formerly referred to as water yield research). Several comments recommended treatments be implemented using an evidence-based approach. The DEIS addressed using an evidence-based approach (DEIS, appendix D). However, the description of treatments associated with the paired watershed study has been clarified to include the evidence-based approach.

Some comments stated new (permanent) roads would be constructed. There was a concern that new roads and timber harvest activities may cause high levels of soil erosion that can negatively affect water quality and soil productivity (including on soils with severe erosion hazard). In all alternatives (DEIS and FEIS), no permanent roads would be constructed and temporary roads would be decommissioned using any of the soil protective measures identified in soil and water best management practices (SW 39) and transportation (T3, T9) design features (see FEIS, appendix C). The soil and water analysis discloses there is an increased risk of runoff and erosion from forest treatments and (new or temporary road construction) if protective design features and best management practices are not made part of the action. However, proven and effective soil and water BMPs (DEIS, appendix C) have been identified and would be implemented during timber harvest activities that are expected to protect soil productivity and water quality. However, in response to comments, the FEIS includes an additional soil and water BMP for to address the concern related to roads constructed on soils with severe erosion hazard (FEIS, appendix C, SW 39). This BMP provides direction and additional soil and water protective measures that are expected to protect soil productivity and water quality. The soils and watershed analysis also discloses the effects associated with decommissioning 860 miles (726 miles on the Coconino NF and 134 miles on the Kaibab NF) of road and reconstructing/relocating approximately 40 miles of existing road. In all action alternatives, road-related impacts would be decreased.

Some opposing views included literature from other geographic locations including Michigan and the northwest (CARA 8). Commenters stated (and we agree) that soil and site productivity can be negatively affected if protective design features and best management practices are not made part of the action. The 4FRI project minimizes vegetation treatment impacts to soil and site productivity through implementation of design features, mitigation measures and the following Soil and Water BMPs listed and located in appendix C, p. 567 of DEIS. They have been developed and would be implemented (for timber harvest and fuels operations and retention of coarse woody debris) to maintain and protect soil productivity, minimize sediment delivery and improve and protect water quality. The chapter 3 soil and water analysis (DEIS table 32, p. 116 and pp. 119-125) and (Soils specialist report pages 62-92 and Attachment 1, page 165) shows less than 15 percent soil disturbance (average at the watershed level) would occur (including temporary road construction) under all action alternatives which is less than 15 percent soil disturbance threshold identified that would maintain long term soil productivity.

Some comments (CARA 8) included (popular not peer reviewed) science that suggested the project (timber harvest and road actions) would result in high soil erosion due to debris slides. 4FRI does not propose any ground disturbance treatments or roads construction on slopes greater than 40 percent and consequently, have very low risk of debris slides and associated erosion than on the Klamath (NF). The effects disclosed in chapter 3 of the DEIS are site-specific to this project. The potential for soil disturbance and soil erosion is disclosed in the DEIS on p. 109 to page 113 (affected environment), and on page 113 to page 118 (environmental consequences) and pages 118-126 (Water) and in the soil specialist report from page 60 to 120. Additionally, design features, mitigation measures and soil and water BMPs located in appendix C, p. 567 of DEIS have been developed and would be implemented (for timber harvest operations) to maintain and protect soil productivity, minimize sediment delivery and improve and protect water quality. Other articles reviewed were considered to be outside the scope of the analysis or not applicable to this site-specific analysis. See the soil and water specialist report for the complete response to comments document.

The DEIS and FEIS soils and watershed analysis discloses there is increased risk of runoff and erosion from forest treatments, maintenance of permanent roads, and temporary road construction if protective design features and best management practices are not made part of the action. All action alternatives include design features and mitigation measures that would minimize vegetation treatment impacts to soil and site productivity (DEIS and FEIS appendix C).

Affected Environment

Soils

Approximately 94 terrestrial ecosystem survey map units were aggregated into 17 strata (specialist report, appendix B). The aggregation of strata was based on similar soils and vegetation types with similar limitations, hazards, and production potentials to management activities. The strata were used in part to design treatments, analyze effects, and are based on the potential plant community and capability of the soils. Short term for soils is considered 3 years (when leaf fall occurs) up to 10 years. Long term is considered greater than 10 years. See the specialist report for details on methodology and analysis process.

Soil Classification

Soil classification varies by strata (see appendix B, table 34 of the specialist report) and is dominated by forest soils in the Alfisol order (boralfs suborder) and grassland soils in the Mollisols order (borolls suborder) and on some ponderosa pine forests strata where stand density has drastically increased. A few strata have ponderosa pine or mixed conifer potential plant community strata that fall into the Inceptisol, Andisol or Entisol soil order and are less developed soils with thinner organic soil surfaces than the mollisol and mollisol integrade soils mentioned above.

Based on soil type and field observations of tree canopy cover (which is variable but commonly exceeds 30 to 50 percent, a closed canopy state), age class and old stump presence, mollisols (especially deep ones) historically probably supported grassy interspaces or open canopy covers (10 to 30 percent). Mollic integrade soils probably supported somewhat closed stands (slightly greater than 30 percent) on rocky or shallow soils and open stands on moderately deep and deep soils. See the specialist report for detailed soils information and a Coconino NF (Steinke, 2007a) and Kaibab NF (Steinke, 2007b) study on mollisol and mollic-integrade soils.

Soil Condition

Soil condition is satisfactory on approximately 841,500 acres (85 percent of the project area) of the ponderosa pine strata on slopes less than about 40 percent. It is satisfactory due to the presence of high and adequate amounts of vegetative ground cover that protects the soil against accelerated erosion and compaction. The other 15 percent of the project area is dominated by impaired soils located on some montane meadows and lesser amounts of inherently unstable, unsuited or unsatisfactory soils. Strata information is located in the appendix B of the specialist report.

Steep Slopes: Although most soils rate out as satisfactory, nutrient cycling is reduced in dense stands (including those in FRCC 2 and 3) and soil condition is approaching “impaired”. On about 30,000 acres of soils and strata where slopes are greater than about 40 percent (strata 42, 43, 47, and portions of 44 and 45) soil condition is unsuited and/or inherently unstable where natural erosion exceeds tolerable erosion. These soils and strata are not suitable for mechanical timber harvesting. Prescribed fire-only treatments are proposed on slopes greater than about 40 percent.

Montane Meadows: On the Coconino NF, soil condition is impaired on slightly more than half of the acres in montane meadows (strata 1, 2, 4, 6, and 10). Soil condition is listed as satisfactory on about 44,476 acres of the montane meadow strata on the Kaibab NF. However, it is probable that the soil condition in these montane meadows is impaired. Refined soil condition assessments that included all three soil functions were not conducted on the Kaibab NF and the assessment was based solely on the ability of the soil to resist erosion. Soil condition in montane meadows located in strata 3, 5, 7, and 8 (about 38,744 acres) is satisfactory.

Wetlands: Soil condition on about 4,400 acres of wetlands (strata 9) ranges from satisfactory to unsatisfactory on the Coconino NF and are generally satisfactory or impaired on the Kaibab NF (as a result of elk bedding and browsing). Most wetlands on the Kaibab NF and many on the Coconino NF are fenced to exclude livestock grazing.

Pinyon-Juniper: Soil condition on about 1,000 acres (strata 46) of pinyon juniper vegetation types on slopes less than 40 percent is variable and has areas of satisfactory and impaired soil condition. A few areas have unsatisfactory soil condition. Impaired and unsatisfactory soil conditions generally have overstocked tree canopy, resulting in poor herbaceous understory composition and productivity, poor nutrient cycling function and low vegetative ground cover. Impaired and unsatisfactory soil conditions are prone to accelerated erosion.

Erosion Hazard

Within the soil and watershed analysis area, approximately 133,850 acres (13 percent) are dominated by soils with severe erosion hazard. About 52,750 acres (5 percent) have soils dominated with moderate erosion hazard. There are about 805,700 acres (81 percent) of strata with slight erosion hazard Resource protection measures are required to assure accelerated soil erosion and compaction does not impair soil productivity and watershed function.

Most strata in the ponderosa pine type currently have a closed stand structure (Steinke 2007ab, McCusker et al. 2012, 2014) with high canopy covers and densities that have reduced the understory forage productivity. However, there is generally sufficient vegetative ground cover to reduce accelerated erosion. Due to the closed stand structure, most strata are at a relatively high risk of active crown fire. Active crown fire poses a high risk of moderate or high burn severity to the watershed under normal or extreme fire behavior conditions.

Watersheds

Watershed Function

The project lies within 82 6th level watersheds (see appendix C, table 35 of the soils report). Fifth and 6th HUC names, watershed condition class, and acres within and outside of proposed treatment area (alternative B) are listed. The watershed condition framework protocol (USDA FS 2010a, 2010b) was used to classify watershed conditions at the 6th HUC level in spring of 2011, including 12 watershed indicators. The term “analysis area” refers to the larger 988,764-acre boundary.

Overall, the ponderosa pine vegetation type is dominated by functional at risk 6th HUC watersheds (about 451,500 acres, or 46 percent of the analysis area) with several impaired watersheds (about 316,800 acres, or about 32 percent of the analysis area) and a few properly functioning watersheds (about 220,400 acres, or about 22 percent of the analysis area) as defined by 12 indicators that were used to assess watershed condition through the watershed condition framework (USDA FS 2011). Watershed dysfunction in the treatment area is a result in large part from dense forests with fire regime condition classes of 2 or 3, and a high density of road networks that can alter hydrology, road proximity to streamcourses, and riparian condition.

The following 5th HUC watersheds have few to several 6th HUC watersheds in the impaired function condition class totaling at least 33 percent of total 5th HUC area: Cataract Creek Rio de Flag, Spring Valley, Sycamore Creek, Upper Cedar Wash, and Walnut Creek. Please see appendix C in the specialist report for detailed condition class by 6th HUC watershed and acres.

Water Quality and Quantity

Water Quality

The Arizona Department of Environmental Quality (ADEQ) 2006/2008 Impaired Waters List indicates there are no impaired streams within the project area. However, a segment of Oak Creek (Verde Watershed) that is approximately 0.25 miles outside of the project boundary and downstream of proposed treatment areas was listed as impaired for two exceedances of the Escherichia coli (E. coli) single sample maximum (SSM) water quality standard.

In 2010 ADEQ completed the Draft 2010 Status of Water Quality in Arizona 305(b) Assessment Report. The 2010 303(d) list for Arizona was approved by EPA and is now final. Oak Creek was again assessed as “not attaining”.

It is very likely that Oak Creek and West Fork Oak Creek will exhibit impaired conditions for the foreseeable future (i.e., at least 3 years and likely longer) as a result of the 2014 Slide Fire. Within the fire perimeter, approximately 3,115 acres (14 percent) burned at high severity, 7,067 acres (32 percent) burned at moderate severity, 10,415 acres (48 percent) burned at low severity, and 1,293 acres (6 percent) were unburned or burned at very low severity. Burned areas are on steep slopes along the Mogollon Escarpment and canyons above Oak Creek and West Fork Oak Creek. It is likely that large amounts of sediment and ash will be deposited in these stream channels and their associated tributaries during and after monsoon storms and during snowmelt. Impacts from the fire to the project are addressed in design features, direct, indirect and cumulative effects.

The potential for water quality contamination from mercury (as a result of prescribed fire emissions) was added to issue 1 as a result of comments on the DEIS. The ADEQ identified Upper and Lower Lake Mary as impaired for the presence of mercury in fish tissue. Although Upper and Lower Lake Mary are designated as domestic water sources, the levels of total mercury observed do not approach drinking water maximum contaminant levels. In 2002, the EPA added five lakes in the Lake Mary Region to Arizona’s 303(d) List as impaired for mercury in fish tissue. These lakes included Upper and Lower Lake Mary that are within the project area (ADEQ 2006, 2008).

Water quality sampling conducted by ADEQ indicate that inputs of mercury from tributaries are comparable among all of the lakes studied, indicating that in-lake processes and the fish species contained within each lake, play an important role in the bioaccumulation of mercury. ADEQ intends to continue fish tissue collection and bioaccumulation studies in the Lake Mary Region in hope of determining the specific factors leading to mercury methylation.

The ADEQ has concluded that watershed loading can potentially be reduced through management of sedimentation and vegetative stability. Recommendations included a review of upland and drainage conditions, so that areas requiring soil stabilization measures and channel improvements may be identified (ADEQ 2010).

Water Quantity

Water yields from the ponderosa pine vegetation type are likely reduced from historic conditions due to increased stand densities that result in higher evapotranspiration rates (Covington and Moore 1994).

Streamcourses

Approximately 2,197 miles of streamcourses occur within the 988,764-acre analysis area, of which approximately 8.2 miles exhibit perennial flow. The three perennial stream segments within the analysis area include the Rio de Flag, Pumphouse Wash, and Sawmill Wash. Appendix B in the water quality specialist report lists stream reaches and their associated lengths and flow regimes. The ephemeral streamcourses are classified as intermittent in the National hydrology data.

Riparian stream segments occur along 92.6 miles of streams within the analysis area. Of these, approximately 85.1 riparian miles (91 percent) occur on the Coconino NF and 7.5 riparian miles (9 percent) occur on the Kaibab NF. Appendix C in the specialist report provides a list of riparian areas by stream reach or name and their associated conditions within the analysis area. Within the analysis area, approximately 47.5 miles of streams are in proper functioning condition, 38.6 miles are functioning at-risk, and 6.6 miles are non-functional.

There are approximately 77.5 miles of protected streamcourses in the analysis area. These are areas where specific soil and water conservation practices (SWCP) and best management practices (BMPs) have been developed to prevent adverse impacts to streamcourses (see the soils and watershed section of appendix C). Appendix G in the specialist report provides a list of the protected streamcourses within the analysis area, their associated functional condition classes and lengths, and a map of the locations.

Wetlands, Riparian Areas, Springs, Flood Zones, and Road Influences

There are 66, natural lakes, reservoirs, and natural wetland depressions within the analysis boundary that impound water for a sufficient duration to exhibit some wetland characteristics; therefore, they are listed in the FWS National Wetlands Inventory database. See table 1 in appendix C of the water quality and riparian report for the list of riparian stream reaches in the analysis area, their associated lengths, and size and condition rating. Tables 1 and 2 in appendix D of the specialist report lists wetland habitats and their associated condition ratings.

There are approximately 145 springs located within the analysis area. Information regarding historic flow or water quality from these springs is minimal. Many springs exhibit downward trends or static-degraded conditions (MacDonald 2011). See chapter 1 for existing and desired condition information for springs and appendix D in the specialist report for the springs' assessment.

There are approximately 986,509 acres within the soils and watershed analysis area that are categorized into various flood zone types. Approximately 687,608 acres have been surveyed for presence of flood zones. See the specialist report for additional information on locations within the project area that are within the 100-year flood zone.

Many roads in the analysis area are inadequately engineered or poorly located on the landscape and are consequently in a state of disrepair. Roads located adjacent to drainage channels or on ridge tops and are subject to erosion and sediment transport. Roads near drainages are contributing to degradation of surface water quality during snowmelt and following short duration high intensity monsoon storms. Some roads have eroded to the point they are entraining sediment in the storm flow. Where stormwater flows down road surfaces, rills and gullies are compromising road surfaces and water quality. See the transportation section in chapter 1 for additional information on existing and desired road conditions.

Soil Productivity and Watershed Function

The units of measures used to compare each alternative include: (1) Acres and percent of soil disturbance by treatment type, 6^{th} HUC watershed and treatment area-wide, and, (2) acres of soil condition and productivity improved, maintained and protected and relative change in watershed function are the units of measure used to compare each alternative in this analysis.

Environmental Consequences

Soils and watershed environmental consequences are presented in both narrative and table format. All treatment acres are approximate. Total treatment acres in other specialist reports may be slightly different depending on GIS processing but are within about 200 acres or .03 percent.

Soil disturbance is summarized by treatment area and 6th HUC watersheds. A threshold of 15 percent aerial extent disturbance is assigned as a guideline where soil impairment and productivity may be appreciably reduced. Past direction from FSM 2509.18-91-1 (superseded by FSM 2550) suggested 15 percent as a threshold where soil productivity may be appreciably reduced. Current direction (FSM 2550) recommends the soil quality standard or threshold be set by the interdisciplinary team and the technical reference “Soil Disturbance Field Guide” (USDA FS 2009) recognizes the importance the extent of soil disturbance has on soil productivity.

Determining the soil disturbance threshold was based on past and current FSM direction, a review of the best available science, consultation with subject matter experts (Elliot, personal communication 2014), the soil disturbance protocol technical reference, and monitoring observations made in recent hazardous fuel reduction projects. The project’s interdisciplinary team determined that the 15 percent guideline is an appropriate threshold where soil disturbance at or below will likely maintain soil productivity. Previous observations and BMP monitoring indicate that the extent of soil disturbance less than about 15 percent adequately protects soil productivity. Evidence of onsite accelerated erosion has not been observed to be present in the form of rills and gullies and any soil compaction did not contribute to accelerated erosion when minor in extent (less than about 15 percent). Elliot (Elliot personal communication 2014) and Bolton and Ward (1991) states that as long as vegetative ground cover is greater than about 60 percent, erosion is minimized, accelerated erosion does not occur and soil productivity is maintained. Therefore, soil disturbance less than about 40 percent and the project’s conservative threshold of about 15 percent should adequately protect soil from accelerated erosion and soil loss. Total treatment acres are about 583,000 acres for Alt. B, 586,000 for Alt. C and 563,000 for alternative D and 581,000 for alternative E.

Table 36 displays potential soil disturbance by alternative for treatment areas and affected 6th code HUC watersheds. Table 37 displays the potential for soil erosion (percent) above the tolerable soil loss threshold.

Table 36. Soil disturbance and erosion by treatment area, 6th-code watershed and alternative

Indicator	Acres and Percent of Treatment Area					Percent of 6th-code Watershed				
	A	B	C	D	E	A	B	C	D	E
Soil disturbance from mechanical activities (acres and percent)	0	54,488 9.3%	59,647 10.2%	54,368 9.6%	52,361 9.1%	0	2.7	2.9	2.7	2.6
Soil disturbance from potential high-severity burns (acres and percent)	0	11,667 2%	11,724 2%	3,569 0.6%	11,620 2%	0 to 33	0.6	0.6	0.2	0.6
Total average soil disturbance from high-severity burns and mechanical (acres/percent)	0 0 to 33	66,155 11.3%	71,371 12.2	57,937 10.3	64,252 11.1	0	3.3	3.5	2.9	3.2
Soil disturbance from mechanical activities and high-severity fire (acres and percent ranging from low to high)	0 to 33%	2.1-18.3	2.5-19.2	2.1-16.3	2.3-18.4	0.1 to 31.2	0.1-11.3	0.1-11.5	0.1-9.7	0.1-10.8

Table 37. Treatment area potential (percent) soil erosion above tolerable soil loss threshold

Indicator	Alternative A Percent of Treatment Area	Alternatives B, C, D, and E Percent of Treatment Area
Potential soil erosion above tolerable levels when 33 percent of soils is severely burned	9	Up to 2 (post-treatment)
Potential soil erosion above tolerable levels when all (100 percent) of soils are severely burned	24	Up to 2 (post-treatment)
Soil erosion above tolerable levels from mechanical activities	0	0

Alternative A – Direct and Indirect Effects

Alternative A proposes no 4FRI treatments but on-going treatments (per implementation of forest plans) would continue. Mechanical and prescribed fire treatment acreage would be much less than all other alternatives so soil disturbance would be less than all other alternatives.

However, treating far fewer acres compared to all other alternatives would result in much more detrimental soil disturbance (up to 33 percent of untreated acres) from effects of uncharacteristic wildfire previously described. Where ongoing acres are treated, soil condition, soil productivity, soil and watershed function would improve but acres treated would be far less than all other alternatives so landscape-wide, implementation of Alternative A is the least effective alternative at improving and protecting soil productivity and watershed function within the 4FRI project area

In alternative A (table 41, above) about 9% of the treatment area would erode above tolerable soil loss thresholds at 33% high severity or 24% at 100% high severity posing substantial risk to soil productivity. Implementation of Alternative A would not improve or maintain soil productivity except in those minimal acres from on-going treatments not proposed in 4FRI but implemented through the forest plans.

Direct and Indirect Effects Common to Alternatives B through E

- Average soil disturbance from mechanical and prescribed fire treatments at the watershed level would be less than 4 percent and less than 12.5 percent at the treatment level which is much less than the established soil productivity threshold of 15 percent .Therefore, implementation of alternatives B through E should maintain long-term soil productivity.
- Alternatives B, C, D and E (soils and watershed report, attachment 1) have a few treatment areas in watersheds where soil disturbance would be above 15 percent but less than 20 percent located in some of the following watersheds (depending on alternative), Government Canyon, Juan Tank Canyon, Curley Wallace Tank, Sinclair Wash, Yeager Draw, Big Springs, Fry Canyon, Volunteer Wash, Walnut Creek-Upper or Lower Lake Mary, Government Prairie, Sawmill tank, and Telephone Tank. Most of these watersheds have few acres proposed for treatment and are minor in extent. Treatments are not expected to pose a risk to overall soil productivity at the treatment level.
- Not all ground disturbing treatments would occur in the same year and soil disturbances represent all treatments implemented the first year as the worst case scenario of disturbance. Prescribed burning would occur after year one and some treatments may be staggered in time and place allowing time enough for the soil to begin dropping pine needle cast and recover.
- Within about 2 years following treatment, areas of soil disturbance routinely would appear to be newly covered with pine leaf duff preventing accelerated erosion and runoff in the short and long term. Implementation of identified soil and water BMPs (see appendix C) adequately protects soil from accelerated erosion and runoff that could affect water quality.
- With implementation of identified soil and water BMPs, ADEQ water quality standards would be met.
- Approximately 496 miles of road would be decommissioned in functioning at risk watersheds, and 226 miles of roads of roads located in impaired function watersheds resulting reduced the hydrologic connectivity between roads and steams and improved water quality. Implementation of identified BMPs is expected to mitigate accelerated erosion, and possible elevated sediment transport to connected streamcourses so as not to pose a risk to

downstream water quality. This is especially true for the road segments that are scheduled to be reconstructed.

- Stream channel treatments would improve water flow regime on 19 miles of functioning at risk and 9 miles in impaired watersheds. This equates to 0.1 percent soil disturbance in the treatment area. Implementation of BMPs is expected to mitigate accelerated erosion, and possible elevated sediment transport to connected streamcourses reducing risk to downstream water quality.
- Restoration of fire adapted ecosystems would begin to occur and where watersheds are functional at risk or impaired, their condition can be expected to improve both in the short and long-term (greater than 2 years) maintaining or improving soil productivity and water quality. Alternatives would reduce the risks to life, property, soil productivity and water quality from post wildfire storm events (flooding and debris flows).
- Protective aspen fencing restoration activities are very limited and effects are not measurable at the treatment and watershed scale. Protective fencing is expected to improve aspen stand structure and spring functional condition and connected soils and would result in overall slight improvement of watershed condition.
- The design of additional adaptive actions identified for roads, springs, and ephemeral channels should assure soil condition and productivity is adequately protected. Additional actions would result in effects to soils similar to those already analyzed.

Short-term impacts from soil disturbances would range from 2.9 percent (lowest in alternative D) to 3.5 percent (highest in alternative C). All action alternatives provide long term soil improvement and protection of soil productivity and watershed function to varying degrees. Overall, implementation of the proposed action (alternative B) is expected to maintain, improve and protect long-term soil productivity and watershed function much better than alternative A, a little better than D and about the same as alternative C. 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 streamcourses 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.

In alternatives B through E no watersheds would have average soil disturbance above 11.5 percent (3.5 percent below the 15 percent soil productivity threshold). Therefore, soil productivity and watershed function should be maintained.

In alternative A, soil disturbance could range from 0 to 33 percent due to unmitigated fire risk which could result in substantial areas of high burn severity following wildfire leading to removal of protective vegetative ground cover. Slopes over 15 percent subject to high burn severity could result in accelerated soil loss where erosion rates are higher than tolerable soil loss posing risk to soil productivity and water quality from sediment delivery into connected streamcourses. Erosion exceeds tolerable soil loss rates where soils have been exposed to high burn severity predominantly in wildfires on slopes greater than 15 percent posing risk to soil productivity and sediment delivery to connected streamcourses. The highest amounts of high burn severity (predicted up to 33 percent) are more likely to occur where forests are untreated (Alternative A) than all action alternatives. There would be potential for high burn severity across more acres in alternative D that the other action alternatives because of the continuing accumulation of surface fuels (Lata 2014).

Paired Watershed Study Effects, Alternatives C and E

A paired watersheds study is proposed to evaluate the effects of vegetation treatment on water yield and water balance.

The total proposed soil disturbance for this study would be up to 2.4 acres, or, 004 percent of all soil disturbance if all instruments are implemented. It is probable that some components or instruments would not be implemented so total soil disturbance would be up to 2.4 acres. There are portions of three 6th HUC watersheds proposed for the study including Walnut Creek Upper Lake Mary, Middle Sycamore Creek and Big Spring Canyon (soils specialist report, attachment 5). There is one control watershed proposed for no treatment in each of the three 6th HUC watersheds totaling about 2,313 acres. Overall, not treating control watersheds reduces soil disturbance very minimally and less than 2 percent.

Not treating the much smaller control watersheds would slightly reduce soil disturbance by about 348 acres (between 0.5 to 2 percent) in the three 6th HUC watersheds. This would reduce the associated soil erosion and sediment delivery in the short-term (up to 2-3 years) after which protective duff quickly builds. Although there would be a little less soil disturbance in the short term, it would be very minor in extent and the amount of soil erosion and sediment that could be delivered into connected streamcourses is probably not measurable at the 6th HUC scale and is not connected to impaired, perennial waters.

The only measurable difference could be at the very fine scale where treated paired watersheds might delivery a little more sediment into drainages than control watersheds for the first couple of years until treated areas soils recover with protective pine needle duff. Due to the minor amount of soil disturbance expected in treated areas (generally 10 to 15 percent), the amount of sediment that might be delivered into streamcourses in the first 2 years is expected to be minimal. Furthermore, there are no treated areas directly connected to water that are impaired by total suspended sediments (prior ADEQ turbidity standard.

Alternatives C and E - Reduced Mechanical Treatment Intensity Effects on Soil Productivity, Water Quality and Watershed Function

Reducing treatment intensity on about 40,000 acres would not directly or indirectly pose risk to soil productivity, water quality or watershed function. With the implementation of identified soil and water BMPs, soil disturbance direct effects associated with treatments has already been shown not to exceed the 15 percent established soil productivity threshold. Reduced treatment intensity would not increase soil disturbance effects.. There would be no indirect, detrimental effects from uncharacteristic wildfire on soil productivity, water quality or watershed function due to the limited number of acres proposed and the size of the treatment stands. Stand size ranges from about 4 to 344 acres with an average of 35 acres. These acres are scattered across numerous 6^{th} HUC watersheds. Throughout the entire project footprint and all connected watersheds, only about 1,880 acres (with the largest single polygon amounting to only about 90 acres) would be at higher risk of uncharacteristic crown fires that could result in soil disturbance following post fire storm events (Lata 2014). These areas are small and disconnected allowing for maintenance of adequate vegetative ground cover that would trap and filter sediment reducing the magnitude of soil disturbance, accelerated erosion, sediment delivery, and reduced water quality, loss soil productivity and watershed function that could otherwise result from uncharacteristic fires associated with dense forests on much larger acreages.

The maximum number of acres in any 6th HUC watershed that could result in increased fire risk due to reduced fire intensity treatments is in RMU 6-3 (646 acres, Lata 2014) which is roughly equivalent to the Coconino Wash Headwaters 6th HUC watershed. For both alternatives, C and E, the total number of acres in the watershed is 51,193 with soil disturbance predicted at the watershed scale from originally proposed EIS treatments of 6.1 percent and 8.7 percent for cumulative effects. Reducing treatment intensity could result in a very slight increase in soil disturbance and would raise soil disturbance from EIS disturbance from 6.1 percent to 7.4 percent while total disturbance from cumulative effects would increase from 8.7 percent to 9.9percent for both alternatives at the watershed scale. It is highly doubtful that this slight increase would result in measurable sediment delivery to connected perennial waters downstream. All other 6th HUC watersheds would have substantially less additional disturbance or fire risk because fewer acres would have reduced mechanical treatment reduction.

In summary for all 6th HUC watersheds, reducing treatment intensity on about 40,000 acres would still result in soil disturbance less than the 15 percent established threshold and therefore, soil productivity and watershed function is expected to be maintained.

Comparison of Alternative Effects

Overall, implementation of the proposed action is expected to maintain, improve and protect long-term soil productivity, and watershed function much better than Alternatives A and D, a little better than E but not as well as C. Implementation of alternative C would probably better restore grasslands than other action alternatives and still has about the same amount of soil disturbance treatment area wide and at the 6th HUC watershed level. Implementation of Alternatives B, C and E 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.

Water Quality and Water Yield

Water quality units of measure are: (1) acres of soil disturbance that exceed tolerance thresholds, (2) acres subjected to high-severity burn, (3) acres of ephemeral streamcourses restored, and (4) number of springs restored. The units of measure for water yield are: (1) increases in stream flow as measured at downstream gaging stations and (2) increases in snowpack retention as measured at SNOTEL sites and snow courses. For this analysis, short term equated to 1 to 2 years and long term is 5 years or more.

Alternative A –Direct and Indirect Effects

There would be no direct changes to surface water quality. There would be no additional acres of ground disturbance from project-related mechanical vegetation treatments, roads, and the use of prescribed fire. Since these activities can have short-term adverse effects to water quality and riparian areas, the alternative poses fewer short-term risks to water quality and riparian areas than the action alternatives.

However, roads that are currently contributing to loss of soil productivity and degradation of water quality would continue contributing to soil destabilization, loss of productivity, and adverse impacts to surface water quality. Ongoing road maintenance of ML-2 and ML-3 roads within the project area would continue as it has in the past.

Adverse effects to water quality, quantity, and riparian condition are possible from high-severity wildfire. Soil erosion models indicate that approximately 24 percent of all soils left untreated could be subject to soil erosion above tolerable levels from severe wildfires if all soils burned under condition of high burn severity. There would be potential to increase flood flows of sediment and debris-laden storm water in streamcourses within and downstream of burned areas. These conditions would adversely affect riparian areas along streamcourses through deposition of large amounts of sediment and debris with the potential to damage or overwhelm riparian systems. Long-term risk to water quality and riparian areas would be greatly increased under the no action alternative.

A high severity wildfire within the Lake Mary Region would result in atmospheric deposition of mercury within and beyond the Lake Mary Region. The resulting soil hydrophobicity would increase stormwater runoff and delivery of mercury-containing sediment to water bodies in the Lake Mary Region.

Water yield originating from the ponderosa pine vegetation type would continue to decline as a result of forest ingrowth that increases stand density. Increased stand density would result in a corresponding increase in interception of precipitation and evapotranspiration by trees, both of which would reduce soil moisture.

Alternatives B through E – Effects in Common

- Temporary roads would be constructed using BMPs and SWCPs and would minimize adverse effects to surface water quality. No riparian areas would be adversely affected by temporary road construction as no temporary roads are proposed within riparian areas.
- Approximately 30 miles would be improved to allow for haul (primarily widening corners to improve turn radii) and about 10 miles of road would be relocated out of stream bottoms. Relocated roads would include rehabilitation of the moved road segment. These practices would improve water quality and riparian area conditions by removing roads from stream bottoms where they do not belong and where they represent a direct and recurring threat to water quality through increased sediment and nutrient delivery and turbidity.
- Through reduced threat of uncharacteristic fire behavior and implementation of design features, BMPs, and mitigation measures as described in appendix C of this FEIS, mercury levels in water bodies of the Lake Mary Region are not expected to increase. Specific BMPs that would minimize or mitigate potential for mercury to be mobilized in sediment and delivered to water bodies include: FE2, FE3, FE5, FE6, FE8, FE9, R6, SW1, SW2, SW6-SW37, T3, T7, and T8 (see appendix C).
- Water yield would be expected to increase only slightly in areas where vegetation treatments remove from 25 to 50 percent of the overall tree canopy cover within a given watershed (Troendle et al. 2001, Burton 1997, Swank 1989, Baker 1999, 2003, Ffolliott et al. 1989, Miller 2007). Snow interception by tree canopies would be reduced, leading to increased snowpack in forest openings.
- Minor, short-term changes (1 to 2 years) in water quality are possible in water bodies adjacent to or downstream from mechanical vegetation treatments, areas subjected to prescribed fire, areas of temporary road construction and decommissioning, and where stream channel restoration activities are conducted. Long-term (5 or more years) surface water quality is expected to improve through more resilient forest conditions that minimize uncharacteristic fire behavior and through improved vegetative ground cover that minimizes soil erosion and sediment transport to connected streamcourses and other water bodies

- BMPs and SWCPs as outlined in appendix C of this FEIS would minimize or mitigate most adverse effects to water quality or riparian areas at the site-specific or localized scale.

Alternatives B through E – Direct and Indirect Effects

Ephemeral and intermittent drainages in the project area typically respond to seasonal runoff events (spring snowmelt and short duration, high-intensity summer monsoon storms). Surface runoff has the potential to entrain sediment and other pollutants, contributing to short-term surface water quality degradation. Sediment delivery ratios normally decline with increasing watershed area, resulting in dilution of sediment delivered to streams from a given activity.

In alternative B and C soil disturbance (that could adversely affect water quality) at the 6th code HUC would range from 3.3 percent to 3.5 percent and range from 0.1 to 11.5 percent across the treatment area. Overall change would not likely be detectable at the landscape (project-wide) scale. Alternative D would result in the lowest level of soil disturbance (2.9 percent at the 6th code HUC scale). However, it would not meet the purpose and need of achieving resilient forest conditions that promote high surface water quality (through protection of forested ecosystems from uncharacteristic fire effects). Restoration of natural fire regimes to fire-dependent landscapes and vegetation types would not occur under in alternative D. Alternative E is similar to B and C with total soil disturbance estimated at 10.8 percent. In this alternative, the distribution and types of disturbances would vary in space, and are expected to be less in Mexican spotted owl PACS. However, differences in changes to water quality when compared to alternatives B and C would not likely be detectable at the landscape scale.

It is unlikely that any action alternative would contribute enough sediment or other pollutants to ephemeral or intermittent drainages within the project area to result in impairment of any downstream waterbodies. With implementation of identified soil and water BMPs, ADEQ water quality standards would be met.

In alternative A, water yield continue to decrease as stand density increases. 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.

Springs, Riparian, and Wetland Function

The units of measure for springs are: (1) initiation of spring discharge from springs that currently do not flow and (2) increases in spring discharge from currently flowing springs following restoration treatments. The unit of measure for riparian and wetland function is soil erosion above tolerance and areas of high severity fire

Alternative A – Direct and Indirect Effects

There would be no restoration of springs and no restoration of ephemeral channels. These areas would continue to exhibit downward trends in functional condition or remain in static condition for the foreseeable future. Reduced riparian area and wetland function would be possible. Ongoing reductions in water yield from the ponderosa pine vegetation type would decrease moisture reaching riparian areas since spring discharge rates would be further reduced and water would not reach streamcourses or recharge shallow or perched aquifers.

Direct and Indirect Effects Common to Alternatives B through E

- Riparian and wetland function are expected to improve through increased groundwater recharge and improved surface flows as a result of stand density reduction and short-term reductions in vegetative ground cover following prescribed fire.
- Restoration of 74 springs has the potential to increase riparian vegetation and wetland function of these springs, depending on existing spring condition and type of restoration activities.
- Decommissioning of roads that have altered flow patterns through increased drainage density (i.e. road ditches that intercept water and lead-out ditches that discharge concentrated ditch flow onto the forest floor) or redirected stormwater runoff (i.e., roads and ditches that intersect streamcourses and discharge stormwater runoff directly to streamcourses) would improve overall watershed hydrology, thus improving water flow to riparian ecosystems.
- Restoration of grassland ecosystems through removal of encroaching trees would improve hydrologic function in meadow ecosystems, potentially increasing riparian vegetation in these areas.
- In the 7,884 areas affected by the Slide Fire, additional soil and water BMPs (see appendix C) should improve vegetative recovery and reestablishment in uplands and streamside management zones. These BMPs would improve sediment capture in the vegetative ground cover and prevent entrainment and transport of sediment to streamcourses, including Oak Creek. Proposed restoration treatments do not pose an increased risk to water quality when recommended Slide Fire BMPs are implemented. Water quality is expected to meet designated beneficial uses and state water quality standards within the 4FRI project area.

Alternatives B through E

Direct and Indirect Effects

More acres would be subjected to low severity prescribed fire in alternative B than alternatives C, D, and E. Low severity prescribed fire reduces rainfall interception and evapotranspirational losses due to short-term reduction in vegetative cover. Alternative C would result in the most acres of mechanical forest thinning. In alternative D, riparian and wetland function are expected to improve, but to a lesser degree than under alternatives B and C since fewer acres would be subjected to prescribed fire which would otherwise reduce vegetative cover and therefore rainfall interception and evapotranspirational losses. In alternative E, there would be more acres of mechanical thinning than alternative B and D but fewer acres than proposed in alternative C. Reduced stand densities could result in short-term increases in water yield from treated areas and therefore improved riparian and wetland function in downstream areas.

Soil and Water Cumulative Effects

The spatial boundary for the soils and watershed cumulative effects analysis is defined by 82 6th HUC watersheds that total about 2,032,000 acres (see appendix C of the soils specialist report). The temporal timeframe for past actions is 2 to 3 years based on vegetative and course woody debris recovery of the site. Vegetative recovery after fuel treatments is generally very rapid, with erosion rates typically dropping to pre-fire levels within 1 to 2 years (Elliot 1996, 2000).

Relative to soils and watershed, there are about 45,000 acres of baseline ground disturbance from roads, private land, grazing allotments, and powerline corridors that occur across the cumulative effects analysis area (see appendix F). The total acres of past, present are future and foreseeable treatment acres within the cumulative effects project area are roughly 290,000 acres (133,000 acres of past and present projects and 157,000 acres of future, foreseeable projects) or about 14 percent of the cumulative boundary area. Of these treatment acres, there would be a predicted about 15 percent of these acres would have ground disturbance, or about 43,500 acres. Approximately 2 percent of the cumulative effects analysis area is expected to have ground disturbance from past, present and future or foreseeable projects. The project would add about 64,200 acres of ground disturbance across the cumulative effects analysis area. The total acreage of disturbed ground would be about 152,800 acres, or about 7.5 percent of the cumulative effects boundary area (see table 38).

Approximately 7,884 acres of restoration treatments are proposed within the Slide Fire perimeter under all action alternatives. Quantitative sediment delivery rates within the Slide Fire were modeled using the Erosion Risk Management Tool (ERMiT), a WEPP modeling application developed by the USFS Rocky Mountain Research Station (USFS, RMRS GTR 188, April 2007). This modeling tool was developed specifically for use with post-fire erosion modeling. Overall, erosion outcomes will depend upon what summer monsoon patterns brings in terms of rainfall amount and intensity for the next 3 to 5 years. A summary of erosion estimates is presented in Table 10 of the water quality and riparian report. Erosion rates are expected to decline each year as revegetation and natural recovery processes occur. Soil erosion would decrease soil productivity through nutrient losses which prolong vegetative recovery, depending upon the amount of soil loss.

Alternative A

The no action alternative would result in no vegetation or fuels reduction treatments being performed, no new temporary road construction, no road obliteration, no unscheduled maintenance of existing roads, no restoration of springs or ephemeral channels, and no prescribed burning within the project. Therefore, there would be no cumulative effects to water quality, ephemeral or intermittent stream channels, watershed condition, or changes to water yield resulting from the alternative. However, land management activities and changing vegetative conditions throughout the last 100 years have produced an uncharacteristic accumulation of fuels and increased tree density throughout much of the project area. These conditions make wildfire a possibility and suppression difficult.

A high severity wildfire within the Lake Mary Region (LMR) would result in atmospheric deposition of mercury within and beyond the LMR. The resulting soil hydrophobicity would increase stormwater runoff and delivery of mercury-containing sediment to water bodies in the LMR. Through reduced threat of uncharacteristic fire behavior and implementation of design features, BMPs, and mitigation measures as described in appendix C of this FEIS, mercury levels in water bodies of the LMR are not expected to increase.

Alternatives B, C, D and E

In alternative C, D and E, the baseline ground disturbance and past, present, and foreseeable activities are the same as described in the introduction. Alternative B would add an additional about 66,155 acres of ground disturbance from treatments for a total acreage across the cumulative effects analysis area of 162,241 acres or about 8 percent. Alternative C would add an additional about 71,371 acres of ground disturbance from treatments. The total acreage across the cumulative effects analysis area would be about 167,458 acres, or about 8.2 percent of the cumulative effects boundary area. Alternative D would add roughly an additional 57,937 acres of ground disturbance from 4FRI treatments. The total acreage across the cumulative effects analysis area would be about 154,023 acres, or about 7.6 percent of the cumulative effects boundary area.

Alternative E would add about 64,252 acres of ground disturbance for a total acreage of about 160,388 or about 7.9 percent.

In alternatives B, C, D and E, further protection of soil and water resources would be provided by the use of best management practices that minimize the potential for soil disturbance. Identified and implemented BMPs are expected to reduce the risk on accelerated erosion, sediment delivery, and nonpoint source pollution to connected streamcourses and maintain water quality in all watersheds. In addition to the use of BMPs, the completion and implementation of the Travel Management EIS would further reduce the number of acres disturbed by closing and decommissioning roads within the cumulative effects boundary. Because of these facts, this alternative would not provide a detrimental cumulative effect to soil resources within the cumulative effects boundary.

In alternatives B, C, D and E, there are six 6th-code watersheds where urban development has a large impact on ground disturbance areas. This project, plus current and future foreseeable projects impacts these watersheds in the following manner. In the Cataract Creek Headwaters watershed there was a 9 percent past, present and future project generated ground disturbance prior to any activities. This percent of ground disturbance increases to 15 percent total cumulative ground disturbance. In the Sinclair Wash watershed, there was a 12 percent past, present and future ground disturbance prior to any activities. This percent of ground disturbance increases to 26 percent total cumulative ground disturbance with all projects, current and foreseeable projects. In the Lower Rio de Flag watershed there was an 8 percent past, present and future project generated ground disturbance that increases to 21 percent total cumulative ground disturbance. In the Middle Oak Creek watershed, there was a 7 percent past, present and future project generated ground disturbance that increases to 11 percent total cumulative ground disturbance. Pumphouse Wash watershed has about 11 percent contributions from past, present and future projects and about 6 percent from the project. Upper Rio de Flag watershed has about 14 percent contribution from past, present and future projects and extra about 3 percent from the project. Implementation of BMPs would minimize any impacts to watersheds, and would be especially important in the watersheds that have a high urban impact already existing.

Summary

Total past, present and reasonable foreseeable actions contribute about 4 percent more ground disturbance to project treatments (average landscape, watershed level-wide by alternative). Total soil disturbance (cumulative effects and project treatments) would range from 7.6 percent (alternative D) to 8.2 percent (alternative C), with alternative B predicted at 8.0 percent and alternative E at 7.9 percent (table 38). The overall extent (around 8 percent for all action alternatives) and magnitude (2 year recovery time) of total ground disturbance is minimal, short term and much less than the 15 percent soil productivity threshold indicating soil productivity would be maintained at the watershed level along with watershed function.

Table 38. Total cumulative effects analysis area 6th-code (acres) by alternative

Effects Indicators	Alternative B	Alternative C	Alternative D	Alternative E
Total Cumulative Effects Analysis Area 6th Code (acres)	2,032,080	2,032,080	2,032,080	2,032,080
Proposed Ground Disturbance (acres)	66,155	71,371	57,937	64,252
Percent of 6th Code Acres Disturbed	3.3	3.5	2.9	3.2
Baseline Conditions				
Baseline Ground Disturbance (acres)	45,041	45,041	45,041	45,501
Total Treatment (acres)	157,505	157,505	157,505	157,505
Future Conditions				
Total Treatment (acres)	157,772	157,772	157,772	157,772
Total Ground Disturbance (acres)	23,666	23,666	23,666	23,666
Current/Ongoing Conditions				
Total Treatment (acres)	154,720	154,720	154,720	154,720
Total Ground Disturbance (acres)	27,380	27,380	27,380	27,380
Project Totals				
Total Cumulative Effects Ground Disturbance (acres)	162,241	167,458	154,023	160,388
Total Cumulative Effects Ground Disturbance (Percent)	8.0	8.2	7.6	7.9

Coconino NF Forest Plan Amendments

Alternatives B and D

Amendment 1 would result in removal of more trees in 18 Mexican spotted owl PACs since trees up to 16 inches d.b.h. could be removed in these areas. Increased vegetative ground cover would improve soil stability by reducing soil erosion rates. Reduced stand densities would also provide for improved protection of treated areas from the high-severity fire effects, further improving overall soil stability and watershed conditions. Reduced evapotranspiration resulting from removal of trees up to 16 inches d.b.h. would likely improve soil moisture status. With implementation of measures outlined in appendix B of this FEIS, adverse effects to water quality and riparian function would be minimized. Overall, these effects would provide greater protection of water quality and riparian areas by reducing the potential for sediment delivery to streamcourses and riparian habitats, improving soil moisture in upland areas, and improving snowpack retention in treated areas.

Without implementation of amendment 1, maintenance of soil productivity and therefore water quality and riparian conditions would not be to the level provided through implementation of the amendment. There would be 18 Mexican spotted owl PACs that would remain at risk of high-severity fire which could degrade soil stability and productivity increasing the risk of adverse effects to water quality and riparian function. Without implementation of this proposed amendment, soil productivity and watershed function, including downstream water quality, would remain at risk from high-severity wildfire effects and pose risk to the sustainability of PACs, core areas, restricted habitat and threshold habitat. Deferring monitoring (and incremental treatment of habitat) of Mexican spotted owl to the FWS biological opinion would not affect water quality or riparian areas on the Coconino NF since no activities would occur that have potential to adversely affect these resources.

Amendment 2 would improve soils and watershed conditions on 28,952 acres (alternatives B, D) and 28,653 acres (alternative C) within the Coconino NF since these treatment areas would be returned to open stand condition representative of historic or reference condition. The increased interspaces would likely improve snowpack retention and therefore, soil moisture status. Lower stand densities would provide greater protection of soils and watershed resources in treated areas from high severity fire effects. These conditions would improve water quality and riparian area conditions by reducing sediment delivery to streamcourses and riparian areas.

Implementation of measures outlined appendix C of this FEIS would minimize or mitigate any adverse effects to water quality and riparian function. Without implementation of amendment 2, approximately 28,952 acres in alternatives B and D and 28,653 acres in alternative C on the Coconino NF would remain at an elevated risk of high-severity effects from wildfire. If such a fire were to occur, surface water quality would likely be adversely affected through increased sediment deliver and turbidity. Sediment delivery to riparian areas could degrade riparian function.

Amendment 3 is intended to ensure that no adverse effects occur to significant, or potentially significant, inventoried heritage sites. Without implementation of amendment 3, adverse effects to inventoried heritage sites, and therefore soil stability could occur. If soils are destabilized, sediment delivery to connected streamcourses and riparian habitats could occur.

Alternative C

Coconino NF

Amendment 1 would have similar effects as amendment 1 under alternative B. However, under this alternative, soils and watershed resources would be further improved in 54 Mexican spotted owl PAC core areas as a result of reintroduction of low-severity prescribed fire to these PACs. Reduced stand densities followed by improved vegetative ground cover would increase fine root biomass of grasses, forbs, and shrubs that protect soils from erosion. Reintroduction of low-severity fire would improve nutrient cycling and increase understory vegetative vigor. These conditions would improve water quality and riparian area conditions by reducing sediment delivery to streamcourses and riparian areas.

Overall, amendment 1 under alternative C would provide greater improvement in water quality and riparian health that under alternative B. Without implementation of this proposed forest plan amendment, reintroduction of low-severity prescribed fire would not occur in 54 Mexican spotted owl PAC core areas, leaving soils and watershed resources at risk of uncharacteristic wildfire that could damage soil stability and productivity and therefore adversely affect surface water quality and riparian area conditions.

Mechanical vegetation treatments within the 6,299 acres of Mexican spotted owl restricted habitat (target/threshold) to achieve a residual basal area ranging from 110 to 150 square feet would improve soils and watershed conditions and therefore water quality by reducing stand densities that are otherwise conducive to high-severity fire effects. Vegetative ground cover would improve in these areas, reducing soil erosion potential and protecting surface water quality.

Deferring monitoring (and incremental treatments of habitat) of Mexican spotted owl to the FWS biological opinion would not affect water quality or riparian areas on the Coconino NF since no activities would occur that have potential to adversely affect these resources.

Amendments 2 and 3: The effects under alterative C would be the same as those described under alternative B even though amendment 2 has slightly different acres (28,653 acres).

Forest Plan Consistency and Movement toward Project Purpose and Need for Soil and Water Resources

Coconino NF Forest Plan: For those projects that get implemented in alternative A, the alternative would be consistent with the water quality related guidelines for soils and watershed management since future projects would incorporate site-specific BMPs and SWCPs in accordance with the national best management practices for water quality management. However, in the absence of restoration treatments (A) vegetative ground cover in dense ponderosa stands would not improve, but remain static. Additionally, soils conditions would not be improved in areas where springs restoration, ephemeral channel restoration, road decommissioning, and aspen fencing are proposed. Soils conditions would likely remain static or could trend downward over time. Where soil erosion is not minimized (e.g., ephemeral channels that exhibit downcutting, incision, or aggradation), alternative A would not be consistent with desired conditions for soils.

All action alternatives are consistent with Coconino NF forest plan components for soils and watershed management since they include treatments aimed at maintaining soils in satisfactory condition or improving soils in unsatisfactory condition. In addition, implementation of site-specific BMPs and SWCPs, see FEIS, appendix C, would maintain or improve soil condition, long term soil productivity and watershed function. However, the action alternatives would be consistent with desired conditions for soils to varying degrees. While alternative A and D would generally be consistent with desired conditions for soils as described above, the risk of uncharacteristic high-severity wildfire would remain in many areas since forest restoration treatments would not be implemented at the same scale as proposed under the action alternatives (B and C). The absence of prescribed fire in most portions of alternative D would elevate the risk of uncharacteristic wildfire that could lead to large areas of high burn severity.

Reduced stand densities and fuel loads would decrease the risk of uncharacteristic fire which typically results in increased soil erosion and long-term loss of soil productivity. Uncharacteristic fire also typically increases soil hydrophobicity, which affects the ability of soils to infiltrate, transmit and store water. Spring and ephemeral channel restoration has the potential to restore hydric (wetland) soil conditions where the frequency or duration of surface inundation or saturation is increased. Improved vegetative ground cover in treated areas would also contribute to improved soil porosity, aggregate stability, organic matter content, nutrient cycling, and carbon sequestration. Decommissioning of roads within the project area would improve soils on these sites. Installation of protective aspen fences would exclude domestic livestock and wildlife ungulates from aspen stands, thereby improving soil conditions in protected areas. Implementation of BMP s and SWCPs (FEIS appendix C) would minimize or mitigate potential adverse effects of treatment activities on soil productivity.

Kaibab NF Land and Resource Management Plan: Under the revised Kaibab National Forest plan, all action alternatives would be consistent with desired conditions for soils and watershed management. All action alternatives are consistent with guidelines for soils since they include implementation of site-specific BMPs and SWCPs, see FEIS, appendix C.

For those projects that would be implemented in alternative A, they would also be consistent with the guidelines for soils and watershed management since future projects would incorporate site-specific BMPs and SWCPs in accordance with the national best management practices for water quality management. However, alternative A would not contribute to desired conditions for soils, wetlands and springs within the KNF portion of the project area as it does not include restoration of native vegetation and natural water flow patterns on at least 6 acres of wetlands within 5 years of plan approval as outlined in the objectives for wetlands/cienegas.

In alternative A risk of uncharacteristic high-severity wildfire would remain in many areas since forest restoration treatments would not be implemented at the same scale as proposed under the action alternatives. In the absence of restoration treatments, herbaceous vegetation composition and productivity in dense ponderosa stands would not improve, but remain static and soil nutrient cycling function would continue to decline. Additionally, soil conditions would not be improved in areas where springs restoration, ephemeral channel restoration, road decommissioning, and aspen fencing are proposed. Soil conditions and productivity would likely remain static or could trend downward over time. Where soil erosion is not minimized (e.g., ephemeral channels that exhibit downcutting, incision, or aggradation), alternative A would not be consistent with desired conditions for soils.

Proposed treatments (alternatives C through E) would reduce tree stand densities and fuel loads would decrease the risk of uncharacteristic fire which typically results in large areas of high burn severity, increased soil erosion, short and long-term loss of soil productivity, and high amounts of sediment delivery into connected streamcourses. Uncharacteristic fire also typically increases soil hydrophobicity, which affects the ability of soils to infiltrate, transmit and store water. Spring and ephemeral channel restoration has the potential to restore hydric (wetland) soil conditions where the frequency or duration of surface inundation or saturation is increased. Improved vegetative ground cover in treated areas would also contribute to improved soil porosity, aggregate stability, organic matter content, nutrient cycling, carbon sequestration and organic ground cover and herbaceous vegetation important for soil protection. Decommissioning including temporary roads and relocation of roads within the project area would improve and protect soils and soil productivity on these sites. Installation of protective aspen fences would exclude domestic livestock and wildlife ungulates from aspen stands, thereby improving soil conditions in protected areas. Implementation of BMP s and SWCPs would minimize or mitigate potential adverse effects of treatment activities on soil productivity.

All action alternatives include restoration of 74 springs and up to 39 miles of ephemeral channels within the project area, which is consistent with desired conditions for soils and wetlands as outlined in the Revised LRMP. Exclosure fences, where warranted, would prevent adverse effects of human activities and vertebrate herbivores (including domestic livestock); such adverse effects include soil disturbance and compaction, riparian vegetation trampling and removal, and defecation near spring sources, etc.). Implementation of BMPs and SWCPs as outlined would minimize and mitigate potential adverse effects to soil productivity and water quality from proposed restoration activities.

In addition to spring and ephemeral channel restoration, relocation of approximately 10 miles of roads out of stream bottoms would have potential to improve cottonwood-willow riparian forest conditions by eliminating soil compaction resulting from road use in stream bottoms. Thinning of adjacent stands of dense ponderosa pine would reduce high fuel loads and would protect cottonwood-willow riparian forests from uncharacteristic fire behavior that could lead to high burn severity, accelerated erosion and loss of soil productivity. Additionally, proposed watershed research included in alternatives C and E would inform future management toward achieving desired conditions for soil s and wetlands within the KNF portion of the project area.

Vegetation

The vegetation analysis is summarized from the silviculture specialist report. The report is incorporated by reference (McCusker et al. 2014). The analysis is focused on determining whether, or to what degree, the project meets purpose and need objectives. It responds to two issues: Issue 2, conservation of large trees, and Issue 3, post-treatment canopy cover and landscape openness.

To address Issue 2, the analysis provides a quantitative pre-treatment and post-treatment three-level analysis for Mexican spotted owl, goshawk, old growth, and vegetation structural stage (VSS) for goshawk habitat at the landscape scale (ponderosa pine vegetation type) to gauge movement toward restoration desired conditions. To address Issue 3 the analysis discloses tree group stocking guides that would be used to meet tree group canopy cover requirements and evaluates the following within goshawk habitat: pre- and post-treatment distribution of habitat structure, overall habitat structure (VSS class), forest density metrics, and openness. See the silviculture report for the complete methodology, assumptions, and limitations discussion.

Changes from the Draft Environmental Impact Statement

New Forest Plan: Between the time the data collection, data gap analysis, data analysis, and DEIS was completed and the FEIS was started the Kaibab National Forest completed and signed their new forest plan in 2014. All of the data analysis for this report was completed under the guidance of the older Kaibab and still current Coconino forest plan (1987, amended). All sections, alternative discussions, tables, and summaries were updated to reflect the changes in the new Kaibab Land and Resource Plan (2014). Discussions about how the different forest plans affected the outcomes of the various treatments and alternatives were developed. Consistency is shown for this project with the Coconino forest plan and the new Kaibab forest plan (2014).

New Mexican Spotted Owl Recovery Plan: Between the DEIS and FEIS the U.S. Fish and Wildlife Service published a revised Mexican Spotted Owl Recovery Plan (USDI FWS 2012). All sections, alternative discussions, tables, and summaries were updated to reflect the changes in the revised plan. A crosswalk was developed to show consistency between the 1995 recovery plan and the revised 2012 recovery plan (see wildlife specialist report). The Coconino NF forest plan (1987) still references the 1995 recovery plan. The Kaibab NF forest plan references the most current recovery plan. Consistency is shown for this project addresses both the 1995 and 2012 recovery plan.

New Alternative (E): As a result from public input a new alternative (E) was developed. The discussion, figures, and tables under “Summary of Alternatives” were all expanded to include alternative E. Alternative E was developed as a restoration treatment without the use of proposed plan amendments. Without amendments, there is no clear plan direction for the development of groups and interspaces. Discussions are a reflection of this difference.

Old Growth: Between the time of the DEIS and the FEIS the Kaibab NF released a new forest plan (USDA FS 2014). Discussions within this report cover the changes in the new plan and their impacts, outcomes, and consistency with project stated purpose and needs. The Coconino NF requires “Until the forest plan is revised, allocate no less than 20 percent of each forested ecosystem management area to old-growth…”; however, the Kaibab forest plan does not allocate old growth. The Kaibab NF defines old growth: “Old growth in southwestern forested ecosystems is different than the traditional definition based on northwestern infrequent fire forests. Due to large differences among Southwest forest types and natural disturbances, old growth forests vary extensively in tree size, age classes, presence and abundance of structural elements, stability, and presence of understory (Helms 1998). Old growth refers to specific habitat components that occur in forests and woodlands—old trees, dead trees (snags), downed wood (coarse woody debris), and structure diversity (Franklin and Spies 1989, Helms 1998, Kaufmann et al. 2007). These important habitat features may occur in small areas, with only a few components, or over larger areas as stands or forests where old growth is concentrated (Kaufmann et al. 2007). In the Southwest, old growth is considered “transitional” (Oliver and Larson 1996), given that the location of old growth shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality). Some species, notably certain plants, require “old forest” communities that may or may not have old growth components but have escaped significant disturbance for lengths of time necessary to provide the suitable stability and environment.” Discussions, tables, summaries were updated to reflect this major difference where possible to identify by forest.

Natural Range of Variability (NRV): In response to Northern Arizona University’s Ecological Restoration Institute, and others, tables, discussions, and an appendix of comparisons was added for the Natural Range of Variability that proposed treatments are compared against. To set the goals that underlie these treatments, it is useful to know as much as possible about past forest conditions, especially the “reference conditions” that existed before forest structure and function were altered by Euro-American settlers. Such conditions were not static, but they sustained themselves across what has been called a “natural range of variability” (Friederici 2004). Post-treatment effects are discussed in context to how treatments move the alternatives toward their NVR. An additional appendix was developed (appendix G) that shows the comparisons among ponderosa pine basal area, all basal area, ponderosa trees per acre, and all trees per acre larger than 5 inches d.b.h. against their respective NRV, for each planned treatment by alternative (some 612 table/graph combinations).

Implementation Plan: The Implementation Plan (FEIS appendix D) was edited and revised to reflect changes in the 2012 Mexican Spotted Owl Recovery Plan, changes in the Kaibab NF forest and, measuring canopy cover at the group and stand level on about 40,000 acres (response to public comment).

Acres Refined: After the DEIS was published, multiple acres and treatment areas were refined: Flagstaff Watershed Protection Project: treatments that had been proposed within Dry Lake Hill and Mormon Mountain were removed, road decommission and haul routes were removed. Changes also occurred (stands were split) in the Elden Environmental Study Area and within Eastside project. Aspen stands on Kendrick that had overlapped into the wilderness boundary were removed (GIS error). New information on PFAs and Mexican spotted owl PACs resulted in changes to proposed treatments for the AZGFD pronghorn corridors/overpass and the paired watershed study. A summary of changes:

- Elimination of small isolated stands,
- Mechanical treatments were changed to reflect the Lee Butte PAC ,
- Core area re-delineation in the Mormon Mountain PACs resulted in modified treatments,
- PFA changes include: Fort Valley, Dogtown Wash, Rosilda Springs, Mud Springs and Pomeroy,

- Bridge and Weatherford2, new PACs, were added to analysis, a nest center changed in the Upper West Fork, the PAC boundary changed in West Buzzard Pt and in the Snowbowl Road/Pipeline PAC resulting in modifications to treatments,
- Weatherford, Jack Smith and Viet were removed from PAC status.
- To eliminate duplication with the Kelly Motorized Trails Project, road decommission that overlapped with this project was removed,
- As a result of motor vehicle use map closed roads treatments in this project were changed to road relocation, and,
- On NFS Road 133A/700F, road relocation and road decommission was identified and there was a change in haul route location.

Coconino NF Slide Fire: The Slide Fire started the afternoon of May 20, 2014, was contained on June 5th, and controlled on June 10th after burning 21,227 acres. The Slide fire burned 7,870 of 4FRI project area acres. The acres burned within the project boundary varied from no-burn to High Burn Severity (greater than 90 percent basal area lost). After field verification of the impacts depicted on the RAVG map of the now altered structure and composition, and the unknown near-term bark beetle mortality, a design feature/mitigation measure was developed. All treatments within the burned area would be deferred for a minimum of five years. This would provide an opportunity for recovery of affected soils and vegetation prior to implementing any actions that may cause additional disturbance. The proposed treatments would not change; however, prior to implementation, appropriate resource specialists would evaluate the area to ensure that treatments are still appropriate and would meet resource objectives.

Canopy Cover at the Stand Level: In response to comments and feedback on the DEIS, approximately 38,256 acres would be managed at the stand level. This equates to 22,772 acres on the Coconino and 15,484 acres on the Kaibab NF) of UEA 40 and UEA 25 non-WUI stands[14] with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean basal area greater than 70 of the VSS 4 size class and a mean number of trees per acre less than 100 of the VSS 4 size class). These acres would be managed for greater residual canopy cover and density of large trees. Residual stand structure would be managed at the upper end of natural range of variability for ponderosa pine in the non-WUI stands that meet these conditions. This would be accomplished by focusing treatments toward the lower end of the planned prescription intensity range, managing for larger group sizes, and/or retaining additional large trees. Post treatment canopy cover in these stands would meet or exceed forest plan guidance for canopy cover, and is intended to achieve 40 percent canopy cover at the stand scale.

Opposing Science

In response to the DEIS, several commenters (Cara115-137) cited Williams and Baker (2012, 2014) (hereafter referred to as W&B) and stated that W&B conducted research that indicates ponderosa pine forests historically had the same, or similar, fire intensities that we see today and that forest densities approached the densities we see today. W&B proposed that current fire extents and intensities are normal when compared to their research. The contributor concludes, “The action alternatives would not restore historic fire regimes but, rather, would take forests outside of the natural, historic range of variability, compromising ecological resilience”. The bulk of the science relating to fire regimes in southwestern ponderosa pine does not agree with W&B

[14] stands not within the wildland-urban interface

(2012, 2014). Fule et al. (2013), question the conclusions of W&B, and describe how the preponderance of scientific evidence indicates that conservation of dry forest ecosystems in the west and their ecological, social, and economic values is not consistent with a contemporary disturbance regime of large, high severity fires, especially under changing climate. Fule et al, 2013, has 18 co-authors, the majority of whom are well published in fire ecology. Reynolds et al, 2013 reports that W&B had similar density numbers (trees per acre and basal area) but Reynolds et al, 2013 explains the relationship in competing terms of frequent fire return intervals of less than 35 years.

Some commenters (Cara 196-200) stated that "above 60% of maximum "Stand Density Index" (SDI), forest stands are at high risk of beetle mortality, and that the intensive logging proposed in the Proposed Action and the Preferred Alternative—which would directly kill and remove, through logging, most of the existing trees—is somehow necessary to prevent and reduce tree mortality". The DEIS does not claim on page 14 or 18 that, above 60 percent of maximum "Stand Density Index" (SDI), forest stands are at high risk of beetle mortality. The DEIS states on page 14 that, "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 over 60 percent of maximum stand density (Long 1985)". This statement is directly related to density related mortality not bark beetle hazard. The reduction of bark beetle hazard promotes forest sustainability and health. Reducing bark beetle hazard is conducted by reducing the stress and competition between individual trees, resulting in a reduction in stand density. The bark beetle hazard model for southwestern ponderosa pine on DEIS page 18 is exclusively based on the tree density relationships developed in the Dendroctonus hazard model by Munson and Anhold 1995 (as documented in Chojnacky et al. 2000) and the draft Ips hazard model developed by McMillin et al. (2011)(Silviculture Specialist Report, page 51). Bark Beetle Hazard or 'susceptibility' is the inherent characteristic of a stand of trees that affect its likelihood of attack and damage by bark beetles (McMillin et al. 2011). Cutting of trees will directly reduce the population but will reduce the hazard and risk of bark beetle outbreaks while maintaining a healthy forest. The use of 60 percent of max SDI by Munson and Anhold 1995 (as documented in Chojnacky et al. 2000) and the draft Ips hazard model developed by McMillin et al. (2011) is appropriate to display bark beetle hazard (aka the likelihood of attack and damage by bark beetles).Chojnacky et al. 2000 indicate that increasing beetle attack is correlated with increasing SDI. Other unknown factors independent of stand density may initially draw bark beetles to a stand, but once in a stand the beetles seek out the pockets of higher SDI. "The methods are trustworthy in predicting that once beetles enter a stand, the more dense stands with larger stand density index (SDI) can be expected to have greater beetle attack" (Chojnacky et al. 2000, p. 10).

Commenters (Cara 196-200) further stated that Oliver (1995) found that, as relatively young ponderosa pine stands reached SDI levels from 300 to 365, beetle mortality reduced stand density by only about 13-20 percent. Mortality was near zero when SDI values were below 230 (Fig. 2 of Oliver 1995). Further, despite modest mortality as stands neared SDI of 365, the stands ultimately continued to grow more mature and more dense, reaching an SDI of 571 (100 percent of maximum SDI) finally (Fig. 1 A-C of Oliver 1995). The commenters (Cara 196-200) misinterpreted and misused Oliver 1995 by taking data that was appropriately used to demonstrate stand density of good sites to poor sites and developing conclusions. In addition, ponderosa pine SDI maximums used in FVS modeling were 500 (Region 5) and 429(Region 6) for Oliver 1995. National standard for ponderosa Pine SDI max is 450. One comment concluded SDI reached 571. It is unknown where or how this conclusion was derived. Oliver 1995 found that "Bark beetle kills created a limiting Stand Density Index of 365 which differed little between stands on poor sites east and good sites west of the crest of the Sierra Nevada and Cascade Range. Although good sites would be expected to carry a greater stand density than would poor sites, more explosive bark beetle populations and density-related stem breakage cancel this site advantage" (Oliver 1995, pg. 213). This Oliver paper demonstrates how SDI is limited to 365 for ponderosa pine when bark beetles are present in the ecosystem. Stands that approach SDI 365 usually suffer large losses from bark beetle epidemics-losses that equal or exceed periodic growth. Figure 2 suggests that beetle kills from endemic populations can begin when stands reach SDI 230 (Oliver 1995).

Commenters stated (Cara 196-200) a Cochran and Barrett (1995) study investigated pine stands and found that, even at higher SDI levels, "there was no apparent correlation between stand density and mortality" (see p. 9 of Cochran and Barrett 1995). In that study, the highest annual growth rates were at SDI values over 200 (Figs. 14, and 18-20 of C&B 1995). The commenters misread and misused this reference. Cochran and Barrett cannot be cited in northern Arizona, or even the southwest, because they used a max SDI for ponderosa pine of 365 instead of 450, as used in the southwest and used in this project. Cochran and Barrett reported mortality at SDI of 200 as only 5-10 percent of the basal area over 30 years. SDI 200 of max 365 SDI is 54 percent of max, and at that percentage, there should be more density related mortality developing than reported (non-beetle). However, comparing their 200 SDI to a max SDI of 450 then they really had only 44 percent of max SDI. This is the upper range for management, but there would be little density related mortality expected to develop, and this is just what C&B reported. Furthermore, they calculated their SDI figure using a different exponent of -1.77 instead of -1.605 for the SDI calculation as used in the southwest and this report. There cannot be any comparisons made to the SDI reported in Oliver (Cochran and Barrett, 1002) and the SDI used in the Silviculture report. They are based on such different fundamental values as to be non-comparable.

Some comments received (Cara 196-200) do not relate to this project since the needs and purpose of this project are to re-establish forest structure, pattern, and composition, within the ponderosa pine ecosystem that will lead to increased forest resiliency and function, and not a bark beetle mitigation project, as the comments would imply.

Affected Environment

Cover Types and Vegetation Communities

The cover types have been grouped into communities. Table 39 lists the acres within 588,716 acres of the project area by cover type. The forest structure and forest health section in chapter 1 includes existing and desired conditions for ponderosa pine and pinyon-juniper woodlands. Existing and desired conditions for grasslands, Gambel oak, aspen and pine-sage can be found in the vegetation composition and diversity section. See the specialist report for details on each vegetation community.

All ponderosa pine forested habitat within the treatment area was stratified for Mexican spotted owl and northern goshawk to meet forest plan requirements (USDA FS 1987) as displayed in table 40 and table 41.

Table 39. Treatment area vegetation cover type acres by restoration unit (RU)

Cover Type	RU 1	RU 3	RU 4	RU 5	RU 6	Total
Nonvegetated						
Barren	120	134	129	1,301	48	1,732
Non-forest Communities						
Grassland	8,226	12,796	22,661	4,928	9	48,703
Forest Communities						
Pinyon-juniper Woodland	1,427	5,884	7,283	8,845	2,219	25,658
Oak Woodland	287	1,633	926	386	30	3,262
Ponderosa Pine	144,113	129,226	134,278	59,034	41,189	507,839
Aspen	420	201	497	403	0	1,522
Total Forested Acres:	146,248	136,944	142,984	68,668	43,437	538,280
Total Treatment Area (acres)	**154,594**	**149,874**	**165,774**	**74,896**	**43,578**	**588,716**

Table 40. Mexican spotted owl (MSO) habitat stratification within the treatment area (in acres) by restoration unit (RU)

MSO Habitat	RU 1	RU 3	RU 4	RU 5	RU 6	Total
Protected Habitat						
Protected Activity Center (acres)	29,175	4,560	586	869	0	35,190
Pine Oak >40% Slope	595	239	3	0	0	837
Total Acres MSO Protected Habitat	29,770	4,799	589	869	0	36,027
Restricted Habitat – Pine Oak						
Threshold	873	1,104	0	0	0	1,977
Target	3,919	2,795	0	0	0	6,714
Restricted Other	25,710	38,527	1,576	606	0	66,419
Total Acres MSO Restricted Habitat	30,502	42,426	1,576	606	0	75,110
Total Acres MSO Habitat	60,272	47,225	2,165	1,475	0	111,137

Table 41. Northern goshawk habitat stratification within the treatment area (acres by RU)

Goshawk Habitat	RU 1	RU 3	RU 4	RU 5	RU 6	Total
Nest Habitat	1,126	1,247	3,562	410	616	6,961
Post-fledging Family Area (PFA)						
Uneven-aged	2,149	2,032	3,788	888	2,664	11,521
Even-aged	1,396	2,396	6,256	1,006	827	11,881
Total PFA	**3,545**	**4,428**	**10,044**	**1,894**	**3,491**	**23,402**
Total PFA and Nest	**4,671**	**5,675**	**13,606**	**2,304**	**4,107**	**30,363**
Landscapes Outside Post-fledging Family Areas (LOPFA)						
Uneven-aged	41,479	30,013	38,981	29,757	22,816	163,046
Even-aged	38,410	46,411	79,678	25,584	14,323	204,406
Total LOPFA:	79,889	76,424	118,659	55,341	37,139	367,452
Total Goshawk Habitat	84,560	82,099	132,265	57,645	41,246	397,815

Forest Health, Vegetation Composition and Diversity

For the purposes of this analysis, forest health is defined by the vigor and condition of the forest stands, and the presence of insects and disease that affect the sustainability of the forest. Chapter 1 of this FEIS describes existing and desired conditions for stand density and insect and disease, key components of forest health. Chapter 1 also describes existing and desired conditions for vegetation composition and diversity.

Natural Range of Variability (NRV)

In response to comments on the DEIS, an evaluation of how alternatives would move toward NRV was included in the vegetation analysis. Table 42 defines the ranges of reference conditions for ponderosa pine in the southwestern U.S. (Reynolds et al. 2013). The ranges serve to inform and compare the analysis with the natural range of variability. These metrics are not project area desired conditions but remain supporting science defining restoration.

Table 42. Ranges of reference conditions for ponderosa pine in the southwestern U.S.

Forest Attribute	Ponderosa Pine
Trees/ acre	11.7-124
Basal area (sq. ft. per acre)	22.1-89.3
Openness (%)*	52-90
Openness on sites with strong tree aggregation (%)*	70-90
Spatial patterns	Grouped or random
Number of trees per group	2-72
Size of groups (acres)	0.003-0.72
Number of groups per acre	6-7
Snags per acre	1-10
Logs per acre	2-20

* Openness is the proportion of area not covered by tree crowns, estimated as the inverse of canopy cover.
Source: Reynolds et al. 2013.

Environmental Consequences

For the effects analysis, the spatial context being considered focuses on 588,716-acres where most of the mechanical and prescribed fire treatments occur. The spatial context for effects related to springs, channels and roads uses the larger 988,764-acre project area. The baseline year used for this analysis is the year 2010 as the existing condition. All past activities and events are included in the existing condition description. In the effects discussion, post treatment refers to the time the final activity is accomplished (year 2020), “short-term” effects refers to effects over the 10-year period from the time the final activity was accomplished (year 2030). Long-term effects are those that go beyond 20-years (year 2050).

All alternatives are compared across forest boundaries (Coconino-Kaibab combined). Both forests follow the Mexican spotted owl guidelines and FWS has already informed 4FRI that the proposed treatments are consistent with both the 1995 and 2012 Mexican Spotted Owl Recovery Plan. For the goshawk analysis, both forests are analyzed, discussed, and displayed using the guidelines from the Coconino NF (USDA FS 1987). The 2014 Kaibab forest plan does not use the same terminology as the Coconino in terms of goshawk management; however, the plan does not preclude this current analysis from using VSS, old growth, and canopy cover to describe forest structure and components. For ease of comparison, analysis, and understanding, we discuss the alternatives in terms of the Coconino forest plan requirements, fully understanding that they are not the same requirements as the Kaibab, but that they are consistent within the context of the project.

Alternative A is the no action alternative as required by 40 CFR 1502.14(d). There would be no changes in current management and the forest plans would continue to be implemented. Alternative A is the point of reference for assessing action alternatives B through E.

The environmental consequences for alternatives B through E are based on the application of the design features and mitigation measures see sections A through E of appendix D for the vegetation treatment design and associated implementation guides.

All Alternatives

Canopy Openness and Maintenance of Interspace

The following treatments are associated with the range of openness: [15]

- **Very Open:** Grassland restoration, savanna
- **Open**: WUI 55, IT 40, SI 40, UEA 40 and pine-sage treatments
- **Moderately Closed**: goshawk LOPFA burn-only, PFA and MSO restricted other Habitats; IT 25, SI 25 and UEA 25 treatments
- **Closed**: goshawk nest burn only, MSO PAC and target and threshold, IT 10, SI 10 and UEA 10 treatments

Table 43 displays the range of openness by alternative. Alternatives B through E result in a wide range of post-treatment openness with all alternatives trending toward the closed side of the range. The unknowns are those areas with no treatment proposed under any alternative.

Table 43. Alternatives A through E comparison of canopy openness

Alternative	Very Open	Open	Moderately Closed	Closed
Current Condition (Alternative A)	3	22	29	45
Alternative B	13	46	28	13
Alternative C	13	45	28	14
Alternative D	13	46	28	13
Alternative E	3	54	29	14

In addition to this analysis, both silviculture and wildlife collaborated on an evaluation of post-treatment canopy openness for canopy-density dependent species. The analysis is summarized in the wildlife section. The complete analysis is in appendix G of this FEIS.

In alternative A, there would be no change in openness and the ability to maintain openings and groups would be reduced. Interspaces would lack definitive definitions under alternative A and

[15] WUI = wildland-urban interface; IT = intermediate thin; SI = stand initiation; UEA = uneven-aged; PFA = post-fledging family areas; LOPFA = landscapes outside PFAs; MSO PAC = Mexican spotted owl protected activity center

without significant interspaces, tree densities (basal area, trees per acre, stand density index, canopy closure) would increase and continue to move away from the desired conditions for most areas. Fire risks and fuel loadings would continue to increase beyond acceptable values as densities and canopy closures increase. Density related mortality, insects, and diseases would be more prominent under this alternative.

The difference between alternatives is the mix of treatments applied across the acres. Alternative B moves the forest from 22 percent open to 46 percent, and moves moderately closed from 29 percent to 28 percent and moves closed from 45 percent to 13 percent. The relative shift in openness from a fairly closed stand structure (74 percent moderately closed to closed pre-treatment) to a more open stand structure (59 percent very open to open) is a designed result of adding interspaces, groups, and regeneration openings. While this appears to be, empirically, a very open forest structure, about 88 percent of the project is within the open to moderately closed interspace category, with the majority of the forest in the moderately closed structure (25-40 percent interspace) with “protected prescribed fire only” treatments. Plan amendments account for the distribution of openness on the Coconino NF.

In response to comments from the public alternative C reflects additional design from the Arizona Game and Fish Department that maintains higher densities (table 66, silviculture report). Alternative C has fewer acres in “No Proposed Treatments” category and has more acres treated with “protected prescribed fire only” treatments. The plan amendments account for the distribution of openness. The difference between alternative E and alternatives B-D is the mix of treatments applied across the acres. In alternative E there are no Coconino NF plan amendments. No grassland or savanna treatments would occur. The variety of treatment types and desired conditions under alternative E would result in a wide range of openness post treatment. The list of resulting openness by treatment type displayed for alternative B is the same for alternative E. However, without the forest plan amendment that allows for interspaces and grassland/savanna treatments, the openness would be more evenly spaced, less distinct, and lacking in purposeful regeneration openings, with no clear direction to create groups. Alternative E would either move the forest toward the desired conditions slowly or maintain current forest structure on the Coconino NF. The project does not require forest plan amendments for the Kaibab NF forest plan (2014). The Kaibab NF would move the forest toward the desired conditions without amendments.

Forest Structure in Goshawk Habitat – All Alternatives

Direct and Indirect Effects

Goshawk habitat forest structure and habitat components were projected out to the years 2020 and 2050 by habitat and restoration unit (RU) scale. Table 44 summarizes the differences in habitat components by alternative. The silviculture report includes additional scales of analysis including restoration sub-unit. This section only provides post-treatment habitat structure. The habitat analysis considers habitat conditions and evaluates impacts to the species.

In alternative A density in terms of stand density index (SDI) and basal area would continue to increase and remain higher than desired in all habitats. All habitats would show an increase in total coarse woody debris (CWD), CWD larger than 12 inches, and snags larger than 18 inches between 2020 and 2050 resulting in conditions at or close to desired.

In alternatives B, C and E in year 2020, all habitats would be within the desired basal area density range with the exception of RU 6 PFA. This is due to the pre-treatment condition in this unit which has low stocking (below the desired condition of 70 square feet) and dense patches of VSS 3.

Treatments would focus on thinning the dense patches and maintaining canopy cover in the mid-aged, mature and old (VSS 4, 5, and 6), further reducing overall density. In the short term (2020) tons of CWD and snags per acre would be below desired, a direct result of prescribed fire treatments. CWD changes in the long term. By 2050, tons of CWD would exceed the minimum desired (with the exception of RU 6 PFA and LOPFA). Snags would remain below desired levels. By year 2050, the desired SDI range at the habitat and RU scale would be attained and density (basal area) would be at or above the desired of 70 square feet. In alternative D the main difference between the effects displayed in alternatives B and C is in post-treatment CWD. In both the short (2020) and long term (2050), tons of CWD would be at or above desired due to the lack of prescribed fire. Snags would have increased yet remain below desired levels.

Table 44. Goshawk forest structure and habitat components in 2020 and 2050 in all restoration units

Alternative	SDI % of Maximum		Trees Per Acre		Basal Area		Tons CWD Total		Tons CWD >12 in.		Snags >18 in.	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
Nest/PFA Habitat												
Alt A	47	50	192	152	115	132	4.6	7.1	0.8	1.4	0.4	0.9
Alt B, C, E	27	33	88	78	72	94	3.0	6.0	0.8	1.8	1.1	0.9
Alt D	30	36	109	95	77	99	5.2	7.2	1.1	1.8	0.7	0.9
Landscapes Outside of PFAs												
Alt A	43	46	182	142	105	122	4.2	6.6	0.6	1.2	0.4	0.8
Alt B,C, E	21	27	67	60	57	76	2.7	5.0	0.6	1.4	1.0	0.9
Alt D	24	29	109	74	77	81	5.2	6.4	1.1	1.4	0.7	0.8

Table 45 characterizes the average overall habitat components in relation to desired (below, above, within) for each alternative.

Table 45. Goshawk forest structure summary by alternative

Indicator	Alternative A		Alternatives B, C and E		Alternative D	
	2020	2050	2020	2050	2020	2050
Stand Density Index	Exceeds	Exceeds	RU 6 exceeds	Meets	RU 6 exceeds	Meets
Basal Area	Exceeds	Exceeds	RU 6 exceeds	Exceeds – Only RU 6 meets	RU 6 exceeds	Exceeds
Coarse Woody Debris (tons per acre)	Moving toward	Meets	Below	Only RU 6 PFA and LOPFA meets	Below	Exceeds
Snags Per Acre	Moving toward	Meets	Below	Below	Moving toward	Exceeds

Canopy Cover

Canopy cover is time-consuming to measure and difficult to standardize to obtain consistent results with different observers. Even the definition of the term is dependent on the method of measurement. To resolve this issue, the Forest Vegetation Simulation (FVS) crown width model was used as the basis for developing stocking densities that would achieve desired canopy cover levels. This was accomplished by establishing ponderosa pine seedling tree groups (site index 75) within FVS, and periodically thinning the groups to determine the stocking that would achieve the desired canopy cover when the trees reached 15 inches d.b.h. (midpoint of the VSS 4 size class). This stocking is considered typical for meeting the canopy cover desired conditions and stocking ranges by tree size class are centered on this value.

These stocking levels were compared to a local study specific to northern Arizona ponderosa pine forest (as reported by Shepperd et al. 2001) that predicted canopy cover at the stand level by inferring the relationship between estimated stand basal area and canopy cover. This comparison indicated the algorithmic relationship between basal area and canopy cover overestimated canopy cover in the larger size classes compared to FVS. Based on this comparison we chose to use the stocking indicated by FVS to meet canopy cover requirements.

The FVS developed stocking guides were then validated thru site visits to areas with variable densities and tree sizes. Comparing the stocking guides to the tree density within VSS 4, 5 and 6 sites that had interlocking or nearly interlocking tree crowns indicated following the stocking guides would meet the desired tree group canopy cover within goshawk habitat.

Alternatives B through E Treatment Design

On the Coconino NF tree group density in goshawk habitat would be managed to meet the canopy cover requirement (Coconino NF only) of 40 plus percent within mid-aged forest (VSS4), mature forest (VSS5), and old forest (VSS6) tree groups except as noted in non-WUI stands below. There is no specific guidance in the current Kaibab NF plan for goshawk habitat except in PFAs. The guidance for the Coconino NF would be used as guidance on the Kaibab NF as well and is consistent with the uneven-aged management guidance of the Kaibab NF plan. This would assure that immature tree groups (VSS 2 and 3) are managed to maintain tree stocking necessary to provide for the desired canopy cover as the groups mature to VSS 4, 5, and 6. Treatment design would vary on about 38,256 acres in alternatives C and E (see discussion below).

Alternatives C and E-Specific Implementation Features

In response to comments on the DEIS, approximately 38,256 acres of VSS 4, 5 and 6 in goshawk habitat would have canopy cover measured at the stand level. On approximately 38,256 acres non-WUI stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean basal area greater than 70 of the VSS4 size class and a mean number of trees per acre less than 100 of the VSS 4 size class) would be managed for greater residual canopy cover and density of large trees. Residual stand structure would be managed at the upper end of natural range of variability for ponderosa pine in the non-WUI stands that meet these conditions. This would be accomplished by focusing treatments toward the lower end of the identified intensity range, managing for larger group sizes, and/or retaining additional large trees.

Table 46 displays treatment types and acres associated with this modification. The implementation plan (FEIS, appendix D) includes design features specific to measuring canopy cover at the stand level in the following treatment types in landscapes outside of PFA (LOPFA).

Table 46. Goshawk treatments and acres to be measured at the stand level

Treatment Type	Acres	Treatment Type by Forest	Acres	Treatment Type by Forest	Acres
Total	38,256	Coconino NF	22,772	Kaibab NF	15,484
dPFA - IT25	25	dPFA - IT40	287	dPFA - IT25	25
dPFA - IT40	287	dPFA - UEA25	209	dPFA - UEA25	361
dPFA - UEA25	570	dPFA - UEA40	234	dPFA - UEA40	266
dPFA - UEA40	500	IT25	872	IT25	366
IT25	1,238	IT40	8,053	IT40	2,346
IT40	10,400	PFA - IT25	9	PFA - IT40	192
PFA - IT25	9	PFA - IT40	608	PFA - UEA25	261
PFA - IT40	800	PFA - SI25	37	PFA - UEA40	378
PFA - SI25	37	PFA - UEA25	64	UEA25	3,149
PFA - UEA25	326	PFA - UEA40	218	UEA40	8,141
PFA - UEA40	595	SI25	22	**Grand Total**	**15,484**
SI25	22	UEA25	2,352		
UEA25	5,501	UEA40	9,805		
UEA40	17,946	**Grand Total**	**22,772**		
Grand Total	**38,256**				

PFA = post-fledging area; dPFA= dispersal post-fledging area; IT = intermediate thin;
SI = stand initiation; UEA = uneven-aged

Environmental Consequences

Alternatives B through E

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 WUI55, UEA40, UEA25, and UEA10 mechanical thin treatments are as displayed in table 47 and figure 37. These are the stocking guides that would be used to meet canopy cover requirements in tree groups within goshawk LOPFA habitat. See sections A and B of the implementation Plan (appendix D) for more detail on incorporating the stocking guides in treatment design. The stocking guidelines apply to all LOPFA habitat with the exception of approximately 38,256 acres (see discussion that follows).

Table 48 and figure 37 are the stocking guides that would be used in all action alternatives to meet canopy cover requirements in tree groups within goshawk PFA habitat.

Specific to alternative C and E, approximately 38,256 acres of VSS 4, 5 and 6 would have canopy cover measured at the stand level. Post treatment canopy cover in these stands would meet or exceed forest plan guidance (goals, standards, or desired conditions) for canopy cover, and is intended to achieve 40 percent cover at the stand scale.

Maintaining high canopy cover percentages across the stand would require treatments to maintain high stocking basal area, high trees per acre, and high SDI. Currently the 38,256 acres encompasses 1,096 stands averaging 143.4 basal area, 508.6 trees per acre, and 281.5 SDI (62.5 percent of max SDI: SDI Max = 450). This would result in continuous canopy cover over most of the stand which would increase the risk of density related mortality and crown fire risk above most other restoration treatments. Silvicultural prescriptions would be implemented to the lower intensity level were possible while trying to maintain stand structure at the upper ends of the NRV, with an intent to maintain 40 percent canopy cover. It is not proposed to change treatment types but to instead to maintain the planned treatments but to limit the treatment intensity such that the silviculturist favor the less intense range of the treatment planned and analyzed.

Table 47. Goshawk LOPFA wildland-urban interface and uneven-age treatment stocking guidelines for tree groups

VSS Class	Diameter Class (inches)	Typical Number of Trees Per Group Stocking for Different Group Sizes[A]					Typical Trees Per Group Stocking at the Midpoint Diameter of the VSS Class[B]	
		1/10-ac group	¼-ac group	½-ac group	¾-ac group	1-ac group	Relative Spacing Range (ft.)	Basal Area[B] ($ft.^2$/acre)
1 & 2	0–4.9	19	48	96	144	193	12 – 18	N/A
3	5–11.9	14	34	68	102	136	N/A	50
4	12–17.9	5	12	23	35	46	N/A	60
5	18–23.9	3	8	15	23	30	N/A	70
6	≥24	2	5	11	16	21	N/A	85

A. These are typical values for the mid-point diameter of the VSS class. Densities within the VSS 4, 5, and 6 classes are equivalent to 40 percent canopy cover. Densities within the VSS 1, 2, and 3 classes are to maintain tree stocking necessary to provide for desired canopy cover as the groups mature to VSS 4, 5, and 6.

B. Variation in tree group stocking above the minimum required to maintain canopy cover can occur and is desired. The smallest trees per acre (TPA) number for the range pertains to the largest diameter of the VSS class; the highest TPA.

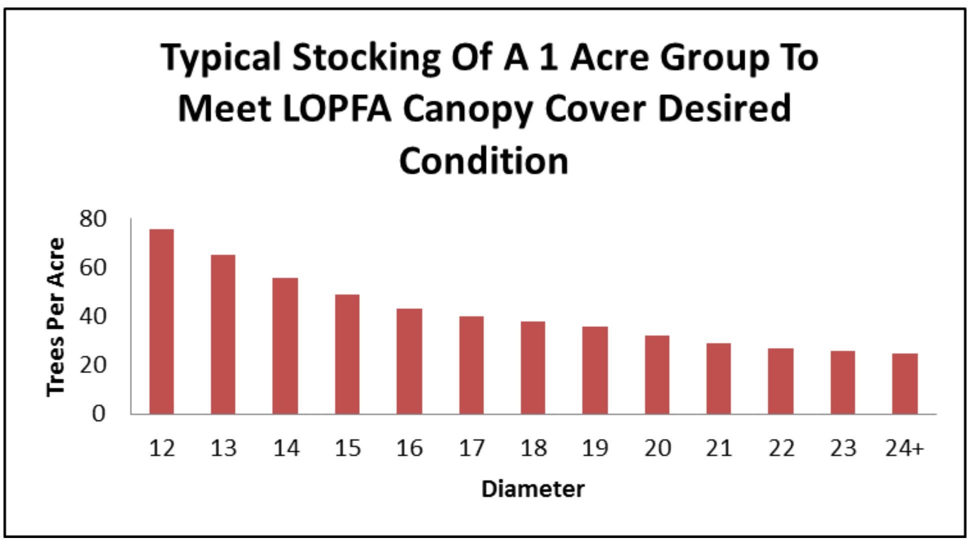


Figure 37. Typical stocking of a 1-acre group to meet LOPFA canopy cover desired condition

Table 48. Stocking guides to meet tree group canopy cover requirements within goshawk PFAs

VSS	D.B.H. Class (inches)	Typical Number of Trees Per Group Stocking for Different Group Sizes[A]					Typical Trees Per Group Stocking at the Midpoint Diameter of the VSS Class[B]	
		1/10-ac group	¼-ac group	½-ac group	¾-ac group	1-ac group	Relative Spacing Range (ft)	Basal Area[B] (ft^2/acre)
1 & 2	0 - 4.9	19	48	97	145	193	12 – 18	N/A
3	5 - 11.9	14	34	68	102	136	N/A	50
4*	12 - 17.9	7	18	35	53	70	N/A	85
5**	18 - 23.9	4	10	20	29	39	N/A	90
6**	24+	3	7	14	20	27	N/A	110

A. These are typical values for the desired condition. Variation can occur and is desired, however ranges should center on these values. See chart below.

B. Rounded to nearest 10 square feet per acre.

* Densities are equivalent to 55 percent canopy cover

** Densities are equivalent to 50 percent canopy cover

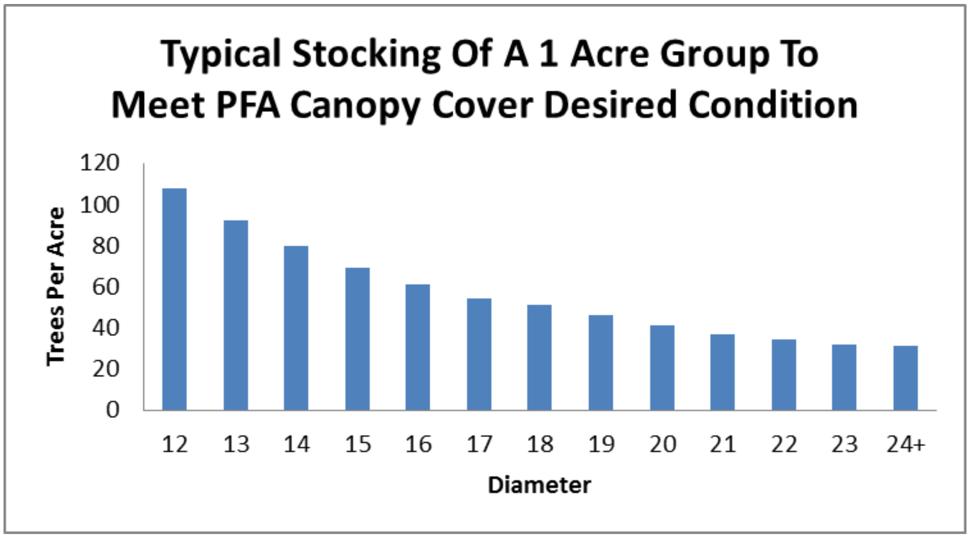


Figure 38. Typical stocking of a 1-acre group to meet PFA canopy cover desired condition

Forest Structure in Even-aged and Uneven-Aged Stands 2020 and 2050

Table 49 summarizes the differences in VSS distribution by alternative. The silviculture report includes additional scales of analysis including restoration sub-unit. The goshawk wildlife analysis evaluates how forest structure affects the species and its habitat.

Alternative A – Direct and Indirect Effects

In 2020 the overall VSS distribution in all goshawk habitats would continue to be dominated by the young and mid-aged (VSS 3 and 4) structural stages. By 2050 there would be underrepresentation throughout all habitats in VSS 1, 2, 3, and VSS 6 in the even-aged stands.

Alternatives B, C and E – Direct and Indirect Effects

In alternatives B and C, even-aged goshawk habitats would have good representation of the VSS 1, 3, 4, and 5 age classes in the LOPFA; an under-representation of the VSS 5 age class in the PFA; an under-representation of the VSS 6 age class in all habitats; and no representation of the VSS 2 age class.

In uneven-aged goshawk habitats there would be a more balanced overall VSS distribution compared to alternative A with improvement toward the desired representation in the grass/forb/shrub, young, mid-aged, and mature forest stages. By 2050 there would be no VSS 1, an underrepresentation of VSS 3, and good overall representation in VSS 2, 4, 5, and 6. Note: alternative E is similar enough to be evaluated with alternative B and C although percentages are slightly different.

Alternative D – Direct and Indirect Effects

The goshawk habitat structural stage analysis for alternative D would be similar to alternatives B and C, with slightly higher overall representation in VSS 3 and slightly lower overall representation in VSS 5. By 2050, there would be slight overall differences in representation in VSS 3, 4, 5 and 6 when compared to alternatives B and C.

Table 49 and table 50 are included to display how the alternatives do (or do not) move toward VSS desired conditions.

Forest Structure in Mexican Spotted Owl Habit

Mexican spotted owl habitat forest structure and habitat components are projected out to the years 2020 (short term) and 2050 (long term) in each alternative and by habitat type is displayed in table 51. In response to comments on the DEIS, the organization of this section has been updated to improve clarity. The wildlife analysis evaluates how forest structure affects the species and it habitat.

Basal Area: In alternative A, basal area would increase and remain higher than desired by 2020. In alternatives B, C and E the desired basal area would be attained by 2020. In alternative D, Basal area would exceed desired in all habitats by 2050.

Stand Density Index (SDI): In alternative A, SDI would continue to increase and would exceed desired conditions by 2020. In alternative B and C in both the short and long term, SDI would be in the extremely high density zone within the target/threshold and protected habitats (with the exception of RU 4), and on the high end of the desired range within restricted other habitat. This would be largely due to the limited mechanical treatment in the protected habitat and the high oak stocking in the restricted habitat.

In alternative D and E SDI density would exceed desired in all habitats by 2050 (with the exception of RU 4). This would be largely due to limited mechanical treatments and prescribed fire in the protected habitat and the high oak stocking and lack of post mechanical treatment burning in the restricted habitat.

Trees in the 12- to 18-inch and 18- to 24-inch size class: In alternative A and B the distribution of size classes would exceed the desired minimum by 2050. Alternatives C and E differ in that the desired minimum would be met or exceeded by 2020. In alternative D, there is progress in all habitat types but target and threshold where the large tree size classes remain below the desired minimum.

Table 49. Alternatives A through E in 2020 and 2050 VSS distribution for goshawk LOPFA even-aged and uneven-aged stands (percent of area)

	VSS 1 (Desired 10%)		VSS 2 (Desired 10%)		VSS 3 (Desired 20%)		VSS 4 (Desired 20%)		VSS 5 (Desired 20%)		VSS 6 (Desired 20%)	
Alternative	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
Even-aged LOPFA												
A	7%	0%	0%	7%	35%	8%	49%	47%	7%	32%	2%	5%
B	13%	0%	0%	13%	21%	3%	37%	30%	26%	34%	3%	21%
C	Alt B	Alt B	Alt B	Alt B	Alt B	Alt B	38% (+1)	Alt B	Alt B	Alt B	Alt B	Alt B
D	Alt B	Alt B	Alt B	Alt B	32% (+11)	7% (+4)	30% (-7)	29% (-1)	22% (-4)	36% (+2)	Alt B	16% (-5)
E	14% (+1)	Alt B	Alt B	14% (+1)	Alt B	Alt B	42% (+5)	33% (+3)	21% (-5)	40% (+6)	1% (-2)	10% (-11)
Uneven-Aged LOPFA												
A	0%	0%	1%	0%	36%	8%	34%	42%	14%	25%	16%	25%
B	7%	0%	0%	6%	18%	1%	20%	19%	33%	19%	23%	55%
C	Alt B	Alt B	Alt B	Alt B	Alt B	Alt B	Alt B	Alt B	Alt B	Alt B	Alt B	54% (-1)
D	Alt B	Alt B	1% (+1)	Alt B	26% (+8)	7 (+6)	18(-2)	Alt B	31% (-2)	18% (-1)	18% (-5)	50% (-5)
E	Alt B	Alt B	Alt B	7% (+1)	19% (+1)	Alt B	21% (+1)	Alt B	32% (-1)	21% (+2)	21% (-2)	51% (-4)

Note: Cells with “Alt B” indicate the value is the same as provided in alternative B and numbers in parentheses with a “+” or “-” symbol display the difference from alternative B.

Table 50. Alternatives A through E 2020 and 2050 VSS distribution for goshawk PFA even-aged and uneven-aged stands (percent of area)

	VSS 1 (Desired 10%)		VSS 2 (Desired 10%)		VSS 3 (Desired 20%)		VSS 4 (Desired 20%)		VSS 5 (Desired 20%)		VSS 6 (Desired 20%)	
Alternative	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
Even-aged PFA												
A	3%	0%	1%	3%	34%	4%	54%	59%	7%	27%	1%	6%
B	9%	0%	0%	9%	22%	2%	46%	41%	14%	39%	8%	9%
C	Alt B	Alt B	Alt B	Alt B	25% (+3)	Alt B	46%	Alt B	Alt B	Alt B	6% (-2)	Alt B
D	Alt B	Alt B	Alt B	Alt B	32% (+10)	4% (+2)	Alt B	40% (-1)	11% (-3)	37% (-2)	2% (-6)	Alt B
E	Alt B	Alt B	Alt B	10% (+1)	23% (+1)	Alt B	47% (+1)	Alt B	Alt B	Alt B	7% (-1)	Alt B
Uneven-Aged PFA												
A	0%	0%	0%	0%	36%	5%	45%	52%	15%	23%	4%	19%
B	8%	0%	0%	8%	18%	0%	41%	29%	24%	39%	10%	24%
C	Alt B	Alt B	Alt B	Alt B	23% (+5)	Alt B	47% (+6)	Alt B	Alt B	Alt B	7% (-3)	Alt B
D	Alt B	Alt B	Alt B	Alt B	25% (+7)	7% (+7)	38% (-3)	23% (-6)	23% (-1)	38% (-1)	6% (-4)	Alt B
E	Alt B	Alt B	Alt B	Alt B	Alt B	Alt B	Alt B	30% (+1)	23% (-1)	Alt B	Alt B	Alt B

Note: Cells with “Alt B” indicate the value is the same as provided in alternative B

Note: Numbers in parentheses with a “+” or “-” symbol display the difference from alternative B

Table 51. Alternatives A through E Mexican spotted owl habitat forest structure and habitat components projected to the years 2020 and 2050**

Alternative	Basal Area (BA)		SDI (% of maximum)		12.0–17.9 in. (% of total SDI)		18.0–23.9 in. (Avg. % of total SDI)		24.0 in.+ (Avg. % of total SDI)		Average Trees per Acre 18 in.+		Average Gambel Oak BA % of Total BA		Tons CWD >12 in.		Snags >18 in.	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
Restricted Target/ Threshold																		
A	137/ 193	169/ 217	80/ 100	84/ 101	82/ 100	84/ 101	28/ 25	28/ 24	27/ 22	13/ 21	14/ 24	19/ 27	7/ 6	8/ 6	10/ 9	13.5/ 25.6	16.1/ 28.4	23.4/ 35.6
B	152/ 193	139/ 171	171/ 201	80/ 100	71/ 87	79/ 95	28/ 25	29/ 24	24/ 19	13/ 21	17 /28	21/ 30	7/ 6	9/ 7	12/ 11	14/ 26	16/ 29	25/ 37
C	152/ 193	129/ 163	164/ 195	80/ 100	67/ 84	78/ 93	28/ 25	24/ 20	22/ 19	13/ 21	17/ 28	18/ 26	7/ 6	10/ 7	13/ 12	13.5/ 25.6	15.6/ 27.6	21.5/ 33.2
D	152/ 193	142/ 173	172/ 201	80/ 100	72/ 88	80/ 95	28/ 25	29/ 24	24/ 19	13/ 21	17/ 27	21/ 30	7/ 6	9/ 7	11 /11	13.5/ 25.6	16.5/ 28.8	24.7/ 37.3
E	151/ 193	139/ 171	171/ 201	80/ 100	72/ 87	80/ 95	28/ 25	28/ 24	23/ 19	13/ 21	17/ 28	21/ 30	8/ 6	9/ 7	12/ 11	13.6/ 25.6	16.3/ 28.9	24.5/ 37.0
Restricted Other																		
A	155	180	78	81	31	28	14	22	8	11	15	28	13	15	11	15.0	18.0	27.6
B	137	78	111	69	37	49	29	25	20	13	21	20	7	13	18	12	11	17
C	137	79	112	69	37	49	29	25	21	13	21	20	7	13	18	11.5	11.5	17.1
D	137	91	127	69	46	58	29	23	20	13	19	18	7	11	15	11.5	11.8	17.0
E	137	79	112	69	37	49	29	25	21	13	21	20	7	13	18	11.5	11.4	17.1
Protected																		
A	155	164	181	78	80	81	31	31	28	14	16	22	8	8	11	15.0	18.0	27.6
B	155	155	176	78	72	76	31	32	28	14	17	24	8	9	13	15	18	28
C	155	152	174	78	71	75	31	32	27	14	18	25	8	9	13	15.0	18.2	28.5
D	155	159	178	78	75	77	31	32	28	14	17	24	8	9	12	15.0	18.1	28.1
E	155	159	179	78	74	78	31	32	29	14	17	23	8	9	12	15.0	18.1	28.0

*Restricted target/threshold is displayed as (average target/average threshold) a combined average.

**In comparison to table 7 in chapter 1, two additional evaluation categories have been included: average percent of total SDI by size class and average Gambel oak BA (percent of total BA).

Trees 24 inch size class: In alternative A, trees in this size class would remain below the desired minimum in both the short (2020) and long term (2050). In alternatives B, C and E by 2020 the size class has good representation in the restricted other habitat and is underrepresented in the target/threshold habitat. By 2050 the size class would exceed the desired minimum in restricted other habitat.

Implementation of group selection as part of the restricted other treatments would result in up to 15 percent of the area trending toward early successional stages, thereby increasing representation of the seedling/sapling age class. In alternative D the largest tree size class would below the desired minimum in target and threshold habitat.

Gambel Oak basal area: In alternative A, the average Gambel oak basal area would be static between 2020 and 2050 and remain below desired in the restricted other habitat. In alternative B, in both the short and long term, the overall average Gambel oak basal area would be above the desired minimum in all habitats but would be limited in RU5 and RU 1 restricted other. In alternative C and D only RU 5 remains below the desired minimum. In alternative E oak basal area would be 5 percent higher when compared to the no action alternative.

Coarse Woody Debris and Snags: In alternatives A-E snags would be below the desired minimum by 2050. All habitats show an increase in coarse woody debris greater than 12 inches between 2020 and 2050. Snags greater than 18 inches also show an increase in target/threshold and protected habitat while remaining static in restricted other.

Old Growth

The old growth standards for the Coconino NF state, “Until the forest plan is revised, allocate no less than 20 percent of each forested ecosystem management area to old-growth as depicted in the table below (forest plan table). In the long term, manage old-growth in patterns that provide for a flow of functions and interactions at multiple scales across the landscape through time. Allocations will consist of landscape percentages meeting old-growth conditions and not specific acres.” The old growth guideline for the Coconino NF states, “All analyses should be at multiple scales—one scale above and one scale below the ecosystem management areas” (USDA FS 1987, p. 70-1).

To be consistent with the Coconino NF forest plan, scales of analysis based on existing divisions of the landscape were developed specifically for this project. The smallest scale is represented at the stand level with stands averaging less than 100 acres in size. The Ecosystem Management Area (EMA) is the restoration sub-unit. Subunits range in size from 4,000 to 109,000 acres. The scale above the EMA is the restoration unit, which ranges in size from 46,000 to 335,000 acres).

The Kaibab NF does not allocate acres to old growth like the Coconino NF but instead relies on the structural components of uneven-aged management to move the forest toward the desired conditions. In the Kaibab NF forest plan, the desired condition at the landscape scale (over 10,000 acres) is to have old growth occur throughout the landscape as a component of uneven-aged management with the location of old growth shifting on the landscape as a result of succession and disturbance (USDA FS 2014). See the silviculture report for a detailed discussion of forest plan direction.

Affected Environment

A review of stand data and habitat classifications within the treatment area indicates there are approximately 507,839 acres of ponderosa pine. Of this total, 192,819 acres meet or are moving toward old growth conditions. Old growth allocations are based on current conditions within the project area along with Coconino forest plan specific management direction. Currently, all restoration units meet or exceed the 20 percent minimum percentage Coconino requirement.

