# Wildlife Specialist Report and Biological Evaluation

## Four-Forest Restoration Initiative Coconino and Kaibab NF Environmental Impact Statement


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# Introduction

This report documents existing and desired ecological conditions, proposed alternatives to address the difference between existing and desired conditions, and analyses of the effects of those alternatives on species of status. Status species include: threatened, endangered and proposed species and their critical habitats listed under the Endangered Species Act of 1973, as amended (ESA); Region 3 Sensitive Species (updated in 2013); Management Indicator Species (MIS; MIS for the Kaibab National Forest [NF] were updated in 2014); and Migratory Birds and their habitats for the Four Forest Restoration Initiative (4FRI) treatment area, Coconino and Kaibab NFs. Regulatory requirements for effects analyses and determinations were met using the best available science, collective expertise of local professionals, reviews and evaluations of habitat conditions as reported in the methodology section, and professional judgment. Status of and effects to wildlife are described in this report by species and/or species assemblages.

The desired condition resulting from implementation of the 4FRI is to re-establish 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). The objective of these analyses is to identify how well the proposed alternatives would accomplish this and thereby change forest resiliency and function. Resiliency increases the ability of the ponderosa pine forest to survive natural disturbances such as insects, disease, fire, and climate change. This project should put treated forests on a trajectory towards comprehensive, landscape-scale restoration with benefits that include improvements in vegetation communities, soil productivity, watershed function, biodiversity, and so improve wildlife habitat.

Detailed descriptions of the alternatives are in the Environmental Impact Statement. Details on the analyses for proposed restoration actions are described in the Silviculture and Fire Ecology specialist reports. This report incorporates these reports by reference.

## Roadmap for Reading This Document

This is an admittedly large and relatively complex document. It is landscape-scaled with site specificity. It addresses habitat conditions for 38 species (including herptofauna, birds, and mammals) under current conditions, future conditions if no management actions are taken, and as affected by each of four action alternatives. The species analyzed here include those listed under the ESA, the Regional Forester’s sensitive species list, management indicator species (MIS) for each forest, migratory birds, one important bird area, and uses guidelines from two NFs. There is law, regulation, and/or policy directing the analysis for each of the species. The purpose of this section is to explain the organization of the document in the hope that this will assist the reader.

This report can be considered as organized into seven distinct sections. From this perspective, the introduction, which is an individual section above with an identifying header (i.e., titled section in the text), can also be considered in a broad sense as including the following headers: Roadmap to Reading This Document (this section), Differences Between the DEIS and the EIS, Analysis Area Location and Description, Applicable Laws, Regulatory Requirements, and Best Available Science. These sections provide the context and direction that frames the rest of the document.

The next section, Methodology, explains the development of components supporting the subsequent analyses. It describes how conclusions were reached or topics developed like the movement and effects of smoke on MSO, how the road-hauling network was developed to minimize disturbance to wildlife, or the creation of a relative index to compare understory response among proposed alternatives.

The Affected Environment section summarizes existing conditions across the landscape. It reviews the existing conditions of the major vegetation types, status of individual species, and stressors on the both species and their habitats. It also includes a review of predicted effects of climate change and how this relates to the 4FRI. The Affected Environment section defines the starting point for estimating vegetation change over time. Each proposed alternative, including the no action alternative, could affect the trajectory of vegetation development in different ways, leading to differences in future forest structure.

The next section, the Description of Alternatives, is straightforward. Each action alternative is described, illustrating both similarities and differences among alternatives. This section also describes the design features developed to safeguard specific habitat elements during implementation (Table 52) and reviews effects from other projects in the vicinity of the 4FRI treatment area.

Environmental Consequences describes the direct and indirect effects of the project on the individual wildlife species. This section is organized by wildlife group, e.g., federally listed species are first, sensitive species are next, etc. Effects by alternative are found within each alternative. Wildlife species are organized by legal or regulatory category to which they belong, e.g., effects to species listed under the ESA are described first, sensitive species are next, etc. Within each category are the individual species and the effects of the alternatives are then reviewed by species. This approach was used because each species list or assemblage has different analysis criteria (i.e., species listed under the ESA are analyzed differently than MIS and others). The Mexican spotted owl (MSO) and northern goshawk analyses are then organized by defined habitat components because for these species each type of habitat (e.g., nesting, foraging, existing, potential, etc.) has particular management guidelines associated with them. The effects of the proposed activities on the species and their habitat are modeled for 2010 (current conditions) immediately after treatment (all treatments are assumed to be completed by the year 2020 for modeling purposes), and in the year 2050. Modeling for 2050 assumed no additional treatments to demonstrate the trajectory for which individual habitat elements would develop. Some differences among alternatives, such as logs, coarse woody debris (CWD), and understory response, are greater immediately after treatment. Other factors, such as overstory development, show greater differences in the year 2050. How the proposed actions would affect each species are summarized by a conclusion statement specific to that species. For example, if a reader wanted to compare the effects of proposed activities in alternatives C and D on existing MSO nesting and roosting habitat, they could navigate the section headers by starting with Environmental Consequences, then Federally Listed Threatened, Endangered, Proposed, and Sensitive Species and Critical Habitat → Mexican Spotted Owls (Threatened) → Alternative C – Preferred Action → Protected Habitat. If interested, they could also look at Other Habitat Effects and Disturbance to learn more about actions within protected habitat. To complete the comparison the reader would then go to alternative D and follow the same series of headers. To pursue this example further, the reader could move from protected to restricted habitat and review that alternative's effects on other components of MSO habitat. Alternately they could go from Environmental Consequences → Federally Listed Threatened, Endangered, Proposed, and Sensitive Species and Critical Habitat → Mexican Spotted Owls (Threatened) → Comparison of Alternatives and review highlights of each alternative's effects on MSO habitat.