Table 8 and table 9 in chapter 1 displays ponderosa pine and pinyon juniper old growth by restoration sub-unit/unit. It describes the various habitats that comprise old growth acres. The Kaibab Forest plan does not specify a percentage of required old growth habitats. To be consistent across forest boundaries this old growth on the Kaibab NF is analyzed to the 20 percent allocated habitat.

Environmental Consequences

Alternative A – Direct and Indirect Effects

In 2020 in ponderosa pine, average (old growth) conditions would be above the minimum criteria with the exception of trees per acre larger than 18 inches d.b.h. and 180 years old. This condition would be deficit in all SUs. The age of these trees is estimated to be in the range of 100 to 140 years old. Coarse woody debris (CWD) greater than 12 inches is estimated to be deficit throughout RU 4 and 6, and in various SUs. Snags per acre are estimated to be deficit in RU 6.

By 2050, all restoration units (RUs) would meet or exceed the criteria for the number of trees per acre (TPA) larger than 18 inches with the exception of RU 6. The age of these trees is estimated to be in the range of 130 to 170 years old. Coarse woody debris greater than 12 inches would remain deficit in RU 6. It is estimated that all the other criteria will be met throughout the allocated old growth acres.

In 2020, the average conditions in pinyon juniper would be above the minimum criteria with the exception of tree age and CWD. The age of the 12 inches and larger trees is estimated to be approximately 90 to 120 years old with a few relic trees approaching the 200-year-old criteria. CWD would be slightly below the equivalent of two pieces per acre. By 2050, the average conditions on the old growth acres would meet or exceed the minimum criteria with the exception of tree age.

Alternatives B through E – Direct and Indirect Effects

In 2020 in ponderosa pine, average (old growth) conditions would be above the minimum criteria with the exception of trees per acre larger than 18 inches d.b.h. and 180 years old which would be deficit in all restoration units. The age of these trees is estimated to be in the range of 100 to 140 years old. Basal area 90 or greater would be below desired in RUs 3, 4, 5 and 6 with the overall average for all acres at a basal area of 82. Alternative D is slightly different than alternatives B, C and E in that the minimal basal area would be attained in RU 3 and the average basal area for all acres would be higher (89).

In alternatives B through E, CWD greater than 12 inches is estimated to be deficit with less than the equivalent of 2 pieces per acre throughout RU 5 and 6, and various SUs.

In alternatives B through E, ponderosa pine old growth conditions would improve over time. In 2050, all restoration units would be very close to or exceed the minimum criteria for trees per acre larger than 18 inches d.b.h. with the exception of RU 6. The age of these trees is estimated be in the range of 130 to 170 years old. It is estimated that all the other criteria would be met throughout the allocated old growth acres.

In pinyon-juniper in 2020, the average conditions are at or above the minimum criteria with the exception of tree age and CWD. The age of the 12-inch and larger trees is estimated to be approximately 90 to 120 years old with a few relic trees approaching the 200 year old criteria. The CWD would be slightly below the equivalent of two pieces per acre. By 2050, the average conditions on the old growth acres would meet or exceed the minimum criteria with the exception of tree age.

Forest Health

Bark Beetle – All Alternatives

Table 52 compares bark beetle hazard ratings by alternative. Alternative A has the highest hazard rating in both the short (2020) and long term (2050). Alternatives B and C would have the highest percent of area with a low to moderate hazard rating in both the short and long term followed by alternative E and then D. Stands with a hazard rating of low or moderate would be expected to be resistant to successful bark beetle attack and large scale mortality.

With the exception of alternative A, the percentage of area in the high hazard rating drops (2020) by over 50 percent with the exception of alternative D which has 43 percent of the area rated as high hazard in 2020. In the long term (2050) the percent of area in the high hazard rating increases in all action alternatives as forest regrowth occurs. While the increase in high hazard is similar in alternatives B, C and E, it is much higher in alternative D. Alternative D reduces the acres of prescribed fires and increases the acres receiving no treatments which leads to an increase in forest densities.

Table 52. Alternatives A through E 2020 and 2050 bark beetle hazard rating

Hazard Rating	Alternative A % of Area	Alternative B % of Area	Alternative C % of Area	Alternative D % of Area	Alternative E % of Area
Low – 2020	4	45	44	27	41
Low – 2050	1	13	13	8	5
Moderate – 2020	13	33	34	29	36
Moderate – 2050	7	34	34	23	40
High – 2020	83	22	22	43	23
High – 2050	92	52	53	69	56

Dwarf Mistletoe – Direct and Indirect Effects for All Alternatives

Table 53 summarizes the change in infection level by alternative. By 2050 (alternative A) 85 percent of trees would be infected and 1 percent of the treatment area would be in the “extreme” infection category. By 2050, only alternatives B and C reduce the percent of area with extreme infection level to 0 percent.

Table 53. Alternatives A through E 2020 and 2050 dwarf mistletoe infection level

Infection Level		Current Condition	Alt A	Alt B	Alt C	Alt D	Alt E
		2010	2020/2050	2020/2050	2020/2050	2020/2050	2020/2050
None/ Low	Percent of Area	66	59/56	60/57	59/57	59/56	59/56
Moderate/ High	Percent of Area	34	40/43	40/43	40/43	40/44	40/43
Extreme	Percent of Area	0	0/1	0/0	0/0	0/1	0/1

Large Tree and Old Forest Structure Sustained Over Time across the Landscape

In alternative A, the Mexican spotted owl habitat forest structure analysis above indicates stocking trending toward adequate in the 18- to 23.9-inch size class and inadequate representation in 24-inch and greater size class. The goshawk habitat structural stage analysis above indicates the mature and old forest structural stages to be underrepresented in even-aged stands and to be trending toward desired in uneven-aged stands. The old growth analysis indicates old growth structural attributes would continue to develop across the landscape. However, the sustainability of the large/old tree component across the landscape may be impaired by density related mortality and forest health issues.

Alternatives B, C, D and E are designed to manage for old age trees to have and sustain as much old forest structure as possible across the landscape. Old trees would not be targeted for cutting. Reference the Old Tree Implementation Plan in appendix D of this FEIS.

The Mexican spotted owl analysis indicates there would be good representation in the 18- to 24-inch size classes in all habitats. Stocking in the 24-inch plus size class would have good representation in the restricted other habitat and would be underrepresented in the target/threshold habitat. In goshawk habitat mature and old forest structural stages (that are currently underrepresented) would trend toward improved representation.

Old growth structural attributes would continue to develop and improve across the landscape. Overall, the forest health analysis indicates the overall sustainability of the ponderosa pine forest would be improved across the landscape including the large/old tree component.

Specific to alternative C and E, approximately 38,256 acres of VSS 4, 5 and 6 would have canopy cover measured at the stand level. Maintaining high canopy cover percentages across the stand would require treatments to maintain high stocking basal area, high trees per acre, and high SDI. Currently the 38,256 acres encompasses 1,096 stands averaging 143.4 basal area, 508.6 trees per acre, and 281.5 SDI (62.5 percent of max SDI: SDI max = 450). The positive growth response of healthy young trees to density reduction is well known (Ffolliott et al. 2000, Latham and Tappeiner 2002). Old growth and large trees have also shown a positive growth response to density reduction as well (Latham and Tappeiner 2002, Kerhoulas et al 2013, Erickson and Waring 2014). The environmental consequences to old forest structure and large tree recruitment on these 38,256 acres is that VSS 4, 5 and 6's will not, for the most part, be released to grow into the next size class with any rapidity. Without adequate mechanical treatment growth response of the VSS 4, and especially the VSS 5 & 6 will be significantly reduced. In long-term consequences, old forest structure and large tree recruitment and retention will be challenged by climate change pressures where these stands, and VSS 4, 5 and 6's in particular, may suffer greater losses than if they had been treated. The reduction in growth will greatly delay, or forgo, these stands reaching desired conditions of uneven-aged stands with components of old growth structure in the shortest possible timeframe.

Vegetation Composition and Diversity

Direct and Indirect Effect of All Alternatives

In alternative A, ponderosa pine tree canopy would continue to increase, shading out understory herbaceous vegetation and further reducing forage production and species diversity. Historic grasslands, savannas, and forest openings would not be restored. 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. Oak and aspen regeneration ability would continue to be impaired. Ponderosa pine tree canopy would continue to increase, shading out understory sage further reducing the sage component and the historic pattern within the pine sage mosaic.

In alternatives B, C, D and E treatments would result in establishment of vigorous aspen regeneration. The historic forest pattern would be restored within the pine sage. Oak basal area would be 5 percent higher in this habitat compared to the no action alternative. Improved oak conditions would be most prevalent within the mechanically treated Mexican spotted owl restricted other habitat. Overall, post treatment oak basal area would be 5 percent higher in alternatives B, C and E when compared to the alternative A. The basal area in alternative D would be 7 percent higher than alternative A because alternative D reduces the acres of prescribed fires and increases the acres receiving no treatments which lead to an increase in forest densities.

Alternatives B, C, and D treatments would restore historic grasslands, savannas, and forest openings by removing ponderosa pine tree canopy that is shading out understory herbaceous vegetation and reducing forage production and species diversity. Alternatives B and D treat grasslands with prescribed fire only while alternative C treat grasslands with a combination of Mechanical and prescribed fire. Alterative E treats historic grasslands, savannas, and forest openings that are not classified as timber suitable lands.

Other Direct and Indirect Effects

Residual Tree Damage

There would be no project-related harvest or tractor yarding of material in alternative A. Some damage to residual trees would be expected in alternative A with the continued felling, tractor yarding and piling operations associated with planned and future harvesting operations that would occur as the forest plans are implemented. Damage would be minimized through contract administration and proper harvest methods. All piling and/or low-severity burning treatments would reduce understory stocking and reduce inter-tree competition as well as stimulate understory vegetation (shrubs, forbs, grasses).

Some damage to residual trees would be expected in alternative B and D with the felling, tractor yarding and piling operations associated with mechanical treatments in ponderosa pine on approximately 384,966 acres of ponderosa pine (table 54). Damage would be minimized through contract administration and proper harvest methods. All piling and/or low-severity burning treatments would reduce understory stocking and reduce inter-tree competition as well as stimulate understory vegetation (shrubs, forbs, grasses).

Some damage to residual trees would be expected in alternatives C with the felling, tractor yarding and piling operations associated with mechanical treatments in ponderosa pine on

431,049 acres. Some damage to residual trees would be expected in alternatives E with the felling, tractor yarding and piling operations associated with mechanical treatments in ponderosa pine on 403,218 acres.

Table 54. Alternatives B, C, D and E residual tree damage

Ground-disturbing Actions	Alternative B	Alternative C	Alternative D	Alternative E
Felling, tractor yarding, piling (acres)	384, 966	431,049	384, 966	403,218

Alternative E would result in the most potential damage because of the extensive harvesting using individual tree selection in overly dense stands. Damage would be minimized through contract administration and proper harvest methods. All piling and/or low-severity burning treatments would reduce understory stocking and reduce inter-tree competition as well as stimulate understory vegetation (shrubs, forbs, grasses).

Some damage to residual trees would be expected in alternatives B through E with the felling, tractor yarding and piling operations associated with mechanical treatments in ponderosa pine. Alternative E would result in the most potential damage. Damage would be minimized through contract administration and proper harvest methods. All piling and/or low-severity burning treatments would reduce understory stocking and reduce inter-tree competition as well as stimulate understory vegetation (shrubs, forbs, grasses). The differences between residual tree damage in alternatives B and D versus C and E are the additional grassland mechanical acre treatments specific to C and E (see silviculture report, tables 43, 59, 69 and 81).

Sustained Yield of Forest Products

In alternative A, there would be no beneficial effect of timber harvest (no biomass output) from this project. Forest products would continue to be provided as the forest plans are implemented.

The direct benefits to the Coconino NF from timber harvest would range from 243,299,684 cubic feet of biomass) to 245,343,350 (alternative C and E). On the Kaibab NF, the biomass output would range from 122,393,816 cubic feet (alternative C and E) to 122,856,697 (alternative B and D). On the Coconino NF, alternatives C and E provide the most biomass. On the Kaibab NF, alternative B and D provides the most (see table 55).

Table 55. Cubic feet of biomass (forest products) by alternative and national forest

National Forest	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Coconino NF	Under forest plan implementation	243,302,331	245,343,350	243,299,684	245,343,350
Kaibab NF	Under forest plan implementation	122,856,697	122,393,816	122,856,697	122,393,816
Total	Under forest plan implementation	**366,159,029**	**367,737,165**	**366,156,380**	**367,737,166**

In alternative A, vegetation development (ingrowth and mortality) within current road right-of-ways would continue on the current trajectory. In alternatives B through E road decommissioning would allow ingrowth of forest vegetation once the road is decommissioned (approximately 2,712 acres).

In alternatives B through E constructing temporary roads would remove trees and forest vegetation within the road right-of-ways on approximately 735 acres. Opening decommissioned roads may remove trees and forest vegetation that has become established (within the road right-of-way since the road was last maintained) within approximately 816 acres. Road reconstruction consists of road improvement activities and road realignments activities, Road realignment of 10 miles of road would remove approximately 30 acres of trees and forest vegetation within the area being reconstructed. 30 miles of road improvement would be expected to occur on small discreet areas and would be expected to remove about 100 acres of forest vegetation. The above listed effects cover the maximum range of management actions.

Aspen Fencing

In alternatives B through E aspen fencing would occur after mechanical and burning treatments and would have no effect to the vegetation. Leaving felled material on the ground for jackstrawing would forego the opportunity to use that material for wood products.

Springs and Channels

In alternatives B through E, springs and ephemeral channels are inclusions within the mechanical and burn treatment areas. Any tree removal that occurs as part of the restoration of these areas would be part of the design for those mechanical treatments that occur around these areas and the effects to the forest vegetation would be similar to the overall treatment. Fencing would have no effect to the vegetation. Bank re-contouring and stabilization would occur along 39 miles of ephemeral channels. This activity would disturb existing forest vegetation. Up to 5 miles of willow reestablishment would occur where evidence indicates historic willow presence. This would create vegetation diversity and allow natural willow expansion into adjacent areas of suitable habitat. The above listed effects cover the maximum range of management actions.

Natural Range of Variability (NRV)

In alternative A trees per acre (greater than 5 inches d.b.h.) and basal area would continue to increase from the historic range, and in most cases the averages exceed the historic range by 2020 and 2050. This alternative represents an increase in tree density, slowing of tree growths, and increased risks from fire, insects, and diseases (see appendix C in the silviculture report for the detailed analysis).

In alternatives B through E, forest attributes (e.g. trees per acre, basal area) would be within the NRV except for Mexican spotted owl PACs, goshawk nest areas and Mexican spotted owl target threshold habitats. As the intensity of treatments increase, the habitats would be structured most closely to the lower end of the NRV. No Proposed Treatments" areas would all exceed the NRV. Mechanical treatments plus fire are more effective than fire alone. But fire is an essential element to achieve the best results to move toward desired conditions.

In alternative C all basal areas increase as other non-pine components increase in size (i.e., Gambel oak) except for Arizona Game and Fish designs which trend away from the NRV.

In alternative D forest attributes would tend to remain at the high end of the NRV. All basal areas increase as other non-pine components increase in size (i.e., Gambel oak). Treatments within goshawk PFAs, Mexican spotted owl PACs, restricted and target and threshold would trend to the high end or exceed the historic ranges.

In alternative E pine basal areas remain within historic ranges but trend into the high end of the range as treatment intensities lessen. Treatments within goshawk PFAs, Mexican spotted owl PAC, restricted, target and threshold would trend to the high end or exceed the historic ranges as does the Arizona Game and Fish design.

Cumulative Effects

For this cumulative effects analysis, the spatial context being considered is the 988,764 acre project area. Cumulative effects are discussed in terms of vegetation and wildfire management activities that have occurred since 2001 and as changes in the existing condition due to present and foreseeable activities, including the effects of the alternative being discussed. The baseline year used for this analysis is the year 2010 as the existing condition. In this analysis, all past activities and events are included in the existing condition description. In the effects discussion, post treatment refers to the time the final activity is accomplished (year 2020), "short-term" effects refers to effects over the 10-year period from the time the final activity was accomplished (year 2030). Beyond 20-years we will be considering effects as "long-term" (year 2050). All Alternatives are compared across forest boundaries (Coconino-Kaibab combined).

Various vegetation management, fuels treatment and prescribed burning that have occurred within the project area from 2001 to 2014. Mechanical vegetation management activities have mainly consisted of tree thinning. This includes 50,940 acres with a fuels reduction emphasis, 14,950 acres with a ponderosa pine restoration emphasis and 750 acres with an emphasis on improving forest structure, health and growth. There has also been 12,560 acres of tree removal to restore ponderosa pine savannas and encroached grasslands, 2,650 acres of removal of dead, damaged or dwarf mistletoe infected trees to improve forest health, 100 acres of tree removal to restore aspen inclusions and 1,935 acres of habitat improvement treatments that reduced tree density within antelope travel corridors. Within the project area there has been 640 acres of tree and vegetation removal associated with powerline corridor management and protection.

Fuels treatments that have been accomplished in association with the above listed mechanical treatments included 3,910 acres of mechanical fuels treatments, 5,070 acres of machine piling and burning and 59,640 acres of broadcast burning. The primary focus of these treatments was to rearrange and reduce activities generated fuels.

Prescribed burns have been implemented on 47,970 acres to reduce natural fuels accumulations and reintroduce fire to fire adapted ecosystems.

Wildfires from 2001 to 2014 effects (silviculture report, tables 94 and 95) have burned on approximately 255,067 acres in or adjacent to the project area. Of these acres, it is estimated that the overall average burn severity to the vegetation was 20 percent high severity, 30 percent mixed severity and 50 percent low severity. There is wide variability among these percentages from fire to fire.

Many of the wildfires that burned within the project in the last 10 years were managed primarily for resource objectives instead of primarily for suppression) (fire ecology specialist report), and produced primarily low severity. All of the projects have decreased the potential for active crown fire and crown fire initiation on acres thinned (14,666), and the potential for crown fire initiation, and high severity effects from surface fire on about 50,900 acres of prescribed fire, and about 52,422 acres of wildfire. Past mechanical and prescribed fire treatments decreased the potential for crown fire by breaking up the vertical and horizontal continuity of canopy fuels.

Cumulative Effects of Alternative A

In alternative A there would be no change 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 adjacent to the project area. Approximately 43,041 acres of vegetation treatments and 58,714 acres of prescribed fire and maintenance burning would be implemented adjacent to the project area by the Forests in the foreseeable future (within 5 years). It is expected that when these actions are completed that these acres will be moving toward the desired conditions. The thinning and prescribed fires treatments in the prior 10 year period were designed to set up the stands to reach their desired conditions according to the then approved forest plans. In conjunction with mechanical treatments there were prescribed fire only treatments designed as fuels treatments to reduce surface fuels as well as reduce ladder fuels and crown fire risks. To those ends the prior treatments will move the acres toward their desired conditions.

The prior thinning and burn and burn only treatments do not indicate that they were primarily to treat within Mexican spotted owl habitat and these habitats will remain overly dense and prone to slow growth, increased insect risks, and high risk for crown fires (Silviculture Report, Table 32).

During past treatments, burning, while allowed outside of core areas, personnel were reluctant to conduct prescribed fires without prior mechanical treatment. Planned treatments will aid forest structure but because of treatment constraints (similar to 4FRI) these stand densities will remain high as will crown fire risk. The Williams District is proposing to treat 31 acres in preparation of cable logging operations within Mexican spotted owl PACs that would cause a loss of most snags and trees (including snags greater than 18 inches d.b.h. and trees greater than 24 inches d.b.h.) across approximately 15 percent of the area with this proposed treatment within the PAC to provide cable corridors and safe logging operations. Approximately 15 percent, or 5 acres, of the PAC area treated with cable logging operations would have most trees removed. 4FRI is not proposing any cable logging operations. Most of the untreated area continues to move away from the desired conditions. Treatments within Mexican spotted owl core areas and PACs are high density stands with high canopy cover and they do not move toward nor are they on trajectories to desired conditions. They remain high risk stands for mortality, density related and bark beetle, and fire.

The treatment acres planned in goshawk habitat within the next 5 years are small, but they will move the forest toward their desired conditions. Density in terms of SDI and basal area continues to increase and remains higher than desired in all habitats. All habitats show an increase in total coarse woody debris (CWD), CWD larger than 12 inches and snags larger than 18 inches between 2020 and 2050 resulting in conditions at or close to desired. Most of the untreated area continues to move away from the desired conditions. Planned forest treatments within this forest component will move the forests toward their desired conditions. Untreated acres will continue to move away from their desired conditions. The presence of prescribed or wildland fire may or may not move untreated acres toward their desired conditions.

In Alternative A, the no change alternative, few treatments would be implemented to create a mosaic of interspaces and tree groups. Existing interspace would continue to be reduced by expanding tree crowns and increased tree densities. Understory vegetation response would be suppressed. Fire risks would not be reduced and would continue to increase. Any large scale tree mortality occurring has the potential to enhance interspace and create tree groups. While the Kaibab and the Coconino have an emphasis to favor uneven-aged management, this silvicultural system does not assure interspaces and groups. The new Kaibab forest plan (2014) has a decidedly restoration silvicultural preference, it has yet to be implemented over large acreages, and in fact will rely on 4FRI for most of the restoration treatments (Kaibab forest plan, p. 20). The Coconino NF has latitude to create opening and groups but has not implemented large areas of openness to date except within wildland-urban interface treatments. In terms of a mosaic of interspaces and tree groups at the landscape level the prior treatments do not significantly move the forest toward the desired conditions at this time.

In Alternative A few treatments would be implemented to create a mosaic of interspaces and tree groups. Existing interspace would continue to be reduced by expanding tree crowns and increased tree densities. Understory vegetation response would be suppressed. Fire risks would not be reduced and would continue to increase. Any large scale tree mortality occurring has the potential to enhance interspace and create tree groups. Overall, currently planned forest treatments should move treated stands toward a trajectory for uneven-aged desired conditions. Untreated stands would continue to move away from desired conditions as densities increase, beetle risks increases and risks of crown fire increase. Forest products would continue to be produced from treated acres.

Cumulative Effects of Alternatives B through E

Past treatments that have resulted in the existing condition were described earlier. Mechanical treatments in alternatives B-D were similarly modeled from a consistent set of assumptions (see silviculture report, table 3). The outputs from the model, across treatments and through time, would have similar results because they are all derived from the same dataset. What varies are the acres treated and the amendments applied to the Coconino NF acres. Grassland and savanna treatments are found in alternative B-D but not in alternative E. Several special area treatments were identified through public comment and are shown separately.

On the Kaibab NF, foreseeable treatments would be restoration-type treatments or there would be a restoration-type treatment option as a result of moving toward the desired conditions outlined in the revised forest plan (USDA 2014). Most all past treatments on the Coconino and Kaibab NF (either even-aged or uneven-aged prescriptions), left the forest with denser stands when compared to the restoration treatments proposed in this project. Spatially, the prior treatments (until recently) tried to leave a uniform distribution of trees with only natural canopy gaps and meadows for openings. The proposed restoration prescriptions would leave a more open forest, post treatment than was prescribed in past treatments. There would be distinct interspaces, groups, and regeneration openings of varying sizes across the landscape to enhance structural diversity. Planned interspaces would average between 10 to 90 percent at the stand level, while canopy cover would be managed at the group level. The proposed restoration treatments are a departure from past management and have desired conditions for interspaces and groups that would move these stands toward a more Natural Range of Variability.

Current stand canopy cover is rooted in past plans and prescriptions for even-aged and uneven-aged management. Canopy cover was managed at the stand level since stands are the basic unit of management. The past emphasis was not necessarily to create new openings within the stands (interspaces) but to enhance site productivity in terms of volumes. The majority of the analysis area is moderately closed (29 percent) to closed (45 percent) indicative of prior treatments prescriptions pre- and post-1996. Because of the current high degree of closed canopy stands, most would be treated under this proposal to reduce canopy cover.

Many prior treated stands would be treated in this project to bring them within their Natural Range of Variability. Most of the prior treated stands are still too dense, canopies too closed, and risks too high (fire and insects) to qualify as a restoration treatment. However, the prior treatments will make it easier to set the stands on a trajectory for restoration. Some foreseeable treatments on the proposed 55,531 acres may leave adequate openness, in terms of the Natural Range of Variability (i.e. 17,838 acres on Turkey/Barney Pasture Forest Health Restoration where dwarf mistletoe and tornado salvage are prime drivers) while others have different priorities and will not necessarily appreciably open the forest. For example the Watts Vegetation Management Project would treat 3,000 acres of non-forest product objective to provide fuelwood and alleviate illegal fuelwood cutting). Foreseeable planned projects would not be of sufficient size to significantly affect openness when considered this project.

Prior mechanical and prescribed fire treatments within Mexican spotted owl habitat (especially PACs and core areas), were either not completed or were completed to a lesser degree to reduce the potential for damaging Mexican spotted owl habitat without prior mechanical preparations. For this reason, prior treatments have done little to reduce the high fire dangers associated with treating these habitats. This project would mechanically treat Mexican spotted owl habitat prior to most burns (some PACs are scheduled for prescribed fire-only treatments) and the risk of unintentional damage by fire would be reduced (somewhat). With this project, Mexican spotted owl PACs and core areas would remain very dense with closed canopies and, therefore, remain very prone to wildfire, density related mortality, insect attacks, and crown fire damage even post-treatments. Prior treatments and proposed treatments within Mexican spotted owl habitat would maintain or move these habitats toward their desired conditions over approximately 108,847 acres.

Alternatives B, C, and D all propose treating up to 16 inches d.b.h. (alternatives B and D) or 17.9 inches d.b.h. (alternative C) in PACs and some treatments within PAC core areas. Alternative C proposes reducing the target basal area in PACs from 150 to 110 to be in alignment with the 2012 Mexican spotted owl guidelines. The proposed treatments within PACs, if completed, would benefit the structural components of the stands, but would still leave them at fairly high densities, SDI, beetle, and crown fire risks.

The proposed treatments that leave high densities within Mexican spotted owl habitat, while not ideal in terms of forest health, would be somewhat offset by their juxtaposition of treated stands surrounding them and offering some protection from uncharacteristic fire, but not offering relief in terms of beetle, density related mortality, or unintended fire ignitions within the habitat boundary. The Mexican spotted owl habitats would remain high risk areas for damage (fire, insect/disease, density) post treatment simply due to the nature of the stand structures required by legislation, and treatment can offer only a limited amount of mitigation.

In goshawk habitat, prior treatments over 169,430 acres have reduced densities within both PFA and LOPFA areas. Treatments from 2001 to 2010 period emphasized uneven-aged management. These acres were designed to move toward forest plans desired conditions. Many of these past treatments would not need mechanical treatments for another 20 years. However under the current 4FRI project many of these stands would be treated again to restore them to within their Natural Range of Variability. Up to 586,110 acres of treatments would occur in this project. When considered with the foreseeable 55,531 acres of treatments that would occur across the Coconino and Kaibab NFs, approximately 638,861 acres would move toward improving forest health and vegetation diversity/composition, sustaining old forest structure over time, and moving forest structure toward the desired conditions.

Mechanical treatments with prescribed fire or prescribed fire-only in this project, combined with proposed (foreseeable) 55,531 acres of prescribed fires and mechanical treatments across the two forests would reduce uncharacteristic fire behavior and crown fire potential on approximately 811,071 acres over the next 10 years. The synergy between the prior treatments and the proposed treatments offer some of the best possible outcomes to reduce uncharacteristic fire behavior in these treatment areas.

Forest Plan Amendments

The following is a description of how the forest plan amendments under this EIS would modify the forest plans standards and guidelines and what the effects to the vegetation resource would be if the amendment did not occur.

Coconino NF

Amendment 1 in alternatives B and D: If the amendment did not occur mechanical treatments would be limited to a maximum of 9 inches d.b.h. in the 18 PACs thereby restricting the treatment to a fuels reduction objective and reducing the ability to improve Mexican spotted owl habitat in terms of age class diversity and liberation of overtopped oak. Treatments within this habitat would continue to meet the intent of the Mexican Spotted Owl Recovery Plan and the Mexican spotted owl habitat definition would not have an effect on the treatments themselves or their outcomes. Following existing forest plan language concerning Mexican spotted owl population and habitat monitoring or Mexican spotted owl habitat design would not have an effect on the treatments themselves or their outcomes.

Amendment 1 in alternative C: If the amendment did not occur mechanical treatments would be limited to a maximum of 9 inches d.b.h. in the 18 PACs. This would restrict the treatment to a fuels reduction objective and reduce the ability to improve Mexican spotted owl habitat in terms of age class diversity and liberation of overtopped oak. Without the use of prescribed fire in 54 Mexican spotted owl core areas, the opportunity to improve Mexican spotted owl habitat in terms of reducing litter/duff cover and stimulating regeneration and growth of native herbaceous vegetation would be eliminated.

Treatments within Mexican spotted owl habitat would continue to meet the intent of the Mexican Spotted Owl Recovery Plan and the habitat definition would not have an effect on the treatments themselves or their outcomes. Mechanical treatments within the 6,299 acres of target/threshold habitat would follow the denser 150 square feet basal area guidance thereby reducing the ability to improve Mexican spotted owl nesting/roosting habitat in terms of sustainability, as indicated by high potential for density related mortality and high bark beetle hazard rating, as well as reducing the ability to improve age class diversity and the liberation of overtopped oak. Following existing forest plan language concerning Mexican spotted owl population and habitat monitoring or Mexican spotted owl habitat design would not have an effect on the treatments themselves or their outcomes.

Amendment 2 in alternatives B, C and D: If the amendment did not occur the lack of clarifying language describing the relationship between non-forested areas (interspace) and natural openings across the landscape could result in interspace establishment being eliminated from the treatment design. The only features contributing to landscape openness would be existing natural openings. If that were to occur, it would inhibit the ability to meet desired conditions in terms of creating a mosaic of interspaces and tree groups of varying shapes and sizes, enhancing the representation of all age and size classes, sustaining old forest structure across the landscape, improving forest health, and enriching vegetation diversity and composition.

The plans lack explicit language for measuring canopy cover. Treatments within goshawk habitat would continue to meet the intent of the forest plans with regards to canopy cover and the lack of explicit language for how or where it is measured would not have an effect on the treatments themselves or their outcomes. Approximately 28,653 acres in alternative C and 28,952 acres in alternatives B and D would be managed under the current forest plan guidelines and desired conditions consistent with an open reference condition would not be met. Treatments within goshawk habitat would continue to meet the intent of the forest plan guidelines. Defining these terms is for clarification purposes and would not have an effect on the treatments themselves or their outcomes.

Amendment 3 in alternatives B, C and D: If the amendment did not occur, it could potentially result in areas not being treated to attain a “no effect” determination. Without treatment, these areas would not move toward desired conditions in terms of creating a mosaic of interspaces and tree groups of varying shapes and sizes, enhancing the representation of all age and size classes, sustaining old forest structure across the landscape, improving forest health and enriching vegetation diversity and composition.

Forest Plan Consistency

Based on the direct effects of alternative A, the project vegetation conditions would continue to move away from the desired conditions outlined in the revised Kaibab forest plan. However, alternative A would not violate any Kaibab forest plan standards or guidelines.

Based on the direct effects of Alternative A, the project vegetation conditions would continue to move away from the desired 4FRI project desired conditions. However, alternative A would not violate any Coconino NF forest plan standards or guidelines.

Alternatives B, C, D and E are consistent with the Kaibab forest plan and the Coconino forest plan standards and the Regionally Consistent Standards and Guidelines as described in the Management Direction section of the silviculture report and as amended under this FEIS. Consistency with the Coconino and Kaibab NF forest plans is also discussed in all treatment designs displayed in the project Implementation Plan (FEIS, appendix D). Consistency with the Coconino NF forest plan is specifically addressed above in the “forest plan amendment” section.

Fire Ecology

Only a summary of the fire ecology analysis is presented here and the report is incorporated by reference. See the fire ecology specialist report (Lata 2014) for the complete analysis. Fire behavior was analyzed at several scales including the project scale (593,211-acre treatment area), the RU, the subunit, and the vegetation type/habitat type to provide a thorough analysis of specific fire effects to different areas. FRCC was analyzed at the project area scale for ponderosa pine and grasslands as they make up 90 percent of the project area. See the specialist report for the complete discussion on analysis methodology.

Changes from the Draft Environmental Impact Statement

As a result of having a new alternative, the discussion, figures, and tables under ‘Summary of Alternatives’ were all expanded to include alternative E, and outputs for the FRCC evaluation for were added to appendix D.

Throughout the fire and air quality report, discussions on potential fire behavior and effects are discussed quantitatively in either acres, or in percent of an area (habitat type, Restoration Unit, Subunit, etc.). These numbers were adjusted for 11 maps, 132 tables, and 35 graphs, to account for changes in boundaries and acres for PACs, PFAs, areas of overlap between 4FRI and other projects, control watersheds for research, and wildfires. Data updated includes descriptions of each alternative, fire type, acres of fuel loading by stand and by treatment, canopy characteristics, Fire Regime Condition Class / Vegetative Condition Class, annual acres to be burned, and fire return intervals. Table 136 in the specialist report shows the difference in the percent of area for each fire type in each major vegetation type for each alternative.

Quantitative data for Fire Regime Condition Class (FRCC) in grasslands was removed and replaced with qualitative. The original data set had “stands” with a Final Cover Type as “Grasslands” that also had VSS, Canopy Closure classification, and single story (SS) vs. multi-story (MS). Those data were used, along with professional expertise and experience in grasslands and FRCC, and professional knowledge for expectations for fire/fire effects to anticipate rough changes to grassland FRCC. In discussions with other team members, the fire ecologist realized that there had been very few grassland stands with tree data, so stand data had to use a version of Most Similar Neighbor for those stands. After looking harder at the data, it seemed like too many assumptions were needed to complete a valid FRCC analysis for montane grasslands in the project area. FRCC software was more accurately interpreted, so Vegetation Condition Class is now included along with FRCC.

Consultation with the weed coordinator for the Coconino National Forest resulted in better numbers for uncharacteristic vegetation (non-native dominated) acres for the ponderosa pine.

Public comments resulted in additional explanation of the parameters used for fire modeling (see fire report, table 2). Additional numbers were added to help clarify which parameters were used, why they were used, and how to interpret them.

Many comments from the public referred to “fuels treatments,” which is a misnomer since, with the exception of 535 acres in RU6, “fuels” is not the primary objective of any 4FRI treatments. The existing discussion was expanded slightly (paragraphs 2 and 3 of the fire report).

Three mitigations were added:

- FE16 was added to ensure Fire Managers and Range Managers coordinate grazing in advance of prescribed fire to ensure there is sufficient surface fuel to meet burn objectives.
- FE17 was added to address managing coarse woody debris.
- FE18 was added to minimize impacts to threatened and sensitive frog species and to avoid the spread of invasive aquatic species when using natural lakes, ponds, or tanks as dip sites for helicopters.

Projects and acres in Cumulative Effects were updated based on better information, updated status of projects, and new projects (in particular, the Flagstaff Watershed Protection Project and the Slide Fire).

In response to public comments, an additional analysis was completed, and added to appendix D, to better explain what is meant by modeling weather percentiles, and to clarify why, for this type of a project, it was not considered to be as useful as the modeling that was done.

Appendix A was updated to reflect direction in the new Kaibab National Forest Land and Resource Management Plan (2014).

In response to public comments, treatment intensity for about 40,000 acres of VSS4, VSS5, and VSS6 stands in alternatives C and E was evaluated as described in appendix D.

Opposing Science

Some commenters (CARA 148, 149, 8) cited publications (Williams and Baker 2013, Williams and Baker 2012) that suggest crown fire was historically much more prevalent in the project area, even in ponderosa pine, than is concluded in the DEIS and in the specialists' reports, in particular the fire ecology, silviculture and wildlife reports. One of the assumptions which is used to make this claim is that the science supporting frequent, low severity fires, is based on "small, scattered studies". The fire ecology report cites over 25 studies that are specific to the project area, and about 50 additional studies that specifically include the rest of Arizona and/or the southwest. Included is a 110 page General Technical Report (Dahms and Geils 1997), that completed an assessment of forest ecosystem health in the southwest, and an 85 page report by The Nature Conservancy (Smith 2006) on historical and current landscape conditions for ponderosa pine in the southwest. The preponderance of science does not agree with Williams and Baker, and was soundly refuted by Fulé et al. (2013). Fulé et al. (2013) has 18 co-authors, including many of the leading researchers of fire ecology in southwestern United States. Reconstructions of dry western US forests in the late 19th century in Arizona, Colorado and Oregon based on General Land Office records were used by Williams and Baker (2012) to infer past fire regimes that had substantial moderate and high-severity burning. They concluded that the patterns of present-day large, high-severity fires are not distinguishable from historical patterns. Fulé et al. (2013) and Fulé 2014 describe errors in their study. First, the use of tree size distributions to reconstruct past fire severity and extent is not supported by empirical age–size relationships nor by studies that directly quantified disturbance history in these forests. Second, the fire severity classification of Williams and Baker (2013) is qualitatively different from most modern classification schemes, and is based on different types of data, leading to an inappropriate comparison. Third, while Williams and Baker (2013) asserted 'surprising' heterogeneity in their reconstructions of stand density and species composition, their data are not substantially different from many previous studies which reached very different conclusions about subsequent forest and fire behavior changes. Contrary to the conclusions of Williams and Baker (2013), the preponderance of scientific evidence indicates that conservation of dry forest ecosystems in the western United States and their ecological, social and economic value is not consistent with a present-day disturbance regime of large, high severity fires, especially under changing climate (Fulé et al. 2013, Fule 2014). In summary, the fire analysis (and project) was informed by the most relevant best available science.

Many papers cited by commenters objecting to mechanical treatments attempted to apply the ecology and/or fire regimes of ecosystems other than ponderosa pine (mixed conifer, spruce fir) or ponderosa pine in the northwest (Northern California, Oregon, Idaho). Ponderosa pine has distinct variations within its geographic range (Oliver and Ryker 1990), and the populations of ponderosa pine in northern Arizona have some fundamental genetic differences from pines in other areas within the range of Ponderosa species (Conkle and Critchfield 1988). There are differences in the openness of crown growth, number of needles, and other characteristics. These two populations would not be expected to have identical fire regimes, even if the study was restricted to ponderosa pine.

There were multiple comments from people objecting to "fuels treatments," "hazardous fuels treatments," and/or "fuels project(s)" (CARA 8, 180). Ecosystem restoration treatments and fuel treatments are not synonymous. Some ecosystem restoration treatments reduce fuel hazard, but not all fuel treatments restore ecosystems. Ecosystem restoration treatments are often designed to recreate presettlement fire regimes, stand structures and species compositions while fuel treatment objectives are primarily to reduce fuels to lessen fire behavior or severity—this is known as “hazard reduction” (Reinhardt et al. 2008). Finney (2001, 2007), and Finney et al. (2007) focused on “fuels management,” which is appropriately used for managing fire behavior when that is the primary concern. However, treating only 20 percent of the landscape, which Finney has shown can be effective in managing fire behavior, would not achieve ecosystem restoration on a landscape scale. An analysis that focuses on where treatments would best minimize fire behavior, may or may not support restoration objectives across the landscape (which include conservation of large and old trees, enhancing large oak, enhancing aspen clones, and other treatments). Of the 586,110 acres proposed for treatment in this EIS, there are about 535 acres of proposed WUI (fuels) treatments. All of the 535 are contiguous and are in RU6 adjacent to the town of Tusayan. With the exception of these acres, the objectives of this EIS are restoration, not hazardous fuels reduction.

One commenter (Cara 8) made multiple references to the work of Jack Cohen (Cohen 1996-2001, 2003, 2008) and related papers. Cohen’s research generally addresses concerns about structure protection, as evidenced by the titles of the 9 Cohen papers referenced by the commenter:

- Reducing the Wildland Fire Threat to Homes: Where and How Much (1999)
- Examination of the Home Destruction in Los Alamos Associated with the Cerro Grande Fire (2000)
- Preventing Disaster – Home Ignitability in the Wildland-Urban Interface (2000)
- What is the Wildland Fire Threat to Homes? (2000)
- Thoughts on the Wildland-Urban Interface Fire Problem (2003)
- The Wildland-Urban Interface Fire Problem: A Consequence of the Fire Exclusion Paradigm (2008)
- Modeling Potential Structure Ignitions from Flame Radiation Exposure with Implications for Wildland/Urban Interface Fire Management (1996)
- Structure Ignition Assessment Can Help Reduce Fire Damages in the W-UI (1997)
- Saving Homes from Wildfires: Regulating the Home Ignition Zone (2001)

We reviewed all these papers, and found the relevancy in these papers was limited to that portion of the 4FRI treatments (about 535 acres) that have a fuels/WUI focus, and how that treatment would be expected to decrease the intensity of a wildfire approaching a WUI area. On those about 535 acres where the proposed treatments are actually fuels treatments, the treatments proposed align with the suggestions here that “fuels treatments” should focus on creating conditions in which fire can occur without devastating consequences, rather than on creating conditions conducive to fire suppression. There was no new information or information that could otherwise inform the analysis. In summary, treating only WUI areas would not meet the purpose and need for restoration and the request to create an alternative was considered to be beyond the scope of the 4FRI and not reasonable enough to warrant alternative development.

Fire and Air Quality Analysis Framework

The following analysis question was used to evaluate movement toward desired conditions by alternative.

Analysis Question 1: Would/how would proposed management actions move the area toward the project's desired condition of having a resilient forest by reducing the potential for undesirable fire behavior and effects? Metrics used to evaluate differences between alternatives include:

- **Type of fire (surface or crown):** Acres (quantitative measure) of each potential fire type following proposed treatments was evaluated.
- **Canopy characteristics—canopy base height, canopy bulk density, and canopy cover (quantitative measures used in fire modeling):** These are canopy characteristics that are important for modeling fire.
- **Surface fuel loading with fire and emissions modeling including coarse woody debris larger than 3 inches, litter, and duff (quantitative measure):** Used to qualitatively evaluate fire effects.
- **FRCC (qualitative measure):** FRCC was determined for ponderosa pine and grasslands which make up the largest vegetation types within the treatment area to determine the relative departure of those ecosystems from reference conditions before and following treatments.

Analysis Question 2: What are the expected effects of smoke/emissions from prescribed fire? This analysis question addresses Key Issue 1, Prescribed Fire Emissions. Metrics used to evaluate differences between alternatives include:

- **Smoke/emissions (quantitative measure)** were evaluated quantitatively by modeled emission quantities in pounds/acre for the most common stand condition under different treatment scenarios.
- **Duff and Coarse Woody Debris >3 inches (quantitative measure)** produce the greatest percentages of emissions when they burn. A minimum amount of litter is necessary for a fire to move across the surface, so changes in those fuel components were modeled, and mapped for a qualitative assessment.

Affected Environment

Existing and desired conditions for fire behavior and FRCC are addressed in the fire ecology section in chapter 1. Most existing condition information is not repeated here.

Fire Behavior at the Landscape Scale

Fire type was modeled for conditions similar to those under which the Schultz Fire burned in 2010. These were not extreme in terms of fuel moisture, temperature (77 degrees Fahrenheit), or relative humidity (11 percent), though fuels were dry, and it was windy (steady at 23 miles per hour). These conditions are common in June across the project area.

Fire Behavior by Restoration Unit (RU)

RU 1

RU 1 is currently the most at risk of all the restoration units in regards to crown fire and its effects. Approximately 42 percent of the RU has crown fire potential, of which 31 percent would be active crown fire. Values at risk in or adjacent to RU1 include: Lake Mary, a source watershed for Flagstaff, and a popular recreation site for locals and visitors to the area (sub-unit 1-1); Pulliam Airport, the commercial airport that serves Flagstaff and surrounding communities (sub-unit 1-1); eastern and southern portions of the city of Flagstaff; the Perkins Telescope (sub-unit 1-1); numerous Mexican spotted owl PACs (more than any other RU), and Walnut Canyon National Monument (sub-unit 1-1). Figure 39 displays locations of no fire, surface, and active/passive crown fire. “No fire” includes that could not burn under conditions modeled because of sparse vegetation (such as on some cinder soils) or no vegetation (water, rock, etc.).

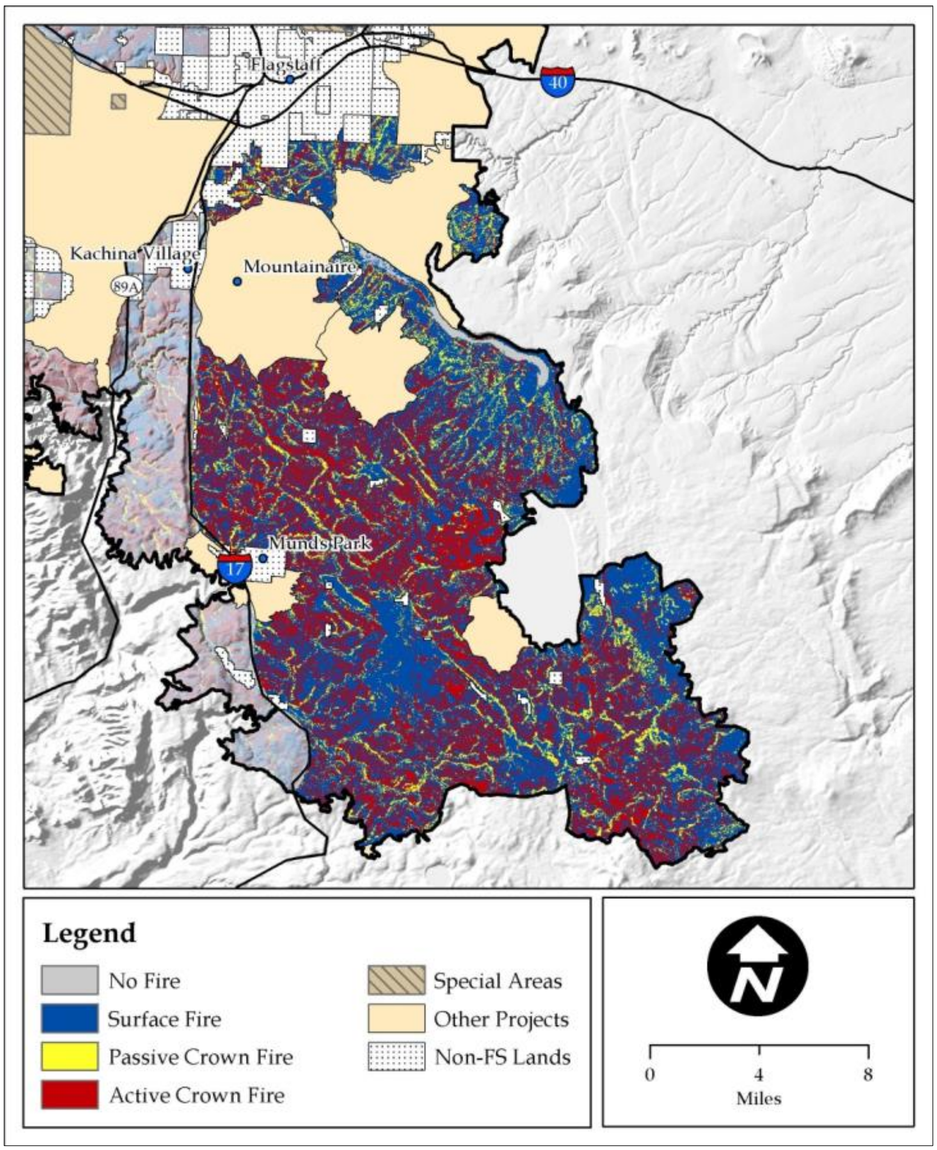


Figure 39. Existing fire potential in RU 1

RU 3

RU 3 has the second greatest potential for undesirable fire effects and behavior. Approximately 39 percent of RU 3 has crown fire potential, of which 30 percent would be active crown fire. Winds on the Mogollon Rim are generally out of the southwest; therefore, values at risk in this restoration unit include: Interstate 17 and Interstate 40, as well as the communities of Flagstaff, Munds Park, Williams, Belmont, Kachina Village, Parks, and Sycamore and Oak Creek Canyon.

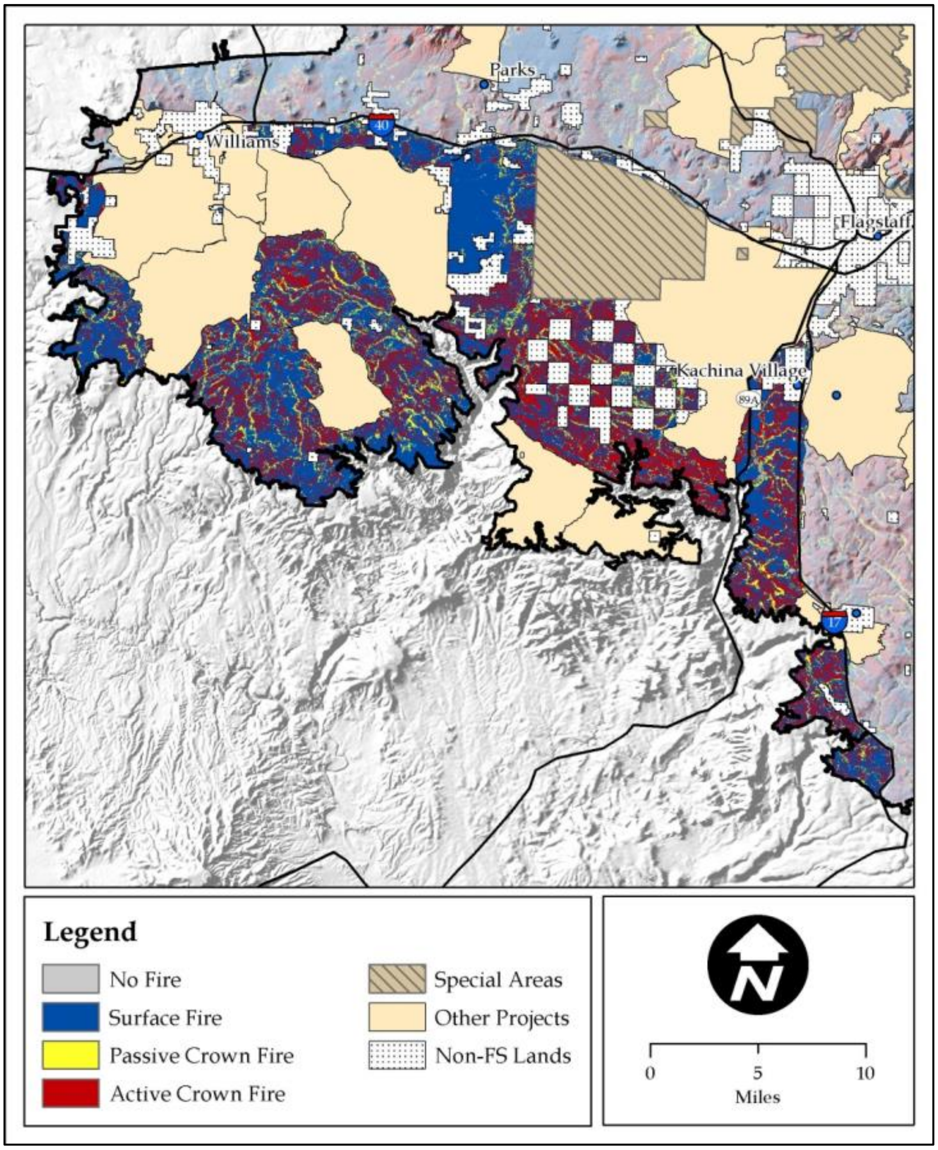


Figure 40. Existing fire potential in RU 3

RU 4

RU 4 has a 32 percent potential for crown fire, of which 25 percent would be active crown fire. RU 4 is located west and north of Flagstaff, and north of Williams and Interstate 40. Wildfire in RU4 has potential to affect the communities of Flagstaff, Williams, Parks, and Belmont, though the prevailing winds would draw fire away from these communities. There is also potential to impact the Fort Valley Experimental Station northwest of Flagstaff.

Over the last 20 years, RU4 has been impacted by several large fires, including the Hockderffer (2004, 16,000 acres) and Pumpkin (2000, 8,700 acres) fires. Areas of potential active crown fire currently exist adjacent to heavy fuel loading in mixed conifer on Kendrick and Sitgreaves mountains, and the San Francisco Peaks.

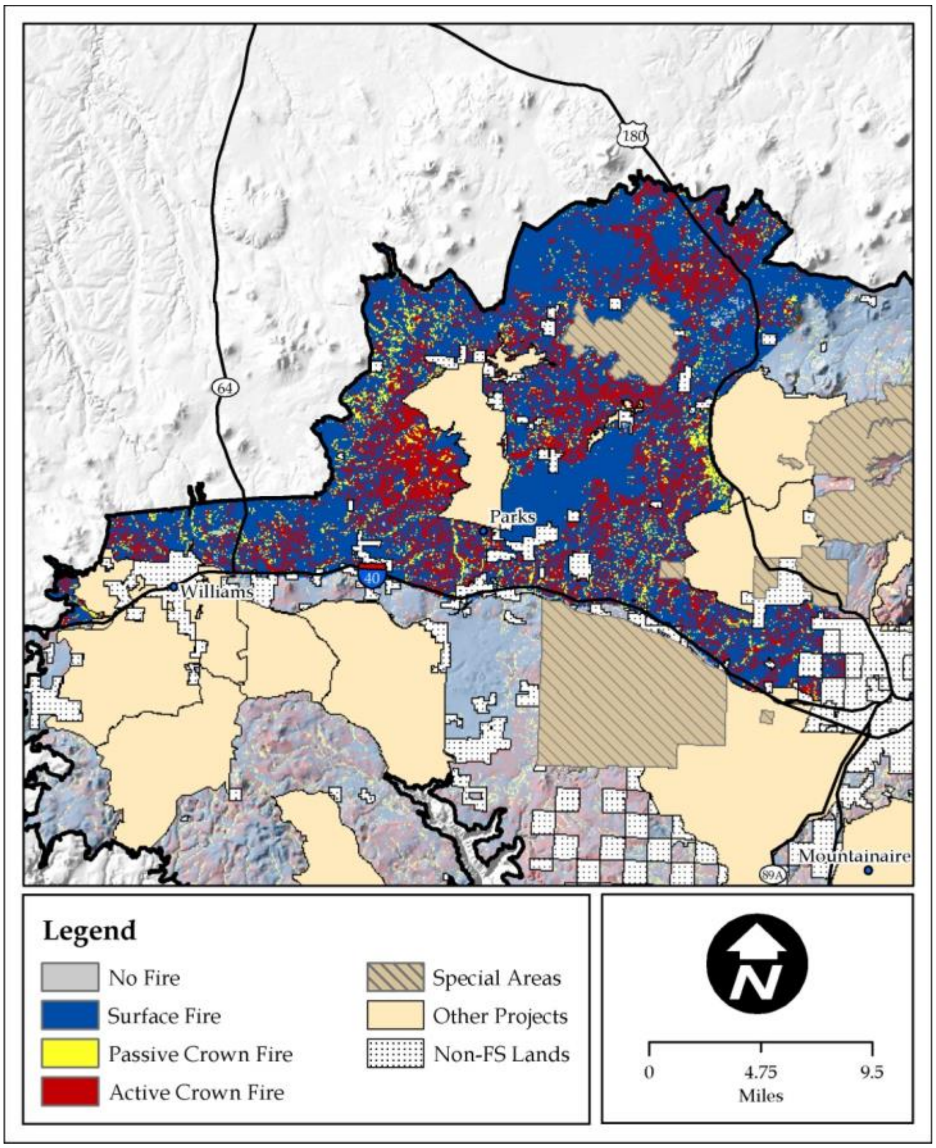


Figure 41. Existing fire potential in RU 4

RU 5

RU 5 has 21 percent potential for crown fire, of which over half would be active crown fire. This restoration unit includes acres burned in the Schultz fire (2010, 17,000 acres) and acres burned in the Radio Fire (1977, 2,600 acres). The Radio Fire burned area is mostly on Mount Elden, which is immediately upslope and adjacent to northern Flagstaff. Housing developments (including Doney Park) and the city of Flagstaff would be adjacent and mostly downslope from any fire occurring in this restoration unit.

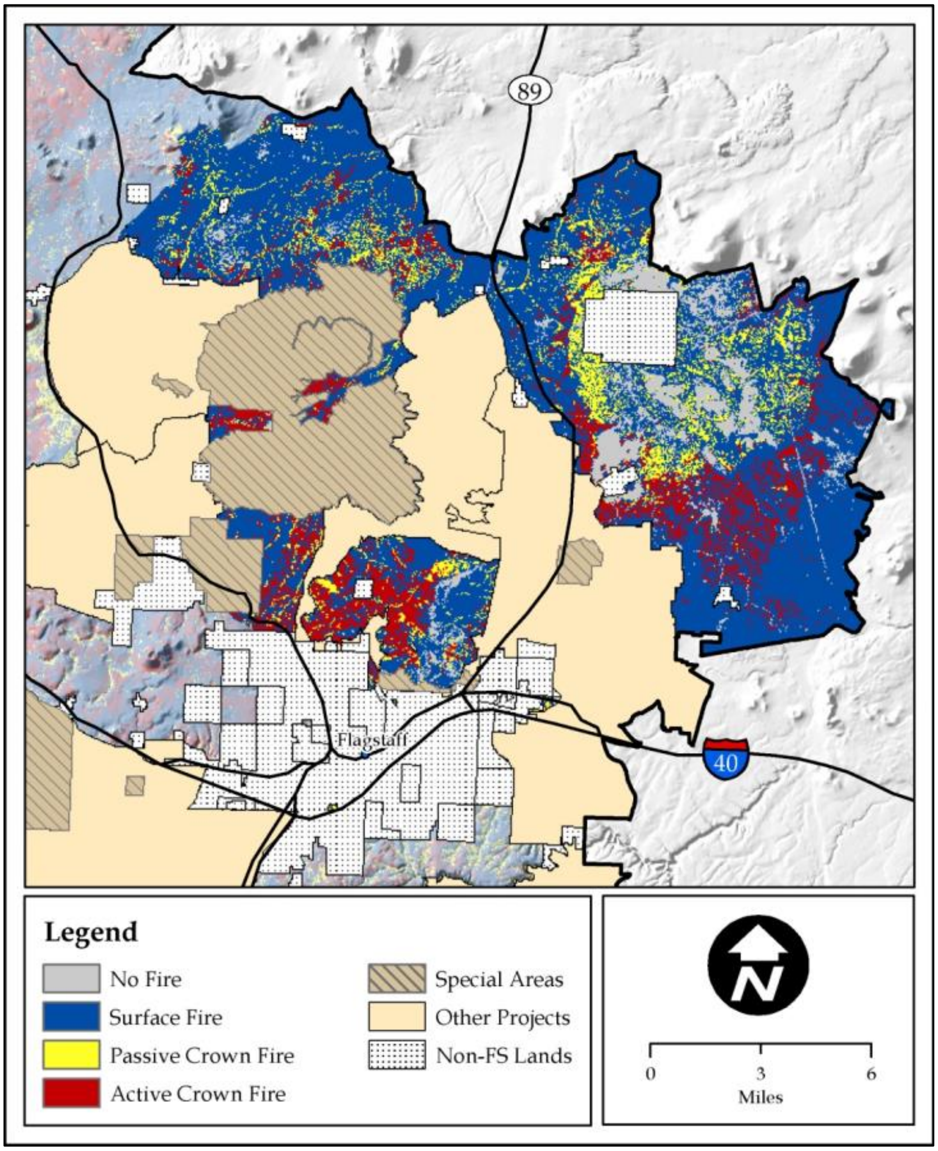


Figure 42. Existing Fire Potential in RU 5

RU 6

RU 6 has a 19 percent potential for crown fire. Of this percent, over 50 percent would be active crown fire. RU 6 is entirely within the Tusayan Ranger District (Kaibab NF). It is located in close proximity to the town of Tusayan and located immediately south of, and adjacent to, Grand Canyon National Park. RU 6 is the driest of all the restoration units. Over half of the RU has been affected by wildfire in the last 10 years. Potential fire behavior in pinyon-juniper which is adjacent to the town of Tusayan is a concern.

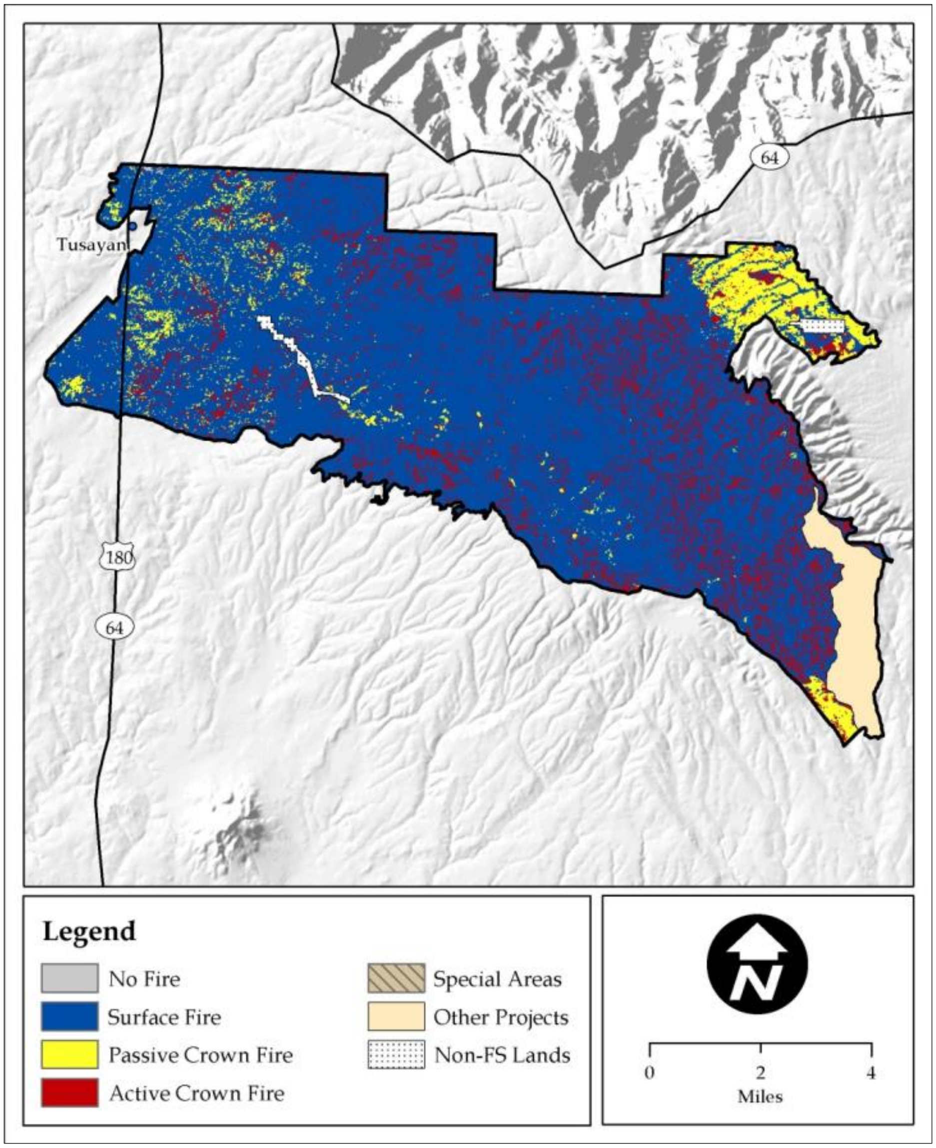


Figure 43. Existing Fire Potential in RU 6

Canopy Characteristics and Surface Fuels Affecting Fire Behavior

The existing and desired condition for canopy characteristics (canopy base heights and canopy bulk density) and surface fuels (coarse woody debris greater than 3 inches, litter, and duff) are presented in chapter 1.

Fire Regime Condition Class

The existing and desired conditions for fire regime condition class are presented in chapter 1.

Environmental Consequences

Throughout this section, changes directly attributable to proposed actions, such as thinning or prescribed fire, are direct effects. These include changes to canopy bulk density, canopy base height, consumption of surface fuel, etc. Changes to the potential behavior and effects of wildfires that result from the direct effects are considered indirect effects.

Alternative A – Direct and Indirect Effects

Under alternative A, there would be no changes to current management and the forest plans would continue to be implemented.

Fire Behavior at the Landscape Scale

At the landscape scale, 38 percent of ponderosa pine and 9 percent of grasslands would have the potential for high-severity effects from crown fire. The potential for crown fire exceeds the desired condition in ponderosa pine by 24 percent and 6 percent in grasslands. Modeled fire type shows the potential for multiple, large (greater than 1,000 acres), high-severity fires across the landscape, with the actual extents dependent on ignition location and environmental conditions. As canopies close up, surface fuel loading would also continue to increase. In the long term (2050), more area would be subject to high-severity surface fire. The changes in canopy fuels would have detrimental effects on understory vegetation and would increasingly suppress surface vegetation (forbs, grasses, and shrubs). The combination of abundant and contiguous canopy fuels, the lack of understory vegetation, and an already high and increasing surface fuel load, would combine to increase the potential for high-severity fire, maintaining the area in a fire regime condition class of 3 into the foreseeable future.

Fire Behavior at the Restoration Unit Scale

In 2020, no restoration units would meet desired conditions for fire behavior, ranging from 42 percent (RU 1) to 14 percent (RU 6) (table 56). In RU 1, there is potential for 60,000 acres of ponderosa pine to burn with high severity (potential crown fire combined with the potential for high-severity surface fire), a subset of which would convert to a non-forested vegetation type (Savage and Mast 2005). Should wildfire burn though the Lake Mary watershed, the second order fire effects (debris flows, and flooding with sediment-laden water) could jeopardize the water supply (from the lakes) as well as, at least temporarily, require the closure of the recreation sites.

In RU 3, multiple drainages line up with the prevailing winds and have the potential to draw fire toward communities, such as Pumphouse Wash (Kachina Village) and Munds Canyon (Munds Park). Adjacency concerns for fire behavior include a number of communities as well as Oak Creek and Sycamore Canyons. Second order fire effects (flooding, debris flows, deposition, erosion, etc.) would have potential to impact Oak Creek and Sycamore Canyons, with the specific locations depending on the slope, proximity, and size of high-severity fire. Overall, with no treatment, there is potential for over 57,000 acres of crown fire (39 percent of the RU), of which over 42,000 (28 percent of the RU) would be active crown fire.

Table 56. Modeled fire type for alternative A (2020) by restoration unit* in acres and (percent of treatment area)

RU	Surface	Passive	Active	No Fire
RU 1	85,639 (55%)	16,450 (11%)	51,355 (33%)	939 (1%)
RU 3	90,371 (60%)	12,941 (9%)	45,500 (30%)	903 (1%)
RU 4	111,515 (67%)	10,968 (7%)	42,643 (26%)	519 (0%)
RU 5	51,458 (70%)	6,447 (9%)	9,558 (13%)	5,740 (8%)
RU 6	37,120 (85%)	2,768 (6%)	3,596 (8%)	45 (0%)
Total	376,102 (64%)	49,575 (8%)	152,652 (26%)	8,147 (1%)

* "No fire" includes acres on which there were insufficient fuels to carry fire, including water, rock, cinders, and areas of sparse vegetation.

No action in RU 4 would have the potential to affect the communities of Flagstaff, Williams, Parks, and Belmont, though the prevailing winds would tend to blow fire away from most of the populations in Williams, Parks, and Belmont. There is also potential to impact the Fort Valley Experimental Station northwest of Flagstaff. Overall, with no treatment, there is potential for over 53,000 acres of crown fire (33 percent of the RU), of which over 42,000 (26 percent of the RU) would be active crown fire.

The northeastern area of RU 5 has scattered cinder cones, and cinder areas which support only sparse vegetation. In these areas, active crown fire is less likely because of decreased potential for high-intensity surface fire and decreased canopy fuel continuity. Overall, with no treatment, there is potential for over 17,000 acres of crown fire (22 percent of the RU), of which almost 10,000 (13 percent of the restoration unit) would be active crown fire.

Active crown fire in RU 6 would mostly be dispersed, with only a few areas of contiguous crown fire. Overall, with no treatment, there would be potential for over 6,000 acres of crown fire (14 percent of the restoration unit), of which over 3,000 (8 percent of the restoration unit) would be active crown fire.

Canopy Characteristics and Surface Fuels Affecting Fire Behavior and Effects

Potential changes to canopy base height and crown bulk density were modeled for the short (2020) and long term (2050). Under this alternative, canopy base height and crown bulk density slowly move toward desirable conditions, as a result of the lower branches becoming shaded out by increasing canopy cover. Increasing canopy cover, combined with the other canopy characteristics at or below desired conditions, would continue to make undesirable fire behavior and effects more likely (table 57).

Total surface fuel loading (coarse woody debris greater than 3 inches, litter, and duff) as modeled over 40 years shows a steady increase that ranges from approximately 9–16 tons per acre in 2010 to 13–25 tons per acre in 2050. There would be approximately 18,000 acres with surface fuel loading greater than 20 tons per acre (maximum average recommended level). These types of fuel loadings could produce undesirable fire effects, including large quantities of emissions. Areas that would have the highest surface fuel loading are often associated with Mexican spotted owl PACs including core areas. RUs 1 and 3 would have the highest surface fuel loading.

Table 57. Alternative A canopy characteristics 2010 to 2050

Year	Canopy Base Height (feet)	Desired Condition (feet)	Canopy Bulk Density (kg/m3)	Desired Condition (kg/m3)	Canopy Cover (%)
2010	15.0	18	0.059	0.05	41
2020	16.7	18	0.059	0.05	43
2050	22.2	18	0.058	0.05	47

Fire Regime Condition Class (FRCC)

Under alternative A, ponderosa pine ecosystems would increasingly become departed from desired conditions, increasing the risk to key ecosystem components (table 58). Acres in Vegetation Condition Class 3 (VCC) would continue to increase and, by 2050, almost 70 percent (350,409 acres) of the ponderosa pine in the area proposed for treatment would be in VCC3. Across the project area, fire regime condition class would be as FRCC 3.

Table 58. Alternative A fire regime condition class (FRCC) 2010 to 2050 in acres and (percent)

Vegetation Condition Class Alternative A	2010		2020		2050	
	Acres	%	Acres	%	Acres	%
1	71,097	14	55,862	11	10,157	2
2	126,960	25	116,803	23	147,273	29
3	309,782	61	335,174	66	350,409	69
FRCC of treatment area =	**3**		**3**		**3**	

Summary of Effects

Under Alternative A, both forest plans would continue to be implemented, but there would be no effective decrease in crown fire potential. Fire regime condition class and vegetative condition class would continue to move away from desired conditions. The direct and indirect effects of Alternative A relate to the effects of the continued degradation of surface and canopy fuel conditions, and the effects of the lack of low severity fire. These include the potential for the direct effects of wildfires of increasing size and severity occurring within the project area. Increasing loads of surface fuels would transfer sufficient heat to the soil when it burned, to produce high severity effects, consuming and killing roots, seeds, biota, and other organic matter in the top layer/s of soil, and decreasing soil productivity. Trees would be damaged or killed as increasing canopy fuels and ladder fuels would allow crown fire to initiate more readily. Mortality rates would increase for large/old trees because of decades of built up fuel around their boles and over their roots, and ladder fuels within or close to their driplines. The indirect effects of such burns could compromise water resources (such as Oak Creek, Mormon Lake, or Lake Mary) from indirect fire effects such as flooding and debris flows. Indirect effects could also include impacts to air quality downwind and downslope of fires. The most likely impacts to air quality being locations northeast of the project area, and in low areas, such as the Verde Valley, Williams, or Flagstaff.

In the short term (less than 20 years) effects of Alternative A would include an increased risk of undesirable behavior and effects. Wildfire behavior would threaten lives, resources, and infrastructure. It would be expected that 65–80 percent of the area burned in wildfires larger than 1,000 acres would burn with low severity effects that would beneficial. In the absence of wildfire, air quality would remain at current levels. In the short term, there would be no impacts on air quality from prescribed fires. Average annual acres burned with high severity wildfire would increase, along the associated air quality impacts. This alternative would not move the areas proposed for treatment toward the desired condition of less than 10 percent crown fire potential under conditions that produced the Schultz Fire. ”No fire” includes acres on which there were insufficient fuels to carry fire, including water, rock, cinders, areas of sparse vegetation, etc.

In the long term (more than 20 years), tens of thousands of acres (the actual amount would be a subset of the 200,000+ acres in the treatment area that would likely burn with high severity effects) would be potentially converted to non-forested systems as a result of high severity fire, while other acres of non-ponderosa pine would be increasingly encroached upon by pine, including aspen, grasslands, and oak. Aspen stands would continue to decline, and some stands would be likely to disappear. In the short term, there would be no impacts on air quality from prescribed fire. If the current average annual acres burned by wildfire remained the same, it is likely that the entire treatment area would burn with wildfire by 2050, along with the associated air quality impacts.

Alternatives B, C, D, and E

The environmental consequences are based on the modeling assumption that one mechanical treatment and two prescribed burns would occur between 2012 and 2019. From 2020 to 2050, no wildfires or additional treatments of any kind were modeled. The effects are based on applying the design features and mitigation displayed in the fire section of appendix C.

Alternatives B through E – Effects in Common

- In the short term (up to 10 years), first entry burns (burns which are the first time fire occurs in an area that has missed several fire cycles, about 20 years in most ponderosa pine) would: (1) effectively raise the canopy base height, decrease canopy bulk density, and decrease the likelihood of crown fire, (2) consume a large portion of accumulated litter and duff, along with the majority of dead/down woody fuels less than 3 inches in diameter, and (3) thin out some small trees (particularly seedlings), maintaining a mosaic of groups and interspaces. In areas where fire has been excluded for many decades, a single prescribed fire would be inadequate to reduce fuels (Lynch et al. 2000).
- In the long term, second entry burns are those burns which occur within about 2 to 10 years of a first entry burn. For second entry burns, fuel loads would be significantly lower than in first entry burns, producing much less smoke and having lower potential for crown fire or high-severity fire.
- As thinning and first-entry burns were completed, burn windows would expand for larger areas so more burning could occur when ventilation was good. The ability to manage unplanned ignitions would expand as 4FRI (and other projects) are implemented.
- Throughout the life of this project, it would be likely that some large and/or old trees would be damaged or killed by prescribed fire as 30,000 to 50,000 acres of prescribed fire would occur each year. Reducing accumulations of fuel in the vicinity of large and/or old trees is best accomplished by a combination of mechanical and prescribed fire treatments, with the specific need being site specific. However, the damage or mortality to these trees would be mitigated (see fire design features and mitigation in appendix C of this FEIS).

- Potential adaptive management actions for transportation, springs, and roads were reviewed. None of the adaptive actions would result in additional effects that are not already disclosed or addressed in alternatives B, C, D, and E.

Fire Behavior at the Landscape Scale

Table 59 displays post treatment fire behavior at the landscape scale for alternatives B, C, and D. In alternative B, the potential for crown fire at the landscape (treatment area) scale would be reduced from 34 percent of 5 percent. Alternative C best reduces the crown fire potential to 4 percent. Alternative D reduces crown fire potential the least (7 percent). See the specialist report which provides environmental consequences by vegetation type and by restoration sub-unit. All action alternatives would meet the desired condition of having crown fire potential on 10 percent or less of the landscape.

Table 59. Alternatives B, C, D, and E Landscape Scale (Treatment Area) Fire Behavior

Modeled Fire Behavior (% of Treatment Area*)	Existing Condition	Alt. B (2020)	Alt. C (2020)	Alt. D (2020)	Alt. E (2020)
Surface fire	64	93	94	92	94
Passive crown fire	9	4	3	4	3
Active crown fire	25	2	2	3	2

* Total percentages do not include acres that would not support fire such as areas where there were insufficient fuels to carry fire, including water, rock, cinders, areas of sparse vegetation, etc.

Fire Behavior at the RU Scale

At the RU scale, the post-treatment potential for crown fire would range from 2 to 8 percent in alternative B; from 2 to 7 percent and from 2 to 8 percent in alternative C; and from 2 to 8 percent in alternative E. Alternatives B, C and E would meet the purpose and need by moving the project area toward desired conditions of having 10 percent or less crown fire potential. Alternative D meets desired conditions for all restoration units except RU1. Approximately 11 percent of the acres in RU 1 would remain at risk of crown fire.

RU 1 – Only alternatives B, C and E would meet fire behavior desired conditions. Crown fire potential would be reduced to 8 percent in alternative B; 7 percent in alternative C, and 8 percent in alternative E. Potential fire behavior would decrease downslope from the mixed conifer on Mormon Mountain, as well adjacent to the city of Flagstaff to the northwest. In all the action alternatives, over 90 percent of active crown fire potential in ponderosa pine would occur in Mexican spotted owl protected habitat. In alternative D, total crown fire potential would be 11 percent, exceeding desired conditions. Within RU1, Mexican spotted owl protected habitat would account for over 92 percent of all active crown fire potential. In alternatives C and E, decreased treatment intensity for about 40,000 acres would add potential crown fire on about 1,750 acres, and potential for active crown fire where previous modeling showed potential for passive crown fire on about 130 acres. This equates to adding the potential for crown fire on less than 1 acre in 1-1 and 1-2; about 2 acres in 1-3 and 1-4, and about 170 acres in 1-5. This would raise crown fire potential in 1-5 to 11 percent (table 75 and table 77, fire ecology report)

RU 3 – Alternatives B, C, D, and E would meet fire behavior desired conditions by reducing crown fire potential to 6 percent of the treatment area for alternatives B, C and D (less than 9,300 acres), and 7 percent for alternative E (9,467 acres). Of the 6 percent, 1 percent would be active crown fire for B and C (less than 2,200 acres), and 2 percent for D and E. There would still be potential for active crown fire in PACs in Kelly Canyon and Pumphouse Wash, including potential for some active and passive crown fire on slopes greater than 30 and 40 percent. Outside of Mexican spotted owl PACs, there would be some contiguous areas of both passive and active crown fire. However, the majority of potential crown fire would be scattered passive crown fire. In alternatives C and E, decreased treatment intensity for about 40,000 acres would add about 91 acres of potential crown fire in 3-1 (8 percent); 38 acres in 3-2 (no change in percent), 201 acres in 3-3 (7 percent); 5 acres in 3-4 (7 percent); and 12 acres in 3-5 (no change in percent) (table 79, fire ecology report).

RU 4 – Alternatives B, C, D, and E would meet fire behavior desired conditions. In alternative B, RU4 would have the potential for 3 percent crown fire (4,729 acres); alternative C would have potential for 2 percent (3,462 acres) crown fire, and alternative E would have potential for 2 percent (3,729 acres). Alternative D would result in the most (5 percent) crown fire potential (8,703 acres). All alternatives would have the potential for approximately 1 percent or less active crown fire.

Most of the potential crown fire in RU4 would be in scattered patches, with few areas of contiguous active crown fire greater than about 15 acres, mostly in areas classified as grasslands or other non-pine vegetation. References to crown fire in grasslands here refer to crown fire in trees growing in the grasslands. There would be larger contiguous acreages of passive crown fire in goshawk PFAs and areas of lower intensity treatments, and some prescribed fire-only treatments. Decreased treatment intensity in some VSS4, VSS5, and VSS6 stands would add the potential for about 14 acres of crown fire in ponderosa pine in RU4.

RU 5 – Alternatives B, C, D, and E would meet fire behavior desired conditions. In alternatives B, C, and D there would be 2 percent crown fire potential, and in alternative D, 5 percent. For all alternatives, the percent of potential active crown fire would be 1 percent or less. There are many areas, some larger than 500 acres, in the north and eastern areas of this RU that are cinder substrate. In these areas, active crown fire would be less likely because of decreased potential for high-intensity surface fire. In alternative C and E decreased treatment intensity in some VSS4, VSS5, and VSS6 stands would add the potential for about 3 acres of additional crown fire in ponderosa pine in 5-1, and about 11 acres in 5-2.

RU 6 – Alternatives B, C, D, and E would meet fire behavior desired conditions. In alternatives B C and E, RU 6 would have 4 percent (2,204) acres with crown fire potential. Of this, 106 acres (less than 1 percent) would have the potential for active crown fire. In alternative D, the potential for crown fire increases to 5 percent, with about 601 acres of active crown fire. In all alternatives, acres with crown fire potential would occur in nest areas/PFA/dPFA (dispersal post-fledging area) habitats and the potential for passive crown fire would be widely dispersed with concentrations in areas with components of juniper and oak, particularly on the northeastern and southeastern corners. In alternative C and E decreased treatment intensity in some VSS4, VSS5, and VSS6 stands would add the potential crown fire in ponderosa pine on about 646 acres in 6-4 (38 percent).

Canopy Characteristics and Surface Fuels Affecting Fire Behavior and Effects

Table 60 displays that the canopy characteristics in alternatives B, C, D, and E would move toward desired conditions immediately post-treatment (2020). Alternatives B, C, and E would meet desired conditions in both the short (2020) and long term (2050) when compared to the existing condition (2010). In the long term (2050), canopy bulk density (when averaged across the landscape) in alternative D meets desired conditions. However, when analyzed by treatment ability to maintain desired openness, canopy bulk density would exceed desired conditions on approximately 28,000 acres resulting in a high potential for crown fire. In alternatives C and E decreased treatment intensity in some VSS 4, VSS 5, and VSS 6 stands would add the potential crown fire in ponderosa pine on about 646 acres in 6-4 (38 percent). Expected changes would include increases in canopy cover and canopy base heights, and decreases in canopy bulk density. The changes would not be of a magnitude that would be expected to shift the overall weighted averages out of the desired conditions for canopy base heights or canopy bulk density (see table 85 and table 86 in the fire ecology report).

Table 60. Alternatives B through E canopy characteristics for ponderosa pine from 2010 to 2050

Alternative	Canopy Base Height (feet)				Canopy Bulk Density (kg/m3)				Canopy Cover (%)		
	2010	2020	2050	Desired Condition	2010	2020	2050	Desired Condition	2010	2020	2050
B	15	25	27	18	0.059	0.032	0.037	<0.05	41	26	34
C	15	25	27	18	0.059	0.032	0.037	<0.05	41	26	34
D	15	18	23	18	0.059	0.035	0.41	<0.05	41	30	38
E	15	24.5	26.5	18	0.059	0.034	0.039	<0.05	41	27	35

Overall, the decreased treatment intensity in alternative C and E would shift about 1,750 acres from surface fire to passive or active crown fire outside of Mexican spotted owl habitat. There would be potential for an additional about 130 acres previously modeled as passive crown fire to support active crown fire (table 71, fire ecology report). Treatments in those areas would have decreased longevity because already closed or moderately closed canopies close up more quickly than moderately open.

In the long term (more than 20 years), potential for undesirable fire behavior, as assessed by changes to canopy fuels, would remain lower than existing condition for about 91 percent of the ponderosa pine in the treatment area. Potential for undesirable fire effects, as assessed by changes to surface fuel loading, would remain lower than existing condition for about 60 percent of the ponderosa pine in the treatment area. In Gambel oak, large oaks would continue to be at some risk of high severity fire, though decreased somewhat from pre-treatment conditions. Air quality impacts could decrease some as the majority of the treatment area could be managed with maintenance burns, producing fewer emissions per acre. Decreased treatment intensity on about 40,000 acres of ponderosa pine would mean many of those acres would move more rapidly away from desired conditions, and be at high risk of high severity fire. These effects would not push any alternative out of desired conditions for fire behavior at any scale of analysis.

Surface Fuel Loading

In alternative B, post-treatment surface fuels (coarse woody debris greater than 3 inches, litter, and duff) would be reduced to recommended levels over most of the treatment area (5 to 20 tons per acre). The exceptions are mostly in RU 1 in Mexican spotted owl PACs where there would be surface fuel loadings greater than 20 tons per acre.

In alternative C, fuel loading would be decreased below 20 tons per acre in most of the treatment areas. There would be approximately 810 acres with surface fuel loading greater than 20 tons per acre occurring mostly in RU 3 in Mexican spotted owl PACs, a few areas in RU 4, and two areas in RU 5 (see figure 74 in the fire ecology report). In this alternative and in the immediate short term (up to 2 years post treatment) coarse woody debris greater than 3 inches would range from 2.46 to 2.96 tons per acres—below forest plan desired conditions. In the long term (2 plus years post-treatment), modeling for this project and research (Waltz et al. 2003) suggest that it would be just a year or two before coarse woody debris (CWD) levels once again meet desired conditions. In alternatives B and D, with no maintenance treatments after 2020, CWD greater than 3 inches would exceed current forest plan guidelines by 2050. When considered by desired openness, both alternatives B and C would meet the recommended tons/acre of surface fuel loading for surface fuel loading.

Table 61 shows that in the short term (2020), Alternatives B, C, and E would result in less than 1 percent of the ponderosa pine having surface fuel loading greater than the recommended 20 tons/acre, and alternative D would have 17 percent. In the long term (2040), the percent area exceeding recommended levels would range from 10 percent (alternative C) to 32 percent (alternative D). There would be at least 2,500 acres with surface fuel loading greater than 20 tons per acre in both the short term (2020) and long term (2050) mostly in Mexican spotted owl PACs or goshawk PFAs in RU 1 and RU 3 where no prescribed fire treatments would occur.

Table 61. Alternatives B through E surface fuel loadings in ponderosa pine from 2010 to 2040 (average by stand and classified by treatment intensity)

Alternative	Year	>15 tons/acre (% ponderosa pine / acres)	>20 tons/acre (% ponderosa pine / acres)
Alternative A (Current Condition)	2010	11 / 66,871	1 / 2,953
Alternative B	2020	1 / 5,418	<1 / 1,048
	2040	11 / 60,396	1 / 5,572
Alternative C	2020	<1 / 2,569	<1 / 810
	2040	10 / 60,205	<1 / 3,531
Alternative D	2020	17 / 77,294	1 / 3,298
	2040	32 / 172,131	4 / 19,269
Alternative E	2020	1 / 9,075	<1 / 1,579

Fire Regime Condition Class (FRCC)

Table 62 compares the existing fire regime condition class to expected changes by alternative. In ponderosa pine in the short term (2020) all action alternatives would move toward desired conditions with alternative C moving the most acres out of vegetation condition class (VCC) 3 (57 percent reduction). In the long term (2050), the percentage of ponderosa pine in VCC 3 would increase in all alternatives with alternative D most closely resembling the existing condition as approximately 45 percent of the landscape would revert back to VCC3. In the short term, all alternatives move the overall fire regime condition class rating from FRCC 3 to FRCC 2. In the long term (2050), in alternative D the overall fire regime condition class rating reverts back to FRCC 3, while the other alternatives remain at an FRCC 2.

In grasslands, only alternative C would move toward desired conditions in both the short (2020) and long term (2050). Alternative D would exceed desired conditions in both the short and long term.

Table 62. Percent change in fire regime condition class (FRCC) by alternative and year (2020 and 2050)

Vegetation and Fire Regime Condition Class	Existing Condition (2010)	Alt B		Alt C		Alt D		Alt E	
		2020	2050	2020	2050	2020	2050	2020	2050
VCC 1	14	26	15	29	16	16	9	22	11
VCC 2	25	69	49	69	49	49	46	73	49
VCC 3	61	5	36	4	35	35	45	5	40
FRCC	3	2	2	2	2	2	3	2	2

Other Restoration Treatments (Springs, Streams, Roads)

Stream and spring would not be expected to have much effect on fire behavior or effects in the short term. In the long term, restored hydrology, particularly in springs, may result in increased surface fuel loading near springs, allowing wildfire or prescribed fire to creep closer to the water source than is generally possible now. Forest plan direction includes using prescribed fire to manage fuels in riparian areas.

Many wildfires that have been started by humans begin in proximity to roads. The alternatives may result in fewer human-started wildfires. The more heavily used roads may have functioned as fire breaks in the past. Once decommissioned, surface fuel loadings would eventually grow back, allowing fire to burn across the area. During the implementation of the mechanical treatments, temporary roads constructed for access would be available for access to burn units, and/or to be used as firelines for prescribed fires.

Acres Affected by the Slide Fire

In alternatives B through E, all treatments in the burned area would be deferred for at least 5 years to allow some recovery of surface and forest vegetation prior to implementation. Following the 5 year deferral, the area would be re-evaluated by the appropriate resource specialists to determine if proposed treatments are still appropriate.

Alternative A: Under alternative A, the 4FRI area burned in the Slide Fire would receive no treatments. In Restoration Unit 3 (Subunits 3-5 and 3-4), the slide fire effects decreased potential for crown fire, so, for the next about 10 years, wildfires burning though areas that had low to moderate severity effects would be expected to be mostly beneficial although, as described above, there is still potential in some areas for high severity fire effects. In areas with high severity effects, fire-killed trees will begin to fall in the next few years. Where fallen trees create ‘jackpots’ of coarse woody debris or where there is some continuity in coarse woody debris at the surface, there is potential for high severity effects soil and vegetation (including regeneration) in the event of a wildfire burning under undesirable conditions.

Alternatives B, C, and E: Prescribed fire would be implemented as indicated by monitoring results after a 5 year deferral. The use of prescribed fire could mitigate the potential for high burn severities (fire effects to soil) resulting from a heavy dead/down component from trees killed in the Slide Fire falling. In areas with little to no change in canopy fuels, thinning would decrease the potential for crown fire and for high severity fire effects from surface fires.

Alternative D: In areas where mechanical treatments were proposed, as stated above, after a deferral of at least 5 years, it may be determined that the proposed mechanical treatments are no longer appropriate. In those cases, there would be no treatment, or treatments would be adjusted to fit existing and desired conditions. Where there would be heavy dead/down fuel loads from fire-killed trees falling and increasing surface fuel loading, there would be increased potential for high burn severity from wildfire burning through the area under undesirable burning conditions.

Summary of Effects: Under alternative A, there would be the greatest risk of undesirable fire effects and behavior. Under all action alternatives, the potential for crown fire is decreased significantly because the horizontal and vertical continuity of the canopy fuels is broken up. Under alternatives B, C, and E, the availability of prescribed fire as a tool across most of the treatment area would increase treatment options for managers as the high severity areas of the Slide Fire recover, and surface fuel loading changes. Alternative D would also decrease potential crown fire, but would not mitigate the increasing potential for high burn severity as fire killed trees fall and add to surface fuel loading, unless there would be no mechanical treatments.

Cumulative Effects

Spatially, the cumulative effects of projects and wildfires were evaluated within the project area (988,764 acres), the South Rim of the Grand Canyon National Park, and the Coconino NF The treatment area in RU6 and the treatment area in the four contiguous Restoration Units to the south of RU 6 (1, 3, 4, and 5) are separated by a little over 23 miles, so projects and wildfires affecting Restoration Unit 6 (RU6) or the southern EIS area are discussed separately. For the southern EIS area, the effects of wildfires and other project are considered for about 15 miles south and west of the project area because prevailing winds during fire season generally have a western, southwestern, or southerly component to them, so fires coming from those directions have better potential to burn into the project area that fires further away or in other directions.

The time frame considered for past projects is 2000 to 2014). All fires included occurred from 2001 through 2013 and are at least 100 acres. The Slide Fire occurred in May of 2014, and was added because it burned in (about 8,000 acres) and adjacent to (about 13,000 acres) the area proposed for treatment. Foreseeable projects extend approximately 10 years into the future. This timeframe accounts for when the majority of actions were or will be completed and for measuring fire effects from prescribed fire and the effects of treatment on potential wildfire behavior.

Past Projects and Natural Disturbances

Within RU 6, near, adjacent to, or within the treatment area, there are about 50,000 acres on which about eight projects were completed within the last 10 years. These projects included mechanical thinning and/or prescribed burning and have, or may, affect potential fire behavior and effects within the treatment area. Objectives of these projects include fuels reduction, maintenance burning, recreating historic stand conditions in PJ (mixed severity), and reducing the risk of stand replacement fire and the rate of spread, intensity, and severity of wildfires that do occur. Three additional projects were considered, but eliminated from analysis because of incomplete data.

Approximately 52,422 acres of wildfire occurred in or around RU 6 from 2000 to 2013. All of the projects listed in table 128 of the fire ecology report) have decreased the potential for active crown fire and crown fire initiation on acres thinned (14,666), and the potential for crown fire initiation, and high severity effects from surface fire on about 50,900 acres of prescribed fire, and about 52,422 acres of wildfire. Past mechanical and prescribed fire treatments decreased the potential for crown fire by breaking up the vertical and horizontal continuity of canopy fuels. Prescribed fire and low severity wildfires further decreased the potential for crown fire, by removing additional ladder fuels, decreasing canopy bulk density, and raising canopy base height.

Maintenance burning and wildfires decreased surface fuel loading in most areas burned, decreasing the potential intensity of subsequent fires.

Past treatments and wildfires have decreased the potential emissions (impacts to air quality) by removing canopy fuels, mostly from thinning on 14,666 acres, but some from wildfire and prescribed fire. Low severity fire would have consumed surface fuels, further decreasing potential for emissions on about 35,000 acres. Where wildfires burned with high severity (about 1,300 acres in and adjacent to the project area), fine canopy fuels (needles and small twigs) were consumed leaving tree stems and branches, some of which have fallen and are now Coarse Woody Debris which have the potential to smolder for days, or weeks. From 2001 through 2013, Grand Canyon National Park implemented prescribed fire on about 40,000 acres within the Colorado River Airshed. Over 22,000 acres were on the South Rim (Grand Canyon National Park), while the Tusayan Ranger District (Kaibab National Forest) completed a little over 50,000 acres of prescribed burning. For RU6 the completion of this many acres contributes to a widespread lowering of potential ignitions per acre from both wildfire and prescribed fire for all alternatives, increasing the number of acres that could be burned while meeting desired conditions for air quality.

There are over forty projects which were completed near, adjacent to, or within the southern EIS (Table 130, fire ecology report) that would have potential to affect fire behavior and effects in the treatment area for all alternatives. An additional seven projects were considered, but eliminated from analysis because of incomplete data. Three others (Blue Ridge Fire Risk, Fossil Creek, and Victorine) were not included because their location makes it unlikely they would affect, or be affected by proposed treatments. There are about 117,517 acres of forest and savanna, and 65,713 acres of grasslands on which projects have been implemented within the last 10 years that included mechanical thinning and/or prescribed burning and have affected, or could affect potential fire behavior and effects in the proposed treatment area.

Within and adjacent to the southeastern part of the project area, including parts of RU1, there is an almost continuous block of (eight) projects implemented between 2001 and 2013 that lower chance of active crown fire or high severity surface fire effects than in areas that have not been treated. In forested habitat, these projects range from 14,500 acres of prescribed fire and 1,800 acres of thinning, to 54,000 acres of thinning and 800 acre of prescribed fire in grasslands. The large treatments across the project area would slow down the rate of spread for large fires (Finney et al. 2006). Thinning along power lines creates a linear feature that helps protect the powerlines in the event of a wildfire, and limits the number of starts caused by power lines (figure 73 of the fire ecology report). Developed two track roads in the thinned areas could be used as firelines for low intensity fires, facilitating subsequent prescribed fire treatments.

Wildfires from 2001 to 2010 burned about 151,782 acres within the southern portion of the project area. Several of the wildfires that burned within this location in the last 10 years were managed primarily for resource objectives (as opposed to being managed primarily for suppression), and produced primarily low severity effects (table 131, fire ecology report).

The combined effects of the projects and wildfires have decreased the potential for undesirable fire behavior and effects on about 134,000 acres of mechanical treatments, and the potential for crown fire initiation, and high severity effects from surface fire on about 120,000 acres of prescribed fire, and about 181,000 acres of wildfire. This applies to all alternatives. As with RU 6, the combined effects of these projects and the wildfires that have burned in and near the southern EIS have created a mosaic of stand conditions across much of the treatment area, and adjacent areas, decreasing the potential for undesirable fire behavior and effects. The scattered large blocks of treatments with decreased fire behavior potential would slow down a large wildfire and decrease the severity of its effects.

In terms of air quality, past treatments and wildfires have decreased the current potential for emissions in areas that burned with low to moderate severity. The cumulative effects of prescribed fires in on the Coconino, Kaibab, and Prescott National Forests over the last 12 years has resulted in one exceedance of NAAQS on one monitor for one day for PM 2.5 in Flagstaff in 2007. Past treatments and wildfires have decreased the potential emissions by removing canopy fuels, mostly from thinning on about 134,000 acres, and by increased canopy base height from wildfire and prescribed fire. Low severity fire would have consumed surface fuels, further decreasing potential for emissions on about 300,000 acres of prescribed fire and wildfire combined. In some areas of high severity fire, canopy fuels were consumed leaving tree stems and branches which, once they fall and become coarse woody debris, have the potential to smolder for days, or weeks

Current, Ongoing, and Foreseeable Actions

Seven projects within RU6 that are implementing mechanical and prescribed fire treatments (as of 2011) or are foreseeable and likely to impact fire behavior and effects within the proposed treatment area for all alternatives. The estimated annual acres of prescribed fire and low severity fire from the South Rim of Grand Canyon National Park are included (23,000 acres), based on trends and averages of the last 10 years. The effects are similar to what was described under RU6 in the previous section, “Past Vegetation Management Activities and Wildfires” (p. 257, fire ecology report), though the locations of some projects are different, as are the acres.

Large areas that can moderate fire behavior can be effective at slowing down wildfires, decreasing the potential for undesirable effects and behavior. An additional treatment west of the Tusayan Airport would help protect the airport and the town of Tusayan for a period of time by extending the treated area further around the airport, as well as further mitigation fire behavior adjacent to the Grand Canyon railroad and the potential for a fast moving wildfire to burn into the park.

Prescribed fires implemented for the projects listed in Table 132 would comply with the regulations and requirements of the Arizona Department of Environmental Quality (ADEQ), as would prescribed fires within Grand Canyon National Park. There are about 21,423 acres of prescribed burns planned in RU6, and Grand Canyon National Park by 2020. There is potential for both the Colorado River Airshed and the Little Colorado River Airshed to be impacted by fires occurring within RU 6 and Grand Canyon National Park. It is likely that similar burn windows would be needed for many of the fires in the park and parts of RU 6.

There are about 275,667 acres of mechanical treatments and 299,524 acres of prescribed fire ongoing or planned that could impact fire behavior and effects within the proposed treatment area for all alternatives (table 133, fire ecology report). Surrounding the community of Flagstaff is a block of projects which include over 45,000 acres of mechanical treatments and over 65,000 acres of prescribed fire. In addition to past projects surrounding the community of Williams, an additional about 17,700 acres of mechanical treatments and about 32,000 acres of prescribed fire are being implemented and planned.

Adjacent to the southern border of RU 1, about 60,000 acres are being planned for both prescribed fire and mechanical treatments. These ongoing projects would augment the effectiveness of past projects designed to minimize the potential for high severity fire near and/or in Williams and surrounding homes. Ongoing maintenance thinning along power lines creates linear features that help protect the power lines in the event of wildfire, and limits the number of starts caused by power lines (see Figure 73, fire ecology report). Developed two track roads in the thinned areas could be used as firelines for low intensity fires. In higher intensity fires, there thick smoke can create a path for electricity to arc from the power lines to something or someone nearby. The Flagstaff Watershed Protection Project is proposing a forest plan amendment to the Coconino forest plan that would allow mechanical treatments in PACs, and to a greater level than had previously been allowed under the existing Coconino forest plan. This would further augment the effects of treatments proposed under the 4FRI Project because it would lower the potential fire intensity and severity in areas adjacent to the area proposed for treatment in the 4FRI Project. This, along with all other adjacent areas proposed for mechanical treatments and/or prescribed fire, would increase the flexibility of land managers when they lay out prescribed fire units because of larger areas with lowered potential for high intensity/severity fire.

Cumulative Effects – Alternative A

Alternative A would continue to maintain 586,110 acres with increasing potential for high severity fire effects and behavior, though the effects would be mitigated to some degree by past wildfires and projects, and current and reasonably foreseeable projects, and any beneficial wildfires that may occur in the future. Alternative A would not contribute to improving the structure, composition, and patterns within the area proposed for treatment. Within the area considered for cumulative effects for Fire Ecology and Air Quality, there would be some improvement from the projects listed above, which includes about 288,719 acres of mechanical treatments and 340,685 acres of prescribed fire in current and foreseeable projects (tables 133 and 132, fire ecology report).

However, the effects would be much less with no 4FRI treatment because of less spatial continuity between treatments than would be created with any of the action alternatives. It would not put the ponderosa pine forests, or the vegetative communities that are cohorts of ponderosa pine on trajectories toward being resilient or sustainable. The treatment area would continue to become less adapted to fire, increasing the potential for undesirable fire behavior and effects when wildfires do occur. When fires did occur, many would have potential for extreme fire behavior and could produce large areas of high severity, which could extend well outside of the treatment area. Many fires starting within the untreated project area would have potential to spread outside of the treatment area. Extreme fire behavior would put lives, property, infrastructure, and natural resources at risk. Post-fire effects would also extend well beyond the perimeters of the fire, and would include such effects as flooding, sedimentation, decreased water quality and quantity, decreased soil productivity, and other effects of fires burning out of their natural range of variation. In effect, Alternative A would produce the effects described for an area much larger than the area proposed for treatment in the action alternatives.

Air quality would be unaffected by prescribed fire from the treatment area, but would be affected by prescribed fires from projects listed in tables 132 and 133 of the fire ecology report. Emissions from 300,000 acres of prescribed fire from current, ongoing, and reasonably foreseeable projects would be managed in compliance with regulations and requirements of the Arizona Department of Environmental Quality (ADEQ). Wildfires occurring in the untreated areas would produce more emissions in areas that were not treated than in areas that were treated, and could augment the effects of prescribed fires (from current and foreseeable projects) on air quality. Areas with potential for impact would be the Colorado River Airshed, the Little Colorado River Watershed, and the Verde River Watershed. Class 1 airsheds that could be affected include Grand Canyon National Park, Sycamore Canyon Wilderness Area.

Cumulative Effects – Alternatives B, C and E

Treatments proposed in alternative B would move 583,330 more acres toward desired conditions for fire behavior and effects across the project area. When considered with past wildfires, and past, current, ongoing, and reasonably foreseeable management activities, would augment the effects of proposed treatments on large (project area), mid (Restoration Unit), and small (Subunit) scales, creating mosaics at all scales of potential fire behavior and effects, dominated by low severity fire. The proposed treatments would fill in most of the acres between past, current, ongoing, and foreseeable management activities, creating a more cohesive, contiguous, restored landscape across the project area.

Treatments proposed in alternative C would move 586,110 more acres, and alternative E would move 403,218 acres toward desired conditions for fire behavior and effects across the project area. Most of the effects would be identical to alternative B, with the exception of PACS and grasslands that would be treated under alternatives C and E, further augmenting the cumulative effects of the proposed actions and past wildfires, and past, current, ongoing, and reasonably foreseeable management activities. Under alternative C, there would be additional acres treated in core areas, and more intense treatments in some PACs, further augmenting treatments from other projects near, or adjacent to the 4FRI areas proposed for treatment.

When the acres above are combined with past mechanical treatments (about 148,000 acres), past prescribed fire (about 167,710 acres) and current and foreseeable mechanical (288,719) and prescribed fire (340,685 acres), the mosaic that would be created would include large, contiguous areas of forests and grasslands that would be in a condition to be resilient to natural disturbances, including wildfire. Potential fire behavior and effects across the landscape included in the cumulative effects analysis area for Fire Ecology and Air Quality would be expected to be beneficial and desirable.

All prescribed fires would be implemented in compliance with ADEQ regulations and requirements as well as forest plan direction to meet legal standards and provide for public safety. Emissions from prescribed fires proposed in alternatives B, C, and E would utilize many of the same burn windows that the about 300,000 acres of current, ongoing, and reasonably foreseeable prescribed fire projects would use. However, the increased acres of prescribed fire would allow more flexibility for implementation, and may make it possible to burn more acres at once with the same impacts. Areas with potential for impact would be the Colorado River Airshed, the Little Colorado River Watershed, and the Verde River Watershed. Class 1 airsheds that could be affected include Grand Canyon National Park, Sycamore Canyon Wilderness Area. As more acres are treated, there would be broader burn windows, potentially resulting in more days of prescribed fire and days of air quality impacts.

Cumulative Effects – Alternative D

Treatments proposed in alternative D would move 563,407 more acres toward desired conditions for fire behavior and effects across the project area. The proposed treatments would fill in most of the acres between past, current, ongoing, and foreseeable projects, creating a more cohesive restored landscape across the project area. Under alternative D, 384,966 acres would not be treated with prescribed fire, so they would not move as far toward desired conditions, and some areas would retain potential for undesirable fire behavior and effects as surface fuel loading increased following thinning, increasing the potential intensity of surface fires.

In most of the area that was thinned and not burned (384,966 acres), there would be potential for greater wildfire emissions from increased surface fuel loading. When combined with emissions from current, ongoing, and reasonably foreseeable management actions, there would be potential for greater air quality impacts when wildfires burned in these areas than in areas that had been previously treated with prescribed fire. That could result in fewer acres of desirable fire (because NAAQs are sometimes too close to the limit for additional permits to be issued for prescribed fire or to allow a wildfire to be managed for something other than full suppression).

Unavoidable Adverse Effects – All Alternatives

In alternative A there would be more larger fires of higher severity than occurred historically, or than are sustainable on the landscape. In recent years, fires on the Mogollon Rim that have taken human lives, destroyed homes/property/infrastructure, and produced high severity effects across large areas not adapted to high severity fire include Rodeo/Chediski 2002 (469,000 acres), Wallow 2011 (538,000 acres), and Whitewater 2012 (about 297,000 acres). Such fires permanently change tens of thousands of acres of forests when they burn with high severity in areas which are not adapted to high severity fire. There is broad consensus that such fires will continue to burn in this area if no action taken, though the specific extent and location of the negative effects could not be known until an incident occurs. First order effects would include (but are not limited to): chemical and physical changes to soil, high levels of mortality across about 30 percent or more of the burned area (assuming about 30 percent high severity), consumption and/or killing of the seed bank, consumption of organic material in soil, including flora and fauna, conversion of forested habitat to non-forested habitat. Second order fire effects would include (but are not limited to) erosion, flooding, debris flows, destroyed infrastructure, changes in visitation to the forest and the economies of local businesses that depend on visitors and degradation of water resources for wildlife and humans. Some of these effects would last just a few days or weeks (infrastructure would be rebuilt), some would take years to recover, some changes would be permanent. For example, topsoil is critical to healthy surface vegetation and would take centuries to recover though, with climate change, it is unknown exactly what the ecological trajectory would be. The loss of old growth and old trees would require decades and centuries to recover. See the air quality section for unavoidable adverse effects for alternatives B through E.