The next (and sixth) general section of the document is References. The analysis of direct and indirect effects on each species includes references and information from the scientific literature and other sources of information. The References section lists each literature source used and referenced in the text of this document. There are about 24 pages of citations at the end of this document and most of the papers are from refereed, technical publications.

The last section, the Appendices, has been organized as a separate document because of the size of this report and its supporting appendices. The appendices represent support for the findings, logic track, and conclusions presented here. This section largely displays additional levels of details that would make the narrative more difficult to follow, but which are still pertinent to the analyses. Some of the information shows how individual habitat metrics track at finer levels of detail. Other appendices represent syntheses of literature on particular topics such as spotted owl biology and ecology or effects of overstory development on understory development and the resulting effects to arthropods. These appendices are intended to support discussions in the main text without bogging the reader down in additional levels of tangential detail, but which could still be informative to the reader.

Theoretically, there are readers who would want to read through every page of this document. Other readers may only be interested in the effects to particular species and could track that species through the main sections of the document. A person could skim through the current status of the landscape (Affected Environment), review individual alternatives (Description of Alternatives), and read about effects to a subset of the wildlife species (Environmental Consequences). Any potential reader may develop additional questions and want to dig deeper into the information provided here or find additional sources of information on a particular topic (Literature Cited). The intent is to provide a full analysis of the effects of each proposed action on each relevant species and the documentation to support the conclusions.

# Changes to the Wildlife Report from the DEIS to the FEIS

After reviewing public comments on the DEIS, and addressing changes that have occurred since the analysis for the DEIS was completed, the wildlife specialist report incorporated changes that reflect these updates.

A new alternative was added to the analysis in response to public comments requesting a treatment plan with no forest plan amendments. This was developed as alternative E. Alternative E is now tracked through the document for each individual species.

- The new Revised MSO Recovery Plan was released to the public in December 2012.
- A new Region 3 sensitive species list was released on September 19, 2013. The sensitive species within this document reflects this change.
- Cumulative effect has been updated with new information.
- The US Fish and Wildlife Service (FWS) in the Federal Register (November 1, 2013) changed migratory bird species' scientific names to conform to accepted use and based on new taxonomy. Changes are reflected in the final document.
- 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 MSO protected activity centers (PAC) within the analysis area.

- New 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 Post-fledging Family Areas (PFAs) for goshawks were developed due to the discovery of new nesting areas within the analysis area.
- Portions of the fire behavior modeling were redone to provide more detailed results.
- The Slide Fire burned 2,600 acres of goshawk habitat and over 4,000 acres of MSO habitat within the 4FRI boundary in June, 2014. The fire affected the Casner Canyon and dispersal 23 PFAs. 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 MSO 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 MSO PACs would be monitored and data collection would focus on occupancy, reproductive success, and changes to vegetation.
- 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 March 2014. The revised plan made the following adjustments to this analysis:
    - ♦ Removed the language that was based on the 1995 MSO Recovery Plan and instead states projects should follow the intent of recovery plans.
    - ♦ Habitat requirements for goshawks are built into the desired conditions for ponderosa pine and frequent fire mixed-conifer instead of standards and guidelines.
    - ♦ Changed the MIS list for the forest. The previous MIS list was removed and replaced with a new list.
    - ♦ A rare and narrow endemic species section was added, requiring additional analyses to be added to this document.
    - ♦ Removed the hiding and thermal cover standards and guidelines for deer and elk.
- About 38,256 acres of treatments were identified in comments to the DEIS 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). While this scenario is addressed in the large tree implementation

plan, the FS was requested to modify the proposed treatments in these particular stands. Stands range from four to 344 acres (mean = 36 acres) and include 1,069 total stands. The individual stands are distributed across much of the treatment area (see silviculture report for details). An artifact of selecting for a preponderance of large trees resulted in an average SDI of 281("extremely high density" resulting in competition-induced mortality and stagnating diameter growth – see Table 5). The response to this comment is to manage to the low end of treatment intensity (the dense end of the treatment spectrum) regardless of site-specific conditions. Post-treatment SDI max would be expected to be at the high end of "high density" or the low end of "extremely high density." These acres do not include stands in MSO habitat. Resulting stand structure would move towards even-aged conditions.

# Analysis Area Location and Description

The Forest Service assessed a 988,764 acre analysis area on the Coconino and Kaibab NFs. The result of the assessment is a proposal to conduct restoration activities within a treatment area totaling about 586,110 acres on the Coconino NF and Kaibab NF. About 355,707 acres of treatment would occur on the Coconino NF with most of the work focused on the Flagstaff Ranger District and limited treatments included on the Mogollon Rim and Red Rock Ranger Districts. About 230,402 acres of treatment would occur on the Williams and Tusayan Ranger Districts of the Kaibab NF (Figure 1). For the purposes of this analysis, the analysis area is the larger 988,764-acre unit and the ponderosa pine treatment area is 507,839 acres.

Within the 988,764 acre analysis area, approximately 390,000 acres have been excluded from this proposal. Over 213,090 acres are being analyzed in separate vegetation analyses, over 30,000 acres are located in special areas that include designated wilderness, and over 145,000 acres are non-Forest Service administered lands.

Due to the size of the analysis area, the landscape was divided into six restoration units. A restoration unit (RU) is a contiguous geographic area that ranges from about 46,000 acres to 333,000 acres in size. A need for change (vegetation structure, pattern, spatial arrangement, potential for undesirable fire behavior and effects) was identified for each RU.

RU 1 and 2 include 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 and RU 2 is generally located west of I-17 and south of the Mogollon Rim. Note that no treatments are proposed in RU 2. RU 3 includes portions of the Williams district (Kaibab NF), Flagstaff and Red Rock districts (Coconino NF) and is generally located south of I-40 and west of I-17. RU 4 includes portions of the Flagstaff district and the Williams district. It is generally located north of I-40 and west of Highway 180. Communities in the vicinity of proposed treatments include Flagstaff, Munds Park, Mormon Lake, Tusayan and Williams, Arizona.

Most of this unit is not ponderosa pine. The team further stratified each RU into several sub-units that range from 4,000 to 109,000 acres in size. Both divisions (RU and sub-units) are based on 6th code watershed boundaries, state and forest transportation systems and the Forest's administrative boundaries (Figure 2).