Coconino NF Forest Plan Amendments

Alternatives B and D

Amendment 1: If amendment 1 is implemented, the resulting decreases in canopy base height, canopy bulk density, and canopy cover would have the indirect effect of slightly decreasing crown fire potential for the 18 Mexican spotted owl PACs that would receive mechanical treatments. An additional indirect effect would be to increase the ability of fire managers to implement prescribed fire within PACs because of decreased potential fire behavior. If amendment 1 is not implemented on the Coconino NF, these 18 PACs (approximately 10,700 acres) would retain the current forest structure that places them at high risk of high-severity fire. Potential fire behavior would make it difficult to implement prescribed fire because of narrow burn windows (weather and fuel conditions that would produce the desired fire effects and behavior). If prescribed fires were implemented on acres adjacent to PACs, it would be more likely that some firelines would need to be created to avoid burning in the PAC, producing ground disturbance that would be less likely under the proposed amendment. There would be little effect on emissions, except for a slight decrease in potential emissions in the event of wildfire following mechanical treatments within the PACs.

Amendment 2: If amendment 2 is implemented, it would allow 28,952acres to be managed for an open reference condition. An indirect effect of managing for open conditions would be to have little potential for active crown fire, moving these acres toward the desired conditions. Open conditions would, in the long run, produce fewer emissions because of less litter and debris from trees, and greater herbaceous component to surface fuels, which is a flashier fuel, burning faster and more cleanly quickly than woody fuels. If amendment 2 is not implemented on the Coconino NF, some treatments could be implemented, but these acres would not move as far toward desired conditions as they would be with the amendment.

Amendment 3: If amendment 3 is implemented, it would allow fire to be used to meet objectives if it was determined to be the best tool. Additionally, it would allow all significant, or potentially significant inventoried sites that are not considered ‘fire sensitive’ to be included in burn units. If amendment 3 is not implemented, all significant, or potentially significant inventoried sites within burn units, regardless of if they are considered ‘fire sensitive’ or not, would be managed for ‘no effect’.

Alternative C

Amendment 1: If amendment 1 is implemented, the resulting decreases in canopy base height, canopy bulk density, and canopy cover would have the indirect effect of slightly decreasing crown fire potential for the 18 Mexican spotted owl PACs that would receive mechanical treatments. An additional indirect effect would be to increase the ability of fire managers to implement prescribed fire within PACs because of decreased potential fire behavior. If amendment 1 is not implemented on the Coconino NF, these 18 PACs (approximately 10,700 acres) would retain the current forest structure that places them at high risk of high-severity fire. Potential fire behavior would make it difficult to implement prescribed fire because of narrow burn windows (weather and fuel conditions that would produce the desired fire effects and behavior). If prescribed fires were implemented on acres adjacent to PACs, it would be more likely that some firelines would need to be created to avoid burning, producing ground disturbance that would be less likely under the proposed amendment. There would be little effect on emissions, except for a slight decrease in potential emissions in the event of wildfire following mechanical treatments within the PACs.

Amendment 2: If amendment 2 is implemented, it would allow 29,017 acres to be managed for an open reference condition. An indirect effect of managing for open conditions would be to have little potential for active crown fire, moving these acres toward the desired conditions. Open conditions would, in the long run, produce fewer emissions because of less litter and debris from trees, and greater herbaceous component to surface fuels, which is a flashier fuel, burning faster and more cleanly quickly than woody fuels. If amendment 2 is not implemented on the Coconino NF, some treatments could be implemented, but these acres would not move as far toward desired conditions as they would be with the amendment.

Amendment 3: If amendment 3 is implemented, it would allow fire to be used to meet objectives if it was determined to be the best tool. Additionally, it would allow all significant, or potentially significant inventoried sites that are not considered ‘fire sensitive’ to be included in burn units. If amendment 3 is not implemented, all significant, or potentially significant inventoried sites within burn units, regardless of if they are considered ‘fire sensitive’ or not, would be managed for ‘no effect’.

Forest Plan Consistency

Management actions proposed under alternatives B through E would meet direction in the revised Kaibab National Forest Land and Resource Management Plan (USDA FS 2014). The alternatives would reduce the risk of uncharacteristic fires and restore the structure, species composition, and function of forested ecosystems (page 3). The new forest plan allows for 3 – 10 tons per acre (pp. 18 and 128). This analysis classifies coarse woody debris post-treatment conditions treatments by intensity without consideration of which forest a given acre is on. For example, if a table shows that 10 percent of the ponderosa pine treated at a ‘high’ intensity would average 3-5 or 7-10 tons per acre, those acres could be within desired conditions for the Kaibab NF. Additionally, the revised Kaibab NF forest plan specifies desired conditions for the wildland-urban interface (WUI) which fall on the more open end of desired conditions for ponderosa pine (forest plan, p. 97), and allow for treatments to follow applicable forest plan guidance for coarse woody debris. Desired conditions for ‘dead and down fuel load’ are between 1 and 5 tons per acre. It does not specify any particular size, or type (woody, herbaceous, needle litter, etc.) of fuel comprising the fuel load. Additionally, page 98 of the revised KNF forest plan states, “…sound reasons for retaining more dense stands may exist,” so there is flexibility built in for habitat needs in the WUI. Alternatives B through E would move treated areas toward desired conditions as defined in the revised LRMP for the Kaibab NF. Alternative C would move more acres toward the desired conditions for all vegetation types treated than any other alternative.

With the proposed amendments, alternatives B-D would be consistent with the current Coconino NF forest plan (see amendment analysis by alternative). Alternative E was designed to be consistent with the current plan.

Air Quality

The air quality analysis is part of the fire ecology report which is incorporated by reference (Lata 2014). This analysis addresses issue 1, prescribed fire emissions. Smoke/ emissions were evaluated quantitatively by modeled emission quantities in pounds per acre for the most common stand condition under different treatment scenarios. Additionally, changes in those fuel components which produce the greatest percentages of emissions when they burn (litter, duff, and coarse woody debris greater than 3 inches) were modeled, and mapped for a qualitative assessment.

Changes from the Draft Environmental Impact Statement and Opposing Science

In response to comments on the DEIS, the fire ecology report includes a discussion on mercury and emissions. Experts at the Environmental Protection Agency (Region 9), the Agency’s liaison to the Arizona Department of Environmental Quality, and the Agency’s Washington Office were contacted to consider the best available information. Overall, after reviewing available literature (Selin 2009, Obrist et al. 2008, Biswas et al. 2007, Wiedinmyer and Friedli 2007, Friedli et al. 2003) and consulting the Environmental Protection Agency (Jason Gerdes, personal communication 3/11/2014) and the Agency’s Washington Office Air Quality lead (Peter Lahm, personal communication 3/11/2014) and the USFS’s liaison to the Air Quality Division of the Arizona Department of Environmental Quality (Ron Sherren, personal communication 3/11/2014). Information available for analyzing the potential for mercury emissions as a result of prescribed fire is considered to be incomplete and unavailable relevant to determining reasonably foreseeable adverse impacts to the human environment as directed by CEQ Sec. 1502.22 (b) 1.See the fire ecology opposing science section for a discussion on opposing science received. See the project’s content analysis report for responses to all emission-related comments received on the DEIS.

Emissions and Public Health

Air pollutants called particulate matter include dust, dirt, soot, smoke and liquid droplets directly emitted into the air by sources such as factories, power plants, cars, construction activity, fires, and natural windblown dust. The Clean Air Act establishes National Ambient Air Quality Standards (NAAQS) for six principal pollutants that pose health hazards: carbon monoxide (CO), lead, nitrogen dioxide, particulate matter less than 10 microns in size (PM 10), particulate matter less than 2.5 microns in size (PM 2.5), ozone, and sulfur dioxide.

The pollutant form of greatest concern from wildland fire, including both prescribed fires and wildfires is particulate matter (PM) (Ottmar 2001, Graham 2012), although fire also creates other criteria pollutants and visibility impacts. Studies of human populations exposed to high concentrations of particles (sometimes in the presence of sulfur dioxide) and laboratory studies of animals and humans indicate there is potential for detrimental effects on human health.

The major subgroups of the population that appear to be most sensitive to the effect of particulate matter include individuals with chronic obstructive pulmonary or cardiovascular disease of influenza, asthmatics, the elderly, and children. Particulate matter also soils and damages materials and is a major cause of visibility impairment.

Radioactive Emissions

Concerns have been raised about the potential for smoke from prescribed fire treatments proposed in 4FRI to contain radioactive substances. During the Cerro Grand fire of 2000, there was considerable public concern regarding the potential release of radionuclides from the Los Alamos National Laboratory (LANL). The evidence suggests that some adverse health effects did result from breathing high concentrations of particulate matter in the smoke (NMED 2002). Such exposures are associated with any forest fire. Deposition of LANL-derived chemicals and radioactive materials from the smoke plume to the soil was minimal (2002 LANL).

Following the Cerro Grande fire that burned the city of Los Alamos and the LANL in New Mexico in 2000, the U.S. Environmental Protection Agency (EPA), New Mexico Environment Department (NMED), and LANL partnered with Department of Energy to operate radiological monitoring systems as well as to initiate several studies to assess the impacts of the fire. The results of these efforts with regard to air quality and human health impact indicated that radionuclides originating from the LANL site during the Cerro Grande Fire were restricted to naturally occurring radionuclides. LANL, the Department of Energy, and NMED monitored radionuclide concentrations in smoke from the Las Conchas fire that burned through the Los Alamos area in the summer of 2011 and reported no significant detection levels. (See the NMED website: http://www.nmenv.state.nm.us/aqb/WildfireSmokeResources).

A study that included Lockett Meadow, within the 4FRI analysis area, found levels of radioactive materials in the soil were no different than background levels, and would provide no added human health risk (Ketterer et al. 2004, Graham 2012a).

Communication with the EPA (Gerdes 2012, Graham 2012) and studies that addressed these emissions (Schollnberger et al. 2002) indicate that radioactive isotopes and other undesirable chemicals are present in wildfire emissions. Some are naturally occurring chemicals that have always been present at some level in wildfire smoke and some have resulted from the weapons testing that occurred in the mid-20th century. The level of smoke that the public is exposed to would not pose as great a risk as wildfire would. Radioactive material that may be carried in the smoke plume carries a risk of human health concerns of less than 1 chance in 10 million (NMED

2002) and the greatest health risk is from breathing high concentrations of particulate matter in the smoke.

Smoke Sensitive Areas and Sensitive Receptors

The Regional Haze State Implementation Plan for Arizona defines sensitive receptors as "population centers such as towns and villages, campgrounds and trails, hospitals, nursing homes, schools, roads, airports, mandatory Class I Federal areas, etc. where smoke and air pollutants can adversely affect public health, safety, and welfare" (see appendix A of the specialist report). Several smoke sensitive areas lay within the airsheds of the areas proposed for treatment (table 63).

Table 63. Smoke-sensitive areas and sensitive receptors

Area	Proximity to implementation area	Concerns
Flagstaff	Within boundaries or directly adjacent in all directions	Hospital, schools, human habitation, visibility, young children, Interstate visibility
Williams	Within boundaries or directly adjacent in all directions	Hospital, schools, human habitation, visibility, young children, Interstate visibility
Verde Valley	Less than 10 miles downslope south and southwest.	Hospital, schools, human habitation, visibility, young children.
Grand Canyon National Park	Adjacent to the northern boundary of project area	Class I airshed, school, human habitation, campgrounds
Havasupai Reservation	About 55 miles Northwest of the EIS project area	Hospital, schools, human habitation, visibility, young children, elders.
Navajo Reservation	Northeast and east of the project area	Hospital, schools, human habitation, visibility, young children, elders.
Hualapai Reservation	About 55 miles west of the project area	Hospital, schools, human habitation, visibility, young children, elders.
Hopi Reservation	Northeast of the project	Hospital, schools, human habitation, visibility, young children, elders.

The most sensitive smoke receptor in the State of Arizona is the Verde Valley, which is easily impacted with nuisance smoke from the cumulative burning on the southern part of the Kaibab NF, the eastern side of the Coconino NF, and the western side of the Prescott NF, as diurnal drainage of smoke from fires settles into this valley. Considerable coordination between forests takes place when burns and wildfires that can affect the Verde Valley take place, facilitated by the interagency Smoke Management Group housed at ADEQ.

Smoke monitors in the Verde Valley (Sedona and Camp Verde) track emissions concentrations, as well as equipment that captures images of visibility conditions. Spikes are found in particulate matter concentrations as smoke from fire activity on the surrounding forests settles into the valley at night, although levels have not exceeded NAAQS thresholds in the Verde Valley. Many complaints of smoke impacts in the Sedona area are primarily concerned with the reduced quality of highly valued scenic views of the Red Rocks. Table 64 lists most of the areas that are expected to be impacted to some degree by implementation of prescribed fires in the 4FRI treatment area. Figure 44 displays the general locations of airsheds that could be impacted by 4FRI actions.

Airsheds 1, 3, and 5 are expected to experience the majority of the smoke impacts originating from the proposed treatment area, with rare instances of mild impacts in airshed 6.

Table 64. Areas expected to be impacted by proposed prescribed fire treatments

Communities	Roads	Recreation Areas
Camp Verde	Highway 180	Wupatki/Sunset Crater National Monuments
Cornville	Lake Mary Road (Co. Rd. 209)	Grand Canyon National Park
Cottonwood	Interstate 17	Oak Creek Canyon
Flagstaff	Co. Rd. 65	Grand Canyon Airport
Mormon Lake	Highway 89A	Flagstaff Airport
Sedona	Interstate 40	Walnut Canyon National Monument

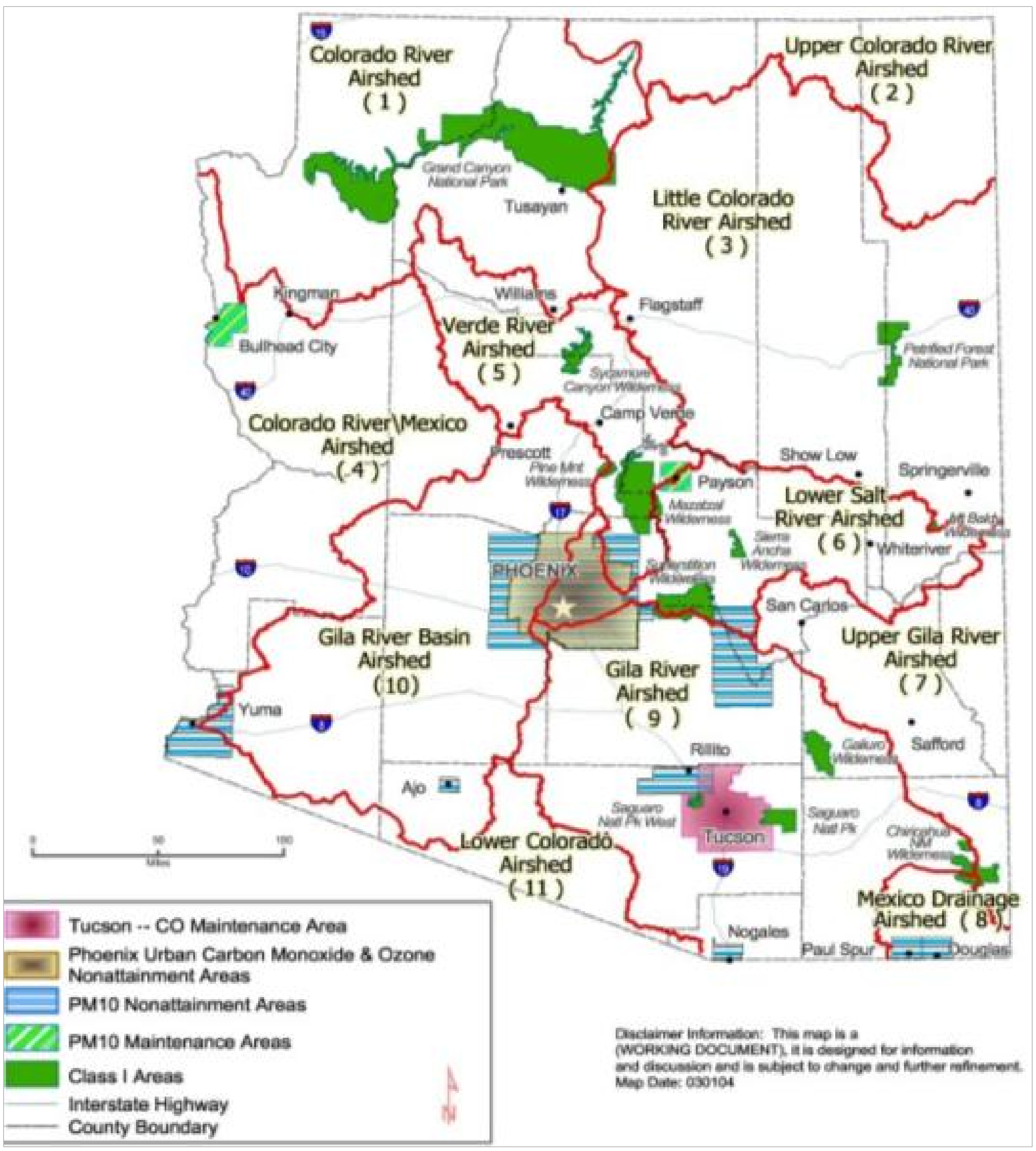


Figure 44. Airsheds defined by the Arizona Department of Environment Quality

Baseline visibility conditions (table 65) have been established for the Grand Canyon National Park and Sycamore Canyon Wilderness which are the two Class I areas potentially affected by activities and wildfires in the 4FRI implementation area. Visibility in the Class I area of Sycamore Canyon Wilderness can also be affected by smoke from fires in the southeast portion of the Kaibab NF. The Forest Service is required to adhere to requirements in the Arizona State Implementation Plan to meet natural condition visibility goals.

Table 65. Baseline and 2064 goal in 2003 Arizona State Implementation Plan (SIP) for natural conditions

Class I Area	Baseline Data Years	Baseline Conditions	2064 Goal in 2003 AZ SIP
Grand Canyon NP	1999–2000, 2002–2004	11.6 dv	6.95 dv
Sycamore Canyon Wilderness	2001–2004	15.2 dv	6.96 dv

Regulatory Requirements

Prescribed fire is implemented only with approved site specific burn plans and with smoke management mitigation and approvals. All burning is conducted according to ADEQ standards and regulations. These standards include the legal limits to smoke emissions from prescribed burns as imposed by Federal and State law. The ADEQ enforces these laws by regulating the acres that are treated based on expected air impacts. These regulations ensure that effects from all burning meet the Clean Air Act requirements. Prescribed fires are initiated under conditions that allow managers to meet both control objectives (fire behavior) and resource objectives (fire effects, including air quality impacts).

Kaibab NF and Coconino NF Prescribed Fire

The Kaibab NF has burned approximately 8,000 acres per year with prescribed fire in ponderosa pine since 2000. When wildfire acres are added, the Kaibab NF averaged approximately 17,000 acres a year (in ponderosa pine) from 2001 through fall of 2010.

From 2001 through fall of 2010, the Coconino NF averaged a little over 13,000 acres of prescribed fire in ponderosa pine. When wildfire acres are added, the Coconino averaged approximately 20,000 acres in ponderosa pine for that same period. No notice of violation of NAAQS standards has ever been issued to the Kaibab NF. Over the same period of time, one exceedance occurred on the Coconino NF. It occurred on one monitor for one day for an exceedance in PM_{10} in Flagstaff in 2007.

Environmental Consequences

Throughout this section, changes directly attributable to proposed actions, such as thinning or prescribed fire, are direct effects. These include changes to canopy bulk density, canopy base height, consumption of surface fuel, etc. Changes to the potential behavior and effects of wildfires that result from the direct effects are considered indirect effects.

Alternative A – Direct and Indirect Effects

In the short term (less than 20 years), effects of alternative A would include an increased risk of undesirable behavior and effects from wildfires (see fire ecology section). Average annual acres burned with wildfire would increase, along with the acres burned with high-severity fire and the associated air quality impacts. In the long term, if the current average annual acres burned by wildfire remained the same, it is likely that the entire treatment area would burn with wildfire by 2050, along with the associated air quality impacts. In the absence of wildfire, air quality would remain at current levels.

Alternatives B, C, and D – Direct and Indirect Effects in Common

- Implementing prescribed fire as proposed would result in lower emissions than if the area burned in a wildfire because there would be less biomass to burn, and would burn under conditions that would minimize air quality impacts.
- Prescribed fires implemented for the projects listed would comply with the regulations and requirements of the ADEQ and any burning done in the proposed treatment areas would comply with the NAAQS.
- Air quality impacts would be most likely to those portions of the Little Colorado River Airshed east and northeast of Flagstaff; the Colorado River Airshed north of Williams and including all of the treatment area in RU6; and the Verde River Airshed. There would be a small chance that there could be some impact to the northern portions of the Lower Salt River Airshed.
- When units are ignited, smoke would be expected to travel on prevailing winds, away from sensitive receptors, and dissipate. Most smoke would dissipate, but some may persist at the surface. Short-term nighttime smoke could settle down the drainages into the towns below, particularly during early morning hours. Nighttime smoke would be expected to reside in low areas down slope from the burn units, because night time winds are generally calm. Daytime smoke would be expected to dissipate mostly downwind from the burn unit. Burn plans written for implementation of the proposed prescribed fires would include modeling to determine the most appropriate conditions under which to burn to minimize smoke impacts.
- In the short term, as first entry burns are implemented, impacts would increase noticeably. Acres with high fuel loading would be burned, in a first step toward restoring the natural fire regime. In subsequent entries, the same acres would produce less smoke, along with maintaining an ecosystem that is resilient to fire, and benefits from it. In the long term, once an area has been burned once, there would be less fuel and, thus, lower emission potential. The combination of lower fuel loads and larger burn units would allow more acres to be burned without exceeding NAAQS.

Alternative B – Direct and Indirect Effects

Under this alternative, prescribed fire would be implemented on up to 58,333 acres annually to produce an average fire return interval of 10 years across 586,110 acres proposed for prescribed fire. Initial entry burns would produce much more emissions per acre than subsequent burns (see discussion on page 137 to page 139 in the fire report.) However, even if the slash was removed from the forest and although the prescribed fires would be spread over many years, the acres to be burned would increase significantly and maintenance burning would be required across the treatment area to maintain a low fuel load and a healthy forest.

Smoke impacts may increase under this alternative because both the Coconino and Kaibab NFs already burn almost as much as they can (given burn windows and other limitations on prescribed burning, including emissions). Under alternatives B, the number of acres available for prescribed fire would be 586,211 acres, which would average 58,792 acres a year. This, in turn, would increase the flexibility for the forests in laying out burn units and managing prescribed fires. With potential for larger burn units, it would be possible to burn 'hotter', so that, although more acres may be burned at one time, the heat created by increased fire behavior could provide more ‘lift’ for the smoke, increasing dispersal and minimizing smoke impacts.

Alternative C – Direct and Indirect Effects

Under this alternative, an average of 58,611 acres would need to receive prescribed fire every year. The effects (indirect) would be almost identical to those in alternative B, with the exceptions being the additional acres of Mexican spotted owl habitat and grasslands proposed for burning. Most acres in PACs and nest cores would be first entry burns that would initially produce a greater volume of smoke. However, surface fuel loads would not be burned in one entry; therefore, smoke would be dispersed over time. In the long term, the alternative would minimize wildfire emissions and effects and allow prescribed fire to be used in the future with lower emissions.

Alternative D – Direct and Indirect Effects

Alternative D proposes to treat 384,966 with mechanical thinning treatments only. Approximately 17,844 acres would need to burn each year to meet a 10-year fire return interval. At some point, these acres (as with most acres within the treatment areas) are likely to burn with wildfire. Under those circumstances, there would be with little warning, little control over the smoke, and a great deal more smoke that if prescribed fire was used.

Alternative D proposes to thin but not burn 70 percent of the treatment area. Approximately 388,526 acres would produce emissions as displayed in figure 45 in the column labeled “only mech” (refers to mechanical) treatment before wildfire and 178,441 (burn only) acres would produce emissions displayed in the column labeled “wildfire after burn only treatments”.

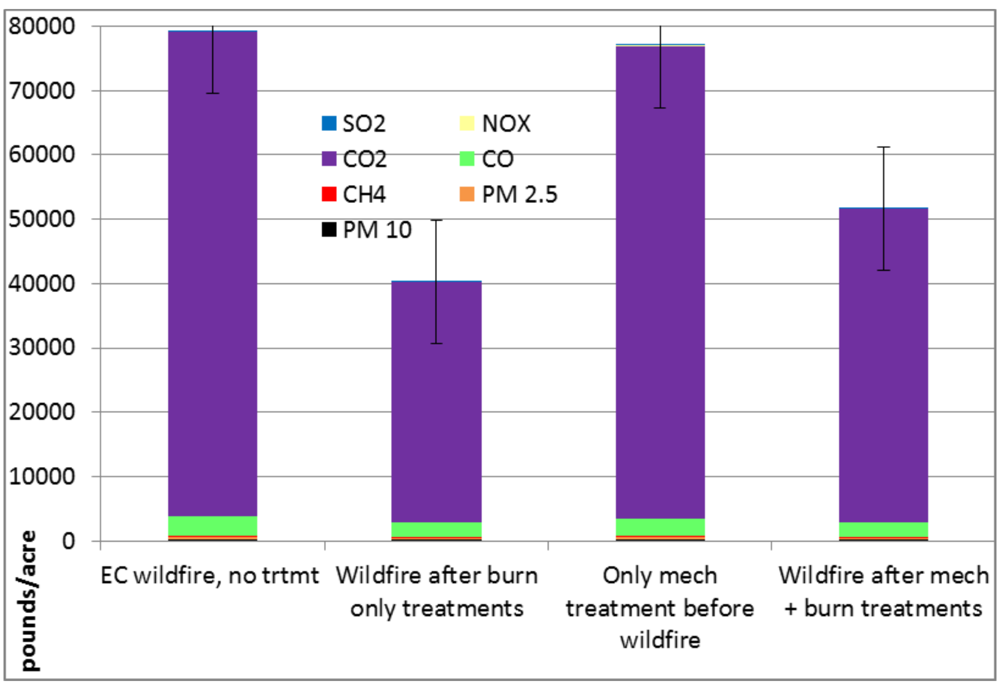


Figure 45. Emissions from surface fuels burning in wildfires after various treatments

Alternative E – Direct and Indirect Effects

This alternative would meet the purpose and need, and desired conditions for air quality. The effects (indirect) would be almost identical to those in alternative B, with the exceptions being the additional acres of Mexican spotted owl habitat and grasslands proposed for burning. Most acres in PACs and nest cores would be first entry burns, but the surface fuel load would not all be burned in one entry, so the smoke would be dispersed over time (see “Terrestrial and Semi-aquatic Wildlife and Plants” section of this FEIS and the wildlife report). Under this alternative, an average of 58,611 acres would need to burn every year, either from wildfire or prescribed fire with a total of 586,110 acres proposed for burning. The ecological effects of smoke would be identical to those under alternative C, except in core areas that would be excluded from burning.

Cumulative Effects

The cumulative effects of prescribed fires in on the Coconino, Kaibab, and Prescott NFs over the last 12 years has resulted in one exceedance of NAAQS on one monitor for one day for PM_{10} in Flagstaff in 2007. Past treatments and wildfires in the last 10 years have decreased the potential emissions by removing canopy fuels, mostly from thinning on approximately 63,000 acres, and by increasing canopy base height, from wildfire and prescribed fire. Low-severity fire would have consumed surface fuels, further decreasing potential for emissions on approximately 151,000 acres. In some areas of high-severity fire, canopy fuels were consumed leaving tree stems and branches which have the potential to smolder for days, or weeks (see fire ecology section for complete list of projects considered for cumulative effects).

There are approximately 18,436 acres of prescribed burns planned in RU 6 and Grand Canyon National Park by 2020. The Colorado River Airshed and the Little Colorado River Airshed have potential for air quality impacts from fires occurring within RU 6 and Grand Canyon National Park. It is likely that similar burn windows would be needed for many of the fires in the park and parts of RU 6.

The emissions from 244,000 acres of prescribed fire in the remainder of the analysis area would be managed in compliance with regulations and requirements of the ADEQ. There would be potential for air quality impacts to the Peaks and Sycamore Canyon Wilderness areas. The Colorado River Airshed, the Little Colorado River Airshed, and the Verde River Airshed are likely to have some air quality impacts from fires occurring in the southern part of the analysis area.

Alternative A

Air quality would be unaffected by prescribed fire from the treatment area, but would be affected by prescribed fires from other projects as noted above. Emissions from 244,000 acres of prescribed fire from current, ongoing, and reasonably foreseeable projects would be managed in compliance with regulations and requirements of the ADEQ. As with prescribed fires, wildfires occurring in the untreated areas would produce more emissions in areas that were not treated and could augment the effects of prescribed fires on air quality. Areas with potential for impact would be the Colorado River Airshed, the Little Colorado River Watershed, and the Verde River Watershed. Class 1 airsheds that could be affected include Grand Canyon National Park and Sycamore Canyon Wilderness Area.

Alternatives B, C, and E

All prescribed fires would be implemented in compliance with ADEQ regulations and requirements as well as forest plan direction to meet legal standards and provide for public safety.

Emissions from prescribed fires proposed in alternatives B and C would utilize many of the same burn windows that the approximately 244,000 acres of current, ongoing, and reasonably foreseeable projects would use. However, the increased acres of prescribed fire would allow more flexibility for implementation, and making it possible to burn more acres at once with the same impacts. Areas with potential for impact would be the Colorado River Airshed, the Little Colorado River Watershed, and the Verde River Watershed. Class 1 airsheds that could be affected include Grand Canyon National Park and Sycamore Canyon Wilderness Area. As more acres are treated, there will be broader burn windows, potentially resulting in more days of prescribed fire and days of air quality impacts.

Alternative D

RU 6 is adjacent to the Grand Canyon National Park, a Class 1 airshed and one of the most heavily visited national parks in the United States. Burn windows for the burns proposed in the action alternatives would be the similar to those for the current, ongoing, and reasonably foreseeable future actions.

The potential for undesirable air quality impacts from prescribed fire would be the same as other alternatives because all prescribed fires are regulated by the same laws regarding allowed emissions. Areas with potential for impact would be the Colorado River Airshed, the Little Colorado River Watershed, and the Verde River Watershed. Class 1 airsheds that could be affected include Grand Canyon National Park and Sycamore Canyon Wilderness Area. In most of the area that was thinned and not burned (388,526 acres), there would be potential for greater wildfire emissions from increased surface fuel loading. When combined with emissions from current, ongoing, and reasonably foreseeable management actions, there would be potential for greater air quality impacts when wildfires burned in these areas than in areas that had been previously treated with low-severity fire.

Unavoidable Adverse Effects – All Alternatives

See fire ecology section for effects from alternative A. In alternatives B through E, in the short term as “1st entry” burns are implemented, impacts would increase noticeably. Acres with high fuel loading would be burned, in a first step toward restoring the natural fire regime. In the long term, the same acres would produce less smoke, along with maintaining an ecosystem that is resilient to fire, and benefits from it. Implementing acres of prescribed fire would produce low severity effects that are beneficial for the landscape. In the long term, high severity fires would no longer possible on the majority of acres that are treated.

There is a risk of short-term human health impacts from prescribed fire. The emissions from prescribed fires, as opposed to wildfires, can be managed by carefully distributing (prescribed) fire over time and space, as well as under appropriated weather conditions (Cohesive Strategy 2002, p. 39). Under alternatives B through E air quality impacts would be most likely to those portions of the Little Colorado River Airshed east and northeast of Flagstaff; the Colorado River Airshed north of Williams and including all of the treatment area in RU6; and the Verde River Airshed. There is a small chance that there could be some impact to the northern portions of the Lower Salt River Airshed.

In all action alternatives implementing prescribed fire would result in lower emissions than if the area burned in a wildfire because there would be less biomass to burn. In the long term, once an area has been burned once, there would be less fuel and, thus, lower emission potential. The combination of lower fuel loads and larger burn units would allow more acres to be burned without exceeding NAAQS.

Forest Plan Amendments and Forest Plan Consistency

See the fire ecology environmental consequences section.

Terrestrial and Semi-aquatic Wildlife and Plants

This section includes key effects and conclusions for terrestrial, semi-aquatic, and plant threatened, endangered, and proposed species and critical habitat listed under the Endangered Species Act of 1973, as amended, Forest Service Southwestern Region Sensitive Species, forest management indicator species, and migratory birds. The wildlife (Noble et al. 2014) and botany report (Crisp 2014) are incorporated by reference. Aquatic species were analyzed separately.

See the specialist reports (project record) for detailed information on methodology, analysis assumptions, best available science and data, habitats, populations, and effects that are not repeated in this section.

Changes from the Draft Environmental Impact Statement

After reviewing public comments on the DEIS a new alternative was added to the analysis. Alternative E is tracked through the document for each individual species. Other changes:

- The 1995 Mexican Spotted Owl Recovery Plan formed the basis of the Mexican spotted owl analysis in the project DEIS. The DEIS included plan amendments that were developed to ensure the preferred alternative (alternative C) would better match the measures in the new recovery plan that was under development at the time. However, the 1995 recovery plan was still the only recovery plan existing at the time of the DEIS development. The U.S. Fish and Wildlife Service (FWS) did participate in meetings, field reviews, and development of treatment objectives during this time to ensure the 4FRI met the intent of the yet to be released revised recovery plan (see project record). The revised Mexican Spotted Owl Recovery Plan was released to the public in December 2012 and the DEIS was released for public comment in March of 2013. Revising the wildlife analysis to reflect the revised recovery plan would have delayed the release of the DEIS indefinitely. The FWS agreed to retain the wording and metrics of the original 1995 recovery plan in analysis documents. The Biological Assessment was submitted to the FWS in February of 2014. While the analysis in the FEIS retains the terminology and guidelines specific to the former recovery plan, the FWS evaluated the effects of the proposed actions on spotted owls using the guides and measures of the revised recovery plan. Consistency with the revised Mexican Spotted Owl Recovery Plan was documented in the effects analysis of the preferred alternative and the corresponding biological opinion as part of consultation with the FWS (see wildlife report, appendix 2 and FWS biological opinion issued on October 20, 2014). A crosswalk between the 1995 and 2012 recovery plans can be found in the wildlife report appendix 3.
- A new Southwestern Region sensitive species list was released on September 19, 2013. The sensitive species within this document reflects this change; and, new survey information was included in the analysis if available.
- The cumulative effect analysis for all species was updated with new information. In response to comments on the level of detail of the analysis Mexican spotted owl and goshawk, additional information and specificity was added to the cumulative effects analysis.
- The FWS in the Federal Register (November 1, 2013) changed migratory bird species' scientific names to conform to accepted use and based on new taxonomy. This change was incorporated.

- Acres within the analysis area were changed. Some individual stands were dropped from treatment resulting in minimal changes. The analysis area boundary was changed by the creation of the Flagstaff Watershed Protection Project. This project removed acres near the San Francisco Peaks and from the Mormon Mountain area. This area and the proposed treatment are now discussed in the cumulative effects section. This also changed the number of Mexican spotted owl PACs within the analysis area.
- New Mexican spotted owl PACs were added due to the discovery of new nesting areas within the analysis area. Other PACs were combined and PAC status was removed from some areas due to loss of habitat from high-severity fires.
- New PFAs for goshawks were developed due to the discovery of new nesting areas within the analysis area.
- Portions of the fire behavior modeling were revised to provide more detailed results.
- A new forestwide Management Indictor Species (MIS) Assessment was completed for the Coconino NF on January 28, 2013 and was used to update that section.
- The Kaibab NF published a revised forest plan in 2014. The revised plan made the following adjustments to this analysis: (1) Removed the language that was based on the 1995 Mexican Spotted Owl Recovery Plan, (2) Habitat requirements for goshawks are built into the desired conditions for ponderosa pine and frequent fire mixed-conifer instead of standards and guidelines, (3)The previous MIS list was removed and replaced with a new list, (4) A rare and narrow endemic species section was added, requiring additional analyses to be added to this document, and, (5) The hiding and thermal cover standards and guidelines for deer and elk was removed.
- In June of 2014, the Slide Fire burned 2,600 acres of goshawk habitat within the 4FRI boundary, affecting the Casner Canyon PFA and dispersal PFA 23. Within the project area, Casner Canyon PFA represents 1.7 percent of PFAs and Dispersal 23 represents 5.5 percent of dispersal PFAs. The fire burned over 4,000 acres of Mexican spotted owl habitat. The fire affected Arizona bugbane habitat. The fire affected habitat for the narrowheaded garter snake, located downstream and outside the treatment area. The impacts of the Slide Fire were incorporated into the analysis.
- As a result of the FWS biological opinion:

  (1) disturbance from hauling was changed from a ¼ mile from core areas within PACs to the exterior boundaries of the PACs themselves. Actual routes were reevaluated and little change was possible. Therefore, additional timing restrictions would be applied with the potential result of dropping some areas from treatment,

  (2) Proposed treatments to PACs affected by the Slide Fire would be re-evaluated in 5 years. If treatments were to occur, core areas would be designated for the canyon PACs that partially overlap the 4FRI footprint,

  (3) Proposed treatments in stands supporting bugbane that were affected by the Slide Fire would be re-evaluated in 5 years. If treatments were to occur, a monitoring was agreed to which would document effects of prescribed fire to bugbane, and,

  (4) Additional details were included in both the wildlife report and the Mexican spotted owl monitoring plan (FEIS, appendix E). Monitoring would be based on the two treatment types (i.e., mechanical and prescribed fire or prescribed fire-only) and both treatment types would

have paired reference PACs. Twelve Mexican spotted owl PACs would be monitored and data collection would focus on occupancy, reproductive success, and changes to vegetation.

Additional analysis was conducted on about 38,256 acres of treatments in goshawk habitat where there is a preponderance of trees 16 inches d.b.h. and larger (22,772 acres on the Coconino and 15,484 acres on the Kaibab NF). These acres do not include stands in Mexican spotted owl habitat.

The following are botany-specific changes:

- Arizona phlox (*Phlox amabilis*) was added to the sensitive species list for both forests. Since it occurs in several units on the Kaibab NF, it was included in the (FEIS) analysis. Recent survey location information was added to the analysis.
- In response to having a revised Kaibab NF forest plan, (1) the botanical analysis was updated to reflect that Garland Prairie is longer proposed as a research natural area. The Prairie has been designed as a management area, and (2) desired condition and guidelines for implementation were added to appendix C of this FEIS to address several rare and narrow endemic plant species that are neither threatened, endangered or Southwestern Region (Region 3) sensitive. This was also done for the Coconino NF as the draft plan (USDA FS 2013) has similar direction for rare and narrow endemic plants.
- A complete analysis and review of comments is included in appendix F of the botany report. In response to comments, inconsistencies in the document were addressed. An example is removing acres and analysis associated with the Flagstaff Watershed Protection Project analysis. In response to comments by the FWS on the draft biological assessment, an administrative study that would address the fire effects on Arizona bugbane was included in the monitoring plan (see appendix E of this FEIS).

Opposing Science

The complete response to comments on the DEIS is located in the project record. Only a summary of the wildlife response is provided here. Botany-related comments were specific to noxious weeds, see that section. A commenter on the DEIS included opposing science for goshawk and stated the project was not utilizing the best available science. The literature (Beier et al. 2008, Beier and Ingraldi 2012) was reviewed. No new relevant, scientific information was provided and the analysis was not changed.

In 2008, Beier et al. compared goshawk reproduction at 13 nest sites located among three different management scenarios that each defined desired conditions for forest structure differently. Their study used recommendations developed by the Ecological Restoration Institute (Northern Arizona University), an advocacy group (Greenwald et al. 2005) and the “Management Recommendations for the Northern Goshawk in the Southwestern United States” (MRNG; Reynolds et al. 1992). They concluded that goshawk reproduction declined as forest structure in the breeding areas more closely resembled any of the tested desired conditions, including forest structure prescribed in the MRNG. In response to this investigation, Reynolds et al. (2012) looked at Beier et al.’s analysis and found several apparent errors which, when taken together, largely discounted the conclusions. Beier et al.’s rebuttal paper (2012) was a discussion of the debate itself and offered no new scientific information.

Beier et al. 2008 is based on a review of the General Technical Report RM-217 - Management Recommendations for the Northern Goshawk in the Southwestern United States (Reynolds et al. 1992). The technical report and the 1996 Regional Amendment to all Southwestern Region Land

Management Plans are not the same. The selected alternative for the 1996 Regional Amendment was the Mexican Spotted Owl Recovery Plan Integration Alternative. The standards and guidelines for northern goshawks in this alternative were developed in early May 1995, and considered all known information from the Goshawk Interagency Implementation Team recommendations, the joint Arizona and New Mexico game agency letters that responded to the DEIS, and experience gained during the implementation of the interim direction (USDA FS 2006). These are the directions used in developing project alternatives unless forest plans are specifically amended.

One of the discussion points in Beier et al. (2008) was whether the assumption that the goshawk is a forest habitat generalist is correct. This is a fundamental aspect of the technical report and the 1996 plan amendment. The assumption was further supported by a review of additional literature in the Final Supplement to the Final Environmental Impact Statement for Amendment of Forest Plans (USDA FS 2006). Beier et al. (2008) cited Greenwald et al. (2005) when discussing whether the goshawk was a habitat specialist and Greenwald et al. (2005) was reviewed in the Final Supplement to the Final Environmental Impact Statement.

Beier et al. (2008) used a small sample size in an observational rather than an experimental approach. They concluded that the production of goshawk fledglings decreased as breeding areas more closely resembled habitat described in Reynolds et al. (1992). Reynolds et al. (2012) found study flaws in Beier et al. (2008) that led to a miscalculation of vegetation structural similarities that introduced a systematic bias into their test. Reynolds et al. (2012) also found evidence of a basic misunderstanding of the desired forest structures described in the technical report as described in Beier et al. (2008), including their assertion that the desired conditions in the MRNG differ markedly from pre-settlement forest structures when ongoing research by the Ecological Restoration Institute describes similar forest structure (see the summary for Ray (2011) below).

Beier and Ingraldi (2012) acknowledged that sampling across a broader spectrum of similarity would provide a much stronger evaluation of the technical report and clarified their findings by stating “we carefully avoided inferring that the recommendations were ‘bad for goshawk.’ Instead we cautiously pointed out that our results provided no evidence that the recommendations improve goshawk nest productivity.”

The 1996 Plan amendment provides for integrated multiple use and sustained yield of goods and services from the Forest in a way that maximizes net public benefits in an environmentally sound manner while conserving goshawks in the southwestern United States.

Beier et al. (2008) did not address prey habitat or other needs of key prey species. Salafsky et al. (2005) suggested that prey density was an important limiting factor of goshawk productivity. Later, studies showed that increased prey density results in increased goshawk reproduction in ponderosa pine (Salafsky et al. 2007). Dewey and Kennedy (2001) reported that significantly heavier nestlings from nests with supplemental food had higher survival rates than nestlings in control nests. In 1996, Ward and Kennedy reported that although there was no significant difference in nestling sizes due to additional food availability, they did document higher nestling survival due to increased time spent at nests by females which consequently provided protection from predators. Wiens et al. (2006) reported that food availability was the primary factor limiting juvenile survival and recommended forest treatments that provide forest structural conditions that allow goshawks to access their prey within breeding areas. Providing for the habitat needs of 14 key prey species of goshawks in the southwestern United States is why the MRNG is described as food-web-based conservation plan (Reynolds et al. 2008).

Greenwald et al. (2005) concluded that the MRNG may be inadequate to protect goshawks. Greenwald et al. (2005) based this conclusion on their review of 12 radio-telemetry-based studies of goshawk habitat selection and 5 non-telemetry studies that looked at the effects of vegetation structure on goshawk home ranges. Reynolds et al. (2008) reviewed the methodology used by Greenwald et al. (2005) and concluded the MRNG appeared rooted in misunderstandings of goshawk habitats described in the MRNG, a discounting of the extent of variation in vegetation structural and seral stages used by goshawks, a limited understanding of the extent to which prey limits goshawks, a failure to recognize the dynamic nature of forests, and an incomplete review of the literature. Reynolds et al. (2008) concluded the MRNG are adequate because they maximize the sustainable amount of mature and old forests in goshawk home ranges and specify intermixtures of prey habitats within home ranges.

Ray (2011) modeled three management strategies for ponderosa pine forest, including: an evidence-based, thin from below followed by prescribed burning restoration treatment; retaining/creating small groups of different diameter classes to mimic the MRNG; and a blend of the two approaches applied to specific areas recommended for treatment by a collaborative group working with the Kaibab NF. The modeled approach for the MRNG did not account for prey habitat, including omission of forest plan direction for snags and coarse woody debris. He evaluated the probability of northern goshawk occupancy in the forest structure resulting from each modeled treatment type. All three strategies showed a decrease in the probability of occupied northern goshawk territories occurring. Results for the MRNG and restoration treatments were not statistically different and the blended approach produced the highest probability of use. Ray (2011) looked at a single point in time and did not model forest structure through time. Ray did reference the importance of the abundance and availability of prey species to goshawk reproduction and survival and concluded that “goshawks are likely to persist while managers restore the ecological integrity of southwest ponderosa pine” (Ray pers. comm.2011).

Vegetation Cover Types and Habitat Stratification

The dominant cover types within the project area are described in the vegetation section. All ponderosa pine forested habitat within the project area was stratified to meet analysis requirements in the Coconino NF forest plan (USDA FS 1987) (and former Kaibab NF forest plan) for Mexican spotted owl and northern goshawk. The stratification does not conflict with the revised Kaibab NF forest plan.

Habitat Connectivity and Bridge Habitat for Canopy-Dependent Species

Current forest structure is much denser in terms of trees per acre and canopy continuity than pre-settlement conditions for ponderosa pine in northern Arizona. Concern was expressed by the public throughout the public involvement process that the scale and intensity of vegetation treatments would affect the connectivity of species that require closed canopy conditions.

The wildlife species of concern identified during the scoping process include the northern goshawk, the Mexican spotted owl, Abert’s squirrel, turkey, mule deer, black bear, and some songbird species. In response to comments and concern, an analysis that evaluates how post-treatment conditions would provide habitat for canopy-dependent wildlife in the short term. Those areas are referred to as “bridge habitat,” suggesting that these more densely-forested areas would be available to wildlife to bridge the time between treatment and the attainment of desired conditions across the broader landscape.

The complete analysis for bridge habitat for canopy-dependent wildlife can be found in appendix G of this FEIS and appendix 7 of the wildlife report. Post-treatment openness (heterogeneity) is summarized in the comparison of alternative effects table for Mexican spotted owl and goshawk (chapter 2). Post-treatment canopy openness is also addressed in the silviculture analysis. Only a summary is provided here.

Forest structure, forest health, vegetation composition and diversity, and fire behavior are highly departed from desired conditions. Chapter 1 describes how existing conditions are affecting wildlife habitat and function. This chapter also provides the existing condition of canopy openness.

Habitat Connectivity and Bridge Habitat Environmental Consequences – All Alternatives

In alternative A (no action), the closed-canopy, high-density, mid-aged forest conditions that are currently common in the project area would persist. There would be less movement toward the natural range of variability. The forest would be less resilient to natural disturbances (fire, insect and disease, climate). There would be less ability to maintain existing large and old trees and increase large tree growth rates.

At the landscape scale, alternatives B through E would maintain more closed canopy conditions than likely occurred historically. About 40 percent of the landscape within the project boundary would be deferred from treatment. Of those acres treated, about 42 percent would remain in a moderately-closed to closed condition after treatment. Landscape-scaled movement corridors that were delineated independent of site-specific treatment assessments in the project design. Old growth conditions account for 36 percent of the ponderosa pine treatment area and are well-distributed across the landscape and would be managed for closed canopy conditions in the long-term. A patch-mosaic of small deferrals would be created all across the project area to maintain wildlife-related features such as sinkholes and hiding cover. Implementation guidance in Mexican spotted owl and northern goshawk habitats includes provisions for higher tree densities and canopy cover relative to the surrounding landscape. All of these measures would provide bridge habitat for canopy-dependent wildlife. It is our assumption that by providing more closed-canopy conditions than likely occurred historically, adequate habitat would be provided for canopy-dependent wildlife. Monitoring would be an important test of this assumption, and adaptive management would be employed if outcomes prove otherwise.

The project also intentionally plans for bridge habitat at the mid-scale through its desired conditions, design features/best management practices/mitigation, the Old and Large Tree Implementation Plans, and the silvicultural design and implementation guide. These factors are described in detail in the appendix C and D of this FEIS. Bridge habitat for canopy-dependent wildlife would also occur at the mid-scale. Some densely forested areas would be deferred simply due to the vagaries of implementation. See individual species for site-specific direct, indirect and cumulative effects.

About 38,256 acres were identified in comments to the DEIS as having a preponderance of trees greater than 16 inches d.b.h. in 1,069 individual stands (see silviculture for a map and details). The high basal area and number of trees per acre in large size classes would result in high stand density index (SDI) within these stands. The average SDI max would be at the threshold of "extremely high density," resulting in competition-induced mortality and stagnating diameter growth. The number of acres combined with the number stands that were identified by an independently developed list of criteria would help ensure bridge habitat is widely distributed across the 4FRI project area. This includes over 10,000 acres in areas identified by the AGFD as key for landscape connectivity for species associated with open habitat.

Table 66. Acres of treatment and nontreatment areas within the 4FRI project area

Area	Description	Acres
Project Area	Total area within 4FRI project boundary	988,764
Exclusions	Other projects	213,090
	Special management areas (wilderness, research natural areas, inventoried roadless areas, Camp Navajo, and experimental forests)	30,668
	Non-FS lands	145,156
	Miscellaneous (other cover types, no-treatment protected activity center (PAC) core areas, inaccessible areas, etc.)	11,138
	Total excluded areas within 4FRI project boundary	**400,052**
Treatment Area	Ponderosa pine treatment area	507,839
	Other cover types treatment area	80,876
	Area within the proposed treatment boundary (includes mechanical treatment and prescribed burning)	**588,716**

Federally Listed Threatened, Endangered, Proposed Candidate Species, and Designated Critical Habitat, and Forest Service Sensitive Species

The following list of federally threatened, endangered, and proposed species was adopted from the Coconino and Kaibab NFs' lists of species. Only those federally listed threatened, endangered, candidate species and their critical habitat, along with Forest Service sensitive species that are known or have potential to occur within the project area were analyzed (table 67). Table 68 lists species that are not present or do not have potential habitat in the project area and were therefore dismissed from further analysis.

Table 67. Threatened, endangered, candidate, and sensitive species evaluated in this analysis

Common Name	Scientific Name	Status
Amphibians		
Northern Leopard Frog	*Lithobates pipiens*	S
Birds		
Mexican Spotted Owl and critical habitat	*Strix occidentalis lucida*	T
California Condor	*Gymnogyps californianus*	E/10j population
Bald Eagle	*Haliaeetus leucocephalus*	S
Northern Goshawk	*Accipiter gentilis*	S/MIS/Mig Bird[1]
American Peregrine Falcon	*Falco peregrinus anatum*	S
Western Burrowing Owl	*Athene cunicularia hypugaea*	S/Mig Bird

Common Name	Scientific Name	Status
Mammals		
Black-footed Ferret	*Mustela nigripes*	E
Navajo Mogollon Vole	*Microtus mogollonensis navaho*	S
Western Red Bat	*Lasiurus blossevillii*	S
Spotted Bat	*Euderma maculatum*	S
Allen's Lappet-browed Bat	*Euderma maculatum*	S
Pale Townsend's Big-Eared Bat	*Corynorhinus townsendii pallescens*	S
Reptiles		
Narrow-headed Garter Snake	*Thamnophis rufipunctatus*	T
Plants		
Arizona bugbane	*Cimicifuga arizonica*	S
Rusby milkvetch	*Astragalus rusbyi*	S
Arizona leatherflower	*Clematis hirsutissima var. hirsutissima*	S
Cliff Fleabane	*Erigeron saxatilis*	S
Flagstaff pennyroyal	*Hedeoma diffusum*	S
Arizona sneezeweed	*Helenium arizonicum*	S
Sunset Crater beardtongue	*Penstemon clutei*	S
Flagstaff beardtongue	*Penstemon nudiflorus*	S
Arizona Phlox	*Phlox amabilis*	S
Blumer's dock	*Rumex orthoneurus*	S
Bebb's willow	*Salix bebbiana*	S

Status: E = Federally Endangered; T = Federally Threatened; C = Federal Candidate; S = Forest Service Sensitive; Mig Birds = Migratory Birds, E/10j populations = Experimental population (section (10)(j) of the ESA)

1. Analyses for management indicator species and migratory birds can be found below

2. Note that Mexican spotted owls are analyzed as a threatened species under the ESA

Table 68. Threatened, endangered, proposed and sensitive species not addressed in this analysis

Common Name	Scientific Name	Rationale	Status
Amphibians			
Chiricahua Leopard Frog	*Lithobates chiracahuensis*	Neither the species nor its habitat occurs in the project area	T
Lowland Leopard Frog	*Lithobates yavapaiensis*	Neither the species nor its habitat occurs in the project area	S
Birds			
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	Neither the species nor its habitat occurs in the project area	E
Yuma Clapper Rail	*Rallus longirostris yumanensis*	Neither the species nor its habitat occurs in the project area	E
Western Yellow-billed Cuckoo	*Coccyzus americanus occidentalis*	Neither the species nor its habitat occurs in the project area	PT
Plants			
San Francisco Peaks ragwort	*Packera franciscana* (*Senecio fransciscanus*	Neither the species nor its habitat occurs in the project area	T

Common Name	Scientific Name	Rationale	Status
Arizona cliffrose	*Purshia subintegra*	Neither the species nor its habitat occurs in the project area	E
Tonto Basin Agave	*Agave delamateri*	Neither the species nor its habitat occurs in the project area	S
Grand Canyon Agave	*Agave phillipsiana*	Neither the species nor its habitat occurs in the project area	S
Mt. Dellenbaugh sandwort	*Arenaria aberrans*	Species is not known to occur in the analysis area	S
Crenulate moonwort	*Botrychium crenulatum*	Species is not known to occur in the analysis area	S
Cochise sedge	*Carex ultra*	Species is not known to occur in the analysis area	S
Disturbed rabbitbrush	*Chrysothamnus molestus*	Species is not known to occur in the analysis area	S
Mogollon thistle	*Cirsium parryi* ssp. *mogollonicum*	Species is not known to occur in the analysis area	S
Metcalf’s tick trefoil	*Desmodium metcalfei*	Species is not known to occur in the analysis area	S
Cliff Fleabane	*Erigeron saxatilis*	Habitat for this species is on steep canyon walls and is not likely to be affected by management actions including burning.	S
Heathleaf wild buckwheat	*Eriogonum ericifolium var. ericifolium*	Neither the species nor its habitat occurs in the project area	S
Ripley wild buckwheat	*Eriogonum ripleyi*	Neither the species nor its habitat occurs in the project area	S
Arizona sunflower	*Helianthus arizonensis*	Species is not known to occur in the analysis area	S
Eastwood alum root	*Heuchera eastwoodiae*	Species is not known to occur in the analysis area	S
Lyngholm’s brakefern	*Pellaea lyngholmii*	Neither the species nor its habitat occurs in the project area	S
Alcove bog orchid	*Platanthera zothecina*	Neither the species nor its habitat occurs in the project area	S
Hualapai milkwort	*Polygala rusbyi*	Neither the species nor its habitat occurs in the project area	S
Verde Valley sage	*Salvia dorrii* ssp. *mearnsii*	Neither the species nor its habitat occurs in the project area	S

Status: E = federally endangered; T = federally threatened; S = Forest Service sensitive, PT= proposed threatened

Mexican Spotted Owl

There are 187 PACs entirely on or overlapping with the Coconino NF. There are 10 PACs that are entirely or partially on the Kaibab NF: seven are PACs administered by the Kaibab NF and 3 PACs overlap with and are administered by the Coconino NF. All 10 of the PACs on the Kaibab NF are on the Williams Ranger District. There are 193 PACs occurring completely or partially on the Coconino and Kaibab NFs. Seventy PACs occur in the 4FRI treatment area.

The treatment area contains about 35,019 acres of Mexican spotted owl protected habitat (figure 46), of which 34,183 acres are within designated PACs that are assumed occupied. The remaining protected habitat (836 acres) occurs on steep slopes where timber harvest has not occurred in the previous 20 years.

Currently, Mexican spotted owl habitat occurs in all restoration units except for RU 6, the Tusayan RD. Approximately 76,091 acres of Mexican spotted owl restricted habitat exists within the treatment area, including 1,977 threshold acres and 6,736 target acres. See methodology section and appendix 4 of the wildlife report for the process used to identify PACs that could potentially be improved from vegetation treatments, the existing condition, and need for habitat improvement.

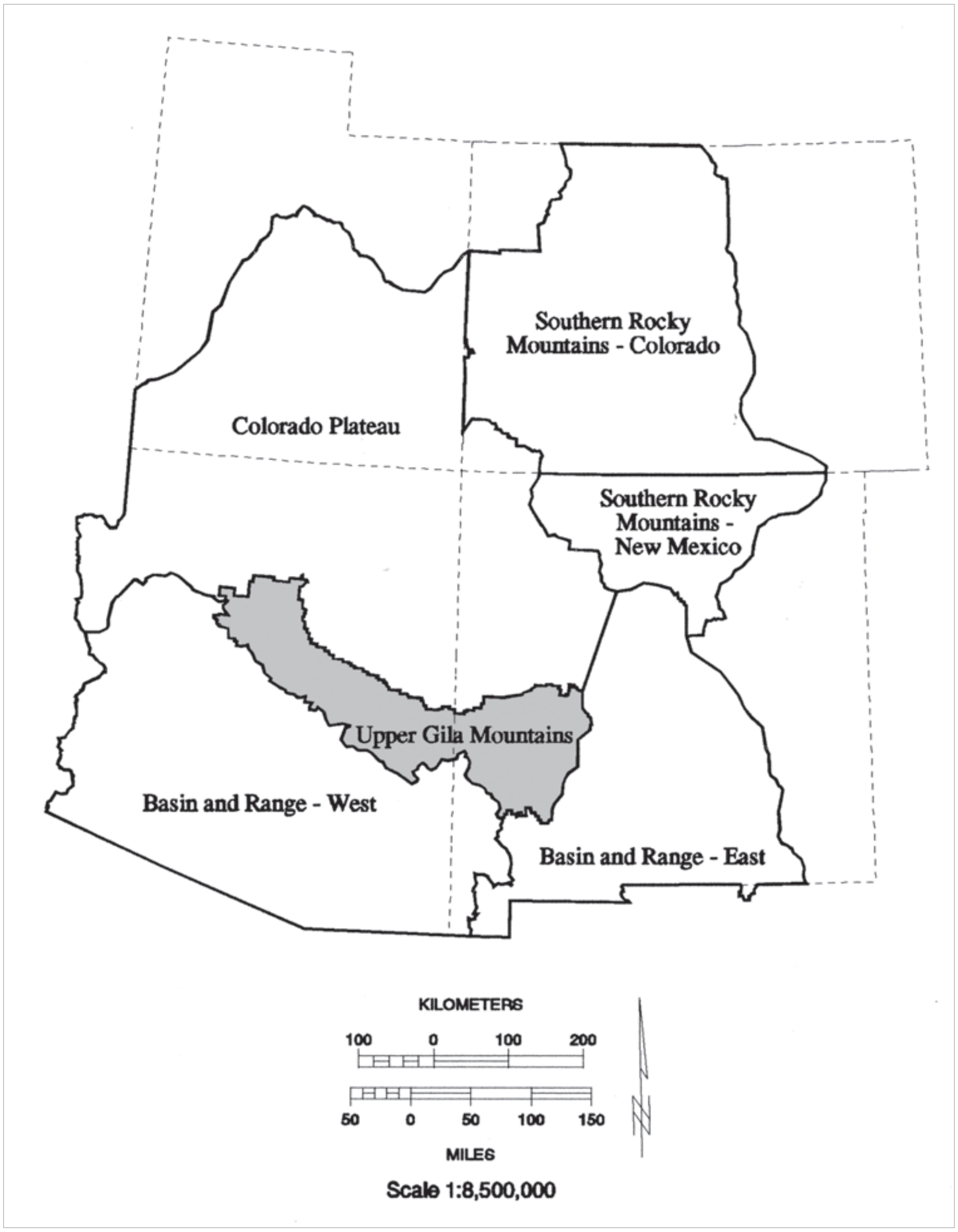


Figure 46. Recovery units designated in the Mexican Spotted Owl Recovery Plan (USDI FWS 1995)

Six critical habitat units (CHUs) occur partially or completely within the project area. Approximately 88,914 acres of Mexican spotted owl critical habitat occur within the treatment area. Figure 47 displays all Mexican spotted owl habitat within the 4FRI treatment area.

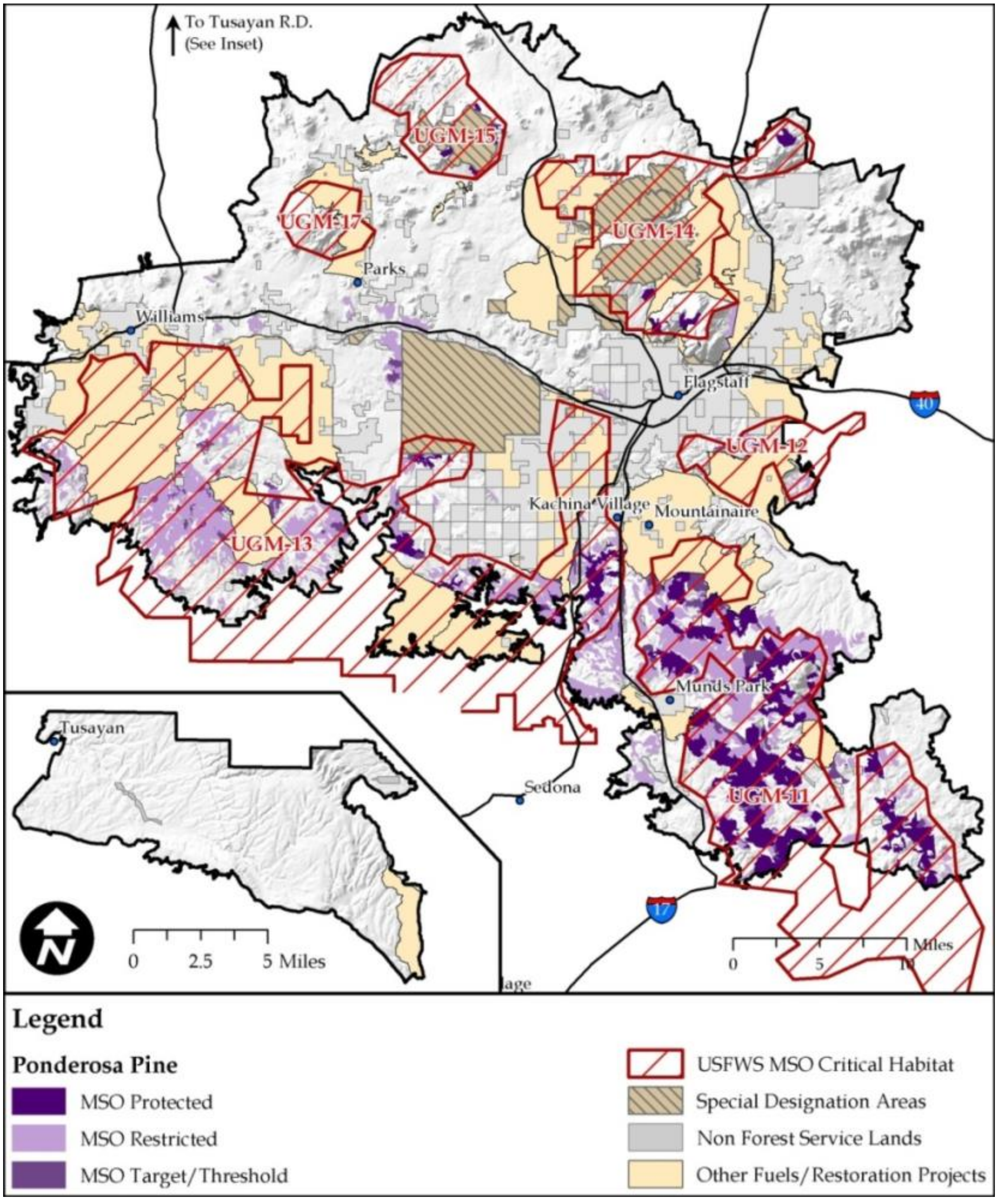


Figure 47. Mexican spotted owl (MSO) habitat and critical habitat unit boundaries within the 4FRI project area

Effects to Mexican spotted owls must be analyzed in terms of effects to the animal, effects to its habitat, and effects to designated critical habitat (ESA, PL 93-205, USDI FWS 2004). Critical habitat includes both protected and restricted habitat, as defined in the (revised) Mexican Spotted

Owl Recovery Plan. Six critical habitat units occur within or overlap the project area, encompassing about 488,974 total acres. Approximately 91,047 acres of protected and restricted habitat critical habitat in the treatment area are within designated critical habitat unit boundaries.

The primary constituent elements essential to the conservation of the owl include those physical and biological features that support nesting, roosting, and foraging. Primary constituent elements evaluated for Mexican spotted owl critical habitat within pine-oak forest include a range of tree species of different sizes and ages with an emphasis on large trees, high density/basal area of large pine, canopy cover 40 percent and greater, high numbers/volumes of snags, logs, and coarse woody debris. Constituent elements include having a wide range of plants with adequate residual cover to maintain fruits, seeds, and plant regeneration.

Surveys and Monitoring

Annual Mexican spotted owl monitoring on the Coconino and Kaibab NFs is highly variable. Some PACs are rarely monitored while others are monitored nearly every year. There have been dramatic fluctuations in PAC occupancy and reproduction between 1987 and 2013 with average annual reproduction varying from 0 to 2.6 young per adult pair on the Coconino NF. There is less information available on reproductive success of Mexican spotted owls on the Kaibab NF. Reproductive effort appears to be strongly influenced by precipitation (Ganey et al. 2011). Uncharacteristic wildfire has altered forest structure and so presumably affected reproductive success as well. Forest management has not likely directly affected Mexican spotted owls since the 1990s given how little work was typically done in Mexican spotted owl habitat. Monitoring summaries for each forest from 1987 to 2013 are presented in the wildlife report.

Summary of Habitat Conditions

Existing Mexican spotted owl protected habitat generally meets nesting and roosting guidelines for trees 12 to 17.9 inches d.b.h., but average values fall short of desired conditions for trees 18 to 23.9 inches d.b.h. and especially for trees greater than or equal to 24 inches d.b.h. Similarly, the number of trees per acre 18 inches d.b.h. or greater and the density of Gambel oak for trees greater than 5 inches d.r.c. (as described in the Recovery Plan) are both consistently low across the landscape (see table 16 in the wildlife report). Acres of protected habitat are primarily within PACs. PACs provide nesting and roosting habitat and are assumed to be occupied. Adequate nesting and roosting habitat is important in achieving Mexican spotted owl recovery (USDI FWS 2012).

According to fire modeling, nearly half of the total Mexican spotted owl habitat in the treatment area (48 percent) would support some form of crown fire with over a third of Mexican spotted owl habitat (42,344 acres) at risk of active crown fire (table 69). Acres within or adjacent to Mexican spotted owl habitat are also at risk from high-intensity surface fire that can result in high-severity effects.

Table 69. Predicted fire behavior in existing (year 2010) Mexican spotted owl habitat

Mexican Spotted Owl Habitat	Habitat Acres	Surface Fire (Acres)	Passive Crown Fire (Acres)	Active Crown Fire (Acres)	Surface Fire (%)	Passive Crown Fire (%)	Active Crown Fire (%)
Protected	35,262	17,954	3,034	14,106	51	9	40
Target/Threshold	8,692	4,275	922	3,482	49	11	40
Restricted	66,419	35,019	6,540	24,756	53	10	37

In 2014, almost 8,000 acres burned within the treatment area above the Mogollon Rim. Most of the fire area was within RU3 with the majority of the burn area in subunit 3-5. Twelve PACs were affected by the fire, including five PACs in the project treatment area. About 800 acres within the treatment area burned with high-severity effects, including about 440 acres within PACs. Approximately 4,143 acres of restricted habitat (within the treatment area) was also affected by the Slide Fire.

Effects of high severity fire are considered the leading threat to Mexican spotted owls (USDI 2012). Most research evaluating effects of fires on spotted owls has largely been on mixed-severity fire effects to the California spotted owl in the Sierra Nevada Mountains. Comments on the DEIS suggested this research is entirely applicable to this project and Mexican spotted owl. The California spotted owl is a different subspecies from the Mexican spotted owl and the forest types they occur in are different from the dry ponderosa pine/Gambel oak habitat within the 4FRI. Although patterns have been identified in the literature, details should be carefully extrapolated when applied to different sub-species of owls and different regions of the country. See the wildlife report for additional information on changed conditions as a result of the Slide Fire, and relevant Mexican spotted owl fire effects literature.

Additional detail on habitat conditions (Mexican spotted owl habitat components) is disclosed in chapter 1 of this FEIS and the vegetation and fire section of this chapter.

Mexican Spotted Owl Habitat – Direct and Indirect Effects

Only a summary of environmental consequences is presented. See the wildlife report for additional details.

Alternative A

In alternative A there would be no changes in current management; ongoing projects would continue to implement the forest plans. Mechanical and prescribed fire treatments in ongoing projects would create canopy gaps and interspace. Creating openings where sunlight can reach the forest floor would benefit most of the species of status analyzed in this report (see species-specific cumulative effects analyses for current and ongoing project effects). Most projects typically avoid treating steep slopes and are designed to retain nesting and roosting elements in goshawk and Mexican spotted owl habitat. Wildfire would continue to be managed primarily for suppression and/or resource benefit objectives, as appropriate. Change to forest structure would continue to occur at a pace similar to the recent past, therefore threats to forest health from insects, disease, drought, and high-severity fire would continue at recent levels or increase as effects of climate change increase.

The sustainability of old and large pine and oak would be compromised by density-related mortality associated with competition and, in the case of large oak, overtopping by ponderosa pine. Forest health and resiliency would continue to erode. Mexican spotted owl habitat would not be resilient to fire, insects, disease, climate change, or their synergistic effects. The percentage of Gambel oak remains low across the landscape in both the short- and long-term, particularly in protected habitat.

The large size-classes would be dominated by limited or stagnant tree growth rates across the ponderosa pine forest. Within stand mortality would remain high and the risk of undesirable fire behavior and effects would remain high. Combined, this would lead to increasingly unsustainable Mexican spotted owl habitat.

Mexican spotted owl prey (small mammal) habitat in terms of logs and coarse woody debris would be maintained through time (short and long term). However, accumulated coarse woody debris could decrease Mexican spotted owl habitat effectiveness (Roberts et al. 2010).No grassland, savanna, or meadow treatments would occur, resulting in nearly 17,000 acres of this important habitat continuing to degrade as a result of pine tree encroachment in Mexican spotted owl prey species habitat. As food and cover decline for small mammals, potential source populations of important prey species would be expected to decline in the long-term. Other specialty habitats important to prey species such as aspen, springs, and ephemeral channels would also continue to degrade or be lost entirely over the long-term. The landscape would move toward homogeneity as ponderosa pine continued to compromise or eliminate these key sources of heterogeneity.

With no treatments occurring, there would be no direct increase or decrease in habitat quality of protected, restricted, or critical habitat in the short-term. In the long-term, Mexican spotted owl habitat quality would decrease as a result of declines in forest health and resiliency. Therefore, alternative A does not move Mexican spotted owl habitat toward the desired conditions described in the forest plans or the Recovery Plan.

Critical Habitat: Alternative A would not improve or restore any aspen (over 960 acres in critical habitat), springs (19 occurring in critical habitat units 11 and 13), and ephemeral channels (over 4 miles of restoration in 4 different critical habitat units). In addition, anywhere from about 3,670 to about 16, 736 acres of grassland, savanna, and meadows would not be improved or restored. These habitats represent a large portion of the habitat heterogeneity that occurs in Mexican spotted owl habitat and in ponderosa pine forests in general and are important to wildlife (Griffis-Kyle and Beier 2003, Finch et al. [vol. 2] 2004 Tree encroachment would continue in the absence of management activities, compromising aspen, grasslands, savannas, meadows, and springs. This would be expected to directly reduce the quality of Mexican spotted owl prey habitat and, in the case of grasslands and savannas, potentially affect source populations of prey species that could disperse into areas used by foraging owls.

Alternatives B through E – Direct and Indirect Effects in Common

- Alternatives B through E have design features that would reduce or eliminate impacts to Mexican spotted owls and its habitat (FEIS appendix C, design features W1 to W22 and table 51 of the wildlife report).
- In nesting and roosting habitat, the average canopy cover across stands would be greater than or equal to 50 percent, based on basal area, trees per acre, tree d.b.h., and percent SDI max. Stands would still average full site occupancy and minimal understory development, further indicating high canopy cover. Overall, changes in the canopy structural elements would be limited, but would move PAC habitat toward desired conditions. The fact that treated PACs would continue to have closed canopies is a reflection of treatment design in PAC habitat.
- Large trees would be retained and targeting mid-aged trees would improve the health, growth rates, and sustainability of large trees. However, trees would be retained in all size classes. Treatments in Mexican spotted owl habitat would not be a simple thin from below. Reducing trees in the 5 to 12 inch d.b.h. range is expected to improve Mexican spotted owl habitat (Irwin et al. 2004, Blakesley et al. 2005). Canopy gaps would increase understory production and benefit prey species (wildlife report appendix 6).
- Improving meadows, springs, ephemeral channel, and aspen stands would improve foraging habitat. Enhancing prey habitat and better defining edge habitat through removal of

ponderosa pine encroachment while retaining Gambel oak and large pine could improve Mexican spotted owl reproduction (Franklin 2000, May and Gutierrez 2002, May et al. 2004, Blakesley 2005).

- Reduced basal area and intermittent openings would increase light, moisture, and nutrient availability for herbaceous understory species. Increased grass and forb development would provide food and cover for arthropods, small mammals and birds. In turn, this can increase prey availability, diversity, and biomass for Mexican spotted owls. Total prey biomass may be more influential on Mexican spotted owl fitness than the abundance of any one prey species (USDI FWS 2012) and allows owls to shift prey if an individual prey species declines (Ganey et al. 2011).
- Mechanical thinning and low-severity prescribed fire would take place at different times in different locations. Mexican spotted owl habitat could be affected by mechanical treatments in one area while prescribed fire occurs in another area in the same period of time. It is expected implementation of the entire project would require 10 or more years to complete.
- A direct effect of prescribed fires would be the consumption of some coarse woody debris (CWD). Modeling for this project and published research in northern Arizona suggest that CWD levels increase following treatment (Waltz et al. 2003, Haase and Sackett 2008, Roccaforte et al. 2012). Levels of CWD would be easily managed with fire and felling techniques to increase or decrease woody debris in different size classes to ensure forest plan guidelines are met. See appendix 19 in the wildlife report for maps comparing surface fuels across the treatment area.
- Large snags (greater than 18 inches d.b.h.) are currently below forest plan guidelines. Some snags would be lost due to operations. Design features include retaining live trees with dead tops and lightning strikes to retain snag-like habitat in a more fire resistant structure. Large snag development is expected to be maintained in the future as more trees attain larger size-classes. Snag retention would improve as result of road decommissioning and reducing vulnerability of snags to firewood collectors (Chambers 2002, Wisdom and Bates 2008, Ganey et al. 2014).
- Burning in PACs would occur outside the nesting season and, with the associated design features would be expected to maintain most large logs and CWD (above). In addition, future recruitment of large logs would be improved by retaining and enhancing the large tree cohort and improving large tree recruitment. Adequate levels of CWD in PACs would be expected after treatment (20 tons per acre is the upper end of the recommended range for fuel loading in southwest ponderosa pine habitat [fire ecology report]).
- Road closures, road relocations, and improvements would contribute to improvements in prey habitat. About 29 percent of the total road miles in 52 PACs would be decommissioned after treatment activities, lessening the amount of long-term disturbance associated with access to Mexican spotted owls and their prey. This would include decommissioning five of 7.6 miles (66 percent) occurring in 13 core areas. Overall, about 115 miles of roads in restricted habitat would be decommissioned across 15 different subunits, including nearly 17 miles within target and threshold habitat.
- Proposed treatments for Mexican spotted owl habitat burned in the Slide Fire consist of two entries of prescribed fire-only (wildlife report, table 131). In addition, about 0.3 miles of ephemeral stream restoration are proposed in restricted habitat (wildlife report, table 132). No ephemeral stream restoration is proposed in protected habitat and no spring restoration or aspen improvement is proposed within the perimeter of the Slide Fire. All treatments within

the burned area would be deferred for a minimum of five years. This would provide an opportunity for recovery of affected soils and vegetation prior to implementing any actions that may cause additional disturbance. The proposed treatments would not change; however, prior to implementation, appropriate resource specialists would evaluate the area to ensure that treatments are still appropriate and would meet resource objectives.

- Disturbance could occur as a result of project-related activities including moving and operating harvest machinery, hauling forest materials, managing prescribed fire, smoke, personnel in the field, and road maintenance and construction. Noise disturbance from project activities may affect foraging Mexican spotted owls, but are not expected to affect nesting or roosting owls due to design features and project planning. Disturbance could result in short-term displacement of foraging owls and owls roosting outside the breeding season. Design features should ensure nesting and roosting owls are not disturbed during the breeding season. See the biological assessment and FWS biological opinion for additional information.
- In the short term, road work and particularly hauling materials off forest could increase the risk of collisions between Mexican spotted owls and vehicles involved in forest harvest activities. The level of risk cannot be quantified, i.e., there are no defined relationships between open road miles, vehicle activity, and collisions with owls. Nevertheless, whatever the current risk level is, it would likely increase with implementation of the 4FRI. This localized, short-term risk would continue to move around the landscape for the duration of project-related harvest activities, although not all harvest and related actions would overlap with Mexican spotted owl habitat. Once harvest activities are complete, about 860 miles of road would be decommissioned, decreasing the risk of collisions across the implementation area over the long-term. See the wildlife report and biological assessment appendix for more detail.
- Direct effects could also occur in regards to loss of nesting habitat if prescribed fire burned outside of prescription. This is not expected to happen and design features are in place to minimize the likelihood of this happening. However, the scale of 4FRI both spatially and temporally increases the risk of this unintended and unquantifiable effect.

Alternative B

Under alternative B, mechanical treatments would occur in portions of all Mexican spotted owl habitats except for core areas. Most (about 86 percent) protected habitat would have vegetation treatments. Most (greater than 70 percent) vegetation treatments would be prescribed fire only, including all 836 acres of steep slope protected habitat. The minimum post-treatment basal area for nesting and roosting habitat would be 150 square feet per acre.

Mechanical treatments would occur on about 72,456 acres of restricted habitat, or 96 percent of the total 75,111 restricted acres in the treatment area. Prescribed fire would include all restricted habitat acres, including target and threshold habitat. Although the implementation schedule is not yet known, on average about 7,250 acres would be mechanically treated per year if implementation was completed in 10 years.

Mexican Spotted Owl Protected Habitat: In this alternative, forest structure would improve for Mexican spotted owl and their prey in 70 PACs. Mechanical thinning in 18 selected PACs (outside of core areas) would include trees up to 16 inches d.b.h. The range in tree sizes would allow creating/maintaining uneven-aged/uneven-sized trees and in so doing attain the multi-story canopy structure described in the recovery plan.

The minimum post-treatment basal area for nesting and roosting habitat would be 150 square feet per acre. Although this is not in line with the revised Recovery Plan (USDI FWS 2012), it does follow the guideline from the original Recovery Plan (USDI 1995), the only recovery plan in effect at the time of data development and analysis for the 4FRI DEIS. PACs would average 140 basal area immediately after treatment and reach 162 basal area by 2050. Total basal area would be reduced in the burn-only PACs and remain above the 150 square feet per acre (table 71, wildlife report).

The overall effect of alternative B on Gambel oak would be to enhance survival of large diameter trees through site-specific thinning, thereby maintaining mast production. This is important to some prey species and maintains hiding cover by stimulating resprouting of small diameter trees. In the long term, the decreased competition with ponderosa pine and decreased risk of high intensity and/or high severity fire would benefit maintenance of large diameter Gambel oak used for nesting by Mexican spotted owls.

The percentages of large trees, those 18 to 23.9 inch d.b.h. would show the most improvement. Abundance of trees greater than 24 inch d.b.h. would show consistent improvement in mechanically treated PACs. Because treatments are site-specific and target the release of big trees from competition with young trees, the ability to retain existing large trees through time would also increase. The percent distribution of larger tree size classes would remain unchanged in the burn-only PACs.

About 88 percent of PAC acres would be burned, including the 18 PACs with mechanical treatments and 52 PACs receiving only prescribed fire treatments. Prescribed fire would not include core areas. Reducing surface fuels and raising canopy base height would reduce the risk of a surface fire becoming a crown fire. Combined, these changes would improve the ability to retain PAC habitat over time, improve Mexican spotted owl prey habitat, and potentially improve the ability for the owls to hunt these areas. The effects of the treatments proposed would persist, maintaining FRCC 2 after 30 years. In general, alternative B would significantly lower the fire risk to key ecosystem components.

Restricted Habitat: Removing mid-sized trees would reduce tree densities, improving overall forest resiliency and increasing growth rates for the largest size-classes. Increasing forest heterogeneity would improve Mexican spotted owl restricted habitat by maintaining future nesting and roosting structure in some areas while also increasing prey habitat and potential Mexican spotted owl foraging opportunities in other areas.

Pine basal area would decrease in all restricted habitats, meeting one of the fundamental objectives of the treatment. Total basal area would move toward presettlement conditions in restricted “other” habitat. These changes would reduce competition-induced mortality and increase resiliency to large-scale stochastic events.

In general (post treatment), target habitat would be close to, but below 150 basal area. Currently, target habitat in RU 1 exceeds 150 basal area. Post-treatment, RU 1 would have the lowest basal area (138). However, the intent and the direction in the implementation plan (FEIS, appendix D) are to meet recovery plan guidelines. Adjustments would be made on the ground to retain a basal area of at least 150. Providing a continuous supply of nesting and roosting habitat requires maintaining a variety of succession stages across the landscape. Threshold habitat would maintain nesting and roosting conditions and these conditions would be achieved sooner in target habitat under alternative B than if no action were taken.

Treatments would increase canopy gaps, as described in the Recovery Plan. Percent SDI max would decrease but remain in the “Extremely High Density” range for target and threshold habitats. Percent SDI max would decrease to the “High Density” category in restricted “other” habitat. Therefore, closed canopy conditions would remain within tree groups. Existing variability in overstory species diversity would remain by design. Prescribed fire would potentially improve flight space for foraging owls by increasing canopy base heights (see fire effects).

Post-treatment, there would be a decrease in small diameter oak (less than 2 inches). This would be followed by prolific sprouting, resulting in an overall increase in small diameter oak stems. Oak would not be targeted for removal; the decrease in restricted “other” habitat would result from increased operations.

By 2050 (as tree growth occurs) trees 18 inch d.b.h. and larger, particularly those greater than 24 inch d.b.h., would consistently increase. Changes in individual subunits follow the same patterns.

Overall, thinning and burning treatments are projected to move restricted habitat toward the restoration of low-severity fire (also see fire ecology section).

Critical Habitat: The percent increase in the largest trees would be most evident in critical habitat units 11 – 13, accounting for about 98 percent of total critical habitat acres (wildlife report, table 141). There would be decreased within-stand mortality that would otherwise differentially affect the older trees, and increase resiliency to stochastic events, including the synergistic effects of climate change. Gambel oak would maintain or increase in basal area.

Snags would consistently remain above the no action levels (wildlife report, table 141). Logs are consistently low, would typically decrease an average of 1/10 of a log per acre immediately after treatment, and exceed forest plan direction by 2050. A similar pattern occurs with coarse woody debris, although immediately post-treatment the values would be near or above forest plan direction and they total volume would increase with time. Patterns for both logs and coarse woody debris relate to the use of prescribed fire and the fact that no treatments were modeled after 2020. Understory index response increases, but the degree of increase varies by critical habitat unit. However, the critical habitat units with larger increases (i.e., critical habitat units 11-13) account for the most acres. The potential for disturbance and collision is addressed in “Effects Common to Alternatives B-E” section.

Alternative C

In alternative C, total treatments in Mexican spotted owl habitat include about 81,500 acres of mechanical thinning and 108,847 acres of low-severity prescribed fire. This represents the most acres of Mexican spotted owl habitat treated in any alternative but the fewest mechanically treated acres. On average about 8,150 acres of Mexican spotted owl habitat would be mechanically treated and 10,885 acres of prescribed fire would occur each year.

The minimum post-treatment basal area in current and future nesting and roosting habitat would be 110 square feet per acre, as recommended in the revised Recovery Plan (USDI FWS 2012). However, total basal area of 150 square feet per acre or greater would be maintained where present in areas with site potential capable of sustaining high tree densities.

Mechanical treatments would occur on about 71,172 acres of restricted habitat, or 95 percent of the total 75,111 restricted acres in the treatment area. Prescribed fire would include over 98 percent of the restricted habitat, including nearly 100 percent of the target and threshold habitat. On average about 7,120 acres would be treated per year.

Mexican Spotted Owl Protected Habitat: Approximately 3,378 acres (33 percent) of the mechanically treated PAC acres would have a 9 inch d.b.h. limit. Removing trees up to 17.9 inch d.b.h. would result in habitat improvements in 8 individual PACs (599 total acres) including Bonita Tank, Crawdad, Frank, Iris Tank, Lee Butte, Mayflower Tank, Sawmill Springs, and T-Six Tank.

Over time, the basal area would range from 134 (year 2020) to 157 (year 2050), well above the minimum value of 110 square feet per acre (see table 87 in the wildlife report). Decreasing the minimum basal area and increasing the diameter limit for trees cut in PACs allows more flexibility to create and maintain nesting and roosting conditions such as uneven sized/aged tree groups, multistory canopy, and increasing large tree growth rates.

Alternative C is the only alternative to preclude the need for building fireline around core areas inside of PACs. This would avoid habitat disturbance in some of the most sensitive areas within Mexican spotted owl habitat. As in any prescribed fire, some areas would not be expected to burn, increasing forest heterogeneity while reducing the overall risk of future high-severity fire in PACs.

In general, alternative C would have similar effects on Gambel oak as alternative B. However, by treating core areas with prescribed fire, thereby decreasing surface fuels and increasing canopy base height, more PAC habitat would be better situated to maintain large oak through time.

The percentages of trees 18 to 23.9 inches d.b.h. would show the most improvement. Abundance of trees greater than 24 inch d.b.h. would show consistent improvement in mechanically treated PACs (wildlife report, appendix 12). Because treatments are site-specific and target the release of big trees from competition with young trees, the ability to retain existing large trees through time would also increase. The Old and Large Tree Implementation Plan would have limited effect in Mexican spotted owl habitat. They complement, but are superseded by the Recovery Plan and by the limited extent of the proposed treatments. The minimal intensity of treatments in Mexican spotted owl habitat is evidenced by the marginal change in forest attributes. However, implementation plan direction provides an additional measure of protection for smaller diameter old trees.

Prescribed fire would occur on over 99 percent of PAC acres in the treatment area. Prescribed fire would include core areas. By 2020 the potential for active crown fire would decrease by 23 percent and the potential for surface fire would increase by over 27 percent (wildlife report, table 90). FRCC would move toward the desired condition of an overall rating of FRCC 2 across the treatment area by 2020 and FRCC2 would be maintained for about 30 years. In general, alternative C would significantly lower the fire risk to key ecosystem components.

Restricted Habitat: The objective of decreasing pine basal area would be met in all restricted habitats. Total basal area in target and threshold habitats would remain above 110 square feet per acre in all subunits and frequently be above 150 in 2020. Reduced basal area would contribute toward maintaining large trees and dense tree groups while improving forest resiliency and reducing the threat of high-severity fire.

Based on basal area and SDI max, canopy cover would remain dense. SDI max would remain in the “extremely high density” range in target and threshold habitat, but decrease to “high density” in restricted “other” habitat. These values ensure that canopy cover would be 50 percent or greater at the stand level and much higher within tree groups in target and threshold habitat. Existing variability in overstory species diversity would remain by design. Combined, these factors should improve or maintain the elements of canopy structure such as cover, density, and species diversity.

Gambel oak basal area would increase in target and threshold habitat and decrease in restricted “other” habitat. The decrease would be in predominantly small and medium diameter oak top-killed by fire, but few oak stems greater than 6 inch d.r.c. would be expected to be top-killed by prescribed fire (Abella 2008). The immediate result would be a decrease in small diameter oak (less than 2 inch d.r.c.) followed by prolific sprouting, resulting in an overall increase in small diameter oak stems. Top-kill and re-sprouting of oak would delay recruitment of oak into larger size-classes. This would reduce the basal area of Gambel oak 5 inches d.r.c. and larger in the long-term in restricted “other” habitat, relative to alternative A, but may still be in line with presettlement conditions (Abella 2008).

Overall, trees less than 18 inch d.b.h. would decrease after treatments in target and threshold habitats, but remain above recommended minimum levels. Trees greater than 18 inches d.b.h. would increase in target and threshold habitats. Changes in individual subunits are variable (see wildlife report, appendix 13).

Prescribed fire in association with mechanical treatments would occur across about 73,828 acres of restricted habitat, including 6,713 acres of target and 1,976 acres of threshold habitats. This would include 2,354 acres of burn-only treatments in restricted habitat and about 300 acres of burn-only prescriptions in target and threshold habitat. About 94 percent of ponderosa pine forest across the treatment area would move into the surface fire category by 2020 with most of these acres coming out the active crown fire category. Changes at this scale should decrease the risk of high-severity fire in Mexican spotted owl habitat. Similar changes would occur in restricted habitat. By 2020 nearly all target and threshold acres (95 percent) would be in the surface fire category. Similarly, about 1/3 of the total restricted “other” acres would move to surface fire behavior with most of these acres coming from the active crown fire category.

More mechanical treatments and the more open nature of foraging habitat would allow fire to achieve more fuels reduction in restricted habitat outside of target and threshold habitat (65,139 acres). The changes in fire behavior would maintain Mexican spotted owl habitat over time. The emphasis on low severity fire would be expected to produce a patchier burn, resulting in a mosaic of habitat conditions for Mexican spotted owls and their prey. Improvements to foraging (i.e., Mexican spotted owl prey) habitat and sub-canopy flight are expected to benefit Mexican spotted owls.

Critical Habitat: This alternative would thin to a larger size-class and a lower minimum basal area in PACs, threshold, and target habitats than the other alternatives. The density of trees 24 inches d.b.h. and greater would consistently increase by 5 to 7 percent by 2050 (wildlife report, table 143). Trees 18 to 23.9 inch d.b.h. would consistently increase by about a percentage and mid-sized trees (12 to 17.9 inches d.b.h.) would consistently decrease. The relationship among the changes in these size-classes indicates that the increase in the number of trees per acre greater than 18 inch d.b.h. is largely due to more trees in the largest size-class. Exceptions to these patterns can be found in Upper Gila Mountain Recovery Units 14 and 15 (wildlife report, table 143). The reason for the exceptions is unknown, but given the differences in total acreage between these two critical habitat units (totaling less than 2 percent of the total critical habitat acres) and the other critical habitat units, the difference likely relates to site-specific conditions.

Snags would consistently remain above the no action levels (wildlife report, table 144). Logs are consistently low, would typically decrease an average of 1/10 of a log per acre immediately after treatment, and exceed forest plan direction by 2050. A similar pattern occurs with coarse woody debris, although immediately post-treatment the values would be near or above forest plan direction and they total volume would increase with time. Patterns for both logs and coarse woody debris relate to the use of prescribed fire and the fact that no treatments were modeled after 2020. Understory index response is similar to, but slightly above the results for alternative B. This would likely be result of using a lower minimum basal area in PACs, threshold, and target habitats.

Alternative D

Under alternative D, mechanical treatments would occur in portions of all Mexican spotted owl habitats except for core areas. Total treatments in Mexican spotted owl habitat include about 82,740 acres of mechanical thinning and 3,500 acres of low severity prescribed fire. This represents the least number of acres treated in any action alternative. However the alternative results in the highest number of acres treated mechanically as a result of limited acres treated with prescribed fire in Mexican spotted owl habitat (similar to alternative B). An average of about 8,270 acres of Mexican spotted owl habitat would be mechanically treated and 350 acres of prescribed fire would occur each year.

Mechanical treatments would occur on about 72,456 acres of restricted habitat, or nearly 97 percent of the total 75,111 restricted acres in the treatment area. About 2,655 acres of restricted habitat (about 3.5 percent) would have prescribed fire-only treatments. On average nearly 7,250 acres would be mechanically treated and about 265 acres treated with prescribed fire each year.

Mexican Spotted Owl Protected Habitat: Approximately 3,378 acres would be improved with mechanical treatments limited to trees up to 9 inches d.b.h. (about 33 percent of the total treated PAC acres). About 6,900 acres would be improved with mechanical treatments addressing trees 9 to 16 inches d.b.h. Competition would be reduced to a greater extent around large pine and oak trees, better enhancing resilience of this important habitat structure.

The minimum post-treatment basal area for nesting and roosting habitat would be 150 square feet per acre. The relatively high, post-treatment basal area in alternative D would leave PAC habitat at risk to environmental perturbations in most PACs.

Although the minimum basal area would remain high, the maximum diameter limit for trees that could be cut in PACs would increase with the plan amendment for the Coconino NF. This would allow more flexibility to better create and maintain nesting and roosting conditions such as uneven sized/aged tree groups, multistory canopy, and increasing large tree growth rates than could be achieved by only cutting trees up to nine inches d.b.h. in PACs. Fireline construction would be required in this alternative. This could create habitat disturbance and potentially increase recreation and erosion impacts associated with fireline. It would also fail to reduce the risk of surface fire transitioning into crown fire in most of the Mexican spotted owl habitat.

No burning in PACs would mean no change in the canopy base height and so no improvements to subcanopy flight space. Therefore, the benefits to foraging Mexican spotted owls included in the other action alternatives would not be a component of alternative D.

Overall results for percent of tree size classes and the number of trees per acre 18 inches d.b.h. and larger would be about the same as those discussed in alternative B. Treatment results would benefit individual large and old trees by decreasing competition, increasing growth rates, and potentially increasing resiliency of individual large trees to stochastic events. Benefits would be limited by both the d.b.h. limit and the higher total basal area. Mexican spotted owl habitat would be improved by thinning around large trees of both overstory species. However, only 18 of 70 PACs would realize any habitat improvements. None of the remaining 52 PACs would receive treatment. Overall, alternative D would do the least to protect and maintain large Gambel oak.

There would be no prescribed fire across 70 percent of the treatment area. Only about 2 percent of protected habitat (836 acres) would see a reduction in surface fuels as a result of prescribed fire in protected (steep slope) habitat. Mechanical treatments on about 10,284 acres of PAC habitat would improve forest structure but also increase surface fuels without a prescribed fire treatment. Modeling indicates the treatment area would revert to FRCC 3 after 30 years of no disturbance after the proposed treatments. The risk to nesting and roosting habitat would remain high given the limited changes in fire behavior within protected habitat and outside Mexican spotted owl habitat.

Restricted Habitat: Thinning objectives in threshold habitat would generally maintain the overall basal area near or above 170 square feet per acre, well above the minimum of 150 square feet per acre. Total target habitat basal area would decrease in the short-term, but would remain above 140 and increase over time. Total basal area in restricted “other” habitat would be under 100 after treatment, then increase over time. Pine basal area would decrease in all restricted habitats. This represents a key contribution toward reducing the risk of high-severity fire in designated Mexican spotted owl habitat. However, basal area would remain highest in this alternative as a result of the lack of fire.

SDI max would be in the “extremely high density” range for target and threshold habitats. Restricted “other” habitat would range from moderate to extremely high densities. Canopy cover would be 50 percent or greater at the tree group level, based on basal area, the number of trees per acre, and tree d.b.h. (see silviculture report for details). Limited prescribed fire would limit improvements to sub-canopy flight space for Mexican spotted owls, thus voiding a potential improvement to foraging habitat present in the other action alternatives.

Gambel oak basal area would consistently increase in target and threshold habitats, compared to alternative A. No oak would be targeted for removal; restricted “other” habitat would decrease after treatments as a result of operations and, in the long-term, would be similar to the no action alternative. Treatments would move forest conditions toward uneven-aged, uneven spacing with canopy gaps as described in the Recovery Plan. These changes would increase forest health and resiliency by reducing competition-induced mortality and increasing resiliency to large scale stochastic events.

Trees 18 to 24 inches d.b.h. have mixed results: relative density would increase in the short-term and results for the long-term were variable, depending on habitat type. Compared to the no action alternative there would be fewer trees in this size-class by 2050 because fewer trees would be growing into the larger size classes (wildlife report, table 110 and appendix 17). However, trees greater than or equal to 24 inch d.b.h. would have 30 to 60 percent increases by 2050 relative to the no action alternative. Treatments would also create canopy gaps, irregular spacing, and diversify age-class distribution. Overall, trees per acre greater than 18 inch d.b.h. would decrease when compared to the no action alternative.

Prescribed fire would occur across 2,655 acres of restricted habitat, including about 300 acres of prescribed fire-only prescriptions in target and threshold habitat. The threat of crown fire in target and threshold habitat would be reduced by the year 2020, decreasing from 51 percent of the area to about 11 percent. Surface fire would be expected in 93 percent of restricted “other” acres.

These reductions would primarily be a result of mechanical treatments given the limited prescribed fire in Mexican spotted owl habitat.

Over time, a combination of increased surface fuels and relatively low canopy base height would increase the risk of future fire transitioning from surface fire into crown fire (see fire ecology section). However, much of the landscape outside of Mexican spotted owl habitat would be moved closer toward the historical range of variation, thereby decreasing the threat of high-severity fire reaching Mexican spotted owl habitat. Prey habitat would be improved by mechanical thinning, but forage development would be restricted by litter accumulations and the lack of the nutritional pulse associated with burning and sub-canopy flight space would remain unchanged.

Critical Habitat: Increases in the density of trees 24 inches d.b.h. and greater by 2050 would consistently be smaller than those achieved in alternatives B or C (wildlife report, table 145). Trees 18 to 23.9 inch d.b.h. would change little, sometimes increasing by a percentage, decreasing by a percentage, or not changing at all. Like alternatives B and C, mid-sized trees (12 to 17.9 inches d.b.h.) would consistently decrease. Mechanical treatments in Mexican spotted owl habitat are the same as those in alternative B. However, no PAC habitat and less than 4 percent of restricted habitat would have prescribed fire. Omitting fire limits the beneficial effect of total treatments in Mexican spotted owl habitat.

Snags would decrease or remain stable, depending on the critical habitat unit. Snags would consistently remain above the no action levels (wildlife report, table 146). Logs and coarse woody debris would consistently increase after treatment, likely due to the limited use of prescribed fire. Post-treatment the values would be above or near forest plan direction and they total volume would consistently increase with time. Understory index would increases, but the degree of increase varies by critical habitat unit. However, the degree of increase would be less than the changes displayed in alternatives B, C or E. The muted increase is likely a result of the lack of prescribed fire across most of the acres treated.

Alternative E

In alternative E, treatments in Mexican spotted owl habitat include 81,500 acres of mechanical thinning with prescribed fire and 22,738 acres of only low severity prescribed fire. On average about 8,150 acres of Mexican spotted owl habitat would be mechanically treated and 2,275 acres of prescribed fire would occur each year. Over half of protected habitat acres (57 percent) would have prescribed fire-only treatments, including all 836 acres of steep slope protected habitat. Less than one third of protected habitat treatments (29 percent) would have mechanical treatments. Little change would occur in forest structure in protected habitat given the reduced treatment area and the emphasis on low-severity, fire-only treatments.

Mechanical treatments would occur on about 71,173 acres of restricted habitat, or about 95 percent of the total restricted acres in the treatment area. Treatments would include nearly 100 percent of the total target and threshold habitat (wildlife report, table 114). On average about 7,383 acres of restricted habitat would be treated per year and more than 98 percent of restricted habitat would be treated with prescribed fire.

Mexican Spotted Owl Protected Habitat: Alternative E would retain the highest density of trees by using a minimum of 150 basal area combined with thinning up to 9 inches d.b.h. in PACs. Alternative E would require firelines and the associated effects to habitat in PACs to exclude fire from core areas (see the related discussion in alternative B). This alternative would retain the highest potential for surface fire progressing into crown fire within occupied nesting and roosting habitat.

Ponderosa pine basal area would remain high post-treatment in the mechanical treatment group and pine basal area would be slightly reduced in the prescribed fire-only PACs (wildlife report, table 116). By 2050 there would little difference in total basal area between alternative E and the no action alternative.

Post-treatment basal area, trees per acre and tree size-classes would be similar to the no action alternative. Overall, changes in the canopy structural elements would be limited to the point where PAC habitat would not necessarily move toward desired conditions. The fact that treated PACs would show limited change is a reflection of treatment design in PAC habitat and the constraints of no forest plan amendments (for the Coconino NF) when treating habitat well outside the historic range of variability.

Gambel oak basal area would remain largely unchanged in the prescribed fire-only group and actually decrease over time in the mechanical treatment group as a result of increased competition with ponderosa pine. Effects to Gambel oak would be similar to alternative D, providing fewer benefits to nesting and roosting habitat than alternatives B or C. The percent distribution of larger tree size classes would remain unchanged in the burn-only PACs (wildlife report, table 116), but risk from high-severity fire would decrease (see fire effects).

In alternative E, treatment would be limited and so would the results. None of the modeled forest structure attributes would drop below recommended levels immediately after treatment (wildlife report, table 116). There would be little to change in densities of trees greater than 18 inches d.b.h. Abundance of trees greater than 24 inch d.b.h. would not increase in mechanically treated PACs and overall trees per acre greater than 18 inch d.b.h. would have little to no change (wildlife report, table 116). Although treatments would be site-specific to target the release of big trees from competition with young trees, the inability to treat trees nine to 18 inches d.b.h. would limit treatment effectiveness. Therefore, no response would be evident in trees greater than 24 inches d.b.h.

Prescribed fire would occur on over 95 percent of PAC acres in the treatment area. Predicted surface fire would increase in protected habitat by about 20 percent in the year 2020 under alternative C (wildlife report, table 119). The probability of active crown fire would decrease by about 16 percent after treatments. FRCC would move toward the desired condition of an overall rating of FRCC 2 for the treatment area and it would remain in this category through 2050 (wildlife report, table 118).

Restricted Habitat: There are more acres of target and threshold habitat in alternative E than in the other alternatives as a result of having no Coconino NF forest plan amendments. When viewed by individual forest, target and threshold acres (i.e., future nesting and roosting habitat in the new recovery plan) no longer met recovery plan direction on the Kaibab NF. Therefore, additional acres of restricted habitat on the Kaibab NF were designated as target and threshold habitat. This increased acres of target habitat project wide and decreased acres of restricted “other” acres in alternative E.

Based on basal area and SDI max, canopy cover would remain dense. SDI max would remain in the “extremely high density” range in target and threshold habitat, but decrease to “high density” in restricted “other” habitat. These values ensure that canopy cover would be 50 percent or greater at the stand level and much higher within tree groups in target and threshold habitat.

Existing variability in overstory species diversity would remain by design. Combined, these factors should improve or maintain the elements of canopy structure such as cover, density, and species diversity.

Gambel oak basal area would increase in target and threshold habitat and decrease in restricted “other” habitat. The decrease would be in predominantly small and medium diameter oak top-killed by fire, but few oak stems greater than 6 inch d.r.c. would be expected to be top-killed by prescribed fire (Abella 2008). The immediate result would be a decrease in small diameter oak (less than 2 inch) followed by prolific sprouting, resulting in an overall increase in small diameter oak stems. Top-kill and re-sprouting of oak would delay recruitment of oak into larger size-classes. This would reduce the basal area of Gambel oak 5 inches d.r.c. and greater in the long-term in restricted “other” habitat, relative to alternative A, but may still meet or exceed presettlement conditions (Abella 2008).

Overall, trees less than 18 inch d.b.h. would decrease after treatments in target and threshold habitats, but remain above recommended minimum levels. Trees greater than 18 inches d.b.h. would increase in target and threshold habitats. Changes in individual subunits are variable (see wildlife report, appendix 17).

Prescribed fire in association with mechanical treatments would occur across about 73,828 acres of restricted habitat, including 6,713 acres of target and 1,976 acres of threshold habitats. This would include 2,354 acres of burn-only treatments in restricted habitat and about 300 acres of burn-only prescriptions in target and threshold habitat. About 94 percent of ponderosa pine forest across the treatment area would move into the surface fire category by 2020 with most of these acres coming out the active crown fire category. Changes at this scale should decrease the risk of high-severity fire in Mexican spotted owl habitat. Similar changes would occur in restricted habitat. By 2020 nearly all target and threshold acres (95 percent) would be in the surface fire category. Similarly, about 1/3 of the total restricted “other” acres would move to surface fire behavior with most of these acres coming from the active crown fire category.

More mechanical treatments and the more open nature of foraging habitat would allow fire to achieve more fuels reduction in restricted habitat outside of target and threshold habitat (65,139 acres). The changes in fire behavior would maintain Mexican spotted owl habitat over time. The emphasis on low severity fire would be expected to produce a patchier burn, resulting in a mosaic of habitat conditions for Mexican spotted owls and their prey. Improvements to foraging (i.e., Mexican spotted owl prey) habitat and sub-canopy flight are expected to benefit Mexican spotted owls.

Critical Habitat: Although alternative E would have the least change in PAC habitat, the changes among tree size-classes are more similar to alternatives B and C than to alternative D (wildlife report, table 147). The difference is likely due to retaining prescribed fire treatments in restricted habitat. Because there are about 1/3 more acres of restricted “other” acres (about 65,850) than protected, threshold, and target acres (about 44,500), treatments in restricted habitat have a greater influence on critical habitat results.

Snags would consistently remain above the no action levels (wildlife report, table 148). Logs are consistently low, would typically decrease an average of 1/10 of a log per acre immediately after treatment, and exceed forest plan direction by 2050. A similar pattern occurs with coarse woody debris, although immediately post-treatment the values would be near or above forest plan direction and the total volume would increase with time. Patterns for both logs and coarse woody debris relate to the use of prescribed fire and the fact that no treatments were modeled after 2020.

Understory index response increases, but the degree of increase tends to be less than alternatives B or C. However, the critical habitat units with larger increases (i.e., critical habitat units 11-13) account for the most acres.

Comparison of Alternatives

In alternative A, with no treatments occurring, there would be no direct increase or decrease of protected, restricted, or critical habitat in the short-term. In the long-term, Mexican spotted owl habitat would decrease as a result of declines in forest health and resiliency. Therefore, alternative A does not move Mexican spotted owl habitat toward the desired conditions described in the forest plans or the recovery plan.

Alternative B would provide for a mosaic of desired stand structure conditions, improving habitat heterogeneity and vegetative diversity in Mexican spotted owl habitat. Alternative B would provide for and sustain long-term nesting and roosting habitat while improving prey habitat and reducing potential risk of high-severity fire and other stochastic events. No treatments would occur in PAC habitat during the breeding season to mitigate adverse effects associated with treatments.

Alternative C would provide for a mosaic of desired stand structure conditions, improving habitat heterogeneity and vegetative diversity in Mexican spotted owl habitat. Alternative C would provide and sustain long-term nesting and roosting habitat while improving prey habitat and reducing potential risk of high-severity fire and other stochastic events.

Alternatives D and E would provide for a mosaic of desired stand structure conditions, but would likely provide for the smallest degree of change in long-term nesting and roosting habitat, making the smallest contribution to long-term resiliency of this habitat component. In protected habitat, fewer trees in the largest size-class classes, higher basal area, and higher percent of SDI max would all result from lack of prescribed fire (alternative D) or using a 9-inch d.b.h. limit on thinning (alternative E). The predicted values for these metrics would reduce understory response and limit future large snag development, limiting prey habitat. The high percent of SDI max means increasing the largest size-classes would be further delayed if in fact it would even be attainable. Tree growth rates would be minimal and PACs would remain vulnerable to stochastic events. Grassland, savanna, and meadow vegetation would have the fewest acres treated and so the least improvements. No treatments would occur in PAC habitat during the breeding season to mitigate adverse effects associated with treatments. Table 70 displays the changes in key forest metrics by alternative in 18 Mexican spotted owl PACs that would be mechanically treated and prescribed burned. Key metrics include tree size class (large trees), percent of SDI max and total basal area (BA).

Critical Habitat: Alternative C would consistently result in more trees in the larger size-classes and lower total BA than the other alternatives (table 70). Alternative B would be consistently close to, but not quite equal to alternative C in most forest structure metrics. Alternatives B and C would result in similar percent SDI max values. Alternative D would consistently result in the fewer trees in the larger size-classes and the highest basal area than alternatives B or C. Alternative E would create a similar distribution in tree size-classes, but would with the fewest tree s in the largest size-classes and would result in total basal area values higher than alternatives B or C. Large trees are an important component of Mexican spotted owl habitat and lowering total basal area would improve forest resiliency Mexican spotted owl habitat. Values for Gambel oak basal area would be similar across alternatives, except for alternative D which would consistently maintain more oak than the other alternatives due to the limited use of fire

Table 70. Changes in key forest metrics in 18 Mexican spotted owl PACs by alternative

Alternative	Year	Trees 12-17.9" d.b.h.	Trees 18 - 23.9" d.b.h.	Trees ≥24" d.b.h. (%)	% of Max SDI	Total BA
Existing Condition	2010	30	14	8	75	148
Alternative A	2020	31	16	9	76	157
	2050	28	23	12	78	174
Alternative B	2020	33	20	10	61	140
	2050	27	28	14	65	162
Alternative C	2020	33	21	11	57	134
	2050	26	29	15	63	157
Alternative D	2020	33	19	10	63	144
	2050	28	27	14	67	165
Alternative E	2020	34	17	9	67	153
	2050	31	25	12	70	172

Alternatives B, C, and E would produce similar results in terms of snags, although alternative C would create slightly more snags across all critical habitat units (table 150 in the wildlife report). The lower numbers of snags in alternative D could be due to fewer trees dying from fewer acres of prescribed fire. Alternative D would retain the highest levels of coarse woody debris, also as a result of limited use of prescribed fire. A similar patter would occur with logs, with the highest numbers resulting from alternative D, the lowest numbers from alternative C, and alternatives B and E are similar. Conversely, alternative D would have the smallest understory response and alternative C would have the largest. Again alternatives B and E would be similar. Each of the primary constituent elements represents components of Mexican spotted owl prey habitat. Overall, alternative C would do most for prey species habitat.

Consistency with Mexican Spotted Owl Biological Opinions (2012 and 2013)

Based on a review of the Coconino NF 2012 and Kaibab NF 2013 forest plan biological opinions (USDI FWS 2012, 2013) and the information discussed in above effects analysis, implementation of any of the action alternatives would be consistent with the forestwide programmatic forest plan biological opinions for the Coconino and Kaibab National Forests and that a forest plan amendment is not necessary.

Mexican Spotted Owl Habitat – Cumulative Effects

The complete analysis for cumulative effects to Mexican spotted owls is discussed in detail in the wildlife specialist report. In response to comments on the DEIS, the analysis was expanded to improve clarity demonstrate an analysis was conducted. Table 71 displays data used for the analysis. The cumulative effects boundary extends ½ mile beyond the analysis area periphery to account for the spatial component of this analysis. There are 110 PACs within the ½ mile buffer around the 4FRI project area boundary (see table 151 in the wildlife report). The temporal component in this analysis was defined as 10 years for short-term effects and 30 years for long-term effects.

Table 71. Total acres of mechanical thinning and prescribed fire by alternative with the addition of past, current and future foreseeable projects in the project area

Action	Total Mechanical Treatment	Total Prescribed Burn	Total Cumulative and Proposed Mechanical Treatments	Total Cumulative and Proposed Prescribed Fire
Total Past, Current and Future Foreseeable Projects in the Project Area	166,520	208,268		
Alternative B	384,966	583,330	551,486	791,598
Alternative C	431,049	586,110	597,569	794,378
Alternative D	384,966	178,441	551,486	386,709
Alternative E	403,500	581,301	570,020	789,569

Projects before 1996 are incorporated into existing conditions. Aspects of existing conditions that are a result of these early projects include a deficit in large trees and snags and even-aged conditions. Pre-1996 projects also had heavy selection pressure for preferred tree genetics to provide healthy trees with good form. This latter effect resulted from harvested areas being regenerated from planting stock or from the selected reserve trees left in seed tree harvest units (Higgins, pers. comm. 2006). Wildlife habitat in the form of nesting, feeding, and loafing sites was reduced by selecting for disease-free trees with symmetric shapes, eliminating fork-top trees, trees with unusual branching patterns, and replanting with selected genetic stock from nurseries.

Past, current, and reasonably foreseeable projects have or would treat about 76,700 acres (39 percent) of Mexican spotted owl habitat, including 12,000 acres of protected and 66,700 acres of restricted habitat. About 39,100 acres of Mexican spotted owl habitat has or is proposed for thinning and about 37,600 acres has or is proposed for prescribed fire (wildlife report, table 152). Nearly all of the treatments were designed to improve Mexican spotted owl habitat or were mitigated to minimize negative effects to the owls and their habitat. About 119,000 acres of Mexican spotted owl habitat are or have been proposed for treatment within the 1/5 buffer of the entire 4FRI project area (wildlife report, table 152).

Most work done in Mexican spotted owl habitat involves mechanical thinning or prescribed fire. Thinning and burning in Mexican spotted owl habitat would follow forest plan/Recovery Plan guidance with rare exceptions such as powerline right of ways. Other projects also include slash disposal, invasive weed treatments, limited acres of animal damage control, erosion control, and disease tree harvest (wildlife report, appendix 10). Effects to Mexican spotted owl habitat are broken down into two broad categories: forest structure and prey habitat. Table 72 displays the various actions and acres considered in the Mexican spotted owl cumulative effects analysis.

Overall, there are about 194,800 acres of Mexican spotted owl habitat within the 4FRI project boundary. Six critical habitat units occur within or overlap the 4FRI analysis area, encompassing nearly 160,000 acres of critical habitat within the project area, including mixed-conifer habitat. About 88,914 acres of pine-oak critical habitat occur within the 4FRI treatment area.

Alternative A

Alternative A would not contribute to the improvement of either forest structure or prey habitat within Mexican spotted owl habitat. The contributions of past, ongoing, and reasonably foreseeable actions would affect habitat for Mexican spotted owl and their prey, but no cumulative effect would result from 4FRI (i.e., no change would occur either spatially and temporally to alter effects of other actions on the landscape).

Alternatives B, C, D and E

Restoration treatments would contribute toward improving Mexican spotted owl forest health and vegetation diversity and composition under alternatives B through E. This would aid in sustaining old forest structure over time and moving forest structure toward desired conditions.

Most of the projects identified as part of the cumulative effects analysis (table 72) occur outside of Mexican spotted owl habitat. Cumulative effects would likely be minimal, but include disturbance related to implementation and operations and smoke drifting and settling away from ignition areas.

Projects with treatments specifically occurring in Mexican spotted owl habitat include prescribed fire (68,097 acres) and mechanical thinning with prescribed fire (51,196 acres) in protected habitat and restricted habitat (table 73 on page 251). Most projects in protected habitat used nine inch d.b.h. limits and some used 12 to 14 inch d.b.h. limits in restricted habitat. Total acres of treatment in Mexican spotted owl habitat within reasonably foreseeable projects are not yet known, but fuels reduction treatments are being developed for the San Francisco Peaks, Mormon Mountain (Flagstaff Watershed Protection Project), Bill Williams Mountain, and Mahan Landmark.

Project treatments primarily decreased the number of trees less than 14 inches d.b.h. The degree of treatment intensity is highly variable, with some projects not cutting trees greater than 12 inches d.b.h. and others looking to lower the threat of high-severity fire in Mexican spotted owl habitat. The overall ratio of trees greater than 12 inches d.b.h. is likely to increase as a result of removing smaller trees and increasing the growth and survivability of larger trees. Total basal area of pine would decrease in the short-term, but because the focus is on small trees, basal area might not substantially change. Overall basal area would be expected to increase in the long-term. Gambel oak is not targeted for removal, but prescribed fire will likely top-kill small diameter oak, potentially decreasing oak basal area in the short term. However, design features should ensure retention of large diameter oak and small oak commonly sprout vigorously after fire. The total basal area of Gambel oak is not expected to change substantially in the long-term. Created canopy gaps should benefit Mexican spotted owl prey species and the reduction in small trees should open the space between ground level and canopy base height, improving Mexican spotted owl flight paths for foraging. However, d.b.h. limits that retain mid-aged trees commonly prevent the development of complex forest structure and decrease inherent habitat heterogeneity. Reduced crown fire risk and increased understory production that result from these treatments tend to be short-term because creation of interspace and irregular tree spacing typically cannot be attained by using board diameter caps focused on mid-sized trees.

Table 72. Cumulative acres of treatment in the 4FRI project area and a ½ mile beyond the project area for Mexican spotted owl (MSO)

Cumulative Effects in the 4FRI Project Area	Thin ponderosa pine habitat	Prescribed burn ponderosa pine habitat	Thin mixed conifer habitat	Prescribed burn mixed conifer habitat	Thin MSO protected habitat	Prescribed Burn MSO protected habitat	Thin MSO Restricted habitat	Prescribed Burn MSO Restricted habitat
Current	74,959	104,912	1,804	2,117	1,302	1,601	17,725	20,914
Future foreseeable	52,141	49,602	9,149	3,723	7,277	1,851	12,807	13,219
Past	28,467	47,914	0	0	0	0	0	0
Total	**155,567**	**202,428**	**10,953**	**5,840**	**8,579**	**3,452**	**30,532**	**34,133**
Cumulative Effects ½ Mile Beyond the 4FRI Project Area	**Thin ponderosa pine habitat**	**Prescribed burn ponderosa pine habitat**	**Thin mixed conifer habitat**	**Prescribed burn mixed conifer habitat**	**Thin MSO protected habitat**	**Prescribed Burn MSO protected habitat**	**Thin MSO Restricted habitat**	**Prescribed Burn MSO Restricted habitat**
Current	90,082	148,134	2,488	2,801	1,986	2,285	29,126	50,742
Future foreseeable	52,141	49,602	9,149	3,723	7,277	1,851	12,807	13,219
Past	31,415	50,862	0	0	0	0	0	0
Total	**173,638**	**248,598**	**11,637**	**6,524**	**9,263**	**4,136**	**41,933**	**63,961**

Table 73. Cumulative effects in Mexican spotted owl habitat by alternative

Activities	Protected	Restricted	Total Acres
Treatment Alternative B			
Prescribed fire Only	20,083	2,655	22,738
Mechanical Thin and prescribed fire	10,284	72,456	82,740
Total Past, Current and Future Foreseeable Projects	**Protected**	**Restricted**	**Total Acres**
Prescribed fire Only	4,136	63,961	68,097
Mechanical Thin and prescribed fire	9,263	41,933	51,196
Cumulative Effects	**Protected**	**Restricted**	**Total Acres**
Prescribed fire Only	24,219	66,616	90,835
Mechanical Thin and prescribed fire	19,547	114,389	133,936
Total-Cumulative Effects Treatment Acres	**43,766**	**181,005**	**224,771**
Treatment Alternative C			
Prescribed fire Only	24,735	2,655	27,390
Mechanical Thin and prescribed fire	10,284	71,172	81,456
Total Past, Current and Future Foreseeable Projects	**Protected**	**Restricted**	**Total Acres**
Prescribed fire Only	4,136	63,961	68,097
Mechanical Thin and prescribed fire	9,263	41,933	51,196
Cumulative Effects	**Protected**	**Restricted**	**Total Acres**
Prescribed fire Only	28,871	66,616	95,487
Mechanical Thin and prescribed fire	19,547	113,105	132,652
Total-Cumulative Effects Treatment Acres	**48,418**	**179,721**	**228,139**
Treatment Alternative D			
Prescribed fire Only	836	2,655	3,491
Mechanical Thin and prescribed fire	10,284	72,456	82,740
Total Past, Current and Future Foreseeable Projects	**Protected**	**Restricted**	**Total Acres**
Prescribed fire Only	4,136	63,961	68,097
Mechanical Thin and prescribed fire	9,263	41,933	51,196
Cumulative Effects	**Protected**	**Restricted**	**Total Acres**
Prescribed fire Only	4,972	66,616	71,588
Mechanical Thin and prescribed fire	19,547	114,389	133,936
Total-Cumulative Effects Treatment Acres	**24,519**	**181,005**	**205,524**
Treatment Alternative E			
Prescribed fire Only	20,083	2,655	22,738
Mechanical Thin and prescribed fire	10,284	71,173	81,457
Total Past, Current and Future Foreseeable Projects	**Protected**	**Restricted**	**Total Acres**
Prescribed fire Only	4,136	63,961	68,097
Mechanical Thin and prescribed fire	9,263	41,933	51,196
Cumulative Effects	**Protected**	**Restricted**	**Total Acres**
Prescribed fire Only	24,219	66,616	90,835
Mechanical Thin and prescribed fire	19,547	113,106	132,653
Total-Cumulative Effects Treatment Acres	**43,766**	**179,722**	**223,488**

Changes are expected in Mexican spotted owl prey habitat. Decreases would occur in coarse woody debris, logs, and snags, commonly decreasing structure in prey habitat in the short-term. Burn prescriptions and ignition techniques should limit these losses. Burned snags fall and provide logs and trees killed by fire will become snags. However, the longevity of fire-killed snags is less than that of snags formed from other processes. However, maintenance burning should provide pulses of snags and logs through time. Less coarse woody debris is expected to be present in the short-term as a result of prescribed fire. Thinning and burning should increase tree growth rates and self-pruning of lower tree branches should replenish coarse woody debris in the long-term. Improving growing conditions should decrease density-related mortality of larger and older trees. Improving recruitment into the larger size classes would improve Mexican spotted owl habitat and the ability to provide large snags that remain on the landscape longer than smaller diameter or fire-created snags. The combination of thinning and burning should improve species richness in the herbaceous understory, increase plant abundance, and improve fruit and seed production.

Current and reasonably foreseeable projects represent polygons omitted from the 4FRI planning effort because some degree of planning was already in progress or they occur outside of ponderosa pine forest. Treating within these polygons will reduce fire threat for Mexican spotted owl habitat within the respective project polygon as well as reducing the threat of high-severity fire starting in these areas and burning habitat outside the polygons. Given the d.b.h. limits employed and the generally low intensity of the treatments in Mexican spotted owl habitat, decreases in the risk of high-severity fire and improvements to understory vegetation/prey habitat are expected to be short term before canopies expand and intercept light, rain, and snow, thereby reducing understory response in the long-term.

Cumulative effects from reasonably foreseeable projects could include disturbance from noise and potentially from smoke. Potential projects from the Bill Williams Mountain Restoration Project (on the Williams Ranger District), Flagstaff Watershed Protection Project (the San Francisco Peaks and Mormon Mountain), reopening or developing rock pits (forestwide) and work in the Mahan-Landmark project (Mogollon Rim) could cumulatively degrade but retain Mexican spotted owl habitat, including PACs and restricted habitat, in the short- and long-term. However, the risk of high-severity fire eliminating Mexican spotted owl habitat would be reduced in the short- and long-term.

Because current and reasonably foreseeable projects represent polygons omitted from the 4FRI treatment area effort, overlap in the spatial component of cumulative effects would largely be avoided. Although smoke and noise can cross project boundaries, both largely disperse with distance. However, some areas where smoke settles could be at further risk of impacts to owls. The Flagstaff Watershed Protection Project could cumulatively increase impacts to owls in PACs adjacent to shared boundaries.

Many current and reasonably foreseeable projects would overlap temporally. It is conceivable that actions would be occurring in PACs on multiple major cinder mountains within the 4FRI boundary where PACs in mixed-conifer forest commonly occur. However, all or most PAC treatments would have timing restrictions, preventing treatments during the breeding season. Also, the most common PAC treatment is prescribed fire, which would be managed to be similar to the owl's evolutionary environment.

Given the various stages of planning or implementation, most project effects would be dispersed both spatially and temporally. Projects in Mexican spotted owl habitat are typically designed to improve habitat, or to degrade elements of habitat structure while retaining habitat function, resulting in a decrease in risk of high-severity fire. Cumulative effects will likely increase disturbance to individual Mexican spotted owls from noise and/or smoke in the short-term. Impacts are not expected to affect fecundity because of timing restrictions. Given typical project objectives, the spatial scale of the cumulative effects area, the distribution of Mexican spotted owl habitat across the project area, and the length of time over which treatments will be implemented (10 or more years), cumulative effects are not expected to negatively impact the Mexican spotted owl population in the long-term. Overall, treatments in Mexican spotted owl habitat should move forest conditions toward desired conditions and decrease the risk of habitat loss to large-scale high severity fire.

Uncertainty and Risk

The practice of prescribed fire has evolved over time and it is commonly used as a tool to reduce surface fuels while also maintaining forest structure/wildlife habitat components such as snags, logs, and coarse woody debris. However, prescribed fire is not a precise tool and there is inherent uncertainty and so potential risk with fire management. There is also risk and uncertainty in not addressing uncharacteristic surface fuel loads in fire-adapted ecosystems.

Randall-Parker and Miller (2002) reported up to 1/3 of snags and almost ½ of all logs were lost following prescribed burning. This was largely an observational study based on five plots. They were experimenting with methodologies and their data collection techniques changed during the course of the study. As the authors point out, the results are not statistically sound. Therefore it was published in a conference proceedings and not in the referred literature

Saab et al. (2006) addressed similar concerns, yielding more rigorous results. Although they also reported loss of nearly ½ the logs from prescribed fire, treatments were conducted during drought conditions with low fuel moistures. Prescribed fire did successfully remove live ladder fuels. However, most of the results were not statistically significant.

Monitoring data from the Coconino NF has documented loss of key habitat components from prescribed fire. Microhabitat monitoring from burns implemented on the Happy Jack Urban Interface Project on the Mogollon Rim Ranger District through late 2004 showed an 8 percent loss of trees greater than 18 inches d.b.h., a 21 percent loss of snags, a 71 percent loss of logs, and a 47 percent loss of Gambel oak trees greater than five inches d.b.h. In addition, prescribed burns conducted along Highway 87 and Forest Highway 3 (2005-2006) appear to have had loss of canopy cover and basal area. These projects did not include PACs and did not have the list of design features developed to minimize loss of key habitat components. Perhaps most important is that the projects being compared had a fuels reduction emphasis different from the restoration emphasis in the 4FRI.

Prescribed burning is expected to reduce the risk of future high-severity fire by reducing accumulations of fuels and raising canopy base height, both of which can benefit Mexican spotted owl habitat in both the short- and long-term. However, it can also modify and/or destroy key habitat components that comprise Mexican spotted owl habitat. Based upon the sheer number of acres proposed for burning each year, and because the intention is to apply prescribed fire to all PACs and nest/roost replacement/target-threshold acres, there is a likelihood that more key habitat components could be unintentionally lost to fire than modeling indicates. Some degree of unintended fire behavior could improve Mexican spotted owl habitat by creating canopy gaps and enriching soils. However, impacts to Mexican spotted owl habitat could also create adverse effects.

Black-footed Ferret (Endangered)

Information on the status of the black-footed ferret was obtained from the FWS (http://www.fws.gov/southwest/es/arizona/Black_Footed_Ferret.htm) and AGFD (http://www.azgfd.gov/w_c/edits/documents/mustnigr.d_001.pdf) web sites accessed March 1, 2013. Additional information on the status of potential habitat came from prairie dog surveys done on the Coconino and Kaibab NFs by AGFD and others starting in 1979 and continuing through 2007 (Wagner 2002, Wagner et al. 2006, Underwood 2007). Small mammal trapping was conducted in Garland and Government Prairies in 2008 (no ferret activity was observed; Ganey and Chambers 2011).

There are presently no known naturally occurring populations of black-footed ferret and no known records of black-footed ferrets on the Coconino or Kaibab NF. Black-footed ferrets are dependent upon prairie dogs for food and burrows, and Gunnison’s prairie-dogs are the only prairie-dog species that occurs in northern Arizona. Within the project area, prairie dogs occur in grasslands. Open linkages have been mapped within the project and are identified for prairie dogs (wildlife report, appendix 4). The closest population is an experimental non-essential population that was reintroduced onto the Espee Ranch in 2007, about 20 miles from the Kaibab NF boundary.

Environmental Consequences

Alternative A – Direct and Indirect Effects

Habitat conditions for black-footed ferret would remain in their current condition, notwithstanding natural processes. Because there are no known black-footed ferrets on the project area, the probability of direct effects to black-footed ferrets from the current condition are low. Understory biomass would continue to decline over the next 40 years (appendix 8 of the wildlife report). This in turn leads to less available habitat for species such as the ferret that rely on prairie dogs for food. This alternative would result in the most stress on meadow and grassland habitats and thus would have the greatest negative contribution to potential black- footed ferret habitat.

Alternatives B through E – Direct and Indirect Effects

Direct effects are unlikely to occur in any action alternative since there are no known locations of black-footed ferrets on the project area and potential habitat would be surveyed prior to implementation. Short-term and localized effects from mechanical thinning and prescribed fire would result in the potential collapsing of burrows and displacement of prairie dogs (prey species) in active prairie dog towns. In all alternatives, there would be restored connectivity of grasslands which would have a beneficial impact on prairie dog populations contributing to potential black-footed ferret habitat. There would be additional opportunities for prairie dogs to colonize new areas and re-colonize areas where trees have encroached previously occupied habitat in Government and Garland Prairie, Kendrick Park, and other grasslands.

Alternative C treats the most acres and elicits the greatest response in understory (see wildlife report, appendix 8). Potential for high-severity fire in grasslands would be reduced with the removal of encroaching trees, and prescribed fire and mechanical treatments in grasslands would improve the stability of the key ecosystem elements by almost doubling acres in FRCC1 and reducing FRCC3 by half (see fire ecology report).

Alternative D produces the lowest response of understory biomass (see appendix 8 in the wildlife report) as there would be 20,645 fewer acres of prescribed fire-only. There would be little change in high-severity fire potential and the lack of prescribed fire in grasslands reduces the acres in

FRCC 1 by 3 percent and increases the acres in FRCC 3 reducing the stability of key ecosystem elements (see fire ecology report). The lack of burning means no nutrient pulse into the system, further limiting understory response. This alternative provides the least amount and lowest quality of habitat for prairie dogs hence less habitat for black-footed ferrets.

Cumulative Effects for Alternatives B through E

The area analyzed for cumulative effects to black-footed ferret encompasses the grasslands within the project area and the associated prairie dog complexes. In this analysis, short-term effects are those occurring within 10 years and long-term effects are 30 years. Direct and indirect effects are unlikely to occur since there are no known locations of black-footed ferrets on the project area and potential habitat will be surveyed prior to implementation. There are no direct or indirect effects to black-footed ferret therefore, no cumulative effects.

Narrow-headed Garter Snake (Threatened)

On the Coconino NF, narrow-headed garter snakes are currently known from Oak Creek Canyon and a few sightings from the East Verde River approximately five and eight miles respectively from the project area. Population numbers in Oak Creek Canyon have decreased significantly, particularly in the lower 1/3 of the canyon. Since the late 1980s they have been entirely absent downstream of Oak Creek Canyon. Historically, this species likely occurred throughout perennial riparian areas in the Verde Valley. Based on cottonwood/willow and mixed broadleaf riparian habitats, this species is considered a potential resident of all Coconino NF ranger districts. Neither this species nor its habitat occurs on the Kaibab NF. There are no known locations of narrow-headed garter snake within the project area; however, 2,894 acres of riparian habitat and ephemeral drainages could provide potential habitat. The entire area within Subunit 3-3 and 3-4 and portions of 3-5 was considered for potential impacts to downstream habitat in Oak Creek.

Proposed critical habitat is designated by the FWS to provide for the survival and recovery of listed species. Proposed critical habitat for the narrow-headed garter snake was listed in the Federal Register on July 10, 2013 (USDI FWS 2013b, figure 13 in the wildlife specialist report). Critical habitat encompasses the West Fork of Oak Creek, Oak Creek, and portions of the East Verde and Verde Rivers.

The Slide fire can directly impact narrow-headed garter snake biology (USDI BAER report 2014) and its proposed critical habitat (USDI FWS 2013). There are 1,771 acres of proposed critical habitat for the narrow-headed garter snake within the Slide Fire perimeter. This is outside of the 4FRI treatment area. Nearly 850 acres of proposed critical habitat (48 percent) lie within moderate to high soil burn severity.

Flood waters would carry ash and sediments into connected drainages which ultimately could reach the two perennial streams. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill fish and macroinvertebrates which are the food base for the garter snake. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation. Environmental Consequences

Alternative A – Direct and Indirect Effects

Under alternative A, habitat conditions for wildlife would largely remain in their current condition. Change would occur through ongoing and future projects in the Oak Creek watershed and natural processes. Because there are no known narrow-headed garter snakes in the project area, direct effects would not occur. However, about 34,700 acres of mechanical thinning and nearly 41,200 acres of prescribed fire would or has occurred in projects within and overlapping this subunit. None of these projects would be in or adjacent to narrow-headed garter snake habitat, i.e., along or in the West Fork and mainstem of Oak Creek. These projects would reduce the risk of high-severity fire effects. However, dense forest conditions would continue with high fire hazard potential persisting. Large, uncharacteristically severe -wildfires could adversely affect garter snake habitat by vegetation and burning soils. This would increase overland flow and soil erosion with potential to deposit high sediment loads in riparian and flowing water habitats. Water quality and riparian conditions would be adversely affected on a wide-scale basis (Water Quality and Riparian report), resulting in cumulative effects (see below).

Alternatives B through E – Direct and Indirect Effects

Under alternatives B through E, project activities would have no direct effect to narrow-headed garter snake or its proposed critical habitat (USDA FS 2013). Project activities would potentially affect 229 acres (1 percent) of proposed critical habitat in the West Fork of Oak Creek subunit through thinning and prescribed fire (figure 48). No narrow-headed garter snakes are known to occur along this portion of West Fork of Oak Creek; and, this portion does not contain perennial water or aquatic habitat characteristics. Therefore no direct effects would occur to the species or its habitat.

Thinning and burning may indirectly affect narrow-headed garter snakes and their habitat in the short-term. Increased sedimentation could result in downstream effects. However, these effects would be reduced or eliminated through BMPs that provide filter strips and maintain course woody debris (see appendix C).

Decreases in water quality can result in potential negative effects to macroinvertebrate and native fish populations. In response to the Slide Fire, additional protective measures were added to protect habitat within and downstream of the 4FRI treatment area (water quality and riparian report; soils specialist report). It is unlikely that alternatives B through E would contribute enough sediment or other pollutants to ephemeral or intermittent drainages within the project area to result in impairment of any downstream waterbodies (water quality and riparian report).

Treatments in subunits connected to these watersheds could potentially lead to increased sedimentation and/or ash flow into narrow-headed garter snake prey habitat (aquatics report). However, the potential increase in sediment or ash over background levels would not likely reach the magnitude to affect habitat for native fish species or garter snakes. Conversely, moving the forested uplands toward historic conditions would increase resilience of these systems and decrease the risk of uncharacteristic, high-severity wildfire. Protective stream buffer strips would be employed along the Sterling Canyon streamcourse to reduce the risk of sediment and ash flow into Upper Oak Creek.

Spring restoration under alternatives B through E would increase riparian vegetation, increasing availability of food and reproductive sites for native fish species. However, restored springs are too disconnected to provide habitat for this highly aquatic garter snake.

Narrow-headed garter snake habitat does not occur within the paired watershed study and associated structures are not expected to increase sedimentation or reduce flow to habitat therefore, no indirect affect is expected from activities associated with the study.

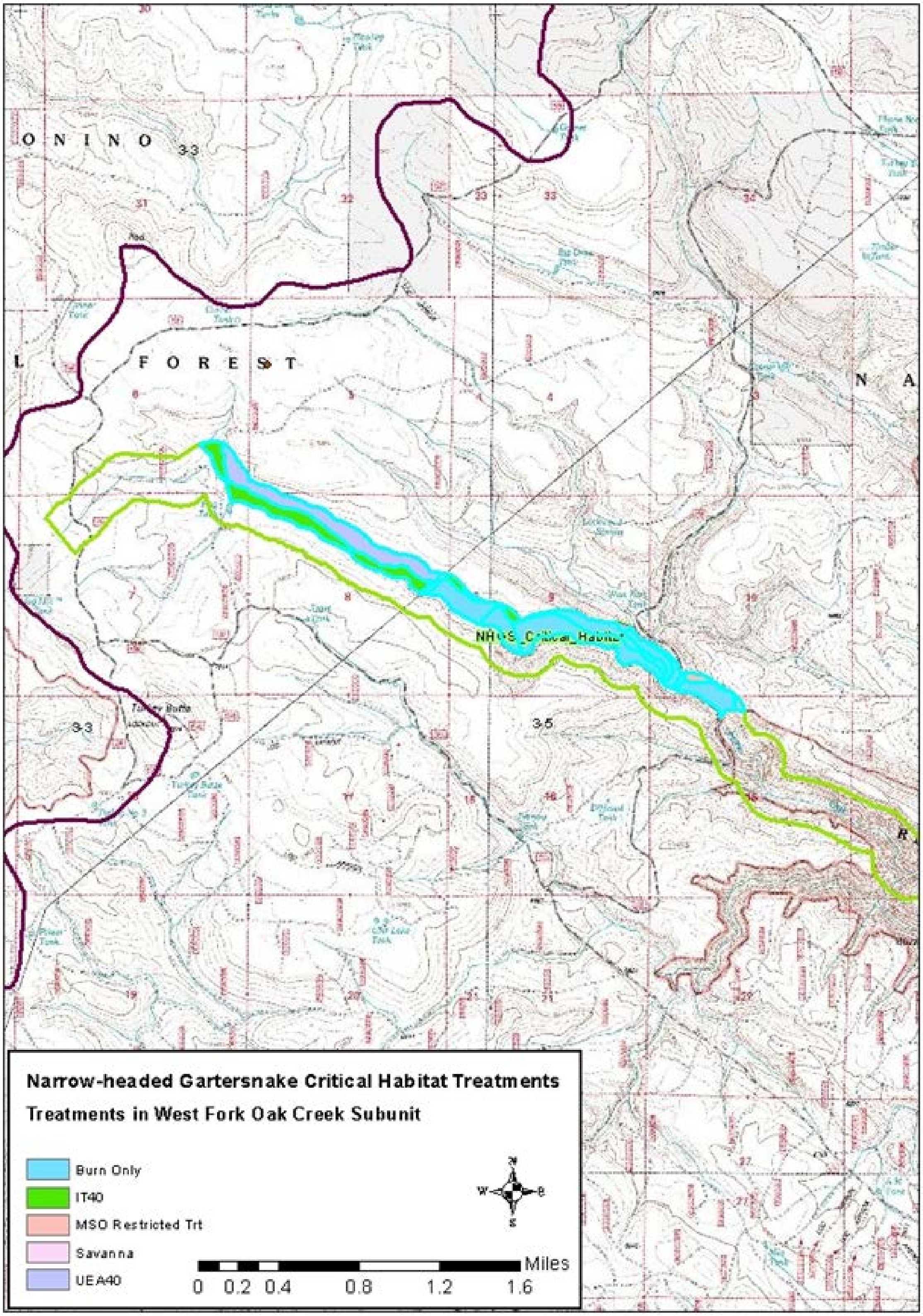


Figure 48. Narrow-headed garter snake treatments in proposed critical habitat for alternatives B, C, D and E

IT=intermediate thin; MSO= Mexican spotted owl; UEA = uneven-aged

Narrow-Headed Garter Snake Proposed Critical Habitat

Primary constituent elements for proposed critical habitat are listed in the Federal Register (USDI FWS 2013b) and addressed as they relate to implementing alternatives B through E. Effects of the Slide Fire on habitat are described above.

BMPs would be in place to mitigate short-term risks to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads. The proposed actions would not regulate or alter flow. Protection measures would be put in place to minimize the potential for soil disturbance within the drainage reducing impacts to critical habitat (see appendix C). Large logs and snags would be maintained as per forest plan direction and while riparian vegetation does not exist in this part of the drainage, bank side scrub vegetation would increase, improving basking and foraging habitat over time. Long-term surface water quality is expected to improve through more resilient forest conditions that minimize uncharacteristic fire behavior and through improved vegetative ground cover that minimizes soil erosion and sediment transport to connected streamcourses and other waterbodies (water quality and riparian area report). Dust abatement would have no effect on critical habitat, as no dust abatement treatments are proposed near open water. Any effects to native fish would be insignificant and discountable (Childs 2014). The proposed Coconino NF forest plan amendments for alternatives B-D would not have measurable effects on narrow-headed garter snake proposed critical habitat.

Cumulative Effects – All Alternatives

Narrow-headed garter snakes only occur in subunit 3-5 in the 4FRI landscape. Vegetation treatments would occur above the Mogollon Rim and narrow-headed garter snake habitat is in the drainage bottoms below the Rim. Therefore, the cumulative effects area analyzed for narrow-headed garter snakes is subunit 3-5 and cumulative effects includes effects of alternative A. Short-term effects are those occurring within 10 years and long-term is 30 years. No directs would result from 4FRI treatments; the following analysis addresses indirect effects.

Past, current, and foreseeable actions were summarized for subunit 3-5 (table 74). Approximately 78 to 88 percent of all cumulative mechanical and prescribed fire treatments in subunit 3-5, respectively, would be a result of the 4FRI. Forest activities in this subunit would be on the Coconino Plateau, above the Mogollon Rim.

Table 74. Summary of restoration units 3-5 cumulative effects for narrow-headed garter snake

Project Type	Goshawk Habitat Treatments			Mexican Spotted Owl Habitat (MSO) Treatments				Rock Pits
	PFA and Nests	LOPFA Habitat		MSO PAC		Restricted Habitat		
		Thin	Prescribed Fire	Thin	Prescribed Fire	Thin	Prescribed Fire	
Current	228	4,653	9,558	71	71	4,637	4,637	0
Future Foreseeable	0	6,940	6,528	1,703	0	6,030	6,442	39
Past	304	10,147	13,925	0	0	0	0	0
Grand Total	**532**	**21,740**	**30,011**	**1,774**	**71**	**10,667**	**11,079**	**39**

Treatments have and would continue to emphasize prescribed fire and mechanical thinning to current uncharacteristic forest structure toward presettlement conditions. These acres are not mutually exclusive – many acres include both treatments. Both activities could potentially add sedimentation to garter snake habitat, but the distance to riparian habitat along West Fork and the mainstem of Oak Creek or to flowing water associated with these creeks is not likely to lead to measureable effects (Water Quality and Riparian Report). BMPs common to vegetation manipulation projects on the Coconino NF would further reduce the likelihood of sediments reaching the West Fork or mainstem of Oak Creek (soils specialist report). Treatments would reduce future fire behavior, limiting or avoiding high-severity fire effects. Two more wildfires were initiated in the watershed in the summer of 2014 after the Slide Fire and the portion of the watershed east of Oak Creek remains vulnerable. Decreasing the risk of additional high-severity fire occurring in this watershed would lessen the risk of compounding the risk of ash and sediment delivery into garter snake habitat.

Under alternative A, the likelihood of sediment affect garter snake habitat is very low. The limited acres of mechanical and prescribed fire treatments combined with the distance to their habitat makes measureable effects unlikely. However, the limited acres of treatment means the trending away from desired conditions would continue (silviculture and fire ecology reports). Forest structure would be dominated by mid-aged trees with high SDI max. These conditions increase the threat of insects and disease. Combined with climate change, the likelihood of large-scale high-severity fire would continue to increase. Sedimentation and ash flow from high-severity could result in adverse effects to narrow-headed garter snakes.

The action alternatives would move the landscape toward desired conditions (silviculture report) and reduce the risk of large-scale high-severity fire. This would reduce the risk of high levels of sediment and ash flow from entering garter snake habitat. Cumulative effects would further reduce the risk of adverse indirect effects to garter snakes.

Determination of Effects

Alternatives B through E may impact narrow-headed garter snake, but considering direct and indirect effects, BMPs, and cumulative effects, **alternatives B through E may affect but are not likely to adversely affect** the species, nor is it likely to adversely affect the snake’s habitat.

Considering direct, indirect, and cumulative effects, implementation of **the proposed action may affect, but is not likely to adversely affect** proposed narrow-headed garter snake critical habitat (Biological Assessment 2014, p. 243).

Bald and Golden Eagle

All golden and bald eagles, regardless of status, are protected under the Bald and Golden Eagle Protection Act. Bald eagles are also addressed as a Forest Service sensitive species.

Golden Eagle

Sightings of golden eagles have been documented, and winter surveys are conducted annually on the Flagstaff Ranger District (Coconino NF) and Williams Ranger District (Kaibab NF) within the project area. Bald eagle annual winter surveys also document golden eagle sightings. There are 18 confirmed golden eagle nests representing 17 nesting areas in the project area (see wildlife report). There are 11 additional potential nests but they have not yet been confirmed. Potential and confirmed nesting golden eagles within the project are located in subunits 1-1, 1-3, 1-6, 2-0, 3-1, 3-4, 3-5, 4-1, 4-2, 4-3, 4-4, 5-2 and 6-2. Golden eagles often nest in areas of high rabbit populations. Golden eagles are well known for subduing large prey; however, most of their diet consists of ground squirrels, rabbits, and prairie dogs. Potential foraging habitat within the treatment area is primarily 48,774 acres of grassland.

For golden eagles, all nests would be protected from disturbance during project implementation. Project design features (FEIS, appendix C) would mitigate potential for disturbance from noise or smoke to nesting golden eagles. Project activities would not substantially interfere with foraging behavior. Restoration treatments would improve foraging habitat and reduced potential of high severity fire impacting nest locations.

Bald and Golden Eagles

Environmental Consequences – All Alternatives

Alternative A includes current and foreseeable projects within the project area. Habitat conditions would largely trend away from desired conditions, although about 127,100 acres of thinning would still occur and prescribed fire would be managed on about 154,514 acres. These acres are not additive because most projects conduct both actions on many of the same acres to manage both forest structure and fuels. Dense forest conditions would still occur and the high fire hazard potential would continue to place potential bald eagle nesting, roosting and foraging habitat at risk with respect to stand-replacing fire. Tree densities would continue to be high slowing or stagnating growth into larger diameter classes, thereby limiting the development of roosting and perching habitat. Meadows, grasslands, and savannas would continue to be encroached, limiting potential foraging areas.

The effects for alternatives B through E reflect design features and mitigation as described for the bald eagle (see appendix C in the DEIS). In alternatives B through E mechanical treatments, prescribed fire, road construction and decommissioning, and the hauling of timber and other restoration activities may cause visual or auditory disturbance that would be localized, of short duration and low intensity. Effects of mechanical treatments would not be expected to substantially interfere with normal feeding behavior. Acres of prescribed burning and mechanical treatment would result in short-term effects and would be minimized due to activities being spatially and temporally separated.

Alternative C restores more acres of potential foraging habitat, and the added mechanical treatments within grasslands would maintain and improve more foraging habitat. There are no nests or roosts within the additional grassland treatments or research areas; therefore, no additional effects would occur from disturbance. Alternative D has the same effects as alternative B and E with one exception. The lack of prescribed fire after thinning treatments would affect surface vegetation patterns as shrubs and other species adapted to fire continue to decline (Huffman and Moore 2004, Moir 1988). The loss of habitat effectiveness would indirectly lead to adverse effects for golden eagles by limiting prey habitat.

Cumulative Effects – All Alternatives

The area analyzed for cumulative effects for bald eagle is the ponderosa pine within the project and ½ -mile boundary outside the project boundary and cumulative effects includes effects of alternative A. This includes about 152,165 acres of thinning and about 202,490 acres of prescribed fire. The temporal timeframe for cumulative effects is 10 (short-term) to 30 (long-term) years.

Cumulative impacts from this alternative would be the greatest to wintering bald eagles. Continued dense forest conditions would limit the growth and sustainability of large trees slowing development of potential winter roost areas. Other activities including utility line and road construction and maintenance, high-impact recreation, and climate change that would combine to result in degradation of nesting and roosting habitat.

In alternatives B through E there would be no effect to nesting eagles; however, there may be potential short-term disturbance to potential foraging habitat with long-term benefits. Short-term disturbance to foraging eagles would occur during thinning, hauling, temporary road construction, and prescribed fire activities and may cause eagles to forage in nearby areas for the duration of the activity. Other activities occurring that may have similar effects include temporary disturbances caused by prescribed fire (104,750 acres) and thinning (104,990 acres) in adjacent projects, or effects to roosting habitat from utility infrastructure development and maintenance (500 acres). These short-term impacts added to similar effects from other activities were considered. Implementation activities of other fuel reduction project activities could occur simultaneously; however, it is not anticipated it would combine to cause a negative effect.

Determination of Effects for All Alternatives

The proposed treatments and activities **would not result in take as defined in the Eagle Act for golden or bald eagles.**

California Condor (Endangered/Experimental Population)

Condors were listed as endangered in 1967 (32 FR 4001) and critical habitat was designated in California in 1976 (41 FR 187). Experimental nonessential population designation was established for the Southwest reintroduction in 1996 (61 FR 54044). The condor recovery program began releasing birds into California 1992 and into Arizona December of 1996. To date, these are the only release sites in the United States. The Kaibab forest plan directs the protection of the condor as a rare and narrow endemic species.

The project treatment area includes areas within and outside the 10(j) recovery zone. All lands north of Interstate 40 are included in the 10(j) area, including RUs 4, 5, and 6. RUs 1 and 3 lie south of the non-essential experimental population area where condors have full protection of endangered species under the ESA. There are no known roost sites within the project boundary.

Environmental Consequences – All Alternatives

In alternative A there would be no direct, indirect or cumulative effects. Alternatives B through E would maintain presettlement trees and retain large post settlement trees as long as restoration goals can be achieved. No project activities would affect cliff habitat. Therefore, nesting or roosting habitat would not be affected by project implementation. Indirect effects to condors could potentially occur because of nearly 48,800 acres of grassland and savanna restoration improving foraging habitat. However, given condors rarely fly over the project area, much less actually forage within it, no measureable effects to condors are expected. Given there would be no measureable direct or indirect effects to condors, than no cumulative effect would accrue. Design features have been developed to protect condors in the event they are detected during project implementation (appendix C, W40 to W44).

Forest Service Sensitive Species

Sensitive species are defined in Forest Service Manual 2670.5 as “those plant and animal species identified by a Regional Forester for which population viability is a concern, as evidenced by: (a) significant current or predicted downward trends in population numbers or density, or (b) significant current or predicted downward trends in habitat capability that would reduce a species’ existing distribution (USDA FS 2005).

The presence of 23 Forest Service sensitive species carried forward for analysis (table 75) was determined by consulting forest records, results of surveys conducted on the forests, and use of the FAAWN (Forest Attributes and Wildlife Needs) database (Patton 2011).

The most recent Regional Forester’s sensitive species list was transmitted to Forest Supervisor’s on September 18, 2013 and is the basis for the species used for this analysis. If survey information was not available the assumption was made that potential habitat was occupied. Species in bold font apply to both the Coconino and Kaibab NFs. Other species apply to the Coconino NF. See the aquatics section for the sensitive species evaluation. See table 68on page 228 for those species (with rationale) that were dismissed from this analysis.

Table 75. Forest Service sensitive species or habitat occurrence in the project area

Common (Scientific Name)	Species or Habitat Occurrence in Project Area
	Amphibians (1)
Northern Leopard Frog *(Lithobates pipiens)*	In Arizona, northern leopard frogs are absent from most historic locations. Frogs were reported from 11 sub-units (1-2, 1-3, 1-4, 1-5, 1-6, 3-4, 3-5, 4-4, 4-5, 5-1) within the project area. Their range within the project boundary is now limited to permanent waters around Stoneman Lake. There are 6 occupied/critical breeding sites and 10 potential breeding sites in the project, or within a ¼ mile of the project area boundary, and they occur within sub-units 1-2, 1-5, and 1-6. Best potential habitat within the project area is tanks and springs that provide permanent water. Although potential habitat occurs in livestock waters in all cover types within RU 1, 3, 4 and 5, the primary breeding and dispersal habitat occurs in RU 1 where the amphibian linkage is designated. RU 1 has 8,230 acres of grassland and 145,793 acres of ponderosa pine, 24 miles of riparian habitat and ephemeral streams and 32 springs.
	Birds (4)
Bald Eagle (*Haliaeetus leucocephalus)*	There are two nesting pairs of bald eagles within the project boundary. One breeding area occurs above the Mogollon Rim near Lower Lake Mary. The same pair has used two different nest locations along Lower Lake Mary (Coconino NF). The area is periodically monitored by AGFD and Northern Arizona Audubon Society. The alternate nest location is adjacent to FR 296A and has a higher level of disturbance within the area. The second breeding area is at Whitehorse Lake on the Kaibab NF. This nest was first documented in May 2012 and is located in an area of high recreation use. The nest was monitored by AGFD and confirmed active with one fledged nestling. In 2013, the adult female was dead and no nesting occurred that year. However, in 2014, the nest was again used and the pair appears to be raising two eaglets. Bald eagles occurring on the Coconino and Kaibab NFs are primarily winter visitors. There are currently 38 eagle roosts spatially identified in GIS for the project area, of which 19 have confirmed use. The remaining 19 roosts are identified as characteristics roosts and do not have documented use. Bald eagle confirmed and characteristic winter roosts are found in 7 sites. Potential habitat within the treatment area is 512,178 acres of ponderosa pine but is habitat is primarily within 2.5 miles from bodies of permanent water (i.e. Upper and Lower Lake Mary, Horseshoe Lake, Mormon Lake and Roger's Lake) and along major roadways (i.e. Interstate 17, 40, 89A and 89N and Federal Highway 3).
Northern Goshawk (*Accipiter gentilis)*	All or parts of 60 PFAs occur within the 4FRI analysis area, comprising 30,011 acres. All or parts of eighteen dispersal PFAs have been identified in the 4FRI analysis area, comprising 10,023 acres. Northern goshawks are assumed to be declining on the Kaibab NF. However, if future weather patterns produce good precipitation, the population could stabilize. On the Coconino NF, a high occupancy rate from about 1991-1993 is explained in part by the number of new territories found in those years. From the mid-nineties, the trend was variable but relatively stable. The occupancy trend declined from 2007 to 2011 (USDA FS 2013). Goshawk surveys date back to the 1990s with recent surveys conducted in 2011 and 2012. See chapter 1 of this FEIS for habitat existing conditions.

Common (Scientific Name)	Species or Habitat Occurrence in Project Area
American Peregrine Falcon (*Falco peregrinus anatum)*	There are 20 confirmed nesting pairs of peregrine falcons within the project area. Nests occur in eight sub-units (1-1, 1-6, 3-1, 3-4, 3-5, 4-3, 4-4, and 5-1). Known nest locations, tall cliffs, open waters, and meadows provide potential habitat within the project boundary. Foraging habitat in the treatment area is primarily 48,774 acres of grassland, 39 miles of riparian habitat and ephemeral streams, and 74 springs and wetlands. Two nests and about 22,000 acres of foraging habitat was affected in the Slide Fire in 2014. Given about 86 percent of the post-fire forest ranged from unburned to moderate severity, with most of the area (48 percent) burning with low severity, and given that peregrine feed almost exclusively on avian prey, no long-term affects to peregrine are predicted to result from the fire.
Western Burrowing Owl (*Athene cunicularia hypugaea)*	Breeding Bird Atlas surveys confirmed nesting in a prairie dog colony near Flagstaff (Coconino NF). However, burrowing owls have not been confirmed within the project area. There are 48,774 acres of grassland habitat within the treatment area that provides potential habitat for prairie dogs and consequently, burrowing owls.
	Mammals (5)
Navajo Mogollon Vole **(***Microtus mogollonensis Navaho)*	Hoffmeister (1986) delineated the range for this vole from Navajo Mountain southward to the western part of the Mogollon Plateau, extending from near Mormon Lake westward toward the town of Williams and up to the Tusayan Ranger District. They occur within open forests and in larger grassland areas such as Garland and Government Prairies on the Williams Ranger District (Ganey and Chambers 2011). There are 512,178 acres of ponderosa pine and 48,774 acres of grassland within the treatment area.
Western Red Bat *(Lasiurus blossevillii)*	In the Grand Canyon Hoffmeister (1971) reports, the western red bat were only found in the bottom of the Canyon near Phantom Ranch and along Bright Angel Creek approximately 6 miles from the project area. On rare occasion, red bats have been documented near Kachina Village (subunit 3-4) and upper West Clear Creek Wilderness and Page Springs Fish Hatchery. The latter two locations are outside of the project area. One bat was radio-tracked near Kachina Village within the project area and roosted in a clump of Gambel oak in dry ponderosa pine forest (Chambers, pers. comm. 2010). Given they are an uncommon summer resident on the Coconino NF, they could conceivably be a rare visitor on the Kaibab NF as well. However, extensive netting on both the Williams and Tusayan Ranger Districts failed to produce records of western red bats. There are 34 caves within 300 feet of the treatment area boundary. A 300-foot buffer around caves entrances and sinkhole rims is a design feature applicable to all action alternatives. Potential foraging habitat within the treatment area includes 512,178 acres of ponderosa pine and 48,774 of grassland. Roosting habitat may occur along the 39 miles of riparian habitat and ephemeral streams.
Spotted Bat *(Euderma maculatum)*	There are 512,178 acres of ponderosa pine and 48, 774 acres of grassland within the treatment area. Spotted bats have been captured in coniferous forests on the Kaibab Plateau over 25 miles from the project area and in other western states. Netting efforts have not result in captures on the Coconino NF or the Williams RD, but spotted bats were captured on the Tusayan Ranger District, RU 6 (Solvesky, pers. comm.2008). There are no known roost locations within the project area. Surveys of abandoned mines and natural caves on the districts did not detect any spotted bats (Corbett 2008).

Common (Scientific Name)	Species or Habitat Occurrence in Project Area
Allen's Lappet-browed Bat (*Idionycteris phyllotis)*	A study conducted on the within the project area (RUs 1, 3, and 6) documented lappet-browed bats using snags for maternity roosts. Female roost trees were all within ponderosa pine forests. They occur across the ponderosa pine belt on the Coconino and Kaibab NFs and occurrences are documented in the project area in sub-units 1-5, 3-3, 5-1, and 6-3. Potential habitat within the treatment area is 512,178 acres of ponderosa pine and 25,658 acres of pinyon-juniper.
Pale Townsend's Big-Eared Bat *(Corynorhinus townsendii pallescens)*	A 2007 bat roost inventory and monitoring project documented Townsend's big-eared bats on both the Kaibab and Coconino NFs (Solvesky and Chambers 2007). Pale Townsend's are known to occur in within the project area (sub-units 4-3, 5-2, 3-3, 1-3 and 3-5). They use a wide range of habitats, including ponderosa pine forest. Potential habitat includes 512,178 acres of ponderosa pine and 48,774 acres of grassland within the treatment area. There are 34 caves within 300 feet of the treatment area boundary. A 300-foot buffer around caves entrances and sinkhole rims is a design feature applicable to all action alternatives.
Plants (11)	
Arizona Bugbane *(Cimicifuga arizonica)*	The plant occupies mesic canyons in the Oak Creek Canyon, West Fork of Oak Creek and its tributaries and West Clear Creek (Coconino NF). The first two areas are in or near the analysis area boundary. Monitoring for Arizona bugbane has occurred on the Coconino and Kaibab NFs since 1993. See table 6 in the botany report for the plant site locations in relation to treatments. In 2014, approximately 117 acres containing Arizona bugbane (West Fork of Oak Creek) were affected by the Slide fire. Based on this data, most of the populations experienced low to moderate severity fire. Only a minor portion was affected by high severity.
Rusby Milkvetch *(Astragalus rusbyi)*	There are numerous occurrences of Rusby milkvetch in the Hart Prairie (2010) and Wing Mountain (2012) projects on the Coconino NF. Occurrences have also been recorded on the Kaibab NF in the Frenchy Project Area (2003) and on the adjacent Camp Navajo (Springer 2009). Coconino Rural Environmental Corps (CREC) (2011) detected numerous locations of this plant in the A-1 Mountain area. Figure 8 and table 7 in the botany report displays occurrences in the project area.
Arizona Leatherflower **(***Clematis hirsutissima var. hirsutissima***)**	Within the project area, many populations occur near Lower Lake Mary, in Skunk Canyon and in Fay Canyon. Arizona leatherflower also occurs on the Tusayan Ranger District of the Kaibab NF, near Ten X Tank (Kaibab NF). Habitat includes rocky hillsides with slopes from 12 percent to 40 percent with aspects generally from 320 to 40 degrees (Arizona Game and Fish Abstracts 1993). Other scattered populations occur on Harold Ranch Road in east Flagstaff (private land), in Mountainaire (private land), Fort Valley, and near Hoe Tank on the Mogollon Rim Ranger District, which is outside the current project area but within ponderosa pine habitat. Table 8 in the botany report displays plant site locations relative to treatments.
Cliff Fleabane **(***Erigeron saxatilis*)	Within the project area cliff fleabane occurs on steep or vertical cliff faces. Table 9 of the botany report displays locations that overlap treatments.
Flagstaff Pennyroyal **(***Hedeoma diffusum***)**	Flagstaff pennyroyal occurs at various areas on the two forests, mainly in the areas of Lake Mary and Marshall Mesa and the rim of Sycamore Canyon on the Kaibab National Forest. Table 10 in the botany report displays site locations relative to treatments.

Common (Scientific Name)	Species or Habitat Occurrence in Project Area
Arizona Sneezeweed (*Helenium arizonicum*)	This endemic species ranges from the Mormon Lake area (Coconino NF) southeastward to the White Mountains area where it grows in drainages, near springs, ponds, and other wet areas. This species has been observed in ephemeral drainages in the Upper Lake Mary watershed (Coconino NF). Numerous groups were detected in the Antelope Park area (Coconino NF) by CREC crews in 2011. There are no known locations on the Kaibab NF. Table 11 in the botany report documents site locations within project treatment units.
Sunset Crater Beardstongue (*Penstemon clutei*)	The range of this species is limited to the Sunset Crater volcanic field near Flagstaff, including the Coconino NF and Sunset Crater National Monument. There are many locations of Sunset Crater beardtongue in the northeast corner of the project area. Many of these are in treatment units where burning or operational burning would occur. See table 12 in the botany report.
Flagstaff Beardtongue *(Penstemon nudiflorus)*	Flagstaff beardtongue grows in dry pine forests, pine/oak, pine/oak/juniper, and pinyon-juniper forests. It occurs on dry slopes, in openings and along edges of openings and in forested areas. Table 13 in the botany report documents site locations within project treatment units by alternative.
Arizona Phlox (*Phlox amabilis*)	Arizona phlox was added to the Southwestern Region (Region 3) sensitive species list in 2013. Therefore, the forests have not conducted specific surveys for it in the past. Occurrences were derived from SEINet, an on-line database of collections and observations from several herbaria. There may be additional undetected occurrences within the project area. Table 14 in the botany report documents locations relative to treatments.
Blumer's Dock (*Rumex orthoneurus*)	The known distribution of Blumer's dock in the project area is limited to a few enclosures around springs and wet areas. The known occurrences of Blumer's dock within the project area are limited to the Hart Prairie Area, where it shares the habitat with Bebb's willow. There may be other occurrences at other locations in the project area where suitable habitat exists.
Bebb's Willow (*Salix bebbiana*	Bebb's willow is a sensitive species for the Coconino NF only. Protection of Bebb's willow was a concern brought up by the public during scoping. The Fern Mountain Botanical Area (established in 1987 in the Coconino forest plan) contains a unique Bebb's willow community. Elsewhere in the project area, Bebb's willows are confined to single plants or groups of plants and the unique Bebb's willow community type is not present. Within the project area, documented locations include the Hart Prairie area and Mormon Lake Area on the Coconino NF. Plant locations relative to treatments are in the botany report on page 92.

Environmental Consequences

Alternative A

Summary of Effects Common to Forest Sensitive Species

Habitat would remain at high risk from undesirable fire effects from high-severity wildfire (see fire ecology section). Fire that results in undesirable fire effects could adversely affect potential habitat by removing understory and overstory vegetation and altering soil structure and nutrients. For sensitive plants, these types of changes to the habitat could adversely affect habitat and populations by damaging soil, killing existing plants, reducing, or destroying seed banks. Springs and ephemeral channels would continue to exhibit downward trends in functional condition or remain in static condition for the foreseeable future (see water quality and riparian report) which could degrade existing and potential habitat. Lack of movement toward historic conditions could result in reduced food and reproductive sites and reduced habitat connectivity. Trees would continue to encroach on habitats and understory biomass would continue to decline over the next 40 years (see wildlife report, appendix 6). Increased trees and reduced understory biomass would impact cover and forage, reducing the quantity and quality of habitats, and increases predation potential.

In terms of nesting and roosting habitat, tree densities, as measured by percent maximum SDI, would continue to be in the high to extremely high density range, slowing growth rates and thereby limiting the development of larger diameter (18 inches and larger) trees and snags, both of which are important for nesting and roosting.

For Southwestern Region sensitive plants, alternative A would affect habitat. Tree density and canopy stands would remain overstocked. There would continue to be a reduction or loss of understory vegetation and therefore, a loss of understory services (see wildlife report, appendix6). Fire hazard would remain high. Severe fire events could adversely affect the habitat and populations of Southwestern Region sensitive plants by damaging soil, killing existing plants and by reducing or destroying the seed bank. Post-fire noxious or invasive weeds would also increase and contribute to the degradation of the habitat and loss of individuals and groups of Southwestern Region sensitive plants. Dead and down fuels would continue to increase, which in turn could negatively affect the vigor of Southwestern Region sensitive plants by increasing the amount of shade and litter (see Vegetation Report).

Cumulative Effects

The cumulative effects analysis boundary and timeframe for each species varies by the habitat it occupies. The temporal timeframe for cumulative effects is 10 (short-term) to 30 (long-term) years unless specifically defined for a species. The detailed analysis for each species is in the wildlife report. This summary only provides key findings. For semi-aquatic species such as the northern leopard frog, degradation of habitat facilitated by this alternative would cumulatively combine with other forest activities, high-impact recreational use, livestock grazing, habitat loss, and degradation on private lands and climate change and would continue to fragment key aquatic and dispersal habitat.

For terrestrial species, birds, and insects, degradation and fragmentation of habitat would cumulatively combine with other forest activities, high-impact recreational use, livestock grazing, use of non-jurisdictional roads, and habitat loss and degradation on private lands and climate change would continue to fragment key nesting and foraging habitat. Prescribed fire treatments in adjacent projects and grazing may result in short-term impacts to habitat, but these are not expected to result in long-term cumulative impacts and are expected to be localized in nature. Continued dense forest conditions would limit the growth and sustainability of large trees slowing development of potential roost areas. Other activities including utility line and road reconstruction and maintenance, high-impact recreation, and climate change would combine to result in degradation of nesting and roosting habitat. See table 153 in the wildlife report for the cumulative effects baseline and assessment of ongoing and reasonably foreseeable actions.

For all sensitive plants, alternative A results in the potential for severe effects from wildfire that could adversely affect the habitat and populations by damaging soil, killing existing plants, and by reducing or destroying the seed bank. Noxious or invasive weeds would increase and contribute to the degradation of the habitat and loss of individuals and populations.

Alternatives B through E

Summary of Effects

See table 76 for the effects and sensitive species effects determinations for alternatives B through E.

Table 76. Sensitive species environmental consequences and effects determination

Species	Alternatives A, B, C, D and E Environmental Consequences (Direct, Indirect, Cumulative)
	Amphibians
Northern Leopard Frog *(Lithobates pipiens)*	**Alternative A** would have no direct effect on northern leopard frog. However there would be substantial indirect effects. Thinning and prescribed fire would still occur in RU1 as a result of current and reasonably foreseeable projects. However, the landscape would continue to move away from desired conditions. Dense forest conditions would still occur and the high fire hazard potential would persist. Springs and ephemeral channels would continue to exhibit downward trends in functional condition or remain in static condition for the foreseeable future (Water Quality and Riparian report) resulting in degradation of potential habitat for frogs. In **alternatives B-E** mitigations measures would reduce the likelihood of direct impacts to frogs from mechanical thinning, temporary road construction, spring, seep and ephemeral drainage restoration, road decommissioning, prescribed fire, and the spread of chytrid fungus. Seventy-four (74) springs/seeps would be restored, with 32 of those in RU 1, which contains all breeding and potential breeding sites. Restoration would increase riparian vegetation increasing availability of food and reproductive sites over the long term, resulting in direct beneficial effects to habitat. Twenty-four (24) miles of ephemeral streams would be restored in RU 1 resulting in improved cover and water flow that provides escape from predators and prevents water loss for migrating leopard frogs. Spring and channel restoration would result in short-term disturbance to vegetation during implementation. Restored vegetation would be expected to recover within 1 to 3 years (soil report). Approximately 120 acres of breeding and dispersal habitat would be impacted by road reconstruction. About 615 acres of forested habitat may be improved within breeding and dispersal habitat. Constructing 71 miles of temporary roads would temporarily disturb vegetation and reduce habitat quality for leopard frogs. In all alternatives the likelihood of large high-severity wildfires adversely affecting potential habitat by destroying understory and overstory vegetation would be reduced in RU 1 by 37 percent in the ponderosa pine and 5 percent in grasslands. **Specific to alternatives C and E:** The installation of paired watershed study instrumentation in drainages within RU 1, 3, and 5 could potentially act as barriers and limit the ability to occupy additional areas. The research areas and weirs would not be within the amphibian linkage or the subunits that contain breeding and potential breeding sites and would not restrict expansion into other habitat. **Specific to alternative C:** Alternative C result in the greatest response in understory (wildlife report, appendix 6) and increases the likelihood of successfully foraging around and migrating between livestock tanks due to decreased risk of predation. The likelihood of large high-severity wildfires adversely affecting potential habitat by destroying understory and overstory vegetation would be reduced in RU 1 by 37 percent in the ponderosa pine and 18 percent in grasslands. **Specific to alternative D:** The lowest response of understory biomass occurs. It would result in less cover reducing the likelihood of successfully foraging around and migrating between livestock tanks due to increased risk of predation. The lack of burning further limits understory response, however, the reduction of prescribed fire could reduce direct impacts to frogs migrating overland between stock tanks. The likelihood of large high-severity wildfires adversely affecting potential habitat by destroying understory and overstory vegetation would be reduced in RU 1 by 32 percent in the ponderosa pine and 1 percent in grasslands. **Cumulative Effects:** The area analyzed for cumulative effects for northern leopard frog is RU1 within the project area and a ¼ mile buffer outside of the project boundary along RU1 to include current and potential breeding sites. The temporal timeframe for cumulative effects is 10 (short-term) to 30 (long-term) years. Alternative would continue to result in indirect impacts to northern leopard frogs. Degradation of habitat facilitated by this alternative would cumulatively combine with other forest activities, high-impact recreational use, livestock grazing, habitat loss and degradation on private lands. Synergistic effects of climate change would continue to fragment key aquatic and dispersal habitat. In

Species	Alternatives A, B, C, D and E Environmental Consequences (Direct, Indirect, Cumulative)
	alternatives B-E direct impacts from mechanical thinning, temporary road construction, prescribed fire, and other restoration activities would combine with ongoing activities that have similar effects. Current, ongoing, and reasonably foreseeable projects listed in appendix 17 of the wildlife report include fuels reduction, forest health, aspen regeneration, tornado rehabilitation, and powerline development and maintenance. Cumulatively, activities are not expected to result in long-term effects and are expected to be localized in nature. **Effects Determination: Alternatives B, C, D and E may impact individuals, but are not likely to cause a trend to federal listing or loss of viability.**
Birds	
Bald Eagle (*Haliaeetus leucocephalus)*	In **alternative A** habitat conditions would trend away from desired conditions, although about 127,100 acres of thinning would still occur and prescribed fire would be managed on about 154,514 acres. These acres are not additive because most projects conduct both actions on many of the same acres to manage both forest structure and fuels. In **alternatives B-E**, there would be no direct adverse effects to nesting eagles as project design features would eliminate disturbance near known nesting sites. Subunit 1-3 could have a restricted burning period to reduce smoke impacts to two nests. Specialist reviewed the other nest site on the Kaibab NF and determined it would not be impacted from smoke. There would be no effect to nesting or roosting eagles, however, short-term disturbance to foraging bald eagles would occur during mechanical treatments, prescribed fire, hauling of timber and other project activities which may cause visual or auditory disturbance to foraging bald eagles. Disturbance would be localized and of short duration and may affect individual birds but would not affect the overall distribution or reproduction of the species. There are no anticipated adverse effects to prey species or prey species habitat. Thinning would improve old tree longevity, resulting in beneficial effects. Snags used by bald eagle would slightly increase post treatment (2020) and continue to increase in the long term. **Alternative D** would provide 5 percent less developing old growth in the short term (post treatment) and 5 percent less long term (30 years post treatment) compared to alternatives B, C and E. **Cumulative Effects:** The area analyzed for cumulative effects is the 988,764-accre project area and within ½ mile of the project boundary. The temporal timeframe for cumulative effects is 10 (short-term) to 30 (long-term) years. Current, ongoing and reasonably foreseeable projects (wildlife report, appendix 17) include fuels reduction, forest health, aspen regeneration, tornado rehabilitation, and powerline development and maintenance. Implementation of other project activities could occur simultaneously; however, it is not anticipated to combine to cause a negative effect. In alternative A continued pine tree encroachment would result in a cumulative impact along with such activities as grazing and high impact recreational use to limit meadow and grassland habitats. Prescribed burning on 98,800 acres in adjacent projects may result in short-term impacts to habitat, but these are not expected to result in long-term cumulative impacts and are expected to be localized in nature. Alternative A would result in the most stress on meadow and grassland habitats and thus would have the greatest negative contribution to potential golden eagle habitat. Alternatives B-E would improve and develop quality potential nesting and roosting habitat by developing groups of large trees and snags that are more fire resilient. This positive effect would be combined with similar effects from activities such as the travel management efforts that may decrease the frequency of disturbance on the majority of potential roost sites, slightly counteracting the effects of utility line and road construction and maintenance and short-term disturbances from vegetation management and prescribed fire. **Effects Determination: Alternatives B, C, D and E may impact individuals, but are not likely to cause a trend to federal listing or loss of viability.**
Northern Goshawk (*Accipiter gentilis)*	Discussion is presented outside of this table on page 283.

Species	Alternatives A, B, C, D and E Environmental Consequences (Direct, Indirect, Cumulative)
American Peregrine Falcon (*Falco peregrinus anatum)*	No direct effects are expected from any alternative (including alternative A) due to eyrie locations (cliff ledges in rugged canyons**). In alternatives B-E** about 1,671 acres of habitat (3 acres/mile) would be impacted by temporary road construction and reconstruction. Road use by machinery and equipment could crush animals moving across the road. Individuals may be impacted in the short term (only during project implementation). Vegetation would be restored over the long term. About 2,577 acres of forested habitat would be impacted in the short term from road decommission activities with positive long term effects. Springs and channel actions result in short-term disturbance to vegetation during implementation but restored vegetation would be expected within a 1-year period. Activity disturbances would be localized, of short duration, and low intensity and may affect individual birds but would not affect the overall distribution or reproduction of the species. Restoring habitats toward historic conditions and increasing water yield across the forest to improve marsh, pond, or lake habitat can increase prey base for peregrine falcons, resulting in an indirect beneficial effect. **Specific to alternative C**: Increased acres of grassland restoration would have a greater beneficial effect to peregrine prey. Constructing weirs that would impact up to 3 acres would not have a discernible impact to prey species habitat at the project level. **Specific to alternative D**: The alternative produces the lowest response of understory biomass. The reduced understory biomass would result in fewer habitats for peregrine prey. **Specific to alternative E:** The lack of savanna and reduced grassland restoration treatments limit understory response and therefore limit habitat for peregrine prey. Alternative E mechanically treats the least amount of grassland and savanna habitats with the second lowest response of understory biomass of all the action alternatives limiting prey and resulting in indirect negative effects to peregrine falcon. **Cumulative Effects**: The area analyzed for cumulative effects is grassland, savanna and riparian habitat within the 988,764-acre project area and within ½ mile of the project boundary. The temporal timeframe for cumulative effects is 10 (short-term) to 30 (long-term) years. Under all alternatives, there would be an additive indirect effect from activities that modify vegetation. Projects wildlife report, appendix 17) where thinning and burning occurs could affect the prey base on a short-term basis by impacting individuals of prey species due to disturbance of prey species' habitat and harm from fire. However, projects would be implemented at different times and/or different locations, thus disturbances to the prey base would be minimized. Other past, present and ongoing projects have implemented thinning (2,304 acres) and prescribed burning (8,951 acres) in grasslands and prescribed burning (11 springs) and mechanical treatment (6 springs) improving habitats for peregrine prey species in the long term. However, alternative A would result in the most stress on meadow and grassland habitats and thus would have the greatest negative contribution to potential grassland habitat. **Effects Determination: Alternatives B, C, D and E may impact individuals, but are not likely to cause a trend to federal listing or loss of viability.**
Western Burrowing Owl (*Athene cunicularia hypugaea)*	In **alternative A**, about 13,440 acres of grassland treatment would occur (wildlife report, appendix 17). In comparison, the action alternatives would include nearly 48,000 to about 104,500 acres of grassland treatments. Tree encroachment and canopy development under existing trees would continue and denser forest conditions would produce lower values in understory biomass (pounds per acre), see appendix 6 of wildlife report. This in turn would lead to less available habitat for prairie dogs and consequently burrowing owls. In **alternatives B-E**, direct effects could occur if motorized equipment runs over above ground nests or burrows. There are no documented nesting burrowing owls on the project area, however potential nesting habitat does exist. While 10-15 percent of the immediate area in grasslands may be disturbed in the short term, the area is expected to quickly be covered with new needle duff and improved herbaceous vegetative cover, improving soil nutrient cycling function and stabilizing soil and maintaining and improving soil productivity in the longer term (more than 2 years) (Soil Resources report). Indirect effects to burrowing owls include effects to owl habitat, owl prey species, or prey species habitat. However, active management in some areas of ponderosa pine forest could potentially affect their habitat, e.g., meadows and grasslands are commonly encroached by pine trees as a result of fire exclusion; restoring these habitats toward historic conditions can increase potential nesting and foraging habitat for western

Species	Alternatives A, B, C, D and E Environmental Consequences (Direct, Indirect, Cumulative)
	burrowing owls. **Specific to alternative C:** Decreases tree encroachment in grasslands by treating 48,206 more acres of grassland, thus decreasing impacts to the larger prairie dog population. Treatments would occur within open linkages providing additional opportunities for Gunnison's prairie dogs to colonize new areas and recolonize areas where trees have encroached previously occupied habitat in Government and Garland Prairie, Kendrick Park and other grasslands. Alternative C elicits the greatest response in understory (appendix 6 of the wildlife report). As a result, the habitat as a whole would be more likely to support a greater prairie dog population in grassland systems in the project area thus supporting more potential owl habitat. **Specific to alternative D**: There would be about 19,923 fewer acres of prescribed fire only, limiting understory response. This alternative provides the least amount and lowest quality of habitat for prairie dogs hence less habitat for burrowing owls. **Specific to alternative E**: The lack of savanna and reduced grassland restoration treatments (on the Coconino NF) limit understory response and therefore limit burrowing owl habitat. Alternative E reduces the acres of potential crown fire by 8 percent however; alternative E mechanically treats the least amount of grassland and savanna habitats with the second lowest response of understory biomass of all the action alternatives limiting prey and resulting in indirect adverse effects to burrowing owl. **Cumulative Effects:** The area analyzed for cumulative effects to burrowing owls encompasses the 988,764-acre project area and the associated prairie dog complexes. The temporal timeframe for cumulative effects is 10 (short-term) to 30 (long-term) years. Alternative A has a cumulative effect of reducing the number of grassland acres within the project area, as dense forest conditions would continue to place burrowing owl habitat and adjacent habitat at risk of tree encroachment. In all alternatives, activities such as the implementation of the travel management decisions are likely to decrease motorized use in grasslands thus decreasing impacts to prairie dog populations. This combined with forest restoration activities (alternatives B-E) could open up more habitats or provide more contiguous swaths of grassland habitat key to supporting thriving prairie dog colonies. Past projects (wildlife report, appendix 17) have implemented thinning on 2,304 acres and prescribed fire on 8,951 acres in grasslands. Short-term and localized effects from mechanical thinning and prescribed fire would result in the potential collapsing of burrows and displacement of prairie dogs. This impact may combine with short-term cumulative impacts from localized dispersed camping, wildfire, and wildfire suppression activities to temporarily displace prairie dog populations (and thus burrowing owls) in a limited area. The thinning of 2,340 acres and prescribed fire on 8,950 acres in grasslands would add to the acres of treatments in this project to reduce tree densities in grasslands and connect open corridors across the analysis area providing additional potential habitat for burrowing owls. **Effects Determination: Alternatives B, C, and D would have no impact to burrowing owls. Alternative E may impact burrowing owl, but is not likely to cause a trend to federal listing or loss of viability.**
Mammals	
Navajo Mogollon Vole *(Microtus mogollonensis Navaho)*	Under **alternative A**, meadows would not be rehabilitated under this project. About 13,440 acres of grassland thinning and burning would occur due to current and future foreseeable projects (wildlife report appendix 17). Vegetation would continue to grow and fuel would continue to accumulate, continuing to have negative effects to vole habitat. Under **alternatives B through E** thinning and prescribed fire activities may disturb individual voles, resulting in direct adverse effects. Prescribed fire would result in the removal of cover and food; however, it is anticipated that meadows and open areas would rebound afterwards, with more vigorous herbaceous vegetation and healthier understory habitats. Such activities would occur across the project area at different times; thereby reducing impacts to this species. The effect would be short-term and would have no impact to the population viability of voles. Decommissioning of roads means more snags would be available in the future within vole habitat. Springs and channel restoration would have short-term disturbance to vegetation limiting habitat for the vole; however vegetation would be expected to recovery within a year, increasing availability of food for small mammals over the long term, resulting in indirect beneficial impacts.

Species	Alternatives A, B, C, D and E Environmental Consequences (Direct, Indirect, Cumulative)
	Alternative C would improve the most habitat as it adds 48,206 acres of grassland restoration treatments and restores larger grasslands such as Garland and Government Prairie where voles are known to occur. **In alternative D**, the lack of prescribed fire after thinning would deteriorate patterns of surface vegetation, as shrubs and other species adapted to fire decline (Huffman and Moore 2004, Moir 1988). Landscape patterns and mosaics that would have been created or maintained with fire would have to be maintained mechanically. Alternative D provides the lowest response of understory biomass. In **alternative E** the lack of savanna and grassland restoration treatments on the Coconino NF would limit understory response and therefore limits vole habitat. It results in the second lowest response of understory biomass of all the action alternatives limiting prey and resulting in indirect adverse effects to the vole. **Cumulative Effects:** The cumulative effects boundary is the 988,764-acre project area. The temporal timeframe for cumulative effects is 10 (short-term) to 30 (long-term) years. Activities that impact the vole include fuels reduction, forest health, aspen regeneration, tornado rehabilitation and powerline development and maintenance. Past and ongoing grassland activities include 8,951 acres of prescribed fire and 2,034 acres of mechanical treatments. Short-term impacts added to similar impacts from nearby projects were considered. Implementation of other project activities could occur simultaneously however, it is not anticipated to combine to cause a negative effect. All alternatives could increase potential habitat quality and quantity and reduce risk of uncharacteristic, high-severity wildfire. This positive effect would be combined with similar effects from activities such as the implementation of the travel management efforts that may decrease the frequency of disturbance on the majority of potential roost sites, slightly counteracting the effects of utility line and road reconstruction and maintenance, and short-term disturbances from vegetation management and prescribed fire. Short-term and localized effects from mechanical thinning, temporary road construction, and prescribed fire would result in the temporary reduction of understory vegetation and soil compaction. This impact may combine with short-term cumulative impacts from localized dispersed camping, wildfire and wildfire suppression activities, ungulate grazing, and drought from climate change to alter availability of both food and cover for voles and temporarily displace voles in a limited area. Livestock are managed in systems designed to allow forage a chance to recover from livestock grazing, reducing the potential for cumulative effects. However wild ungulates would continue to reduce vegetative understory and affect plant composition. **Effects Determination: Alternatives B, C, D and E may impact the Navajo Mogollon vole, but is not likely to cause a trend to federal listing or loss of viability.**
Western Red Bat *(Lasiurus blossevillii)*	In **alternative A** habitat would continue to exist for this species, however, the high fire hazard potential would persist, and a large, uncharacteristically severe wildfire event could have the potential to affect individuals. Acres of grassland in FRCC1 would decrease in the absence of treatments beyond the 13,440 acres of grassland thinning and burning resulting from the continuation of current and future foreseeable projects (wildlife report appendix 17). At the landscape scale, woody species would continue to encroach into openings and species composition shift in favor of less fire adapted species. **Alternatives B through E** thinning and prescribed fire could potentially disturb red bats if they are roosting in trees or hibernating among leaf litter. However, most prescribed fire would occur in the spring and fall and burn plans within ½ mile of known roosts/hibernacula would be designed to limit smoke at critical times (April through July and mid-winter). There would be a slight short-term decrease in snags followed by an increase over the long-term. The short-term loss of snags is not expected to affect the overall distribution of western red bats on the Forests. Prescribed fire would result in the removal of cover and food; however, it is anticipated that meadows and open areas would rebound afterwards, with more vigorous herbaceous vegetation and healthier understory habitats. This would enhance prey habitat. Restoring openings and edge habitat within the forest and improving understory vegetation that would benefit bats and their prey. Moving these habitats toward historic conditions would increase habitat resiliency and decrease the risk of uncharacteristic, high-severity wildfire. Spring and channel restoration would improve riparian vegetation, increasing availability of food for prey species over the long-term, resulting in indirect beneficial effects. **Cumulative Effects:** The area analyzed for cumulative effects for western red bat is the 988,764-acre project area. The temporal timeframe for

Species	Alternatives A, B, C, D and E Environmental Consequences (Direct, Indirect, Cumulative)
	cumulative effects is 10 (short-term) to 30 (long-term) years. Short-term impacts added to similar impacts from other past, present and reasonably foreseeable projects were considered for all alternatives. Implementation of other fuel reduction project activities could occur simultaneously; however, it is not anticipated to combine to cause a negative effect. Ungulate grazing within the project area reduces understory vegetation, which reduces plant availability to adult insects, a primary food source. Generally, grazing systems are managed on a rotational grazing system to allow forage a chance to recover from livestock grazing, reducing the potential for cumulative impacts. However wild ungulates would continue to reduce vegetative understory and affect plant composition in meadows and around waters. Cumulatively, alternative A would have the most negative effect. Degradation of habitat would cumulatively combine with other Forest activities, high-impact recreational use, livestock grazing, use of non-jurisdictional roads, habitat loss and degradation on private lands and climate change would continue to fragment key roosting and foraging habitat. Prescribed burning treatments in adjacent projects and grazing may result in short-term impacts to habitat, but these are not expected to result in long-term cumulative impacts and are expected to be localized in nature. This alternative would result in the most stress on meadow, grassland and ponderosa pine habitats and thus would have the greatest negative contribution to potential western red bat habitat. In alternatives B-E, short-term impacts added to similar impacts from other past, present and reasonably foreseeable projects were considered. Implementation of other fuel reduction project activities could occur simultaneously; however, it is not anticipated to combine to cause a negative effect. **Effects Determination: Alternatives B, C, D and E may impact the western red bat, but is not likely to cause a trend to federal listing or loss of viability.**
Spotted Bat *(Euderma maculatum)*	In **alternative A**, about 13,440 acres of grassland treatment due would continue to be implemented (wildlife report appendix 17). However, the high fire hazard potential would persist, and a large, uncharacteristically severe wildfire event could have the potential to affect individuals. In **alternatives B through E** prescribed fire occurring when bats are rearing young (April through July) or in deep hibernation (mid-winter) can have negative effects on local populations. However, most prescribed burning would occur in the spring and fall and burn plans within ½ mile of caves, mines or cliff habitats would be designed to limit smoke at critical times (April through May and mid-winter). Other effects from prescribed fire are the same as described for the greater western mastiff bat. **Alternative C** treats the most acres and elicits the greatest response in understory and the greatest availability of food for bats. Alternative D produces the lowest response of understory biomass of all the action alternatives limiting prey and resulting in indirect adverse effects to spotted bat. In alternative E the lack of savanna and grassland restoration treatments on the Coconino NF would limit understory response and therefore limits prey habitat. It results in the second lowest response of understory biomass of all the action alternatives limiting prey and resulting in indirect adverse effects to spotted bat. **Cumulative Effects:** The area analyzed for cumulative effects for spotted bat is the 988,764-acre project area. The temporal timeframe for cumulative effects is 10 (short-term) to 30 (long-term) years. Current, ongoing and reasonably foreseeable projects include fuels reduction, forest health, aspen regeneration, tornado rehabilitation and powerline development and maintenance (wildlife report, appendix 17). Past and ongoing grassland activities include 8,951 acres of prescribed fire and 2,034 acres of mechanical treatments. Alternative A would not create disturbance to roosting habitat nor would it improve foraging habitat within the project area. In alternatives B-E there may be the potential for short-term disturbance to potential foraging and roosting habitat with long-term benefits. Short-term disturbance to bats would occur during thinning, hauling, and prescribed fire activities and may cause disturbance in nearby areas for the duration of the activity. These short-term impacts added to similar impacts from other past, present and reasonably foreseeable mechanical vegetation management and fuels reduction projects were considered. Implementation of other vegetation management and fuel reduction project activities could occur simultaneously; however, it is not anticipated to combine to cause a negative effect. Ungulate grazing would continue within the project area reducing understory vegetation. Generally, grazing systems are managed on a rotational grazing system to allow forage a chance to recover from

Species	Alternatives A, B, C, D and E Environmental Consequences (Direct, Indirect, Cumulative)
	livestock grazing, reducing the potential for cumulative impacts. However wild ungulates would continue to reduce vegetative understory and affect plant composition in meadows and around waters. **Effects Determination: Alternatives B, C, D and E may impact spotted bat, but is not likely to cause a trend to federal listing or loss of viability.**
Allen's Lappet-browed Bat (*Idionycteris phyllotis)*	In **alternative A** only current and foreseeable projects would continue with combined treatment acres totaling about ½ or less of most of the 4FRI action alternatives (wildlife report appendix 17). Habitat would still exist for this species, however, the high fire hazard potential would persist, and a large, uncharacteristically severe wildfire event could have the potential to affect individuals. Most of the forested area within the project area is in a moderately closed or closed canopy condition. Under alternative A, grasslands and forest openings would not be restored, thus there would be reduced foraging habitat. In **alternatives B through E** thinning and prescribed fire activities could potentially disturb bats if they are roosting in trees within treatment areas. Most prescribed fire would occur in the spring and fall and burn plans within ½ mile of known roosts/hibernacula or un-surveyed caves and mine shafts would be designed to limit smoke at critical times (April through May and mid-winter). Prescribed fire may also result in the loss of individual snags which could affect roosting bats; however, mitigation including managing for retention of all snags 18 inches in diameter and greater would reduce the impact. There would be a slight short-term increase in snags followed by a continuing increase over the long-term. Prescribed fire would result in the removal of cover and food; however, it is anticipated that meadows and open areas would rebound afterwards, with more vigorous herbaceous vegetation and healthier understory habitats. The reduction of dense forest canopy and increased growth in the herbaceous vegetation would result in indirect beneficial impacts to bats. Increasing diversity and density of understory vegetation provides habitat for prey population. Treatments would aid in restoring openings and edge habitat that would benefit bats and their prey. Moving these habitats toward historic conditions would also increase resiliency and decrease the risk of uncharacteristic, high-severity wildfire. Decommissioning of roads means more snags would be available in the future within bat habitat providing more roosting structures. Spring and channel restoration would improve riparian vegetation, increasing availability of food for bats over the long term, resulting in indirect beneficial effects. In alternative E the lack of savanna and grassland restoration treatments on the Coconino NF would limit understory response and therefore limits prey habitat. It results in the second lowest response of understory biomass of all the action alternatives limiting prey and resulting in indirect adverse effects to the bat. Alternative D provides the lowest response of understory biomass. **Cumulative Effects**: The area analyzed for cumulative effects is the 988,764-acre project area. The temporal timeframe for cumulative effects is 10 (short-term) to 30 (long-term) years. Current, ongoing and reasonably foreseeable projects include fuels reduction, forest health, aspen regeneration, tornado rehabilitation, grazing and powerline development and maintenance (wildlife report, appendix 17). In alternative A, degradation of habitat would cumulatively combine with other forest activities, including high-impact recreational use, livestock grazing, use of non-jurisdictional roads, habitat loss and degradation on private lands, and climate change would continue to fragment key roosting and foraging habitat. Prescribed burning treatments and grazing may result in short-term impacts to habitat, but these are not expected to result in long-term cumulative impacts and are expected to be localized in nature. Alternative A would result in the most stress on meadow, grassland and ponderosa pine habitats and thus would have the greatest negative contribution to potential Allen's lappet-browed bat habitat. In alternatives B-E short -term disturbance to bats would occur during thinning, hauling and prescribed burning activities and may cause disturbance in nearby areas for the duration of the activity. Roosting and foraging habitat may be reduced in some areas in the short-term. A slight short-term increase in snags (greater than 12 inches diameter) followed by a continued increase over the long-term (with a slight reduction of large snags (greater than 18 inches diameter)) is expected. Implementation of other fuel reduction and restoration project activities could occur simultaneously; however, it is not anticipated to combine to cause a negative effect. Other fuels reduction and restoration projects may also result in cumulative effects of decreased large snags (greater than 18 inches in diameter) into the future. However, decreased fire

Species	Alternatives A, B, C, D and E Environmental Consequences (Direct, Indirect, Cumulative)
	potential, increasing tree growth that results in larger trees and increased snag recruitment would improve the ability of tree roosting bats to locate roost sites across the landscape. Although individual trees may be lost, large snags would be maintained and developed across the landscape to provide roosting habitat. The Slide Fire likely improved habitat. About 86 percent of the area within the fire perimeter was either unburned (6 percent) or burned at low (48 percent) to moderate severity (32 percent). While some potential roost structure was probably lost in the high severity portions of the fire, additional snag recruitment will occur from fire, beetles, and other stressors in the majority of the burned area. The fire likely improved prey habitat. Ungulate grazing within the project area reduces understory vegetation, which reduces plant availability to adult insects, a primary food source. However, grazing systems are generally managed on a rotational grazing system to allow forage a chance to recover from livestock grazing. This would reduce the potential for cumulative impacts. Wild ungulates would continue to reduce vegetative understory and affect plant composition in meadows and around waters. **Effects Determination: Alternatives B, C, D and E may impact Allen's lappet-browed bat, but is not likely to cause a trend to federal listing or loss of viability.**
Pale Townsend's Big-Eared Bat *(Corynorhinus townsendii pallescens)*	Under **alternative A**, only current and foreseeable projects would continue with combined treatment acres totaling about 13,440 acres of grassland treatment due to current and future foreseeable projects (appendix 17). As tree densities become greater there would be less edge habitat thereby reduced foraging opportunities. Marginal foraging habitat would still exist for this species, however, the high fire hazard potential would persist, and a large crown wildfire event could have the potential to affect individuals, resulting in indirect adverse effects. In **alternatives B-E** all known caves would be buffered from thinning treatments within 300 feet of the cave. This would eliminate the potential for damage to the cave from mechanized equipment or increased sedimentation and would eliminate disturbance to Townsend's bats if they are roosting in caves. Thinning and prescribed burning activities could potentially disturb Townsend's bats if they are roosting in trees within the ponderosa pine treatment area. Prescribed burning occurring when bats are rearing young (April –July) or in deep hibernation (mid-winter) can have negative effects on local populations. However, most prescribed burning would occur in the spring and fall and burn plans within ½ mile of known roosts/hibernacula or un-surveyed caves and mine shafts would be designed to limit smoke at critical times (April –May and mid-winter). Prescribed burning may also result in the loss of individual snags which could affect roosting bats; however mitigation including managing for retention of all snags 18 inch diameter and greater prior to prescribed burning would reduce the impact. The proposed decommissioning of roads means more snags would be available in the future within Townsend's big-eared bat habitat providing more roosting structures. Spring and channel restoration would improve riparian vegetation, increasing availability of food for Noctuids and therefore Townsend's big-eared bat over the long term, resulting in indirect beneficial impacts. **In alternative C**, the overall increase in grassland treatments would have a beneficial impact on Townsend's big-eared bat prey resulting in indirect beneficial effects. **Alternative D** produces the lowest response of understory biomass of all the action alternatives limiting prey and resulting in indirect adverse effects to Townsend's big-eared bat. In **alternative E** the lack of savanna and grassland restoration treatments on the Coconino NF would limit understory response and therefore limits prey habitat. It results in the second lowest response of understory biomass of all the action alternatives limiting prey and resulting in indirect adverse effects to pale Townsend's big-eared bat. **Cumulative Effects**: The area analyzed for cumulative effects is the 988,764-acre project area. The temporal timeframe for cumulative effects is 10 (short-term) to 30 (long-term) years. Past and ongoing grassland activities include 8,951 acres of prescribed fire and 2,034 acres of mechanical treatments. Short-term impacts added to similar impacts from other past, present, and reasonably foreseeable projects were considered. Implementation of other fuel reduction project activities could occur simultaneously; however, it is not anticipated to combine to cause a negative effect. Ungulate grazing within the project area reduces understory vegetation, which reduces plant availability to adult insects, a primary food source. Generally, grazing systems are managed on a rotational grazing system to allow forage a chance to recover from livestock grazing, reducing the potential for cumulative impacts. However wild ungulates would continue to reduce vegetative understory and

Species	Alternatives A, B, C, D and E Environmental Consequences (Direct, Indirect, Cumulative)
	affect plant composition in meadows and around waters. Travel management implementation has reduced the number of roads near Townsend's big-eared bat roost locations. **Effects Determination: Alternatives B, C, D and E may impact may impact pale Townsend's big-eared bat, but are not likely to cause a trend to federal listing or loss of viability.**
	Plants
Arizona Bugbane *(Cimicifuga arizonica)*	In **alternative A**, tree density and canopy stands would remain overstocked. There would continue to be a reduction or loss of understory vegetation and therefore, a loss of understory services (see wildlife report, appendix6). Fire hazard would remain high. Severe fire events could adversely affect the habitat and populations of Southwestern Region sensitive plants by damaging soil, killing existing plants and by reducing or destroying the seed bank. Post-fire noxious or invasive weeds would also increase and contribute to the degradation of the habitat and loss of individuals and groups of Southwestern Region sensitive plants. Dead and down fuels would continue to increase, which in turn could negatively affect the vigor of Southwestern Region sensitive plants by increasing the amount of shade and litter (see Vegetation Report). In **alternatives B-E** direct and indirect effects from fire may include loss of plants or the loss of shade from alteration of ponderosa pine stands on upland habitats. These effects would be mitigated to protect the shady environment needed by Arizona bugbane (FEIS, appendix C.). In response to the Slide Fire in 2014, mitigation was developed to determine whether treatment would be allowed to occur in the future (FEIS, appendix C). Some populations of bugbane occur within Mexican spotted owl (MSO) habitat. These areas would be subject to the restrictions for MSO, including seasonal restrictions during the summer months, which coincide with the growing season of the plants. The mitigations for MSO may indirectly benefit bugbane. Management actions would increase the risk of invasion from noxious or invasive weeds. These effects would be mitigated by incorporating best management practices (FEIS, appendix C) would mitigate the effects of increased disturbance from management activities, and help to control the spread and introduction of weeds within the habitat of Arizona bugbane. **Cumulative Effects:** The cumulative effects boundary is the range of Arizona bugbane within the Coconino and Kaibab NFs. The time limit is from the year 2000 to present. Past impacts include grazing, recreation, wildfire, and natural disturbances such as flooding, drought, tornados, mortality in overstory trees and the recent 2014 Slide Fire. Slide Fire effects to factors such as erosion, flooding and landslides in the future are not known at this time. Natural events have (and continue to) affected the habitat and distribution of Arizona bugbane in some areas. Ongoing and foreseeable vegetation projects have treatments similar to 4FRI (Bill Williams, Turkey/Barney). In alternatives B-E, Impacts to ongoing and foreseeable impacts (vegetation projects, grazing) are mitigated by treatment design; therefore the cumulative effects are nonsignificant. **Effects Determination: Alternatives B, C, D and E may impact individuals of Arizona bugbane (Cimicifuga arizonica) but is not likely to result in a trend toward federal listing or loss of viability.**
Rusby Milkvetch *(Astragalus rusbyi)*	The effects for **alternative A** are described in the summary of effects. **Alternatives B, C, D and E** direct effects include the immediate loss of individual plants or population groups through management actions. In the long term, there would be benefits from reduced competition and increased amounts of sunlight and nutrients. Burning is a disturbance that can release nutrients, reduce plant competition, and increase the amount of available sunlight light. Survey and mitigation would reduce the risk of increased noxious or invasive weeds and damage or loss from springs, channels, road activities. **Cumulative Effects:** The cumulative effects boundary is the range of Rusby milkvetch which is confined to the volcanic fields of the San Francisco Peaks, approximately 1, 152,000 acres (Priest et al. 2001). Only a portion of this area, the ponderosa pine forest, is suitable habitat. Several large wildfires have occurred in the project area; but cumulatively, this represents less that 5 percent of the available habitat. Implementation of travel management on both forests combined with such actions as road decommissioning in this project would reduce the impacts of vehicle traffic in the habitat of Rusby milkvetch. Implementation will continue in projects (such as Hart Prairie, Wing Mountain,

Species	Alternatives A, B, C, D and E Environmental Consequences (Direct, Indirect, Cumulative)
	Frenchy, and Pomeroy) in the range of Rusby milkvetch. The Flagstaff Watershed Protection Project is currently under analysis. The areal extent of the project is similar to that of the Mount Elden Dry Lake Hills trail project. Numerous locations of Rusby milkvetch were documented in the project area during pre-implementation surveys in 2013. The cumulative effects for alternative A are described in the summary of effects. In alternatives B-E other actions including grazing and foreseeable trail construction (Mt Elden, Dry Lake Hills) when combined with 4FRI would continue to occur in the range of Rusby milkvetch and continue to affect it. Cumulatively, none of these actions would lead to a trend toward federal listing. **Effects Determination: Alternatives B, C, D and E may impact individuals of Rusby milkvetch but are not likely to result in a trend toward federal listing or loss of viability.**
Arizona Leatherflower (*Clematis hirsutissima var. hirsutissima***)**	The effects for **alternative A** are described in the summary of effects. With mitigation, **alternatives B through E** direct and indirect effects are similar to those for Rusby milkvetch. **Cumulative Effects:** The cumulative effects boundary is the occupied habitat within the 988,764-acre project boundary. The timeframe for cumulative effects is 2007 when the species was returned to the Southwestern Region's sensitive species list after being absent from it for nearly 10 years Past actions such as grazing, fire suppression, wildfires, timber, recreation, and plant collecting have occurred and have contributed to existing condition; however, effects of high-severity fire are unknown. Actions on non-forest lands may have affected the occurrence and distribution of Arizona leatherflower in other areas. Many areas in and near Flagstaff that provided potential habitat for the plants have been altered or developed, making the habitat no longer suitable. At least one population on private land was destroyed during a road realignment project. Implementation of travel management combined with project road decommissioning would reduce the impacts of vehicle traffic in the habitat. The cumulative effects for alternative A are described in the summary of effects. In alternatives B-E implementation of prescribed fire projects (Skunk RX Burn) and trail projects near known populations and the continuation of grazing and potential wildfire when combined with 4FRI actions within the habitat and would continue to affect it. None of these actions would lead to a trend toward federal listing. **Effects Determination: Alternatives B, C, D and E may impact individuals of Arizona leatherflower but are not likely to result in a trend toward federal listing or loss of viability.**
Cliff Fleabane (*Erigeron saxatilis***)**	Within the project area, cliff fleabane occurs on steep or vertical cliff faces. Locations for this species within treatment units are shown in table 9 of the botany report. No silviculture treatments are proposed for any of these units. One of the locations above is on a steep slope greater than 40 percent and the others are within Mexican spotted owl PACs. Additionally, the habitat for it is steep cliffs and bedrock boulders. It is unlikely that there would be enough fuel accumulated to allow fire to enter the areas where this species grows. No management (**alternative A**) or the management actions proposed in **alternatives B-E** are likely to affect individuals or habitat of cliff fleabane. With no direct or indirect effects there would be no cumulative effects. **Effects Determination: The four forest restoration initiative would not affect individuals of Cliff fleabane. The habitat for this species is on steep canyon walls and is not likely to be affected by management actions.**
Flagstaff Pennyroyal (*Hedeoma diffusum***)**	The effects for alternative A are described in the summary of effects. With mitigation, the direct and indirect effects of alternatives B through E are similar to those discussed for Rusby milkvetch. Mitigation measures (FEIS, appendix C) would be incorporated into implementation to reduce effects to nonsignificant levels. **Cumulative Effects:** The spatial boundary is the range of Flagstaff pennyroyal in the project area including the areas roughly from Flagstaff, east to Marshall Lake and Fisher point, then south to the vicinity of Mountainaire, then to Lower Lake Mary on the Coconino

Species	Alternatives A, B, C, D and E Environmental Consequences (Direct, Indirect, Cumulative)
	NF and a limited amount of habitat along the edge of Sycamore on the Kaibab NF The cumulative effects timeframe is from 2000 to present.. Activities on non-forest lands in suitable habitat have reduced about 10 percent of the total historical range. The species occurs in several recently analyzed or implemented fuels reduction projects (including Kachina 2003, Mountainaire 2006, Elk Park 2007, see botany report for complete information). These projects covered about 75 percent of the total acreage of the potential habitat managed by the Coconino NF. These projects did not adversely affect the abundance or distribution of Flagstaff pennyroyal and when combined with the effects of this project, would not adversely affect this species. About 831 acres of prescribed fire would occur (foreseeable) in the Skunk project (Coconino NF) and 20, 197 acres would occur on the Eastside project (Coconino NF). In past and foreseeable projects, effects to Flagstaff pennyroyal were mitigated or would be mitigated to nonsignificant levels. Other ongoing and foreseeable actions include dispersed recreation and new motorized trails. The Kelly Trails system (Coconino NF) was analyzed in 2012. Effects to Flagstaff pennyroyal and its habitat were mitigated by design features such as building or rerouting existing trails into areas of no concern. The cumulative effects for alternative A are described in the summary of effects. The ongoing and foreseeable projects, when combined with 4FRI actions, would not result in measurable cumulative impacts. Any impact would be nonsignificant. Implementation of travel management decisions on both forests when combined with such actions as road decommissioning in this project would reduce the impacts of vehicle traffic in the habitat of Flagstaff pennyroyal. **Effects Determination: Alternatives B, C, D and E may impact individuals of Flagstaff pennyroyal but are not likely to result in a trend toward federal listing or loss of viability.**
Arizona Sneezeweed (*Helenium arizonicum*)	This species occurs in ephemeral drainages in the Upper Lake Mary watershed. Numerous groups were detected in the Antelope Park area in 2011. There are no known locations of Arizona sneezeweed on the Kaibab NF. There are no documented occurrences of Arizona sneezeweed in any of the areas scheduled for spring and channel restoration. The effects for alternative A are described in the summary of effects**. In alternatives B-E**, mitigation measures and design features focus on surveying these areas before implementation. Other mitigations and design features, specifically 13, 14 and 15 (botany report) would mitigate effects from spring and channel restoration to this species. Other direct and indirect effects to Arizona sneezeweed are similar to those for Rusby milkvetch. With mitigation (see botany report) effects would be reduced to nonsignificant levels. **Cumulative Effects:** The boundary includes the range of Arizona sneezeweed within the 988,764-acre project area which is roughly the area from the Mormon Lake area southward to the project boundary. The cumulative effects timeframe is from 1999 (when the species was added to the Southwestern Region's sensitive species list) to present. Past natural events such as persistent drought that began in 1996 and lasted for over 10 years probably affected the abundance and distribution of the species due to its affinity for moist soil. The drought compounded such effects as fire severity and impacts from grazers seeking water sources, which decreased in availability during the drought (see climate change section for additional information). Alteration of habitat through diversion of water for use to water animals might have also affected the habitat. There have been no past fuels reduction projects in the area where Arizona sneezeweed was documented during surveys. Upper Beaver Creek Watershed Fuels Reduction Project (2010) contains many locations of Arizona sneezeweed. Portions of the project area will used as 4FRIshelf stock. Management activities analyzed in the Upper Beaver Creek Area are similar to those for this project, including tree removal, fuels reduction and burning. Effects to Arizona sneezeweed were mitigated through several resources including botany, watershed, timber and fire. The Kelly Trails system (Coconino NF) was analyzed in 2012. Effects to Flagstaff pennyroyal and its habitat were mitigated by design features such as building or rerouting existing trails into areas of no concern. Other ongoing and foreseeable actions include dispersed recreation and new motorized trails. The cumulative effects for alternative A are described in the summary of effects. In alternative B-E, when ongoing and foreseeable actions

Species	Alternatives A, B, C, D and E Environmental Consequences (Direct, Indirect, Cumulative)
	are combined with 4FRI actions, there would be no measurable cumulative impacts. Any impact would be nonsignificant. Implementation of travel management decisions on both forests when combined with such actions as road decommissioning in this project would reduce the impacts of vehicle traffic in the habitat of Arizona sneezeweed. **Effects Determination: Alternatives B, C, D and E may impact individuals of Arizona sneezeweed but are not likely to result in a trend toward federal listing or loss of viability.**
Sunset Crater Beardstongue (*Penstemon clutei*)	There are numerous locations of Sunset Crater beardtongue in the northeast corner of the project area. Many of these are in treatment units where burning or operational burning would occur. Some units will be treated using the grassland restoration or grassland mechanical prescriptions. The effects for alternative A are described in the summary of effects**.** In **alternatives B, C, D and E** a few units would be treated using the grassland restoration or grassland mechanical prescriptions. In those units, the effects would be similar to mechanical treatment for other species such as Rusby milkvetch (discussed above). Treatments in any specific unit containing Sunset Crater beardtongue may vary by alternative (see table 12 in the botany report) but the general effects of management actions are the same for all alternatives. **Cumulative Effects:** The cumulative effects boundary is the potential habitat of the Sunset Crater beardtongue, which is an endemic and occurs only in the Sunset Crater volcanic field of the Coconino National Forest and Sunset Crater National Monument. Sunset Crater beardtongue does not occur on the Kaibab National Forest. The temporal timeframe for cumulative effects is from 1973 (when the effects of fire to Sunset Crater beardtongue were first noted by a former Coconino NF wildlife biologist) to present. In 1992, a tornado occurred within the habitat and a subsequent salvage sale occurred. Monitoring in 1996 project found no adverse effects from the storm or the salvage sale. Two fuels reduction projects (Eastside 2006) and Jack Smith/Schultz (2006) are ongoing but are not directly affecting the species due to the small portions of the habitat affected and actions are limited prescribed fire. Several large wildfires have occurred in the habitat (Burnt Fire (1973), Wild Bill Fire (1993), Hochderffer (1996), Cinder Hills Fire (2009), and Schultz Fire (2010). The Schultz Fire caused severe environmental damage including flooding and soil erosion, some of which extended into the habitat. Post-fire rehabilitation actions affected some of the potential habitat. The long-term effects on habitat and native plants include noxious or invasive weed invasion and continued disturbance of the habitat. However, favorable responses to burning because of the Schultz Fire were observed in 2011 and 2012 and numerous occurrences have been recorded in the areas of the Schultz Fire east of Highway 89. These observations confirm the observations by Goodwin (1979) and support the findings that Sunset Crater beardtongue would benefit from burning. The cinder hills area that contains most of the habitat is heavily used for recreation (ongoing activity). In all alternatives (including no action) the Schultz Fire Sediment Reduction Project (2012) will continue to redirect floodwaters onto Forest Service lands, increasing the risk of noxious or invasive weeds and providing an ongoing source of disturbance. Management actions to mitigate the effects of flooding to private property and redirection of the floodwaters to Forest Service lands is expected to continue for an indefinite period of time. Continued growth in the Doney Park could possibly decrease in the amount of suitable habitat available on non-forest lands. Several utility corridors are present in the potential habitat. The ongoing and foreseeable construction, expansion, and maintenance of these corridors would result in loss of individuals along the corridor routes. The cumulative effects for alternative A are described in the summary of effects. In alternatives B-E, given the baseline condition, ongoing and foreseeable projects/activities when combined with the 4FRI actions that would affect habitat would not significantly impact the habitat or the species. **Effects Determination: Alternatives B, C, D and E may impact individuals of Sunset Crater beardtongue but are not likely to result in a trend toward federal listing or loss of viability.**

Species	Alternatives A, B, C, D and E Environmental Consequences (Direct, Indirect, Cumulative)
Flagstaff Beardtongue *(Penstemon nudiflorus)*	There are several locations of Flagstaff beardtongue in the project area. See table 13 in the botany report for documented locations and proposed treatments. The effects for alternative A are described in the summary of effects**.** The direct and indirect effects of **alternatives B, C, D and E** are similar to those for Rusby milkvetch. Mitigation and design features would reduce effects to nonsignificant levels. There are no documented occurrences of Flagstaff beardtongue in areas being analyzed for spring and channel restoration so there would be no direct or indirect effects from those actions. **Cumulative Effects:** The cumulative effects area is the 988,764-acre project boundary The cumulative effects temporal timeframe is from 1999 to present. This represents the length of time that Flagstaff beardtongue has been on the Southwestern Region's sensitive species list.. Past fuels projects occurred in approximately 10 percent of the cumulative effects area and did not adversely affect the abundance or distribution of the species. The total acreage of several large fires that have occurred within potential habitat is about 10, 500 acres which represents less than 10 percent of the potential habitat. Severe wildfires can potentially destroy plants and alter habitat, but the effects of these fires on Flagstaff beardtongue and its habitat are unknown. Impacts from ungulate grazing in certain areas include past and present loss of individual plants and alteration of habitat through trampling and compaction. Dispersed recreation is an ongoing activity that occurs in the habitat. Several utility corridors are present in potential habitat. Construction, expansion, and maintenance of these corridors would result in loss of individuals along the corridor routes. The cumulative effects for alternative A are described in the summary of effects**.** In alternative B-E, implementation of travel management decisions on both forests when combined with such actions as road decommissioning in this project would reduce the impacts of vehicle traffic in the habitat. Past, present and foreseeable actions when combined with 4FRI actions would have no adverse effects in short or long term because they would not lead to a significant decrease in habitat or number of plants present in the project area. **Effects Determination: Alternatives B, C, D and E may impact individuals of Flagstaff beardtongue but are not likely to result in a trend toward federal listing or loss of viability.**
Arizona Phlox (*Phlox amabilis*)	Arizona phlox was added to the Southwestern Region sensitive species list in 2013. Therefore, the forests have not conducted specific surveys for it in the past. The occurrences discussed (botany report, table 14) were derived from SEINet, an on-line database of collections and observations from several herbaria. There may be additional undetected occurrences within the project area. The effects for alternative A are described in the summary of effects**.** Alternatives B through E direct and indirect effects are similar to those for Rusby milkvetch and include death or destruction of groups or individuals through management activities. These direct effects **of alternatives B-E** would be mitigated by following mitigations and design features displayed in the botany report. Effects would be reduced to nonsignificant levels. **Cumulative Effects:** There is no information about the cumulative effects of management actions on Arizona phlox in the project area since the species was added to the Southwestern Region sensitive species list in 2013 and the effects to it were not considered in past analyses. The effects of management activities (all alternatives) are likely similar to those for the other Southwestern Region sensitive species. **Effects Determination: Alternatives B, C, D and E may impact individuals of Arizona phlox (*Phlox amabilis)* but is not likely to result in a trend toward federal listing or loss of viability.**
Blumer's Dock (*Rumex orthoneurus*)	The effects for alternative A are described in the summary of effects**.** In **alternatives B, C, D and E** most effect would be the direct losses of individuals from management actions. Mitigation measures displayed in the botany report would reduce effects to nonsignificant levels.