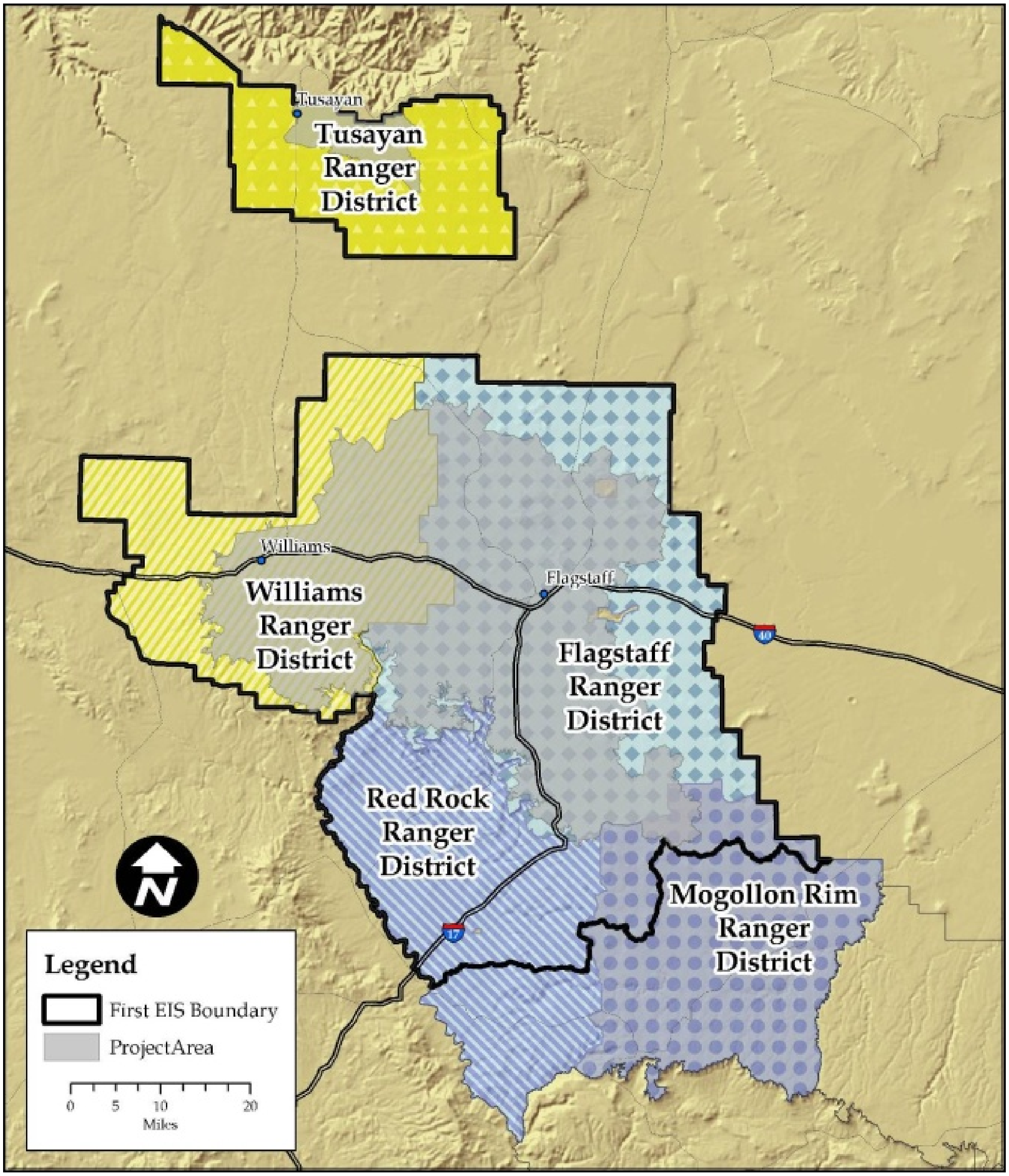


**Figure 1. Coconino NF and Kaibab NF Ranger Districts within the analysis area**

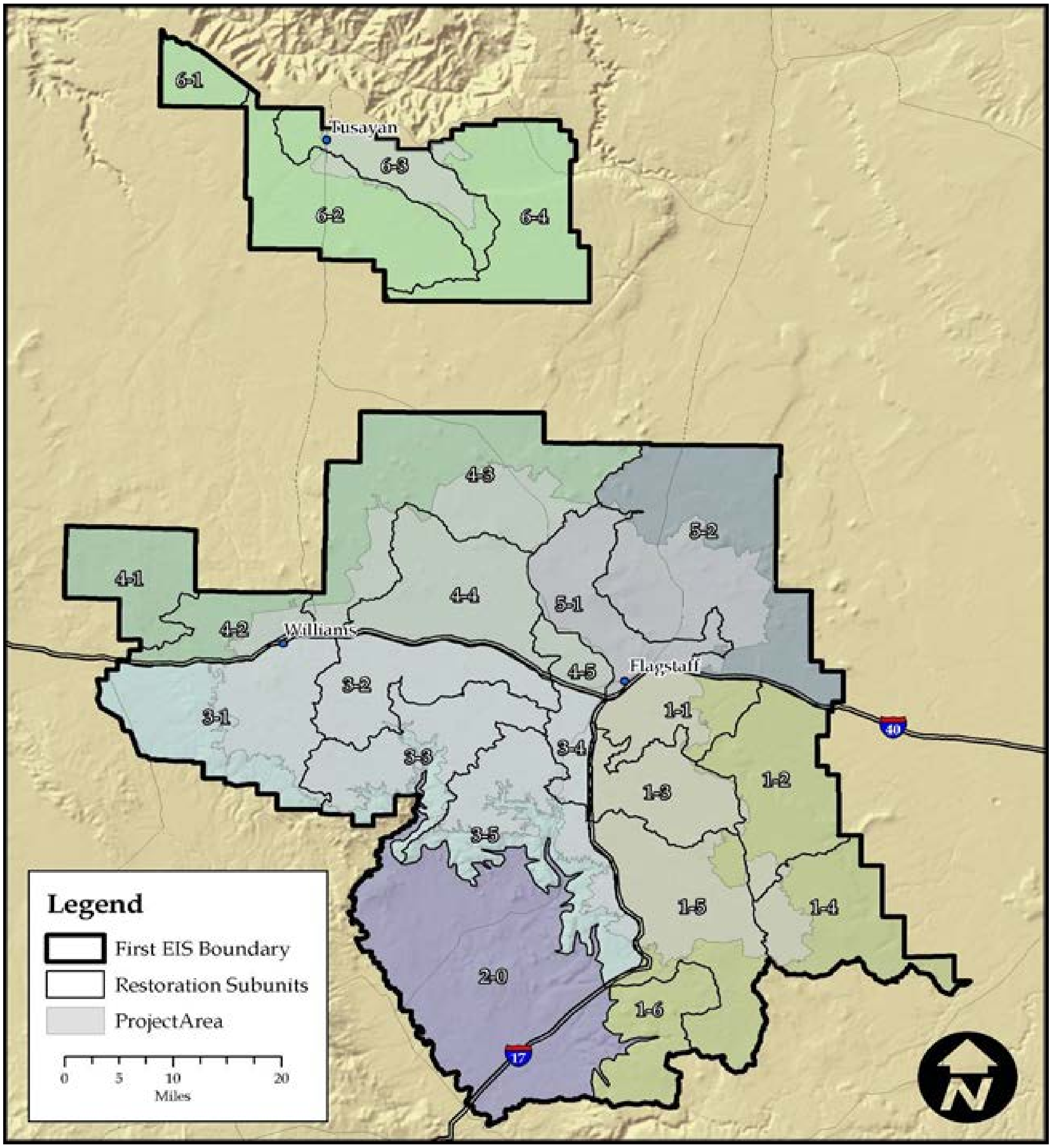


**Figure 2. Restoration Units (1st digit in number codes) and subunits (second digit in number codes) within the project area**