Species	Alternatives A, B, C, D and E Environmental Consequences (Direct, Indirect, Cumulative)
	Cumulative Effects: The cumulative effects boundary is the 988,764-acre project area. The cumulative effects timeframe is from 1991, when the nearby Tonto NF prepared a management plan for Blumer's dock, to the present. Persistent drought in the northern Arizona area that began in 1996 and lasted for over 10 years probably affected the abundance and distribution of Blumer's dock due to its affinity for wet areas. The drought compounded such effects as fire severity and impacts from grazers. Several utility corridors are present in the potential habitat of Blumer's dock. The presence of these corridors provides corridors for dispersal of noxious or invasive weeds along the utility corridor and in adjacent forested areas. These past events have formed the baseline for the current existing condition Dispersed recreation is an ongoing activity that occurs in certain areas the habitat. Management activities that were analyzed as part of the Hart Prairie project (2010) will continue to be implemented including several activities in or near the Hart Prairie Preserve and Fern Mountain Botanical Area. Ongoing activities include construction and/or reconstruction of several enclosures that will provide refugia for Blumer's dock. Construction, expansion, and maintenance of utility corridors would result in loss of individuals along the corridor routes. The cumulative effects for alternative A are described in the summary of effects**.** When alternatives B, C, D and E activities are combined with ongoing and foreseeable activities, the result is expected to have minor but beneficial effects to the habitat. **Effects Determination: Alternatives B, C, D and E may impact individuals of Blumer's dock but are not likely to result in a trend toward federal listing or loss of viability.**
Bebb's Willow (*Salix bebbiana*	The largest population of Bebb's willow on the Coconino National Forest occurs in the Hart Prairie area, which has approximately 1300 plants (see botany report for additional information). There are no documented locations of Bebb's willow within the project area on the Kaibab NF but Bebb's willows may be present in some areas such as around springs and channels. These areas would be surveyed before implementation and mitigation measures and design features would be incorporated as needed (FEIS, appendix C). The effects for alternative A are described in the summary of effects**.** In alternatives B, C, D and E the most significant effect to Bebb's willow from management actions is direct losses of individual. With mitigation and design features displayed in the botany report and appendix C in the FEIS) effects would be reduced to nonsignificant levels. **Cumulative Effects:** The cumulative effects boundary is the Coconino NF portion of the project area. The temporal timeline is from 1987 (with the publication of the Coconino NF forest plan) to the present. Cumulative effects to Bebb's willow on the Kaibab NF were excluded from this discussion because there are no documented occurrences in the Kaibab portion of the project and Bebb's willow has no special status on the Kaibab NF. Fern Mountain Botanical Area (186 acres) is dominated by Bebb's willow and represents a unique riparian community. Approximately 1,300 Bebb's willow plants occur in the Hart Prairie area in the botanical area and the Hart Prairie Preserve. Past management actions, including the establishment of the botanical area and restoration actions conducted by The Nature Conservancy and the Forest Service, represents the baseline (existing condition) for the species. Management activities that were analyzed as part of the Hart Prairie project (2010) will continue to be initiated including several activities in or near the Hart Prairie Preserve and Fern Mountain Botanical Area. Ongoing activities include construction and/or reconstruction of several enclosures that would provide refugia for Bebb's willow, which would improve the distribution of age classes. The Apache Maid Allotment analysis, which is a concurrent but unrelated analysis, includes the Railroad Spring area. Spring restoration sites in the project may provide locations and opportunities for Bebb's willow restoration. The cumulative effects for alternative A are described in the summary of effects**.** In alternatives B-E, given the baseline condition, ongoing and foreseeable projects when considered with 4FRI actions would be beneficial to habitat and populations. **Effects Determination: Alternatives B, C, D and E may impact individuals of Bebb's willow but are not likely to result in a trend toward federal listing or loss of viability.**

Northern Goshawk

This analysis addresses policy requirements and responds to key issues raised by the public including Issue 2, Conservation of Large Trees and Issue 3, Canopy Cover and post-treatment landscape open-ness in the context of impacts to goshawk and post-treatment viability. Metrics used to evaluate impacts are described in Environmental Consequences. This report utilizes and incorporates by reference the vegetation cover type and vegetation existing condition information provided in the silviculture report (McCusker et al. 2014) and the respective forestwide management indicator species reports.

Summary of Habitat Condition

The existing and desired conditions for forest structure and vegetation features relevant to prey species in goshawk habitat are summarized in chapter 1 of this FEIS. However a recent wildfire on the Coconino NF did change habitat conditions on 2,600 acres of goshawk habitat. The Slide Fire (2014) burned 2,600 acres of goshawk habitat within the 4FRI boundary, affecting the Casner Canyon PFA and dispersal PFA 23. Within the 4FRI area, Casner Canyon PFA represents 1.7 percent of PFAs and dispersal 23 represents 5.5 percent of dispersal PFAs in the analysis area.

Vegetation burn severity was assessed using RAVG (Rapid Assessment of Vegetation Condition) and soil burn severity was assessed using BARC (Burned Area Reflectance Classification). The majority of fire effects in the Casner Cabin PFA were in the low soil burn severity category for both vegetation and soil with about 15 to 20 percent (vegetation, soil) of the PFA in the moderate burn severity category with most of the rest either unchanged or with very low burn severity. Little of this PFA experienced high severity impacts. It would be expected that 124 acres of moderate to high soil burn severity would have increased water repellency as a result of the fire (BAER soil report 2014) and would experience accelerated erosion during precipitation events until the soil repellency layer is broken down and water can infiltrate the soil properly. These acres would recover more slowly than the other burned acres. The low soil burn severity acres would have the majority of the soil layers intact however most of the understory would have been burned. See the wildlife report for details on soil burn severity and basal area mortality by PFA/dPFA.

Analysis Framework

Goshawk habitat was evaluated in terms of PFA/ dPFA and LOPFAs. PFAs are about 600 acres in size (including the nest areas, replacement nest areas, and habitat most likely to be used by fledglings during early development. Dispersal PFAs are approximately 600 acre areas that could potentially support nesting goshawks but have not been surveyed. The Coconino forest plan (USDA FS 1987) and the Kaibab forest plan (USDA FS 2014) have direction to include a minimum of six nest areas and replacement nest areas within each PFA. Nest areas would be about 25 to 30 acres in size (minimally 30 acres (Coconino NF)) and based on active nest sites followed by the most recently used historical nest sites.

The Coconino NF forest plan has a guideline that states that distribution of forest structure should be evaluated at the ecosystem management area level, at the mid-scale, and at the small scale of site. This section analyzes vegetative structural stages, tons per acre of coarse woody debris (greater than 3 inches), tons per acre of logs, snags greater than 18 inch d.b.h., basal area of all trees, percent of max SDI and understory index within LOPFAs and PFA/dPFAs at the subunit scale and restoration unit scale. This section also examines the distribution of vegetation structural stages within individual PFAs.

Treatment types and the acres are described in more detail in the silvicultural report, chapter 1 of this FEIS and in appendix D (implementation plan). Treatment acres by individual PFAs and dPFAs are shown in appendix 9 of the wildlife report. Predicted densities of large logs and coarse woody debris per acre by restoration unit, subunit, and alternative are displayed in appendix 20 of the wildlife report.

Direct and Indirect Effects

Alternative A

There would not be any direct effects from alternative A because there are no actions occurring. Indirect effects, those that cause physical changes to the quantity and quality of the goshawk's habitat and that of its prey species.

Ongoing projects and those that would occur in the foreseeable future could improve age-class distribution and health in goshawk habitat, reduce the threat of uncharacteristic fire, and indirectly improve prey habitat. These include projects such as thinning and/or burning, aspen restoration, re-planting 12 acres of pine in a severely burned area, and about a mile of stream channel restoration. There are about 17,000 acres of thinning and 14,000 acres of burning (grassland, pinyon-juniper), about 5,000 acres of aspen restoration, and 58 miles of road obliteration and/or road closure. See appendix 17 in the wildlife specialist report for more details.

Under the no action alternative, the overall landscape would move toward desired conditions slower than the other alternative. PFAs/dPFAs and LOPFAs would have less age class diversity. Specifically it would have the lowest proportion in grass-forb-shrubs and seedlings and saplings (VSS 1 and VSS 2), the highest proportion in mid-aged forest (VSS 3 and VSS 4) and the lowest proportion in older age classes (VSS 5 and VSS 6) (see wildlife report, pp. 421-422).

Coarse woody debris provides foraging habitat and cover for prey species; contributes to nutrient cycling which is essential for maintaining habitat productivity; and is an element of surface fuels. In the short term (2020), LOPFA and PFA/dPFA habitat in alternative A would have higher amounts of coarse woody debris than alternatives B, C and E and lower amounts than alternative D. In the long term (2050), LOPFA and PFA/dPFA habitat in alternative A would have higher amounts of coarse woody debris than any of the alternatives. This general pattern holds true for the restoration unit and subunit scales.

Logs provide important habitat features for prey species, including substrate for foraging, den and nest sites, and cover. Log density per acre would increase from year 2020 to year 2050 so although alternative A would not meet Coconino NF or Kaibab NF forest plan recommendations of at least 3 large logs per acre in the short term, recommendations from both forest plans would be exceeded in the long term. More logs would be provided in PFA/dPFA versus LOPFA habitat

Snags provide nesting and denning habitat, roosts, and foraging habitat for many bird and mammal species. Snags would be created by density induced mortality among the existing trees on the landscape, primarily from competition resulting from the VSS 3 and VSS 4 trees. In the short term (2020), alternative A would have the lowest density of large snags per acre in PFA/dPFAs. In the long term (2050), there are no differences in the density of large snags between alternatives in PFAs/dPFAs. Snag density would not achieve the recommendations in the Coconino NF forest plan for at least 2 large snags per acre in the short or long term. In the long term, snag density recommendations from the Kaibab NF Plan would be met in PFA/dPFA habitat and nearly meet the low end of an average of 1 to 2 snags per acre (0.95 snags per acre) in LOPFA habitat.

Density was evaluated using stand density index percent of maximum (SDI percent of Max) and basal area of all trees and was considered one of the indicators of the health and sustainability of goshawk habitat. The condition of goshawk habitat (PFA/dPFA and LOPFA) in alternative A is mainly high density or extremely high density in all restoration units and subunits in 2010, increasing by 2020, and increasing again by 2050. A reduction in the number of trees per acre and competition-induced mortality would be likely and could negatively affect the sustainability of existing old growth, and old trees (important for nest trees, prey habitat, and perches).

Density would increase over time in all restoration units in both PFA/dPFA and LOPFA habitat. In PFA/dPFA habitat, Restoration Unit 6 has the lowest densities over time whereas Restoration Unit 4 has the highest. LOPFA has the same Restoration Unit trend and interestingly, Restoration Unit 6 remains at or near moderate density levels through 2020.

At the subunit level in PFA/dPFA habitat, subunit 6-3 has the lowest density over time while subunit 3-5 has the highest density over time. In LOPFA habitat, subunit 5-1 has the lowest density (at or near moderate density in years 2010 and 2020) while subunit 3-5 has the highest.

Alternative A would be considerably less open in PFA/dPFA and LOPFA habitat than alternatives B, C, D, and E due to lack of treatments. Understory biomass would continue to decline in both the PFAs/dPFAs and LOPFAs under alternative A because openings or interspaces would not be created in this alternative and canopy cover would increase over time (wildlife report, appendix 8). This general pattern holds true for the restoration unit and subunit scales. This alternative would result in the lowest amount of expected herbaceous biomass of all the alternatives (figure 32, wildlife report). Consequently, this alternative would be the least beneficial for grasses, sedges and forbs, and cool-season plants which all respond favorably to reductions in overstory density. This would be the least improvement to bird and mammal forage directly and the arthropod community indirectly.

Effects Common to Alternatives B, C, D and E

Roads - About 49 miles of roads would be decommissioned in 57 PFAs/dPFAs in alternatives B, C, D, and E (wildlife report appendix 9). About 41 miles would be decommissioned in PFAs, 7.7 miles in dPFAs, and about 811 miles in LOPFA habitat. This would improve the quality of the habitat in those areas where the roads are decommissioned.

About one third mile of road would be relocated in 7 PFAs/dPFAs. The impacts from relocated roads are similar to those associated with temporary roads and would be expected to occur in small discreet areas. About 31 miles of temporary roads would be constructed (and decommissioned) in PFAs, about 9 miles would be constructed in dPFAs, and about 481 would be constructed in LOPFA habitat. The effects of temporary road construction to goshawk PFA and nest habitat would include removal of trees and understory vegetation along the road alignment, potentially affecting localized prey habitat. Implementing breeding season timing restrictions would eliminate disturbance impacts to nesting goshawks.

While 60 PFAs are identified for treatments, 73 PFAs would have some sort of hauling occurring through the PFA. About 21 percent of the PFAs (15 PFAs) would have less than 1 mile of haul road, 21 percent (15) would have 1 to 2 miles of haul road, and 59 percent (43) would have 2 to about 6 miles of haul roads. With breeding season timing restrictions on the haul routes through all but three of the PFAs, the impact from hauling through the PFAs would be limited to outside of the breeding season when most goshawks are not nesting.

For the majority of the PFAs, timing restrictions would alleviate both disturbance impacts to nesting and breeding behavior as well as the potential for goshawk collision with equipment implementing commercial mechanical treatments during this time period. This would comply with direction in the Coconino forest plan to “limit human activities in or near nest sites and post-fledging family areas during the breeding season so that goshawk reproductive success is not affected by human activities”. It would also comply with a guideline in the Kaibab forest plan “Potentially disturbing project-related activities should be minimized in occupied goshawk nest areas during nesting season of March 1 through September 30”.

In all action alternatives disturbance could occur as a result of project-related activities including moving and operating harvest machinery, hauling forest materials, building fire line, managing prescribed burns, smoke, personnel in the field, and road maintenance and construction. Noise disturbance from project activities may disturb goshawks during the breeding season and negatively affect reproduction. The breeding season is from March 1 through September 30. Design features that would reduce disturbance-related effects include:

- Prescribed burn plans would be designed and implemented to minimize smoke impacts to nesting birds and minimized loss of nest trees, including goshawk nest stands.
- Fuels in goshawk nesting areas will be evaluated and if necessary, will be manipulated outside of the breeding period (March 1 to September 30) to ensure low severity fire effects from prescribed fire.
- Not all harvest activities would occur in occupied PFAs during the breeding season. However, work could potentially occur on a case-by-case basis through coordination with the district biologist if pre-treatment surveys determine they are not occupied.
- Spring and ephemeral drainage restoration projects would not occur in the Barney Spring, Tree Spring, Schultz Pass, Squaw, Marteen, Coxcombs, Pumphouse, Walnut, Faye, Marshall Mesa, Newman, Cherry Canyon , and Monument 36 PFAs during the breeding season (March 1-September 30) if occupied. However work could continue on a case-by-case basis through coordination with the district biologist if pre-treatment surveys have determined they are not occupied or impacts will not affect nesting birds.
- In the 3 PFAs with hauling during the breeding season, logging trucks would not exceed 25 miles per hour when traveling through PFAs during the nesting season.
- Road construction, obliteration, relocation, and maintenance would not occur inside PFAs during the breeding season (March 1-September 30) if occupied.

Post-Treatment Landscape Openness (Issue 3) – Even though there is a shift from more closed to more open conditions in alternatives B, C, D, and E (see discussion, below), tree groups and tree group densities would be managed to meet canopy cover requirements in PFA/dPFA habitat as follows: “Tree group density would be managed to meet the following requirements: canopy cover for mid-aged forest (VSS4) should average 1/3 60+ percent and 2/3 50+ percent. Mature forest (VSS 5) and old forest (VSS 6) should average (50+ percent). 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” (see the Implementation Plan in appendix D in the FEIS).

Eighty-four percent of the PFA/dPFA is estimated to be moderately closed to closed suggesting that understory needed by prey and invertebrates is relatively low in PFA/dPFA habitat. It is somewhat higher in LOPFA habitat. Closed conditions would render the PFA more vulnerable to uncharacteristic fire, density-related mortality, and could compromise the health and sustainability of goshawk habitat. These conditions do not reflect Coconino forest plan guidance to provide healthy, sustainable forest environment for post-fledging family needs. It is compliant with Kaibab NF forest plan direction which allows for denser tree conditions in some locations and higher basal areas in some areas, such as in PFAs. It is expected to meet canopy cover guidelines listed in the Coconino forest plan.

Table 77. Acres and percentage of openness in goshawk habitat by alternative

Habitat	Openness	Existing Acres (Percent)	Alternative B Acres (Percent)	Alternative C Acres (Percent)	Alternative D Acres (Percent)	Alternative E Acres (Percent)
PFA/dPFA 30,015 acres	Very Open	499 (2%)	499 (2%)	499 (2%)	499 (2%)	499 (2%)
	Open	4,271 (14%)	16,441 (55%)	16,103 (54%)	16,441 (55%)	16,103 (54%)
	Subtotal Very Open & Open PFA/dPFA	4,770 (16%)	16,940 (56%)	16,602 (55%)	16,940 (56%)	16,602 (55%)
	Moderately Closed	11,531 (38%)	8,064 (27%)	8,163 (27%)	8,064 (27%)	8,163 (27%)
	Closed	13,714 (46%)	5,010 (17%)	5,250 (17%)	5,010 (17%)	5,250 (17%)
	Subtotal Moderately Closed & Closed PFA/dPFA	25,245 (84%)	13,074 (44%)	21,576 (72%)	13,074 (44%)	21,576 (72%)
LOPFA 367,452 acres	Very Open	14,329 (4%)	66,601 (18%)	66,383 (18%)	66,601 (18%)	14,329 (4%)
	Open	100,639 (27%)	208,903 (57%)	204,797 (56%)	208,903 (57%)	251,360 (68%)
	Subtotal Very Open & Open LOPFA	114,968 31%	275,504 75%	271,180 74%	275,504 75%	265,689 72%
	Moderately Closed	111,840 (30%)	66,379 (18%)	67,045 (18%)	66,379 (18%)	70,069 (19%)
	Closed	140,644 (38%)	25,569 (7%)	29,228 (8%)	25,569 (7%)	31,694 (9%)
	Subtotal Moderately Closed & Closed LOPFA	252,484 (69%)	91,948 (25%)	96,273 (26%)	91,948 (25%)	101,763 (28%)

Prescribed Fire – The effects of burning would be influenced by several factors. These factors include fire intensity, burn season, the life history stage of goshawks during burning, the phenological state of vegetation during burning, fuel loading, fuel composition, and architecture of fuels at the site to be burned. Burning effects would also be related to how similar burning conditions are to the natural fire regime. Knapp et al (2009) provide a good overview of the ecological effects of prescribed fire season. Goshawks and their prey could be directly affected by the heat, flames, and smoke of a fire or indirectly through habitat modification. Animals that live in fire-adapted ponderosa pine forests have presumably developed behavioral adaptations to escape fires or find refugia and allow populations to persist (Knapp et al 2009).

Old and Large (24 inch d.b.h. and greater) Trees – The stakeholder-developed old tree protection strategy was incorporated into all action alternatives, the implementation plan and the monitoring and adaptive management plans. This is beneficial for goshawks because goshawks rely on old (which can be the largest) trees for nesting and perching. There is a design feature that states that trees greater than 24 inches d.b.h. would not be harvested in restricted Mexican spotted owl habitat. Protected habitat has an 18 inch d.b.h. cutting limit. PFA/dPFA and LOPFA habitat overlaps restricted and protected habitat. These diameter limits would benefit goshawks because large trees are used for nesting and perching and are habitat for prey species.

Springs and Ephemeral Channels – Springs and ephemeral channels are inclusions within the mechanical and burn treatment areas. In alternatives B, C, D, and E, there would be a total of 6.2 miles of ephemeral stream channel restoration in 11 PFAs (wildlife report, table 165); restoration of one spring in the Tree Spring PFA (number 030405019); and restoration of 73 springs in LOPFA habitat (wildlife report, table 166). Breeding season timing restrictions would apply to reduce disturbance to nesting goshawks. Up to 4 miles of protective fencing would be established around restored springs. Fencing would have no effect to the vegetation. Bank recontouring and stabilization would occur along 39 miles of ephemeral channels. This activity would disturb existing forest vegetation. Up to 5 miles of willow reestablishment would occur where evidence indicates historic willow presence. This would create vegetation diversity and allow natural willow expansion into adjacent areas of suitable habitat.

Improving springs and restoring ephemeral channels in the action alternatives would improve prey species habitat in those areas where the treatments occur. Implementing breeding season timing restrictions would alleviate disturbance to goshawks during the nesting season during activities.

Alternative B

Alternative B would propose a variety of treatments to move toward desired condition in goshawk habitat. This alternative would treat the third most acres of total goshawk habitat, and LOPFA habitat, compared to the other action alternatives and the second highest amount of PFA and dPFA habitat.

The goshawk habitat structural stage analysis for alternative B in the silvicultural report indicates that overall post treatment VSS distribution in the even-aged goshawk habitats will have good representation of the VSS 1, 3 and 4 age classes, and the VSS 5 age class in the LOPFA; under-representation of the VSS 6 age class and the VSS 5 age class in the PFA; and no representation of the VSS 2 age class. The uneven-aged goshawk habitats will have good representation in the LOPFA of VSS 3, 4, 5 and 6 and of VSS 4 and 5 in the PFA; VSS 1 is underrepresented in the LOPFA and VSS 1, 3 and 6 are underrepresented in the PFA; there is no representation of the VSS 2 age class in all habitats. Overall even-aged stands would trend toward uneven-aged and uneven-aged stands would be maintained as uneven-aged.

Amounts of coarse woody debris in this alternative would increase from year 2020 to year 2050 in both PFAs/dPFAs and LOPFAs so although alternative B would not meet forest plan recommendations in the short term, recommendations would be reached in the long term.

In the short term, neither PFA/dPFA or LOPFA habitat would meet recommendations of a minimum of three large logs per acre in the Coconino forest plan and the Kaibab forest plan. However it would meet these recommendations in the long term in both types of goshawk habitat. Predicted densities of large logs per acre by restoration unit, subunit, and alternative are displayed in appendix 20 of the wildlife report.

Snags created in alternative B would predominantly result from prescribed fire although density induced mortality among VSS 3 and VSS 4 trees on the landscape would be a factor as well. Snag density in PFA/dPFA habitat would meet the recommendations of an average of 1-2 snags per acre in the Kaibab forest plan in the short term and long term. Snag density in LOPFA habitat would nearly meet the Kaibab forest plan recommendations in the short term (average of 0.94 snags per acre) and the long term (average of 0.93 snags per acre).

In alternative B, the stand density index percent of maximum (as an indicator of forest density and forest health) would decline in both PFA/dPFA and LOPFA habitat in the short term (2020) and increase slightly in the long term (2050) though still remaining lower than existing values. In both the short and long term, goshawk habitat under this alternative would be healthier than if no treatment were to occur.

The majority of individual sub-units and restoration units would improve from being in an extremely high density zone (56+ percent) to a moderate density (25-34 percent) or high density (35-55 percent) zone, especially in the short term. By 2050, tree density would increase but not to the extent of current levels. In PFA/dPFA habitat, Restoration Unit 6 would have the lowest densities over time whereas Restoration Unit 1 would have the highest. In LOPFA habitat, Restoration Unit 5 would have the lowest densities and Restoration Unit 1 would have the highest.

This alternative would result in the highest amount of expected herbaceous biomass of all the alternatives. Consequently, this alternative would be the most beneficial for grasses, sedges and forbs, and cool-season plants which all respond favorably to reductions in overstory density. This would be the most improvement to bird and mammal forage directly and the arthropod community indirectly. Like the other alternatives, understory production would decline by year 2050.

Alternative C

This alternative would treat over 555,000 acres, the most goshawk habitat in all habitat categories. This includes about 18,600 acres of treated Mexican spotted owl habitat. About 70 percent (42) of the 60 treated PFAs would have between 76 and 100 percent of each PFA treated by mechanical or prescribed burning in alternative C. Five (8 percent) PFAs would have between 50 percent and 75 percent treated. Eight PFAs (13 percent) would have between 25 percent and 49 percent treated and less the 25 percent of the treated acres would be within each of the remaining five PFAs. As the percent of the PFA that is treated increases, the relative portion of the PFA that would move toward desired conditions for goshawk habitat would also increase.

The goshawk habitat structural stage analysis for alternative C indicates overall post treatment VSS distribution in the even-aged goshawk habitats will have good representation of the VSS 1, 3 and 4 age classes, and the VSS 5 age class in the LOPFA; under-representation of the VSS 6 age class and the VSS 5 age class in the PFA; no representation of the VSS 2 age class. The uneven-aged goshawk habitats will have good representation in the LOPFA of VSS 3, 4, 5 and 6 and of

VSS 4 and 5 in the PFA; VSS 1 is underrepresented in the LOPFA and VSS 1, 3 and 6 are underrepresented in the PFA; there is no representation of the VSS 2 age class in all habitats

Tons per acre of coarse woody debris would increase from year 2020 to year 2050 and higher amounts of coarse woody debris would occur in PFAs/dPFAs than in LOPFAs. Predicted tons of coarse woody debris per acre by restoration unit, subunit, and alternative are displayed in appendix 9. Amounts of coarse woody debris in this alternative would increase from year 2020 to year 2050 in both PFAs/dPFAs and LOPFAs so although alternative C would not meet forest plan recommendations in the short term, recommendations would be reached in the long term.

In the short term, neither PFA/dPFA nor LOPFA habitat would meet recommendations of a minimum of three large logs per acre in the Coconino forest plan and the Kaibab forest plan. However it would meet these recommendations in the long term in both types of goshawk habitat.

Snags created in alternative C would predominantly result from prescribed fire although density induced mortality among VSS 3 and VSS 4 trees on the landscape would be a factor as well. Snag density would increase in both the PFAs/dPFAs and LOPFAs over time in alternative C but still would not achieve the recommendations in the Coconino forest plan for at least 2 large snags per acre. Snag density in PFA/dPFA habitat would meet the recommendations of an average of 1-2 snags per acre in the Kaibab forest plan in the short term and long term. Snag density in LOPFA habitat would nearly meet the Kaibab forest plan recommendations in the short term (average of 0.94 snags per acre) and the long term (average of 0.93 snags per acre).

In alternative C, the stand density index percent of maximum (as an indicator of forest density and forest health) would decline in both PFA/dPFA and LOPFA habitat in the short term (2020) and increase slightly in the long term (2050) though still remaining lower than existing values. In both the short and long term, goshawk habitat under this alternative would be healthier than if no treatment were to occur.

Density in LOPFA habitat would also improve in the short and long term compared to alternative A. Eight subunits would improve from being in an extremely high density zone (56+ percent) to high density (35-55 percent) by 2020 and remain in high density through 2050. Subunits 3-2 and 6-3 subunits improve but only to a lower end of the high density zone. Five subunits improve from high to moderate density in the short term (Subunits 1-2, 4-3, 4-4, 5-1, 5-2, and 6-2) then shift to high density in the long term as tree growth continues. Subunit 4-2 is the only one that would remain at moderate density in the long term. These would improve the quality and sustainability of nesting and fledging habitat as well as prey habitat. In addition, the longevity of existing old-growth trees would be enhanced by thinning adjacent smaller trees and density-related mortality would be reduced.

As density slowly increases by 2050, there would be increased risk from insect and disease, uncharacteristic fire, and density related mortality; less understory, and slower tree growth. Risks associated with dense forest conditions would be reduced and resilience to the impacts of large scale disturbance under drier and warmer conditions would be improved by implementing the treatments proposed under alternative C. Impacts to forest health are described in more detail in the silvicultural report.

Alternative C is similar to alternative B. These alternatives would result in the highest amount of expected herbaceous biomass of all the alternatives. Consequently, this alternative would be the most beneficial for grasses, sedges and forbs, and cool-season plants which all respond favorably to reductions in overstory density. This would be the most improvement to bird and mammal forage directly and the arthropod community indirectly. Like the other alternatives, understory production would decline by year 2050.

Alternative D

About 60 percent (36) of the 60 treated PFAs would have between 76 and 100 percent of each PFA treated by mechanical or prescribed burning in alternative D. Six PFAs (10 percent) would have between 50 percent and 75 percent treated. Eleven PFAs (18 percent) would have between 25 percent and 49 percent treated and less the 25 percent of the treated acres would be within each of the remaining seven PFAs (. As the percent of the PFA that is treated increases, the relative portion of the PFA that would move toward desired conditions for goshawk habitat would also increase.

This alternative would treat 76 percent (37,323 acres) of PFA/dPFA habitat of which 6,643 acres occur in Mexican spotted owl habitat. Alternative D treats about the same amount of goshawk habitat outside of Mexican spotted owl habitat as alternative B (30,680 acres) and a slightly higher amount than alternative C and alternative E.

Alternative D shows slightly less increase in VSS 5 and 6, or acres of large trees, due to the continued dense conditions of VSS 3 and 4 size trees occupying the majority of the area due to the lack of prescribed burning in alternative D.

In the silvicultural report, the goshawk habitat structural stage analysis for alternative D indicates overall post treatment VSS distribution in the even-aged goshawk habitats will have good representation of the VSS 1, 3 and 4 age classes, and the VSS 5 age class in the LOPFA; under-representation of the VSS 6 age class and the VSS 5 age class in the PFA; no representation of the VSS 2 age class. The uneven-aged goshawk habitats will have good representation in the LOPFA of VSS 3, 4, 5 and 6 and of VSS 3, 4 and 5 in the PFA; VSS 1 is underrepresented in the LOPFA and VSS 1 and 6 are underrepresented in the PFA; there is no representation of the VSS 2 age class in all habitats.

In the short term (2020), LOPFA and PFA/dPFA habitat in alternative D would have the highest amounts of coarse woody debris compared to the other alternatives (as a result of having no prescribed fire on over 60 percent of the treatment area). In the long term (2050), LOPFA habitat would have higher amounts of coarse woody debris than alternatives B, C, and E and similar amounts as alternative A. In the long term, PFA/dPFA habitat would have higher amounts of coarse woody debris than in any other alternative. Tons per acre of coarse woody debris would increase from year 2020 to year 2050 and higher amounts of coarse woody debris would occur in PFAs/dPFAs than in LOPFAs.

In PFA/dPFA habitat, alternative D would be the only alternative to meet recommendations of a minimum of three large snags per acre in the Coconino forest plan and the Kaibab forest plan in the short term, and it would meet these recommendations in the long term as well. In LOPFA habitat, Kaibab forest plan and Coconino forest plan recommendations would not be met in the short term but would be in the long term.

Snag density would increase in both the PFAs/dPFAs and LOPFAs over time in alternative D but still would not achieve the recommendations in the Coconino forest plan for at least 2 large snags per acre. Average snag density in PFA/dPFA habitat would not meet the recommendations of an average of 1-2 snags per acre in the Kaibab forest plan in the short term but would meet it in the long term. Snag density in LOPFA habitat would not meet the Kaibab forest plan recommendations in the short term (average of 0.6 snags per acre) or the long term (average of 0.91 snags per acre).

In alternative D, the stand density index percent of maximum (as an indicator of forest density and forest health) would decline in both PFA/dPFA and LOPFA habitat in the short term (2020) and increase slightly in the long term (2050) though still remaining lower than existing values except in Restoration Unit 6 (wildlife report, table 182). In both the short and long term, goshawk habitat under this alternative would be healthier than if no treatment were to occur.

On the average, alternative D would produce more understory in the short term (2020) and long term (2050) than alternative A but lesser amounts than alternatives B, C, and E. Like alternatives B, C, and E, understory would increase in the short term as openings and interspaces are created and tree density is reduced then decline by 2050 in both PFA/dPFA and LOPFA habitat as tree canopies expand and fill in the gaps. Generally, alternative D would result in less understory biomass in PFA/dPFA and LOPFA habitat than alternatives B, C, and E. This general pattern holds true for the restoration unit and subunit scales except in Subunit 1-2 in which alternative D would result in higher production than alternative E. This is because alternative D mechanically treats fewer acres than alternatives B, C, and E and reduces the acreage that would receive prescribed fire by almost 70 percent compared to alternative B, the proposed action.

Alternative E

Of the 60 PFAs being treated within the project area in alternative E, about 68 percent of them would have their entire territories treated by mechanical or prescribed burning in alternative E (same as alternative B, less than alternative C and more than alternative D). About 12 percent would have 50-75 percent of the PFA treated (same as alternative C and higher than alternatives B and D). About 15 percent would have 25-49 percent of the PFA treated (more than in alternatives B and C and less than alternative D) and 8 percent would have less than 25 percent of the PFA treated (same as alternatives B and C, and less than alternative D). As the percent of the PFA that is treated increases, the relative portion of the PFA that would move toward desired conditions for goshawk habitat would also increase.

An analysis of the goshawk structure attributes for alternative E showed very minor differences in LOPFA habitat (Subunits 3-2, 3-5, and 4-3) compared to alternative B. All numbers and percentages are the same for alternative E as alternative B for the remaining subunits and at the restoration unit and habitat scales. Therefore, the summary of post treatment and 2050 habitat conditions for alternative B is the same for alternative E.

Alternative E would increase the amount of coarse woody debris which provides foraging habitat and cover for prey species. By 2050, alternative E would be within the recommended range of 5-7 tons per acre in the Coconino forest plan and Kaibab forest plan.

Log density per acre in this alternative would increase from year 2020 to year 2050 so although alternative E would not meet forest plan recommendations of at least 3 large logs per acre in the short term, recommendations would be exceeded in the long term. More logs would be provided in PFA/dPFA versus LOPFA habitat. Snags created in alternative E would predominantly result from prescribed fire although density induced mortality among VSS 3 and VSS 4 trees on the landscape would be a factor as well.

In the short term (2020), alternative E would have the highest density of large snags per acre in PFA/dPFAs. This general pattern holds true for the restoration unit and subunit scales as well. In the long term (2050), the density of large snags is similar between alternatives in PFAs/dPFAs and in LOPFAs. Snag density would not change in PFAs/dPFAs over time in alternative E and would decrease slightly in LOPFAs over time.

This alternative would not achieve the recommendations in the Kaibab forest plan or Coconino forest plan for at least 2 large snags per acre at any scale in the short or long term. Snag density in PFA/dPFA habitat would meet the recommendations of an average of 1-2 snags per acre in the Kaibab forest plan in the short term and long term. Snag density in LOPFA habitat would nearly meet the Kaibab forest plan recommendations in the short term (average of 0.97 snags per acre) and the long term (average of 0.93 snags per acre).

In alternative E, the stand density index percent of maximum (as an indicator of forest density and forest health) would decline in both PFA/dPFA and LOPFA habitat in the short term (2020) and increase slightly in the long term (2050) though still remaining lower than existing values The majority of the restoration units in PFA/dPFA habitat would improve from being in an extremely high density zone (56+ percent) to high density (35-55 percent) by 2020. Moderate density is 25-34 percent. In both the short and long term, goshawk habitat under this alternative would be healthier than if no treatment were to occur.

This alternative would provide an increased amount of understory in the short term (2020) as openings and interspaces are created and tree density is reduced in both PFAs/dPFAs and LOPFAs. Like the other alternatives, understory production would decline by year 2050 (about as much as alternatives B and C) as tree canopies expand and fill in the gaps but it would have more understory in the long term than alternatives D or A in PFA/dPFA and in LOPFA. It would have less understory in the long term than alternatives B and C in LOPFA. This alternative would be beneficial for grasses, sedges and forbs, and cool-season plants which all respond favorably to reductions in overstory density. It would also be beneficial to bird and mammal forage directly, the arthropod community indirectly, and for goshawk prey species

Cumulative Effects

Because of the size of the 4FRI analysis area, the analysis area itself was considered adequate for assessing cumulative effects. However, due to the potential for disturbance to goshawks, the cumulative effects boundary was extended ½ mile beyond the analysis area to account for the spatial component of this analysis. There are 87 PFAs and 23 dPFAs within the ½ mile buffer around and including the 4FRI project area boundary. The temporal component in this analysis was defined as 10 years for short-term effects and 30 years for long-term effects.

Projects before 1996 are incorporated into existing conditions. Aspects of existing conditions that are a result of these early projects include even-aged conditions and a deficit of large trees, old trees, logs, and snags. Pre-1996 projects also had heavy selection pressure for healthy trees with good form to maintain preferred tree genetics. This latter effect resulted from harvested areas being regenerated from planting stock or from the selected reserve trees left in seed tree harvest units (Higgins, personal communications 2008). Wildlife habitat in the form of nesting, feeding, and loafing sites was modified by this emphasis on disease-free trees with symmetric shapes and the selective cutting of fork-top trees and trees with unusual branching patterns. Reforestation occurred with selected genetic stock from nurseries.

Overall, about 64,701 PFA/dPFA habitat acres are within the 4FRI project boundary. Past, current, and reasonably foreseeable projects have or will thin about 185,275 acres of goshawk habitat, which includes 3,493 acres of goshawk PFA treatments, and have used or will use prescribed burning in about 255,122 acres, which includes about 187,025 acres of LOPFA burning. The rest is in Mexican spotted owl habitat and could be either LOPFA or PFA habitat (table 78). Specific LOPFA or PFA treatments were designed to maintain or improve goshawk habitat or were mitigated to minimize negative effects to the goshawks and their habitat.

Effects to Forest Structure

Past and ongoing thinning would have decreased tree competition and improved tree growth rates. Many of the past projects may not have moved toward desired forest structure conditions in terms of uneven-aged forests with canopy gaps, but probably did improve forest health by decreasing tree densities, thereby reducing vulnerability to stochastic events such insects, disease, and high-severity fire. These benefits would also help general forest health under drier and warmer conditions such as drought and climate change.

The thinning with a restoration emphasis and savanna restoration treatments were designed to reestablish forest openings and attain a mosaic of interspaces and tree groups of varying sized and shapes. Thinning treatments with restoration objectives are similar to the goshawk habitat and Mexican spotted owl restricted other habitat treatments proposed under this EIS and have resulted in similar diversity in age and size class. Results from all other treatments listed were incidental to this desired condition.

Thinning projects that included tree diameter limits focused on removing small to medium-sized trees. This “thinning from below” approach was designed to retain pre-settlement and large post-settlement trees, increasing the ratio of large trees and likely increasing recruitment of trees into larger size-classes by 2050. Combined, these actions should contribute to increasing the density of trees larger than 18 inches d.b.h. In the short-term, using diameter caps limits habitat diversity, simplifying habitat in areas where the forest plans and the Mexican Spotted Owl Recovery Plan promote complex habitat structure. This can negatively affect some wildlife species associated with closed canopy forest. The only way to avoid these issues is to retain trees below the diameter cap limit which increases stand density. This reduces or precludes attaining other stand objectives such as increasing tree growth rates, developing larger trees sooner, and adding resiliency to the stand.

Thinning projects in Mexican spotted owl habitat (which is also used by goshawks) typically followed Recovery Plan (USDI Fish and Wildlife Service 1995) direction. Only removing trees 9 inches d.b.h. and smaller in Mexican spotted owl protected habitat reduces ladder fuels, thereby decreasing the risk of surface fire becoming crown fire. While this aids in retaining forest structure needed by the Mexican spotted owl over time, it did little to improve the quality of goshawk habitat. These projects should result in post-treatment basal areas, tree density, and canopy cover values meeting or moving toward Mexican Spotted Owl Recovery Plan direction but can sustain higher than desired values for goshawks with little improvement in prey habitat.

Group selection harvest with a restoration emphasis was designed to reestablish forest openings and attain a mosaic of interspaces and tree groups of varying sized and shapes. This treatment would decrease tree density while moving toward desired stand structure conditions in LOPFA habitat by maintaining dense groups of trees and providing foraging habitat.

Table 78. Cumulative acres of treatment in the 4FRI project area plus ½ mile beyond the project area; pine and mixed conifer

Cumulative Effects in the 4FRI Project Area	Thin Ponderosa Pine in LOPFA	Prescribed Burn Ponderosa Pine in LOPFA	Goshawk PFA/Nest Treatments	Thin Ponderosa Pine or Mixed Conifer in MSO Restricted Habitat	Thin Mixed Conifer or Ponderosa Pine in MSO Protected and PAC Habitat	Prescribed Burn Mixed Conifer or Ponderosa Pine in MSO Protected and PAC Habitat	Prescribed Burn Mixed Conifer or Ponderosa Pine in MSO Restricted Habitat
Current	61,230	97,908	228	29,129	1,986	1,465	50,742
Future foreseeable	39,159	38,255	2,047	12,807	7,277	931	13,219
Past	30,197	50,862	1,218				
Total	**130,586**	**187,025**	**3,498**	**41,936**	**9,263**	**2,396**	**79,568**

LOPFA = landscapes outside of post-fledging family areas; PFA = post-fledging family area; MSO = Mexican spotted owl; PAC = protected activity center

Table 79. Cumulative treatments and activities in 4FRI project area plus ½ mile beyond the project area - other activities

Project Type	Thin grassland (acres)	Prescribed burn grassland (acres)	Thin pinyon-juniper (acres)	Prescribed burn pinyon-juniper (acres)	Road obliteration (miles)	Road closure (miles)	Aspen regeneration (acres)	Rock pit development (No. of pits)	Water development (No.)	Channel restoration (miles)
Current	3,194	2,915	326	326	16	18	4,637			1
Future foreseeable	3,739	3,590	4,090	2,000	28		428	39		
Past	4,550	47	2,460	1,100	10		140		24	
Total	**11,483**	**6,552**	**6,876**	**3,426**	**54**	**18**	**5,205**	**39**	**24**	**1**

The cumulative effect of thinning operations on snags is difficult to summarize because of the lack of information about the type of snags that occur on the ground, their density, and distribution. Snags would decrease due to safety concerns during operations, but snags are also created from mechanical damage, drought, and fire and are protected or avoided in some operations. The value of snags to prey species varies depending on the species and depending on snag density, diameter, height, age, presence of bark, and spatial distribution.

Between 2001 and 2010, wildfires burned about 108,160 acres of the project area. It is estimated that the overall average burn severity to the vegetation was 20 to 45 percent high severity (estimated from the rapid assessment of vegetation conditions after wildfire [RAVG] database; see fire ecology report) with up to 30 percent mixed severity and 50 percent low severity (silviculture report). There is wide variability among fires. Mixed and high-severity wildfires have killed a larger proportion of old forest structure or eliminated existing forest altogether. Mixed and high-severity wildfire also killed large oaks that were replaced by oak sprouts, thereby changing oak structure from old (food and nest structures for goshawk prey species) to young (potential cover for prey species but reduced mast production).

Prescribed fire, typically associated with the above thinning projects, and wildfire managed for resource benefit would predominantly produce low-severity fire, reducing surface fuels. Fire causes tree mortality, particularly in seedling/sapling sized trees and susceptible pre-settlement trees. In the short-term, snags and logs can be reduced in number and distribution. Other results can include raising canopy base height, improving understory response, and decreasing the risk of losing habitat to future high-severity fires.

Effects to Prey Habitat

Thinning treatments open the overstory canopy and remove sub-canopy structure, allowing more light to reach the forest floor and increasing moisture availability. Canopy openings tend to be relatively short-lived because increased growth rates in residual trees reestablish continuous canopy cover. This allows for a short-term increase in understory production, improving prey food and cover. However, thinning typically does not provide long-term understory benefits unless interspace or forest openings are created. Group selection harvest with a restoration emphasis was designed to reestablish forest openings and attain a mosaic of interspaces and tree groups. This treatment would create patches of openings where understory development could persist for the long-term.

Removing conifer competition to release Gambel oak would contribute to maintaining and improving oak growth and vigor, improving habitat for prey species.

Broadcast burning would decrease tree seedlings, reduce surface fuels, increase understory production, and improve nutrient availability. The scale of these changes would largely depend on site-specific forest structure, but in general would decrease risk of high-severity fire and increase food and cover for prey species. Reducing tree stems per acre and creating a nutrient pulse would benefit habitat for both goshawks (overstory) and their prey (overstory and understory).

Piling fuels provides nesting and hiding cover for prey species, but most piles are eventually burned. Pile burning can cause mortality to individual animals. Invasive weed treatments improve prey habitat by releasing native species. Invasive weeds may provide cover, but typically do not produce forage. Some invasive weeds can increase risk of high-severity fire and some are less flammable seasonally, reducing the effectiveness of prescribed fire. Erosion control would move prey habitat toward desired conditions. Animal damage control would consist of direct removal of prey species, causing a short-term, localized decrease in prey numbers.

The affected environment for the range analysis is the 4FRI project area. Only allotments within the project area have been considered. Of the 988,764 acres of this project area, 790,985 are within grazing allotments and 197,779 acres are not grazed by livestock (appendix 18). Within the project area there are 49 livestock grazing allotments, 47 are active allotments and two are vacant. About 80 percent of the total project is grazed and that includes most goshawk habitat. Plant species composition and diversity is expected to be maintained in the long-term by ongoing and future grazing. Bird and small mammal populations in pastures with early summer grazing are likely to be more vulnerable to predators due to the loss of cover when animals are nesting or young are dispersing. The number of pastures with early summer grazing is limited; seasonal use is rotated so that the same pastures are not grazed in spring/early summer in successive years. Grazing pressure is uneven across the landscape and some areas have much higher impacts (e.g., near water) and some areas have fewer impacts (steeper slopes and areas with high canopy cover). Allotments are managed to provide 60 percent or more of the understory biomass for wildlife. However, areas in which livestock congregate commonly have higher use. Overall, forest plan guidance directs the range program to maintain adequate understory conditions.

Other activities have restored habitat heterogeneity, directly improving prey habitats. These include treatments in grasslands, oak, aspen and pine sage.

Reasonably Foreseeable Actions

Known future projects expected to overlap goshawk habitat include Turkey/Barney Pasture Forest Health Restoration, AZARNG Thinning, Burning, Camp Navajo Westside Buffer Thinning and Prescribed Fire Project, Marshall Fuels Reduction, Bill Williams Mountain Restoration Project, Flagstaff Watershed Protection/Fuels Reduction, and Greater Flagstaff Forest Partnership. These could result in about 30,000 acres of thinning in LOPFA habitat, 1,218 acres of burning in PFA habitat in addition to 29,233 acres of thinning in Mexican spotted owl habitat which would be either LOPFA or PFA/dPFA habitat as well. Some projects may have negative impacts to goshawks and their habitat (Right-of-Way maintenance for powerlines, reopening rock pits). Thinning and burning in grasslands and pinyon juniper vegetation may improve habitat for prey species which could disperse in goshawk habitat. Road obliteration could increase the amount of prey habitat once roads re-establish with vegetation, and would reduce human disturbance. Aspen regeneration and reforestation could improve species diversity and the balance of age classes. However, with limited detail on most of the foreseeable actions, sometimes including a lack of specific boundaries on where the actions will take place, it is difficult to assess all impacts to goshawk habitat. Collectively, long-term indirect benefits to goshawk habitat are expected in both forest structure and prey habitat in thinning and burning treatments by improving forest health, resiliency, and creating tree groups and canopy gaps within goshawk habitat. Project activities would typically include elements of the following actions:

Both the Coconino and Kaibab NFs have implemented travel management within the analysis area. These efforts will affect impacts from fuelwood cutting, hunting, and recreational camping across both forests. On the Coconino NF, the public is no longer allowed to travel cross country to search for fuelwood, but may drive off-road to gather cut wood. This will likely limit effects of wood cutting in any one area while distributing effects across broader areas. The Kaibab NF will only allow off-road travel in designated fuelwood areas and will thus limit habitat impacts to localized areas. Areas within fuelwood designated areas (short-term) and along roads (long-term) may fall short of forest plan guidelines for dead woody material. The rule change on both forests will likely leave higher densities of dead and down woody material across most of the forest, in areas further from roads than under previous rules. While there are species-specific rules for cutting dead trees, it is not uncommon for larger snags of all tree species to be cut. This occurs closer to roads and decreasing miles of open road should decrease the loss of this resource.

Both forests have on-going maintenance of rights-of-way for power, gas, and oil lines and associated infrastructure. This involves thinning and burning within the rights-of-way to keep the area clear of trees and shrubs. Right-of-way maintenance prevents forest development, retaining early seral habitat in linear swaths across the landscape. Rights-of-way include 32,344 acres with the majority of the area on the Coconino NF. Currently there are 500 acres proposed for right-of-way clearing.

Grazing is an on-going activity. Only allotments within the project area have been considered. Of the 988,764 acres of this project area, 790,985 are within grazing allotments and 197,779 acres that are not grazed by livestock (see map in appendix 18). Within the project area there are 49 livestock grazing allotments, 47 are active allotments and two are vacant See Cumulative Effects for all Alternatives under the Description of Alternatives for more details. Timing and conditions vary by allotment. On average, 30-40 percent of the forage is allowed for utilization by livestock and wildlife. There is no proposal to increase livestock numbers within these allotments. Therefore there are no additional effects beyond existing conditions.

There are approximately 150,000 acres of non-Forest Service administered lands within the project area. These areas include primary residences and vacation homes, Navajo Army Depot and other Department of Defense lands, and ranchland. The Navajo Army Depot is planning development of new training ranges and thinning and prescribed burning. The Department of Defense is planning 17,049 acres of thinning and burning in ponderosa pine and some grasslands restoration. The Greater Flagstaff Forest Partnership is planning to burn and thin 535 acres of ponderosa pine habitat around the Flagstaff area.

Cumulative Effects from Alternative A

Alternative A would contribute to the improvement of forest structure and prey habitat within goshawk habitat, but progress toward desired conditions would be slower and occur at a smaller scale than alternatives B, C, D, or E.

Maintaining existing conditions would extend the current deficit of trees greater than 24 inches d.b.h. Current levels of trees per acre greater than or equal to 18 inches d.b.h., already below forest plan and Recovery Plan direction, would likely be maintained due to increases in mortality rates resulting from competition. Slow to stagnating tree growth rates would prolong the time required for mid-aged trees to grow into mature trees. Replacement of mid-aged trees by younger trees would occur at low rates because of current deficits in small size-classes, delaying, limiting, or preventing the long-term attainment of desired conditions for mature and old-growth forest. Ponderosa pine is not a shade adapted species. Therefore, consistently high canopy cover would delay or prevent development of multi-storied and uneven-aged forest structure in the long-term. Growth could be further suppressed and mortality rates increased if climate patterns continue toward hotter and drier growing conditions. Within-stand mortality resulting from competition for rooting space, water, and nutrient availability, vulnerability to insects and disease, and fire could lead to patches of more open conditions. This could reduce potential nesting habitat even in locations where individual trees might benefit and eventually grow into larger size-classes.

Dense forest structure could increase the risk of insect and disease outbreaks occurring and increase the scale at which they occur. Stochastic events outside the historical range of variability could continue to slow or prevent development of new goshawk nesting habitat.

The 18 miles of road closures, with slightly reduced access to the existing roads footprint, would result in a slightly lower threat to large snag persistence than currently exists but with a much smaller extent than the action alternatives. Although ecosystem function would improve in grassland and aspen habitats in response to thinning and burning treatments, function would be at a much reduced scale when compared to the greater amount of treatments in other alternatives. Ecosystem function would decline in areas without disturbance or treatments to reduce conifers in these open or early seral habitats. Spring and channel function would continue to decline at the landscape level because so few restorative treatments are occurring or are expected to occur.

The ability to retain sustainable and resilient ecosystems would be further compromised by vulnerability to high-severity fires due to lack of treatments. The overt threat of high-severity fire could limit options for treating uncharacteristic fuel loads through the use of unplanned ignitions, compounding the risk of high-severity fire through time.

Cumulative Effects from Alternatives B through E

Most of the projects identified as part of the cumulative effects analysis occur in LOPFA habitat (table 80). The majority of past, current, and foreseeable future treatment acres are prescribed fire only. Alternatives B, C, D, and E also have the majority of the treatments in LOPFA. However, most of the treatments are mechanical thin with prescribed fire. Alternative C cumulatively has the most treatment acres whereas alternative D has the fewest. Alternative B cumulatively has the fewest acres treated with prescribed fire and the most acreage treated mechanically followed by prescribed burning.

Restoration treatments would contribute toward improving forest health, vegetation diversity, and vegetation composition in goshawk habitat under alternatives B through E. This would aid in sustaining old forest structure over time and moving forest structure toward desired conditions.

Table 80. Cumulative effects in goshawk habitat by alternative[16]

Treatment	PFA/dPFA	LOPFA	MSO Restricted	MSO Protected or PACs	Total Acres
Alternative B					
Prescribed fire Only	12,427	107,193	Included in previous two columns		119,620
Mechanical Thin and prescribed fire	26,560	356,644			383,204
Prescribed Fire Only Prey Habitat	297	30,026			30,323
Mechanical Thin and Prescribed Fire Prey Habitat	126	1,635			1,761
Total Past, Current and Future Foreseeable Projects	**PFA/dPFA**	**LOPFA**	**MSO Restricted**	**MSO Protected or PACs**	**Total Acres**
Prescribed fire Only	0	187,025	79,568	2,396	268,989

[16] LOPFA = landscapes outside of post-fledging family areas; PFA = post-fledging family area; dPFA = dispersal PFA; MSO = Mexican spotted owl; PAC = protected activity center

Treatment	PFA/dPFA	LOPFA	MSO Restricted	MSO Protected or PACs	Total Acres
Mechanical Thin	0	130,586	41,936	9,263	181,785
Northern goshawk nest treatments (assumed mechanical)	3,498	0	0	0	3,498
Mechanical Thin in prey habitat (grassland, PJ, aspen)	0	25,199	0	0	23,564
Prescribed Fire in prey habitat (grassland, PJ)	0	9,978	0	0	9,978
Cumulative Effects	**PFA/dPFA**	**LOPFA**	**MSO Restricted**	**MSO Protected or PACs**	**Total Acres**
Prescribed fire Only	12,427	187,025	79,568	2,396	281,416
Mechanical Thin and Prescribed Fire	19,547	487,230	114,389	0	621,166
Prescribed Fire Only Prey Habitat	0	40,004	0	0	40,004
Mechanical Thin and Prescribed Fire Prey Habitat	0	26,834	0	0	26,834
Total-Cumulative Effects Treatment Acres (PFA/dPFA, LOPFA)	**31,974**	**674,255**	**193,957**	**2,396**	**905,582**
Alternative C					
Prescribed fire Only	13,469	110,798	Included in previous two columns		124,267
Mechanical Thin and prescribed fire	26,647	354,623			381,270
Prescribed Fire Only Prey Habitat	297	30,011			30,308
Mechanical Thin and Prescribed Fire Prey Habitat	126	1,635			1,761
Total Past, Current and Future Foreseeable Projects	**PFA/dPFA**	**LOPFA**	**MSO Restricted**	**MSO Protected or PACs**	**Total Acres**
Prescribed fire Only	0	187,025	79,568	2,396	268,989
Mechanical Thin	0	130,586	41,936	9,263	181,785
Northern goshawk nest treatments (assumed mechanical)	3,498	0	0	0	3,498
Mechanical Thin in prey habitat (grassland, PJ, aspen)	0	25,199	0	0	23,564
Prescribed Fire in prey habitat (grassland, PJ)	0	9,978	0	0	9,978
Cumulative Effects	**PFA/dPFA**	**LOPFA**	**MSO Restricted**	**MSO Protected or PACs**	**Total Acres**
Prescribed fire Only	13,469	297,823	79,568	2,396	393,256
Mechanical Thin and prescribed fire	30,145	485,209	41,936	9,263	566,553

Treatment	PFA/dPFA	LOPFA	MSO Restricted	MSO Protected or PACs	Total Acres
Total-Cumulative Effects Treatment Acres (PFA/dPFA, LOPFA)	**43,614**	**783,032**	**121,504**	**11,659**	**959,809**
Alternative D					
Prescribed fire Only	10,096	90,277	Included in previous two columns		100,373
Mechanical Thin and prescribed fire	27,894	356,644			384,538
Prescribed Fire Only Prey Habitat	496	72,669			73,165
Mechanical Thin and Prescribed Fire Prey Habitat	126	1,635			1,761
Total Past, Current and Future Foreseeable Projects	**PFA/dPFA**	**LOPFA**	**MSO Restricted**	**MSO Protected or PACs**	**Total Acres**
Prescribed fire Only	0	187,025	79,568	2,396	268,989
Mechanical Thin		130,586	41,936	9,263	181,785
Northern goshawk nest treatments (assumed mechanical)	3,498	0	0	0	3,498
Mechanical Thin in prey habitat (grassland, PJ, aspen)	0	25,199	0	0	23,564
Prescribed Fire in prey habitat (grassland, PJ)	0	9,978	0	0	9,978
Cumulative Effects	**PFA/dPFA**	**LOPFA**	**MSO Restricted**	**MSO Protected or PACs**	**Total Acres**
Prescribed fire Only	10,096	277,302	79,568	2,396	369,362
Mechanical Thin and prescribed fire	31,392	360,142	41,936	9,263	442,733
Total-Cumulative Effects Treatment Acres (PFA/dPFA, LOPFA)	**41,488**	**637,444**	**121,504**	**11,659**	**812,095**
Alternative E					
Prescribed fire Only	12,423	134,621	Included in previous two columns		147,044
Mechanical Thin and prescribed fire	26,467	327,074			353,541
Prescribed Fire Only Prey Habitat	423	30,336			30,759
Mechanical Thin and Prescribed Fire Prey Habitat	273	51,037			51,310
Total Past, Current and Future Foreseeable Projects	**PFA/dPFA**	**LOPFA**	**MSO Restricted**	**MSO Protected or PACs**	**Total Acres**
Prescribed Fire Only		187,025	79,568	2,396	268,989
Mechanical Thin		130,586	41,936	9,263	181,785

Treatment	PFA/dPFA	LOPFA	MSO Restricted	MSO Protected or PACs	Total Acres
Northern goshawk nest treatments (assumed mechanical)	3,498	0	0	0	3,498
Mechanical Thin in prey habitat (grassland, PJ, aspen)	0	25,199	0	0	23,564
Prescribed Fire in prey habitat (grassland, PJ)	0	9,978	0	0	9,978
Cumulative Effects	**PFA/dPFA**	**LOPFA**	**MSO Restricted**	**MSO Protected or PACs**	**Total Acres**
Prescribed fire Only	12,423	321,643	79,568	2,396	416,030
Mechanical Thin and prescribed fire	29,965	457,660	41,936	9,263	538,824
Total-Cumulative Effects Treatment Acres (PFA/dPFA, LOPFA)	**42,388**	**779,303**	**121,504**	**11,659**	**954,854**

Project treatments primarily decreased the number of trees less than 14 inches d.b.h. The degree of treatment intensity is highly variable, with some projects not cutting trees greater than 12 inches d.b.h. and others looking to lower the threat of high-severity fire in goshawk habitat. The overall ratio of trees greater than 12 inches d.b.h. is likely to increase as a result of removing smaller trees and increasing the growth and survivability of larger trees. Total basal area of pine would decrease in the short-term, but because the focus is on small trees, basal area might not substantially change. Overall basal area would be expected to increase in the long-term. Gambel oak is not targeted for removal, but prescribed fire will likely top-kill small diameter oak, potentially decreasing oak basal area in the short term. However, design features should ensure retention of large diameter oak and small oak commonly sprout vigorously after fire. The total basal area of Gambel oak is not expected to change substantially in the long-term. Created canopy gaps, interspaces, and tree groups should benefit prey species and thinning should hasten tree growth, improving goshawk habitat.

Changes are expected in goshawk prey habitat. Decreases would occur in coarse woody debris, logs, and snags, commonly decreasing structure in prey habitat in the short-term. Burn prescriptions and ignition techniques should limit these losses. Burned snags fall and provide logs and trees killed by fire will become snags. However, the longevity of fire-killed snags is less than that of snags formed from other processes. However, maintenance burning should provide pulses of snags and logs through time. Less coarse woody debris is expected to be present in the short-term as a result of prescribed fire. Thinning and burning should increase tree growth rates and self-pruning of lower tree branches should replenish coarse woody debris in the long-term. Improving growing conditions should decrease density-related mortality of larger and older trees. Improving recruitment into the larger size classes would improve goshawk habitat and the ability to provide large snags that remain on the landscape longer than smaller diameter or fire-created snags. The combination of thinning and burning should improve species richness in the herbaceous understory, increase plant abundance, and improve fruit and seed production.

Current and reasonably foreseeable projects represent polygons omitted from the 4FRI planning effort because some degree of planning was already in progress or they occur outside of ponderosa pine forest. Treating within these polygons will reduce fire threat for goshawk habitat within the respective project polygon as well as reducing the threat of high-severity fire starting in these areas and burning habitat outside the polygons. In addition, improvements to understory vegetation and prey habitat are expected to occur in goshawk habitat and be more persistent in the long-term compared to more conservative treatments in Mexican spotted owl habitat that are employed because Mexican spotted owl have different habitat requirements than goshawks.

Cumulative effects from reasonably foreseeable projects could include disturbance from noise and potentially from smoke but could collectively work to improve goshawk habitat, including PFAs, because the risk of high-severity fire eliminating goshawk habitat would be reduced in the short- and long-term. Because current and reasonably foreseeable projects represent polygons omitted from the 4FRI treatment area effort, overlap in the spatial component of cumulative effects would largely be avoided. Although smoke and noise can cross project boundaries, both largely disperse with distance. However, some areas where smoke settles could have longer duration short term effects. The Flagstaff Watershed Protection Project could cumulatively increase impacts to goshawks in PFAs adjacent to shared boundaries.

Many current and reasonably foreseeable projects would overlap temporally. It is conceivable that actions would be occurring in PFAs in multiple locations within the 4FRI boundary. However, all or most PFA mechanical treatments or activities would have timing restrictions, postponing treatments until after the breeding season. Prescribed fire could occur at any time. Adult goshawks would be expected to adapt to fire because it inhabits ponderosa pine, which is a fire adapted vegetation type in the southwest,

Given the various stages of planning or implementation, most project effects would be dispersed both spatially and temporally. Projects in goshawk habitat are typically designed to improve habitat, or to degrade elements of habitat structure while retaining habitat function, resulting in a decrease in risk of high-severity fire. Cumulative effects will likely increase disturbance to individual goshawks from noise and/or smoke in the short-term. Impacts are not expected to affect fecundity because of timing restrictions. Given typical project objectives, the spatial scale of the cumulative effects area, the distribution of goshawk habitat across the project area, and the length of time over which treatments will be implemented (10 or more years), cumulative effects are not expected to negatively impact the goshawk population in the long-term. Overall, treatments in goshawk habitat should move forest conditions toward desired conditions and decrease the risk of habitat loss to large-scale high severity fire.

Northern Goshawk Determination of Effect: Implementation of alternatives B, C, D and E **may impact individuals, but is not likely to cause a trend to federal listing or loss of viability**.

Coconino NF Forest Plan Amendments – Sensitive and Other Protected Species

Not incorporating these amendments would affect the habitat of most sensitive species addressed in this report (see the wildlife report for the complete analysis). The Mexican spotted owl amendments (amendment 1) would allow managing for lower tree densities and basal area, creating canopy gaps, creating and sustaining more large pine and oak trees in the long-term, more large snags through time, and increasing understory response. Not incorporating these amendments would allow:

- uncharacteristically dense forest conditions, fewer big pine and oak trees, and increased fire risk for wildlife using forested habitats in 18 PACs (related to the proposed mechanical treatments in all action alternatives);

- uncharacteristically dense forest conditions, lower crown base height, and increased fire risk in 54 PACs (related to the proposed prescribed fire treatments in alternative C only);
- fewer PACs attaining the desired post-treatments condition due to sequencing of treatments through time (all action alternatives);
- tree densities maintained well above the minimum basal area stand values recommended in the Mexican Spotted Owl Recovery Plan across all PACs, target, and threshold habitats (i.e., not using the best science available; alternative C only); and
- understory conditions would continue to decline across Mexican spotted owl habitat, affecting prey habitat and likely decreasing the total prey biomass for raptors and carnivores.

Not including amendment 2 related to management of canopy cover and open reference conditions within ponderosa pine forest would prevent the ability to include rooting space necessary to sustain dense groups of trees, reduce forest densities and associated forest health (measured by the percent maximum SDI), and prevent the restoration of grasslands and savanna. This would decrease the ability to maintain dense groups of trees along with shrub and herbaceous vegetation, decreasing foods for herbivores, granivores, insectivores, and so for carnivores as well. Grassland species and dispersing individuals of prey species (primarily rodents and lagomorphs) that aid in maintaining prey populations in forested habitat would be reduced as trees continue to encroach upon open habitats. Simultaneously, habitat for species that depend on closed canopy would gradually increase.

Currently, many of the sensitive species depend on habitats or habitat elements related to canopy openings. Existing closed canopy forests limit or eliminate many of the necessary habitat components needed by these species. The desired condition of closed canopy tree groups interspersed with open rooting space that supports herbaceous vegetation would provide key habitat components for these species of status as well as species adapted to closed-canopy forests. Achieving this situation is the reason for the amendments and this interspersion of habitats, which is a fundamental part of the desired condition, would not be attained without incorporating the amendments into the action alternatives.

For botanical species, alternatives B, C and D each contain nonsignificant forest plan amendments that focus on allowing treatments in Mexican spotted owl PACs (amendment 1) and northern goshawk habitats (amendment 2) that are currently outside the authority of the current plan. None of these amendments is expected to change the analysis for Southwestern Region sensitive plants or for noxious or invasive weeds significantly, if the mitigations and design features outlined in the botany specialist report are incorporated into the management actions that would result from these changes. Minor but insignificant changes to the amount of canopy cover and interspaces would result from the changes allowed in these amendments. These changes could result in minor but insignificant increases in growing space for all understory plants including sensitive plants and noxious or invasive weeds. The results would be minor increases in resources for sensitive plants and a slight increase in opportunities for new occupation but these effects are minor and discountable. There may also be a minor but insignificant increase in disturbance resulting from treatments that would occur because of these treatments, but the increase would not significantly increase the risk of noxious or invasive weed invasions. There would be no effect to sensitive and other protected species from amendment 3.

No plan amendments are proposed on the Kaibab NF. There are no conflicts between past and present guidance for sensitive and no change was needed in the analysis to be compliant with the revised Kaibab NF forest plan. Mitigation for management actions area similar to those for

Southwestern Region sensitive species was incorporated into the FEIS to address the protection of narrow endemic species.

Forest Service Management Indicator Species (MIS)

Since the DEIS was published in 2013, the Kaibab NF revised their forest plan and changed the MIS list. Grace's warbler and western bluebird represent ponderosa pine stands and pronghorn were retained as indicators of grasslands. Calculations of forestwide MIS habitat acres were revised. For bird species, the entire potential natural vegetation type (PNVT) acres for the cover type were used; therefore a project will not increase the amount of cover type within the PNVT but could affect the quality of habitat. For the pronghorn, not all the grassland PNVT acres shown for plan revision are used since this include grasslands that not used pronghorn.

Table 81 summarizes (with rationale) the management indicator species not analyzed. Table 82 summarizes the management indicator species analyzed. The table provides the current forestwide habitat and population trends. The effects analysis is organized by habitat type with habitat trends presented in narrative and population trends summarized in tables with some exceptions. Both habitat and population trends are displayed in tabular form for snags in ponderosa pine (hairy woodpecker), late-seral aspen and snags in aspens (red-naped sapsucker), and early-seral aspen and pinyon-juniper (mule deer). Aquatic MIS are analyzed separately in the aquatics species section of this chapter.

Table 81. Management indicator species not included in the analysis

Management Indicator Species/	Key MIS Habitat Component Indicator	Comments
Mexican Spotted Owl (*Strix occidentalis lucida)*	Late-seral mixed conifer and spruce-fir on Coconino NF	There is no mixed conifer or spruce fir habitat being treated in the proposed treatment area.
Red Squirrel (*Tamiasciurus hudsonicus*)	Late-seral mixed conifer and spruce-fir on Coconino NF	There is no mixed conifer or spruce fir habitat being treated in the proposed treatment area.
Yellow-breasted Chat (*Icteria virens*)	Late-seral, low-elevation, riparian habitat (< 7,000') on Coconino NF	There are 6 miles of proposed ephemeral stream channel restoration with riparian vegetation on the Coconino NF; only a fraction of this habitat occurs below 7,000 feet elevation. Riparian vegetation within these ephemeral channels does not include woody vegetation. The proposed restoration would not remove woody riparian vegetation. Thinning and prescribed fire could increase water-yield for up to 5 years. This would not affect the late-serial riparian habitat.
Lucy's Warbler (*Vermivora luciae*)		
Lincoln's Sparrow (*Melospia lincolnii*)		
Cinnamon Teal (*Anas cyanoptera*)	Wetlands on Coconino NF	There are no proposed activities within wetland habitat. The 6 miles of proposed ephemeral stream restoration with riparian habitat is not teal habitat. Thinning and prescribed fire could increase water-yield for up to 5 years. This would not affect the wetland habitat.
Ruby-crowned kinglet *(Regulus calendula)*	Mixed Conifer on Kaibab NF	There is no mixed conifer being treated in the proposed treatment area.

Thirteen management indicator species (MIS) whose distribution on the forest encompasses part or all of the treatment area were included in the terrestrial effects analysis (table 82). The analysis is based also on the forest plans and projected changes in acreage of quality habitat under all of the alternatives.

Data and Best Available Science

Management indicator species and the habitats they represent are listed in the most recent Coconino NF (USDA 2013) Forestwide Management Indicator Species reports (incorporated by reference). For the analysis of the 2014 Revised Kaibab LRMP MIS species, the information provide in the wildlife specialist report for the Revised Kaibab National Forest Land and Resource Management Plan (Keckler and Foster 2013) was used and is incorporated by reference into the MIS analysis.

While the Kaibab NF has changed their MIS list, a thorough review of the best available science, including the biology, ecology, and effects of management on individual species was included in the 2010 update of the Kaibab NF Forestwide MIS report and this document was used to help support effects to the Coconino NF MIS. The 2010 Kaibab NF Forestwide MIS report (USDA 2010a) is incorporated by reference into this document.

Determining MIS presence and associated trend calls included data from the annual songbird surveys conducted on both the Coconino and Kaibab NFs. Surveys were initiated on the Kaibab NF in 2005 and on the Coconino NF in 2006. Initially each forest conducted its own survey effort, starting the season with two weeks of field training. The Rocky Mountain Bird Observatory, a non-government organization that is a leader in avian population sampling and analysis, took over the sampling effort and associated data analysis in 2007. Data, monitoring reports, and information about the Observatory and their western states monitoring program can be found at: http://www.rmbo.org/public/monitoring.

Population status and trend updates for all game species were provided by the AGFD for the project. These updates by individual game species and initial assessment of project-related effects to each species were incorporated in the MIS analysis.

Goshawk surveys are completed annually on the Coconino NF. The goshawk field survey effort was coordinated between the two NFs in 2011 because of the scale of the restoration project and 6,485 acres were surveyed. The coordinated effort has continued annually since then.

The Forest Vegetation Simulator (FVS) tree growth model was used to determine changes in forest stand dynamics by alternative (for more information on FVS see the silviculture report). This information was used for changes in ponderosa pine seral stages. Where possible, data on forestwide vegetation was taken from the forestwide reports for MIS species.

The MIS analysis incorporates all data associated with determining the surrogate habitat capability index as required by the Coconino NF forest plan. The habitat capability index is designed to assess whether enough habitat has been adequately distributed across the forest to maintain populations of MIS.

Table 82 displays current habitat and population trends for management indicator species.

Table 82. Management indicator species (MIS) analyzed and forestwide current habitat and population trends

Management Indicator Species	Key MIS Habitat Component Indicator	Habitat Component Analyzed	Current Forestwide Habitat Trend	Current Forestwide Population Trend	Acres of Key MIS Habitat Forestwide	Acres/Percent of Habitat Analyzed within Project Area
Coconino NF						
Aquatic Macroinvertebrates	Riparian	See aquatics MIS section	See aquatics MIS section	See aquatics MIS section	See aquatics MIS section	See aquatics MIS section
Northern Goshawk	Late-seral ponderosa pine	Ponderosa pine	Slightly Upward	Stable to Decreasing	253,407	55,956 / 22%
Pygmy Nuthatch						
Turkey				Stable		
Abert's Squirrel	Early seral ponderosa pine	Ponderosa pine	Slightly Increasing	Stable	93,443	13,331 / 14%
Rocky Mountain Elk	Early seral ponderosa pine, mixed conifer, and spruce-fir	Ponderosa pine	Slightly Increasing	Decreasing (latest AGFD data)		
Hairy Woodpecker	Snags in ponderosa pine, mixed conifer and spruce-fir	Snags in ponderosa pine	Increasing	Slightly increasing	900,426	318,432 / 35%
Red-naped Sapsucker	Late-seral aspen and snags in aspens	Aspen and aspen snags	Decreasing	Declining	10,000	874 to 1,082 / 9% to 11%
Mule Deer	Early seral aspen and pinyon-juniper	Aspen	Decreasing	Declining to Stable	10,000	874 to 1,082 / 9% to 11%
		Pinyon juniper	Stable to Slightly Increasing		600,660	10,786 / 2%
Juniper Titmouse	Late-seral pinyon-juniper, and snags in pinyon-juniper	Pinyon-juniper and snags in pinyon-juniper	Increasing	Stable	600,660	10,786 / 2%
Pronghorn	Early and late seral grasslands	Grassland	Stable to Declining	Stable	260,025	22,672 / 9%
Kaibab NF						
Grace's Warbler	Ponderosa Pine	Ponderosa Pine	Stable	Stable	541,000	189,407 / 37%
Western Bluebird						
Pronghorn	Grassland	Grassland	Stable	Stable	112,250	Up to 26,152 / 23%

Direct and Indirect Effects to Management Indicator Species

Table 83 summarizes management indicator habitat and population trends by alternative.

Table 83. Management indicator species habitat and population trends by habitat and alternative – updated

Species	Alternative A	Alternatives B, C, D and E
Late Seral Ponderosa Pine—Coconino NF		
Northern Goshawk	In the long term (30 years), the quality of the habitat would decrease as canopies closed and tree densities increased. A net increase in quantity of habitat with a decrease in quality of habitat coupled with some decreases in amounts of prey species' habitat and unknown to decreasing population trends for MIS prey species would be expected to have static impact on the population trend for the goshawk.	Alternatives B and C would produce the largest increase in the quantity of late seral ponderosa pine habitat as well as the most improvement in the quality of habitat for northern goshawks and their prey species as all elements move toward desired future conditions. Overall, alternatives B and C increase habitat quantity and improve habitat quality for northern goshawk and its prey species slightly more than alternatives D and E. Alternatives B through E would likely change the forestwide population trend to stable in the short-term due the increases in nesting habitat components and the development of a diverse understory. The forestwide population trend would change to increasing in the long-term. Alternatives B and C would have similar impacts on goshawks; alternatives D and E would not be as beneficial.
Pygmy Nuthatch	Alternative A would not result in an immediate change to the quantity or quality of habitat and would likely continue the current population trend of stable in the short term. With the likelihood of wildfires, the long-term population trend could change to decreasing.	Alternatives B through E would likely change the forestwide population trend to increasing in the long term due to increasing in late-seral habitat over a large area of ponderosa pine habitat on the forest. For the short term, these alternatives would likely continue the stable forestwide population trend, while moving toward an increasing trend. Alternatives B and C would have similar impacts on the species and alternatives D and E would not be as beneficial.
Turkey	Alternative A would not result in an immediate change to the quantity or quality of habitat. The current forestwide population trend as stable in the short term would continue. With the likelihood of wildfire, loss of Gambel oak to shading from pines, and lack of understory development, the long term forestwide population trend could change to decreasing.	The action alternatives would improve other forest habitat in addition to the increase of early-seral habitat for elk and would change the current stable to increasing population trend to increasing. However, population trends for elk are influenced more by hunting than by forest management and will remain as stable to increasing trend until the AGFD, along with the input from the forest, determine the population level desirable for these elk herds. Alternatives B through E would likely change the forestwide population trend to increasing in both the short and long term. The population trend is influenced by other habitat factors than the development of late-seral ponderosa pine, with the main factor being the state hunt structure. Alternatives B and C would have similar impacts on the species and alternatives D and E would not be as beneficial.

Species	Alternative A	Alternatives B, C, D and E
Ponderosa Pine – Kaibab NF		
Grace's Warbler	Alternative A would not improve the quality of habitat available. Existing interspace would continue to be encroached upon by expanding tree crowns and ingrowth. Any large scale tree mortality occurring has the potential to enhance interspace and create tree groups (silviculture report). Since the analysis area is within 37 percent of the forestwide ponderosa pine habitat this could result in a declining habitat trend. There is also increase risk of loss of habitat due to the threat of uncharacteristic high-severity wildfires. Population trends for the Grace's warbler and western bluebird would likely be stable to declining.	Alternatives B through E would change the habitat trend for the Grace's warbler from stable to increasing in the long-term and would likely keep the habitat trend at stable in the short term. While treatments would create tree groups, development of large trees would not occur in the short-term. Grace's warbler population trends would likely stay as stable in the short term and change to increasing in the long term as more trees were recruited into the larger size-classes. Alternative D would develop the least amount of habitat. Alternatives B and C would have similar results and would likely be the most beneficial. Alternative E would be similar to alternatives B and C, but could result in less habitat created, depending on the effects of prescribed fire.
Western Bluebirds	Same effects as for Grace's Warbler.	Alternatives B through E would change the habitat trend from stable to increasing in both the short- and long-term. Understory development would likely be the short-term limiting factor on bluebird populations. The population trend would likely remain stable in the short-term and increase in the long-term as habitat conditions improve and more large snags develop, providing potential nesting substrate. Alternative D would develop the least amount of habitat. Alternatives B and C would have similar results and would likely be the most beneficial. Alternative E would be similar to alternatives B and C, but could result in less habitat development, depending on the effects of prescribed fire on forest openings.
Early Seral Ponderosa Pine – Coconino NF		
Elk	Alternative A would not result in an immediate change to the quantity or quality of habitat used by elk. Forage would decrease in the long due to the closure of the forest. The current unnatural stand densities would threaten sustainability of elk habitat over time by limiting understory production and creating risk for uncharacteristic, high-severity fire. Alternative A would likely promote at least a stable forestwide elk population trend in the short term.	Alternatives B through E would improve other forest habitat in addition to the increase of early-seral habitat for elk and would change the current stable to increasing population trend to increasing. However, population trends for elk are influenced more by hunting than by forest management and will remain as stable to increasing trend until the AGFD, along with the input from the forest, determine the population level desirable for these elk herds.

Species	Alternative A	Alternatives B, C, D and E
Abert's Squirrel	Alternative A would continue to provide habitat for the short term. In the long-term, the alternative would threaten long-term viability. Large-scale losses of habitat from uncharacteristically large, stand-replacing fire would affect (decrease) squirrel populations across both forests. Alternative A would not change the current stable forestwide Abert's squirrel population trend in the short term but in the long term would change the trend to decreasing.	In the long term, there would be more sustainable squirrel habitat because the risk of high-severity fire and therefore long-term degradation or loss of squirrel habitat would be significantly reduced (USDA FS 2010a). Alternatives B through E could have short term disturbance impacts that could change the forestwide population trend to decreasing because the treatment area includes approximately 41 percent of the ponderosa pine habitat on the forest. However, the alternatives would likely change the forestwide population trend to an increasing trend in the long term. These population trends are based on other habitat components than early-seral ponderosa pine habitat.
Snags in Ponderosa Pine – Coconino NF		
Hairy woodpecker	Alternative A would not change the short term forestwide habitat or population trend for the hairy woodpecker because it continues the current level of activities on the forest. In the long term, it is likely the forestwide habitat and population trends would stabilize or decrease for the species due to large stand replacing wildfires. It is unknown how this would also affect forestwide population and habitat trends.	Alternatives B through E would likely continue the stable forestwide population trends in the short term, but treatments would likely decrease snag habitat in the short-term. In the long term, the forestwide habitat and population trend would change to increasing. Alternative D would have the least amount of positive effects with its reduced amount of prescribed fire, since returning fire to the ponderosa pine system would also produce habitat component for the hairy woodpecker (USDA FS 2010a).
Late-seral Aspen and Snags in Aspens – Coconino NF		
Red-naped Sapsucker	Alternative A would not change the current declining red-naped sapsucker forestwide population and habitat trends in the short or long term. The decreasing trend would continue due to the fact that the approximately 11 percent of the aspen on the district would not be treated and would likely continue to deteriorate or be lost to wildfires.	Alternatives B through E would change the forestwide habitat trend to stable in the short term and increasing in the long term. In the long term, the forestwide population trend is likely to either be stable or increasing as a result of treating about 9 to 11 percent of the aspen habitat on the forest. Nevertheless, it will take time to recruit large trees and snags into the system.
Early-seral Aspen and Pinyon-Juniper – Coconino NF		
Mule Deer	Under alternative A, the current unnatural stand densities in ponderosa pine would threaten sustainability of mule deer habitat by maintaining the risk of uncharacteristic, high-severity fire. Alternative A would not improve habitat condition in the limited amount of pinyon-juniper within the analysis area. Alternative A would not change the mule deer population trend in the short- or long-term because the habitat quality is likely to be negatively impacted due to continued aspen decline, localized competition for forage	Alternatives B through E would leave approximately 67 percent (15,626 acres) of the acreage in old growth pinyon-juniper (silviculture report). Therefore only 7,690 acres would be potentially managed as early-seral pinyon-juniper. However, the thinning and burning in the pinyon-juniper would open up the canopy and allow the development of understory plants (wildlife report appendix 8) which would increase the forage potential for mule deer in these areas. The action alternatives would likely change the mule deer forestwide population trend to stable both in the short and long term due to the improvement in other habitat components that will benefit deer. However,

Species	Alternative A	Alternatives B, C, D and E
	with elk and livestock, and increasing tree densities and canopy closure which reduce ground cover and shrub layer used by mule deer (wildlife report appendix 6). In addition, there is potential for a decreasing trend in the long term due to the potential of large scale stand replacing wildfires.	forestwide population trends are affected by hunting as well as forest management.
Late Seral Pinyon-Juniper and Snags in Pinyon-Juniper Habitat – Coconino NF		
Juniper Titmouse	Alterative A would not change forestwide habitat or population trend in the short or long term. The trends would continue to be stable due to the fact that the project would only affect 1 percent of the habitat on the forest.	Alternatives B, C, and D would help reduce tree density and develop understory components in pinyon-juniper stands, but would not change the short- or long-term forestwide habitat or population trends from stable because less than 1 percent of the pinyon-juniper habitat forestwide would be affected.
Early and Late Seral Grasslands – Coconino NF		
Pronghorn	Alternative A would not change the currently stable trend in the overall pronghorn population and forestwide habitat in the short-term, but in the long-term it would change both population and forestwide habitat trends to decreasing. The decreasing trend would be due to the continued decline in grassland conditions from conifer and shrub encroachment. The project area also contains important fawning areas for the forest that would affect forestwide population trends.	Alternatives B and D would help move the forestwide grassland habitat trend from stable to increasing depending on how much conifer and shrub are removed. The alternatives would likely help move the forestwide pronghorn population trend from stable to increasing. Alternative C would change the forestwide grassland habitat trend to increasing in both the short-and long-term. This is due to the removal of trees in current grasslands and the restoration of historical grasslands, 1,562 acres. The alternative would also do approximately 27,000 acres of savanna treatments. The alternative would likely change the forestwide pronghorn population trend from stable to increasing. There would be an improvement in sighting distances and connectivity of pronghorn habitats and prescribed fire would increase diversity and productivity of herbaceous plants, improving foraging and fawning habitat for pronghorn. In alternative E while the grassland habitat would be improved, habitat connectivity for the pronghorn would not improve. The alternative would likely have the pronghorn forestwide population and habitat trends remain as stable both in the short and long term since only 9 percent of the forestwide habitat would be treated.

Species	Alternative A	Alternatives B, C, D and E
Early and Late Seral Grasslands – Kaibab NF		
Pronghorn	Alternative A would not change the currently stable forestwide trends for the pronghorn population and habitat in the short-term, but in the long-term it would change both forestwide population and habitat trends to decreasing. The decreasing trend would be due to the continued decline in grassland conditions from conifer and shrub encroachment. The project area contains important fawning areas on the forest that would affect forestwide population trends.	Alternatives B and D could help move have the forestwide grassland habitat trend from stable to increasing depending on how much conifer and shrub are removed. The alternatives would likely have the forestwide pronghorn population trend as stable to increasing. There would be an improvement in pronghorn habitat connectivity within forested areas and prescribed fire would increase diversity and productivity of herbaceous plants, will improving foraging and fawning habitat for pronghorn. Alternative C would change the forestwide grassland habitat trend to increasing in both short and long term. This is due to the removal of trees in current grasslands and the restoration of historical grasslands. The alternative would have the pronghorn forestwide population trend as stable or increasing. There would be an improvement in pronghorn habitat connectivity within forested areas and prescribed fire would increase diversity and productivity of herbaceous plants, will improving foraging and fawning habitat for pronghorn. In alternative E while treatments in these areas would open up the stands, most areas would not have the same level of improved habitat effectiveness. The alternative would likely have the pronghorn forestwide population and habitat trends remain as stable both in the short and long term since 23 percent of the forestwide habitat would be treated.

Cumulative Effects to Management Indicator Species

The affected environment for cumulative effects varies by species (table 84). The analysis includes the combined impacts of all activities within the area as evaluated by each alternative. The effects of projects that already have been implemented were used to help describe current conditions of the project area and will not be discussed in this section. Ongoing and reasonably foreseeable activities are listed in the cumulative effects section in the wildlife report. Cumulative effects can be an integral part of the effects analysis for wildlife and are discussed for each species.

Table 84. Area of analysis for cumulative effects by species

Area of Analysis	Species	Reason for Selection
Within analysis area	Pygmy nuthatch, turkey, Abert's squirrel, hairy woodpecker, red-naped sapsucker, juniper titmouse, Grace's warbler, western bluebird	Abert's squirrel use is focused on the area around their nest trees. Birds may move to other areas, but their nesting habitat is the most limiting factor for these species.
½-mile buffer around analysis area	Goshawk	The ½-mile buffer takes into account potential disturbance activities for these species found within the analysis area.
Game Management Unit	Elk, mule deer, pronghorn	These species have wider mobility; game management units are designed to encompass herd movements.

Alternative A – Coconino and Kaibab NFs

The cumulative effects of the treatments in appendix 17 of the wildlife report under alternative A would improve the habitats of goshawk, pygmy nuthatch, turkey, hairy woodpecker, elk, mule deer and Abert's squirrel in the long term. Movement corridors and savanna treatments incorporated into ponderosa pine on the Kaibab NF would benefit pronghorn by creating forage and movement corridors. The two miles of improving the fence along Highway 180 will help facilitate the pronghorn crossing between summer and winter range between GMUs 7 and 9. Aspen treatments would have limited effects to red-naped sapsuckers in the short term, but should improve habitat in the long-term. Fuelwood gathering would affect the goshawk, pygmy nuthatch, hairy woodpecker, red-naped sapsucker, pronghorn, juniper titmouse, western bluebird and Grace's warbler by removing snags and logs needed for nesting or prey species. Because only a small amount of pinyon-juniper habitat will be treated, impacts to populations of juniper titmice are not expected. The proposed activities could benefit pronghorn locally by creating openings to support browse and improve landscape permeability.

ROW maintenance would benefit species that use open habitat like pronghorn, elk, and turkey by keeping liner strips of grassland open across the forest. These areas could also support prey species for goshawks. ROW maintenance can also remove snags, logs, shrubs, and large trees, negatively affecting species tied to these habitat features such as the pygmy nuthatch, hairy woodpecker, western bluebird, and mule deer.

Development on private lands, particularly in the grassland and savanna habitats, will reduce habitat quantity and quality and affect movement corridors for pronghorn, deer and elk. Additionally, the exurban development and the additional training ranges on the Navajo Army Depot will likely limit use by and movement of deer and elk in many of these areas. The Navajo

Army Depot has also cleared or plans to develop NEPA to thin and/or use prescribed fire to improve conditions on approximately 21,885 acres of ponderosa pine habitat and grasslands. This would improve habitat conditions for the ponderosa pine and grassland species.

On the Coconino NF, for the goshawk and pronghorn, the improvement of habitat across the southern part of the forest would not change the forestwide habitat trend, but would help stabilize forestwide population trends. The forestwide habitat trend for the pygmy nuthatch would be improved by thinning projects that retain and enhance the large tree component within the ponderosa pine forest. This may help the forestwide population trends to stabilize. The tassel-eared squirrel, mule deer, elk, red-naped sapsucker, wild turkey, hairy woodpecker, and juniper titmouse forestwide population and habitat trends would not change.

On the Kaibab NF, for the pronghorn, the improvement of habitat across the southern part of the forest would not change the forestwide habitat trend, but would help stabilize forestwide population trend. The forestwide habitat trend for the Grace's warbler and western bluebird would be improved by thinning projects that retain and enhance the large tree component within the ponderosa pine forest and provide a mosaic of stand conditions within the ponderosa pine habitat. It is likely the forestwide population trends for the Grace's warbler and the western bluebird would not change.

Alternatives B, C, D and E – Coconino NF Management Indicator Species

The planned thinning and burning of 83,302 to 134,471 acres of ponderosa pine habitat within the project area will help reduce small tree densities and help move habitat toward historical stand structures. These treatments would have the same benefits discussed in alternative A, but when added to the additional treatments in the action alternative, would provide for improvement across the landscape. These treatments would affect the goshawk, pygmy nuthatch, turkey, hairy woodpecker, elk, mule deer and Abert's squirrel by improving their habitats in the long term. There is an additional 70,138 to 87,988 acres treated outside the project area that would further enhance mule deer and elk herd movements.

Aspen restoration would impact 46 percent of the forest aspen clones. These treatments would have limited improvement of the red-naped sapsucker in the short term, but should improve habitat components in the long-term. When combined with the proposed treatments in the action alternatives, this would improve most of the aspen clones outside of wilderness areas.

Fuelwood gathering and travel management requirements together help determine where the public collects fuelwood. Proposed treatments should help limit the amount of area not meeting forest requirements. This would affect the goshawk, pygmy nuthatch, hairy woodpecker, red-naped sapsucker and juniper titmouse by removing snags that are needed for nesting or prey species. Pinyon-juniper thinning and burning, ROW maintenance and development on private and other federal lands would have the same impacts as described for alternative A.

For all species, the cumulative effects of the above projects would not change the predicted forestwide habitat and population trends.

Alternatives B, C, D and E – Kaibab NF Management Indicator Species

The planned thinning and burning of 39,166 to 60,934 acres of ponderosa pine habitat would help reduce small tree densities and help move habitat toward historical stand structures. When added to the additional treatments in the action alternatives, would provide for improvement across the landscape. These treatments would affect the Grace's warble and western bluebird by improving their habitats in the long term. The Grace's warble forestwide habitat trend would be improved by thinning projects that retain and enhance the large tree component within the ponderosa pine forest and the western bluebird by the openings created within the ponderosa pine habitat and the creation and retention of large snags. The ponderosa pine savanna treatments, 4,416 of the above acres, would benefit the pronghorn by creating forage and corridors for movement between areas.

The 4FRI team and the AGFD located a suitable site for a future wildlife crossing over Interstate 40 between Flagstaff and Williams. Treatment objectives in these stands are to maximize sight distance for pronghorn in movement corridors and create approaches to I-40 through currently forested lands. Changes to these stands would incorporate connected openings/interspaces to facilitate east-west movements around private lands as well. Overall, this change would improve pronghorn connectivity immediately after treatment and would support potential improvements in the future as well.

Fuelwood gathering and travel management requirements together help determine where the public can legally collect fuelwood. There would likely be less dead woody material available within fuelwood areas closer to roads. This would affect the western bluebird and Grace's warbler by removing snags that are needed for nesting or prey species. ROW maintenance, pronghorn fence crossings, and development on private and other federal lands would have the same impacts as described above for alternative A.

For all the species, the cumulative effects of the above projects would not change the predicted forestwide habitat and population trends.

Coconino NF Forest Plan Amendments

Not incorporating the proposed amendments would affect the habitat of most of the MIS addressed in this report (table 190 in the wildlife report). The Mexican spotted owl amendments (amendment 1) would allow managing for lower tree densities and basal area, creating canopy gaps, creating and sustaining more large pine and oak trees in the long-term, larger snags through time, and increasing understory response. Not incorporating these amendments would allow:

- uncharacteristically dense forest conditions, fewer big pine and oak trees, and increased risk of high-severity fire for wildlife using forested habitats in 18 PACs (related to the proposed mechanical treatments in alternatives B through E) .
- uncharacteristically dense forest conditions, lower canopy base height, and increased risk of high-severity fire in 53 PACs (related to the proposed prescribed fire treatments in alternative C only).
- fewer PACs attaining the desired post-treatment conditions due to sequencing of treatments through time (alternatives B through E).
- tree densities maintained well above the minimum basal area stand values recommended in the draft recovery plan across all PACs, target, and threshold habitats (i.e., not using the best science available; alternative C only).
- understory conditions would continue to decline across Mexican spotted owl habitat, affecting prey habitat and likely decreasing the total prey biomass for raptors.

Not including the amendment related to management of canopy cover and open reference conditions within ponderosa pine forest (amendment 2) would prevent the ability to include rooting space necessary to sustain dense groups of trees, reduce forest densities and associated forest health issues (measured by the percent SDI max), and prevent the restoration of grasslands and savanna. This would decrease the ability to maintain dense groups of trees along with shrub and herbaceous vegetation, decreasing foods for herbivores, granivores, insectivores, and so for carnivores as well. Grassland species and dispersing individuals of prey species (primarily rodents and lagomorphs) that aid in maintaining prey populations in forested habitat would be reduced as trees continue to encroach upon open habitats. Simultaneously, habitat for species that depend on closed canopy would gradually increase.

Currently, many of the MIS depend on habitats or habitat elements related to canopy openings or early seral conditions. Existing closed canopy forests limit or eliminate many of the necessary habitat components needed by these species. The desired condition of closed canopy tree groups interspersed with open rooting space that supports herbaceous vegetation would provide key habitat components for these species of status as well as other species adapted to closed-canopy forests. Achieving this situation is the reason for the amendments and this interspersion of habitats, which is a fundamental part of the desired condition, would not be attained without incorporating the amendments into the action alternatives. There would be no effect to MIS from amendment 3.

Migratory Birds

Arizona Partners in Flight identified physiographic areas and priority migratory bird species by broad habitat types (Latta et al. 1999). In March 2008, the FWS released its 2008 “Birds of Conservation Concern Report” (USDI FWS 2008). This analysis considered high priority bird species from both Arizona Partners in Flight and the FWS birds of conservation concern (wildlife report, table 48).

The Coconino and Kaibab NFs occur within two bird conservation regions (BCRs): the Southern Rockies/Colorado Plateau (BCR 16) and Sierra Madre Occidental (BCR 34). For the Kaibab NF, the analysis area only occurs within BCR 34. Proposed management effects to individual species also considered information from the Birds of North America web site (England and Luadenslayer 1993, Bechard and Schmutz 1995, Hahn 1996, Vickery 1996, Toblaske 1997, Barlow et al. 1999, Sterling 1999, Cicero 2000, Stacier and Guzy 2002, Bechard et al. 2010, Guzy and Lowther 2012).

In response to comments on the DEIS, additional information on affected habitat has been included to support the environmental consequences. However, important habitat features and life history considerations continue to be incorporated by reference from the specialist report.

Affected Environment and Environmental Consequences

The following habitats would be affected in the analysis area. Not all bird species described have been located within the analysis area, but they have the potential of occurring here. While riparian habitat and cliffs/rock habitats are found in the analysis area, the proposed activities would not affect these habitat types.

Ponderosa Pine Habitat Type

It is estimated that approximately 3,680,000 acres of ponderosa pine forest exists in Arizona, representing approximately 5 percent of the total land area of the state. It occupies much of the mountain and plateau country above 6,500 feet elevation, replaced by mixed conifer forest above 8,500 feet (Latta et al. 1999). The analysis area contains approximately 507,830 acres of ponderosa pine habitat. The analysis area is approximately 14 percent of the ponderosa pine habitat in Arizona and 38 percent of the ponderosa pine PNVT cover type on both forests.

The following species are analyzed for this vegetation type: northern goshawk, flammulated owl, olive-sided flycatcher, Cordilleran flycatcher, Grace's warbler, Lewis's woodpecker, purple martin, and Cassin's finch.

All but the northern goshawk and purple martin would have potential removal of nesting habitat that would result in the potential to kill young of the year. Due to low amount of removing nest habitat while young are still in the nest, there no measureable negative effects to any these birds' populations from alternatives B, C, D and E.

Aspen Habitat Type

In some areas, aspen forms extensive pure stands. In others, aspen is a minor component of the forest landscape, and can be found in ponderosa pine, and mixed conifer stands (Latta et al 1999). It is estimated that approximately 79,000 acres of aspen exist in Arizona. Aspen stands typically have a maximum life span of 200 years. Without a substantial disturbance such as high-severity fire or overstory removal to stimulate early seral renewal, the aspen will die out and as it becomes dominated by conifers (Latta et al 1999). The analysis area contains approximately 1,522 acres of aspen habitat. The analysis area is approximately 2 percent of the aspen habitat in Arizona and 4 percent of the aspen on both forests.

The red-naped sapsucker is the only species within the aspen habitat. Only a small percentage of aspen or snags would be removed and not all removed trees would have active nest sites due to either not being nest trees or treatments occurring outside of breeding season. However, there would be potential of loss of young of the year. The removal of any eggs or fledgling would not result in a measurable negative effect to the red-naped sapsucker population from alternatives B, C, D and E.

Pinyon-Juniper Habitat Type

It is estimated that approximately 13,167,460 acres of pinyon-juniper forest exists in Arizona. Pinyon-juniper is cold-adapted evergreen woodland situated above desert or grassland vegetation and below ponderosa pine forests. The habitat is characterized by varying co-dominance of juniper species and pinyon pine. Typically, pinyon-juniper exhibits an open woodland arrangement with well-spaced trees. However, depending on site variables, pinyon-juniper may range from an openly-spaced savanna to closed woodland (Latta et al. 1999). The analysis area contains approximately 25,658 acres of pinyon-juniper habitat. The analysis area is less than 1 percent of the pinyon-juniper habitat on both forests.

The following species are analyzed for this vegetation type: gray vireo, pinyon jay, juniper titmouse, black-throated gray warbler, and gray flycatcher. There would be potential for young of the year being killed by removal of pinyon-juniper habitat through burning and mechanical treatment for these species. The project only occurs within less than 1 percent of the pinyon-juniper that occurs over both forests. Not all treatments would occur during the breeding season. The removal of any eggs or fledgling would not result in a measurable negative effect any of these species' population from alternatives B, C, D and E.

High Elevation Grasslands Habitat Type

The High Elevation Grassland habitat type is defined in Arizona Partners in Flight as subalpine-alpine grasslands/montane meadows and Plains/Great Basin Grasslands. Upland grasslands in northern Arizona comprise all grass-dominated sites from the lower limits of the montane zone up to alpine tundra. There is an estimated 20,230 acres of upland grasslands in the state. Plains/Great Basin Grasslands occur in northern Arizona. While they cover a much larger area than upland grasslands, there are no current estimates for acreage (Latta et al. 1999). The analysis area contains approximately 48,703 acres of grassland habitat. The analysis area is approximately 10 percent of the grassland habitat on both forests.

The following species are analyzed for this vegetation type: Swainson’s hawk, ferruginous hawk, burrowing owl, grasshopper sparrow, and Bendire’s thrasher. Only the burrowing owl, grasshopper sparrow, and Bendire’s thrasher have potential for mechanical treatments of removing nest with young of year, or for the grasshopper sparrow and Bendire’s thrasher the loss of nest sites through burning. Due to limit amount of habitat that would be affect by the implementation of the project and not all habitat would be affected during the nesting season, it would not result in a measurable negative effect any of these species’ population from alternatives B, C, D and E.

Important Bird Areas

Anderson Mesa is the only important bird area (IBA) within the project area. The IBA covers approximately 167,843 acres. This site serves as a principle stopover for migrating waterfowl, water birds, and wading birds in Arizona, particularly for dabbling ducks (e.g., cinnamon teal) during spring migration. It also has habitat for pinyon jays, a species of conservation concern.

There are 63,157 acres of the project area within the IBA, covering about 38 percent of the Anderson Mesa IBA. About 42,486 to 43,864 acres of habitat would be treated within the project area, equaling about 25 to 26 percent of the IBA. While most acres proposed for treatment are within ponderosa pine habitat, treatments in the IBA would also occur in grassland, aspen and pinyon juniper habitats. In addition, 53 miles of road decommissioning, restoration of six springs, and 7.5 miles of ephemeral stream channel restoration activities are proposed within the IBA.

In all action alternatives, wildlife design features for bald and golden eagle and other raptors and great blue herons (FEIS appendix C) would help mitigate impacts from treatments and hauling harvested materials from other treatment areas.

Forest Plan Amendments – Effects to Migratory Birds and Important Bird Areas

Not incorporating amendment 1 and 2 would affect the habitat of most of the migratory birds addressed in this report (see the wildlife report for complete analysis). Not including the amendments would not be expected to affect the Anderson Mesa Important Bird Area (IBA). The Mexican spotted owl amendments (amendment 1) would allow managing for lower tree densities and basal area, creating canopy gaps, creating and sustaining more large pine and oak trees in the long-term, more large snags through time, and increasing understory response. Not incorporating these amendments would allow:

- uncharacteristically dense forest conditions, fewer big pine and oak trees, and increased fire risk for wildlife using forested habitats in 18 PACs (related to the proposed mechanical treatments in all action alternatives);
- uncharacteristically dense forest conditions, lower crown base height, and increased fire risk in 56 PACs (related to the proposed prescribed fire treatments in alternative C only);
- fewer PACs attaining the desired post-treatments condition due to sequencing of treatments through time (all action alternatives);
- uncharacteristically dense forest conditions, fewer canopy openings, and fewer large pine and oak trees in restricted habitat that would be managed as threshold habitat where no resident Mexican spotted owls exist on the Kaibab NF (all action alternatives);

- tree densities maintained well above the minimum basal area stand values recommended in the draft recovery plan across all PACs, target, and threshold habitats (i.e., not using the best science available; alternative C only); and
- understory conditions would continue to decline across Mexican spotted owl habitat, affecting prey habitat and likely decreasing the total prey biomass for raptors.

Not including the amendment related to management of canopy cover and open reference conditions within ponderosa pine forest (amendment 2) would prevent the ability to include rooting space necessary to sustain dense groups of trees, reduce forest densities and associated forest health (measured by the percent maximum SDI), and prevent the restoration of grasslands and savanna. This would decrease the ability to maintain dense groups of trees along with shrub and herbaceous vegetation, decreasing foods for herbivores, granivores, insectivores, and so for carnivores as well. Grassland species and dispersing individuals of prey species (primarily rodents and rabbits/hares) that aid in maintaining prey populations in forested habitat would be reduced as trees continue to encroach upon open habitats. Simultaneously, habitat for species that depend on closed canopy would gradually increase.

Currently, many migratory birds depend on habitats or habitat elements related to canopy openings or early seral conditions. Existing closed canopy forests limit or eliminate many of the necessary habitat components needed by these species. The desired condition of closed canopy tree groups interspersed with open rooting space that supports herbaceous vegetation would provide key habitat components for these species of status as well as species adapted to closed-canopy forests. Achieving this situation is the reason for the amendments. This interspersion of habitats, which is a fundamental part of the desired condition, would not be attained without incorporating the amendments into the action alternatives. Amendment 3 would not affect migratory birds.

Cumulative Effects for Migratory Birds

The effects of projects that already have been implemented were used to help describe current conditions of the analysis area and will not be discussed in this section. Ongoing and reasonably foreseeable activities are listed in appendix 17 of the wildlife report. Cumulative effects discussed here have occurred since 2001 and are considered changes in the existing condition, including the effects of the alternative being discussed. The time frame considered is approximately 10 years in the future at which time the majority of the actions proposed will have been completed and the vegetation response to these actions would have occurred. The area of analysis for cumulative effects is the project area. While birds may move to other areas, their nesting habitat, along with winter roost areas for bald eagles, is the most limiting factor for these species.

Because of their seasonal movement, the primary management concern for migratory birds is nesting habitat and, for bald eagles, winter roost sites and known nest sites. The cumulative analysis area for migratory birds is the project area. Past, present and reasonably foreseeable activities are listed appendix 12. The effects of projects already implemented were used to describe existing conditions of the project area and will not be discussed in this section.

There are many on-going or planned projects that will thin ponderosa pine habitat. These thinning treatments vary greatly and include noncommercial thinning, group selection, sanitation thinning, and shelterwood cuts. Slash treatments associated with these thinning treatments include lopping and scattering, hand and dozer piling and burning, and prescribed burning. There is an estimated 122,468 acres of thinning from other projects within the project area.