The 4FRI is primarily focused on ponderosa pine forest. The overall objective is to restore or move the forest on a trajectory leading to restoration (see the silviculture and fire ecology reports for details). Within and adjacent to the treatment area are other vegetation cover types. The 4FRI will take advantage of opportunities to improve wildlife habitat within grassland, savanna, and meadows, Gambel oak associations within the pine, aspen, pinyon-juniper woodlands, and springs and ephemeral channels. The term meadow is used in this report to identify grassy openings within ponderosa pine forest. Meadows are essentially grasslands as identified by soil type (i.e., true mollisols) but function differently from grasslands in terms of wildlife habitat. Meadows can be thought of as openings within the forest whereas grasslands are more extensive openings that may contain widely scattered groups or individual trees. Meadows identified in the

4FRI are typically dominated by ponderosa pine trees. Details on vegetation within the project area, the stratification of forested and non-forested land within the project area, and analysis areas by species are described in Methodology. The desired condition is to restore tree density and pattern to the natural range of variability while meeting forest plan requirements, as amended, in MSO and goshawk habitats. Canopy gaps and interspaces would provide adequate space for the development of rooting zones for tree groups and an increase in the grass/forb understory. Canopy gaps and interspaces between tree groups or individuals, based on site productivity and soil type, would range from 10 percent on highly productive sites to as high as 90 percent on those soil types that have an open reference condition. Pre-settlement tree evidence would be used to help determine the historic range of variability in tree densities.

# Applicable Laws, Regulatory Requirements, and Best Available Science

## Regulatory Framework

The Forest Service is legally required to comply with a number of federal laws, regulations, and policy, including: the Endangered Species Act of 1973, as amended (ESA), the Bald and Golden Eagle Protection Act of 1940, as amended, Forest Service Manual (FSM) 2600, the Migratory Bird Treaty Act of 1918 (as amended), Executive Order 13186 (migratory birds), National Environmental Policy Act, 1969, National Forest Management Act, 1976 (as amended), and the Coconino and Kaibab National Forest Land and Resource Management Plans (as amended), 1987 and 2014, respectively.

### Endangered Species Act (ESA)

The ESA directs all Federal agencies to use their authorities to carry out programs for the conservation of listed species. It prohibits Federal agencies from carrying out actions likely to jeopardize the continued existence of species listed under the Endangered Species Act. It further requires federal agencies to consult with the FWS on actions authorized, funded, or carried out by such agencies that may affect listed species and/or their designated Critical Habitat. The ESA requires consultation with the Secretary of the Interior whenever an action is likely to jeopardize the continued existence of any species proposed for listing as threatened or endangered, or whenever an action might result in destruction or adverse modification of Critical Habitat proposed for listing.

The Endangered Species Act (ESA, PL 93-205), Forest Service Manuals (FSM) 2670.11, 2670.21, and 2670.31, and forest plan standards and guidelines all require that National Forest land be managed for both conservation and recovery of endangered, threatened, and proposed (TEP) species. Section 7 of the ESA requires a Biological Assessment (BA) be done by Federal agencies for review by the Secretary of Interior to ensure that agency actions are not likely to jeopardize the continued existence of federally listed species and includes actions that further the conservation of endangered species and threatened species listed pursuant the ESA. FSM 2670 directs Forests to manage habitats to assist in the recovery of TEP species, and to avoid actions "which may cause a species to become threatened or endangered".

### Forest Service Manual (FSM) Direction

The BA was prepared in accordance with FSM direction 2672.42 and meets legal requirements set forth under Section 7 of the Endangered Species Act of 1973, as amended, and implementing regulations [19 U.S.C. 1536 (c), 50 CFR 402.12 (f) and 402.14 (c)] to ensure that Forest Service actions do not contribute to loss of viability of any native or desired non-native plant or animal species, or contribute to trends toward Federal listing of any species; and, to provide a process and standard by which to ensure that threatened, endangered, proposed, and sensitive species receive full consideration in the decision making process.

## Forest Service Sensitive Species

Sensitive species are defined 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 (FSM 2670.5). A primary objective of Forest Service policy is to develop and implement management practices to ensure that species do not become threatened or endangered due to Forest Service actions (FSM 2670.22). Project-level guidance described in FSM 2672.4 was followed:

1. All listed, proposed, and sensitive species known or expected to be in the project area or that the project could potentially affect were identified. Presence was determined by direct observation, ranger district files, and use of the FAAWN database (Patton 2011, see Methodology). The FWS was contacted at the start of the planning process and was involved in project design before project boundaries were even delineated.