Many of the thinning projects include prescribed burning. There are also additional burn-only areas within the ponderosa pine habitat. There are also many areas that have maintenance burns occurring on five to 20-year cycles. There is an estimated 195,405 acres of burning in the project area. There will also be 4,416 acres of ponderosa pine savanna restoration occurring on the Kaibab NF.

Both forests are actively trying to restore aspen clones. The majority of the aspen on the Coconino NF is found within wilderness areas, whereas aspen is usually found in small patches scattered within the ponderosa pine forest on the south zone Kaibab NF. There are 683 acres of planned aspen restoration and subsequent barrier construction planned on the Kaibab NF and 4,637 acres of planned aspen restoration with associated barriers on the Coconino NF. In total, 5,320 acres of aspen restoration are planned or ongoing within the 4 FRI treatment area.

Both the Coconino and Kaibab NFs have begun implementing travel management within the treatment area. These efforts will affect impacts from fuelwood cutting, hunting, and recreational camping across both forests. On the Coconino NF, the public is allowed to travel cross country to collect cut fuelwood with the proper permit. On the Kaibab NF, the public is only allowed to drive off-road to collect fuelwood within designated areas. While there are species-specific rules for cutting dead trees, it is not uncommon for larger snags to be cut. This occurs closer to roads and decreasing miles of open road should decrease the loss of the resource. The Kaibab NF will allow for retrieval of elk during hunting season in all GMUs while the Coconino NF will allow elk retrieval in all GMU except 5a and 5b. The Coconino NF designated 300-foot corridors on select roads for people wanting to park vehicles away from roads. Parking along roads without camping corridors on the Coconino NF will be allowed up to 30 feet away. The Kaibab NF will allow parking up to 30 feet away from all open roads and does not have any designated areas for parking further in from roads for camping.

Pinyon-juniper thinning and burning is occurring on both forests. The Kaibab and Coconino NFs have planned 7,040 acres to be treated within the project area. Grassland restoration treatments include removal of encroaching conifers and prescribed burning to rejuvenate grasses and forbs. Within the project areas there are 9,840 acres of planned grassland treatments.

Both forests have on-going maintenance of rights-of-way (ROWs) for power and gas lines. This involves thinning and burning within the ROWs to keep the area clear of trees and shrubs. ROWs include 32,344 acres with the majority of the area on the Coconino NF.

Grazing is occurring through the project area on both forests. Grazing is an on-going activity and the timing of season of use varies by allotment. On average, 30 to 40 percent of the forage is allowed for utilization by livestock and wildlife. There is no proposal to increase any livestock numbers within these allotments. Therefore there is no additional affects beyond existing conditions.

There are approximately 150,000 acres of non-Forest Service administered lands within the project area. These areas include housing tracts, Navajo Army Depot, vacation homes, and ranchland. The Navajo Army Depot is planning development of new training ranges and thinning and prescribed burning. The Department of Defense is planning 17,049 acres of thinning and burning in ponderosa pine and some grasslands restoration. The Greater Flagstaff Forest Partnership is planning to burn and thin 535 acres of ponderosa pine habitat around the Flagstaff area.

Cumulative Effects of Alternatives B through E

Resulting forest structure from planned thinning and burning of 195,405 acres of ponderosa pine habitat outside of the 4FRI would result in habitat resembling the historical range of variation. In the long-term, wildlife species are less likely to be adversely affected by treatments that result in habitat conditions consistent with those their evolutionary past and so are expected to respond positively to the ongoing and proposed thinning projects (Kalies et al. 2010). These treatments would improve habitat for most birds species associated with the ponderosa pine cover type in the long term (e.g., bark gleaners, woodpeckers, and flycatchers), but may negatively affect foliage gleaners in the short term (Patton and Gordon 1995, George et al. 2005).

The proposed aspen restoration is planned for areas that are a high priority for restoration on both forests. Cumulatively, this would treat the aspen outside of wilderness that are at most risk of being lost in the near future. These treatments would yield limited improvements for the red-naped sapsucker in the short term, but should improve their habitat components in the long term.

Fuelwood gathering and travel management requirements together help determine where the public collects fuelwood. The public will be limited in where they can travel off road to gather fuelwood on both the Coconino and Kaibab NFs. This will likely leave higher densities of dead and down woody material in areas further from roads. Less dead woody material would be expected to remain within fuelwood areas and areas closer to roads. Designated fuelwood areas on the Kaibab NF may not always meet forest plan requirements once wood gathering activities are terminated. Areas adjacent to roads may be deficit on the Coconino NF. This could have a negative effect on species that use snags or down material in the ponderosa pine, aspen, and pinyon-juniper. In grasslands, the travel management requirements will benefit grassland species by preventing the cross country travel into their habitat.

Pinyon-juniper thinning and burning has the potential to both remove habitat and improve habitat for the birds that use this habitat type. The proposed activities could result in loss of young of year depending on timing of activities. The effects to Pinyon-juniper associated species are expected to be limited because only a small amount of this habitat would be treated within the cumulative effects analysis area.

ROW maintenance will help keep strips of land open and create the equivalent of relatively narrow, liner grasslands. While this may affect individual birds, there is not likely to be a cumulative effect to any species because of the limited space and spatial configuration of this habitat.

Development on private land and other federal lands continue to remove habitat within and adjacent to the project area. With the development of the additional training ranges on the Navajo Army Depot this will likely move more species out of area. The cover type with the most development occurring is within grasslands and savanna habitat. This will remove habitat and potentially cause some mortality of grassland species, particularly young-of-the-year, depending on the timing of the development.

The Coconino NF has implemented an innovative management strategy to protect wetlands from grazing and prolonged drought within the Anderson Mesa IBA by regulating the timing and duration of livestock grazing in permitted areas. Wetlands are being protected from livestock by constructing fences that still allow passage of wildlife. Habitat restoration, including the restoration of grasslands, is in progress. Ranchers are actively engaged through the Diablo Trust and numerous conservation organizations have assisted in achieving conservation objectives for the site.

The cumulative effects for the migratory birds could result in some incidental mortality caused by project implementation activities. How much mortality would be proportional to how many acres are treated during the spring nesting season of April, May, June, and July. Seasonal restrictions would limit project implementation activities between March 1 and September 30 in goshawk nest area and PFAs and within Mexican spotted owl PACs, which would reduce potential of loss for species listed in ponderosa pine habitat. Prescribed fire can also occur in the fall, outside of the spring nesting season. Since only a small percentage of habitats would be treated at any one time, the loss of eggs or nestlings would not result in a measurable negative effect to the migratory birds populations listed above.

Rare and Narrow Endemic Species for the Kaibab NF

The Kaibab forest plan (USDA FS 2014) provides desired conditions and guideline for the protection of rare and endemic species on the forest. Table 85 shows which terrestrial species are considered rare and endemic on the forest and if they are located within the 4FRI analysis area. No further documentation is required for species not located within the analysis area.

Table 85. Forest planning species classified as having restricted distributions or narrow endemic species

Species	Rare	Narrow Endemic	Found in the 4FRI Analysis Area	Comment
California condor	Yes	No	Yes	Covered in the TES section
Apache trout	Yes	No	No	Only found on North Kaibab Ranger District
Arizona black rattlesnake	Yes	No	Yes	Additional analysis provided
Utah Mountain kingsnake	Yes	No	No	Only found on North Kaibab Ranger District
Persephone’s darner	Yes	No	No	Riparian habitat required – not affected by project activities
Kaibab fairy shrimp	No	Yes	No	Only found on North Kaibab Ranger District
Kaibab variable tiger beetle	No	Yes	No	Only found on North Kaibab Ranger District
Kaibab Indra swallowtail	No	Yes	No	No habitat within the analysis area
House Rock Valley chisel-toothed kangaroo rat	No	Yes	No	Only found on North Kaibab Ranger District
Kaibab least chipmunk	No	Yes	No	Only found on North Kaibab Ranger District
Kaibab tree squirrel	No	Yes	No	Only found on North Kaibab Ranger District
Kaibab northern pocket gopher	No	Yes	No	Only found on North Kaibab Ranger District

The following behavior and natural history was extracted from Bergamini et al. (2014). The Arizona black rattlesnake is almost exclusively endemic to Arizona. Very little is known about this species in its northern habitat and its distribution within the 4FRI project area, so inferences are drawn from what is documented about C. Cerberus from lower elevational or latitudinal habitats. Several factors, including poor habitat, very limited water resources and competition with similar species may limit the occurrence in the Tusayan Ranger District.

Project activities would have limited activities in riparian zones or along perennial streams (see soil and watershed design features and BMPs), therefore project activities would not be expected to directly affect these habitats except through spring and ephemeral channel restoration. Ungulate grazing can affect Arizona black rattlesnake habitat in mesic habitats. Restoration of springs and ephemeral channels (alternatives B through E) would be protected (fencing, jackstrawing, etc.) to minimize risk of ungulate grazing post-treatment (see wildlife and soil and watershed design features). To protect hibernacula the following design features (FEIS appendix C) were developed based on recommendations by Bergamini et al. (2014):

- Avoid management practices with potential to impact to hibernacula.
- Avoid temporary road construction within 300 feet of identified hibernacula locations

Within ¼ mile of known hibernaculum:

- Conduct prescribed fires from November 1 to March 31 to minimize impacts to snakes. Avoid prescribed fire within ¼ mile of outside the denning season.
- Ignite slash piles in winter or ignite from the exterior, lighting no more than a contiguous 25 percent of the pile's edge to minimize impacts to Arizona black rattlesnakes.

The Coconino NF is currently in the process of revising their forest plan. Although no list of narrow and endemic wildlife exists at this time, forest plan direction would be followed once species are identified and if they occur within treatment area.

Other Forest Plan Required Analyses for Wildlife

Hiding and Thermal Cover

The Coconino NF forest plan direction for wildlife calls for at least 30 percent hiding and thermal cover. The forest plan stipulates cover be assessed in 10 thousand acre blocks. Of this total at least one third should be thermal cover, one third hiding cover, and the remaining one third in either thermal or hiding cover. Results from the queries done to assess wildlife cover (see Methods section in the wildlife report for details) indicate the existing landscape is dominated by cover. In alternative A cover would continue to increase through time and the percent of the area that provides no cover approaches zero by the year 2050.

The action alternatives reduce hiding cover through the thinning and opening of current forest conditions. Results are similar between alternatives overall. Restoration units continue to meet or exceed forest plan direction in the year 2020, except for Restoration 3 under alternative C. The main difference between action alternatives and no action is in the year 2050 when much percentages of the area do not meet either hiding or thermal cover. This suggests wildlife cover can be met, even when using dated forms of evaluation, while successfully moving forest conditions toward the historical range of variation. Given the historical conditions documented for northern Arizona forests and the fact that target ratios for cover were developed to optimize deer and elk habitat in northeastern Oregon, a decrease in overall cover values likely represents an increase in forest resiliency and sustainability.

Aquatic Species and Habitat

This section includes summarized effects and conclusions for aquatic threatened, endangered, and proposed species and critical habitat listed under the Endangered Species Act of 1973, as amended, Forest Service Southwestern Region sensitive species, and Coconino and Kaibab NFs aquatic management indicator species (MIS).

The aquatics specialist report (Childs 2014) is incorporated by reference. See the specialist report for detailed information on methodology, analysis assumptions, best available science and data, habitats, populations, and effects that are not repeated in this section.

Changes from the Draft Environmental Impact Statement and Opposing Science

Changes are described in chapter 2 of this FEIS. No comments that included literature that could be considered opposing that was entirely specific to aquatic species or habitat was received. Comments and literature that were soil and water quality-related were addressed by the soils and water quality specialists (Steinke 2014, MacDonald 2014). Also see the content analysis for all aquatic-related responses. The analysis was updated as needed in response to comments from the Arizona Game and Fish Department.

Aquatic Federally Listed Threatened, Endangered, Proposed Candidate Species, and Designated Critical Habitat, and Forest Service Sensitive Species

The Threatened, Endangered and Sensitive Species (TES) List for the Coconino and Kaibab National Forests were reviewed and a list of TES species was created for this project based on known occurrence or, in the absence of survey data, the presence of suitable habitat. The following is a description of the species their habitat, and an analysis of the effects of implementation of each alternative on each species.

Five endangered, one candidate, and three Forest Service sensitive fish and four macroinvertebrates and/or their habitat were considered in this analysis because of their potential occurrence within the project analysis area. Table 86 lists species considered and provides a summarized existing condition narrative. Table 87 describes the affected environment for species evaluated.

Three species (Gila chub, razorback sucker, and Colorado pikeminnow) were eliminated from further analysis because these species do not have critical habitat, potential habitat, or occupied habitat in the analysis area. Gila Trout was eliminated from further analysis because this species does not have occupied habitat in the analysis area.

Management Indicator Species

All references to aquatic macroinvertebrates and their habitat are for the Coconino NF.

Table 86. Aquatic threatened, endangered, candidate, and sensitive species evaluated in this analysis

Common Name	Scientific Name	Status[1]	Occurrence[2]	Coconino NF Forestwide Habitat (miles)	Potential Habitat in Affected Environment (miles)	Occupied Habitat in Affected Environment (miles)
Fish						
Gila Chub	*Gila intermedia*	E, WC	Downstream	13.3*	0	0
Roundtail Chub	*Gila robusta*	C, WC, FS-S	Occurs	350.9	77.9	77.9
Spikedace	*Meda fulgida*	E, WC	Downstream	134.3*	36.8*	0
Colorado Pikeminnow	*Ptychocheilus lucius*	E[3], WC	Downstream	55.6	0	0
Loach Minnow	*Tiaroga cobitis*	E, WC	Historic	95.8*	36.8*	0
Razorback Sucker	*Xyrauchen texanus*	E, WC	Downstream	55.6*	0	0
Desert Sucker	*Catostomus clarki*	WC, FS-S	Occurs	236.7	77.9	77.9
Sonora Sucker	*Catostomus insignis*	WC, FS-S	Occurs	236.7	77.9	77.9
Macroinvertebrates						
California floater	*Anodonta californiensis*	FS-S	Historic	368.6	77.9	0
A Caddisfly	*Lepidostoma knulli*	FS-S	Occurs	ca. 13 mi	13	Unknown
A mayfly	*Moribaetis mimbresaurus*	FS-S	Occurs	ca. 13 mi	72.6	Unknown

1. Status: T = Federally listed as threatened, E = Federally listed as endangered, C = Candidate for Federal listing as threatened or endangered, WC = Wildlife of special concern in Arizona (1996 AGFD classification pending revision to Article 4 of the state regulations), FS-S = Forest Service sensitive species
2. Occurs = Species known to occur in the project area, or in the general vicinity of the area, Downstream = Species occurs downstream of project area, Historic = Species occurred historically in project area
3. Colorado pikeminnow is listed as endangered; the species is listed as "experimental non-essential" in Arizona.

* All habitat is also critical habitat

Table 87. Aquatic threatened, endangered, candidate, sensitive, and management indicator (MIS) species evaluated in this analysis and their affected environment

Common (Scientific Name)	Affected Environment
Threatened and Endangered Aquatic Species	
Spikedace (*Meda fulgida*) and critical habitat	Spikedace is historic to the Verde River. However, the species has not been detected for years in this system and may be extirpated. There are 134.3 miles of spikedace critical habitat within the Coconino NF boundary. Within the analysis area, the species has 36.8 miles of critical habitat, in middle and lower Oak Creek. Although unoccupied, this habitat is analyzed for potential effects from the proposed alternatives.
Loach Minnow (*Tiaroga cobitis*) and critical habitat	Loach minnow has been extirpated from the Verde River, and it has not been detected in that stream since 1938 (Minckley 1993). There are 95.8 miles of loach minnow critical habitat within the Coconino NF boundary. Within the analysis area, the species has 36.8 miles of critical habitat, in middle and lower Oak Creek. Although unoccupied, this habitat is analyzed for potential effects from the proposed alternatives.
Aquatic Candidate Species	
Roundtail Chub (*Gila robusta*)	There are 350.9 miles of potential roundtail chub habitat within the Coconino NF boundary. Within the analysis area, the species occupies 77.9 miles (22.2 percent) of perennial stream, including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek.
Southwestern Region Forest Service Aquatic Sensitive Species	
Desert Sucker *(Catostomus clarki)*	There are 236.7 miles of potential desert sucker habitat within the Coconino NF boundary. Within the analysis area, the species occupies 77.9 miles (32.9 percent) of perennial stream, including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek.
Sonora Sucker *(Catostomus insignis)*	There are 236.7 miles of potential Sonora sucker habitat within the Coconino NF boundary. Within the analysis area, the species occupies 77.9 miles (32.9 percent) of perennial stream, including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek.
California Floater *(Anodonta californiensis)*	There are 368.6 miles of potential California floater habitat within the Coconino NF boundary. Within the analysis area, there are 77.9 miles (21.1 percent) of potential perennial stream habitat, including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek.
A Mayfly *(Homoleptohyphes quercus)*	The species is poorly known in Arizona, but the holotype male was collected from Oak Creek at the confluence of Pump House Wash in 1984 (McCafferty 2007).
A Caddisfly (*Lepidostoma knulli)*	Moulton et al. (1994) lists two sites in Apache and Coconino Counties, Arizona. In Coconino County, the species was collected in Oak Creek Canyon, Manzanita Recreation Area, 1993.
Aquatic Management Indicator Species (MIS)	
Macroinvertebrates	As a group, aquatic macroinvertebrates are identified in the Coconino NF forest plan as MIS for high and low elevation late-seral riparian areas. There are 368.6 miles of potential macroinvertebrate habitat within the Coconino NF boundary. Within the analysis area, macroinvertebrates occupy 83.7 miles (22.7 percent) of perennial stream, including Munds Canyon, Oak Creek, Pumphouse Wash, Rio de Flag, Sawmill Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek.

Environmental Consequences

Potential impacts to aquatic resources are compared to the sediment outputs predicted in the soils and hydrology specialist report (Steinke 2014, MacDonald 2014). The primary environmental consequence to aquatic habitat and associated species from timber and vegetation treatments would be increased ground disturbance which has the potential to increase the rate of soil erosion over natural background levels. The analysis focuses on the predicted ground disturbance and its effect in regards to the following:

- Changes in sediment and erosion
- Alterations to channel morphology—increased sediment has the potential to alter stream channel morphology
- Changes to stream temperatures—alterations in morphology can change the width to depth ratio of channels and shallower wider channels can lead to more drastic diurnal fluctuation in stream temperature and higher and lower temperature extremes
- Effects on riparian vegetation—loss of upland watershed vegetation can lead to flashier hydrographs which erode stream channels, lowering the water table impacting riparian vegetation
- Macroinvertebrate assemblage—alteration in channel morphology or increases in sediment can alter the macroinvertebrate assemblage

General Effects on Aquatic Habitat

Alternative A

Under the no action alternative, 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 adjacent to the project area. Approximately 43,041 acres of vegetation treatments and 58,714 acres of prescribed fire and maintenance burning would be implemented adjacent to the project area by the Forests 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. However, there would be no restoration of springs and no restoration of ephemeral channels. These areas would continue to exhibit downward trends in functional condition or remain in static condition for the foreseeable future.

This alternative would result in no additional acres of ground disturbance from mechanical vegetation treatments, piling of activity-related woody debris, construction and maintenance of temporary roads, road obliteration, fence construction, and the use of prescribed fire. Because these activities can have short-term adverse effects to water quality and riparian areas, alternative A poses fewer short-term risks to water quality and riparian areas than the Action Alternatives. Implementation of alternative A would put soils and watersheds at risk of continued uncharacteristic wildfires that could result in loss of soil productivity and sediment delivery to connected streamcourses (Steinke 2014).

Alternatives B, C, D, and E

The perennial streams within the project area that contain fish and/or macroinvertebrates are Munds Canyon, Oak Creek, Pumphouse Wash, Rio de Flag, Sawmill Wash, Sterling Canyon, Sycamore Creek, and West Fork Oak Creek (aquatics report, figure 14). Three watersheds (Upper Oak Creek, West Fork of Oak Creek and Pumphouse Wash have predicted cumulative effects soil disturbance greater than 15 percent as a result of the May, 2014 Slide Fire (Steinke 2014). For these reasons, additional protective measures were added with BMPs (see appendix C) to protect habitat within and downstream of the Slide fire area.

Direct effects of vegetation management on stream systems should be minor when Forest Service BMPs (Southwestern Region FSH 2509.22) are followed (see appendix C) are followed. Limiting vegetation management activities from impacting stream courses should lead to minor or inconsequential direct effects to stream habitat and associated biota. While prescribed fire has the ability to have direct effects to stream channels, none of the action alternatives propose for ignitions to occur within riparian areas or along stream channels, but fire is allowed to back downslope into these areas. If fire burns riparian areas, there is the potential for some ash and localized erosion to occur; however, these effects should be minor in degree and extent.

Most effects to aquatic habitat and biota are the result of upland terrestrial changes that result in changes to sediment and water transport in the watershed. The primary negative impacts to aquatic systems and their associated biota from vegetation treatment and prescribed fire come as indirect effects. These indirect effects include: increased sediment, loss of riparian vegetation, altered macroinvertebrate assemblages, lowering of groundwater tables and decreased perennial flows, increased stream temperature, larger peak flows, stock tank impacts, and changes in channel form (Bisson et al. 2003, Swank et al. 1989).

In alternatives B through E, spring conditions would improve for up to74 springs within the analysis area (aquatics report, table 25). Initially, spring habitats would experience short-term increases in sediment production and transport as a result of restoration activities. As restored springs stabilize, however, springs would show increased surface flows and improved groundwater levels. Additionally, vegetation treatments at the watershed scale combined with prescribed burning could restore or improve hydrologic function of springs that currently have reduced discharge due to evapotranspiration losses of soil water that could otherwise recharge groundwater in perched or shallow aquifers (MacDonald 2014). Most of these springs are part of a larger perennial system. Spring improvement would increase potential habitat for Macroinvertebrates at the spring site and increase potential for both fish and macroinvertebrate habitat downstream.

Thirty-nine miles of ephemeral streamcourses would be treated to reduce channel and bank scour, downcutting, aggradation, and uncharacteristic levels of sediment transport. As restored areas stabilize, ephemeral streamcourse banks would have more gentle angles of repose that would support vegetative cover, more favorable floodplains to increase soil water storage, and reduced stream velocities; thus decreasing sediment transport (into fish and macroinvertebrate habitat), channel downcutting, and stream bank undercutting that results in bank failure.

A total of approximately 860 miles (726 miles on the Coconino NF and 134 miles on the Kaibab NF) of existing system roads and unauthorized roads would be decommissioned under all action alternatives. These activities would return unproductive acreage to a more stable, productive status over the long term by improving water infiltration, naturalizing water flow, increasing vegetative ground cover and reducing erosion (MacDonald 2014). Upon completion of road decommissioning activities, long term erosion rates for decommissioned roads are expected to approach natural erosion rates for TEUs where these roads occur. With implementation of appropriate BMPs as outlined in the FEIS appendix C, water quality and riparian ecosystem conditions would be improved, improving habitat for fish and Macroinvertebrates.

Approximately 40 miles of roads would be reconstructed to reduce adverse effects to surface water quality. These legacy roads are located in close proximity to, or within streamcourses. By relocating these roads to upland locations, sediment delivery directly to streamcourses (aquatic habitats) would be minimized.

Approximately 520 miles of temporary roads would be necessary to conduct vegetation treatments. These roads would be constructed (and decommissioned) using BMPs as outlined appendix C of this FEIS (table 27 in the aquatics report) thus minimizing adverse impacts to surface water quality. No riparian areas would be adversely affected by temporary road construction as none are proposed within riparian areas. Since the DEIS was issued, an additional design feature was developed to clarify when temporary roads would be decommissioned (see appendix C, T9).

Road-related operations would include dust abatement treatments. Eight road segments have been identified for dust abatement, totaling less than 7 miles in length. The average dust abatement treatment length would be about 0.9 miles, ranging from 0.3 to 2.5 miles. Because of the limited application spatially and temporally, and because locations do not include sensitive areas such as open water, dust abatement is not expected to result in measurable effects to aquatic species or their habitat.

Potential Impacts to Watersheds and Streamcourses

The potential impacts to watersheds and streamcourses was used to evaluate environmental consequences for fish and MIS. In all action alternatives, the effects from the Slide Fire where severely burn areas occur on slopes over 15 percent (Steinke 2014) were evaluated.

Rio de Flag Watershed: In the Rio de Flag 6th code HUC watershed there is no predicted sediment delivery to any 6th code HUC including Switzer Canyon, Sinclair Wash, Upper Rio de Flag because no prescribed burning is proposed on slopes greater than 15 percent.

Sawmill Wash Watershed: Sawmill Wash is part of the Canyon Diablo 4th Code HUC watershed. Only a small portion of this stream is perennial, but it is important habitat for wildlife and macroinvertebrates (MIS). There would be no change in sedimentation or ash effects to this perennial section. A buffer strip of at least 120 feet (soil and water BMP 8; Steinke 2014) would be used to protect this streamcourse where prescribed burning does occur.

Sycamore Creek Watershed: Sycamore Creek receives water from seven 6th Code HUC watersheds including Lower Sycamore Creek, Tule Canyon, Middle Sycamore Creek, Little Lo Spring Canyon, Volunteer Canyon, Big Spring Canyon and Upper Sycamore Creek.

- In Big Spring Canyon, Volunteer Canyon, Little Lo Spring Canyon, Middle Sycamore and Tule Canyon 6th Code HUC prescribed burning is proposed on slopes greater than 15 percent. These streamcourses would be protected with a 70-foot buffer strips (BMP 8; Steinke 2014) to mitigate sediment and ash flow potential.
- Lower Sycamore Creek 6th Code HUC watershed is also perennial, and may be affected by prescribed burning within the upstream treatment subunits just discussed. Any effects that

occur upstream would also impact this downstream-most portion of the creek. Lower Sycamore Creek contains both native fish and macroinvertebrates.

Oak Creek Watershed: Oak Creek receives water from five 6th Code HUC watersheds and about 18 different streamcourses. Many treatment subunits overlap with these streamcourses and watersheds, making the effects analysis quite complicated.

Oak Creek receives water from the Pumphouse 6th Code HUC watershed, which includes six different streamcourses. The Pumphouse Wash streamcourse runs through project subunits 1-3 and 3-4. There are no differences in proposed prescribed burning in subunit 1-3 for Pumphouse Wash, but alternative D proposes substantially fewer acres of prescribed burning of slopes over 40 percent along this streamcourse in subunit 3-4 than Alternatives B, C, or E. The risk of increased sediment and ash flow would be greater for these alternatives than for alternative D. A buffer strip of at least 120 feet (BMP 8; Steinke 2014) would be used to protect this streamcourse in subunit 3-4.

- No prescribed fire is proposed along the Schoolhouse Draw, Woody Wash and Fry Canyon streamcourses.
- In Kelly and James Canyon prescribed burning of slopes greater than 40 percent is proposed. A buffer strip of at least 70 feet (BMP 8; Steinke 2014) would be used to protect these streamcourses.

West Fork Oak Creek Watershed: This 6th Code HUC watershed receives runoff from one ephemeral tributary that runs through subunit 3-5, Casner Cabin Draw. All alternatives propose some prescribed burning on slopes greater than 15 percent near this streamcourse. A buffer strip of at least 70 feet (BMP 8; Steinke 2014) would be maintained.

Prescribed burning on slopes greater than 40 percent would occur in alternatives B, C and E. Alternative D proposes no prescribed burning in these areas, alternatives C and E would pose more risk than alternative B, which would pose more risk than alternative D, for sediment and ash flow into the streamcourse. However, protective stream buffer strips of at least 120 feet (BMP 8; Steinke 2014) would be employed along the entire length of West Fork Oak Creek for Alternatives B, C, and E.

Upper Oak Creek Watershed: Oak Creek receives water in this 6th Code HUC watershed from four streamcourses that run through project subunit 3-5: Bee Canyon, Surveyor Canyon, Crazy Park Canyon, and Sterling Canyon.

- Bee Canyon, Surveyor Canyon and Crazy Park Canyon: No prescribed burning would occur on slopes greater than 15 percent.

Lower Sterling Canyon Watershed: Prescribed burning is proposed on slopes greater than 15 percent in alternatives B, C, and E. There is a greater risk of sediment and ash flow to Sterling Canyon for B, C and E when compared to alternative D. A buffer strip of at least 70 feet (BMP 8; Steinke 2014) would be maintained along the Sterling Canyon streamcourse to reduce risk.

Munds Canyon Watershed: Munds Canyon runs through portions of subunits 1-5 and 3-5 (aquatics report, figure 15). Alternatives B, C, and E propose far more acres of prescribed burning on slopes greater than 15 percent than alternative D. Thus, there is a greater risk of sediment and ash flow to the Munds Canyon streamcourse, and eventually to Oak Creek, for alternatives B, C, and E.

Although streamcourses are not well-defined, a buffer strip of at least 120 feet (BMP 8; Steinke 2014) would be maintained to lessen the potential for sediment and ash to flow into Munds Canyon and Oak Creek.

Middle Oak Creek Watershed: This watershed receives water from Casner Canyon 1, which runs through project subunit 3-5, and may be affected by the action alternatives. Prescribed burning on slopes greater than 15 percent is proposed for the upper reaches of Casner Cabin 1 in all action alternatives (B-E). A filter strip of at least 70 feet (BMP 8; Steinke 2014) would be used along the upper portion of this streamcourse to lessen the potential for sediment and ash flow into Oak Creek.

Cumulative Effects to Aquatic Habitat

The geographic setting and boundary for the cumulative effects analysis (all alternatives) is all 82 6th HUC watersheds within or intersecting the project boundary for a total of about 2,032,080 acres. The timeframe for past actions is 2-3 years based on vegetative and course woody debris recovery of the site. Vegetative recovery after fuel treatments is generally very rapid, with erosion rates typically dropping to pre-fire levels within 1 to 2 years (Elliot et al. 2010:93).

Cumulative effects includes past timber sales and their associated roads, hazardous fuel and prescribed burning projects that can affect the acres of soil disturbance, primarily through fuel treatments, as well as past burning and wildfires, range allotments, roads, private land, power corridors and recreation activities. Recreation activities are dispersed across the cumulative effects boundary area and are not quantifiable.

Alternative A

Fuels reduction related projects are expected to occur within the cumulative effects project boundary. For the cumulative effects boundary area, there are approximately 157,500 acres of future and foreseeable treatment acres within the cumulative effects boundary (about 8 percent of the cumulative effects area). Assuming a 15 percent disturbance factor for treatments, there are a total of approximately 23,667 acres of ground disturbance from projects within the cumulative effects boundary area, or about 1 percent of the cumulative effects boundary area.

Cumulative Effects Baseline – Alternatives B, C, D and E

There are about 45,000 acres of baseline ground disturbance from roads, private land, grazing allotments, and powerline corridors that occur across the cumulative effects analysis area. The total acres of past, present, future and foreseeable treatment acres within the cumulative effects project area are roughly 290,000 acres (133,000 acres of past and present projects and 157,000 acres of future, foreseeable projects) or about 14 percent of the cumulative effects boundary area. Of these treatment acres, about 15 percent (43,500 acres) would have ground disturbance, or just over 2 percent of the cumulative effects analysis area. The project would add an additional 64,200 acres of ground disturbance for a total acreage of ground disturbance across the cumulative effects analysis area, of about 152,800 acres, or about 7.5 percent of the cumulative effects boundary area.

There are six 6th code watersheds where urban development has a large impact on ground disturbance. This project, plus current and future foreseeable projects impacts these watersheds in the following manner. In the Cataract Creek Headwaters watershed there was a 9 percent baseline ground disturbance prior to any activities. This percent of ground disturbance increases to 15 percent total cumulative ground disturbance. In the Sinclair Wash watershed, there was a 12 percent baseline ground disturbance prior to any activities. This percent of ground disturbance increases to 26 percent total cumulative ground disturbance with all current and foreseeable projects. In the Lower Rio de Flag watershed there was an 8 percent baseline ground disturbance that increases to 21 percent total cumulative ground disturbance. In the Middle Oak Creek watershed, there was a 7 percent baseline ground disturbance that increases to 11 percent total cumulative ground disturbance. Pumphouse Wash watershed has about 11 percent contributions from past, present and future projects and about 6 percent from 4FRI. Upper Rio de Flag watershed has about 14 percent contribution from past, present and future projects and about 3 percent from 4FRI. Implementation of BMPs would minimize any impacts to watersheds, and would be especially important in the watersheds that have a high urban impact already existing.

Implementation of BMPs would minimize any impacts to watersheds, and would be especially important in the watersheds that have a high urban impact already existing.

Total past, present and reasonable foreseeable actions contribute about 4 percent more ground disturbance to project treatments (average landscape, watershed level-wide by alternative). Total soil disturbance (cumulative effects and project treatments) would range from 7.6 percent (alternative D) to 8.2 percent (alternative C), with alternative B predicted at 8.0 percent and alternative E at 7.9 percent. The overall extent (around 8 percent for all action alternatives) and magnitude (2 year recovery time) of total ground disturbance is minimal, short term and much less than the 15 percent soil productivity threshold indicating soil productivity would be maintained at the watershed level along with watershed function.

Further protection of soil resources is provided by the use of best management practices that minimize the potential for soil disturbance. Identified and implemented BMPs are expected to reduce the risk on accelerated erosion, sediment delivery, and nonpoint source pollution to connected streamcourses and maintain water quality in all watersheds. In addition to the use of BMPs, implementation of the Travel Management EIS will further reduce the number of acres disturbed by closing and decommissioning roads within the cumulative effects boundary. Because of these facts, these alternatives would not provide detrimental cumulative effects to soil resources within the cumulative effects boundary. A discussion of cumulative effects resulting from the Slide Fire is found below.

The Slide Fire (Coconino NF, 2014) resulted in disturbances to 3 watersheds that cumulatively exceed the 15 percent ground disturbance threshold. They include Upper Oak Creek with a total of 4,362 acres or 20.6 percent of the watershed, West Fork of Oak Creek with a total of 16,432 acres or 30.1 percent of the watershed, and Pumphouse Wash with 11,423 acres or 18.2 percent of the watershed. The fire burned in portions of Fry Canyon and Dry Creek but cumulative ground disturbance totaled less than 10 percent.

To adequately protect soil productivity, water quality and watershed function, additional soil and water BMPs were identified (FEIS appendix C) that should allow adequate time (minimum of 5 years) for protective vegetative ground cover recovery in uplands and streamside management zones so that sediment will be trapped in the vegetative ground cover and not contribute excessive sediment into streamcourses. Research indicates that vegetative ground cover recovery occurs within about 5 years, sufficient to be similar to pre-fire conditions at levels that prevent erosion above tolerable limits after which treatments can be considered (Steinke 2014) USDA 2014 (BAER).

The combined cumulative effects of post fire soil disturbance plus 4FRI treatments are not expected to disturb more than about 15 percent of the soil and do not pose risk to soil productivity or water quality when implementing Slide Fire BMPs (aquatics report, table 27). Treatments would be deferred for at least 5 years, and this will assure adequate vegetative ground cover establishment in streamside management zones. Soil productivity is expected to be maintained and water quality is expected to meet designated beneficial uses and meet state water quality standards.

Alternatives C and E – Management of Canopy Cover

In response to comments on the DEIS, approximately 38, 256 acres would be treated less intensively (from the proposed savanna treatment). The soils and watershed report (Steinke 2014) found reducing treatment intensity on these acres would not directly or indirectly pose risk to soil productivity, water quality or watershed function. With the implementation of identified soil and water BMPs, soil disturbance direct effects associated with all proposed treatments has already been shown not to exceed the 15 percent established soil productivity threshold. Therefore, reduced treatment intensity would not exceed this threshold. For these reasons, there would be no measurable impact on aquatic habitat or aquatic species including threatened and endangered, candidate, Forest Service sensitive and Coconino NF management indicator species.

Effects of Coconino NF Forest Plan Amendments on Aquatic Species and Habitat

All proposed forest plan amendments are specific, one-time variances for the Coconino NF portion of the restoration project. The language proposed does not apply to any other forest project.

Alternatives B and D

Amendments 1 and 2

These proposed forest plan amendments are specific to Mexican spotted owl and Northern goshawk habitat. They would not result in measurable effects to aquatic species or their habitat compared to the general direct, indirect, and cumulative effects presented above for vegetation management and prescribed fire. These amendments would have no effect on aquatic species or their habitat.

Amendment 3

Amendment 3, which allows for management to achieve a “no adverse effect” determination for significant or potentially significant inventoried heritage sites, would not have a measurable effect on aquatic species or their habitat. Although heritage sites are often located in or near riparian areas and the consequence of this amendment would be to eliminate activities that could cause surface erosion around these sites, the number and size of inventoried heritage sites in riparian areas is insignificant compared to the proposed treatment area. This amendment would have no effect on aquatic species or their habitat.

Alternative C

Amendments 1 and 2

These proposed forest plan amendments are specific to Mexican spotted owl and Northern goshawk habitat. They would not result in measurable effects to aquatic species or their habitat compared to the general direct, indirect, and cumulative effects presented above for vegetation management and prescribed fire. These amendments would have no effect on aquatic species or their habitat.

Amendment 3

Amendment 3 would have no effect on aquatic species of their habitat. Although heritage sites are often located in or near riparian areas and the consequence of this amendment would be to eliminate activities that could cause surface erosion around these sites, the number and size of inventoried heritage sites in riparian areas is insignificant compared to the proposed treatment area.

Effects of Alternatives on Threatened, Endangered, and Candidate Species

Threatened, endangered, and Forest sensitive (TES) aquatic species in and adjacent to the project area are all located on the Coconino NF. Units and subunits (and relevant 6th Code HUC watersheds) that contain these species are: 1-3 (Pumphouse Wash), 1-4 (Sawmill Wash), 1-5 (Munds Canyon), 3-3 (Lower Sycamore Creek, Middle Sycamore Creek, Upper Sycamore Creek), 3-4 (Pumphouse Wash), 3-5 (Middle Oak Creek, Munds Canyon, Upper Oak Creek, West Fork Oak Creek), and 5-1 (Lower Rio de Flag). All other watersheds within the analysis area do not contain TES aquatic species habitat, and therefore are not considered further with respect to TES species effects.

Spikedace (Meda fulgida) and loach minnow (Tiaroga cobitis)

Alternative A

Spikedace and loach minnow are not currently present within the affected environment. Alternative A would have no indirect effect on these species.

Critical Habitat for Spikedace and Loach Minnow

Perennial streams on the Coconino NF within and adjacent to the project area are at high risk of increased sedimentation and ash flows resulting from stand-replacing crown fires. The effects of increased sedimentation on aquatic habitat have been described above. Alternative A (no action) would not mitigate these potential negative impacts. However, it is difficult to compare the effects of the no action alternative with the potential effects of wildfire.

The Slide Fire could have a tremendous impact on existing spikedace and loach minnow critical habitat (USDI FWS 2012). Flood waters could carry ash and sediments into connected drainages which could reach West Fork of Oak Creek, and ultimately the Oak Creek mainstem. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are the food base for spikedace and loach minnow.

The cumulative effects of the no action alternative (see cumulative effects for aquatic species and habitat) demonstrate the potential for destructive effects to the forest terrestrial landscape, riparian zone, and aquatic habitat, for both terrestrial and aquatic wildlife, fish, and macroinvertebrates, resulting from the Slide Fire on untreated landscapes.

Alternatives B, C, D, and E

Species Determination: Spikedace and loach minnow are not currently present within the affected environment. Therefore, alternative B-E would have **no effect** on these species.

Critical Habitat

Alternative C proposes more acres of mechanical vegetation treatments than does alternative B. Alternative D proposes far fewer acres of prescribed fire treatments than does either alternative B or C. However, while reducing the risk of sedimentation and ash flows, the proposed reduction in acres of prescribed fire would not meet the purpose and need of the project, because the natural fire regime would not be returned to the landscape under this alternative. When compared to alternative B, alternative E proposes more acres of mechanical vegetation treatments.

Within the analysis area, critical habitat for spikedace and loach minnow exists in the middle and lower portions of Oak Creek (USDI FWS 2012). Prescribed fire treatments in subunits connected to this watershed or its 6^{th} HUC watersheds upstream could potentially lead to short-term increases in sedimentation and/or ash flow into spikedace and loach minnow critical habitat. However, BMPs would be in place to mitigate these risks and proposed treatments would occur over a 10-year period, rather than all at once, so any impacts should be localized in extent. In addition, the soils and water report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope. The short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which spikedace and loach minnow live.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. BMPs would be in place to mitigate these short-term risks to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads. Dust abatement would have no effect on spikedace or loach minnow critical habitat, as no dust abatement treatments are proposed near open water. Proposed Coconino forest plan amendments would not have measurable effects on spikedace or loach minnow critical habitat, as discussed above.

The Slide Fire could have an impact on existing spikedace and loach minnow critical habitat (USDI FWS 2012). Impacts are described in alternative A. Additional protective measures were added with BMPs 37 and 38 (table 27 in the aquatics report) to protect habitat within and downstream of the Slide Fire area. However, considering direct, indirect, and cumulative effects, and BMPs, alternatives B through E **may affect but are not likely to adversely affect** spikedace or loach minnow critical habitat.

Candidate Species

Roundtail Chub (Gila robusta)

Within the analysis area, roundtail Chub occupies 77.9 miles of perennial stream (22.2 percent of its habitat on the CNF), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek.

Perennial streams on the Coconino NF within and adjacent to the project area are at high risk of increased sedimentation and ash flows resulting from stand-replacing crown fires. The effects of increased sedimentation on aquatic habitat have been described above. Ash flows produced from forest fires can negatively impact water quality by increasing pH and decreasing dissolved oxygen levels (Earl and Blinn 2003). Stream morphology can be changed by sediment deposition.

Alternative A

Under alternative A, projects would continue within the 4FRI footprint. Forest plan guidance and use of appropriate BMPs should continue moving forest vegetation toward healthier and more sustainable forest structure. However, the limited acres treated in typical projects combined with the current forest structure across the ponderosa pine forest would leave the forest trending away from desired conditions at the landscape scale. Dense forest conditions would still occur and the high fire hazard potential would persist. It is predicted that under alternative A up to 33 percent of soils could burn with high severity (Lata 2014). The WEPP model (Steinke 2014) predicts that slopes greater than 15 percent that burn with high severity would result in erosion above tolerable levels, risking loss of soil productivity and sediment transportation. The timing of future crown fire events and spatial configuration relative to sediment delivery cannot be determined, so it is assumed that the short-term cumulative effects would not change the current trends for aquatic macroinvertebrates and their habitat. Long-term effects from high-severity fire would be expected to maintain or change the forest-wide trends to decreasing for macroinvertebrate populations and their habitat.

The Slide Fire (USDA FS 2014) could have a tremendous impact on existing roundtail chub habitat . Flood waters could carry ash and sediments into connected drainages which could reach West Fork of Oak Creek, and ultimately the Oak Creek mainstem. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are the food base for roundtail chub.

Thinning and prescribed fire that would occur in alternative A (no action) would not mitigate these potential negative impacts. However, it is difficult to compare the effects of the no action alternative with the potential effects of wildfire.

Potential sediment delivery from 74 springs, 39 miles of ephemeral channels, and 860 miles of existing or unauthorized roads proposed for decommissioning would continue for both the short- and long-term.

The cumulative effects of the no action alternative (see cumulative effects for aquatic species and habitat) demonstrate the potential for destructive effects to the forest terrestrial landscape, riparian zone, and aquatic habitat, for both terrestrial and aquatic wildlife, fish, and macroinvertebrates, resulting from the Slide Fire on untreated landscapes.

Alternatives B, C, D, and E

Alternative C proposes more acres of mechanical vegetation treatments than does alternative B. Alternative D proposes far fewer acres of prescribed fire treatments than does either alternative B or C. However, while reducing the risk of sedimentation and ash flows, the proposed reduction in acres of prescribed fire would not meet the purpose and need of the project, because the natural fire regime would not be returned to the landscape under this alternative. When compared to alternative B, alternative E proposes more acres of mechanical vegetation treatments.

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under alternatives B through E could result in soil erosion in areas where slope exceeds 15 percent. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (aquatics report, table 29). However, BMPs (aquatics report, table 27) would be in place to mitigate these risks and proposed treatments would occur over a 10-year period, rather than all at once, so any impacts should be localized in extent. In addition, the soils and water report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (aquatics report, table 29). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which roundtail chub live. Furthermore, roundtail chub is a long-lived species (adults live over 10 years), so the risk of short term effects to roundtail chub and its habitat is also mitigated by the fact that the species is adapted to occasional sediment pulses and can reproduce after such occurrences have dissipated.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. BMPs would be in place to mitigate these short-term risks to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads. Dust abatement would have no effect on roundtail chub or its habitat, as no dust abatement treatments are proposed near open water.

The proposed Coconino NF forest plan amendments in alternatives B-D would not have measurable effects on roundtail chub or its habitat (see aquatic habitat general effects).

The Slide Fire (USDA FS 2014) could have an impact on existing roundtail chub habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Additional protective measures were added with BMPs 37 and 38 (table 27 in the aquatics report) to protect habitat within and downstream of the Slide Fire area.

The cumulative effects that may occur after the Slide Fire, resulting from an untreated environment (as described in alternative A) demonstrate the potential for destructive effects to the forest terrestrial landscape, riparian zone, and aquatic habitat, for both terrestrial and aquatic wildlife, fish, and macroinvertebrates.

Considering direct, indirect, and cumulative effects, and BMPs, alternatives B through E **may affect but are not likely to adversely affect** roundtail chub or its habitat.

Forest Sensitive Species

The most recent Regional Forester's Sensitive Species list was transmitted to Forest Supervisor's on September 18, 2013 and is the basis for the species used for this analysis. If survey information was not available the assumption was made that potential habitat was occupied.

Perennial streams on the Coconino NF within and adjacent to the project area are at high risk of increased sedimentation and ash flows resulting from stand-replacing crown fires. The effects of increased sedimentation on aquatic habitat have been described previously. Ash flows produced from forest fires can negatively impact water quality by increasing pH and decreasing dissolved oxygen levels (Earl and Blinn 2003). Stream morphology can be changed by sediment deposition.

Roundtail Chub (Gila robusta)

See the candidate species section for existing condition information on habitat.

Alternative A

Under alternative A, projects would continue within the 4FRI footprint. Forest plan guidance and use of appropriate BMPs should continue moving forest vegetation toward healthier and more sustainable forest structure. However, the limited acres treated in typical projects combined with the current forest structure across the ponderosa pine forest would leave the forest trending away from desired conditions at the landscape scale. Dense forest conditions would still occur and the high fire hazard potential would persist. It is predicted that under alternative A up to 33 percent of soils could burn with high severity (Lata 2014). The WEPP model (Steinke 2014) predicts that slopes greater than 15 percent that burn with high severity would result in erosion above tolerable levels, risking loss of soil productivity and sediment transportation. The timing of future crown fire events and spatial configuration relative to sediment delivery cannot be determined, so it is assumed that the short-term cumulative effects would not change the current trends for aquatic macroinvertebrates and their habitat. Long-term effects from high-severity fire would be expected to maintain or change the forest-wide trends to decreasing for macroinvertebrate populations and their habitat.

The Slide Fire (USDA FS 2014) could have a tremendous impact on existing roundtail chub habitat. Flood waters could carry ash and sediments into connected drainages which could reach West Fork of Oak Creek, and ultimately the Oak Creek mainstem. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are the food base for roundtail chub.

Thinning and prescribed fire that would occur in alternative A (no action) would not mitigate these potential negative impacts. However, it is difficult to compare the effects of the no action alternative with the potential effects of wildfire.

Potential sediment delivery from 74 springs, 39 miles of ephemeral channels, and 860 miles of existing or unauthorized roads proposed for decommissioning would continue for both the short- and long-term.

The cumulative effects of the no action alternative (alternative A) demonstrate the potential for destructive effects to the forest terrestrial landscape, riparian zone, and aquatic habitat, for both terrestrial and aquatic wildlife, fish, and macroinvertebrates, resulting from the Slide Fire on untreated landscapes.

Alternatives B, C, D, and E

The impacts of alternative B-E to the species are the same as described in the candidate species section.

Considering direct, indirect, and cumulative effects, and BMPs, alternatives B –E **may impact individuals, but are not likely to cause a trend to federal listing or loss of viability**.

Desert Sucker (Catostomus clarki) and Sonora Sucker (C. insignis)

Within the analysis area, Desert and Sonora Sucker occupy 77.9 miles of perennial stream (32.9 percent of their habitat on the CNF), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek.

Alternative A

Alternative A (no action) would not mitigate the current high risk of high intensity wildfires and the resulting impacts to perennials streams. However, it is difficult to quantify the effects of the no action alternative as compared to the potential effects of wildfire. The Slide Fire (USDA 2014) could have a tremendous impact on existing sucker habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are one of the principal foods for juvenile suckers. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

Alternatives B, C, D, and E

Alternative C proposes more acres of mechanical vegetation treatments than does alternative B. Alternative D proposes far fewer acres of prescribed fire treatments than does either alternative B or C. However, while reducing the risk of sedimentation and ash flows, the proposed reduction in acres of prescribed fire would not meet the purpose and need of the project, because the natural fire regime would not be returned to the landscape under this alternative. When compared to alternative B, alternative E proposes more acres of mechanical vegetation treatments.

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under alternative B-E could result in soil erosion in areas where slope exceeds 15 percent. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (table 29 in the aquatics report). However, BMPs (table 27 in the aquatics report) would be in place to mitigate these risks and proposed treatments would occur over a 10-year period, rather than all at once, so any impacts should be localized in extent. In addition, the soils and water report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (table 29 in the aquatics report). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which the suckers live. Desert and Sonora suckers are long-lived species (adults live over 10 years), so the risk of short term effects to their habitat is also mitigated by the fact that these species are adapted to occasional sediment pulses and can reproduce after such occurrences have dissipated.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. BMPs (FEIS, appendix C) would mitigate these short-term risks to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on Desert and Sonora sucker or its habitat, as no dust abatement treatments are proposed near open water. The proposed Coconino forest plan amendments would not have measurable effects on Desert and Sonora sucker or its habitat.

The Slide Fire (USDA FS 2014) could have a tremendous impact on existing desert sucker habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach West Fork and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are one of the principal foods for juvenile desert sucker. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

Considering direct, indirect, and cumulative effects, and BMPs, alternatives B-E may impact Desert and Sonora Sucker habitat, but considering cumulative effects, **alternatives B-E are not likely to cause a trend to federal listing or loss of viability.**

California Floater (Anodonta californiensis)

There are 368.6 miles of potential California floater habitat within the Coconino Forest boundary. Within the analysis area, there are 77.9 miles (21.1 percent) of potential perennial stream habitat (table 18, aquatics report), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek.

Alternative A

The Slide Fire (USDA FS 2014) could have a tremendous impact on existing California floater habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The cumulative effects of alternative A (see general effects to aquatic habitat) demonstrate the potential for destructive effects to the forest terrestrial landscape, riparian zone, and aquatic habitat, for both terrestrial and aquatic wildlife, fish, and macroinvertebrates, resulting from the Slide Fire on untreated landscapes.

Alternatives B, C, D, and E

In all action alternatives the soils and water report (Steinke 2014) indicates that prescribed fire treatments could result in soil erosion in areas where slope exceeds 15 percent. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (aquatics report, table 29). However, BMPs (aquatics report, table 27) would be in place to mitigate these risks and proposed treatments would occur over a 10-year period, rather than all at once, so any impacts should be localized in extent. In addition, the soils and water report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (aquatics report, table 29). The short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams that represent historic California floater habitat.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. BMPs would be in place to mitigate these short-term risks to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads. Dust abatement would have no effect on California floater habitat, as no dust abatement treatments are proposed near open water.

The proposed Coconino NF forest plan amendments in alternatives B-D would not have measurable effects on California floater habitat (see aquatic habitat general effects).

The potential impacts to existing California floater habitat from the Slide Fire (USDA FS 2014) is described in alternative A However, in alternatives B through E, additional protective measures were added with BMPs 37 and 38 (aquatics report, table 27and FEIS, appendix C) to protect habitat within and downstream of the Slide Fire area.

Considering direct, indirect, and cumulative effects, and BMPs, **alternatives B, C, D, and E are not likely to cause a trend toward federal listing or loss of viability.**

A Caddisfly (Lepidostoma knulli)

There are about 13 miles of potential A. caddisfly habitat within the Coconino NF boundary. Within the analysis area, the species may occupy all 13 miles of perennial Oak Creek above Sedona (table 18 in the aquatics report). Blinn and Ruiter (2006, 2009) noted that the species occurred in cool stream segments with generally swift-flowing water, dominated by large cobbles with low embeddedness of interstitial gravels.

Alternative A

Under alternative A, projects would continue within the 4FRI footprint. Forest plan guidance and use of appropriate BMPs should continue moving forest vegetation toward healthier and more sustainable forest structure. However, the limited acres treated in typical projects combined with the current forest structure across the ponderosa pine forest would leave the forest trending away from desired conditions at the landscape scale. Dense forest conditions would still occur and the high fire hazard potential would persist. It is predicted that under alternative A up to 33percent of soils could burn with high severity (Lata 2014). The WEPP model (Steinke 2014) predicts that slopes greater than 15percent that burn with high severity would result in erosion above tolerable levels, risking loss of soil productivity and sediment transportation. The timing of future crown fire events and spatial configuration relative to sediment delivery cannot be determined, so it is assumed that the short-term cumulative effects would not change the current trends for aquatic macroinvertebrates and their habitat. Long-term effects from high-severity fire would be expected to maintain or change the forest-wide trends to decreasing for macroinvertebrate populations and their habitat. Thinning and prescribed fire that would occur in alternative A (from other projects) would not mitigate these potential negative impacts. However, it is difficult to compare the effects of the no action alternative with the potential effects of wildfire.

The Slide Fire (USDA FS 2014) could have a tremendous impact on existing A. caddisfly habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Ash changes the pH and oxygen levels of water which can kill macroinvertebrates. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

Alternatives B, C, D, and E

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under alternative B-E could result in soil erosion in areas where slope exceeds 15 percent. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (table 29 in the aquatics report). However, BMPs (aquatics report, table 27) would be in place to mitigate these risks and proposed treatments would occur over a 10-year period, rather than all at once, so any impacts should be localized in extent. In addition, the soils and water report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (table 29 in the aquatics report).

Although alternatives C and E propose more acres of mechanical vegetation treatments, BMPs (aquatics report, table 27) would be in place to mitigate these risks and proposed treatments would occur over a 10-year period, rather than all at once, so any impacts should be localized in extent. Alternative D proposes far fewer acres of prescribed fire treatments than does either alternative B or C. However, while reducing the risk of sedimentation and ash flows, the proposed reduction in acres of prescribed fire would not meet the purpose and need of the project, because the natural fire regime would not be returned to the landscape under this alternative.

The short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds that represent A. caddisfly habitat.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. BMPs (see appendix C) would be in place to mitigate these short-term risks to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads. Dust abatement would have no effect on A. caddisfly habitat, as no dust abatement treatments are proposed near open water.

The potential impacts from the Slide Fire to existing A. caddisfly habitat is the same as described in alternative A.

The proposed Coconino NF forest plan amendments in alternatives B-D would not have measurable effects on A. caddisfly habitat (see aquatic habitat general effects).

Considering direct, indirect, and cumulative effects, and BMPs, alternative B-E **are not likely to cause a trend to federal listing or loss of viability.**

A Mayfly (Moribaetis mimbresaurus)

There are about 13 miles of potential A. mayfly habitat within the Coconino Forest boundary. Within the analysis area, the species may occupy all 13 miles of perennial Oak Creek above Sedona (aquatics report). The species is poorly known, but larvae of this genus are splash-zone dwellers that are frequently found exposed on wet surfaces above the water line, on the surfaces of rocks in fast water, at the bases of waterfalls, or rocks along the shoreline of fast-water areas (Waltz and McCafferty 1983).

Alternative A

Alternative A would not mitigate these potential negative impacts to perennial streams from wildfire. However, it is difficult to compare the effects of the no action alternative with the potential effects of wildfire.

The Slide Fire (USDA FS 2014) could have a tremendous impact on existing A. mayfly habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Ash changes the pH and oxygen levels of water which can kill macroinvertebrates. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

Alternatives B, C, D, and E

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under alternative B-E could result in soil erosion in areas where slope exceeds 15 percent. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (table 29 in the aquatics report). However, BMPs (aquatics report, table 27) would be in place to mitigate these risks and proposed treatments would occur over a 10-year period, rather than all at once, so any impacts to A. mayfly habitat should be localized in extent. In addition, the soils and water report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (aquatics report, table 29).

Although alternatives C and E propose more acres of mechanical vegetation treatments, BMPs (aquatics report, table 27) would be in place to mitigate these risks and proposed treatments would occur over a 10-year period, rather than all at once, so any impacts to A. mayfly habitat should be localized in extent. Alternative D proposes far fewer acres of prescribed fire treatments than does either alternative B or C. However, while reducing the risk of sedimentation and ash flows, the proposed reduction in acres of prescribed fire would not meet the purpose and need of the project, because the natural fire regime would not be returned to the landscape under this alternative.

The short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds that represent A. mayfly habitat.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. BMPs (see appendix C) would be in place to mitigate these short-term risks to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads. Dust abatement would have no effect on A. mayfly habitat, as no dust abatement treatments are proposed near open water.

The potential impacts from the Slide Fire to existing A. mayfly habitat is the same as described in alternative A.

The proposed Coconino NF forest plan amendments in alternatives B, C, and D would not have measurable effects on A. mayfly habitat (see aquatic habitat general effects).

Considering direct, indirect, and cumulative effects, and BMPs, alternatives B through E **are not likely to cause a trend to federal listing or loss of viability.**

Management Indicator Species (Macroinvertebrates)

There are about 294 miles of potential macroinvertebrate habitat (perennial stream) within the Coconino Forest boundary. Within the analysis area, there are about 84 miles (about 28 percent) of potential perennial stream habitat (aquatics report, table 23), including Munds Canyon, Oak Creek, Pumphouse Wash, Rio de Flag, Sawmill Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Details on direct and indirect effects of proposed actions under the 4FRI are described above.

Alternative A

Current and ongoing projects would proceed within the 4FRI project area footprint under the no action alternative. These projects are listed in appendix F of the EIS.

Alternative A would not result in an immediate change to the quantity or quality of riparian habitat. Few projects alter riparian habitat, so at the 4FRI project and forest level, little change would occur under this alternative. Mitigation measures have already been implemented in the vicinity of the Slide Fire to reduce sedimentation into connected waters, including: application of mulch (certified weed free straw) and seed on moderate to high severity areas with slopes less than 40 percent to reduce soil loss, stabilize soils, and enhance habitat recovery. This work encompassed sites with high potential to flood, have debris flow, and are connect directly to perennial water

The lack of landscape-scale restoration would maintain the current level of hydrologic function. Hydrologic function is currently reduced due to uncharacteristic tree densities. Evapotranspiration from trees pulls water from the soils that could otherwise recharge groundwater (MacDonald 2014). In the long-term, less groundwater recharge and reduced discharge could lead to decreased flow in perennial streams, particularly combined with the predicted effects of climate change.

Under alternative A, 520 miles of temporary roads associated with the 4FRI would not be created, potentially reducing sediment delivery. Similarly, 860 miles of road decommissioning associated with the 4FRI, including 726 miles on the Coconino NF, would not occur, maintaining current sediment levels. Spring and ephemeral channel restoration would not occur as proposed. Effects of sedimentation from these sources are not expected to be significant because few of these total acres are directly associated with perennial streams. However, individual roads, springs, and ephemeral channels could affect localized portions of streams.

Conifer encroachment into riparian habitat would continue. Increased shading would help maintain cooler water temperatures which can negatively affect macroinvertebrates (USDA 2013). Increased overstory shading in riparian areas would decrease riparian ground cover that can filter sediments. Conifer encroachment would also provide fuel connectivity, increasing the risk of high-severity fire burning up to or into riparian habitats. High-severity fire can result in loss of stream shading and delivery of high sedimentation and ash loads into aquatic habitats. The risk of these stand-replacing crown fires remains high on the Coconino NF and represents a threat to macroinvertebrate populations within the project area (effects of increased sedimentation on aquatic habitat is described above).

The Slide Fire could cause large-scale impacts to existing macroinvertebrate populations and their habitat. Flood waters could deliver ash and sediments from connected drainages into the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of individual storm events. Multiple precipitation events could occur in a day or within a week and within different drainages within the same watershed and each could result in transport of ash. Ash changes the pH and oxygen levels of water which can kill macroinvertebrates. Flooding, landslides, and debris flows can alter stream channel characteristics, cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

Alternative A would maintain the stable trend for macroinvertebrate populations and the stable to improving trends in riparian habitats in the short-term. Factors that could influence long-term trends include a consistent decrease in hydrologic function resulting from high tree densities. Alternately, uncharacteristic, high-severity fires could open forests, removing ground cover in the short-term and forest cover in the long-term. Increased run-off from burned areas would likely increase sedimentation and ash flow if this were to occur. Trends in both macroinvertebrate populations and their habitats would be negatively affected in the long-term.

Alternatives B-E

None of the action alternatives would include treatments in riparian habitats associated with perennial streams. A series of BMPs have been developed for soil and water conservation (Soil and Water report and appendix C of this FEIS). These include streamside management zones (also known as filter strips) with increasing widths for increasing soil erosion hazards. This is expected to minimize potential sediments reaching riparian areas.

The soils and water report (Steinke 2014) indicates that prescribed fire treatments could result in soil erosion in areas where slope exceeds 15 percent. There is a short-term risk (1-2 years) of sedimentation flow resulting from these treatments (aquatics report, table 29). However, BMPs (aquatics report, table 27) would be in place to mitigate these risks. Prescribed fire ignitions would not occur inside the streamside management zones, but fire would be allowed to burn into riparian areas. Additional BMPs would address soil health, retention of coarse woody debris, and to minimize sediment transport from upland operations (see appendix C). Implementation would be organized by task order. Task orders would typically be completed in about 3 years' time. If 4FRI implementation was completed in 10 years' time, on average 1/10 of the area would be treated in a given year. Because perennial water is limited on this landscape, most of the treated acres would not affect riparian or aquatic habitats. Most sediment is expected to remain on site due to the BMPs.

The Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (aquatics report, table 29). BMPs would be implemented to address soil health, retention of coarse woody debris, and to minimize sediment transport from upland operations (see appendix C). Short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and the streams that represent macroinvertebrate habitat.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. BMPs would be in place to mitigate these short-term risks to realize long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads. Dust abatement would have no effect on macroinvertebrate habitat, as no dust abatement treatments are proposed near open water.

The proposed Coconino NF forest plan amendments in alternatives B-D would not have measurable effects on macroinvertebrate habitat (see aquatic habitat general effects).

While many of the proposed actions could lead to sediments reaching perennial waters, the likelihood of this happening depends on the distance from disturbed site to the stream, the intervening slope, vegetation, and BMPs, and the scale and timing of precipitation events. Effects would be expected to be limited and localized. Therefore, the action alternatives would not change the forest-wide trends for macroinvertebrates or the quality of their habitat in the short-term. The 5th code watersheds within and intercepted by the 4FRI treatment area contain about 28 percent of the total 294 miles of perennial streams occurring on the forest (aquatics report, table 24).

Therefore, the action alternatives could lead to limited and localized decreases in aquatic macroinvertebrate populations and riparian habitat due to sedimentation. Decreased water quality could also alter the species taxa relationships and/or decrease macroinvertebrate species diversity.

In the short-term, the scale of these potential impacts would not affect the forest wide trends for macroinvertebrate populations or the quality of their habitat. Because the combined actions of the project would include moving forest structure toward the historical range of variation, decommissioning roads, moving road segments to reduce sedimentation impacts, and spring and ephemeral channel restoration would all lead to long-term improvements. This would maintain or improve the current forest-wide trends in riparian habitat (stable to improving) and in macroinvertebrate populations (stable).

Cumulative Effects for Management Indicator Species

The boundary for the 4FRI project area includes or overlaps several 5th code HUC watersheds containing perennial waters (aquatics report, table 24). The project boundary and associated stream miles within these 5th code watersheds (about 84 miles) were used to evaluate cumulative effects.

Total past, current, and future foreseeable projects in the 4FRI area include about 166,520 acres of mechanical treatment (cumulative effects supplement for Aquatic Species, project record). About ¾ of the mechanical treatments consist of thinning in goshawk habitat outside of post-fledging family areas. Other main areas of mechanical treatments in cumulative effects includes thinning in: grasslands (about 11,500 acres); Mexican spotted owl protected activity centers (about 7,400 acres); pinyon-juniper (about 6,900 acres); and aspen regeneration (about 5,200 acres). In addition, about 3,550 acres of thinning would occur in mixed-conifer habitat managed for Mexican spotted owl. By following the goshawk guidelines as incorporated into the forest plan and conducting vegetation restoration, these actions would move treated areas toward the natural range of variation. Thinning would be expected to improve hydrologic function (Steinke 2014), potentially improving riparian conditions. Results would be limited in Mexican spotted owl habitat because treatment intensities are typically light for this species. The restoration of vegetation types encroached by ponderosa pine and creating interspace in formerly contiguous forest would also reduce the risk of large-scale high-severity fire. Improved forest resilience would also decrease drought and insect-caused tree mortality which could also reduce fire effects. The Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope, in the ponderosa pine vegetation type.

Total past, current, and future foreseeable projects in the 4FRI area include about 208,300 acres of prescribed fire (cumulative effects supplement for Aquatic Species, project record). About 82 percent of these acres occurred within goshawk habitat outside of post-fledging family areas (170,700 acres). Prescribed fire has also been conducted in: grasslands (about 6,550 acres); Mexican spotted owl protected activity centers (about 2,240 acres); and pinyon-juniper (about 3,425 acres). In addition, about 3,600 acres of thinning would occur in Mexican spotted owl mixed-conifer habitat. Prescribed fire reduces surface fuel loading and typically increases canopy base height. Torching can occur, burning individual trees or groups of trees. Combined with the post-fire nutrient pulse, these effects can increase understory response. Coarse woody debris and logs typically decrease after fire, but increases occur within a few years post-treatment (Lata 2014). Increased understory biomass and woody debris would aid in stabilizing soils and filtering sediments. Changes in vegetation structure resulting from prescribed fire should reduce the risk of surface fire transitioning into crown fire, decreasing the risk of uncharacteristic sediment loads and ash pulses reaching perennial streams. The short-term risk associated with prescribed fire can yield long-term benefits, including restoring the health of watersheds and the streams that represent macroinvertebrate habitat.

Some public commenters on the draft EIS stated the analysis had exaggerated the risk of large-scale high-severity fire in the 4FRI landscape. Since receiving those comments the Slide Fire burned over 21,000 acres in and adjacent to proposed 4FRI treatments, affecting about 15 percent of the watershed acres upstream of the City of Sedona (USDA 2014). Flood waters could carry ash and sediments into connected drainages which could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water which can kill macroinvertebrates. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation. Sedimentation, ash, and the subsequent effects to stream characteristics can directly impact macroinvertebrates and their habitat. The cumulative effects of thinning and prescribed fire should reduce the probability of other high-severity fires in the 4FR treatment area.

Past cumulative effects include 24 water developments. All the developments are on the Tusayan Ranger District. Each development is designed for wildlife using municipal water. Naturally flowing water will not be affected. No perennial waters occur on this district. Hydrologically the district is connected to the Little Colorado River, not the Verde River. There would be no cumulative effects on aquatic macroinvertebrates or their habitat on the Coconino NF. One current project on the Coconino NF is incorporating channel restoration. Potential effects from this would be cumulative with the 39 miles of ephemeral stream restoration proposed in the 4FRI. This restoration work could create a short-term (1 season) sediment pulse if precipitation transported materials off-site. Long-term benefits would include an overall decrease of sediment delivery to streams.

Under alternative A, projects would continue within the 4FRI footprint. Following forest plan guidance and use of appropriate BMPs should continue moving forest vegetation toward healthier and more sustainable forest structure. However, the limited acres treated in typical projects combined with the current forest structure across the ponderosa pine forest would leave the forest trending away from desired conditions at the landscape scale (McCusker et al. 2014). Dense forest conditions would still occur and the high fire hazard potential would persist. It is predicted that under alternative A up to 33 percent of soils could burn with high severity (Lata 2014). The WEPP model (Steinke 2014) predicts that slopes greater than 15 percent that burn with high severity would result in erosion above tolerable levels, risking loss of soil productivity and sediment transportation. The timing of future crown fire events and spatial configuration relative to sediment delivery cannot be determined, so it is assumed that the short-term cumulative effects would not change the current trends for aquatic macroinvertebrates and their habitat. Long-term effects from high-severity fire would be expected to maintain or change the forest-wide trends to decreasing for macroinvertebrate populations and their habitat.

The action alternatives would cumulatively account for about 551,500 (alternatives B and D) to 597,600 (alternative C) acres of mechanical treatments. About 70 percent of these acres are accounted for by the 4FRI and have the objective of achieving or moving toward restoration. The limited erosion potential expected from mechanical treatments on this landscape, along with the BMPs commonly implemented for mechanical treatments, are expected to retain sediments on site.

The action alternatives would cumulatively account for about 790,600 (alternatives B and E) to about 794,400 (alternative C) acres of prescribed fire. The exception to these ranges is in alternative D where about 386,700 acres of prescribed fire would occur. Alternatives B, C, or E would account for nearly ¾ of the cumulative acres of prescribed fire. Alternative D would account for about 54 percent of these acres. Prescribed fire would reduce litter, coarse woody debris, and logs in the short-term. This may allow some sediment to move off-site. However, the limited perennial water in the 4FRI project area means most acres treated would not be in immediate proximity to streams. Use of BMPs should further restrict effects of sedimentation. Woody debris and litter is expected to be within the recommended forest plan levels within a few years of implementation. Their replenishment would start shortly after completion of the burns.

Mechanical and prescribed fire treatments combined would decrease the probability of future surface fire transitioning into crown fire. Removal of ladder fuels, decreasing surface fuels, and creating canopy gaps, openings, and interspace would limit fire effects on forest overstory. These same changes would increase understory development and create sediment traps. Interrupting canopy connectivity would also limit the scale of crown fire and torching. The amount of high severity burning in future fires should be reduced relative to current conditions. Combined, this would limit the scale of run-off, sediment and ash flow entering streams after future fires. Flooding, landslides, and debris flows can alter stream channel characteristics, scour drainages, and modify or remove riparian vegetation.

The action alternatives combined with cumulative effects could lead to a short-term decrease in perennial stream habitat quality due to sedimentation. Although sediments reaching riparian areas should minimal as described above, perennial streams near treated areas could be negatively affected. Therefore, the action alternatives could lead to localized, short-term decreases in aquatic macroinvertebrate populations and riparian habitat quality due to sedimentation. Decreased water quality could also alter the species taxa relationships and/or decrease macroinvertebrate species diversity. However, these potential short-term effects are not expected to change the forest-wide trends. In the long-term, moving forest structure toward the historical range of variation, decommissioning roads, moving specific road segments to reduce sedimentation impacts, and spring and ephemeral channel restoration would lead to long-term improvements. This would maintain or improve the current forest-wide trends in riparian habitat (stable to improving) and in macroinvertebrate populations (stable).

Noxious and Invasive Weeds

The noxious and invasive weed analysis is part of the botany specialist report, which is incorporated by reference (Crisp 2014).

Noxious and invasive weed direction originated from a three-forest analysis (USDA FS 2005). The noxious weed FEIS and record of decision were incorporated into the forest plans by amendment 20 to the Coconino NF forest plan. Even though it is not directly referenced in the revised Kaibab NF forest plan, it continues to provide direction and guidance for the Forest.

Changes from the Draft Environmental Impact Statement

A complete analysis and review of comments is included in appendix F of the botany report. One comment letter included peer-reviewed science and recommendations for addressing invasive weeds. The commenters provided relevant science for consideration; and, the science was not considered to be opposing science. One suggestion was to rank noxious weeds using the Invasive Species Assessment Protocol: http://www.natureserve.org/getData/plantData.jsp. After reviewing the recommendations, the ranking and assessment of weed species was retained because it comes directly from the noxious weed FEIS. However, the fire effects information system for each noxious or invasive weed species was reviewed and narratives were updated as needed. For leafy spurge, two additional design features were developed. For Dalmatian toadflax, the science was incorporated into the analysis as existing condition. Literature provided on musk thistle and Scotch thistle. There was a concern not enough measures that had been included to address any increase in cheatgrass. McGlone et al. 2012 was incorporated into the botany report. The incorporation did not change the analysis or design features. See the Arizona bugbane discussion for effects from the Slide Fire of 2014.

Opposing Science

Some commenters recommended no herbicides be used to treat non-native invasive weeds due to the potential effects to human health and biotic resources. The title of references that were submitted by one commenter include: “Glyphosate herbicide, the poison from the Skies, “Monsanto's Toxic Herbicide Glyphosate: A Review of its Health and Environmental Effects” Organic Producers Association of Queensland”, and “Possible human health impacts of Monsanto's transgenic glyphosate-resistant soybeans.”

Commenters stated the DEIS did not adequately address the impacts associated with the use of herbicides. Various articles and studies were reviewed. These comments were categorized as being already decided by a previous analysis. The effects of herbicide use were analyzed and disclosed in the Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds (2005) for the Kaibab and Coconino NFs. The analysis was incorporated into the Coconino NF forest plan as amendment 20. In the FEIS, language has been updated to reflect a new Kaibab NF Land and Resource Management Plan (USDA FS 2014). While the direction provided in the noxious weeds FEIS still provides direction, it is no longer incorporated into the forest plan. This analysis tiers to the noxious weeds FEIS and decision and no changes were made to the proposed actions.

The Noxious or Invasive Weed EIS evaluated the impacts of glyphosate based herbicides and proposed restrictions on the use of these chemicals within limited spray zones (buffers around human habitation and recreation sites), near water and other critical wildlife habitat areas. Restrictions and extra protective measures are outlined in “Appendix B - Design Features, Best Management Practices, Required Protection Measures, and Mitigation Measures” of the weed EIS. BMP B15 (DEIS, page 570) incorporates the weeds mitigation measures (appendix B of the weed EIS) in their entirety. The DEIS (page 256) and FEIS references the incorporation of appendix B of the Weed EIS into Coconino forest plan amendment 20. The complete response to comments document for botany and non-native invasive weeds is party of the botany report.

Affected Environment

The species displayed in table 88 were evaluated for presence/absence in the treatment area. The species ranking is from the noxious weed FEIS and relates to the prioritization process that used various criteria including difficulty of control, successes with control efforts elsewhere, and lifecycle (perennial vs. annual).

The options listed in table 88 in the objective column include prevention, eradication, and control. Prevention means minimizing introduction of a weed species into the project area and usually by combining with eradication to allow for elimination of spot populations as they arise. Eradication means attempting to totally eliminate a species from the forests. Control means preventing seed production throughout a target patch and reducing the area covered by a species, whereas contain means to prevent the species from expanding beyond the perimeter of existing patches.

Table 88. Treatment area noxious and invasive weeds evaluation

Species*	Common Name	Species Rank	Objective	Known to Occur in Treatment Areas (Y/N)
Euphorbia esula	leafy spurge	1	Eradicate	Y
Centaurea solstitialis	yellow starthistle	2	Eradicate	N
Centaurea melitensis	Malta starthistle	3	Eradicate	N*
Alhagi maurorum Syn. *Alhaghi pseudoalhagi*	camelthorn	4	Contain/Control	Y
Acroptilon repens	Russian knapweed	5	Contain/Control	Y
Cardaria draba	whitetop	6	Eradicate	Y
Salvia aethiopis	Mediterranean sage	7	Eradicate	Y
Carduus nutans	musk thistle	8	Eradicate	Y
Centaurea diffusa	diffuse knapweed	9	Contain/Control	Y
*Centaurea stoebe ssp. micranthos (*Syn. *Centaurea maculosa, Centaurea biebersteinii)*	spotted knapweed	10	Eradicate	Y
Onopordum acanthium	Scotch thistle	11	Eradicate/Control	Y
Elaeagnus angustifolia	Russian olive	12	Contain/Control	N*
Tamarix spp.	tamarisk	13	Contain/Control	Y
Rubus procerus Syn. *R. armeniacus or R. discolor*	Himalayan blackberry	14	Contain/Control	N*
Cynoglossum officinale	houndstongue	15	Eradicate	N
Arundo donax	giant reed	16	Contain/Control	N*
Potentilla recta	sulfur cinquefoil	17	Prevent/Eradicate	N*
Linaria dalmatica	Dalmatian toadflax	18	Contain/Control	Y
Ailanthus altissima	tree of heaven	19	Contain/Control	N*
Cirsium vulgare	bull thistle	20	Contain/Control	Y
Ulmus pumila	Siberian elm	21	Contain/Control	N*
Bromus tectorum	cheatgrass	22	Contain/Control specific populations	Y
Avena fatua	wild oats	23	Contain/Control	N*
Dipsacus fullonum	common teasel	24	Eradicate	N*
Chrysanthemum leucanthemum Syn *Leucanthemum vulgare*	oxeye daisy	Unassigned	Prevent/Eradicate	N
Cirsium arvense	Canada thistle	Unassigned	Prevent/Eradicate	N*
Halogeton glomeratus	halogeton	Unassigned	Prevent/Eradicate	N*
Isatis tinctoria	dyers woad	Unassigned	Prevent/Eradicate	N*
Myriophyllum spicatum	Eurasian water milfoil	Unassigned	Unassigned	N

N* = these species are not known to occur within treatment areas for the project, but are of concern due to their proximity and potential effects to restoration treatments. Partners have expressed concern for these species. Their rating system is explained below (Smith 2012).

In addition to the species identified for treatment in the forest plan, external partners expressed concern for other noxious or invasive weed species. Their rankings, goals for management, and rationale (discussed below) were incorporated into analysis and monitoring plan.

High Risk – These species currently have limited geographic distribution within project treatment areas, and if current inventories indicate their presence within treatment areas, these species should be eradicated as soon as practicable: leafy spurge (*Euphorbia esula*), camelthorn (*Alhagi maurorum*) spotted knapweed (*Centaurea maculosa*), diffuse knapweed (*Centaurea diffusa*), Russian knapweed (*Acroptilon repens*), white top (*Cardaria draba*), Mediterranean sage (*Salvia aethiopis*), Scotch thistle (*Onopordum acanthium*), salt cedar (*Tamarix spp.)* and musk thistle (*Carduus nutans*).

Medium Risk – These species have widespread distribution within the project treatment area in large populations, with either no effective treatment, or cost-prohibitive effective treatment, or for which effectiveness of current treatment strategies is unknown or not monitored. The project includes several forms of monitoring including implementation effectiveness and adaptive management for these species: cheatgrass (*Bromus tectorum*), Dalmatian toadflax (*Linaria dalmatica*), bull thistle (*Cirsium vulgare*), and wild oats (*Avena fatua*).

Watch List – Partners prepared this list of species as species to watch for and exclude from treated areas. If these species are detected, aggressive eradication efforts should be a top priority and applied quickly. We reviewed the documented locations for these species and found none in the areas to be treated. These species include Malta starthistle (*Centaurea melitensis*), Russian olive (*Elaeagnus angustifolia*), yellow starthistle (*Centaurea solstitialis*) Himalayan blackberry (*Rubus armeniacus* and *Rubus discolor*), giant reed (*Arundo donax*), sulfur cinquefoil (*Potentilla recta*), tree of heaven (A*ilanthus altissima*), Siberian elm (*Ulmus pumila*), halogeton (*Halogeton glomeratus*), dyer's woad (*Isatis tinctoria*), Eurasian water-milfoil (*Myriophyllum spicatum*), oxeye daisy (*Leucanthemum vulgare*), and Canada thistle (*Cirsium arvense*), common teasel (*Dipsacus sylvestris*)

Environmental Consequences

Alternative A – Direct, Indirect, and Cumulative Effects

There would be no direct effects. Weed infestations that might have been detected and treated would go unnoticed and continue to expand unless detected by other surveys or independent observations. The on-going weed treatments for several species in recently analyzed or future projects not included in this project includes releases of biological control insects in various parts of the forests, treatments in recent or future wildfires where noxious or invasive weeds may be problematic and would continue. These projects would not cover as much area as that being analyzed under this project.

The cumulative effects boundary is the Coconino and Kaibab NFs and the temporal timeframe is from 1995 to the present. Indirectly, increases in fire hazard and severity would increase the risk of noxious weed invasions in the project area. Warmer climate conditions may affect ecosystems by altering biotic and abiotic factors and increase the extent and severity of disturbances for some species (Bradley et al. 2010, Hellmann et al. 2008, Middleton 2006). Climate may favor the spread of invasive exotic grasses into arid lands where the native vegetation is too sparse to carry a fire. When these areas burn, they typically convert to non-native monocultures and the native vegetation is lost (USDA FS 2010). Ongoing FS management actions combined with Arizona

Department of Transportation, Coconino County, and the City of Flagstaff would continue to address and mitigate effects of noxious or invasive weeds and reduce the spread into new areas.

Alternatives B, C, D and E – Direct and Indirect Effects

Direct effects include ground-disturbing activities that would have the potential to increase the acreage and/or density of the existing infestations within the project area. Management activities that would create localized severe disturbance include burned areas from slash piles, the creation of log decks, bare soil created through temporary road construction, road reconstruction (both road improvement and road relocation), decommissioning, stream channel restoration, and use by machinery during mechanical thinning. Broadcast burning and hand thinning would be sources of disturbance but the level of disturbance would not be as severe. Direct and indirect effects of temporary road construction, road reconstruction, road maintenance, or decommissioning include disturbance and increased risk of dispersal of existing weed species and populations and the introduction of new species. However, reducing the road mileage would help reduce the risk of present and future dispersal of noxious or invasive weeds along roadways (Rooney 2005). Spring and channel restoration would increase disturbance in the treated areas. With the incorporation of mitigation and best management practices (BMP) (see appendix C of the DEIS), these effects would be reduced to a nonsignificant levels. Based on review of the soils, water, fire, and vegetation analyses, there would be no measurable effect related to treating approximately 39,000 acres less intensively.

Cumulative Effects

The cumulative effects boundary is the Coconino and Kaibab NFs within the project area boundary. This temporal timeframe includes management actions related to noxious or invasive weeds since 1995 to the present.

Beginning in 1995, the Coconino and Kaibab NFs began surveying and documenting noxious or invasive weed occurrences. Since 1997, noxious or invasive weed surveys were generally conducted on forest projects that would have management actions associated with soil disturbance. In 2005, the three-forest noxious weeds FEIS document and its provisions were incorporated into the Coconino NF and Kaibab NF by amendments 20 (Coconino NF) and 7 (Kaibab NF).This document represented a major change in the management of noxious or invasive weed control on the forests by allowing the use of herbicides on forest lands. All of the above actions were beneficial management actions that supported management control objectives for noxious or invasive weeds on the forest. These past actions have influenced the existing condition or baseline.

The Coconino and Kaibab National Forests implemented the Travel Management Rule in 2012. The cumulative effects to this and other species are the reduction in the numbers of motorized routes and the elimination of cross-country travel. Negative effects from motorized vehicles such as crushing of plants, damage to potential habitat such damage to soils, fragmentation of habitat and introduction of noxious or invasive weeds into the habitats and/or populations have been reduced. These reductions would be from the elimination of most cross-country travel and through the reduction of road density. These actions, combined with such actions as road decommissioning in this project would reduce the impacts of vehicle traffic and the risks of noxious or invasive weed invasions that accompany motor vehicle travel.

Project implementation will continue in previously analyzed projects. These projects will continue to provide sources of effects similar to the direct and indirect effects described above including mitigations for noxious or invasive weed control. Projects include the Hart Prairie Fuels

Reduction and Forest Health Project (2010), Wing Mountain Fuels Reduction and Forest Health Restoration (2012), Frenchy (2003) and Pomeroy (2003). The Flagstaff Watershed Protection Project is currently under analysis. The areal extent of the project is similar to that of the Mount Elden Dry Lake Hills trail project. Noxious or invasive weed locations were documented in the project area during pre-implementation surveys.

Other actions such as grazing will continue to occur in the project area. Livestock grazing that is currently occurring on the forests under permit will continue to utilized at the permitted levels allowed in the annual operating instructions for each allotment. Wildfires will continue to occur in the project area. The effects of these fires will include varying levels of disturbance from the fires as well as disturbance and the risks of noxious or invasive weed introductions from management activities that occur in response to suppression and rehabilitation.

Noxious or invasive survey and control will continue in other jurisdictions within or adjacent to the project boundary including survey and control along county, state and federal highways, within municipalities and on state projects receiving federal funding. Collectively, these actions are expected to reduce the densities and areas of infestations on local basis but are not anticipated to substantially reduce the distribution and acreage of noxious or invasive weeds on an area-wide basis. These actions will reduce the risk of expansion of noxious or invasive weeds from established infestations to other areas. Actions on private lands within or adjacent areas are expected to continue, including uses that contribute to introduction and dispersal of noxious or invasive weeds, introductions of non-native plants through planting and noxious or invasive weed control on private parcels. None of these actions is under Forest Service control but affect the abundance and distribution of noxious or invasive weeds within the project boundary.

Grand Canyon National Park (GCNP) adjoins the Kaibab National Forest on the northern boundary of the project area and has an active noxious or invasive weed survey and treatment program. Priority species for the south rim area of the National Park for 2012 are listed in appendix D. Due to the common boundary, it is possible that weed infestations will move across boundary lines and invade adjoining forestlands on the Tusayan Ranger District.

Foreseeable actions include projects discussed in the cumulative effects document (FEIS appendix F) includes actions implemented as part of this project and the ongoing weed control programs on the forests. Collectively, these actions have the potential to control and/or eradicate many noxious or invasive weed populations on the forests and prevent the introduction of new species. The goals are complementary to the goals established in weed EIS and to current forest plan direction for the forests.

Forest Plan Amendments

See the forest plan evaluation in the botanical sensitive species section of this FEIS. Also see appendix E in the botany report.

Forest Plan Consistency

Mitigation measures were developed (as displayed in B15 to B23 in FEIS appendix C) to reduce or minimize the effects of management actions on existing and potential noxious or invasive weed infestations. Areas to be treated will be surveyed noxious or invasive weeds before treatments are implemented. All management activities would occur as analyzed in the various specialists reports and described in the FEIS. The management actions untaken in this project are complementary and enhance the control objectives for each noxious or invasive weed species as identified in the Final Environmental Impact Statement for Integrated Treatment of Noxious or

Invasive Weeds for Coconino, Kaibab and Prescott National Forests. The unit of measure is compliance and effectiveness of BMPs as outlined in the 3 forest noxious or invasive weeds.

By adhering to the direction from the integrated weeds FEIS, the use of pesticides, herbicides, and biological control agents should minimize impacts on non-target flora and fauna. For these reasons, the project is consistent with Kaibab forest plan desired conditions and guidelines. There are no conflicts between past and present guidance and no change is needed in the analysis. The project is consistent with Amendment 20 of the Coconino NF forest plan.

Heritage Resources

A summary of the heritage analysis is presented here and the complete heritage specialist report (Gifford et al. 2014) is incorporated by reference.

The ponderosa pine ecosystem is the focus of the 4FRI Forest restoration project. Within the project area, cultural resources range temporally from prehistoric times through the historic period and into the modern day. Prehistoric sites include rock art, cliff dwellings, pit houses, multiple room pueblos and artifact scatters. Historic resources consist of mills and logging railroads, trails and historic roads such as Beale Road; cabins and homesteads, Forest Service administrative sites, sheep and cattle industry related sites, mining camps, Civilian Conservation Corps remains, and American Indian shelters such as sweat lodges and brush shelters.

Cultural resources also include American Indian traditional use areas and places known as “traditional cultural properties” (Parker and King 1998). Traditional cultural properties hold a central and important position in American Indian culture.

Basis for Evaluation of Effects

The proposed action in the 4FRI DEIS includes ground-disturbing activities such as mechanical thinning, hand thinning, stream restoration, temporary road construction, existing and temporary road closures, and fencing. A programmatic agreement between the Southwestern Region of the Forest Service, the Arizona, New Mexico, Texas and Oklahoma State Historic Preservation Officers (SHPO) and the Advisory Council on Historic Preservation (ACHP; USDA 2003) guides national forests in the region in identifying, evaluating and protecting cultural resources on National Forest System lands. In consultation with SHPO, the Coconino and Kaibab National Forests also developed a document called the “Four Forest Restoration Initiative (4FRI) Heritage Resources Strategy” (Gifford 2011; hereafter referred to as “the Heritage Strategy”). Three elements are identified in the Heritage Strategy that would assist in reaching a “no adverse effect” determination for this project.

- The first is the focus on the programmatic agreement, appendix J. It outlines the consultation protocols and strategies for implementing large-scale fuels reduction, vegetation treatment, and habitat improvement projects.
- The second component is the archaeological site density model created by the Coconino and Kaibab Forests. This model, created using existing site inventory data, identified high and low site densities areas and assists in the design of survey strategies for specific project locations.
- The third aspect is the Heritage Strategy. The programmatic agreement, appendix J requires areas of intensive ground disturbances and areas of high site densities to receive 100 percent survey. However, the strategy provides that areas of low site density can receive up to 25

percent of new or additional survey if existing surveys are not considered adequate. Sample survey needs are to be determined by Heritage Program managers on a project by project or individual task order basis (see Gifford 2011:14-17 for details on 4FRI survey strategies).

Phased Section 106 Compliance

Because of the size of this undertaking, implementation would be phased over several years. The programmatic agreement, appendix J allows for the phasing of Section 106 compliance evaluations. The programmatic agreement, appendix J, the Heritage Strategy and the initial 4FRI Section 106 report describe the methods to be used to achieve a “no adverse effect” determination for 4FRI as a whole.

Individual task orders or specific project areas will be evaluated by Forest Heritage Program staff for inventory needs and then surveyed to the appropriate level as defined in the Heritage Strategy. A Section 106 report will be produced for each project area as they are identified. Consultation with the SHPO and tribes will be completed prior to implementing each task orders.

Changes from the Draft Environmental Impact Statement and Opposing Science

Little change occurred in the heritage analysis from DEIS to FEIS. The analysis did use the most recent alternative numbers. No commenters submitted literature that could be considered to be opposing science.

Affected Environment

Existing Condition

The area of potential effect for the first 4FRI EIS is based on four alternatives. The overall analysis area is 988,930 acres but not all of those acres would be treated. Proposed treatments are as follows: Alternative A will not treat any acres; alternative B is 587,924 acres; alternative C is 593,211 acres; alternative D is 567,279; and alternative E is 581,020 (see chapter 2). Throughout the project, archaeological site densities range from 1 to 66 sites per square mile per the 4FRI heritage site density model (see Gifford (2011) for a full explanation of how the model was developed). Within the analysis area there are 5,513 recorded archaeological sites with 123,716 acres on the Coconino and 214,485 acres on the Kaibab that have been previously surveyed for cultural resources.

Long-term timber management and grazing activities have been conducted within the 4FRI project area over the past 100 years. Historic activities such as skidding logs, temporary road construction and chaining have affected sites over that time span. Hunting and fuel wood gathering activities, which may include driving off existing roads, has also had some effects on cultural resources. Even with these effects from past activities, many sites still retain sufficient integrity to be considered eligible for the National Register of Historic Places.

Though prehistoric sites are likely to have been burned in the past (Covington et al. 1997), many prehistoric and historic archaeological sites are now under threat from unnatural high intensity wild fires due to increasing fuel loads in and around them. A low intensity burn across a site can clear light fuels and not adversely affect sites. However, high intensity fires can cause pueblo rock walls to spall and scorch rock art panels. Though there has been an increase in hazard fuels reduction projects on both Forests over the last decade, a large amount of the archaeological resources within the project area still have high levels of dead fuels growing in and around them

(Crossley, Gifford, and Lyndon 2003, Coconino site records and Kaibab Annual Heritage Fire Report submitted to the SHPO). Heritage resources are also threatened by damage associated with fire suppression tactics like bulldozer constructed fire lines and safety zones. After a site has been intensely burned they are more exposed, consequently more vulnerable to vandalism and erosion.

As part of the Travel Management analysis, the Coconino and Kaibab identified and recommended road closures that are adversely affecting cultural resources. Many of these roads have not yet been physically closed to the public, leaving these cultural sites potentially vulnerable to continued affects from both intentional and opportunistic vandalism and soil erosion.

Habitat for some native plants desired by traditional collectors is also disappearing and natural springs are drying up due to various causes which may include climate change and overstocked forests. Plant collection areas and springs were used historically and still have cultural values that are important to the tribes. There are also dry ephemeral stream channels near to or in heritage sites that in some instances are damaging sites' stratigraphic integrity and eroding cultural materials. See Tribal Relations Specialist Report for more discussion.

Environmental Consequences

The environmental consequences for alternatives B, C, D and E include applying the design features and mitigation measures displayed in appendix C of this FEIS. These are generally accepted measures that have already been consulted on with the SHPO and the tribes (also see table 4 in the heritage report). Specific mitigation measures will be devised during the heritage analysis and tribal consultation for each individual task order.

Alternative A – Direct and Indirect Effects

Existing fuels in and around archaeological sites would continue to increase. This may result in more frequent and intense wildfires which could result in site and artifact damage such as spalling of rock art and cracking of artifacts as well as post-fire erosion (Deal 1999, USDI 2004, Oster 2012). Fire suppression actions, particularly bulldozer operations, may also damage or destroy surface and subsurface archaeological sites resulting in the loss of those resources and their research potential. Additionally, sites are more visible after a fire, especially high intensity fires, and much more vulnerable to vandalism and erosion.

Soil erosion due to uncharacteristic wildfires could have both a direct and indirect effect on cultural resources. Rain and snow melt can cause channels to form within denuded sites, or mud slides from nearby slopes may deposit soil and debris within site boundaries leading to the loss of data potential and characteristics that make historic properties eligible for the National Register of Historic Places.

No action may result in the possible reduction over time of pre-European settlement adapted native plants. Some of which have been collected since historical times by American Indians for food and medicine. Additionally, springs and seeps are important locations to American Indians and other members of the public and increasingly overstocked forests may have some effect on those historic water sources.

Alternative B – Direct and Indirect Effects

Unnatural fuel loading should be reduced around National Register listed or eligible cultural resources. Uncharacteristic fire behavior should also be reduced. Thinning and low intensity prescribed fires can reduce current fuel loads which would then assist in preventing extensive heat damage during wildfires. There would be less need for fire suppression activities, consequently reducing the threat of ground disturbing activities like bulldozer fire-line construction.

Mechanical thinning treatments, temporary road construction and closures, skidding and other ground disturbing activities associated with 4FRI have the potential to affect cultural resources. Impacts can include rutting, erosion, dislocation or breakage of artifacts and features and destruction of sites and site stratigraphy. Prescribed burning also has the potential to affect fire sensitive sites. These potential effects are addressed through site avoidance strategies and implementing the site protection measures listed in the programmatic agreement, appendix J, and in the Heritage Strategy (Gifford 2011).

Initial reduction of heavy fuels may lead to an increase in site visibility, public visitation, and possible vandalism. Those issues are reduced through management actions that include project specific as well as long term monitoring. Initial entry prescribed burns are periodically revisited and burned to reduce natural fuel accumulation and archaeological site monitoring is part of that process. Possible road decommissioning can also assist in limiting access to some archaeological sites thus reducing post-burn visibility and visitation at those sites.

There is the possibility that cultural resources would be discovered during project implementation. Discovery guidance is found in the programmatic agreement, appendix J.

Alternative C – Direct and Indirect Effects

This alternative is focused on preserving an undisclosed numbers of trees 16” in diameter and larger. It is more of a socio-political concern to contemporary culture rather than an impact to historic properties. Many of the ground disturbing activities associated with this alternative are similar to those identified in alternative B, and have the same potential to affect cultural resources. Key components of this alternative include additional mechanical and prescribed burning on specific grasslands; wildlife and watershed research and restoration as related to the Large Tree Retention Strategy identified by the 4FRI partnership. This alternative includes similar actions as alternative B, with maintaining large trees and expanded grassland restoration as the primary differences.

One concern for heritage resources under this alternative is the increases in mechanical treatments. The Heritage Strategy does address this concern. For intensive ground disturbing activities, it requires a 100 percent archaeological survey for historic properties prior to project implementation, thus identifying cultural resources prior to ground disturbing actions. If additional high impact or intense mechanical treatments are needed under this alternative, additional archaeological survey would be necessary.

One potential benefit of this alternative is the preservation of culturally modified trees. The Heritage Strategy incorporates various levels of survey but not 100 percent across the entire project area. Since sample surveys do not identify all historic resources, leaving a larger number of 16-inch and larger trees in place may preserve some of these unrecorded culturally modified trees. Conversely, one negative aspect of leaving large trees in place was noted during the bark beetle infestation on the Coconino National Forest. During that period a number of larger ponderosa pines died in drier parts of the Forest. Some of those trees had taken root in archaeological sites. When these dead trees fell they uprooted portions of sites. Both of these examples are very limited in scale and would be minimized through implementing the 4FRI project. Landscape-level forest restoration can potentially decrease bark beetle impacts through a healthier forest and culturally modified trees on the Coconino and Kaibab National Forests occur primarily in aspen stands; not ponderosa pine, the focus of this project. Any effects under 4FRI would be very limited.

Alternative D – Direct and Indirect Effects

Alternative D focuses on reducing prescribed burning by over 50 percent across the project in comparison to the proposed action (B). The alternative was developed in response to social concerns regarding smoke impacts in and around the area. Actions under alternative D are similar to those found in the proposed action (alternative B) with the principle difference being decreases in levels of prescribed burning and other options to remove thinning debris. Potential impacts to cultural resources are similar to alternative B. The Heritage Strategy is flexible enough to respond to all of the various levels of implementation under alternatives B, C and D.

Alternative D may benefit some fire sensitive cultural resources in areas of the Forest with lower site densities. Per the Heritage Strategy (Gifford 2011), burn units with high site densities are surveyed at 100 percent. In areas of low density, the Heritage Strategy option is to survey an additional 25 percent if necessary. Current national forest data, along with the 4FRI site density models and local heritage personnel's resource knowledge, will be used to identify and protect the majority of fire sensitive sites found in both high and low density areas. Nonetheless, there is always the possibility that small numbers of these fire sensitive sites could be affected and a reduction in prescribed burning may assist in preserving them.

The proposed reduction in burning under this alternative addresses those concerns. Also see Environmental Justice in the economics report for potential impacts to tribes.

A 50 percent reduction of prescribed burning leaves a significant amount of post thinning debris and slash on the forests. Without prescribed burning, actions identified in the alternative such as chipping, shredding, mastication and off-site removal of material would be required. Some of these activities may include ground disturbing actions that could have an effect on cultural resources. Forest and district archaeological staff can address these effects by increasing the amount of archaeological survey within the area of these ground disturbing activities and ensuring that cultural resources are avoided or the adverse effects are mitigated.

Alternative E – Direct and Indirect Effects

This alternative is similar to alternative C in the amount of mechanical and burn treatment areas proposed, additional acres of grassland treatments on the Kaibab NF, and the incorporation of wildlife and watershed research on both Forests. It proposes mechanically treating trees up to 9-inch diameter at breast height (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.

As in alternative C, the primary concern will be the increase in areas proposed for mechanical treatment. The Heritage Strategy does address this concern and was designed to achieve a "no adverse effect" determination pursuant to the programmatic agreement. It requires that areas planned to have intensive ground disturbing activities are inventoried for historic properties at 100 percent prior to implementation. If additional high impact or intense mechanical treatments are needed under this alternative, additional archaeological surveys would be necessary.

Because sample surveys do not identify all historic resources, the increase in survey coverage on the Coconino National Forest will result in a major decrease in the potential to adversely impact cultural resources. However, the majority of the treatment areas are within the ponderosa pine eco-zone, an area that has been found to generally have a low occurrence of historic properties.

Another potential benefit of this alternative is the preservation of culturally modified trees. The Heritage Strategy incorporates various levels of survey but not 100 percent across the entire project area. This alternative will leave a large number of 9 in. and above trees in place, thus may preserve some of these unrecorded culturally modified trees. Conversely, one negative aspect of leaving large trees in place was noted during the bark beetle infestation on the Coconino National Forest. During that period a number of larger ponderosa pines died in drier parts of the Forest. Some of those trees had taken root in archaeological sites. When these dead trees fell they uprooted portions of sites. Both of these examples are very limited in scale and would be minimized through implementing the 4FRI project. Landscape-level forest restoration can potentially decrease bark beetle impacts through a healthier forest and culturally modified trees on the Coconino and Kaibab National Forests occur primarily in aspen stands; not ponderosa pine, the focus of this project. So any effects under 4FRI are very limited.

Under this alternative, no forest plan amendments are proposed. Without a forest plan amendment that revises the current "no effect" standard (USDA Forest Service 1978, p. 53) to "no adverse effect," 100 percent of the area of potential effect would need to be surveyed and all sites avoided. If all areas cannot be surveyed, and/or all sites cannot be avoided, this alternative would not be consistent with the existing forest plan.

Also see Environmental Justice in the economics and tribal relations specialist reports for potential impacts to tribes.

Cumulative Effects

The spatial scale for cumulative effects is the area of potential effect. Past, present, and foreseeable projects in appendix F of this FEIS were reviewed and used for the analysis. Therefore, the temporal timeframe is about 10 years.

Alternative A

Under the no action alternative, the forest plans would continue to be implemented. The proposed large scale, landscape level forest health project does not occur, and there will be no additional effects as a result of this project. The present and foreseeable future undertakings will continue to have the potential to affect cultural resources. These undertakings will go through the section 106 review process and all cultural resources that are listed on the National Register or eligible for the Register will be avoided or the adverse effects will be mitigated. Any cumulative effects to cultural resources that could occur would therefore be considered to result in a "no adverse effect" determination.

Alternatives B

Alternative B has the potential to increase the amount of ground-disturbing activities, including mechanical treatments, temporary road construction, skidding, stream restoration, fence construction and other ground disturbing activities. When considered together with the past present and foreseeable future actions, these activities have the potential to affect cultural resources. All undertakings that have the potential to affect cultural resources will go through the section 106 review process, however, and all cultural resources that are listed on the National Register or eligible for the Register will be avoided or the adverse effects will be mitigated. In addition, protection measures including archaeological monitors during mechanical activities, keeping ground disturbing activities out of site boundaries by flagging and avoiding sites, and post prescribed burn site monitoring to assess the effects of the low intensity burns, will help to minimize the effects. The potential cumulative effects to cultural resources from increased ground disturbing activities and prescribed burning resulting from this alternative would therefore be considered to result in a “no adverse effect” determination.

There is a possibility for an increase in archaeological site vandalism resulting from increased visibility once the project is implemented. This visibility will be greater than that caused by past, present or foreseeable future undertakings in the area because more surface vegetation cover would be removed than ever before. However, the management practice of implementing low to moderate intensity prescribed fire typically does not sterilize soil or completely remove ground fuels like a high intensity uncontrolled wildfire. Low intensity fires also tend to leave some trees in place that would eventually cover the surface with a recurring needle cast. Sites are periodically monitored both during project implementation as well as for NHPA section 110 purposes by agency and volunteer personnel. Proposed road closures would reduce access to some of these areas as well, reducing the potential for increased vandalism. The cumulative effect of increased visibility resulting from this alternative would therefore be considered to result in a “no adverse effect” determination.

The cumulative effects on cultural resources resulting from any potential increase in erosion are also minimal. Reducing fuel loads and implementing low to moderate intensity prescribed fires does not cause soil sterilization or hydrophobic soils as high intensity wildfires do. As noted previously, low intensity prescribed fires leave some vegetation in place and revegetation occurs soon afterwards if soils are not sterilized. However, as implementation occurs, archaeologists would monitor for erosion concerns by examining sites in the project areas, focused on slopes, drainages, and other high probability areas with cultural resources present. The cumulative effects to cultural resources caused by an increase in erosion resulting from this alternative would therefore be considered to result in a “no adverse effect” determination.

Alternative C

The addition of the Large Tree Implementation Plan in this alternative would have little additional effect on cultural resources. However, an increase in prescribed burning, as well as similar actions identified under alternative B, such as mechanical treatments, prescribed burning, stream restoration and fence construction with mechanical clearing have the potential to affect cultural resources. Hand construction of fences, however, may or may not be subject to consultation as determined by the Forest Archaeologist in the Southwestern Region Programmatic Agreement (appendix A, section III of the programmatic agreement). These issues are identified under the Cumulative Effects section for alternative B and not repeated here. As noted previously, all undertakings that have the potential to affect cultural resources will go through the section 106 process and all cultural resources that are listed on the National Register or eligible for the Register will be avoided or the adverse effects will be mitigated. An increase in these types of activities will not result in an adverse effect to cultural resources as long as the projects comply with section 106.

Alternative D

As with alternatives B and C, similar increases in activities under alternative D such as mechanical treatments and ground disturbances can add to the effects on cultural resources. Additionally, specific to this alternative, is a reduction in prescribed burning which may involve other means of slash and debris removal. Actions such as chipping, shredding and mastication as well as removal of material off-site may include an increase in ground disturbing actions. As noted above, all undertakings that have the potential to affect cultural resources will go through the Section 106 process and all cultural resources that are listed on the National Register or eligible for the Register will be avoided or the adverse effects will be mitigated. Overall, the cumulative effects on cultural resources as a result of alternative D resulting from this alternative would therefore be considered to result in a "no adverse effect" determination.

Alternative E

The addition of the Large Tree Implementation Plan in this alternative would have little additional effect on cultural resources. As with alternatives B and C, similar increases in activities under alternative D, such as mechanical treatments and ground disturbances, can add to the effects on cultural resources. Alternative E may also increase ground disturbance in that it adds acres of grassland treatments on the Kaibab National Forest and incorporates wildlife and watershed research on both Forests that could cause additional ground disturbances through actions such as mechanical thinning, chipping, shredding and mastication as well as removal of material off-site.

Under this alternative, no forest plan amendments are proposed which could result in 100 percent of the area of potential effect being surveyed and all sites avoided to achieve a "no effect" determination as called for in the forest plan, which would reduce the effects of this undertaking on cultural resources. As noted above, on both the Kaibab and the Coconino National Forests, all undertakings that have the potential to affect cultural resources will go through the section 106 process and all cultural resources that are listed on the National Register or eligible for the Register will be avoided mitigation measures that are likely to be implemented will focus on limiting the amount of potential adverse effects to heritage properties. Overall, the cumulative effects on cultural resources as a result of alternative E are considered to result in a "no adverse effect" determination.

Forest Plan Consistency

The Coconino NF forest plan as written has some conflicting direction regarding managing significant, or potentially significant, inventoried sites. One standard directs management to strive to achieve a "no effect" determination (USDA FS 1978, p. 53). A second standard directs management to achieve a "no effect" determination in consultation with SHPO and ACHP (36 CFR 800). An amendment is proposed to remove the inconsistencies between the standards in alternatives B, C, and D. Amendment 3 is a specific, one-time variance for the Coconino NF restoration project. Amendment 3 revises the "no effect" standard to clarify that significant or potentially significant sites would be managed to achieve a no effect or no adverse effect determination whenever possible, and where adverse effects cannot be avoided, they would be minimized to the extent possible in consultation with the SHPO, Advisory Council, tribes, and other consulting parties. Once the project is complete, current forest plan direction would apply to the project area. The language proposed does not apply to any other forest project. The amendments would be authorized per direction in the National Forest Management Act of 1976 and its implementing regulations found in 36 CFR 219 (1982).