2. Occupied and suitable (i.e., potentially occupied) habitat was identified and appropriate vegetation classes defined in the vegetation database. Habitat was summarized by acres for individual sensitive species (see Affected Environment).

3. An analysis of the effects of the proposed action on species and their habitat was conducted for individual sensitive species (see Environmental Consequences).

4. A discussion of cumulative effects resulting from the planned project in relationship to existing conditions and other related projects (see Description of Alternatives and Environmental Consequences).

5. Determinations of no effect, beneficial effect, or "may" effect on the species and the process and rationale for the determination was completed for individual sensitive species (see Environmental Consequences).

6. Design features for removing, avoiding, or compensating for adverse effects is presented in the Description of Alternatives.

7. Many sources of information were used in the development of this biological evaluation. A list of contributors is presented above, data sources are identified in Methodology, literature references are identified in the Literature Cited, and consultation with the FWS is documented in appendix 2.

## The National Forest Management Act of 1976

The National Forest Management Act of 1976 required the Secretary of Agriculture to develop guidelines for land management planning with the individual forest being the planning unit or area. The Act states that “Fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area.” (36 CFR § 219.19). A viable population is defined as “[a population] which has the estimated numbers and distribution of reproductive individuals to insure its continued existence is well distributed in the planning area." (§ 219.19). Therefore, management of viable populations is intended to be accomplished at the individual National Forest level (planning area).

## National Environmental Policy Act of 1969 (NEPA)

NEPA established procedures for decision making, disclosure of effects, and public involvement on all major federal actions. Forest Service Manual 1950.2 requires a consideration of the impacts of Forest Service proposed actions on the physical, biological, social, and economic aspects of the human environment (40 CFR § 1508.14).

## Management Indicator Species (MIS)

Management Indicators are: "Plant and animal species, communities, or special habitats selected for emphasis in planning, and which are monitored during forest plan implementation in order to assess the effects of management activities on their populations and the populations of other species with similar habitat needs which they may represent" (FSM2620.5). Forestwide assessments summarize current knowledge of population and habitat trends for management indicator species on both the Coconino (USDA 2013) and Kaibab (Keckler and Foster 2013) NFs. Additional site specific (Game Management Unit) population information was provided by Arizona Game and Fish Department (AGFD) with their annual survey results.

## Migratory Bird Treaty Act (MBTA)

The MBTA (as amended 1998) implements conventions between the United States and four other countries (Canada, Mexico, Japan, and Russia) for the protection of migratory birds (16 U.S.C. 703). Executive Order (EO) 13186, signed January 10, 2001, imposes procedural requirements on evaluating project level effects on migratory birds with emphasis on state designated priority species. Under this combined direction the FS must identify where unintentional take reasonably attributable to agency action is having, or is likely to have, a measurable negative effect on migratory bird populations. Removal or destruction of vegetation is not considered "take" under the MBTA. Project evaluations should include effects to Important Bird Areas where applicable and be aware of opportunities to restore or enhance migratory bird habitat or mitigate negative project effects.

## Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (Eagle Act), originally passed in 1940, prohibits the take, possession, sale, purchase, barter, offer to sell, purchase, or barter, transport, export, or import, of any bald or golden eagle, alive or dead, including any part, nest, or egg, unless allowed by permit (16U.S.C 668(a) -668(d); 50CFR 22). "Take" is defined as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb" a bald or golden eagle. The term "disturb" under the Eagle Act was recently defined via a final rule published in the Federal Register on June 5, 2007 (72 FR 31332). "Disturb" means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.

All golden and bald eagles are protected under the Eagle Act. Project analysis must determine if take is likely to occur with implementation of the action alternatives. The FWS issued a report titled Interim Golden Eagle Technical Guidance: Inventory and Monitoring Protocols; and Other

Recommendations in Support of Golden Eagle Management and Permit Issuance (Pagel et. al 2010) to protect golden eagles.

## E.O. 13443 Facilitation of Hunting Heritage and Wildlife Conservation

The purpose of this order is to direct Federal agencies that have programs and activities that have a measurable effect on public land management, outdoor recreation, and wildlife management, including the Department of the Interior and the Department of Agriculture, to facilitate the expansion and enhancement of hunting opportunities and the management of game species and their habitat.

## Forest Plans

**Forest Plans (as amended):** Forest plans provide specific goals, objectives, standards, and guidelines for management activities on National Forest lands. The Coconino NF Land and Resource Management Plan (USDA 1987a, as amended 2011; hereafter called Coconino forest plan) determined standards and guidelines for snags and downed logs, wildlife cover, raptor nest buffers, old growth, turkey nesting and roosting habitat, and bear habitat. It also provides wildlife direction for other programs, including forest management, range management, recreation, and etc. The plan incorporated the MSO Recovery Plan (USDI 1995) and Management Recommendations for the Northern Goshawk (Reynolds et al. 1992).

The Kaibab NF Revised Land and Resource Management Plan (USDA 2014; hereafter called Kaibab forest plan) provides directions for the range of snags and down materials along with desired conditions of the vegetation types across the forest. The guidelines in the Threatened, Endangered and Sensitive species section shows the forest will follow the intent of the Revised MSO Recovery Plan (USDA 2012). Because wildlife direction is interwoven throughout both forest plans, more detail can be reviewed in appendix 1.

**Consistency with MSO Forest Plan Biological Opinions (BOs):** Based on a review of the Land and Resource Management Plan (LRMP) Biological Opinions (BOs) for the Coconino (USDI 2012a) and Kaibab NFs (USDI 2014) and the information discussed in the effects analysis, implementation of any of the action alternatives would be consistent with the forestwide programmatic LRMP Biological Opinions for the Coconino and Kaibab NFs.

**Methodology**

**Wildlife Analysis Questions and Units of Measure for Evaluation**

What effect would temporary road construction and reconstruction, road decommissioning, road relocation, road use during project implementation and related disturbances have on Threatened, Endangered and Forest Service Sensitive Species, forestwide MIS populations and their habitat trends, and migratory birds in the project area?

**Unit of measure**: miles of road by habitat/vegetation type.

What effect would thinning and its related disturbances have on **Threatened, Endangered and Forest Service Sensitive**, forestwide **MIS** populations and their habitat trends, and **migratory birds** in the project area?

**Units of measure**: acres treated by habitat/vegetation type; change in numbers per acre of snags, logs, and CWD; changes in percent distribution of tree size-classes, changes in canopy, habitat associated with the numbers of springs restored and miles of ephemeral channel restored, potential fire behavior and effects, relative change in biomass yield of herbaceous understory species, qualitative changes in tree diversity; and changes in acres of wildlife cover.

What effect would prescribed fire and its related disturbances have on **Threatened, Endangered and Forest Service Sensitive**, forestwide **MIS** populations and their habitat trends, and **migratory birds** in the project area?

**Units of measure:** acres treated by habitat/vegetation type; change in numbers per acre of snags, logs and CWD; changes in percent distribution of tree size-classes, changes in canopy, habitat associated with the numbers of springs restored and miles of ephemeral channel restored, changes in potential fire behavior and effects; relative change in biomass yield of herbaceous understory species, qualitative changes in tree diversity; and changes in acres of wildlife cover.

How would project activities affect **Threatened, Endangered and Forest Service Sensitive**, forestwide **MIS** populations and their habitat trends, and **migratory birds** in the project area?

**Unit of measure:** change in numbers per acre of snags, logs and CWD; changes in percent distribution of tree size-classes, changes in canopy, habitat associated with the numbers of springs restored and miles of ephemeral channel restored, potential fire behavior and effects; relative change in biomass yield of herbaceous understory species, qualitative changes in tree diversity; and changes in acres of wildlife cover.

How would project activities affect individual animals and populations listed as **Threatened Species, eagles, and goshawks**?

**Units of measure:** acres treated by habitat/vegetation type; change in numbers per acre of snags, logs and CWD; changes in percent distribution of tree size-classes, changes in canopy, habitat associated with the numbers of springs restored and miles of ephemeral channel restored, potential fire behavior and effects; relative change in biomass yield of herbaceous understory species, qualitative changes in tree diversity; and changes in acres of wildlife cover.

How would the project affect the risk of high-severity fire in and adjacent to Threatened, Endangered, Sensitive Species, and MIS and their habitats?

**Units of measure**: changes in Fire Regime Condition Class, change in percent distribution of tree size-classes, relative changes in canopy continuity, and changes in potential fire behavior.

How would the project affect potential impacts of climate change on wildlife?

**Units of measure**: changes in percent distribution of tree size-classes, changes in tree density, and changes in the relative measure of herbaceous understory biomass yield, changes in Fire Regime Condition Class, and changes in potential fire behavior.

How would project activities in combination with other federal, state, and private projects affect Threatened, Endangered, Forest Service Sensitive Species, and MIS and their habitats?

**Units of measure**: evaluation of acres of disturbance that overlap in time and space by individual species and/or assemblage of species (e.g. thinning, burning, road miles, etc.).

### Fire Regime and Vegetation Condition Classes

Fire Regime Condition Class (FRCC) is a largely qualitative ecological evaluation protocol developed to support planning and risk assessments, particularly in regards to fire. It uses three classes for describing the relative degree of departure from reference conditions, particularly in regards to fire regimes, and the risk of the loss of key ecosystem components in the event of a disturbance, such as a fire (Table 1).