Direction for heritage resources was evaluated for both the Coconino and Kaibab NF (heritage report, table 5). With forest plan amendment 3, the project is consistent with the Coconino NF forest plan because heritage routinely inventories and evaluates sites for all projects. The project is consistent with Kaibab NF forest plan desired conditions for heritage resources because cultural resources, including known traditional cultural properties would be preserved, protected, or restored. All historic properties would be evaluated for their eligibility to the National Register of Historic Places. The 4FRI Heritage Strategy uses the Southwestern Region programmatic agreement, appendix J, and a forest heritage site density model to inform the process for compliance with section 106 of the National Historic Preservation Act within the individual treatment areas (Gifford 2011). All forest plan standards have been incorporated into the project. Special features such as the General Crook National Historic Trail and the Bill Williams Traditional Cultural Property would be protected.

Socio-Economics

A summary of the socio-economic report is presented here. The specialist report (Jaworski 2014) is incorporated by reference. The analysis describes the current conditions and trends related to the social and economic environment of the planning area, including: population and demographic changes, potential environmental justice populations, and employment and income conditions.

Economic impacts were modeled using IMPLAN Professional Version 3.0 with 2010 data. Economic efficiency analysis was conducted with QuickSilver Version 6. Social impacts use the baseline social conditions presented in the affected environment section, national visitor use monitoring profiles (USDA FS 2011a and 2011b), and information from the Coconino and Kaibab Economic and Social Sustainability Assessments (USDA FS 2008a, 2008b) to discern the primary values that the forests provide to area residents and visitors.

The regional economic impact analysis borrowed from the 2012 report, “Workforce Needs of the Four Forest Restoration Initiative Project: An Analysis,” conducted by researchers at Northern Arizona University’s Ecological Restoration Institute (Combrink et al 2012).

The temporal boundaries for the socioeconomic analysis extend 10-years, which is the proposed project period. The measurable social and economic consequences of the action alternatives are expected to occur during this period.

Changes from the Draft Environmental Impact Statement and Opposing Science

In response to comments on the DEIS, the socioeconomic analysis incorporates a more detailed explanation of study area determination to clarify why Maricopa and Navajo counties were included in the economic analysis and Gila County was not. The analysis includes additional discussion of community-level effects to airshed and infrastructure under each alternative and identifies communities that would experience the highest risk of fire and the assets (e.g., watersheds, ecosystem services, private property) that could be affected. The analysis includes a discussion of the potential effects employment supported by Grand Canyon visitation from a wildfire and evaluates the social and economic consequences of alternative E, which was not considered in the DEIS. Since the DEIS was published, the efficiency analysis as revised and the potential public savings from 4FRI treatments was evaluated. The analysis also includes the Combrink et al. (2013) study of the 2010 Schultz Fire. The analysis uses new timber and biomass harvest volume figures, which resulted in revised economic impact (employment and income) estimates.

No literature submittals that could be categorized as opposing science were received. How the analysis addressed comments received on the DEIS is discussed above. The complete response to comments document for socioeconomics is in the project record.

Affected Environment

Communities in the vicinity of proposed treatments include Flagstaff, Munds Park, Mormon Lake, Tusayan and Williams, Arizona. Much of the related processing of 4FRI forest products is expected to occur in Winslow, Arizona.

These communities are heavily influenced by their proximity to protected public lands, particularly Grand Canyon National Park. Tourism is a major economic driver, particularly in Tusayan and Williams. The economies are increasingly dependent on management, education, and tourism sectors, while consumptive natural resource industries have declined. Over the past 20 years, the population in the study area has grown substantially, indicating that the area offers both economic opportunity and natural amenities.

Population

The study area is home to 4,270,020 people (U.S. Census Bureau 2010). Table 89 displays population data for the counties, state, and nation in 1990, 2000, and 2010. Maricopa County is by far the largest county in the study area. Maricopa County alone accounts for approximately 60 percent of Arizona's population. All counties within the study area are fast-growing (over 10 percent population growth in a 10-year period). Population growth in Yavapai and Maricopa counties was similar from 1990 to 2010, growing approximately twice as fast as Navajo and Coconino counties. While Maricopa County's growth is driven by economic diversity and activity, Yavapai, Coconino and Navajo counties' growth is more amenity-based because of the easy access to open space and federal lands. Slower growth in Navajo and Coconino counties reflect their lower population density and corresponding lower levels of public services like health care and transportation. In Yavapai County, both the population density and median age are much higher than Navajo and Coconino counties, reflecting the influence of retirees on the county's population growth.

Table 89. Population change 1990 to 2010

Geographic Area	1990 Population	2000 Population	Percent Growth 1990–2000	2010 Population	Percent Growth 2000–2010
Coconino County	96,591	116,320	20.4%	134,421	15.6%
Maricopa County	2,122,101	3,072,149	44.8%	3,817,117	24.2%
Navajo County	77,658	97,470	25.5%	107,449	10.2%
Yavapai County	107,714	167,517	55.5%	211,033	26.0%
Arizona	3,665,228	5,130,632	40.0%	6,392,017	24.6%
United States	248,709,873	281,421,906	13.2%	308,745,538	9.7%

Source: U.S. Census Bureau 2010

Economic Diversity, Employment, and Income

Per capita income in the study area is similar to per capita income in the state and nation. Navajo and Coconino counties have lower per capita income than the other study area counties, the state, and the nation (table 90). This is consistent with the finding in the environmental justice section that Navajo and Coconino counties have higher poverty rates relative to the study area, the state, and the nation. A greater proportion of personal income in Navajo County is made up of non-labor income (such as transfer payments), which indicates that low-income assistance programs may be a greater portion of household income. Yavapai County has a slightly higher rate of non-labor income but given the demographics of this county and its higher per capita income, these payments are more likely to consist of earned interest and social security payments to retirees. Another indicator that poverty is the greatest concern in Navajo County is that its unemployment rate has consistently been 30 to 50 percent higher than the other counties in the study area.

Table 90. Per capita income, labor and nonlabor income, and unemployment

Geographic Area	Per Capita Income (2010 Dollars)	Labor (2009)	Non-Labor (2009)	Unemployment (2010)
Coconino County	19,703	62%	38%	8.9%
Maricopa County	25,350	66%	34%	9.1%
Navajo County	16,745	47%	53%	15.7%
Yavapai County	22,619	43%	57%	10.5%
Arizona	23,618	62%	38%	10.0%
United States	26,059	64%	36%	9.6%

Source: U.S. Census Bureau 2010, table DP03

Maricopa County has the most diverse economy in the study area, with only retail trade and government sectors accounting for more than 10 percent of employment. The other counties in the study area have lower economic diversity with some distinctive differences in sectors of employment. Yavapai County, as would be expected of a retirement community, has the largest percentage of its employment in health and social services compared to the rest of the study area. This diversity reflects the demographics driving the local economy. By contrast, Coconino County, which has a larger tourism base to its economy, has the highest percentage of accommodations and food services and arts, entertainment, and recreation within the study area. Navajo County has a smaller percentage of employment in service industries that would support tourism or retirement-age in migration, but has the highest employment rates in government and consumptive natural resource sectors (agriculture, forestry, fishing and hunting, and mining). Wage differences and higher unemployment may also be tied to these factors. Within Navajo County, poverty, unemployment, and income appear to be unevenly distributed geographically. Most employment centers are south of I-40 in Winslow and other more centralized communities. North of I-40, the county is dominated by three Indian reservations (see figure 49 on page 367 for race and ethnicity information) where there are fewer employment opportunities, lower population density, and less opportunity for amenity-based population and economic growth as seen in parts of Coconino and Yavapai counties.

Forestry-Related Economic Environment

Table 91 shows the economic contribution of forestry-related sectors to the local economy. In terms of employment, forestry-related sectors account for approximately one-third of 1 percent of study area employment. This is less than the statewide contribution, where forestry-related jobs account for approximately 0.63 percent of total employment. The same trend is observed in employee compensation and output—the forestry sector in the study area is relatively smaller than in other parts of the state. However, Navajo County is specialized in forestry-related sectors, with nearly 7 percent of total output in the county derived from these sectors. The economic data suggest that Navajo County is both the most underserved county (in terms of economic opportunities) and also the most reliant on forest-related employment in the study area. Therefore, Navajo County may be particularly influenced by economic changes related to the project.

Table 91. Economic contribution of forestry-related sectors in the study area

Geographic Area	Employment		Employee Compensation (in $ Million)		Output (in $ Million)	
	Value	% of Total	Value	% of Total	Value	% of Total
Coconino County	182	0.25	4	0.13	15	0.19
Maricopa County	6,784	0.31	192	0.20	801	0.26
Navajo County	683	2.04	33	2.49	245	6.56
Yavapai County	154	0.22	5	0.22	12	0.16
Study Area Total	7,803	0.33	221	0.22	955	0.29
Arizona	20,169	0.63	575	0.42	1,713	1.26

Source: MIG 2009

The Economics of Wildfire

Annually, millions of dollars are spent suppressing wildfires in the United States. In 2007, there were 27 large fires in the U.S. that cost $547 million to suppress (WFLC 2010). Between 2000 and 2008, the percentage of the Forest Service budget spent on extinguishing wildfires expanded from 25 to 44 percent (WFLC 2010). Furthermore, suppression costs account for only a fraction of the total cost of wildfires. The Western Forestry Leadership Coalition (WFLC) estimates that total wildfire-related expenses range from two to thirty times the reported suppression costs (2010).

A principal reason for the increasing cost is the growing number of homes located in the wildland-urban interface. Suppression activities are frequently undertaken when wildfire threatens private property. A century of fire suppression has led to increased fuels and therefore frequency of high-intensity wildfire. The spread of the wildland-urban interface has increased the probability that wildfires will occur near private residences. These two factors, the growth of the wildland-urban interface and the use of suppression tactics, increase the cost of wildfire and increase the importance of forestry treatments to reduce fuels that have increased high-intensity fires. Table 92 presents the extent of the wildland-urban interface in the study area counties and the western United States.

Table 92. Wildland-urban interface, planning area, and West-Wide (2000)

Geographic Area	WUI Area with Homes	WUI Homes as Percent of Total Homes	West-Wide Rank by Existing Wildfire Risk
Coconino County	21.5%	25.6	55 of 413
Navajo County	26.5%	18.7	93 of 413
Maricopa County	16.9%	0.3	161 of 413
Yavapai County	23.5%	9.7	71 of 413
Western U.S.	13.9%	3.9	N/A

Source: Guide et al. 2008

One-quarter of Coconino County homes, nearly 20 percent of Navajo County homes, and approximately 10 percent of Yavapai County homes are located within the WUI. Both Coconino and Yavapai counties are also in the top quintile for existing fire risk. These factors make it more likely the Coconino and Yavapai counties will experience large, expensive wildfires.

Nonmarket Values

The economic value of Forest Service management is not entirely captured in market transactions. Much of the value of National Forests is "nonmarket" in nature – meaning that many of the benefits that forests provide to humans do not have a price. The lack of a price, however, should not be conflated with an absence of value. Indeed, nonmarket values from forests provide economic benefits to adjacent communities and forest visitors.

Ecosystem services are "components of nature, directly enjoyed, consumed, or used to yield human well-being" (Boyd and Banzhaf 2007). Healthy forests provide numerous ecosystem services, including clean water and air, biodiversity, forest products, and many other goods and services. Consistent with direction provided in 40 CFR 1502.23 and Forest Service Handbook 1909.15 (7/06/04) and 22.35 (01/14/05), the analysis of environmental consequences considers non-market goods and services primarily in qualitative terms. Where appropriate, discussion of how the alternatives may affect non-market values will be presented. However, due to the qualitative nature of these discussions, direct comparisons between changes in market and non-market values are generally not possible.

Environmental Justice

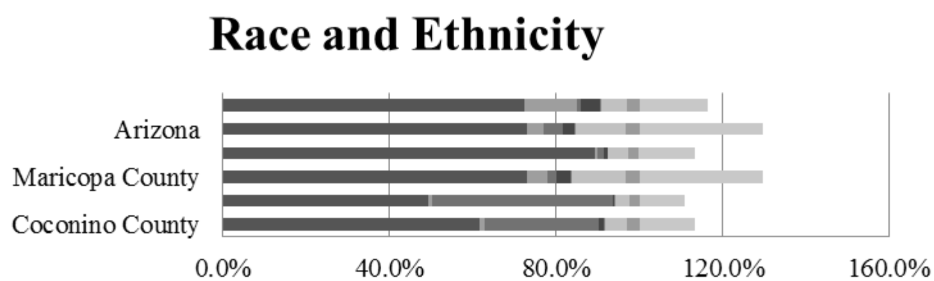
In 1994, President Clinton issued Executive Order 12898. This order directs federal agencies to focus attention on the human health and environmental conditions in minority and low-income communities. The purpose of Executive Order 12898 is to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects on minority and low-income populations.

The emphasis of environmental justice is on health effects and/or the benefits of a healthy environment. The CEQ has interpreted health effects with a broad definition: "Such effects may include ecological, cultural, human health, economic or social impacts on minority communities, low-income communities, or Indian Tribes …when those impacts are interrelated to impacts on the natural or physical environment" (CEQ 1997). According to the U.S. Census Bureau (2010) data reported in figure 49, study area counties differ substantially in their racial and ethnic composition.

Coconino and Navajo counties have high concentrations of American Indian residents, due to the presence of five reservations in Coconino County and three reservations in Navajo County. Maricopa and Yavapai counties also contain Indian reservations; however, their concentrations of American Indian residents are small relative to Coconino County, Navajo County, and Arizona.[17] Maricopa County has the highest proportion of Hispanic/Latino residents in the study area, although it is equivalent to Arizona's proportion (29.6 percent). In contrast, Yavapai County is less diverse than both the state and nation. Approximately 90 percent of Yavapai County residents self-identify as white. As a result, environmental justice issues are more likely to occur in Coconino and Maricopa counties than Yavapai County. However, a finding of low racial/ethnic diversity does not eliminate the need to consider potential disproportionate impacts of Forest Service management actions. A county may have a low overall concentration of minority

[17] Coconino County contains all or part of the Navajo Indian Reservation, Hualapai Indian Reservation, Hopi Indian Reservation, Havasupai Indian Reservation, and Kaibab Indian Reservation. Navajo County contains part of the Navajo Indian Reservation, Hopi Indian Reservation, and Fort Apache Indian Reservation. Maricopa County contains all or part of the Fort McDowell Yavapai Nation, the Gila River Indian Community, and the Salt River-Pima Indian Community. Yavapai County contains all or part of the Yavapai-Prescott Indian Reservation, the Yavapai-Apache Nation Indian Reservation, the Hualapai Indian Reservation, and the Camp Verde Indian Reservation.

residents, but still have areas with a high concentration of minority residents who could be adversely affected by management actions.



	Coconino County	Navajo County	Maricopa County	Yavapai County	Arizona	United States
White	61.7%	49.3%	73.0%	89.3%	73.0%	72.4%
Black or African American	1.2%	0.9%	5.0%	0.6%	4.1%	12.6%
American Indian and Alaska Native	27.3%	43.4%	2.1%	1.7%	4.6%	0.9%
Asian	1.4%	0.5%	3.5%	0.8%	2.8%	4.8%
Native Hawaiian and Other Pacific Islander	0.1%	0.1%	0.2%	0.1%	0.2%	0.2%
Some Other Race	5.2%	3.4%	12.8%	4.9%	11.9%	6.2%
Two or More Races	3.1%	2.5%	3.5%	2.5%	3.4%	2.9%
Hispanic or Latino (of any race)	13.5%	10.8%	29.6%	13.6%	29.6%	16.3%

Figure 49. Race and ethnicity (Source: U.S. Census Bureau 2010, table DP-1)

The incidence of poverty in Coconino and Navajo counties is not evenly distributed among racial and ethnic groups. Approximately 50 percent of American Indian residents in Coconino County and 70 percent of American Indian residents in Navajo County live in poverty (U.S. Census Bureau 2000). The high proportion of American Indian residents in these counties, therefore, increases the poverty rate relative to other study area counties and the state.

Based on the minority status and poverty data (see specialist report), Coconino County appears most at risk for environmental justice issues. The largest minority group in the county, American Indians, also experience a very high poverty rate. Furthermore, Coconino County contains the most acreage that could be affected by the first stage of 4FRI, which suggests that the consequences of management actions would be felt most acutely by Coconino County residents. In contrast, although Navajo County also has a high proprotion of American Indian residents and a high poverty rate, the first stage 4FRI treatments would not occur in the county. Navajo County would be chiefly affected by employment associated with the proposed plant in Winslow.

In response to a comment from the June 2012 NEPA update public meeting, the possibility of smoke-related environmental justice consequences in Snowflake, Arizona were evaluated. The community does not have a meaningfully greater percentage of minority residents than the state and Snowflake has a smaller proportion of individuals living in poverty than either the state or nation (U.S. Census Bureau 2010). In addition, the community is geographically distant from the project area, and therefore unlikely to experience acute smoke effects. As a result, Snowflake is not considered an environmental justice community in this analysis.

The air quality analysis finds that Flagstaff, Williams, Verde Valley, and Grand Canyon National Park are smoke sensitive areas within proximity to the proposed treatments. The communities of Camp Verde, Cornville, Cottonwood, and Flagstaff are expected to be affected by the proposed prescribed fire treatments. Camp Verde, Cornville, Cottonwood, and Flagstaff all have lower concentrations of minority residents and lower poverty rates than the study area as a whole (U.S. Census Bureau 2000). Therefore, the potentially disproportionate effect of smoke emissions on these communities is not an environmental justice issue. However, the implications of smoke emissions on 4FRI area communities, particularly vulnerable communities, are addressed in both the air quality and social analyses.

Numerous tribal communities are in airsheds that may be affected by 4FRI prescribed fires. The potential for disproportionate smoke emissions effects to tribal communities is addressed in the environmental consequences analysis. Effects to tribal uses are addressed in the tribal relations report.

Environmental Consequences

The economic analysis uses two types of analysis: (1) regional economic impact analysis and (2) economic efficiency analysis.

Regional Economic Impact

Economic impact analysis measures how activities related to the project would affect employment, income, and economic activity in the regional economy. Table 93 displays the change in employment and income between current conditions and the action alternatives. Therefore, 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 project 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.

Table 93. Summary of economic impacts, change from current conditions

Indicator	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Change in Employment	--	1,599	1,615	1,599	1,535
Change in Labor Income	--	$74.9 million	$75.6 million	$74.9 million	$71.9 million

A breakdown and analysis of employment and labor income consequences are addressed below and in the alternative-specific descriptions of consequences.

Tourism and Visitor Spending: According to the national visitor use monitoring reports, there are approximately 2,868,000 visits to the Coconino NF and 456,000 visits to the Kaibab NF each year (USDA FS 2011a and 2011b). It is unknown what portion of these visits occurs in the project area. At any given time during the 10-year treatment period, approximately 2 percent of the Coconino and Kaibab NFs would not be suitable for recreational use.

Visitors to the Coconino and Kaibab National Forests support approximately 3,000 jobs and $110 million in labor income in the study area economy, annually. None of the alternatives is expected to change the economic contribution from recreation. Although the project treatments would make portions of the forests temporarily unsuitable for recreational use, 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). Annually, the project treatments would affect about 60,000 acres of the more than three million acres of the Coconino and Kaibab NFs (2 percent of the total acreage). Therefore, the probability that visitor use would be substantially disturbed is low within the Forests.

Grazing: In the project area, 49 allotments provide forage for 110,173 cattle animal unit months (AUMs) and 13,616 sheep AUMs. Project treatments would entail one major pasture burn per year, per allotment. Over the 10-year treatment period, a 10 percent reduction in AUMs is expected. At the end of the 10 years, a return to pre-treatment AUM levels would occur. Therefore, during the 10-year treatment period, cattle AUMs would decrease to approximately 100,000 and sheep AUMs would decrease to approximately 12,250.

At current levels, grazing supports approximately 130 jobs and $2.15 million in labor income in the local economy, annually. The brief duration and advance notice of disturbances due to project treatments will make it easier for ranchers to adapt to changes. As a result, no reductions in grazing-related employment are expected. However, minor and temporary reductions in rancher income are possible if ranchers purchase more expensive private forage or reduce their stocking levels. However, over the long-run, improved forest health would improve forage quality and ranching viability.

Treatment and Forest Products*:* 4FRI treatments would produce commercially-valuable forest products. Table 94 shows the expected forest product volumes from project treatment for all action alternatives. These are the total volumes over the 10-year project period; annually, approximately one-tenth of the volume would be harvested and processed.

Table 94. Forest product volumes, by alternative

Forest Product	Alternative B	Alternative C	Alternative D	Alternative E
Timber (ccf)	3,566,683	3,602,303	3,566,656	3,428,155
Biomass (dry tons)	79,218	78,095	79,218	77,909

The NAU workforce analysis estimates 422 full-time equivalent (FTE) private sector employees will be required to support full implementation of the 4FRI. This estimate is not based on any alternative considered in this analysis, but is based on treatment of all four forests – approximately one-half of this employment is expected under the first stage implementation (Coconino and Kaibab NFs). The employment estimate includes only direct employment – it does not capture employment in forest product utilization, effects to suppliers, or the consequences of employee spending. The workforce analysis is based on an extrapolation of the employment impacts of the White Mountain Stewardship Project on the Apache-Sitgreaves National Forest (Combrink et al. 2012).

An additional 300 FTE jobs are expected as a result of forest product utilization and other indirect effects. Again, approximately half of this employment can be attributed to the first stage implementation (Combrink et al. 2012). The total workforce estimate, therefore, is 361 FTE employees. These estimates do not include induced effects (the effects from households spending income associated with the project).

An internal analysis was conducted using an input-output method. The employment estimates obtained are higher than the NAU workforce analysis estimates. Between 726 and 763 direct jobs (full and part-time jobs) would be supported by project harvesting and restoration activities. An additional 869 to 912 indirect and induced jobs would be supported in forest product utilization, supplying firms, and as a result of household spending. Thus, the first stage of project is expected to support between 1,595 and 1,675 private sector jobs on an average annual basis. While this estimate is higher than the NAU workforce analysis estimate, there are two key factors that explain the discrepancy: (1) the NAU estimate uses full-time equivalents (FTE). The internal estimate includes both full and part-time jobs. (2) The NAU estimate does not account for induced employment effects, which are the consequences of increased household spending attributable to project-related employment. For example, the individuals employed by firms contracted to implement project harvesting and restoration activities will spend their money on housing, gas, groceries, and other goods and services in the local economy. The firms that these individuals buy from will benefit from these expenditures. Therefore, even counties without harvesting and processing firms may experience economic activity due to the project.

U.S. Forest Service Employment: The Forest Service does not anticipate that additional employees would be required to administer project implementation. Approximately 35 Forest Service personnel would be required to administer and monitor implementation. Existing personnel are expected to meet this need (Combrink et al 2012). The indirect and induced impacts of implementation and monitoring are expected to support approximately eight jobs in the local economy. In total, implementation and monitoring is expected to support 42 jobs. This represents no change from existing conditions.

Economic Efficiency

Economic efficiency analysis measures the ratio of economic benefits to economic costs resulting from activities under the project. However, not all elements of the economic efficiency analysis are easily monetized to fit within the net present value framework. The subsequent section analyzes direct costs as well as effects to health, tourism, ecosystem services, and the timber market.

Avoided Treatment Costs: Treatment is associated with a decrease in wildfire suppression costs and a decrease in net resource damage (Mercer et al. 2000). Prescribed burning is often preferred to mechanical thinning due to the lower cost of prescribed burning. However, depending on proximity to urban centers, mechanical thinning may be preferred in some circumstances. The cost of smoke exposure, for instance, is higher when prescribed burning occurs near population centers. Mechanical treatment also has costs that are not accounted for in the cost of implementation, such as soil erosion. However, the indirect consequences of prescribed burning are more easily observable, which generally make it a less publicly popular treatment option.

The cost of prescribed burning ranges from $50 to $300 per acre on the Coconino and Kaibab NFs. The cost of thinning generally ranges from $100 to $400 per acre on the forests, but some projects may be as costly as $1,500 per acre.[18]

[18] The cost difference between prescribed burning and thinning is larger than indicated in these data, as the per acre prescribed burning costs include the cost of NEPA, planning, and a fire management organization. In contrast, the per acre thinning estimates include only crew and equipment costs.

Table 95 summarizes the present value of avoided costs from the use of stewardship contracts that rely on the utilization of small diameter wood to make private restoration economically feasible. The analysis uses typical treatment costs to evaluate what it would cost the Forest Service to treat an acreage equivalent to the first stage of the project over a 10-year period. Over the 10-year treatment period, assuming a 4 percent discount rate, the first stage of the project would avoid between $156 and $232 million of cost to the taxpayer. This figure can be viewed as a proxy for the economic value of project treatments.

Table 95. Present value cost savings to taxpayer of 4FRI treatments over 10-year period, 4 percent discount rate

Treatment Costs	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Prescribed Fire Acres	--	583,330	586,110	178,441	586,020
Estimated Cost of Prescribed Fire per Acre	--	$175	$175	$175	$175
Mechanical Treatment Acres	--	384,996	431,049	384,966	403,218
Estimated Cost of Mechanical Treatment per Acre	--	$400	$400	$400	$400
Net Present Cost of Treatments	--	$216 million	$232 million	$156 million	$222 million

Wildfire Costs: Central to the economic efficiency analysis of forest treatment is the relationship between treatment (prescribed burning and thinning, in the case of the project) and wildfire risk (incidence) and hazard (severity) reduction. Mercer (2000) notes that treatment is associated with a decrease in wildfire suppression costs and a decrease in net resource damage; however, the precise relationship between treatment and wildfire cost reduction is not identified. Therefore, the following discussion of economic efficiency is primarily descriptive in its analysis of tradeoffs.

Direct costs include only expenses associated with personnel and supplies used to suppress a wildfire. Federal and state budgets are finite – and increasingly limited in recent years. The direct cost of extinguishing a wildfire can be devastating for state and federal agencies. From 2000 to 2008, wildfire suppression funding increased from 25 percent to 44 percent of the U.S. Forest Service budget (WFLC 2010). The more money spent suppressing wildfires, the less funding remains for activities that promote forest health and improve the quality of recreation opportunities for visitors. Table 96 on page 372 displays historic wildfire expenditures[19] of the Coconino and Kaibab NFs.

Wildfire costs are very difficult to predict because wildfires range enormously in size, terrain, and proximity to local communities. All of these factors will affect the direct cost of dealing with a wildfire. The Wallow Fire of summer 2011, for instance, cost more than $79 million to extinguish (WMI 2011). However, not all wildfires need to be extinguished. Fire is a natural part of the landscape and unnecessary wildfire suppression leads to fuel buildup and increased fire risk and hazard.

[19] Wildfire suppression and wildfire use expenditures are reported together. However, according to the budget and fire staff, suppression accounts for the vast majority of the reported expenditures.

Suppression costs are generally only a small component of the total cost of a wildfire. The Western Forestry Leadership Coalition finds that the total cost of wildfire ranges from two to 30 times greater than the suppression cost (WFLC 2010). A full cost accounting of the 2010 Schultz Fire, which occurred in the vicinity of the 4FRI project area, estimated that the fire cost between $133 million to $147 million (Combrink et al 2013). Forest Service expenditures associated with the fire accounted for $14.4 million (Combrink et al 2013). For context, historic wildfire suppression costs data are presented in table 96.

Table 96. Historic wildfire suppression costs, by national forest

Year	Coconino National Forest	Kaibab National Forest
2006	$11,554,537	$6,821,329
2007	$5,473,007	$1,969,503
2008	$1,181,338	$1,442,289
2009	$6,081,460	$5,718,035
2010	$13,500,703	$6,332,694
2011	$5,137,758	*N/A*
Average Annual Expenditure	**$7,154,801**	**$4,456,770**

Source: Forest Service Fire Ecology and Budget Staff, Coconino and Kaibab National Forests

Health Impacts: Smoke is inevitable in the airsheds of northern Arizona, whether from wildfire or prescribed fire. Smoke can travel great distances and affect communities far away from the burn unit, sometimes persisting after the burn has been completed. Fires burning under historic conditions (wildfire or prescribed fire) produce behavior and effects that are low to moderate. Fires that burn under more extreme conditions (most/all fires in this category are wildfires) produce behavior and effects that are moderate to severe.

Ambient particulate matter (PM) concentrations increase substantially during a wildfire (Kochi et al 2010b). A dose-response function is an equation that estimates the health consequences of exposure to pollution. Compared to conventional PM studies (based on urban air pollution), wildfire studies are “less likely to find a significant positive mortality effect in spite of the substantial increases in PM levels during the wildfire period” (Kochi et al 2010a). There are several probable reasons for this finding, including: (1) urban air pollution and wildfire smoke are chemically different (wildfire smoke is generally less toxic), (2) wildfire events are more likely to promote averting behavior, such as evacuation (Kochi et al 2010a). However, the wildfire studies did find increased hospital admissions linked to asthma and respiratory problems during wildfire events (Kochi et al 2010a). PM studies find that the dose-response function is not linear. In other words, a doubling of PM concentration more than doubles the health consequences. Furthermore, at low-levels an increase in PM may result in no measureable health consequences (Kochi et al 2010b).

Five key health outcomes are considered in the literature: (1) mortality, (2) restricted activity days, (3) hospital admissions, (4) respiratory symptoms, and (5) self-treatment. Kochi et al (2010b) estimate that the cost of health effects due to smoke from wildfire events range from $0.26 million to $1.2 billion depending on the scale of the fire and the health outcomes considered.

The timing of prescribed fires is predictable, the volume of smoke produced is far less than in a wildfire, and there is time to notify the public when burns will be implemented. As a result, adverse health consequences are less likely to result from prescribed fires.

Tourism: During wildfire events, tourism decreases due to evacuations, road closures, and negative publicity (Mercer et al 2000). Depending on the size and intensity of the wildfire, impacts to tourism may be long-lasting. For instance, the 2002 Rodeo-Chediski fire burned 106 miles of trails on the Apache-Sitgreaves National Forest (Morton et al 2003). Recreation and tourism displacement can reduce contributions to the local economy (discussed previously in the “Regional Economic Impact” section). In addition to the costs to local businesses, individuals may have lower consumer surplus[20] values if they must recreate at a substitute site due to the presence of fire or smoke. Knotek et al (2008) find that local visitors are more accepting of prescribed fire than non-local visitors are. This finding may be due to (1) better communication between federal agencies and local residents, (2) more local familiarity with the role of fire in the landscape, or (3) more opportunities to engage in substitute behavior.

Ecosystem Services: Wildfire has the potential to reduce ecosystem service values through: (1) destruction of wildlife habitat, (2) water quality and watershed impacts, (3) damage to cultural and archaeological sites, and (4) soil erosion and impacts to water quality (Morton et al 2003). In contrast, forest restoration has the potential to improve ecosystem services. Expected ecosystem service benefits from 4FRI treatment include:

- Reduction of unnaturally large wildfires
- Protection of watersheds, leading to increases in surface water and decreases in soil loss
- Diversification of understory composition and protection of rare habitat from fire
- Better management of wildlife habitat
- Enhanced recreation that is aesthetically pleasing
- Sequestering carbon in large trees and soils (Combrink et al. 2012).

Timber Market: Prescribed burning allows for the measured and controlled use of fire to manage forest density and health. Wildfire events, however, are unplanned and have the potential to cause extreme destruction. Wildfires can be a substantial shock to timber markets. Following a wildfire, some of the killed timber is salvaged and brought to market. This can flood markets, temporarily decreasing the price of timber. In the American Southwest, processing capacity is generally too limited for this to lead to a substantial price shock. However, in the longer-term, the price of timber increases due to reduced timber inventories (Mercer et al. 2000). The Rodeo-Chediski fire burned approximately 1 billion board feet of timber, valued at more than $300 million (Morton et al. 2003).

Social Consequences

In addition to effects on the local economy, activities under the project have the potential to affect quality of life. The social consequences are measured both quantitatively and qualitatively, with a particular focus on traffic, smoke emissions, recreation displacement, scenery management, and environmental justice.

[20] Consumer surplus is the value that individuals receive above what is paid to consume the good or service. For instance, if an individual pays $10 to recreate at a site, but would be willing to pay $25, his/her consumer surplus is $15.

Road Traffic: Truck volume would increase throughout the project treatment period. Approximately 120,000 additional truck trips per year are expected to result from activities under the project. Individuals who commute along the roads to be used for activities will experience longer drive times. Longer commutes reduce quality of life due to increased stress and reduced leisure time. Individuals who live and recreate in proximity to the roads used for activities may be disturbed by increased noise and dust associated with the truck traffic. The transportation report addresses project-related road traffic in detail.

Smoke Emissions and Quality of Life: Smoke emissions are 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 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.

Recreation Displacement and Scenery Management: Both wildfire and prescribed burns may prevent individuals from recreating at their favorite sites. When individuals engage in substitute behavior within the local area, there is unlikely to be a decrease in visitor spending. However, individuals may get less pleasure from their alternate pursuit. As a result, consumer surplus and quality of life are reduced.

Wildfire, prescribed burns, and other treatments may adversely affect scenic areas. The 4FRI treatments would affect scenery; however, all anticipated effects are short-term. Forest visitors and nearby residents may have interrupted views during portions of the 10-year treatment period. The ability to experience scenic views is central to many individuals’ visit to the forests. A change in scenery may affect both quality of life and consumer surplus. The scenery and recreation analyses address the consequences in detail.

Environmental Justice

The goal of environmental justice is for agency decision-makers to identify impacts that are disproportionately high and adverse with respect to minority and low-income populations and identify alternatives that will avoid or mitigate those impacts. None of the alternatives would reduce employment and income relative to current conditions, therefore, no disproportionate adverse economic effects would occur. The mill in Cameron, which is on the Navajo Nation, may benefit from increased supply from 4FRI. However, any effect to the mill is likely to be small. Changes in employment and income associated with the mill are more likely to be affected by activities unrelated to 4FRI, such as potential growth in Tuba City.

Smoke emissions resulting from wildfires and prescribed burns can have health and quality of life consequences. Smoke is most likely to 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. No alternative eliminates fire on the forests - smoke from wildfires and prescribed fires would occur regardless of chosen alternative. Additional detail on smoke emissions is contained in the alternative-specific description of environmental consequences.

Traditional and sacred forest uses would continue under all alternatives. The heritage and tribal relations reports address these uses and potential effects in detail.

Cumulative Effects – All Alternatives

Forest restoration activities are emphasized in the existing and proposed forest plans in the region. Restoration activities would continue to occur in the region regardless of the project decision. Between 2000 and 2013, approximately 138,679 acres have been mechanically treated and 122,800 acres have been treated with prescribed fire on the Coconino and Kaibab NFs. During this period, another 105,793 acres were treated on private, state, and other federally-managed lands in the vicinity of the project area. On-going and reasonably foreseeable projects will use mechanical treatment on an additional 209,938 acres and prescribed fire on 253,790 acres. Reasonably foreseeable actions on private, state, and other federally-managed lands will mechanically treat 18,448 acres and use prescribed fire on 19,082 acres. These actions will occur regardless of the selected 4FRI alternative.

Alternative A

The effect of past, present and reasonably foreseeable treatment activities in the project area would improve forest health relative to existing conditions even without the implementation of 4FRI. Ongoing and reasonably foreseeable prescribed fire treatments will contribute to smoke emissions, which may affect the health and quality of life of individuals who live near or visit the forests. Since alternative A would not prescribe additional treatments, it would not cause cumulative effects related to smoke emissions from prescribed fire. However, the risk of uncharacteristic wildfire and associated smoke emissions in the project area would be highest under this alternative.

Alternatives B, C, and E

The effect of past, present, and reasonably foreseeable treatment activities in the project area would improve forest health relative to existing conditions even without the implementation of the project. Under alternatives B, C and E, due to the expected increase in the size of the timber harvesting and processing industry in the region, the local economic impact of current and future restoration activities would increase. The estimated employment and income consequences of non-project treatment activities, therefore, are likely underestimated in the related environmental compliance documents.

Ongoing and reasonably foreseeable prescribed fire treatments will contribute to smoke emissions, which may affect the health and quality of life of individuals who live near or visit the forests. Project treatments and other ongoing and foreseeable treatments could increase exposure to smoke emissions, which could cause cumulative effects to health and quality of life for individuals who are sensitive to smoke. However, the cumulative effect of these treatments would be to decrease the risk of uncharacteristic wildfire, which would decrease the probability of smoke emissions associated with these events.

Other on-going and reasonably foreseeable vegetation treatments in the project area will reduce the opportunities for substitute behavior when the preferred recreation site is unavailable. As a result, individuals may choose to stay home, which would decrease visitor spending and consumer surplus to a greater extent than estimated in the direct and indirect effects analysis.

Planned expansions and improvements to recreation opportunities within the project area, however, may counterbalance the visitor use consequences of treatment. Increased recreation opportunities may increase both the number and appeal of substitute recreation activities in the study area.

The extent to which these two forces (vegetation treatment and recreation opportunity improvement) will balance each other is unknown. Therefore, the cumulative effects to the social and economic impacts from recreation cannot be precisely described. Based on the available information, the net effect to visitor spending and consumer surplus from on-going and reasonably foreseeable actions is not expected to change.

Alternative D

Under alternative D, due to the expected increase in the size of the timber harvesting and processing industry in the region, the local economic impact of current and future restoration activities would increase. The estimated employment and income consequences of non-project treatment activities, therefore, are likely underestimated in the related environmental compliance documents.

Ongoing and reasonably foreseeable prescribed fire treatments will contribute to smoke emissions, which may affect the health and quality of life of individuals who live near or visit the forests. Alternative D would treat fewer acres with prescribed fire than alternatives B, C, and E. Therefore, cumulative effects to smoke emissions from prescribed fire would be lower under alternative D, which may improve quality of life for individuals who are sensitive to smoke. However, this alternative would be less effective at reducing the risk of uncharacteristic wildfire, which may cause greater smoke emissions over time. The cumulative effects to social and economic conditions related to recreation are the same as described under alternatives B, C and E.

Coconino NF Plan Amendments (Alternatives B, C, and D)

The proposed forest plan amendments address management in Mexican spotted owl habitat (amendment 1), management of canopy cover and management of select areas for open reference conditions (amendment 2), and managing for a no effect or no adverse effect for heritage resources (amendment 3). Economic activity would not be affected by the proposed amendments, therefore, their implementation (or not) would not lead to differences in local employment or economic efficiency. Social conditions would not be affected by the proposed amendments. Since no social or economic effects would result from the implementation of the proposed amendments, low income and minority populations would not be disproportionately affected.

Unavoidable Adverse Environmental Consequences

Unavoidable adverse impacts are associated with activities that have the potential to affect quality of life. Social consequences focus on traffic, smoke emissions, recreation displacement and scenery management.

Forest Plan Consistency

The land and resource management plans for the Kaibab and Coconino NFs do not specify desired conditions and strategies specific to the social and economic environment. However, both plans incorporate strategic direction related to air quality, transportation, forest products, wildland fire management, and other resource areas that are relevant to the social and economic environment. The following consistency analysis draws on those sections that are linked to proposed management actions under the 4FRI project.

The following desired conditions and guidelines from the Kaibab NF plan (2014) are relevant to the 4FRI project:

- Fire management needs to maintain an appropriate balance between smoke impacts and public concerns" (p. 19).
- "Project design for prescribed fires and strategies for managing wildfires should incorporate as many emissions reduction techniques as feasible, subject to economic, technical, safety criteria, and land management objectives" (p. 56).
- "Wood products and other products are available to businesses and individuals in a manner that is consistent with other desired conditions on a sustainable basis within the capacity of the land" (p. 71).
- "A sustainable supply of wood is available to support a wood harvesting and utilization industry of a size and diversity that can effectively and efficiently restore and maintain the desired conditions for ponderosa pine and frequent fire mixed conifer communities" (p. 71).

As described above, smoke emissions are 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 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. Therefore, the 4FRI project would be consistent with statements (1) and (2), above.

The 4FRI project would contribute to a sustainable supply of wood in the project area, which would support local employment and income in the wood products sector, as described above. Therefore, the 4FRI project would contribute to the attainment of desired conditions related to wood products on the Kaibab NF (statements (3) and (4), above). See the vegetation analysis for consistency with standards and guidelines and objectives for forestry and forest products.

Furthermore, the 4FRI analysis is consistent with management approaches for various major vegetation types or community types. In particular, the Kaibab NF plan emphasizes collaboration in the management of ponderosa pine and aspen (pp. 20, 28, 29). 4FRI is a large-scale, collaboratively driven project that is consistent with the forest plan's management approach to involve stakeholders in forest restoration. The heritage, fire, and wildlife sections of the 4FRI analysis provide detail on collaboration efforts with federal and state agencies, tribes, and communities.

The following desired conditions and guidelines from the Coconino NF plan (1987, as amended) are relevant to the 4FRI project:

- "Provide and manage a serviceable road transportation system that meets needs for public access, land management, resource protection, and user safety" (forest plan, p. 24).
- "Manage smoke from prescribed fires to meet legal standards and to provide for public safety" (forest plan, p. 92).

The 4FRI project would create no new permanent roads. Implementation of 4FRI would decommission 904 miles of existing roads (across the two forests). The transportation analysis discloses how each alternative moves toward a safe and more affordable transportation system. Therefore, the 4FRI project would be consistent with statement (1), above. The project's consistency with statement (2) is the same as described above for the Kaibab NF plan.

Recreation

A summary of the recreation report is presented here and the specialist report (Minor 2014) is incorporated by reference. The potential impact of the project to recreational opportunities was not raised as a concern by the public. Please refer to the specialist report for methodology, data, and supporting information.

This analysis evaluates the following questions to respond to/meet forest plan direction:

- Would project activities affect provision of a variety of recreation opportunities? (Measure: acres of opportunities provided).
- Would project activities result in substantial interference with the nature and purposes of the Arizona National Scenic Trail or adverse impacts to the Trail corridor? (Measure: describe treatments and their effects)
- Would smoke from pile burning and prescribed fire affect provision of recreation opportunities? (Measure: describe and compare potential effects).
- Would the proposed restoration activities diverge from reference conditions identified for the forest or result in inconsistencies in the mapped recreation opportunity spectrum (ROS) settings? (Measure: acres meeting ROS settings and miles of roads or acres of treatment in ROS classes impacted by roads in the project area).

Changes from the Draft Environmental Impact Statement and Opposing Science

In addition to those changes summarized in chapter 2 of the DEIS, changes to the recreation specialist report include:

- Corrections to acreages of treatment areas and corresponding GIS analysis for recreation opportunity spectrum acres adjustments for all alternatives,
- Addition of alternative E analysis,
- Removal of 1988 Kaibab NF forest plan direction for recreation,
- Addition of 2014 Kaibab NF revised forest plan direction for recreation and removal of reference to and analysis of 1988 Kaibab NF forest plan amendments,
- Addition of 2013 Draft Coconino NF revised forest plan direction for recreation. This includes updated recommended wilderness information for the preferred alternative (modified alternative B),
- Corrections to web addresses of citations if incorrect,
- Changed conditions as result of the May 2014 Slide Fire, and
- Clarifications or minor edits as a result of comments received and in response to comments.

No comments included literature that could be considered "opposing science".

Affected Environment

The Coconino and Kaibab NFs provide diverse outdoor recreation opportunities, connecting people with nature in a variety of settings. See the specialist report for maps that display general locations of recreation settings within the project area. The 4FRI project area is included in the Northern Arizona Council of Governments region that includes Coconino, Navajo, Apache, and Yavapai Counties. In comparison with the Arizona state figures, more residents in the Northern Arizona Council of Governments region participate in outdoor recreation activities more times throughout the year than in other regions of Arizona. The entire list of activities people participate in is available on the [FS Natural Resource Manager website (http://apps.fs.usda.gov/nrm/nvum/results/)](http://apps.fs.usda.gov/nrm/nvum/results/).

According to national visitor use monitoring reports, most visitors to the Coconino NF use day-use developed sites (such as picnic areas, observation points, and trailheads) and undeveloped areas (the general forest area with no developed facilities). On the Kaibab NF, the majority of visitors use overnight developed sites (campgrounds) and day-use developed sites. In all of these sites, visitors may engage in a number of different recreation activities (they are not limited to camping when staying at a campground). See the socio-economic report for additional information on population growth, demographics, and tourism-related economics that affects recreation use.

There are approximately 220 miles of dispersed camping corridors along the designated road system on the Coconino NF portion of the project where restoration activities would take place. This represents about 37 percent of designated camping corridors on the Coconino NF. About 4.2 percent of visitors to the Coconino report that they dispersed camp in undeveloped areas (USDA FS 2012). The Kaibab NF provides short road segments for recreation access including dispersed camping. Less than half of the short road segments would be affected by restoration activities. Approximately 9.2 percent of recreationists indicated that they dispersed camp in undeveloped areas (USDA FS 2012c).

The Arizona National Scenic Trail (Arizona Trail) was designated a National Scenic Trail by Congress in the Omnibus Public Land Management Act of 2009 (figure 50). The Arizona Trail is Arizona's only National Scenic Trail and provides local hiking opportunities around the Flagstaff area, as well as a recreational experience to long distance hikers, mountain bikers and equestrians. The Arizona Trail corridor represents a connected landscape across the state. As the trail becomes better known, people from the U.S. and internationally are coming to experience a unique cross-section of Arizona that can only be seen by traveling the Arizona Trail. The Coconino NF forest plan provides guidance on how the non-motorized trail is to be managed. The Kaibab NF forest plan provides desired conditions that the project must move toward (recreation specialist report, p. 47).

The recreation opportunity spectrum (ROS) is a classification system that describes different outdoor recreation settings across the forests using seven standard classes that range from primitive, undeveloped settings to urban, highly developed settings. Attributes typically considered in describing the settings are size, scenic quality, type and degree of access, remoteness, level of development, social encounters, and the amount of on-site management. Over 60 percent of the project is in the roaded natural ROS class, approximately 20 percent is in semi-primitive motorized, and there is less than 10 percent is in each of the remaining classes. The 4FRI project does not include restoration activities in developed recreation sites, special areas, or designated wilderness. ROS classes and miles of road by ROS class are displayed in tabular and map form in the specialist report.

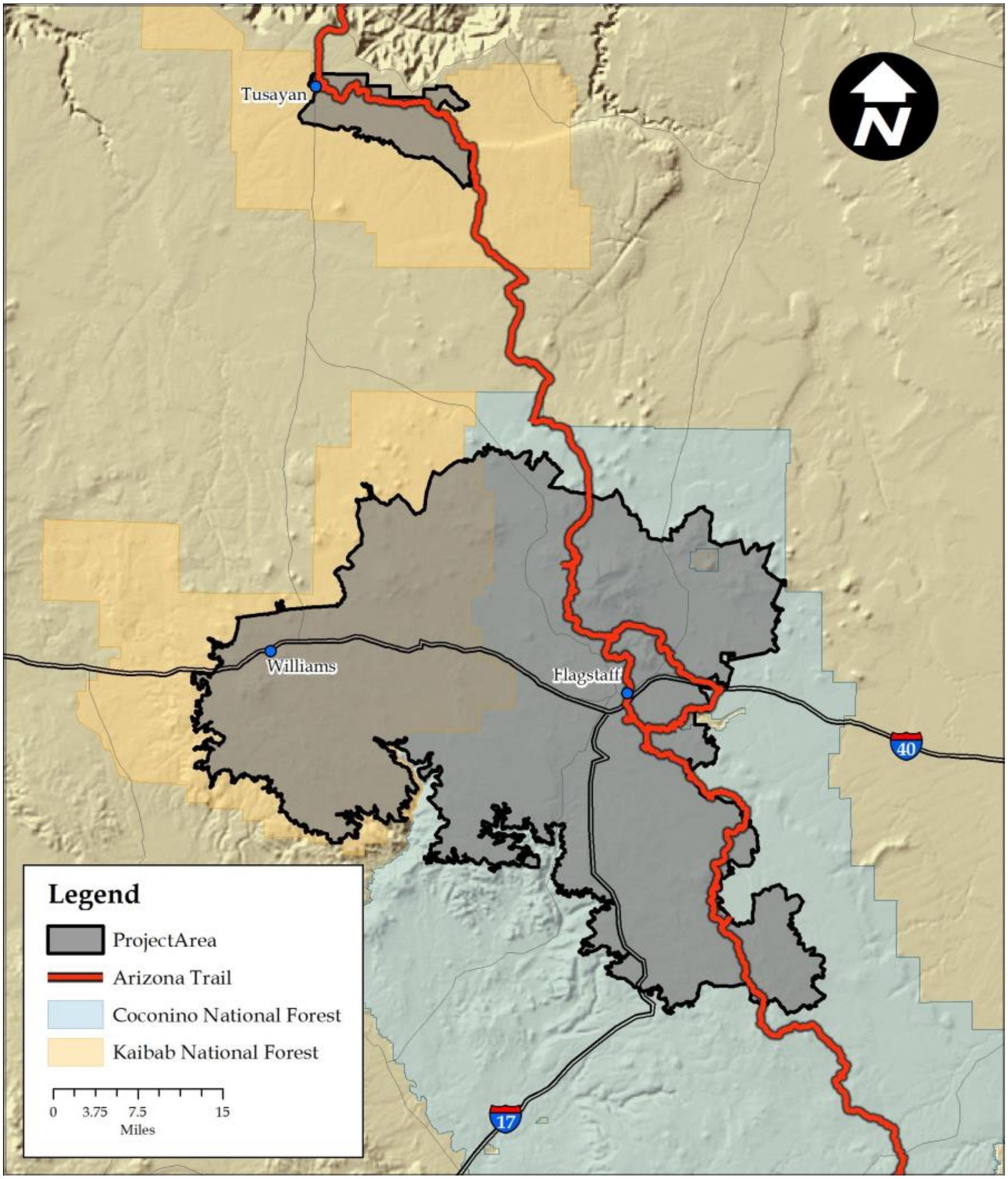


Figure 50. The Arizona National Scenic Trail

Throughout much of the project area, numerous resource management activities have occurred including vegetation management, road maintenance, developed recreation site construction, trail construction and maintenance, prescribed fires, hazard tree removal, utility corridor clearing and others. In addition, there have been numerous wildfires in the area. Not all projects have met or currently meet the characterizations and mapped ROS classes at this time.

Environmental Consequences

The environmental consequences are organized to sequentially follow the analysis questions presented earlier. The environmental consequences are based on the application of design criteria and mitigation developed to eliminate or reduce adverse effects of the proposed actions on sensitive resources. See the recreation section of appendix C in the FEIS.

Cumulative Effects

For all alternatives the cumulative effects area is the ponderosa pine forest on the Coconino and Kaibab NFs. The cumulative effects period is 20 to 30 years. Management activities and natural processes that have affected, or continue to affect, vegetation structure, spatial arrangement and pattern, composition and diversity, natural processes (such as fire), and movement toward increased forest resiliency and function. Past vegetation management activities have resulted in an even-aged forest structure that is generally undesirable for recreation settings. The specialist report provides an overall assessment of positive and negative cumulative effects of past, present and future projects on recreation.

Alternative A

Direct and Indirect Effects

Under the no action alternative, there would be no immediate direct, indirect, or cumulative effects on the existing recreational settings or facilities, or the Arizona National Scenic Trail. Since no direct management actions would occur, the existing recreational settings (ROS) would not change. There would be no change in current rate of management actions, and there would be scattered treatments where the existing recreational settings could change in the short term (1-5 years). In the short term, there would be no change in recreation opportunities. In the long term, up to 589,923 acres could be affected in the event of large scale, high-intensity wildfire or insect or disease outbreak. If this were to occur in a large enough area, there would be substantial interference or adverse impacts to the Arizona Trail.

Cumulative Effects

Cumulatively, the no action alternative (when considered with past, present, and future projects) would not immediately change recreation opportunities and the associated recreation settings on the forests. Increased demand for ponderosa pine forest settings is expected. This alternative is expected to result in declining forest health, unhealthy stands (that have resulted from past wildfires and past timber sales), and a less sustainable forest. There would be a decline in the quality and availability of satisfactory recreation settings as well as the slow decline in provision of distinct ROS classes.

The no action alternative would result in the forest being more susceptible to large intensity wildfire or beetle attack. This would result in a decrease in recreation opportunities while at the same time, the desire for recreation use is increasing as a result of population growth and the public is increasingly dependent on national forests for recreation and leisure activities. Thus, this alternative would result in a cumulative decrease in the ability of the Coconino and Kaibab NFs to meet recreation demands over the long term.

The current and planned vegetation management treatments and burning projects on both forests, as well as opportunities for managed wildfire result in cumulative improvements in forest health and sustainability in the ponderosa pine, but are at such a small scale that the benefits to the recreation settings in the ponderosa pine forest on the Coconino and Kaibab NFs are small and localized. In the event of a large, high-intensity wildfires, or large scale insect infestation resulting from existing conditions, the desired recreation settings and ROS class characteristics forest users seek would be so altered that the cumulative effects would result in a lack of desired recreation settings and long-term changes in ROS classes.

Motorized travel management implementation in combination with the no action alternative is expected to have mostly positive effects on recreation settings due to prohibition of cross-country motorized travel. The quality of many recreation settings in ROS classes were declining due to increased motorized use and increasing occurrences of cross-country travel. Present and future activities may result in degradation along heavily used camping corridors, but these would be small and localized.

Desired recreation setting characteristics such as large, mature trees, healthy understory, and diversity of tree age classes, sizes, and species are also at high risk from the effects of climate change. Increased tree mortality and loss of large, mature trees would result in a cumulative decrease in recreation settings.

Alternative B

Direct and Indirect Effects

Recreation Opportunities

There would be short-term and temporary decreases in the provision of recreation opportunities on parts of the Coconino and Kaibab NFs. Some forest users would be dissatisfied with their lack of access to portions of the project area during management activities such as thinning projects and prescribed fires. Areas may be closed to the public due to hazardous conditions which would result in forest user displacement and user dissatisfaction. The treatments would not result in substantial interference or long term adverse impacts to the Arizona Trail. There would be short term disruptions and dissatisfaction of trail users on some segments of the trail during the duration of the project. In the long term, the health and vigor of trailside vegetation would be improved, views expanded, and risks from potential disturbances reduced for the trail and recreation opportunity it provides.

There could also be an increase in crowding in nearby open forest areas. Since this project would affect 40,000 acres at one time, or 2 percent of the south Kaibab and Coconino NFs, it is unlikely that crowding ratings would increase more than the 25 percent in areas that have already been identified as having crowded conditions.

Direct effects of pile burning, prescribed fires, and fire line preparation are the potential for short term displacement of recreationists during implementation (campers may need to be moved out, trail users may not be able to use a trail during firing operations), or visitor dissatisfaction (seeing slash piles or pile burning, smoky conditions from pile or prescribed fires while people are visiting the area); however, these effects are expected to be of short duration and intensity (fire line preparation would likely last less than a year and smoky conditions in any one particular area are likely to last a week or less). Mitigations such as timing burning for adequate ventilation, avoiding high use holidays, and provision of visitor information would reduce these short term effects.

Indirect effects would include recreation user displacement (potentially including trail users, hunters, anglers, winter users, fuelwood gatherers), increased use of special areas and designated wilderness, and potential crowding in areas not receiving forest management treatments. Restoration activities would help to assure long-term provision of recreation opportunities.

Mitigations that include provision of information about treatment and burning locations would help to inform visitors of places to avoid or other locations that are not receiving active treatments. Mitigations to provide information about the location of restoration activities as well as places where there are no activities planned may help reduce visitor frustration about finding a camping location and assist campers in making choices about where they will engage in camping activities (see the recreation section in appendix C of this FEIS).

Recreation Settings

Direct and indirect effects to recreation settings from mechanical treatments would result in short-term (immediate to 5 years), temporary changes in up to 72 percent of ROS settings quality (urban to roaded natural) in the project area. The short-term effects would persist one or more seasons until activity slash is treated and the treated area recovers to an “unaltered” or “undisturbed” natural appearance.

Effects of mechanical treatments are expected to take longer (immediate to 10 years) to recover in the two semi-primitive ROS settings since these would have less evidence of treatment or development to begin with and would require more time to naturalize. Twenty-eight percent of the project area is in the two semi-primitive ROS settings in the project area. Mitigation measures have been designed to ensure that direct effects of project activities are short-term, and important recreation values are protected in the long term. ROS classes are expected to be changed 1 to 5 years after treatment, but following completion of vegetation treatments should display many of the characteristics described for each setting.

As required in the Kaibab NF forest plan, temporary changes in ROS classes are documented in the recreation report and the timeline for meeting the mapped ROS classes is 15 years from the beginning of project implementation (5 years following the last projected treatment). There would be one exception to this for aspen treatments. Since these activities require fencing or creation of barriers until trees can withstand ungulate grazing, it is anticipated aspen stands would not meet desired ROS classes until at least 20 years following project implementation.

There would be short-term and temporary changes in ROS classes as well as decreases in the scenic quality of trailside recreation settings due to restoration activities (see report for examples). Following completion of treatments, trailside settings are expected to naturalize quickly (within 1 to 3 years) and the scenic quality of the settings would be improved.

There would be short-term disturbance and temporary changes in ROS classes and roadside recreation settings during road reconstruction. Recreation visitors may be inconvenienced and have to wait during some activities, or roads may be temporarily closed causing displacement. Long-term effects would be improved water quality at stream crossings, and safer and better maintained roads for forest user enjoyment (see the soils and water quality and riparian report).

Decommissioning of existing and unauthorized roads would improve recreation settings over time and would improve ROS classes. Temporary road construction would result in short-term disturbance and temporary changes in ROS classes. New linear features would be added to recreation settings reducing the scenic quality for 3 to 10 years. There may be some increase in illegal motorized vehicle use of these roads until they are decommissioned. Once these roads have been decommissioned, they are usually not apparent to the casual user. Mitigation measures would be used to close off entrance and exit locations of these roads, as well as use of BMPs (see appendix C of this FEIS). Opening closed roads would have similar effects as reopening temporary roads; however, decommissioning would result in the roads revegetating and becoming natural appearing over time. Since these roads would not be reopened, in the long term the decommissioned roads would meet and improve ROS classes.

Spring improvements would improve and meet ROS classes. Channel restoration would improve recreation settings over time. There would be short to moderate term changes in ROS settings where aspen are treated. Ephemeral channel restoration fencing and aspen restoration fencing and jackstrawing would cause temporary changes in the ROS class setting characteristics since the natural appearing environment would be somewhat altered. When the fencing is removed or jackstrawed trees burn or begin to break up and decompose, treatment areas would meet ROS classes. This alternative would provide for restoration treatments along both utility corridors and road rights-of-ways. Mitigation measures to feather abrupt edges of corridors and rights-of-way should provide improve the ROS class compliance. Based on information compiled for this project (Noble 2014), the mechanical treatments improve all understory characteristics, thinning and prescribed fire increase most understory characteristics with the possible exceptions of shrubs and Gambel oak. A healthier, more varied understory would result on improved recreation settings on at least 384,966 acres where thinning and prescribed fire would occur, as well as some improvement on 198,364 acres of prescribed fire-only.

This alternative provides for the long-term protection of recreational settings and facilities on 384,966 acres where mechanical thinning and burning would occur by improving stand conditions and reducing fuel loading, and would lower the risk of high-intensity fire somewhat on 198,364 acres where prescribed fire would occur. Maintaining healthy, green forests and reducing the risk of large scale, high-intensity fires in the project area would have a positive effect on protecting and maintaining high quality recreation settings into the future.

Coconino NF Forest Plan Amendments

Amendment 1: While constructed features such as trails or recreation sites are generally placed outside of Mexican spotted owl protected activity centers (PACs), older trail alignments or recreation sites may precede delineation of these areas, and may be located within or adjacent to PACs. For recreation this would result in potential reductions in the risk of wildfire in Mexican spotted owl PACs compared to compliance with the existing forest plan language and direction. It would also open up these PACs somewhat creating the potential for views beyond the immediate foreground. This would have a slight positive effect on recreation settings and scenic quality associated with the settings.

Amendment 2 would help to meet the desired conditions for recreation including “recreation areas have deteriorated due to lack of natural processes such as fire and declining forest health, as well as provide high scenic and recreational values”. It would also meet Coconino NF plan goals for recreation including: “Manage the recreation resource to increase opportunities for a wide variety of developed and dispersed experiences” goals and objectives “there is a range of recreational setting opportunities for people to enjoy the area’s many scenic and aesthetic qualities. The diversity and quality of recreation opportunities, settings, and experiences are within acceptable limits of change to ecosystem stability and condition.” It would make more progress toward restoration than implementing the existing forest plan direction. There would be improvement in recreation settings and scenic quality associated with the settings.

Amendment 3 would not affect recreation resources associated with this project.

Cumulative Effects

The cumulative effects of alternative B and past, present and future projects would have short term and local negative cumulative effects on the provision of recreation opportunities and the associated recreation settings on the forests. Forest users seeking ponderosa pine recreation settings may be displaced or restricted, and the quality of recreation sites may temporarily decrease during management activities on this project and other current or future projects. Long distance hikers may have trips disrupted or may be rerouted to different areas in the short term.

Alternative B would restore the ponderosa pine forest health and sustainability to about 500,000 acres; this combined with other restoration activities would decrease the risk of high severity wildfire or large insect outbreaks. Increasing numbers of recreation users and demand for ponderosa pine recreation settings will continue to strain the agency's capacity and in some areas of concentrated use, the resource capacity. With increasing demand for ponderosa pine forest settings, the large scale improvements to forest health and sustainability of this project and similar vegetation and burning projects such as Upper Beaver Creek Forest Restoration, Hart Prairie Forest Restoration, Marshall Forest Restoration, Rim Lakes Forest Restoration and others are expected to result in cumulative retention or improvement in the quality of recreation settings and an increase in the ability of the Coconino and Kaibab National Forests to meet recreation demands over the long term.

The current and planned vegetation management treatments and burning projects on both forests, as well as opportunities for managed wildfire, cumulatively result in improvements in forest health and sustainability in the ponderosa pine that are large and widespread. In the event of a wildfire, or insect infestation the restored forest would likely experience more typical low severity fire and small scale insect infestation. The cumulative effects to desired recreation settings and ROS class characteristics forest users seek would be maintained and improved.

Utility corridor clearing in combination with alternative B would result in short term and localized negative cumulative effects on both forests.

Motorized Travel Management implementation in combination with alternative B is expected to have mostly positive effects on recreation settings due to prohibition of cross country motorized travel and decommissioning of user created routes and some existing forest roads. The quality of many recreation settings in ROS classes were declining due to increased, unconfined motorized use and increasing occurrences of cross country travel. Present and future activities may result in additional degradation along camping corridors, but these will be short term and localized. There would be positive cumulative effects and an overall improvement in ROS classes as a result of these activities. In some areas motorized restrictions resulting from the travel management rules may combine with temporary access restrictions that will be necessary under this alternative to make portions of the National Forest unavailable for motorized access.

Road and trail construction projects in combination with alternative B would result in negative effects to small and localized recreation settings across both forests. Little new road construction is proposed now or in the future in cumulative effects projects. Motorized trails projects include new construction, road to trail conversion and route decommissioning in appropriate ROS classes. This would have positive cumulative effects in more primitive ROS classes when decommissioned routes naturalize, and expected characteristics are re-established.

Desired recreation setting characteristics such as large, mature trees, healthy understory, and diversity of tree age classes, sizes, and species are also at high risk from the effects of climate change. Alternative B and other restoration projects would cumulatively result in improved forest structure, composition and diversity and more resilient forest conditions, decreased tree stress and potential for decreased mortality.

Alternative C

Direct and Indirect Effects

Recreation Settings

The effects described in alternative B would be the same for alternative C with the exception of the number of acres restored. Approximately 21 percent more acres would receive mechanical and prescribed fire restoration treatments, 1 percent more prescribed fire-only. This alternative would provide the greatest potential to reduce the risk of large scale, high-severity fires in the project area. It would have a more positive effect than alternative B on protecting and maintaining high quality recreation settings over time. Alternative C would result in 10 percent more temporary changes in ROS classes during project implementation. Assuming a linear relationship, up to ten percent more forest users may be affected by the additional treatments.

Alternative C would construct up to 12 weirs[21] and 12 weather stations (disturbing approximately 3 acres) as part of watershed improvements and metrics. Effects to recreation settings would be to increase the visibility of human disturbances on 3 acres within the project area and remove these from potential recreation use. Design criteria (FEIS, appendix C) are included to assure that constructed features use natural or natural appearing materials that reduce the visibility and contrast as much as possible.

Recreation Opportunities

There would be some reduction of recreation opportunities during active forest thinning and prescribed burning. It is estimated that there would be a 10 percent increase or about 66,000 acres could be affected at one time. Areas may be closed to the public due to hazardous conditions which would result in forest user displacement and user dissatisfaction. There could also be an increase in crowding in nearby open forest areas. The effects from pile burning (smoke) are the same as described in alternative B.

This alternative provides for the long-term protection of recreational settings and facilities on 434,049 acres where mechanical thinning and burning would occur by improving stand conditions and reducing fuel loading, and will lower the risk of high severity fire somewhat on 155,211 acres where prescribed burning-only will occur. Maintaining healthy, green forests and reducing the risk of large scale, high-severity fires in the project area will have a positive effect on protecting and maintaining high quality recreation settings into the future.

See alternative B for roads and other management activities. Weir construction (see alternative C description) would result in short-term decreases in ROS classes. Mitigation measures (see appendix C of this FEIS) would be used so that natural or natural appearing materials are used in the weir construction, and the landscape architect would be involved in the design of the fixtures so that they would meet the ROS class.

The effects of alternative C activities to the Arizona National Scenic Trail are the same as described in alternative B.

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[21] A weir is a constructed structure that restricts water flow into a defined area for ease of water flow measurement. The structure is often "V" shaped. The water flowing through the constriction can be measured up the walls, and is often measured in cubic feet per second.

Coconino NF Forest Plan Amendments

Amendment 1 increases the size of trees that could be removed in 18 Mexican spotted owl Protected Activity Centers (PACs) and allows use of low intensity prescribed fire within 54 PAC core areas. Old, large diameter trees are often an important part of the scenic quality of recreation settings. While constructed features such as trails or recreation sites are generally placed outside of PACs, older trail alignments or recreation sites may precede delineation of these areas, and may be located within or adjacent to PACs. For recreation this would result in more potential reductions in the risk of wildfire in Mexican spotted owl PACs compared to compliance with the existing forest plan language and direction, and more than would be implemented in action alternatives B, D, or E. It would open up these PACs more creating the potential for views beyond the immediate foreground. This would have a somewhat greater positive effect on recreation settings and scenic quality associated with the settings than action alternatives B, D, or E.

Amendment 2: 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 will 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. The effects to recreation would be the same as with alternative B. The exception for less aggressive treatment would have no effect on recreation.

Amendment 3: There would be no effects to recreation resources from implementation of this amendment.

Cumulative Effects

Cumulative effects of alternative C are the same as alternative B. The other projects such as construction of weirs and weather stations would result in no or very small, localized cumulative effects.

Alternative D

Direct and Indirect Effects

The short-term and temporary decreases in the provision of recreation opportunities on the Coconino and Kaibab NF and dissatisfaction would be the same as described in alternative B. Direct effects of vegetation management and mitigation measures are the same as for alternatives B and C. See the scenery section for impacts to scenic quality in terms of recreation settings. The effects of roads on recreation resources would be the same as alternatives B and C. The effects to hunters, anglers, and fuelwood gathering are the same as described in alternative B and C. The effects to ROS classes from roads, springs, channels, aspen, utility corridors, and road rights-of-way treatments are the same as described in alternatives B and C.

The completion of restoration activities would provide some protection of 384,966 acres across both national forests from mechanical thinning, but less than Alternatives B or C. Prescribed burning would be much decreased, occurring on only 178,441 acres or about 30 percent of the project area. The proposed alternative D activities would help to assure some provision of recreation opportunities, but these would be limited since prescribed fire would not be used to help maintain forest health and resilience.

Direct effects of pile burning, prescribed fire and fire line preparation have the least potential for short term displacement of recreationists during implementation since much less area would be treated through these methods. This alternative would cause the fewest days of smoky conditions due to pile burning or prescribed fire. Fire line preparation would occur on about one-quarter of the area, the least of the action alternatives. Prescribed fire would occur on about one-third of the project area. The immediate effects following prescribed burning are the same as described in alternative B and C.

The direct effects of alternative D to dispersed camping corridors along designated road systems would be similar or slightly greater than alternatives B or C Initial ground recovery may be faster with slash removal and less prescribed fire, but the potential for crown fire or high-intensity ground fire is reduced on only a third of the treatment acres. There would still be some camper displacement along some of the designated camping corridors during implementation when there are temporary closures.

Indirect effects of mechanical treatments on both forests in terms of crowding in designated camping corridors would be similar as described in alternative B and C. However, initial recovery would be faster than those areas receiving prescribed fire, but the risk of fire starts would be greater with this alternative.

There may be longer hiking and motorized user temporary closures (including the Arizona National Scenic Trail) with alternative D since slash would be mechanically treated: chipped/shredded/masticated or transported away from the site. There would be shorter temporary closures associated with prescribed fire activities since only a third of the treatment area would be burned.

There would be short-term and temporary changes in ROS classes as well as decreases in the scenic quality of trailside recreation settings due to restoration activities. These could include visible skid trails, and log landings on nearby roads, increased noise from mechanical thinning, and slash treatment or removal. There would be 99 acres of blackened areas where slash piles would be burned. Following completion of treatments, trailside settings are expected to naturalize quickly (within 1 to 3 years) and the scenic quality of the settings would be improved. Understory vegetation would respond, but not as much as alternatives B or C.

Direct and indirect effects to recreation settings of mechanical treatments would be a short-term, temporary change in ROS setting quality until the effects of logging and slash treatment activities fade and become vegetated and the treated area recovers to an “unaltered” or “undisturbed” natural appearance. Mitigation measures would ensure that direct effects of project activities are short-term, and important recreation values are protected in the long term.

This alternative does less than alternatives B or C to provide for the long-term protection of recreational settings and facilities on the project area since total prescribed fire would be reduced to 178,441 acres. The risk of high-intensity fire would be the greatest of all action alternatives, but less than the no action alternative. This alternative has the least positive effect in terms of moving toward desired conditions and protecting and maintaining high quality recreation settings into the future. The understory is expected to be improved but not as much as alternatives B and C. About one-quarter of the area proposed for restoration would have well-improved recreation settings, the remainder would have somewhat improved recreation settings.

Alternative D would result in some reduction of recreation opportunities during active forest thinning and prescribed burning, and potentially longer slash treatment duration than alternatives B or C. Areas may be closed to the public due to hazardous conditions which would result in forest user displacement and user dissatisfaction. There could also be an increase in crowding in nearby open forest areas.

Smoke from pile burning would be minimal with alternative D. Only 99 acres of would be thinned, hand piled, and burned. Smoke from prescribed fire would occur on about a third of the acreage as alternatives B or C. Short-term effects are the same as described in alternative B and C. This alternative provides for the long-term protection of recreational settings and facilities on 384,966 acres where mechanical thinning would occur, improving stand conditions, and would reduce the fuel loads on 178,441 acres where prescribed burning would occur. The risk of high-intensity wildfire would be lessened in the short term, but lack of prescribed fire and repeat burning would result in increasing risk of wildfire over time.

Coconino NF Forest Plan Amendments

Amendment 1: The effects of this forest plan amendment would be the same as with alternative B.

Amendment 2: The effects to recreation from this plan amendment would be the same as alternatives B and C.

Amendment 3 would have no effect on recreation resources.

Cumulative Effects

Alternative D would thin approximately 384,966 acres of the ponderosa pine forest and prescribed burn 178,441 acres. These actions would reduce the risk of high severity crown fire and large insect outbreaks in the short term. About 1/3 as much area would receive prescribed burning. Fuel loads would continue to be high in 2/3 of the area. Alternative D would result in the forest being more susceptible to wildfire than alternatives B or C. The effects of this Alternative and other projects would result in a declining quality of recreation opportunities while at the same time, the desire for recreation use is increasing as a result of population growth and the public is increasingly dependent on national forests for recreation and leisure activities. Thus, this alternative would result in a cumulative decrease in the ability of the Coconino and Kaibab National Forests to meet recreation demands over the long term, although not as much as the no action alternative.

This alternative would likely require additional mechanical means to chip or haul activity slash resulting from thinning activities. This would likely result in temporary restrictions to parts of the forest that may combine with motor vehicle restrictions included in the new travel management rules to restrict vehicle access to larger parts of the Forest, thus temporarily decreasing recreation opportunities, but not necessarily recreational quality. These cumulative impacts on recreational opportunities are expected to be localized to where the treatment work is taking place and would be limited to weeks or months in time.

All other cumulative impacts are the same as described in alternative B.

Alternative E

Direct and Indirect Effects

The effects described in alternative E would be the same for alternative B with the exception of that approximately 6 percent more acres would receive mechanical and prescribed fire restoration treatments, but 10 percent less are would receive prescribed fire-only treatment. This alternative would treat slash using chipping, shredding, mastication and removal of biomass off-site similar to alternative D and the effects would be similar to that portion of alternative D. Mexican spotted owl PAC core areas would be mechanically treated to 9 inches d.b.h. resulting less age class diversity and fewer trees being removed. No acres would be managed for open reference condition. Watershed research would occur. No plan amendments would be required. Treating 38,256 acres less aggressively would have no effect on recreation.

Restoration acres would be greater than alternative B, but less than alternative C. There would be a less positive effect on protecting and maintaining high quality recreation settings over time. It would have a more positive effect than alternative B on protecting and maintaining high quality recreation settings over time. Alternative E would result in 1 percent less temporary changes in ROS classes during project implementation than alternative C. Assuming a linear relationship, up to 1 percent fewer forest users would be affected by the slightly reduced amount of treatments.

All other effects are the same as described for alternative B and C with two exceptions. Alternative E would result potentially longer slash treatment duration (more disruption to recreation opportunities) than alternatives B or C. Smoke from pile burning would be slightly less with alternative E since some slash would be processed and removed for biomass off-site. Prescribed burning would occur on a little less acreage as Alternatives B or C.

Cumulative Effects

The cumulative effects of alternative E and past, present and future projects would be similar to those of alternatives B and C with two exceptions. This alternative result in fewer localized benefits to the recreation settings within the ponderosa pine forest on the Forests. There is less of a cumulative benefit toward maintaining resilient ponderosa pine forest types to provide recreational opportunities. In the event of a wildfire, there is some chance of high and moderate severity ground fire as a result of high fuels loadings. Since wildfire risks are still a threat due to less clumpy and group-like structure, and lack of tree interspaces, the desired recreation settings, and ROS class characteristics forest users seek would be more limited, and the cumulative effects would result in a lack of desired recreation settings and long term changes in ROS classes.

Alternative E and other vegetation management projects would cumulatively result in somewhat improved forest structure, but less improvement in forest composition and diversity than alternative C. The forest resilience would be improved in the short term, but risk of wildfire would continue and with it the potential for large scale fires that could kill many trees, including vulnerable old, mature trees.

Compatibility with the Kaibab Revised Forest Plan

The Kaibab National Forest Revised Plan adds the Bill Williams Mountain Management Area. There are 22 acres of treatment proposed in alternative C that overlap the management area in scattered locations. The proposed mechanical and prescribed fire treatments are compatible with the desired conditions for this Management Area that risk is low for substantial damage to the municipal water supply, infrastructure, water quality, visual quality, and cultural integrity (Forest Service 2012). It is in line with standards and guidelines, and the objective to implement a project to improve the health and sustainability of forest conditions on and surrounding Bill Williams Mountain within five years (Forest Service 2012). Potential effects of mechanical and prescribed fire treatments on recreation and scenery can be found in these sections of the 4FRI EIS as well as associated specialist reports. See the 4FRI EIS for effects to other resources.

Prescribed fire or mechanical treatments and prescribed fire are proposed in alternative C in several recreation sites (campgrounds, picnic areas, snowplay areas) Effects of treatments would be similar to those analyzed for provision of recreation opportunities in the recreation and scenery sections of this FEIS and specialist reports.

4FRI treatments are proposed on eight acres of potential wilderness identified in the revised KNF forest plan (2014). The management approach in the revised KNF forest plan (2014) states that "Recommended wilderness on the KNF is intended to be managed consistent with the intent of the 1964 Wilderness Act, specifically with a focus on maintaining or achieving wilderness values.

Although all of these areas have been managed as semi-primitive, non-motorized areas in the past, they have not been managed as wilderness. Some contain evidence of human activities such as old roadbeds, stumps from timber sales, and livestock management structures. Management may be needed including restoration, trail maintenance, and road obliteration to achieve or retain the desired wilderness values. Because recommended wilderness is not designated wilderness, use of motorized or mechanized equipment may be appropriate when it is used to move the areas toward the desired natural appearing primitive settings." The eight acres identified would fit within the management needs identified, specifically restoration. Effects would be similar to those analyzed in the 4FRI EIS for vegetation and fire (as well as associated specialist reports) as well as in the recreation and scenery sections of the EIS and this and the Scenery specialist reports.

There are 60,247 acres of proposed 4FRI treatments that overlap with the Wildland Urban Interface (WUI) Management Area of the Kaibab NF. WUI is generally considered to be the wildland area surrounding resident populations and other human developments having special significance, that are at imminent risk from wildfire. Project treatments are compatible with the management approach in the revised Kaibab NF forest plan (2014). The effects of these treatments are found in the FEIS and specialist reports.

The recreation report also evaluates consistency with the draft Coconino Land and Resource Management Plan, as currently written (recreation report, pp. 69-77).

Lands and Minerals

A summary of the lands and minerals report is presented here. The specialist report (Rowe 2014) is incorporated by reference. See the report for the complete methodology and analysis process.

Changes from the Draft Environmental Impact Statement and Opposing Science

No comments on the DEIS that included literature that could be categorized as opposing was received for lands and minerals. Updates to acreages and alternatives are discussed in chapter 2 of this FEIS.

Lands Special Uses

Lands special use authorizations include permits, term permits, leases, and easements that authorize occupancy and use of National Forest System lands. Authorized activities include uses such as utility corridors, roadways, communications sites, and research projects, as well as many other uses. The terms of these authorizations vary based upon the type of use.

As of March 2012, there were 496 active lands special use permits in the project area. Additionally, there are approximately 30 to 40 temporary permits issued each year for commercial filming, photography, and other short term uses. Research permits are also regularly issued within the project area; while many are short term in nature, there are also long-term research permits.

Most lands special use permits allow vegetation clearing around the facilities they authorize, to provide for access and/or fuel reduction. Within the project area, the bulk of this vegetation treatment occurs in association with power, gas, and other utility corridors. Of the 496 permits in the project area, 37 fall into this category. They represent approximately 32,345 acres of vegetation that are being managed regularly. Not all of these acres lie within the project area however, as permit acreages are recorded for the entire authorization and generally not broken down by township and range.

Recent years show an increasing demand for lands special uses. As development in communities in and around the forests increase, their need to utilize public lands in support of their infrastructure will also increase. Proposals for power lines, rights of way, communications sites, water transmission lines, and roadways have increased steadily and will continue to do so in future years. Increased interest in renewable energy sources, such as wind and solar, has also contributed to the increased demand.

Minerals

Locatable mineral production on the Coconino NF includes manganese, gypsum, flagstone, and pumice. Saleable minerals production includes cinders, crushed aggregate, fill rock and dirt, and landscape rock. There are no oil or gas leases. Potential geothermal resources are associated with the San Francisco Volcanic Field.

Presently, no known coal, oil, or gas reserves are located on the Kaibab NF. The primary economic mineral resource consists of limited locatable mineral deposits. Many are small and, in today economic climate, not commercially viable. There are, however, uranium deposits that are of higher grade than approximately 85 percent of the world’s known uranium deposits (International Atomic Energy Agency 2009; World Nuclear Association 2009; as cited in the special uses-minerals-lands specialist report for the Kaibab Forest Plan Revision, 2011). Salable minerals consist of sand and gravel deposits, building materials, and cinders. The area of the Tusayan District that was designated as part of the Grand Canyon Game Preserve is withdrawn from mineral entry.

The Coconino-Kaibab Rock Pit Environmental Analysis, currently underway, would allow the use and development of 19 rock pits on the Coconino NF and 20 on the Kaibab NF. Many of these pits would be new sources. Most of the rock would be used by the forests, but some may be made available for sale to counties, cities, and other agencies. The purpose of the project is to provide materials that would serve both forests. It is not specific to this project.

Environmental Consequences

No issue (large trees, emissions from prescribed fire, or post-treatment landscape openness) identified in the DEIS has any effect on lands special uses and/or minerals, and therefore they do not serve as indicators for analyzing the effects of the project on these resources. However, the project would have an indirect effect in the form of reduced fire risk. Therefore, the indicator used for this analysis is the number of acres with reduced fire risk.

Alternative A

Under this alternative, no restoration activities would occur. Stand and vegetation structures would not be improved, which would make the landscape in the project area less resilient to disturbance and would provide increased fuels for wildland fires. Increased fire danger, and the potential for increased intensity of wildland fires, would impact lands special uses by threatening the structures they authorize in both the short term (10 years) and long term (20 years and more). Any structures associated with active minerals sites would also be similarly threatened. Long-term effects could be the destruction of these facilities by fire, and possibly the closure of fire-damaged areas for rehabilitation. There may be short-term, temporary effects in the form of restricted access to sites during fire suppression activities or post-fire rehabilitation. See fire ecology report for detailed information on existing and foreseeable fire risk.

Effects of Alternatives B, C, D and E

All action alternatives would improve forest health, by providing for a variety of restoration activities. While they vary in specific approaches, the overall effect on lands special uses and minerals would be the same. Increased forest health would lower the risk wildland fires and lower the potential for fires of high intensity. This would reduce the threat to the structures authorized for lands special uses and mineral projects.

Of the action alternatives, alternative C treats the most acres; therefore, it provides the greatest improvement to forest health and reduced risk of fire.

All action alternatives would require construction of 520 miles of temporary roads and the reconstruction of 40 miles of existing roads, which would result in increased demand for mineral materials for road surfacing. This could result in the need for new source pits, if existing pits proved insufficient. It could also result in the need for new source pits in the future, if existing pits are depleted by this project.

There could be short-term, temporary impacts to land special uses and mineral projects as site-specific restoration activities were implemented. For example, access to sites may be temporarily restricted while thinning or burning was occurring. The duration of these impacts would be only as long as the site-specific activities were occurring, for example, the amount of time that thinning was occurring in the vicinity of a particular permit area or mineral site. Prior to any site-specific implementation, the Forest Service would work with affected permit or claim holders to determine site-specific concerns, such as timing restoration activities to avoid periods of high use or access need by the permit holders. Such mitigation would minimize potential adverse effects to these resources. In alternatives C and E (based on the fire analysis and degree of change in acres with the potential for crown fire) treating 38,256 acres less aggressively would have no impact on lands and special uses. Infrastructure related to special uses would continue to be protected. Under all alternatives, there is no foreseeable irretrievable or irreversible commitment of resources.

Effects of Coconino NF Forest Plan Amendments

Alternatives B through D would require amendments to the forest plan. Because each amendment addresses a specific resource concern, potential effects are analyzed in terms of the management prescription and how it would affect lands and minerals special uses (rather than in terms of acres treated). Analysis is presented in terms of “additional effects,” meaning those beyond what would be imparted by the alternatives themselves.

Amendments Addressing Mexican Spotted Owl

Amendment 1 is the most complex amendments being considered under the project, because it addresses six different elements in managing Mexican spotted owl habitat and because the proposed amendment language for four of these elements varies for each alternative. Additionally, two elements apply only to the Coconino NF. These amendments are summarized in chapter 1 and appendix B of this FEIS. In alternatives B–D, restoration would still occur and the number of acres treated would be the same. There would be no overall change in the effect to lands and minerals special uses.

Amendments Addressing Goshawks

Amendment 2 would not alter the acres treated for restoration activities and therefore would have no additional effects to lands and mineral special uses.

Amendment Addressing Cultural Resources

Amendment 3 would have no additional effect on lands and mineral special uses, as authorization of such uses already requires archeological and cultural screening.

Cumulative Effects

Actions considered in determining cumulative environmental effects are those known or anticipated to occur within the project area over the next 10 to 15 years. The cumulative effects analysis area is the same as the project area.

See appendix F of this FEIS for past, present, and future projects that may have a cumulative effect on the current project.

Appendix F shows that the Forest Service has completed 270,295 acres of vegetation and prescribed fire treatments within the project area. Additionally, examination of existing special use authorizations for power and gas lines reveals that approximately 32,345 additional acres have been treated by permit holders as part of routine maintenance around authorized facilities (special uses database system record search, April 2012). These actions have indirectly reduced the risk of fire to infrastructure authorized by lands special use permits and minerals permits.

Appendix F also lists ongoing and future fuels treatment projects within the project area, which are summarized in table 97. Under all alternatives, these actions would continue, as well as the routine clearing done by permit holders. These projects would contribute to forest health and restoration of the forest to its natural vegetative structure, which would in turn contribute to the reduction of fires that could produce severe effects to lands special uses and minerals (such as damaging or destroying infrastructure).

Table 97. Past, present, and future Forest Service actions with vegetation and/or fuels treatments within the project area

Project Type	Acres Treated (Prescribed Fire and Vegetation Treatments)
Past (2000-2013)	270,295
Current/Ongoing	361,973
Reasonably Foreseeable (Future)	102,194
Private/State/Other non NFS lands (Past/Current/Ongoing/Future)	144,673
Lands Special Uses – routine maintenance	32,345
TOTAL	**911,480**

Alternative A

Permit holders would continue to conduct routine vegetation clearing on 32,345 acres as part of routine facilities maintenance, and 879,135 acres would be treated in planned fuels projects. Fire risk would be reduced on a total of 911,480 acres. Forest health would only be increased within those acres, not across the project area as a whole. Therefore the risk of wildland fires of uncharacteristic intensity would be reduced somewhat within the project area, but not as much as under the Action Alternatives.

Alternatives B, C, D, and E

Under all action alternatives, the number of treated acres would be increased approximately 1.6 times over those under the no action alternative, to nearly 1.5 million acres (table 98). This would more than double the number of acres with reduced risk of wildfire. Overall forest health would be improved and the risk of severe wildland fires that could endanger lands special use and mineral sites would be reduced. Alternative C treats the greatest number of acres and therefore contributes the most to forest health. Alternatives B and E treat fewer acres than alternative C, but the difference is not significant to lands special uses. Alternative D would treat the fewest acres.

Table 98. Combined acres treated under current project and past, present, and foreseeable projects

Alternative	Acres Treated Under This Project	Total Treated Acres in Project Area
A	0	911,480
B	583,330	1,494,810
C	586,110	1,497,590
D	563,407	1,474,887
E	581,301	1,492,781

Scenery

A summary of the scenery report is presented here. The specialist report (Minor 2014) is incorporated by reference.

Currently the scenery resources of Coconino NF are managed through the application of the visual management system (VMS). The VMS was used to develop visual quality objectives that are prescribed in the forest plan for all lands within the Coconino NF. The visual quality objective classifications range from preservation, retention, partial retention, modification, to maximum modification. The VMS process has been updated in the scenery management system (SMS), which has been incorporated into the Kaibab NF forest plan via amendment 6 for the Williams and Tusayan Ranger Districts (USDA FS 2010).

This analysis evaluates the following questions to respond to/meet forest plan direction (questions 1 through 3) and issues from scoping/public involvement (question 4 through 5):

1. To what degree would the proposed restoration activities affect the scenic integrity of the treatment area? (Measure: acres not meeting scenery integrity objectives (SIO).)
2. Would visual disturbances detract from the natural appearance or be outside of the historic range of variability? (Measure: qualitative description of anticipated disturbances.)
3. Would the proposed restoration activities sustain the valued scenic character and its scenery attributes through time? (Measure: acres meeting scenic character and scenery attributes.)

4. In what ways would prescribed fire smoke affect scenery? (Measure: qualitative description.)
5. Are large, mature trees retained as part of the scenic character? (Measure: Percent of old growth allocation in ponderosa pine and pinyon-juniper.)

A summary of the analysis completed for scenic resources is presented here. Please refer to the specialist report for methodology, data, and supporting information.

Changes from the Draft Environmental Impact Statement and Opposing Science

Changes to the scenery specialist report in addition to those discussed above. These include:

- Corrections to acreages of treatment areas and corresponding GIS analysis for scenic integrity objective acre adjustments for all alternatives.
- Addition of alternative E analysis.
- Removal of 1988 Kaibab NF forest plan direction for scenery.
- Addition of 2014 Kaibab NF revised forest plan direction for recreation and removal of reference to and analysis of 1987 Kaibab NF forest plan amendments.
- Addition of 2013 draft Coconino NF revised forest plan direction for scenery.
- Re-check of web addresses for citations and correction if needed.
- Changed conditions as result of the May 2014 Slide Fire. For no burn areas within the fire boundary where mechanical and fire treatments would continue, there is no change to effects analyzed for the alternatives.
- Clarifications or minor edits as a result of comments received and in response to comments.

No comments were received on the DEIS that included literature that could be categorized as “opposing science”.

Affected Environment

The project area encompasses the Arizona communities of Flagstaff, Mountainaire, Munds Park, Kachina Village, Mormon Lake, Doney Park, Parks, Williams, and Tusayan. Major access routes include Interstates 40 and 17, U.S. Highways 89, 180, and 66, State Route 64, County Road 73, and Lake Mary Road (Forest Highway 3). These communities and routes receive high use and users have high concern for scenery.

The treatment area’s dominant scenic identity is the continuous ponderosa pine forest, interspersed with grasslands, meadows, or sagebrush that overlays the undulating volcanic and sedimentary landforms. The treatment area is viewed at foreground, middle ground, and background distances from sensitive roadways, trails, and recreation sites located within and around the boundary.

Historic conditions better match scenic preferences for large, mature trees and forests with a more open structure (Ryan 2005), and current photos (see chapter 1 of the DEIS and figure 10 in the specialist report) are more representative of the higher density, continuous canopies, and similar ages classes found today. The vegetation is the dominant scenic attribute in the treatment area. There are substantial opportunities for improvement of the ecological function and for scenery attributes. The existing vegetation density and lack of high frequency, low-intensity fires are inconsistent with the desired scenic character and its sustainability:

- The dense conifer vegetation often obscures views of existing scenic attributes within the forest canopy and understory, and greatly restricts viewing access to potential scenic attributes.
- Inter-tree spaces and openings have been filled with small and medium sized trees, where if these were open, they would allow for sunlight to reach the forest floor adding to the scenic quality as well as helping provide for greater understory vegetation composition and abundance.
- Currently there is a risk of large scale, high-intensity fire that could result in elimination of the vegetation scenic attributes that are desired.
- Seeps, springs, and ephemeral drainages have had conifers encroach and overtop other species reducing their function over time. When these features are functioning properly, they provide high scenic quality and auditory, tactile, and visual features not found without the presence of water.
- Throughout the forest, unauthorized routes and redundant roads have been created. These detract from the scenic quality of the area by forming un-natural linear features that are uncharacteristic of the landscape. Decommissioning the routes and roads will restore characteristic features.

Scenery Attribute Risk Determination

Scenic stability uses a descriptive six level rating scale from very high stability to no stability to identify the degree to which the scenic attributes of the valued scenic character are likely to be perpetuated within the ecosystem. The highest scenic stability ratings indicate resilient ecosystems that are functioning within their reference conditions. Lower scenic stability ratings indicate areas where intensive vegetation management practices intended to restore ecosystem health and function could also benefit scenery by restoring and/or maintaining valued attributes of scenic character. Areas of higher scenic stability need less intensive management activities to maintain their valued scenic character attributes.

Scenery Attributes

- The ponderosa pine forest has an open appearance with tree groups of varying ages, sizes and shapes and a mosaic of interspaces and openings. **This scenery attribute is at high risk.**
- Old age ponderosa pine trees are well represented across the treatment area. **This scenic attribute is at moderate risk.**
- The ponderosa pine and pinyon-juniper forests in the treatment area have a healthy, diverse understory. **This scenic attribute is at moderate risk.**
- The treatment area has a resilient forest where frequent, low-intensity fires occur without wide-spread crown fire or high-intensity surface fires. **This scenery attribute is at high risk.**
- Much of the forest has open appearance of tree groups and openings making the forest more resilient to mortality from insects and disease. **This scenery attribute is at moderate risk.**
- Within the ponderosa pine and pinyon-juniper forests, there is a healthy, resilient understory trees and shrubs including Gambel oak, aspen, and sagebrush. Prairies and grasslands provide

important contrast to the forested landscape. **The scenic attributes of Gambel oak, grasslands, and pine-sagebrush are a moderate risk, aspen is at high risk.**

Minor Scenery Attribute

- Springs, seeps and ephemeral channels because of the diversity they provide, including contrast in color, shape, and texture. In addition, the presence of water, even if seasonal, increases the valued scenery. **The scenic attributes of seeps, springs, and ephemeral channels are at moderate risk.**
- While roads provide important scenery viewing platforms, as well as access to the forest, scenic quality is improved by decommissioning some closed forest roads and unauthorized routes. **The scenery attributes of decommissioned roads are at moderate risk.**

Environmental Consequences

Alternative A

Direct and Indirect Effects

In the no action alternative the treatment area would continue to be mostly natural appearing for several years. Important scenic attributes such as scattered groups of trees of all ages with grassy openings, evidence of frequent low-intensity fire, large mature tree character, diverse understory, prominent aspen, Gambel oak and grasslands, and functioning riparian systems and ephemeral channels that historically contributed to the attractiveness of the area would continue to decline.

Views into the project area from roads, trails, recreation sites, and residential areas would be further reduced due to the overstocked condition of the stands, and the grass/forb/shrub understory component would continue to decline in composition and decrease in abundance. Unauthorized routes and closed roads would not be decommissioned, and would continue to be visible linear features uncharacteristic in the landscape. If unauthorized routes and decommissioned roads were unused, they would naturalize in 10 to 20 years.

In the event of an uncharacteristic high-intensity wildfire such as the Schultz Fire (Coconino NF, 2010) or Slide Fire (Coconino NF, 2014) the existing landscape character would be suddenly altered with little opportunity to slow or control the change. The landscape would be changed to such a degree that very few of the scenic objectives could be met in the short term or long term. Although short-term, smoke from high-intensity wildfire would cause scenic quality to be diminished and would obscure views to scenic attributes. Emergency fire suppression would result in short-term impacts (see specialist report for details). There would be long-term (more than 20 years) impacts to major landscape attributes such as ponderosa pine forests with large, mature trees.

This alternative would not meet the project desired conditions or forest plan direction. It would not move the treatment area toward scenic stability. Over time, scenic stability would decrease and move to very low. No action would result in continuation of current risks to scenic attributes and it is reasonable to assume that these risks would increase each year and could be exacerbated by climate change. The alternative would not meet long-term scenic integrity objectives since these are dependent upon improving the condition of scenic attributes so that they are more resilient to ecological stressors.

Cumulative Effects

The cumulative effects analysis area is the ponderosa pine forest on the Coconino and Kaibab NFs. The timeline for analysis is 20 to 30 years because most long-term effects of the alternatives are assessed out to a 20 to 30 year timeframe (with the exception of large-scale high-intensity wildfire which is more difficult to project).

The cumulative effects of past management activities are visible as the existing conditions. Vegetation management practices, fire suppression, and overgrazing have resulted in the current even-aged forest structure, overstocked conditions, and sparse understory trees, shrubs, grasses, and forbs.

Alternative A

The cumulative effects of past management activities are visible as the existing conditions. Vegetation management practices, fire suppression, and over grazing have resulted in the current overly dense forests, even-aged forest structure, and sparse understory trees, shrubs, grasses and forbs.

The short term cumulative effects (1-5 years) of the no action alternative combined with similar current and future restoration treatments and prescribed burning projects are expected to be negligible, unless additional large scale, high severity wildfires occur in the ponderosa pine type. If wildfires burn large areas, the scenic quality would be decreased, and there would be long term negative changes (10 to 100 years) in scenic character. The scenic attributes that contribute to high scenic integrity, such as an open forest with tree groups of varying ages, sizes and shapes, large, mature trees, and healthy, diverse understory would decline or not be present. The scenic impact of a high-severity wildfire would combine with scenic impacts from adjacent land development, powerline development and maintenance, and impacts from dispersed recreation use to result in a cumulative impact so that scenic integrity is greatly diminished in areas burned for up to a decade or more. In some places there would be a chance that climate change could contribute to type changes in parts of the ponderosa pine forest so that these characteristics would be replaced with difference landscape characteristics, which would also cumulatively impact scenic attributes.

In the absence of large, high severity wildfires, long term cumulative effects of the no action alternative and present and future vegetation management and prescribed burning projects would be small and localized. In the absence of large scale treatment, the scale of treatments that are currently accomplished would not result in improvement to scenic stability or scenic integrity. Ongoing and future vegetation treatment and prescribed fire will result in about 28 percent of the project area and adjacent acres receiving mechanical treatment, and about 33 percent of this same area receiving prescribed fire over the next two decades. This would result in a declining trend in scenic stability and inability to meet or improve scenic integrity objectives in the long term. The desired landscape character of an open forest with tree groups of varying sizes, shapes and ages, presence of large, mature trees, and healthy, diverse understory would not be met. This could combine with scenic effects such as increased creation of bare ground from mineral extraction and unauthorized roads and trails to aggravate decreased acreage, and health of overstory and understory vegetation. Ongoing grazing and recreation use, especially dispersed uses resulting in decreased vegetation cover and increased bare ground would also contribute to this decline. Utility corridor maintenance or the potential for new corridors would result in uncharacteristic scenic features where forested areas are cleared in straight that deviate from the natural landscape patterns. Scenic effects from unhealthy forest conditions resulting from potential increases disease and drought would cumulatively result in declining scenic attractiveness and sense of place.

The scenic evaluation in (scenery report, table 3) indicates the only positive effect/trend would be the cumulative effect of motorized travel management. All other ongoing or reasonably foreseen actions would result in a decline in the scenic stability of the vegetation, water and land form that create the landscape character of the area, decreased long term scenic attractiveness as the unique natural and cultural elements that combine to form the scenic beauty of the area decline, and a downward trend in the scenic integrity objectives as deviations from the valued landscape character become more pronounced.

Alternatives B, C, D and E – Effects in Common

There would be short-term effects to scenery from restoration treatments in aspen stands. For this analysis, short term effects to aspen may last as long as 20 years. This is different than the timeline for short term effects for the proposed mechanical treatments for conifers.

- Spring restoration includes removal of some vegetation and prescribed burning near the sites. There are minimal to low effects to SIO from these treatments. Effects would be similar to those described for mechanical treatment and prescribed fire, although at a much smaller scale.
- Channel treatments would have short-term effects (lasting 1 to 5 years) on scenic attributes. Bare soil would be exposed, rocks and logs moved, and some disturbance from vegetation restoration would be visible for a few years until the desired understory vegetation begins to fill-in and re-establish. These activities would have low effects to SIO. Following treatment, these areas would be improved and would make progress toward desired conditions.
- All fencing actions (aspen, ephemeral channels) would introduce unnatural linear features into the landscape that would not be natural appearing. Since these are isolated areas scattered around the over 500,000 acres project area, introduction of linear features would have low effects. If the fences are maintained, wood fencing would have very low effects and would meet the SIO. If they fall into disrepair, this would detract from their appearance, but they would still meet the SIO. Wire fencing materials would be more noticeable than wooden fences. Wire and metal posts can be shiny and their color can contrast with the natural surroundings. Mitigation measures would be used to introduce the fewest contrasting elements where wire fencing is used and effort would be made to locate site the fencing where it would be least noticeable. Wire fencing would have low effects and would meet the SIO.
- Placement of jack-straw treatment would not meet the requirements for foregrounds of high concern level roads in high SIO areas in the short term. Beyond the foreground 300 feet, jack-straw piling may be suitable, and would be mitigated by carefully locating piles. These areas would drop to moderate SIO for 10 to 20 years. As jack-straw barrier begins to deteriorate, trees lose their brown needles, branches break off, and logs lose their bark and grey out, the jack-straw piles compress and become less noticeable. It is anticipated that the aspen would be large enough to withstand ungulate browsing by the time the jack-straw piles have deteriorated or burned in follow up prescribed fire activities. These areas would improve over time to the mapped SIO. The timeline for jackstrawing around aspen would be longer than for conifers, up to 20 years. Design criteria would be implemented to avoid placement of jackstraw within 1000 feet of high concern level roads or the Arizona National Scenic trail (see appendix C).

- Potential effects from road reconstruction include exposure of bare soil, tree stumps, and contrasting color and texture of surfacing materials. These effects would usually be short term (1 to 5 years) and become less noticeable as natural vegetation is re-established and the surfacing material begins to be incorporated into the soil horizon.
- The construction of new roads would add new, unnatural linear features into the landscape on a temporary basis. Trees would be removed, soil exposed, and roadbeds constructed including minimal drainage features. This would have moderate effects on the mapped SIO. In high SIO (about 50 percent of the area), the new road construction would drop these areas one level to moderate until the roads are decommissioned and begin to naturalize, about 5 years later. Mitigation measures and BMPs would hasten recovery. The new temporary roads would naturalize over time and become less noticeable to the casual observer.
- There would be short-term effects (up to 5 years) from road decommission as the roads have drainage established, are roughened, seeded, and mulched with pine needles, and small slash. Mitigation measures and BMPs would be used. The existing closed roads would naturalize over time and become unnoticeable to the casual observer.
- Hand thinning usually has little or no short-term effects on scenery. Trees are cut down, and then cut into segments that can be treated. Effects may include slash from limbing and topping trees. Project mitigations require slash to be treated.

Alternative B

Direct and Indirect Effects

There would be a low-to-moderate effect on scenic quality during and immediately following mechanical treatment methods. The presence of skid trails, landings, and piled or scattered slash would also result in a moderate reduction of the scenic quality until harvesting activities are completed, and mitigation measures are implemented. The effects in these areas would be short-term (lasting 1 to 5 years after treatment) since skid trails would be rehabilitated and activity generated slash would be treated or mostly removed to be utilized. The ground disturbance resulting from using machines to pile slash would be noticeable for 1 to 3 years after project completion, depending on how quickly the areas revegetate. Scraped trees would heal or scars would become less noticeable over time.

Where utility corridors cross the restoration area, the proposed mechanical treatments adjacent to the corridors will help to improve the scenic quality. Mitigation measures have been developed to feather treatments or increase their intensity close to the corridors. This will have the effect of reducing the contrast between the cleared corridors and dense stands adjacent to them.

Effects from pile burning would be primarily limited to the immediate dead and live fuels of the slash pile, although some scorching and mortality of residual trees would be expected. Smoke from pile burning would be dense when the piles are ignited and as they burn, but would be short term in most cases.

Prescribed fire would likely result in short-term, moderate reduction in scenic quality. The presence of charred surface vegetation and red or black trees would present a contrast to the otherwise green surroundings. These contrasts would soften and become less noticeable within two or three growing seasons after project completion as the understory component (grass, aspen, and oak seedlings, etc.) moved in, as singed trees either recovered or die, and as dead standing trees fall down. Smoke from prescribed fire would be heaviest during the initial burns, and would reduce visibility of the scenic landscape in the short term. Some residual smoke could be expected to continue in small localized areas where stumps or roots smolder for up to a few weeks. The residual smoke would have little if any effect on visibility of scenic attributes.

Effects may last longer and be more pronounced in areas of moderate to high fire intensity. In these locations, standing dead trees may be present for a decade or more until they fall down. Understory vegetation would take some time to recover, but is expected to look more natural appearing within 5 years. Since it is expected that this would be produced over no more than 10 percent of treatment area, effects would be localized and limited.

Repeat burning would result in fewer effects than described above since fuel loadings would be reduced by initial prescribed burns. Effects are expected to be noticeable for a shorter duration, and within 2 to 3 years, the areas will be natural appearing. Smoke from repeat burning would not be as heavy as initial burns, and would be expected to be shorter in duration.

Coconino NF Forest Plan Amendments

Amendment 1: The effects of this amendment would be to move vegetation in these areas slightly closer to restored conditions. They would slightly improve scenic stability in Mexican spotted owl PACs, but these areas would still be at risk for disturbances such as high-severity wildfire or large scale insect and disease outbreaks.

Amendment 2 would move vegetation closer to desired conditions, improve scenic stability, and overall scenic integrity. It would result in improved forest structure and pattern, forest health, and vegetation composition and diversity, and overall forest resiliency all of which would relate directly to decreased risks to scenery from natural disturbances.

Amendment 3 would have no effect on scenery.

Cumulative Effects

The short-term cumulative effects (1 to 5 years) of the alternative B combined with similar current and future restoration treatments and prescribed burning projects are expected to be widespread. There would be evidence of restoration treatments and the scenic quality would be decreased in some places in most of the ponderosa pine on the Coconino and Kaibab NF. For example, in areas where restoration treatments result in skid trails or removal of vegetation for staging areas or log decks, there could be a cumulative impact to scenic attributes where activities such as dispersed recreational use, grazing, or adjunct private land or infrastructure development is also occurring. In general, these cumulative impacts to scenic attributes would be localized in scale (1 to 10 acres) and would most likely to be of short-term duration (1 to 5 years).

In the long term (5 to 20 or 30 years), there would be large and widespread improvement in the health and sustainability of scenic attributes that make up the landscape character of the ponderosa pine forest. Forest users would experience an open forest with tree groups of varying ages, sizes and shapes, large, mature trees, and healthy, diverse understory. In many places, the scenic integrity objectives would be met.

When natural stressors such as wildfires or insect outbreaks occur, or human activities such as new utility corridors, a new recreation site, or a new private subdivision are developed, the cumulative effects of alternative B and other projects would result in small and localized changes in the scenic character of the ponderosa pine forest. When drought conditions or unusual weather events as a result of climate change occur, the ponderosa pine forest would be healthier and more resilient to such events, thus counteracting the effects of climate change which are likely to detract from scenic attributes. The overall trend from this alternative would be toward improving landscape attributes, and sustainable landscape character.

Alternative C

Direct and Indirect Effects

Effects would be similar to alternative B. About 10 percent more acres would be mechanically treated and about 1 percent more acres burned than alternative B. Alternative C would improve understory species abundance and composition slightly more than alternative B since the combined thinning and prescribed fire has been found to be a more effective tool (Laughlin et al. 2008). This alternative would result in slightly better understory response and slightly more large trees, which would better meet scenic objectives.

Since high severity fire is a risk factor for most scenery attributes, the proposed mechanical and prescribed fire treatments in alternative C would result in improvements to scenic stability. Repeat low severity prescribed fire would help keep the forest structure open and with groups of trees, recycle nutrients, and improve the understory composition and vigor.

This alternative adds a number of watershed research actions (approximately 2.4 acres of disturbance) to support watershed research. The construction of these features would create contrast with the characteristic natural landscape. Mitigation measures to assure the weirs are constructed of natural appearing materials, and are of a shape and form that does not create too much contrast would help blend with the surrounding landscape. Careful location of the towers would help them to be in scale with surrounding trees. Lack of fire for 5 to 7 years would result in slightly less progress toward restoration and scenic stability in the controlled watersheds.

Coconino NF Forest Plan Amendments

Amendment 1: This alternative increase the size of trees that could be removed in 18 Mexican spotted owl PACs and allows use of low intensity prescribed fire within 54 PAC core areas. Old, large diameter trees are an important part of the scenic quality. There may a slight decrease in scenic quality as a result of removing larger diameter trees, but it would also result in slightly greater reduction of tree density in these areas which is important for scenic stability. While there would be short term effects from tree removal and burning, there would be slight improvement in overall scenic stability than with alternatives B or D. The amendment would allow for more treatments which would open up the PACs creating the potential for views beyond the immediate foreground. This would have a somewhat greater positive effect on scenic quality than action alternatives B or D.

Amendment 2: The overall effects to scenery would be to better meet the desired conditions for scenery and better assure improvement in scenic stability. The exception for less aggressive treatment on 38,256 acres of goshawk habitat would result in somewhat more contrast between stands that would be more fully restored and those with less treatment. About 9 percent of the project area, in scattered locations, would make less progress toward desired conditions for forest structure. This same area would make more progress toward large tree recruitment.

Amendment 3: There would be no effects to scenery from this amendment.

Cumulative Effects

The cumulative effects would be similar to alternative B. There would be slightly more negative short-term cumulative effects in localized areas (areas with skid trails, pile burns, and staging areas) since this alternative would mechanically treat and burn about 10 percent more acres, and prescribed burn about 1 percent more acres. However, there would also be slightly more positive long-term cumulative effects from counteracting drought and insect damage likely to occur as a result of climate change since there would be more mechanical treatment and burning to facilitate greater forest resiliency.

Alternative D

Direct and Indirect Effects

Effects of mechanical thinning would be similar to Alternatives B and C. Disposing of slash through chipping, shredding or mastication would have fewer short term scenery effects than Alternatives B or C. Long term effects of these types of slash treatment would likely result in decline of understory vegetation health and the increased fuels loading would increase the vulnerability of the area to high severity wildfire. In the event of wildfire, there would be negative effects to the project area including to important scenic attributes such as increased large tree mortality. Scenic quality would be immediately reduced, and there would be long term negative changes in scenic integrity objectives.

Slash disposal via chipping, shredding, mastication and removal of biofuel would have negligible short term effects to scenery, primarily creating contrast of newly chipped wood with the surrounding forest floor. The long term effects would include increased vulnerability to high severity wildfire as noted above.

Prescribed burning would have effects similar to those described in alternatives B and C, but would occur on only about a third of the area. There would be a reduction and duration in the amount of smoke produced since less acreage would be burned. This would lessen the short term effects of obscuring scenic attributes. It would improve health of understory vegetation the least of all action alternatives, in the 178,441 acres where it would occur.

Coconino NF Forest Plan Amendments

The effect of forest plan amendments is the same as described for alternative B.

Cumulative Effects

The short-term cumulative effects (1 to 5 years) of alternative D combined with similar current and future restoration treatments and prescribed burning projects are expected to be widespread, but of small scale (1 to 10 acres) where they occur. For example, in areas where there would be evidence of mechanical thinning treatments, together with evidence of grazing and dispersed recreation impacts or infrastructure development (utility lines), the scenic quality would be cumulatively decreased in these places.

In the long term (5 to 20 or 30 years), initially there would be widespread improvement in forest structure, but vulnerability to wildfire would remain high thus limiting forest resiliency. While this alternative would counteract impacts to large trees and understory vegetation resulting from climate change and the resulting drought and vulnerability to insect outbreaks and disease, it would be very limited. Specifically, the understory would not be as healthy or diverse and understory vegetation would continue to be cumulatively impacted by grazing, recreational use, and abiotic factors such as drought.

When natural stressors such as wildfires or insect outbreaks occur, or human activities such as new utility corridors, a new recreation site, or a new private subdivision are developed, the effects of alternative D could serve to slightly counteract the scenic effects of these activities and other projects, but it would be limited compared to other alternatives. When drought conditions or unusual weather events as a result of climate change occur, the ponderosa pine forest would be not be as resilient to such events. The overall trend to scenic quality resulting from this alternative in combination with other activities and projects would be toward level or downward for improving landscape attributes, and sustainable landscape character.

Alternative E

Direct and Indirect Effects

Effects of mechanical treatments and burning would be similar to those described in alternative B with approximately 403,500 acres being treated, but slash disposal effects would be similar to alternative D where slash is chipped, shredded, masticated or removed. Prescribed fire only would be used on about 177,801 acres with two fires occurring over the 10-year treatment period.

As analyzed for alternative D, the short term visual effects of slash piles and burned areas associated with the piles would not occur. Treating or removing the slash may take longer than burning and would produce noise and dust.

Prescribed burning in combination with mechanical treatments would have effects similar to those described in alternative B. There would be a reduction and duration in the amount of smoke produced since slash would be removed. Areas of prescribed fire only would be similar to alternative D.

Less aggressive treatment on 38,256 acres of goshawk habitat would result in somewhat more contrast between stands that would be more fully restored and those with less treatment. About 9 percent of the project area, in scattered locations, would make less progress toward desired conditions for forest structure. This same area would make more progress toward large tree recruitment.

Cumulative Effects

The cumulative effects would be similar to alternative B. There would be slightly fewer negative short-term cumulative effects in localized areas (no pile burns) since this alternative would mechanically treat about 7 percent fewer acres and burn about 1 percent fewer acres. There would also be slightly lower positive long-term cumulative effects from counteracting drought and insect damage likely to occur as a result of climate change since there would be less mechanical treatment and burning to facilitate greater forest resiliency.

Compliance with Forest Plans and Scenic Attributes – All Alternatives

The project would help achieve the desired conditions for scenery as defined in the forest plans: “Protect and enhance the scenic and aesthetic values of the Kaibab National Forest” and “Maintain and enhance visual resource values by including visual quality objectives in resource planning and management activities” for the Coconino (scenery report, tables 1 and 2). Designation of interim SIO and meeting forest plan mapped SIO in the long term would be met under this alternative. Scenic quality would be enhanced to a greater extent and for a longer period than under alternatives A and D, but not as long as Alternatives C or E as the diversity of tree species, size, and spatial distribution is improved. Throughout much of the treatment area, stand density would be reduced. The views along primary and secondary travel corridors, from communities, and developed recreation sites and trails would be more open and diverse. Visitors traveling along these corridors would experience a sequence of enclosures and openings that add variety and afford more expansive views into the treatment area. Natural meadows and grasslands would be improved, aspen stands regenerated, and oaks reinvigorated which would increase visual diversity and make these valued scenic features more prominent across the landscape. Conifer stands would feature clumped, uneven-aged groups interspersed with openings. The understory component of shrubs, grasses and forbs would develop and respond to the open canopy conditions, further increasing visual diversity.

The potential for crown fire would be decreased from about 34 percent to about 5 percent of the treatment area (see fire ecology and air quality specialist report). Since high severity fire is a risk factor for most scenery attributes, the proposed mechanical and prescribed fire treatments would result in improvements to scenic stability. Repeat low severity prescribed fire would help keep the forest structure open with groups of trees, recycle nutrients, and improve the understory composition and vigor.

The short term visual disturbances of 1 to 5 years after completion of restoration activities would be within the reference conditions of the area. In the short term the disturbances would be visible and would lower the scenic quality. At the completion of the thinning and prescribed burning, the natural appearance of the area will begin to recover, and will improve over time. Throughout project implementation it is expected that the valued scenic character will begin to improve, and the risks to scenic attributes will decrease.

Slightly fewer acres (about 10 percent less) will be thinned and burned under this alternative than alternative C and about 1 percent less than alternative E. This alternative may result in less understory vegetation improvement than with alternative C. Combined thinning and burning is the preferred tool to improve understory composition and abundance (Laughlin et al 2006). It would not make any change or improvement in Garland Prairie management area.

Tribal Relations

A summary of the tribal relations analysis, including the consultation process is presented here. The complete specialist report (Johnson et al. 2014) is incorporated by reference.

The project is situated across a landscape that is aboriginal to at least 16 American Indian Tribes. Many of these tribal aboriginal lands overlap one another and areas of prominence which are considered sacred by tribes here in the Southwestern United States. American Indian Law requires consultation between the U.S. Forest Service and federally recognized American Indian tribes; however, recognizing that we share a common interest to maintain the health of the forest consultation extends beyond the legal requirements. With the knowledge that American Indian people have inhabited the area of 4FRI for centuries, tribal consultation will consider traditional knowledge to restore and maintain a healthy forest ecosystem.

Changes from the Draft Environmental Impact Statement and Opposing Science

The changes that occurred from DEIS to FEIS (see chapter 2) had minimal impacts to tribal relations, with the exception of analyzing a new alternative (E). No comments included literature that could be categorized as “opposing science” for Tribal Relations.

Consultation Process

The following tribes and tribal chapters who have historic ties and an interest in the Coconino and Kaibab National Forests were consulted with and include: Kaibab Band of Paiute Indians, Navajo

Nation including Coppermine, Coalmine, Naness, Lechee, Leupp, Bodaway, Cameron, Tuba City, Dilkon and Tolani Lake Chapters, Kaibab Band of Paiute Indians, San Juan Southern Paiute, White Mountain Apache, Yavapai-Apache Nation, San Carlos Apache, Hualapai, Yavapai-Prescott Indian Tribe, Havasupai, Tonto Apache, Pueblo of Zuni, Pueblo of Acoma, Hopi, and Fort McDowell Yavapai Nation (table 99).

Tribal consultation is primarily direct face-to-face meetings between federally recognized tribes and the Federal government. Consultation may include sharing of information through letter carried mail, email, and follow-up telephone calls which supplement the face-to-face meetings. Tribes that do not participate in tribal consultation continue to receive information via email and hand delivered mail. Information is shared unless a tribe asks specifically to not be informed. The tribal relations specialist report (project record) contains an up-to-date, complete listing of information sharing and consultations with federally recognized tribes regarding 4FRI. Tribal consultation will be ongoing throughout the entire span of the 4FRI project.

Table 99. Summary of 4FRI Project tribal consultation

September 10, 2009	Havasupai, Hopi, Hualapai, Kaibab Band of Paiute Indians, Pueblo of Zuni, Navajo Nation, and Yavapai-Prescott	The Kaibab NF Supervisor sent an invitation to seven federally recognized Tribes to discuss 4FRI and other Forest projects.	N/A
September 28, 2009	Havasupai, Hopi, Hualapai, Kaibab Band of Paiute Indians, Pueblo of Zuni	An initial presentation on 4FRI was given during the Kaibab NF intertribal meeting.	Kaibab NF
May 5, 2010	Hopi, Pueblo of Zuni, Hualapai, Yavapai-Apache, Navajo Nation, and Yavapai-Prescott	The Forest emailed information on 4FRI as an early “heads-up” on upcoming consultation.	N/A
June 29, 2010	Yavapai-Apache Nation Chairman and staff.	The Forest provided a brief overview of 4FRI.	Yavapai-Apache Nation tribal offices, Camp Verde, AZ
July 14, 2010	Ft. McDowell Yavapai Nation	The Forest introduced 4FRI to cultural department.	Fort McDowell Yavapai Nation tribal offices, Fountain Hills, AZ
September 14, 2010	Hopi, Havasupai, Hualapai, Navajo Nation.	Introduction and presentation of 4FRI to Tribes in attendance of intertribal meeting, presentation by Henry Provencio	In the backdrop of the Schultz Fire landscape, Coconino County, AZ
December 7, 2010	Hopi	Presentation to Hopi; by Henry Provencio	Hopi Cultural Offices, Kykotsmovi, AZ
January 11, 2011	Hopi	Presentation on 4FRI Heritage by D. Gifford	Hopi Cultural Offices, Kykotsmovi, AZ

Date	Tribe(s)	Type of Contact	Location
January 18, 2011	Hopi, Navajo Nation, Yavapai-Prescott, Ft. McDowell Yavapai, Hualapai, Havasupai, White Mt Apache, Yavapai-Apache, and Pueblo of Zuni.	emailed information on Woody Biomass Program	N/A
January 27, 2011	Hopi, Navajo Nation, Hualapai, Pueblo of Zuni, Pueblo of Acoma, Yavapai-Prescott, Yavapai-Apache, Ft. McDowell Yavapai, Tonto Apache, White Mountain Apache, San Carlos Apache, Havasupai, emailed to Hopi, Navajo Nation, Yavapai-Prescott, Ft. McDowell Yavapai, Hualapai, Havasupai, White Mt Apache, Yavapai-Apache, and Pueblo of Zuni	The Forests mailed scoping letters to Tribal leaders and emailed letter to representatives (also see chapter 1 of the DEIS).	N/A
February 8, 2011	Havasupai, Hopi, Hualapai, Kaibab Band of Paiute Indians, Navajo Nation, Yavapai-Prescott Indian Tribe, and Pueblo of Pueblo of Zuni	The Kaibab NF Supervisor sent a letter to seven federally recognized Tribes with a copy of the SOPA and notification of the 4FRI project.	N/A
February 15, 2011	Yavapai-Prescott Indian Tribe	Kaibab provided update of 4FRI.	Yavapai-Prescott tribal offices, Prescott, AZ
February 16, 2011	Hualapai	Kaibab provided update of 4FRI.	Hualapai cultural offices, Peach Springs, AZ
February 23, 2011	Pueblo of Zuni	Kaibab provided update of 4FRI.	Zuni cultural offices, Zuni, NM
February 24, 2011	Navajo Nation	Kaibab provided update of 4FRI.	Navajo Historic Preservation Department, Window Rock, AZ
March 7, 2011	Havasupai Tribe	Presentation of 4FRI by H. Provencio and D. Fleishman	Coconino National Forest S.O.[22]
March 21, 2011	Hopi	Response to January 27 letter and supports site avoidance.	N/A
March 23, 2011	Hopi	Kaibab staff provided update[23]	

[22] Staff discussed 4FRI project during the Sacred Sites Listening Session. Havasupai Tribe identified areas of concern. Tribe requested the following comments be documented. 1) High turnover of FS staff creates problems with site protection on long term projects. 2) Some tribal members are against thinning because all trees are important and provide life.
[23] Hopi Tribe would like to be involved in developing cultural resource sample surveys and request consultation on survey strategy.

Date	Tribe(s)	Type of Contact	Location
May 3, 2011	Hopi, Navajo Nation including Coppermine, Coalmine, Naness, Lechee, Leupp, Bodaway and Cameron Chapters, Hualapai, Pueblo of Zuni, Pueblo of Acoma, Yavapai-Prescott, Yavapai-Apache, Ft. McDowell Yavapai, Tonto Apache, White Mountain Apache, San Carlos Apache, Havasupai, emailed to Hopi, Navajo Nation, Yavapai-Prescott, Ft. McDowell Yavapai, Hualapai, Havasupai, White Mt Apache, Yavapai-Apache, Kaibab Band of Paiute, and Pueblo of Zuni.	Letter for proposed locations for 39 material pits to provide cinders, gravel, and other aggregate materials for surfacing of unpaved roads and for maintenance purposes for 4FRI	N/A
May 9, 2011	Havasupai, Hopi, Hualapai, Kaibab Band of Paiute Indians, Navajo Nation Yavapai-Prescott Indian Tribe, and Pueblo of Pueblo of Zuni.	The Kaibab Forest Supervisor sent a letter to seven federally recognized Tribes with a copy of the SOPA and notification of the 4FRI Mineral Pit Project	N/A
May 12, 2011	Hopi, Navajo Nation, Hualapai, Pueblo of Zuni, Pueblo of Acoma, Yavapai-Prescott, Yavapai-Apache, Ft. McDowell Yavapai, Tonto Apache, White Mountain Apache, San Carlos Apache, Havasupai, emailed to Hopi, Navajo Nation, Yavapai-Prescott, Ft. McDowell Yavapai, Hualapai, Havasupai, White Mt Apache, Yavapai-Apache, and Pueblo of Zuni.	The Forests sent the heritage report.	N/A
June 6, 2011	Hopi	Letter sent to Coconino regarding Heritage report on Survey discrepancies between Kaibab and Coconino.	N/A
June 22, 2011	Hopi	Met to discuss Heritage survey regarding their June 6, response letter.	Hopi Cultural Offices, Kykotsmovi, AZ
August 22, 2011	Navajo Nation Kaibab Band of Paiute Indians, White Mountain Apache, Yavapai-Apache Nation, San Carlos Apache, Hualapai Tribe, Yavapai-Prescott Indian Tribe, Havasupai, Tonto Apache, Pueblo of Pueblo of Zuni, Pueblo of Acoma, Hopi Tribe, and Fort McDowell Yavapai Nation.	The second 4FRI scoping letter was sent to 20 Tribal leaders (also see chapter 1 of the DEIS). No additional comments were received. See chapter 1 for a summary of concerns and issues raised throughout consultation.	N/A
February 19, 2012	Navajo Nation Coalmine Chapter.	Presentation on 4FRI project areas	Coalmine Chapter Building, Navajo Nation

Date	Tribe(s)	Type of Contact	Location
April 6, 2012	Navajo Nation Kaibab Band of Paiute Indians, White Mountain Apache, Yavapai-Apache Nation, San Carlos Apache, Hualapai Tribe, Yavapai-Prescott Indian Tribe, Havasupai, Tonto Apache, Pueblo of Pueblo of Zuni, Pueblo of Acoma, Hopi Tribe and Fort McDowell Yavapai Nation.	Tribes were sent a list of projects (including 4FRI) being analyzed under NEPA.[24]	N/A
May 20, 2012	Navajo Nation Cameron Chapter	Presentation on 4FRI project area, provided maps and brief discussion.	Cameron Chapter House, Cameron, AZ
September 19, 2012	Hopi	Kaibab Forest Supervisor provided update on 4FRI Reviewed process of phased consultation on specific Task Orders throughout life of project.	Hopi Cultural Offices, Kykotsmovi, AZ
September 20, 2012	Navajo Nation	Kaibab Forest Supervisor provided update on 4FRI Reviewed process of phased consultation on specific Task Orders throughout life of project.	Navajo Historic Preservation Department, Window Rock, AZ
September 20, 2012	Pueblo of Zuni	Kaibab Forest Supervisor provided update on 4FRI Reviewed process of phased consultation on specific Task Orders throughout life of project.	Zuni cultural offices, Zuni, NM
October 4, 2012	Havasupai	The Kaibab NF Forest Supervisor provided an update on the 4FRI project to the Tribal Council.	Supai, AZ

Contemporary Uses and Traditional Cultural Properties (TCP)

Traditional Cultural Properties: American Indian resources may consist of shrines, trails and historic roads, and shelters such as sweat lodges and brush shelters. Traditional use areas and places are known as traditional cultural properties/places (TCPs). TCPs are places traditionally used by cultural groups over generations. TCPs within the project area include the San Francisco Peaks on the Coconino NF, and Red Butte and Bill Williams Mountain on the Kaibab NF. Natural springs are also considered TCPs and/or sacred sites by some tribes. Many plants are gathered for ceremonial on or near TCPs. See appendix A of the heritage report for additional discussion on management of TCPs.

Contemporary Uses: The entire project area is managed by the Forest Service and is aboriginal land to the consulting tribes. Along with aboriginal ties to the land, many tribal members also use the forest for traditional resources and ceremonies and for gathering medicinal plants for other traditional and cultural purposes. Traditional gatherings and ceremonies are conducted throughout

[24] On April 6, 2012, all Tribes were sent a list of projects (including 4FRI) being analyzed under NEPA. On May 5, 2012, a meeting was held with the Hopi Tribal staff for the purposes of discussing ongoing consultation projects, including 4FRI. No follow-up assignments for the forests specifically addressed 4FRI.

the forests and may or may not occur at the knowledge of the land manager. Additionally these activities may occur over the span of an hour, to several hours or several days.

The forests recognize the importance of maintaining these traditions to area tribes and will accommodate traditional use of Forest Service lands by American Indians provided it complies with existing laws and regulations. In an attempt to reduce the likelihood of conflicts between traditional tribal activities and operations related to 4FRI, consultation and coordination is a critical component between the tribes and the forests regarding the timing and locations of specific planned activities and operations.

Years of government-to-government consultation have identified numerous traditional uses in or near the 4FRI project area. Examples of these uses include collection of forest products such as medicinal plants, tree boughs, ceremonial fuelwood, and piñon nuts (table 100), and ongoing use of ceremonial sites, shrines, and traditional gathering areas. Plant collecting is almost always conducted in more than one area to not deplete any particular plant species. In some cases, specific traditional use areas have been identified on the forests through project-level consultation. However, it is assumed most traditional use areas have not yet been identified. While some traditional uses consistently occur in one location, others may occur in a variety of locations based on the availability of resources.

Table 100. Example of forest products and their traditional use

Forest Product	Use
Juniper Boughs	Shade structures
Small Fir Trees	Ceremony dances
Fir, Pinyon, and Juniper Boughs	Ceremony dances
Cat tails	Ceremony dances
Poles	Corrals, shades
Green Oak up to 6”	Bows, Kiva ladder rungs
Ponderosa Logs	Traditional ceremonial structures
Willow Branches	Basketry
Yucca	Basket, soap

Threats to Contemporary Uses and Traditional Cultural Properties

Wildfires are a threat to all forest products; however, fire suppression in the forest has also caused damage in the form of preventing the healthy production of juniper boughs, limiting the growth and production of small fir trees, and limiting the number of large ponderosa logs for ceremonial structures. Habitat for some native plants desired by tribal traditional collectors is disappearing and natural springs are drying up due to overstocked forests. Some of the affected plant collection areas and springs that were used historically still have associated cultural values that are important to the tribes. Concerns expressed by Tribe during tribal consultation include:

- Traditional cultural properties are at risk of being damaged or lost from high-severity fire,
- Springs and plant collection areas are at risk of being damaged or destroyed by high-severity fire,
- Overstocked stands are reducing the sunlight available for cultural and medicinal plants,
- Springs that are important to tribal ceremonies are drying up,

- A lack of low-intensity fire is reducing regeneration of plant collection areas,
- Smoke may affect some tribal communities,
- Tribes need access for ceremonies and traditional gathering, and
- Tribes are concerned about the preservation of cultural resources.

Environmental Consequences

The following mitigation (see appendix C in the FEIS for complete list) are common to alternatives B through E. The environmental consequences are based on applying these measures.

- Consult with Native Americans when projects and activities are planned in sites or areas of known religious or cultural significance,
- Project undertakings would be inventoried for cultural resources and areas of Native American religious use,
- Prior to initiating project-specific task orders, the forests would consult with federally recognized tribes to identify traditional use areas and, if necessary, develop project-specific mitigation measures to accommodate traditional use of the forest by tribal members,
- When areas are selected for treatment, detailed maps of the area would be presented to tribes through on-going tribal consultation to determine if other sensitive areas of tribal importance could be potentially impacted, and
- Treatment timing would be adjusted to avoid seasonal plant gathering and ceremonial use.

Alternative A

TCPs are at risk from high-severity fire because it can destroy the setting of the TCP including seed and habitat for native plants. Soil erosion due to high-severity wildfire could have a direct and indirect effect on traditional collecting areas. Rain and snow melt could cause channels to form, or mud slides from nearby slopes could deposit soil and debris over traditional areas leading to the loss of biological communities for both plant and animal species used by the tribes. This erosion could negatively impact areas where traditional use plants grow thereby limiting opportunities for collection and for traditional use. Additional indirect effects of erosion (as a result of wildfire) are damage to cultural resources when they are unearthed and displaced.

In this alternative, overstocked stands would continue to reduce the sunlight available for native cultural and medicinal plants. A lack of low-intensity fire would further reduce the regeneration of plants collected by native people. Over time, alternative A may result in the reduction of pre-settlement native plants, some of which have been collected since historical times by American Indians for food and medicine. Additionally, as tree density (overstocking) increases, historic water sources such as springs and seeps (that are important locations to American Indians) may dry up, affecting historic uses.

With continued drying trends across the southwest, the forests would likely issue forest closures and fire restrictions thus effecting traditional uses and ceremonies. Access could be limited during active fire suppression activities.

Alternative B

Alternative B proposes restoration treatments that would result in reduced fuel loading and a more open forest structure and pattern. Mechanical and prescribed fire treatments would reduce the potential for uncharacteristically intense fire behavior. This would reduce the potential for severe impacts to National Register listed or National Register eligible heritage resources (which are known to be of interest to the tribes representing the “footprints of their ancestors.”). Mechanical treatment and low-intensity prescribed fires would reduce current fuel loads which would help to prevent extensive heat damage to traditional collection and gathering areas from future wildfires. There would be less need for fire suppression activities, consequently less of a threat from ground disturbing activities like bulldozer fire-line construction in sensitive areas.

Mechanical thinning treatments, temporary road construction, decommissioning, and other ground disturbing activities associated with 4FRI have the potential to affect traditional collecting and gathering, ceremonial areas, and TCPs by temporarily displacing collecting gathering and ceremonial activities. Impacts would not be as disruptive as those periods of wildfire suppression. Access concerns would be addressed through on-going consultations between the forests and American Indian groups. In addition, mitigation was developed to minimize disruption of activities and includes adjusting treatment timing to coincide with seasonal plant gathering and ceremonial use.

Using prescribed fire also has the potential to affect fire sensitive areas. However, as early as the first growing season after the initial reduction of heavy fuels, an increase in understory plant growth would be expected. Mechanical treatments may provide better habitat for these plants to thrive. Fire and ground disturbance can also enhance certain plant species such as wild tobacco. Overall, treatments could provide a prolific diversification of certain plant species. Local tribal people could potentially have greater access to collecting areas as existing roads are improved. The demand for ground water that is currently occurring from dense tree growth would be reduced. Treatments may promote an increase in water flowing from springs and possibly restore springs that have dried up. Activities proposed in alternative B would result in greater opportunity for contemporary tribal uses such as native plant collection and enhancement of TCPs such as springs.

All action alternatives (B through E) create the potential for increased smoke. Most of the smoke from fire use on the Coconino and Kaibab NFs would carry from the southwest to the northeast and to the Havasupai Reservation and western portions of the Navajo Nation Reservation. Many people living in these areas are seniors with health conditions and sensitivity to smoke. The effects of limited communications may hinder receiving adequate information about smoke. Some may not have access to an internet website to receive information on planned prescribed fires. In addition, there may be language barriers and cultural differences. Tribal consultation would continue throughout project implementation and will strive to inform tribes on the timing, type, and amount of smoke tribes may experience during implementation. See the complete environmental justice analysis in the economics report.

Alternative C

Many of the ground disturbing activities associated with this alternative are similar to those identified in alternative B, and have the same potential to affect traditional collecting and gathering, ceremonial areas, and TCPs. Key components of this alternative include additional acres of mechanical and prescribed fire on specific grasslands, wildlife and watershed research, and inclusion of the Large Tree Implementation Plan.

One concern for traditional collecting and gathering, ceremonial areas, and TCPs under this alternative is the increase in mechanical treatment acres. If additional high impact or intense mechanical treatments occur under this alternative, additional tribal consultation would be necessary. Protection of cultural resources are discussed in the heritage section (see the heritage section and appendix C of the DEIS for additional information).

Alternative D

Alternative D would reduce the use of prescribed fire across the project area in comparison to the proposed action (alternative B). This would reduce the potential for smoke to impact tribal communities. Potential impacts to traditional collecting and gathering, and ceremonial areas and TCPs are the same as described in alternative B.

Alternative E

This alternative is similar to alternative C in the amount of proposed mechanical and burn treatment areas. Also 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 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. No forest plan amendments are proposed.

As in alternative C, the primary concern will be the increase in areas proposed for mechanical treatment. A potential benefit of this alternative is the preservation of culturally modified trees. This alternative will leave large numbers of 9 inch and above trees in place, thus may preserve some of these culturally modified trees. Conversely, one negative aspect of leaving large trees in place was noted during the bark beetle infestation on the Coconino National Forest. During that period a number of larger ponderosa pines died in drier parts of the forest.

Coconino Forest Plan Amendments – All Alternatives

Amendment 1: There would be no discernible effects to heritage resources or tribal relations from defining target and threshold habitat or Mexican spotted owl monitoring. Applying prescribed fire and the size and amount of trees to be cut within Mexican spotted owl habitats would have the same direct, indirect, and cumulative effects as described for each action alternative.

Amendment 2: There would be no discernible effects to heritage resources or tribal relations from these amendments. The direct, indirect, and cumulative effects would be the same as described for each action alternative.

Amendment 3: Though surveys and monitoring of heritage resources would occur and BMPs would be implemented, there would be a chance that heritage resources would be impacted (see heritage resources section). There would be no additional discernible effects to heritage resources or tribal relations from this amendment. The direct, indirect, and cumulative effects would be the same as described for each action alternative.

Forest Plan Consistency

Alternatives B through E are in compliance with the Coconino NF and Kaibab NF forest plan because all alternatives promotes management of the forest by reducing the fuel load of the forest resulting in the restoration of resources used by the tribes. Tribal consultation will be imperative in the timing of proposed mechanical treatment so it does not conflict with tribal ceremonial use of the forest.

Cumulative Effects – All Alternatives

In **alternative A**, increased fuel load would result in larger wildfires and the loss of stable slopes will result in increased erosion. This erosion will impact areas where plants grow for traditional use. Prominent landmarks identified as TCPs could be severely impacted if a wildfire burned through these areas. Springs would continue to dry up or be polluted by excessive runoff by flash flooding as a result of rain in burned slopes.

Alternative B has the potential to increase the amount of ground-disturbing activities, including mechanical treatments, temporary road construction, skidding, stream restoration, fence construction and other ground disturbing activities. When considered together with the past present and foreseeable future actions, these activities have the potential to affect cultural resources such as traditional collecting, gathering and ceremonial use areas and TCPs. All undertakings that have the potential to affect cultural resources will go through tribal consultation. In addition, protection measures such as the possibility of tribal monitors during mechanical activities, keeping ground disturbing activities out of sensitive areas by flagging and avoiding the sensitive areas, and post prescribed burn monitoring to assess the effects of the low intensity burns, will help to minimize the effects. The potential cumulative effects to cultural resources and TCPs such as springs from increased ground disturbing activities and prescribed burning resulting from this alternative are therefore not considered to be adverse. The cumulative effect of increased visibility is not considered to be adverse.

The cumulative effects on TCPs, gathering and ceremonial areas resulting from any potential increase in erosion are also minimal. Reducing fuel loads and implementing low to moderate intensity prescribed fires does not cause soil sterilization or hydrophobic soils as high intensity wildfires do. Low intensity prescribed fires leave some vegetation in place and re-vegetation occurs soon afterwards if soils are not sterilized. However, as implementation occurs, monitors would check for erosion concerns by examining culturally sensitive locations like TCPs and ceremonial sites in the project areas, including focusing on slopes, drainages, and other high probability areas with cultural resources present. The cumulative effects to cultural resources caused by an increase in erosion are not considered to be adverse.

In **alternative C** the addition of the Large Tree Implementation Plan would have little additional effect on cultural resources, TCPs and gathering and collecting areas. However, an increase in prescribed burning, as well as similar actions identified under alternative B, such as mechanical treatments, prescribed burning, stream restoration and fence construction have the potential to affect these resources. These issues are identified under the Cumulative Effects section under alternative B and not repeated here. As noted previously, all undertakings that have the potential to affect cultural resources will go through tribal consultation. An increase in these types of activities will not result in an adverse effect to cultural resources as long as tribal consultation is conducted prior to project implementation, protection measures are imposed and post project implementation monitoring is conducted when appropriate.

As with alternatives B and C, similar increases in activities under **alternative D** such as mechanical treatments and ground disturbances can add to the effects on cultural resources. Additionally, specific to this alternative, is a reduction in the prescribed fire acres which may involve other means of slash and debris removal. Actions such as chipping, shredding, and mastication as well as removal of material off-site may include an increase in ground disturbing actions. As noted above, all undertakings that have the potential to affect cultural resources would not have an adverse effect if the measures identified above are implemented. Protection of cultural resources measures are discussed in the heritage section (see heritage section in chapter 3 and appendix C of this FEIS). Overall, the cumulative effects on cultural resources as a result of alternative D are not considered to be adverse.

As with Alternatives B and C, similar increases in activities under **alternative E** such as mechanical treatments and ground disturbances can add to the effects to tribal use of the land. The addition of the Large Tree Implementation Plan would have little additional effect on cultural resources, TCPs and gathering and collecting areas. The alternative also adds acres of grassland treatments on the Kaibab National Forest and incorporates wildlife and watershed research on both forests. Actions such as chipping, shredding and mastication as well as removal of material off-site may include an increase in ground disturbing actions. As noted above, on both the Kaibab and the Coconino National Forests all of the undertakings that have the potential to affect TCPs will go through the Section 106 process and all effects to TCP resources that are listed on the National Register or eligible for the Register will be avoided. Overall, the cumulative effects on cultural resources as a result of alternative E are not considered to be adverse.

Range

A summary from the range specialist report is presented here and the complete report is incorporated by reference (Hannemann 2014). Refer to the specialist report for additional information that includes: methodology, the grazing history of the project area, and supporting information. This analysis incorporates questions designed to evaluate movement toward desired conditions and concerns brought up by the public during scoping: (1) How would project activities affect livestock grazing management in the project area? (2) How would project activities affect livestock forage in the project area? (3) Would livestock grazing affect the restoration of understory species? (4) How would livestock grazing affect the ability to return fire as a natural process to the project area? and (5) How would climate change affect the range resource and how would the project affect climate change (relative to range)?

Changes from the Draft Environmental Impact Statement and Opposing Science

Acres and alternatives were corrected or updated as described in chapter 1 of this FEIS. In response to comments on the DEIS (Cara 181) that indicated there was inadequate mitigation related to post-fire grazing, a new design feature was added that clarifies that restrictions in grazing of livestock would primarily occur after significant burns in a pasture (see R7 and R8 in appendix C). No comments that included opposing views were received for the range resource. As a result of comments on the DEIS, the range analysis was updated to reflect managing canopy cover on approximately 38,256 acres in alternatives C and E at the stand level (see chapter 3 effects).

Affected Environment

The affected environment for the range analysis is approximately 989,029 acres. Only allotments within the project area have been considered. Within the project area, approximately 791,250 acres are within grazing allotments and 197,779 acres are not grazed by livestock. The amount of each allotment lying within the project area averages 65 percent and varies between 0.002 to 100 percent.

There are 49 livestock grazing allotments of which 47 are active allotments and 2 are vacant (see the specialist report for figures displaying allotments within the project area). Of the 49 allotments, 40 permit cattle grazing and 9 permit sheep grazing.

There are 229 main pastures located within the project area. Main pastures are the large pastures that are used more than 20 days per year by livestock. Total allotment acres and acres by RU can be found in the specialist report in table 2. Restoration units were used for display purposes only and were not used in the analysis. See the specialist report for details on allotment grazing management systems, current numbers of permitted livestock, and seasons of use within the project area.

A study was conducted in 2011 on the trends of understory vegetation within the project area (Brewer 2011). Currently the range has seen a shift to warm season species dominance in many areas of northern Arizona as a result of relative lower winter moisture and to higher summer moisture. The warm season plant that has benefited most from this shift is blue grama. Because blue grama is a dense mat forming species, many areas have seen an increase in perennial plant cover and ground cover. The trends of forage production during this time period have been static.

Environmental Consequences

The environmental consequences for alternatives B, C, D, and E are based on the application of resource protection measures and are based on the environmental consequences in the silviculture, fire, and wildlife (herbaceous understory analysis) reports. See the range section in appendix C of this FEIS for the complete list of resource protection measures.

Alternative A – Direct and Indirect Effects

In alternative A there would be no changes in current management and the forest plans would continue to be implemented. Those forest plan actions and allocations are incorporated by reference. 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 adjacent 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 adjacent to the project area by the Forests in the foreseeable future (within 5 years).

Because no project-related treatments would occur on approximately 600,000 acres, trees would remain dominantly even-aged and primarily of mid-size with little large or small trees. Trees would remain evenly spaced throughout the forest. Tree density would remain and increase to continue the probability for increase in tree mortality from insects, disease, and fire. This increase in trees and no prescribed burning into the future would reduce the amount of understory vegetation, and affect species composition by reducing shade intolerant understory species and increase shade tolerant species. Understory species would also be reduced because the buildup of pine needles and the lack of nutrient cycling provided by burning. Appendix 6 of the wildlife report gives a complete review of these effects.

The reduction in understory vegetation would reduce the amount of forage available to livestock. Over time, livestock numbers would be reduced until the number of trees were removed. This reduction in forage and decrease in livestock numbers has been recorded through the last 100 years throughout the project area (page 21 of this report). There is no reason to believe that this trend would not continue under Alternative A.

In alternative A, approximately 431,000 acres of prescribed fire would not occur. Without these acres of prescribed burning, no pasture rest periods after burning would be necessary. Grazing management would continue without this impact.

Even with projects that are implemented under the forest plans, alternative A does not adequately reduce the increased risk of uncharacteristic wildfire through thinning or prescribed burning. Eighty-four percent of the project area is currently at risk from wildfire and this is projected to only increase in the future. These uncharacteristic wildfires can burn with high severity and burn through multiple pastures burning fences and other structural range improvements. Uncharacteristic wildfire would have an adverse impact on livestock grazing management and forage until the area recovers and structural improvements are replaced. See the fire ecology report for additional information (Lata 2014). However, there are no unavoidable adverse effects in alternative A related to livestock grazing. There are also no irreversible and irretrievable commitments of resources. Alternative A complies with the Coconino and Kaibab forest plans for livestock grazing.

Alternatives B, C, D, and E – Direct and Indirect Effects

The removal of trees during the timber thinning operations would have little effect on livestock grazing. Mitigations would be implemented to maintain structural range improvements and keep livestock within designated pastures during this operation. Pastures may be deferred during the timber operation to minimize equipment and livestock conflicts but it is not mandatory.

The allotments within the project area have the ability to rest a main pasture for one year after a burn with little impact to overall allotment grazing management. However, some allotment may have to temporarily reduced livestock numbers or season of use because of the combined impacts of these prescribed burns with other factors like wildfires and drought. If the burned areas do not recover within a year then livestock would likely continue to run in the same pastures, reducing the amount of rotational grazing on an allotment. This may also lead to a temporary reduction in livestock numbers or a reduction in length of grazing season to maintain the health of the grazed pastures until the treatment area recovers and rotational grazing is restored.

Adaptive management would continue to be used to adjust livestock numbers to meet annual forage production, with or without the burns. After approximately 10 years of implementation, it is expected that the increase in forage from these treatments would allow livestock numbers or grazing seasons to return to current levels on most allotments.

Mechanical treatment and prescribed burning would increase understory vegetation. Understory species and composition would change primarily by increasing shade intolerant understory species and decreasing shade tolerant species. The increase in forage would have a short-term (within 3 years) and long-term (10-year) beneficial effect to livestock grazing.

Prescribed burning would have an adverse effect to livestock grazing by removing forage available to livestock. This effect is short term until the forage plants can regrow, typically within one year. This effect would be offset by the long term increase in forage. The prescribed burning would be phased through the planning period to minimize impacts to an individual allotment.

Spring exclosure areas would not be available for livestock grazing and would have an adverse impact on available forage within a pasture. However, these exclosures would not be large enough and would not amass in any particular pasture to reduce pasture stocking rates. In addition, by the time these exclosures would be completed, it is anticipated the increase in pasture forage by the tree thinning and burning would help to offset the forage lost within the exclosures. Spring projects would not have a measureable impact on the capacity of allotment or grazing management.

The ephemeral drainage improvements would have a benefit to livestock grazing management by increasing forage by improving bank stability and decreasing the amount of sediment to downstream stock tanks.

Aspen exclosure areas would not be available for livestock grazing and would have an adverse impact on available forage within a pasture. However, the majority of these exclosures would not be large enough or amassed in any particular pasture to reduce pasture stocking rates. Aspen projects would not have a measureable impact on the capacity of allotment or grazing management.

Road and route decommissioning would have a beneficial effect to livestock grazing by growing additional forage in the old road bed. Constructing temporary roads would have a temporary adverse effect to livestock grazing when the forage on the road was disturbed. Road reconstruction would have no effect on livestock grazing. No road project would have a measureable impact on the capacity of allotment or grazing management.

There are no long-term, unavoidable adverse effects in alternatives B through E related to livestock grazing because effects would be short term in nature and wouldn't affect grazing permit capacity. There would also be no irreversible and irretrievable commitments of resources because forage would grow back in the next growing season after treatments or after managed grazing. Alternatives B, C, D, and E would comply with the Coconino and Kaibab forest plans for livestock grazing.

Direct and Indirect Effects Common to Alternatives C and E

In response to comments on the DEIS, approximately 38,256 acres of goshawk habitat would have canopy cover measured at the stand level where there is a preponderance of VSS 4, 5 and 6. The vegetation and fire analysis for these acres is incorporated by reference. The spatial arrangement of the stands affected by this change is not contiguous and no individual pasture would have more than 20 percent of allotment acres impacted. Although movement toward the desired condition would be considerably less on these acres, it represents improved conditions when compared to no action. No measurable direct, indirect or cumulative impacts to grazing are expected from managing almost 39,000 acres (dispersed across the 988,764-acre landscape) at the stand level because the acres represent less than 5 percent of the livestock allotments within the project area.

Alternative B – Direct and Indirect Effects

Alternative B would affect all grazing allotments within the project area and 184 main summer pastures with mechanical and prescribed fire treatments. Ten pastures would be affected by prescribed fire-only treatments. Mechanical treatments by allotment would vary from 0 to 35,180 acres. See the specialist report for detailed information on acres affected by allotment. Prescribed fire-only treatments by allotment would vary from 0 to 18,802 acres. Mechanical and prescribed fire treatments would have a benefit to livestock grazing management by an increase in forage (also see effects common to all action alternatives). Treating up to two pastures per year per allotment would have an adverse effect to livestock grazing management and forage until the burn area shows range readiness (see effects common to all action alternatives).

Alternative B reduces the risk of uncharacteristic wildfire through thinning 384,966 acres and burning 583,330 acres within the project area over the next 10 years. These treatments would reduce heavy fuel loading, break up the tree canopy, raising the tree canopy, and burning fine ground fuels (Fire Report, Lata 2014). These actions would reduce the risk of uncharacteristic wildfires can burn with high severity and can burn through multiple pastures, burning fences and other structural range improvements adversely affecting livestock management.

Alternative C – Direct and Indirect Effects

Alternative C would affect 192 main summer pastures with mechanical and prescribed fire treatments. Two pastures would be affected by burning only treatments. Table 7 in the specialist report displays the total acres of vegetation and prescribed fire treatments within each allotment. Thinning treatments by allotment vary from 0 to 36,187 acres. Prescribed fire only treatments by allotment vary from 0 to 17,227 acres. Mechanical and prescribed fire treatments would have a benefit to livestock grazing management by an increase in forage. Up to two pastures per year per allotment would have an adverse effect to livestock grazing management and forage until the burn area shows range readiness (see effects common to all action alternatives).

Alternative C reduces the risk of uncharacteristic wildfire through thinning 434,049 acres and burning 586,110 acres within the project area over the next 10 years. These treatments would reduce heavy fuel loading, break up the tree canopy, raise the tree canopy, and burn fine ground fuels (Lata 2014). These actions reduce the risk of uncharacteristic wildfires that can burn with high severity through multiple pastures burning fences and other structural range improvements, and adversely affecting livestock management.

Alternative D – Direct and Indirect Effects

Alternative D would affect 184 main summer pastures with mechanical and prescribed fire treatments. Ten pastures would be affected by prescribed fire-only treatments. Nine pastures that have mechanical treatments would not have prescribed fire. Mechanical treatments by allotment would vary from 0 to 35,180 acres. Prescribed fire only treatments by allotment would vary from 0 to 18,402 acres. Mechanical and prescribed fire treatments would benefit livestock grazing management by increasing forage. Up to two pastures per year per allotment would have an adverse effect to livestock grazing management and forage until the burn area shows range readiness. The nine pastures that do not have prescribed fire would not need to be rested from livestock grazing. However, the pastures would not have the added benefit of increased forage that prescribed fire provides.

Alternative D reduces the risk of uncharacteristic wildfire through thinning 384,966 acres and burning 178,441 acres within the project area over the next 10 years. These treatments reduce heavy fuel loading, break up the tree canopy, raising the tree canopy, and burning fine ground fuels (Fire Report, Lata 2014). These actions reduce the risk of uncharacteristic wildfires can burn with high severity and can burn through multiple pastures, burning fences and other structural range improvements adversely affecting livestock management.

Alternative E – Direct and Indirect Effects

Alternative E would affect 192 main summer pastures with thinning and burning treatments. Ten pastures would be affected by burning only treatments. Nine pastures that have mechanical treatments do not have burning. Thinning treatments by allotment vary from 0 to 35,554 acres. Burning only treatments by allotment vary from 0 to 18,139 acres. Thinning and burning treatments would have a benefit to livestock grazing management by an increase in forage. Up to two pastures per year per allotment would have an adverse effect to livestock grazing management and forage until the burn area shows range readiness. The nine pastures that do not have burning would not need to be rested from livestock grazing but would not have added benefit of an increase in forage that burning provides.

Alternative E reduces the risk of uncharacteristic wildfire through thinning 403,218 acres and burning 581,019 acres within the project area over the next 10 years. These treatments reduce heavy fuel loading, break up the tree canopy, raising the tree canopy, and burning fine ground fuels (Fire Report, Lata 2014). These actions reduce the risk of uncharacteristic wildfires can burn with high severity and can burn through multiple pastures, burning fences and other structural range improvements adversely affecting livestock management.

Coconino NF Forest Plan Amendments

Alternative B and D

Amendment 1: Ground disturbance would result in short-term reduction in forage for authorized livestock. The monitoring portion of the amendment would not affect grazing management.

Amendment 2: Restoration actions in general would benefit grazing management. The canopy cover portion of the amendment would have no effect on grazing management.

Amendment 3 would have no effect on grazing management.

Alternative C

Amendment 1: The effects (benefits) of implementing amendment 1 in Mexican spotted owl habitat are the same as described for alternative B. In alternative C, additional acres of Mexican spotted owl habitat would receive prescribed fire which would further benefit grazing management.

Amendment 2: The effects of implementing amendment 2 would be the same as described for alternative B.

Amendment 3 would have no effect on grazing management.

Comparison of Alternatives

Alternative C would provide for the biggest increase in forage and best long-term improvements in grazing management, closely followed by alternative B and then E. Alternative D has the same thinning treatments as alternative B but burning is much less. Alternative A would result an increase in tree density, increased risk of uncharacteristic wildfire, and reduced forage production over time. A good representation of these alternative differences is displayed in Figure 8 of the understory analysis in the wildlife report (Wildlife Report, appendix 6). This figure displays the understory biomass differences based on modeled changes in tree basal area over the next 40 years.

The effect to livestock grazing management is less in alternative D because of the reduced amount of burning. Allotments B, C, and E have similar amount of burning and would have more effect on grazing management. However, the number of main pastures affected by burning is 184 for alternatives B, C, and E. Alternative D’s less burning reduces the alteration of grazing management schedules by nine pastures. Alternative D also reduces the long term benefit of increased forage that burning provides with a reduction of burning on roughly 400,000 acres. No burning would occur in alternative A so it would not have an effect on grazing management.

Cumulative Effects – All Alternatives

The spatial area considered for cumulative effects analysis includes 100 percent of the acres within allotments that occur within the project area. This is a logical boundary because changes to grazing management in one pasture of an allotment affect the management in the entire allotment. The project area occupies an average of 65 percent of each allotment that the project area intersects, with several being wholly within the project area and the minimum occupancy of a single allotment being less that .01 percent.

The time frame for these combined effects is 10 years because changes in condition and trend in the vegetation depend on the presence of favorable growing conditions after cattle leave the pasture. If growing conditions are favorable, plant height and canopy cover would completely recover from the impacts of the proposed forest management activities within 1 year. If growing conditions are not favorable, plant recovery would occur more slowly (up to 2 to 3 years). Vegetation recovery from the other activities and natural events may take this long depending on annual weather conditions particularly annual precipitation.

Cumulative Effects Baseline

The baseline includes the vegetation and prescribed fire projects from 2001 to 2010 including 140,614 acres of mechanical thinning and 119,751 acres of prescribed fire within the project boundary, most on the same locations. The baseline also includes the use of up-to-date grazing systems and adaptive management on all the allotment acres of the cumulative effects area and the use of over 20 livestock/elk exclusions to protect aspen and over 15 exclosures to protect riparian areas.

Past restoration projects (see specialist report, cumulative list of projects) within the project area have increased forage and understory vegetation. Forest Service policy has changed over time and the forests are now allowed to be managed for un-evened age tree management and to allow fire to return to its nature role in the ecosystem. Current grazing management conducted utilizing adaptive management procedures to meet objectives established in existing allotment management plans, is also part of the existing baseline.

Areas included with the cumulative effects analysis area, external to National Forest System lands, are primarily lands under private ownership and lands under the jurisdiction of the State of Arizona and the National Park Service. Grazing on adjacent forest land is grazed very similarly to grazing within the project area. Livestock grazing occurs in the majority of these areas except within the Walnut Canyon National Monument. Private lands within communities are not typically utilized by livestock with the exception of horses. Private lands outside of communities typically provide forage for livestock consisting mostly of small livestock operations, but can provide for larger livestock operations when the private land is in larger blocks. State lands are also utilized by livestock with many of these state lands managed in conjunction with Forest Service allotments. There are no indications that livestock use within these areas is going to change dramatically during the next 10 years. In addition, these lands are not large enough that livestock use could be moved to these areas to offset the effects of the proposed treatments.

Livestock Grazing Management and Livestock Forage

The cumulative effect to livestock grazing management and livestock forage for alternative A is no change in the short term but a long-term decrease in forage with an increase in trees. Within the cumulative effects boundary, 588,182 acres related to the 4FRI project boundary would not be treated and would have no change in the short term but there would be a long-term decrease in forage with an increase in trees. When other current and foreseeable projects are considered, an additional 146,891 acres will be treated (31,492 mechanical thinning and prescribed fire, 49,466 acres of thinning only and 65,933 acres of prescribed fire-only) and affect 15 percent of the allotment acres. Livestock grazing management would be affected by these treatments in the same as the other alternatives. Pastures would be rested and deferred as these treatments are completed. With less treatment acres, pastures rotations will be less affected.

The alternatives B, C, and D proposed treatments and the other current/foreseeable projects generally overlap in time and space (see cumulative effects description in appendix F). When 4FRI acres are combined with vegetation and prescribed fire projects, 74 percent of the cumulative effects boundary (89 percent of all allotments) would have reduced forage. However, this would be a short-term effect with a typical duration of 1 year after burning.

In the long term, forage would increase on these same acres in the cumulative effects boundary. In terms of grazing management, even though 705,695 acres have reduced forage for a period of 1 year, this would not affect grazing management because mitigation restrictions would apply to all planned and ongoing projects. No more than one main pasture per allotment would be burned per year on the majority of the allotments, and this would not add to the grazing management effects because these mitigation restrictions also apply to these on-going projects.

Livestock Grazing Impacts to Fire

The cumulative effect of livestock grazing on meeting the objective of restoring fire to the landscape for alternative A would not change because of the minimal and managed direct or indirect effect of current grazing (see effects analysis). The same would be true for alternatives B, C, and D, with minimal and managed direct and indirect effects of livestock management with the proposed treatments (see effects analysis). The ability to meet fire objectives in alternatives B, C, and D when considered with on-going and foreseeable projects that includes 65,933 acres of prescribed fire (see cumulative effects report) would not be affected due to the current grazing management strategies that are in place and due to the use of adaptive management.

Livestock Grazing Impacts to Understory

The cumulative effect of livestock grazing to achieving increased understory response for alternative A would not change because of the minimal and managed direct or indirect of current grazing (see effects analysis). The same would be true for alternatives B, C, and D, with minimal and managed direct and indirect effects of livestock management with these proposed treatments. The ability to achieve increased understory response in alternatives B, C, and D when considered with on-going and foreseeable projects that includes 31,492 mechanical thinning and prescribed fire, 49,466 acres of thinning only, and 65,933 acres of prescribed fire-only treatments (see cumulative effects report) would not be affected due to the current grazing management strategies in place and due to the use of adaptive management. Livestock grazing would adapt to changes in forage conditions through time.

Transportation

A summary of the transportation report is presented here. The specialist report (Fleishman 2014) is incorporated by reference.

Currently, there are approximately 4,278 miles of roads within the analysis area that are managed under Forest Service jurisdiction. Of this total, approximately 3,334 miles are open roads and 944 miles are closed roads. In addition to the roads that are currently managed by the Forest Service, there are approximately 374 miles of additional unauthorized roads that have been identified within the analysis area, for a total of approximately 4,652 miles of roads on Forest Service lands within the project area. See the specialist report for details on miles (and locations) of road by operational maintenance level (1 through 5).

Not all of the 4,278 miles of road within the (approximately) 990,000 acre analysis area would be needed for removal of forest products. A haul route analysis identified approximately 2,297 miles of existing road necessary for removal of forest products after harvest.

Changes from the Draft Environmental Impact Statement and Opposing Science

Since the DEIS, other projects that affect the road system within the 4FRI boundary have been completed or address roads separately. The Kelly Trails project and the Flagstaff Watershed Protection Project reduce the total miles of road decommissioning within the 4FRI project boundary by approximately 45 miles from what was proposed in the draft environmental impact statement. Table 101 displays the changes. Comments received on the transportation system that included literature that could be categorized as opposing are addressed in the soils and watershed, water quality and riparian analyses.

For all action alternatives, additional mitigation measures have been added in response to comments concerning temporary roads (FEIS, appendix C) and an additional category for temporary roads has been added to adaptive management actions on temporary roads.

Table 101. Changes in road decommission miles from the draft EIS to the final EIS (Coconino NF)

Change	Rationale	Miles
Open Roads Added to Proposed Decommission list in FEIS		**1.8**
FS 133A	Correction after Kelly Trails Decision	1.8
Roads Removed from Proposed Decommission List in FEIS		**46.7**
Decommission in DEIS are now decommissioned in Kelly Trails	Kelly Trails NEPA decision	2.2
Decommissioned in DEIS is now an open road in Kelly Trails	Kelly Trails NEPA decision	0.6
Decommissioned in DEIS is now converted to a trail Road in Kelly Trails	Kelly Trails NEPA decision	7.7
Decommission in DEIS, now open road	Errata Correction	8.7
Decommission in DEIS, now removed from the project area	Removal of Flagstaff Watershed Protection Project from analysis area	21.6
Decommissioned in DEIS, now removed because is outside project area	Errata Correction	3.7
Decommissioned in DEIS, now removed because it is a system motorized trail	Errata Correction	2.2
Total Reduction in Road Decommissioning		**45.0**

Environmental Consequences

The analysis focuses on two items related to the purpose and need of the project:

- How access to the project area is met by alternative to implement the project. The unit of measure is miles of system road and miles of temporary road.
- How each alternative moves toward a safe and more affordable transportation system that is identified within each forests respective travel analysis project (TAP) documents. The unit of

measure is miles of decommissioned roads, miles of open road for a more affordable road system, and miles of road maintenance for road safety.

The timeframe for the analysis is life of the project (about10 to 15 years).

Alternative A

Direct and Indirect Effects

Under Alternative A, current road management would continue on the two Forests, including implementing the Travel Management Rule (TMR) open road system. There is not a need to implement a transportation system to implement the proposed action, however, the transportation system will be adequate to access the analysis area as defined in each Forests respective TMR decisions for both the short-term(current to 10 years) and long-term (greater than 10 years from current). Approved NEPA projects will continue under the current forest plans, of which there are about 31 miles of temporary roads that may be constructed and up to 223 miles of roads that are approved for road decommissioning.

Additional NEPA analyses would be necessary to carry out additional on-the-ground closure activities, therefore this alternative does not move begin to implement toward a safe and more affordable road system. Road maintenance would continue, primarily on maintenance level 3-5 roads, as well as a limited basis on level 2 roads.

Cumulative Effects

There are about 21 miles of proposed temporary roads and about 33 miles of roads proposed for decommissioning in future and foreseeable projects. These miles would be added to about 31 miles of temporary roads that may be constructed and up to 223 miles of roads that are approved for road decommissioning under current and ongoing projects. This alternative would not add any additional road related activities; hence there are no cumulative effects over and above the actions that have signed NEPA decisions or future and foreseeable decisions that are being proposed outside of this project.

Alternatives B, C, D, and E

Reconstruction/maintenance of open, existing roads may include road blading, culvert installation, culvert replacement, spot surfacing and gravelling (surfacing is either imported from off-site or created locally from small road side borrow sources), and removal of vegetation from the road edge for improved site distance on the roads. This activity is expected to occur on approximately 2,218 miles of Forest Service road. This is expected to be completed in association with contracts to remove wood biomass on the mechanical harvest acres that are proposed under this EIS, but can be done with Forest Service personnel as well. The 2,218 miles of haul route reconstruction/maintenance, in combination with the 520 miles of temporary road, does provide for full access to the area to be able to implement the proposed action during the life of the activity. In addition, there is a short-term benefit for a safer transportation system through improved surfacing, improved site distances and signage during the life of the project. If the roads are not on a long-term maintenance schedule, the effect to the safety of the transportation system will decrease as drainages and road surfaces continue to degrade. A long-term maintenance schedule after the life of this project for roads is outside the scope of this analysis. Additional analysis in response to comments of looking at treatment to the low end of the HRV on about 38,260 acres in alternatives C and E has not changed the need for a transportation system, thus has not changed effects for roads related to this analysis.

An indirect effect of the proposed thinning activities is the removal of vegetation to improve site distance. This effect would decrease over time as vegetation re-established itself, hover, the desired condition is for an open stand condition and these effects would be effective for both the short and a portion of the long-term. Routine maintenance activities that occur during the life of this project would also maintain site distances.

Roads can have many negative effects of forest resources. See the soil specialist report, the water quality/riparian specialist report, the wildlife specialist report, and the aquatics specialist report for full disclosure of the negative effects of roads. Some impacts would be decreased during this action through the maintenance of drainage structures, but this action does not remove roads, thus there still is harassment to wildlife from the road remaining in place.

The spot surfacing and gravelling component of this activity would require the use of a local rock source (either commercial or rock sources on Forest Service land), but would not deplete all available rock sources in or adjacent to the project area. The total amount of material necessary is not quantifiable at this time but would be identified with specific road packages as projects are implemented. There would be energy use necessary for this activity for equipment to be able to maintain roads and haul trucks to transport material. The amount of energy use would be minimized for haul needs of material by utilizing the closest pit available for the material type needed for the project.

Road reconstruction/relocation in the vicinity of ephemeral, intermittent, and perennial streams would be designed to lessen the impact on these steam courses. Approximately 10 miles of road within the project area have this road treatment. The desired condition for stream road segments is to have ephemeral, intermittent, and perennial water courses slow the speed of water flow, have access to the flood plain, transport sediment, and maintain longer sustained base flows on the landscape, rather than a flush of peak flows. Floodplains are functioning and lessen the impacts of floods on human safety and health. Relocating steep road pitches and relocating short segments of roads to improve turn radii would decrease maintenance costs and improve site distance on roads. Road reconstruction/relocation may include the road relocation out of drainages, relocating short segments of steep pitched roads to a lower gradient, relocating a short segment of road to improve turn radii, construction of rock rip-rap, the installation of new culverts, and the construction of low water crossings. See the soils and watershed and wildlife specialist reports for the impact of roads on resources.

This activity does have limited effect to the needed transportation system for access because the existing transportation system could be utilized in place, but does provide a related short-term and long-term benefit to soil and water effects that are discussed within the soil and water specialist report. The reconstruction away from streams does have a slight major improvement in the ability to maintain roads, and such, would provide a short-term and long-term benefit to a more affordable and safe road system on approximately 10 miles of road within the analysis area. Reconstruction/relocation by definition would require the use of a local rock source (either commercial or rock sources on Forest Service land), but would not deplete all available rock sources in or adjacent to the project area.

Temporary and closed system roads that are constructed and opened for treatment purposes would be used during project implementation to provide for access to the area to implement the proposed action. This occurs on approximately 520 miles (253 miles of temporary roads and decommission when treatments are finished and 268 miles of existing system roads that have been previously closed/decommissioned as temporary roads that are opened and decommissioned after use) and is primarily a short-term effect that occurs during the first 10-years of the project. A small, unquantifiable portion of this effect is expected to occur after a 10-year timeframe due to implementation timeframes associated with contracts. Effects to soil and water resources, wildlife, as well as recreation resources are expected to occur during this timeframe and are discussed within the respective specialist reports. Temporary roads may have fewer adverse effects than do permanent roads, depending on the extent to which they are decommissioned (Gucinski et al, 2001:31). Temporary road construction would be governed by contract specifications to minimize the time that the roads are in place (Resource Protection Measure T10 and FEIS, appendix C) and resource impacts to soil and water, wildlife and recreation resources and will utilize design features within these specialists' reports to minimize impacts to the respective resources.

Once treatment has occurred, temporary roads would be decommissioned. Unneeded, closed (ML 1) roads would be decommissioned as needed and returned to a more natural state. Decommissioning of system roads and unauthorized routes would use an adaptive management framework that is outlined in each action alternative (and in appendix A of the transportation report) and would also utilize design features outlined in the soil and water specialist report. This would occur on approximately 520 miles of temporary roads within the analysis area, and approximately 42 miles of system roads within the analysis area. The decommissioning of 42 miles of current system roads on the Coconino National Forest begins to move the road system toward a safe and more affordable transportation system. The majority of this work is expected to occur in the short-term of the first 10 years of the project. The 42 miles of decommissioned system road is a long-term beneficial effect and is moving toward a more affordable transportation system as defined by the minimum open road system.

Decommissioning would occur on approximately 860 miles of road in alternatives B through E. This activity would occur after the removal of forest products and does not have an effect on having a transportation system in place to provide access for implementation. See the soils and water quality and wildlife reports for short-term impacts. In the long-term decommissioning would remove the road bed. This would decrease the negative effects of sedimentation, compaction, and hydrologic effects. It would remove disturbance to terrestrial wildlife that resulted (temporary) open roads. This activity removes the long term maintenance need and costs associated with 860 miles of roads, moving toward a more sustainable and affordable road system.

There may be a negative effect to access for implementation of prescribed burning in alternatives B, C and E on approximately 860 miles of roads for both the short term and the long term and an indirect effect to implementation if roads slated for decommission are to be used as firelines/containment lines for prescribed burns (primarily long-term effect on maintenance due to the timeframe for naturalization of decommissioned roads is 10 years). In alternative D, the acres of prescribed burning is decreased, and the corresponding road mileage that would be used to access prescribe burn sites is decreased to about 225 miles of road that can affect access for implementation. Alternative D also has an indirect effect to implementation if roads slated for decommission are to be used as firelines/containment lines for prescribed burns on about 225 miles of road slated for decommissioning. The decommissioning of about 860 miles of road would have a short term and long term positive effect on creating a safe and more affordable transportation system.

Summary of Effects – All Alternatives

The effects of increased amount of road maintenance on 2,218 miles of open roads are a short term improvement in access to implement the project, as well as providing for a safe transportation system in the short term. There would still be negative affects to other resources from the road. Road maintenance would minimize sediments from the existing system, but not completely remove the road as a source of sediment. The reconstruction of 10 miles of roads out of stream channels would have a short-term and long-term improvement in a safe and more affordable transportation system on about 3 miles, and would directly remove roads out of stream channels, thus decreasing sediment production at these sites. The construction, use and decommissioning of about 520 miles of temporary road would be necessary to effectively implement the proposed action and is primarily a short-term benefit from a transportation standpoint, but would be a short-term negative effect to other resources until the road is decommissioned after use. The decommissioning of 860 miles of road does move toward a more economic and efficient road system as defined in each Forest's respective travel management plan (TAP) in both the short and long-term through the reduction of miles of system roads, and does decrease the long-term negative effects of roads to soil, water, aquatics and wildlife associated with the 860 miles of road.

Forest Plan Amendments

On the Coconino NF, the proposed forest plan amendments address management in Mexican spotted owl habitat (amendment 1), management of canopy cover (amendment 2) and managing select acres for an open reference conditions. Amendment 3 addresses heritage resources. No road activities would be affected by implementing (or not implementing) the proposed amendments.

Cumulative Effects

The cumulative effects boundary is the approximately 990,000-acre analysis area. The timeframe of the cumulative effects analysis for past projects is 10 years. Tables 5 and 6 in the specialist report displays the projects within the analysis area and the corresponding roads related decisions within the projects.

There are about 257 miles of road decommissioning within previous projects and that 4FRI would add an additional 860 miles of decommissioned roads. The total of about 1,166 miles of decommissioned roads would move the cumulative effects analysis area closer to a safer and more affordable road system.

In addition, there are 2.9 miles of road relocation in other projects and that there would be 9.4 miles of additional road relocation from the 4FRI project for a total of 12.3 miles of road relocation. This would have a limited effect on creating a safer and more affordable road system. Thus, there are a total of about 1,178 miles (1,166 miles decommissioned roads and about 12 miles of relocated roads) of action proposed between past, present, and future foreseeable roads projects and the 4FRI project that would create a safer and move toward the open road system that is defined in each Forest's respective travel management decisions, and remove negative impacts to other resources from 1,178 miles of road.

There would be a total of approximately 583 miles of temporary roads that would be opened and subsequently decommissioned. These actions are related to access to 4FRI and adjacent project areas, and as such, meet the need for access. No new roads or borrow sources would be added under this project, thus, 4FRI is not contributing to borrow sources that are used to maintain a safe and more affordable road system.

The 2,218 miles of road maintenance from project implementation would have a short term improvement for access to the project area, as well as meet the needs of annual road maintenance for the two Forests within the cumulative effects project area. The road maintenance also provides a short term improvement in safe and more affordable access during the effective life of the maintenance; hence 4FRI would add an additional approximately 1,718 miles of road maintenance over the current approximately 500 miles of level 3-5 roads that currently occur on the two Forests within the 4FRI area.

There are an additional 49 miles of roads directly identified within the project area that are of managed by other jurisdictions (6 miles of State highway and 43 miles of county roads). An additional 635 miles of other jurisdiction roads are located directly adjacent or bisect the project area and a portion of these roads are likely to be used for haul, depending on where products are hauled to for manufacturing and/or shipping. Of the 635 miles there are 290 miles of Federal Highways, there are 159 miles of State highways, and multiple county roads totaling 186 miles. In addition, Coconino County has maintenance agreements on multiple Forest Service roads within the project area. The specialist report lists the other jurisdiction roads that are associated with the 4FRI FEIS, as well as National Forest System roads where Coconino County has maintenance responsibilities.

There is not a unit of measure related to other jurisdictional roads, however, many of the roads that are currently under county road maintenance will be roads that will be used for haul of wood from the project area and there is an opportunity to coordinate maintenance responsibilities during product removal with Coconino County. There is also a need to provide for safety along the county maintained roads during hauling operation because these roads access private inholdings within each respective national forest. Resource protection measures (FEIS, appendix C) would require coordination with Coconino County and to provide for safety signage during operations.

Climate Change

Introduction

Climate scientists agree that the earth is undergoing a warming trend, and that human-caused elevations in atmospheric concentrations of carbon dioxide (CO_2) and other greenhouse gases are among the causes of global temperature increases. The observed concentrations of these greenhouse gases are projected to increase. Climate change may intensify the risk of ecosystem change for terrestrial and aquatic systems, affecting ecosystem structure, function, and productivity (USDA FS 2010).

Southwestern ecosystems have evolved under a long and complex history of climate variability and change. Taking into consideration the number of mega-droughts and other climate-related variation, through time, southwestern systems have some built-in resilience (see silviculture report). However, between 1984 and 2006, an estimated 18 percent of southwestern coniferous forest was lost to increased fire and bark-beetle outbreaks likely resulting from drought and high average temperatures (Williams et al. 2010; see wildlife report).

This analysis synthesizes the direct and indirect environmental consequence information from the specialist reports (as applicable). It incorporates by reference the two planning documents, the “Kaibab National Forest’s Climate Change Approach for Plan Revision” (USDA FS 2012) and the “Southwestern Region Climate Change Trends and Forest Planning” (USDA FS 2010). See the specialist reports for cumulative effects analyses that consider climate.

Changes from the Draft Environmental Impact Statement and Opposing Science

All resources updated analyses as needed between DEIS and FEIS (see chapter 2 of this FEIS). Environmental consequences related to forest resiliency and potential impacts of climate change remained unchanged or changes were so minor as to not be measurable.

Approximately three form letters (Cara 109 is the master form letter) questioned the best available science used to evaluate potential impacts from climate change. The complete response to the comments and questions on climate-related science is in the fire ecology report in appendix H. The complete response to CARA 109 is in the project record.

The first contention stated the use of Woods et al. (2012) was not valid because the literature was an unpublished report. The final report was issued later in 2013, with no changes in conclusions, and the reference has been updated in the final report. Reviews and syntheses of multiple research studies have always been a valuable source of information. Combining and/or comparing multiple datasets in one document can produce added value because the studies can be viewed in context with others, and the combined data sets may strengthen or weaken conclusions from the individual studies, and/or produce new conclusions by remixed data and conclusions. Woods et al. (2012) took data and results from published studies (mostly from northern Arizona) and synthesized a new study to estimate the potential for restoration efforts (4FRI in particular) to mitigate the risk of catastrophic wildfire and stabilize carbon storage in ponderosa pine forests. The study specifically addressed the area proposed for treatment by the 4FRI, so is pertinent. This report is available upon request and is in the project record.

A second contention in the form letter was that Hurteau and North (2009) was not a relevant study to the project and the conclusions not consistent with the project analysis because the 4FRI DEIS did not consider soil carbon. The commenter found the conclusions and assumptions in this paper questionable. However, no specifics were provided that would assist with a response.

The stated purpose of this study was to "determine if current aboveground forest carbon stocks in fire-excluded southwestern ponderosa pine forest are higher than pre-fire exclusion carbon stocks reconstructed from 1876, quantify the carbon costs of thinning treatments to reduce high-severity wildfire risk, and compare post treatment (thinning and burning) carbon stocks with reconstructed 1876 carbon stocks." This study is not cited in the DEIS or in the Fire Ecology report as a reference for the idea that 'burning a forest turns it into a carbon sink', though it does point out that high severity fire can turn a forest into a carbon source. It is cited to support the statement (which we agree with) that fire-excluded forests contain more carbon that non-fire excluded forests. It also supports the idea that these forests are at greater risk of high-severity fire than non-fire excluded forests.

The third contention stated Savage and Mast (2005) was cited in the DEIS to support of a statement about carbon emissions but the study does not even contain the word "carbon." The fire ecology analysis cited Savage and Mast to describe potential effects from high severity fire. On page 251 of the fire ecology report states, "Savage and Mast (2005) showed that these conditions can persist for decades". The integrity of a forest structure and species composition (Savage and Mast 2005) is relevant to carbon sequestration and climate change dynamics.

The fourth contention stated Finkral and Evans (2008) data was not relevant to the 4FRI analysis because "Their study area was near Flagstaff, in the region of this project, and they estimated a

2.8 percent annual risk of fire in the area. This is a 36-year fire rotation, contradicting the frequent-fire assumption that the Forest Service is using to justify burning the area every 5 years".

Finkral and Evans discuss some of the research that has been done on restoration and carbon sequestration, and point out that "…dense forests have become a sink for carbon and an offset to the rising concentrations of greenhouse gases in the atmosphere…', but conclude that in a stand-replacing fire, a thinned stand would release 2410 kg C ha_1 less to the atmosphere than an untreated stand. However, the thinning treatment resulted in stand structural changes that make the stand less likely to support a crown fire and therefore more likely to avoid the carbon releases associated with crown fires, even under extreme fire conditions. So the decrease in C released would be even lower. The 2.8 percent number includes all the successful suppression efforts over the 15 years used to calculate the annual risk (1986 – 2000), and only included fires larger than 50 acres. The actual number of ignitions is much greater than that, and forest conditions that support high severity/high intensity fire have increased in the 14 years since the (Sisk et al. 2004) study was completed. It is unclear where the 'every 5 years' number comes from. Regardless of the source, fire rotation and 'every 5 years' are not the same thing. Fire rotation is the length of time necessary for an area equal to the entire area of interest to burn. Fire return interval (implied by 'every 5 years') is the period of time between fires at a given point, or the arithmetic average of all fire intervals in a given area over a given time period. The 4FRI analysis does not discuss fire rotation, as it is not relevant to the analysis. The preferred average fire return interval in the ponderosa pine in the project area is 10 years. This is supported by the preponderance of published scientific literature (see Fire Ecology Report pg. 48).

A final contention related to using Baker 2009 and Campbell 2012 in the context of fuel treatments. Regarding Baker (2009), if all else is the same (surface fuel loading, etc.), we agree there can be more intense fire in an area that is thinned. The following is from the Fire Ecology report (pp. 28–29): "Reducing canopy fuel loading may increase surface fire behavior because more wind and sunlight can reach the surface, however overall fire behavior is more significant:

"Modifying canopy fuels as prescribed in this method may lead to increased surface fire intensity and spread rate under the same environmental conditions, even if surface fuels are the same before and after canopy treatment. Reducing CBD to preclude crown fire leads to increases in the wind adjustment factor (the proportion of 20-foot windspeed that reaches midflame height). Also, a more open canopy may lead to lower fine dead fuel moisture content. These factors increase surface fire intensity and spread rate. Therefore, canopy fuel treatments reduce the potential for crown fire at the expense of slightly increased surface fire spread rate and intensity. However, critical levels of fire behavior (limit of manual or mechanical control) are less likely to be reached in stands treated to withstand crown fires, as all crown fires are uncontrollable. Though surface intensity may be increased after treatment, a fire that remains on the surface beneath a timber stand is generally controllable" (Scott 2003). However, following prescribed fire, surface fuel loading would be lower, effectively decreasing the potential fire intensity."

Campbell et al. 2012 evaluated the effects of fuel treatments and wildfire on forest C stocks. With the exception of 535 acres of fuel reduction in a WUI area, the 4FRI is proposing restoration treatments, not fuel treatments. They state: "…removing fine canopy fuels (i.e. leaves and twigs) practically necessitates removing the branches and boles to which they are attached, conventional fuel-reduction treatments usually remove more C from a forest stand than would a wildfire burning in an untreated stand..". The treatments proposed in the 4FRI are not at all 'conventional fuel-reduction' treatments. They are restoration treatments which are designed to produce and/or promote multi-story/multi-age stands.

Current Conditions and Trends

Southwest Climate Influences

Only a summary of the Southwest climate influence is described here as the "Southwestern Region Climate Change Trends and Forest Planning" (USDA FS 2010) is incorporated by reference. The climate of the southwestern United States is often referred to as dry and hot; however, it is very complex. While low deserts of the Southwest experience heat and drying winds in the early summer, forested mountain areas and plateaus may experience cold and drifting snow during winter. Climate variability is the norm within this region, as temperature and precipitation fluctuate on time scales ranging from seasons to centuries. The major feature that sets climate of the Southwest apart from the rest of the United States is the North American Monsoon, which, in the U.S., is most noticeable in Arizona and New Mexico. Up to 50 percent of the annual rainfall of Arizona and New Mexico occurs as monsoonal storms from July through September (Sheppard et al. 2002, USDA FS 2010).

While many factors influence climate in the Southwest during a particular year or season, predictable patterns hold across the years and decades to define the region's climate. In summary:

- The overall aridity relates to a global circulation pattern known as Hadley circulation, which creates a semi- permanent high-pressure zone over the Southwest.
- Relatively high temperatures with dynamic daily swings define this geographic region.
- Mountains and other differences in elevation affect local climate patterns.
- The North American Monsoon works to bring moisture from the tropics into the region during the summer months (USDA FS 2010).

Based on current projections, the primary regional level effects of climate change most likely to occur in the Southwest include: warmer temperatures, decreasing precipitation, decreased water availability with increased demand, and, increased extreme disturbance events. These climate change factors could, in turn, affect ecological, weather related disturbances, and socioeconomic demands, including increases in:

- Frequency of extreme weather events (intense storms),
- Wildfire risks
- Outbreaks of insects, diseases, and spread of nonnative invasive species,
- Water scarcity coupled with increased demand,
- National forest socioeconomic uses and demands, and,
- Changes in habitat quality and quantity for certain desired wildlife and plant species (USDA FS 2012).

Climate Change Threats to Local Resources

The purpose of the 4FRI project is to reduce the threats to resources that would be intensified with climate change. Currently, over 50 percent of the forested acres in the project area have reduced resiliency. Reduced resiliency increases the potential for severe effects from wildfire, density-related mortality in trees, and reduced resiliency to insect and disease. Currently, over 38 percent of the project area could sustain high-severity effects from crown fire. Treatments have been designed to increase forest resiliency and sustainability. Resiliency should increase the ability of the ponderosa pine forest in the project area to survive natural disturbances such as fire, insect and disease and the extreme weather events associated with climate change. Some resources at risk in the project area include rare and endemic plants, soil and watersheds, recreation settings, carbon storage, andnoxious weeds.

Rare and Endemic Plants: As environmental conditions change, the ability of rare and endemic plant species to adapt may be negatively affected. Water availability may decrease in some areas while temperatures generally increase. Climate change coupled with other factors such as habitat loss could lead to extirpations and increased risks of extinction.

Soils and watersheds: Uncharacteristic wildfires could result in a loss of soil productivity and sediment delivery to connected streamcourses. Decreased soil moisture due to less precipitation expected from climate change and impaired or unsatisfactory soil conditions from wildfire events may lead to an overall decrease in long-term soil productivity. There may also be a loss of sequestered carbon through burning of the overstory and through increased erosion rates.

Recreation Settings: Desired recreation setting characteristics such as large, mature trees, healthy understory, and diversity of tree age classes, sizes, and species would be at high risk from the effects of climate change. Unmanaged forests have shown increases in tree stress and mortality as a result of global warming, and old, mature trees are especially vulnerable (Ritchie 2008, VanMantgem et al 2009, Williams et al 2010).

Burn Frequency and Carbon Storage: Woods et al. (2012) found that, although burn frequency affected the rate and total amount of carbon storage in a ponderosa pine forest, both 20 year and 10 year fire return intervals produced forests that were net carbon sinks, while the no action alternative forest became a net carbon source. Figure 51 displays carbon storage per acre comparing a no action 'baseline' scenario with 10 and 20-year fire return intervals in a ponderosa pine forest of northern Arizona (adapted from Woods et al. 2012).

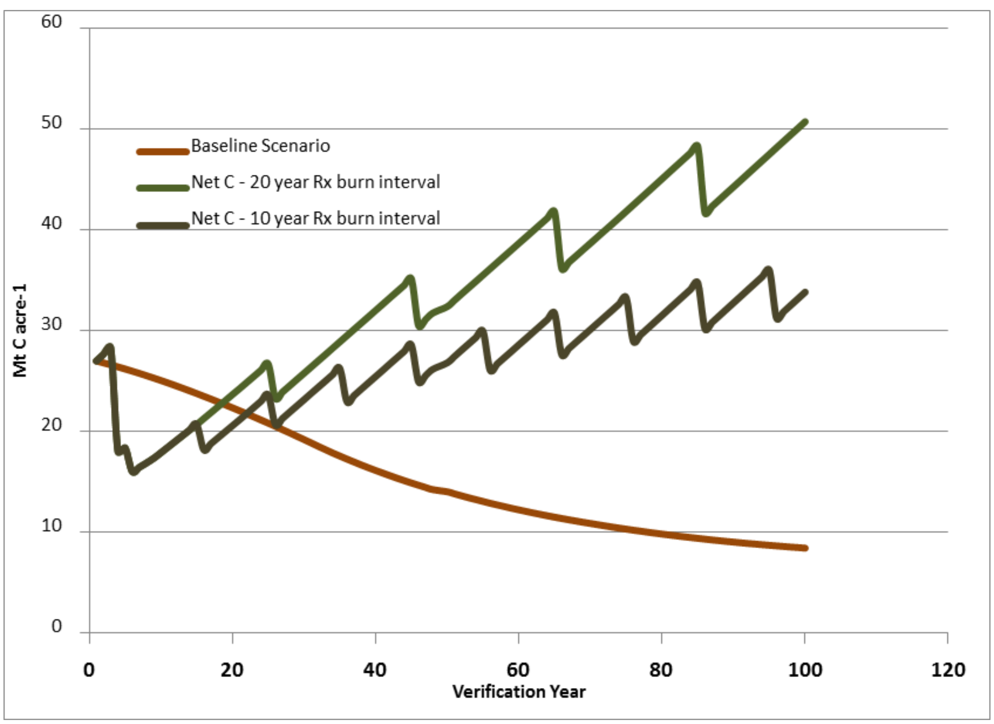

Figure 51. Carbon storage per acre comparing the no action baseline scenario with 10- and 20-year fire return intervals (Woods et al. 2012)

Noxious Weeds: Climate change is expected to be a source of widespread disturbances; and, disturbance is a major factor in noxious weed invasions. Higher temperatures would occur and precipitation cycles would be modified from current patterns over large areas.

Strategies to Address Climate Change

In 2010, The Nature Conservancy hosted a series of climate change workshops with the objective being to address climate change questions related to forest and wildlife health and impacts to communities within the 4FRI area. Long-term (2040 to 2060), high priority strategic recommendations from the workshop included thinning to create a mosaic of clumps and groups of trees with intermixed openings, treat more acres with prescribed burns, and allow more wildland fire to burn (see wildlife report).

This is in alignment with the strategy developed by the Southwestern Region of the Forest Service (USDA FS 2010). Actions to address climate change are those that:

- Enhance adaptation by anticipating and planning for disturbances from intense storms,
- Reduce vulnerability by restoring and maintaining resilient native ecosystems,
- Increase water conservation and plan for reductions in upland water supplies,
- Anticipate increases in forest recreation,
- Use markets and demand for wood and biomass for restoration, renewable energy, and carbon sequestration, and,
- Monitor climate change influences.

The 4FRI project encompasses several of the strategies to address climate change including (but not limited to) creating groups of trees with openings, returning fire to the landscape, and improving soils and watershed conditions.

Environmental Consequences

The scope of this analysis is confined to the project area which encompasses almost one million acres. This scale is most relevant to the questions (USDA FS 2009) addressed by the analysis:

1. How would climate change affect movement toward the project’s purpose and need which focuses on restoring function and resiliency to the ecosystem? The indicators are:
    - ♦ Qualitative assessment of how the indicators of climate change would affect vegetation, fire risk and behavior, rare and endemic plants, noxious weeds, soil productivity and watershed function, wildlife species and habitat, and socio-economic use and demand including grazing and recreation.
2. How would the project impact climate change in terms of storing or releasing carbon into the atmosphere? The indicator is:
    - ♦ Short-term and long-term emissions and alterations to carbon cycle caused by mechanical treatments and use of prescribed fire.

Alternative A

In alternative A, forest plans would continue to be implemented. For vegetation resources, under the projected future climate conditions, the dense forest conditions resulting from the no action alternative would be at a high risk of density-related and bark beetle mortality. Vegetation would have limited resilience to survive and recover from potential large scale impacts. Under drier and warmer weather conditions, the potential impacts of these risks to ecosystem would be increased. Carbon stocks would remain high.

Individual tree growth would be low to the point of stagnation. As tree density increases, many areas would experience higher mortality (release of carbon) than growth (carbon storage). This trend would result in areas becoming a carbon source to the atmosphere (see silviculture report).

Although fire-excluded forests contain higher carbon stocks, this benefit is outweighed in the long term by the loss that would be likely from uncharacteristic stand-replacing fires if left untreated (Hurteau et al. 2011). In alternative A, 34 percent of the area would have the potential for high-severity fire effects from crown fire. Large-scale fire events that could occur with no treatment (alternative A) could release significant amounts of carbon into the atmosphere. Kolb et al. (2007) have shown that biomass and carbon may fail to recover. The Horseshoe Fire (on the Kaibab NF) was still a net carbon source fifteen years after the fire (figure 52 and figure 53). Savage and Mast (2005) showed that these conditions can persist for decades (see fire ecology report).

Figure 52. 15 years after the Horseshoe Fire (photo from November 2011)

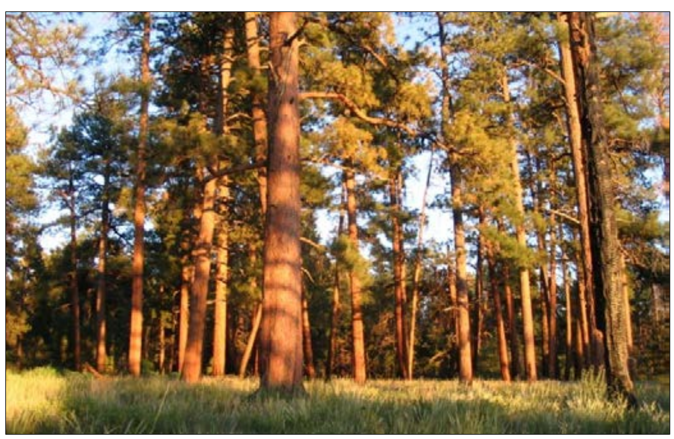

Figure 53. Healthy ponderosa pine forest

Alternative A would not improve the ability of rare and endemic plant species to adapt to suitable areas. Climate change coupled with other factors such as habitat loss could lead to extirpations and increased risks of extinction.

Approximately 38 percent of the project area would be at risk from severe high effects from crown fire. Larger and more frequent fires would be expected (Marlon et al. 2009). Climate may favor the spread of invasive exotic grasses into arid lands where the native vegetation is too sparse to carry a fire. When these areas burn, they typically convert to non-native monocultures and the native vegetation is lost (USDA FS 2010).

Implementation of alternative A would put soils and watersheds at risk of continued uncharacteristic wildfires that could result in loss of soil productivity and sediment delivery to connected streamcourses. Soil erosion models indicate that approximately 24 percent of all soils left untreated could be subject to soil erosion above tolerable levels from severe wildfires if all soils burned under condition of high burn severity (see water quality and riparian report).

In alternative A, approximately 166,897 acres of current and ongoing vegetation treatments and 195,076 acres of prescribed fire projects would continue to be implemented adjacent to the treatment area. Approximately 43,041 acres of vegetation treatments and 58,714 acres of prescribed fire and maintenance burning would be implemented adjacent to the treatment area by the Forests in the foreseeable future (within 5 years). Alternative A does not contain thinning activities that would open the canopy and allow for improved soil condition and productivity in about 600,000 acres of the project area. Within these acres, long-term soil productivity is not expected to be improved from the beneficial effects from an increase in grass species that corresponds to a larger root network essential in loosening up and improvement of soil structure and promotes better water infiltration, air exchange, and soil microbial cycling of nutrients. Water storage in soil is not expected to improve and with an expected decrease in precipitation as is predicted with climate change, there would be less water available to plants.

In the no action alternative under drier and warmer weather conditions, individual tree growth would be limited to the point of stagnation. As tree density increases, many areas would experience higher mortality. Wildlife species requiring closed canopy forest conditions or old or large tree, snag, and log structure would be negatively impacted in the long-term. Open forest, savanna, and meadow and grassland habitats would potentially increase in the long-term (see wildlife report).

For uses such as authorized grazing, allotment use is managed to respond to seasonal and annual changes in forage production. Increased temperatures combined with decreased precipitation could lead to lower plant productivity and cover, which in turn could decrease litter cover. In the past, to address drought, some allotments were completely destocked while others were reduced to as little as 20 percent stocking. Allotment management would change as forage productivity changes from climate (see range report).

For recreation resources, climate change was only evaluated as part of cumulative effects. In alternative A, increased tree mortality and loss of large, mature trees would result in a cumulative decrease in recreation settings within the project area.

Alternatives B, C, D and E

Under projected, future climate conditions, restoration treatments (e.g., mechanical treatment, prescribed fire) in alternatives B, C, D and E would promote low-density stand structures, characterized by larger, fire-resistant trees (see silviculture specialist report). Mechanical treatment and prescribed burning would help to mitigate the negative impacts of stand replacing fire in dry, dense forests, by consuming less biomass and releasing less carbon into the atmosphere (Finkeral and Evans 2008, Wiedinmyer and Hurteau 2010).

Some of the carbon within the estimated 366,159,029 cubic feet (alternative B) to 367,737,166 cubic feet (alternative E) of biomass removed by mechanical thinning would be sequestered for a time in the form of building materials (silviculture specialist report). This assertion is supported by Ryan et al. (2010) who found that wood products which substitute standard building materials such as steel and concrete produce far less greenhouse gas emissions during their production while simultaneously sequestering carbon (Fire Ecology Report). Finkeral et al. found that while the treatment initially produced a 30 percent reduction in the carbon held in trees, it significantly reduced the threat of an active crown fire, which they predicted would kill all the trees and release 3.7 tons of carbon per acre in any untreated areas.

Alternatives B through E reduce the potential for high-severity effects from crown fire by about 25 percent (alternative C) when compared to alternative A. Mechanical treatment and prescribed fire that produce only low-to-moderate severity effects would reduce on-site carbon stocks and releases carbon into the atmosphere at a lower rate than high-severity fire.

The low-to-moderate effects that would result from alternatives B through E should afford for greater carbon storage in southwestern fire-adapted ecosystems over time (Hurteau and North 2009). Research by Hurteau and North (2009) has also shown that the long-term gains acquired through prescribed fire and mechanical thinning outweighs short-term losses in sequestered carbon. In the long term (e.g., 100 years) thinning and burning would create more resilient forests, less prone to stand-replacing events, and subsequently, able to store more carbon in the form of large trees.

For rare and endemic plant species, the actions proposed in alternatives B through E would provide more resiliency to local vegetative communities (see silviculture and wildlife understory analysis), restore natural fire regimes and reduce the risk of habitat loss due to severe high effects (see fire ecology report). These actions are particularly important to all endemic species analyzed with one exception, Bebb’s willow (see botany report).

In alternatives B through E, potential increase/spread of noxious or invasive weeds caused by disturbance would be reduced to a nonsignificant level by incorporating the mitigations, BMPs, and noxious or invasive weed treatments for the project. Increasing forest resiliency and function within the project area would diminish the impacts of climate change.

To realize a management based net gain in soil carbon, there must be an increase in carbon entering the soil through a productivity increase over current levels or a decrease in decomposition and erosion (Neary et al. 2002). Productivity in arid forest ecosystems is low due to moisture limitations and the decomposition rates are among the lowest in the continental U.S. (Neary et al 2002), which is true for this project area.

It is likely that the forests within the project area have more stored carbon than pre-European settlement due to a change in stored carbon from understory to stand level tree productivity (Neary et al. 2002). As stated above, heavily stocked sites are subject to rapid removal of stored carbon through wildfires. The action alternatives propose removal of dense vegetation on about 384,966 acres in alternatives B and D and up to about 431,049 acres in alternative C. This is expected to actually decrease the amount of carbon sequestered over current stand conditions, but the harvest action will convert the existing stored carbon on-site to below ground storage, thus reducing its potential loss from wildfire (Neary et al. 2002). Implementation of alternatives B through E would reduce the risk of uncharacteristic wildfire that could result in loss of soil productivity, downstream water quality and watershed function, as well would improve overall soil productivity in the long-run through increased understory vegetation. The increase in ground cover of grasses, forbs, and shrubs, which have higher fine root turnover rates than large woody plants would result in greater soil organic matter content over time.

The thinning, under the action alternatives, would improve soil condition and productivity for soil infiltration and nutrient cycling because an increase in grass species corresponds to a larger root network essential in loosening up and improvement of soil structure and promotes better water infiltration, air exchange and soil microbial cycling of nutrients thus improving the ability of the soil to store water which would mitigate the potential loss of overall net-precipitation that is expected with climate change. Decomposition rates are also likely to increase with a grass/forb ecosystem compared to a lignin based forest ecosystem, so there may be an increase loss of soil carbon after treatments as the site transitions to a grass/forb understory. Erosion is expected to decrease across the site with the removal of approximately 860 miles of roads and the reduced risk of stand replacing wildfires and the expected increase in soil productivity, thus potentially increasing carbon storage on-site. Neary et al (2002) suggests that “perhaps the best Carbon sequestration strategy in these inherently low productivity ecosystems is to return their structures to within their historical range of variability”. The action alternatives would move toward a more sustainable carbon sequestration scenario for the project area, especially for soil carbon. Carbon sequestration is a means to counter expected human impacts that exacerbate climate change.

Risks associated with dense forest conditions would be reduced and forest resiliency large-scale disturbance under drier and warmer conditions would be improved by implementing the treatments proposed under alternatives B through E. The increased acres of mechanical and prescribed burning in alternative C would be expected to increase forest health and resiliency more than the alternatives B or D. Individual tree growth would improve, resulting in larger average tree sizes. Wildlife species requiring habitat elements associated with closed canopy forest conditions or old or large tree, snag, and log structure would be more sustainable as forest resiliency improved. Open forest, savanna, and meadow and grassland habitats would remain stable in the long-term (wildlife specialist report).

Alternatives B through E would increase forage in most allotments in the project area. Collectively, there would be the no discernible additive (adverse) effects or benefits that were offset by the increase in forage, decrease in moisture, or increase in temperature. Livestock grazing would continue to use adaptive management to match forage production with livestock numbers in a grazing management system (see range specialist report).

For recreation resources, climate change was only evaluated as part of cumulative effects. Alternative B through E, as well as other restoration projects, would cumulatively result in improved forest structure, composition and diversity and more resilient forest conditions, decreased tree stress and potential for decreased mortality. This would reduce the risk of losing desired recreation setting characteristics such as large, mature trees, healthy understory, and diversity of tree age classes, sizes, and species.

The cumulative effects for climate change are incorporated into each resource’s analysis. See the individual resource sections in chapter 3 of this FEIS.

Short-term Uses and Long-term Productivity

NEPA requires consideration of “the relationship between short-term uses of man’s environment and the maintenance and enhancement of long-term productivity” (40 CFR 1502.16). As declared by the Congress, this includes using all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans (NEPA Section 101). This disclosure focuses on soil, water, and vegetation resources.

Soils and Water

Overall, ponderosa pine, aspen, and grassland restoration along with other proposed treatments including prescribed fire would be expected to increase ecosystem resiliency to uncharacteristic fire and move soils and watersheds toward satisfactory and functional condition in both the short and long term and maintain or improve long-term soil productivity and water quality (see soils specialist report and water quality and riparian specialist report).

Vegetation

Short-term effects of tree removal and prescribed fire would reduce inter-tree competition, and free up growing space for residual trees and understory vegetation. Under all alternatives, the proposed actions and associated design features would not affect long-term productivity of forest vegetation and timber resources (see silviculture specialist report).

Unavoidable Adverse Effects

Alternatives B, C, D and E

All action alternatives would result in some unavoidable short-term adverse effects on threatened and endangered species and critical habitat, short term adverse effects on candidate species, proposed species and their critical habitat, sensitive species (individuals), water quality (short term), air quality (short term, during prescribed fire activities), and recreation settings and scenery (short term). However, all alternatives include design features, mitigation measures, and best management practices (FEIS appendix B) that would reduce these adverse effects to the extent practicable while still achieving project objectives.

Irreversible and Irretrievable Commitments of Resources

Irreversible commitments of resources are those that cannot be regained, such as the extinction of a species or the removal of mined ore. Irretrievable commitments are those that are lost for a period of time such as the temporary loss of timber productivity in forested areas that are kept clear for use as a power line rights-of-way or road.

An irretrievable commitment of resources is associated with alternative A. In alternative A there is the likelihood that there would be additional larger fires with larger areas with higher severity fires than occurred historically. Post-fire effects that require decades of recovery would be irretrievable in the short term and potentially the long term. For example, topsoil which is critical to healthy surface vegetation would take centuries to recover. The loss of old growth and old trees would be irretrievable as it would require decades and centuries to recover. When considered with climate change, it is unknown exactly what the ecological trajectory would be for the replacement of old growth and old trees (see fire ecology report).

Cumulative Effects

A summary of past, present, and reasonably foreseeable management actions and natural disturbances that were evaluated by most resources is located in appendix F of this FEIS. See the project record for the comprehensive master list of all projects and for additional information on each project. Site-specific cumulative effects analyses are displayed in chapter 3 by resource.

Other Required Disclosures

NEPA at 40 CFR 1502.25(a) directs "to the fullest extent possible, agencies shall prepare draft environmental impact statements concurrently with and integrated with other environmental review laws and executive orders."

- Clean Water Act (CWA) Section 404 outlines the permitting process for dredging or discharging fill material into waters of the U.S., including wetlands. CWA Section 401 allows states and tribes to review and approve, set conditions on, or deny Federal permits (such as 404 permits) that may result in a discharge to state or tribal waters, including wetlands. To implement springs, streams, and temporary road construction and decommissioning, obtain a 404/401 permit from the U.S. Army Corps of Engineers.
- Coordinate with ADEQ and obtain water quality certification from ADEQ as needed prior to project implementation.
- In accordance with the legal requirements set forth under Section 7 of the Endangered Species Act ([ESA] 16 U.S.C. 1536 (c)), formal consultation was conducted with FWS and a biological opinion was received on October 20, 2014. Continue coordination with FWS throughout project implementation as treatments are completed and effects monitored.
- Initial concurrence from Arizona State Historic Preservation Office (AZ SHPO) was received in accordance with Section 106 of the National Historic Preservation Act. Per the Programmatic Agreement with AZ SHPO, there will be continued coordination and clearances conducted for each action proposed during implementation.
- Per agreement with affected tribes, coordination with federally recognized tribes would occur prior to initiating project-specific task orders to identify traditional use areas and, if necessary, develop project-specific mitigation measures to accommodate traditional use of the forest by tribal members.
- All burning would be coordinated daily with the Arizona Department of Environmental Quality (ADEQ). Burning would not take place on any portion of the project without prior approval from ADEQ.

Compatibility with Goals of Other Local, State and Federal, Governments

As part of the collaborative effort, the Forests have engaged other local, state, federal and tribal governments since 2011. At a local governmental level, the project is not in conflict with City of Flagstaff, Williams, Tusayan and Sedona goals or plans. The cities have received project updates since 2011 (see project record). Community Wildfire Protection Plans (CWPP) for Flagstaff, Williams and Tusayan informed the project's purpose and need for action. Treatments were designed to be in alignment with CWPP objectives. The project is in alignment with the goals of Coconino County which seeks to reduce the risk of high-severity fire and protect community watersheds. Coconino County has expressed support for the project since 2011 (see project record). Since 2011 the Coconino Natural Resource Conservation District (DEIS CARA 176) and Flagstaff Fire Department (DEIS CARA 40) have been stakeholders and have provided comments. Although not directly affected by the project, eastern Arizona counties have commented on the project since 2011. Counties including Navajo, Apache, Graham, Greenlee and Gila commented on the DEIS and provided a review of how the project aligns with county goals and plans (DEIS CARA 184, 76, 89, 174, 163, 164, 158,). The counties had specific comments and recommendations but overall concluded the project was not in conflict with county goals and objectives. At the State level, the Arizona Department of Game and Fish was designated as a cooperating agency for the project in 2012 and has continued to support the project (DEIS CARA 113). The Arizona State Forestry Division has been a stakeholder since 2011 and has provided comments and recommendations since scoping (DEIS, CARA 166). Federal agencies including the Bureau of Land Management (scoping comment) and the National Park Service (DEIS, CARA 118) and did not identify conflicts. Tribal consultation was initiated in 2011. No conflicts with tribal plans or goals have been identified (tribal relations report).

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Chapter 4. Consultation and Coordination

Introduction

This chapter lists all tribes, organizations and Federal, State, and local government agencies and other parties consulted during the development of the environmental impact statement. Arizona Game and Fish Department is a cooperating agency. This chapter also lists those who commented during the formal draft environmental impact statement (DEIS) comment period. All parties listed in this chapter were provided the final environmental impact statement (FEIS). Distribution methods include paper copies, DVDs, and electronic documents posted on the 4FRI Web site: http://www.fs.usda.gov/4FRI.

Tribal Consultation

The following tribes and tribal chapters who have historic ties and an interest in the Coconino and Kaibab National Forests were consulted with and include: Kaibab Band of Paiute Indians, Navajo Nation including Coppermine, Coalmine, Naness, Lechee, Leupp, Bodaway, Cameron, Tuba City, Dilkon and Tolani Lake Chapters, Kaibab Band of Paiute Indians, San Juan Southern Paiute, White Mountain Apache, Yavapai-Apache Nation, San Carlos Apache, Hualapai, Yavapai-Prescott Indian Tribe, Havasupai, Tonto Apache, Pueblo of Zuni, Pueblo of Acoma, Hopi, and Fort McDowell Yavapai Nation.

Federal, State, and Local Agencies and Representatives

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APHIS PPD/EAD, Riverdale, MD

Director, Planning and Review, Washington, DC

Chief of Naval Operations and Environmental Readiness Division

OEPC, Director, Washington, DC

U.S. Coast Guard, Office of Environmental Management, Washington, DC

FAA, Western Pacific Region, Lawndale, CA

NRCS, National Environmental Coordinator, Washington, DC

National Agricultural Library, Acquisitions and Serials Branch, Beltsville, MD

NOAA Fisheries Southwest Region, Habitat Conservation Division, Long Beach, CA

U.S. Army Corps of Engineers, South Pacific Division CESPD-CMP, San Francisco, CA

U.S. EPA, Region IX, San Francisco, CA

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USDI Fish and Wildlife Service, Flagstaff, AZ

USDI National Park Service, Flagstaff, AZ

State

Arizona Department of Environmental Quality, Phoenix, AZ

Arizona Game and Fish Department, Flagstaff, AZ – Cooperating Agency

Arizona Department of Transportation

Arizona State Fire

Arizona State Forestry Division, Flagstaff, AZ
Arizona State Historic Preservation Office
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City of Flagstaff, Flagstaff, AZ
Clarkdale Fire Department, Clarkdale, AZ
Coconino City Council, Flagstaff, AZ
Coconino County Supervisor, Flagstaff, AZ
Flagstaff City Council, Flagstaff, AZ
Gila County, Silver City, NM
Graham County, Safford, AZ
Greenlee County, Clifton, AZ
Mountainaire Community Council, Flagstaff, AZ
Navajo County, Holbrook, AZ
Sedona City Council, Sedona, AZ
Tusayan City Council, Tusayan, AZ
Williams City Council, Williams, AZ
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Commenters on the DEIS

Below are the names of all those who commented on the DEIS **during the formal comment period**.

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Apache County
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Arizona Department of Environmental Quality – Water Quality Division
Arizona Elk Society
Arizona Game and Fish Department
Arizona State Forestry
Arizona Wildlife Federation
Bellmont Home Owners Association
Center for Biological Diversity
Coconino County
Coconino County NRDC
Conservation Congress
Department of the Interior – Office of Environmental Policy and Compliance (US FWS)
Eastern Arizona Counties Organization
Environmental Protection Agency – Region IX
Flagstaff Fire Department
Four-Forest Restoration Initiative Stakeholders
Friends of Northern Arizona
Friends of Walnut Canyon
Gila County
Graham County
Grand Canyon Trust
Grand Canyon Wildlands Council
Greater Flagstaff Forest Partnership
Great Old Broads for Wilderness
Greenlee County
John Muir Project and Center for Biological Diversity
National Park Service – Wupatki, Sunset Crater and Walnut Canyon
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The following personnel (table 102) were directly involved with preparation of the final environmental impact statement (FEIS).

Table 102. 4FRI FEIS Coconino and Kaibab NF preparers and contributors

Name	Title	FEIS Contribution	Education and Experience
Annette Fredette	4FRI Team Leader, Planner	Interdisciplinary Team Leadership and Planner	B.S., Forestry, Northern Arizona University, 1988, Years of Experience: 26
Bill Noble	Wildlife Biologist, 4FRI Team	Terrestrial wildlife	M.S., Wildlife Sciences (major) and Forest Sciences (minor), Oregon State University, 1994; B.S., Wildlife Biology, University of Montana, 1985. Years of Experience: 24
Cary Thompson	Wildlife Biologist, Coconino NF	Forest Service sensitive wildlife species	B.S., Biology, Fish and Wildlife Emphasis, Northern Arizona University, 1995. Years of Experience: 19
Charlotte Minor	Forest Recreation Program Manager, Coconino NF	Scenery, Recreation	M.S., Landscape Architecture, University of Arizona, 1990; B.S., Forestry, Northern Arizona University, 1981. Years of Experience: 24
Chirre Keckler	Forest Wildlife Biologist, Kaibab NF	Forest Service MIS and Migratory Birds	B.S., Wildlife Management, Northwestern State University, 1984. Years of experience: 25
Craig Johnson	Forest Tribal Liaison, Coconino NF	Tribal Consultation	M.A., Applied Archeology, Northern Arizona University, 1998. Years of Experience: 15
Daniel Kipervaser	4FRI Monitoring Coordinator	Adaptive Management and Monitoring Plan	M.S., Ecology, Colorado State University, 2007; B.S., Biology and Environmental Policy, Colby College, 1998. Years of Experience: 12
Dave Gifford	Archeologist, U.S. BOR	Heritage Resources	B.S., History, Arizona State University, 1988. Year of Experience: 20
Deborah Crisp	Coconino NF Botanist	Botanical Resources	M.S., Forestry, Northern Arizona University, 2004. Years of Experience: 32
Delilah Jaworski	Social Scientist, TEAMS	Socioeconomics	M.S., Environment and Development, London School of Economics, 2008. Years of Experience: 6
Dick Fleishman	4FRI Assistant Interdisciplinary Leader	Soils, Watershed, Transportation, Operations	M.S., Public Administration, Northern Arizona University, 1990; B.S., Forest Management, Northern Arizona University, 1980. Years of Experience: 34

Name	Title	FEIS Contribution	Education and Experience
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Henry Provencio	Former Interdisciplinary Leader, 4FRI Team	Interdisciplinary Leadership	B.S., Wildlife Conservation Biology, Arizona State University, 1997. Years of Experience: 24
Julie Rowe	Special Uses Program Manager, Red Rock District, Coconino NF	Lands and Special Uses	B.A., University of California, Santa Cruz, 1992. Years of Experience: 15
Christopher (Kit) MacDonald	Forest Soil Scientist, Kaibab NF	Water Quality and Riparian	Ph.D., Forestry with soil emphasis coursework, Stephen F. Austin University, ongoing. M.S., Forestry with soil science emphasis, Stephen F. Austin University, 1999. Years of Experience: 25
Margaret Hangan	Kaibab NF Heritage and Tribal Relations Program Manager	Heritage Resources	M.A., Anthropology, California State University, Bakersfield, 2003; B.A., Anthropology, Pitzer College, 1989. Years of Experience: 16
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