**Table 1. Fire regime condition class definitions**

| Condition Class | Departure from historic Fire Regime |
|---|---|
| 1 | Fire regimes are within historical ranges. Risk of losing key ecosystem components is low. Vegetation attributes are intact and functioning within historical ranges. |
| 2 | Fire regimes are moderately altered from historical range. Risk of losing key ecosystem components is moderate. Fire frequencies have departed from historical ranges by one or more return intervals. This has resulted in moderate changes to one or more of the following: fire size, intensity, severity, and/or landscape patterns. Vegetation attributes have been moderately altered from their historical range. |
| 3 | Fire regimes are significantly altered from historical ranges. Risk of losing key ecosystem components is high. Fire frequencies have departed from historical frequencies by multiple return intervals resulting in dramatic alterations to: fire size, intensity, severity, and landscape patterns, and/or vegetation attributes. |

In ponderosa pine, a true FRCC1 would include dominance of old and/or large trees (Harrington and Sackett 1992). It would take decades, regardless of treatments, to move areas lacking in large and/or old trees to a Vegetation Condition Class (VCC) 1. It is not possible to evaluate the number of large, old trees versus large trees, so a crosswalk was developed using VSS classes from the silvicultural database (details in Fire Ecology report).

The timespan 2020 to 2050 was modeled without treatments with the assumption that no disturbances occurred (fires, insects, disease, drought, etc.). Although it is likely there would be management treatments, wildfires, insects, or disease, it is too speculative to try to determine the size and location of such events over the next 30 years. As a result, the data show a shift ‘down’ a class for many acres. The data used for this assessment used size class rather than age for tracking tree development, so FRCC1 acres may be biased high. For details, see the Fire Ecology report.

# Methodology Used for Data Collection and Analysis

## Best Available Science

This analysis is based on best available scientific information. Data sources included research and life history literature and technical reports (see literature cited section and appendices 6, 10, and 11), forest plan standards and guidelines (appendix 1), participation of researchers and managers from other agencies (as cited in this report), approved survey protocols, professional judgment, and the integration of other specialist reports from this project (silviculture, fire, soils and watershed, and transportation) to determine impacts to wildlife species and their habitats (see project record for additional information). The 4FRI interdisciplinary team developed spatially defined databases for use in a Geographic Information System (GIS) from which the majority of the data and information contained in this report were derived. This database includes variables related to forest structure and forest health, i.e., wildlife habitat such as snags, downed logs, tree density, size-classes, and species, old growth, wildlife habitat classifications, and understory biomass index (see project record for additional information). See the silviculture and fire ecology reports for details on the metrics incorporated into this report and their respective modeling approaches, definitions, and assumptions.

## Spatial and Temporal Scales

Effects to species and their habitats were evaluated at multiple scales. Depending on the species and specific analysis, this could include the site (based on stand data), restoration subunit (see figure 2), RU (see figure 2), and/or individual forest. Data used was generated from modeling identified in the silviculture report (silviculture report). Short-term is post treatment (2020), representing conditions after all tree cutting and tree removal occurs followed by prescribed fire in 2015 and in 2019. Note that only the 2015 fire was modeled for aspen treatments. The timeframe for short term effects associated with aspen treatment is 2012 (when tree cutting is complete) and 2015 (when one prescribed fire would be conducted). Long-term is 30 years post-treatment, 2050.

Details on modeling to evaluate the potential for undesirable fire behavior and effects and the departure from historical fire regimes can be found in the fire specialist's report. Details regarding habitat associated with springs and ephemeral stream channels are in the soils and watershed report. All specialist reports can be located in the project record.

Whenever possible, species-specific habitat and locality data were used. Additionally, data queried by Potential Natural Vegetation Type (PNVT) and forest plan Management Area (Coconino NF) or Desired Conditions (Kaibab NF) were used to help with analysis of effects to species' habitats.

Data is typically reported to the nearest acre, mile, or percentage. Most values have been rounded from their actual decimal values. Totals were calculated before any values were rounded in order to give the most accurate sum. Any apparent inconsistency between the total values reported in a table and a sum resulting from adding up individual values in a table typically accounts for a discrepancy of about 1 percent in the case of rounding percentages or miles, and less than two acres in the case of acres.

In an attempt to avoid confusion over these kinds of inconsistencies, minor adjustments to the numbers in the EIS document were made to allow for numbers in tables to add up correctly as displayed. As a result, some numbers may not be exactly the same in the EIS document as compared to this report. The numbers in this report are the most accurate and any differences do not alter the determination of effects.

## Modeling and Habitat Evaluation

### Mexican Spotted Owl Habitat

Forest plans in the Southwest Region of the FS, as amended, provide specific goals, objectives, standards, and guidelines for management activities in designated MSO habitat. The 1996 ROD amended the plans with specific direction for management in MSO habitat. Almost 83 percent of the public comments received on the DEIS for the 1996 amendment clearly preferred alternative E because of the overall environmental effects associated with this alternative. However, alternative G was selected in the Final EIS for the 1996 amendment because it was developed explicitly in response to information provided in the newly published MSO Recovery Plan ("Recovery Plan;" USDI 1995). The revised Kaibab forest plan (USDA 2014) simply states projects need to follow the intent of appropriate recovery plans. The 1996 ROD amended forest plans in the southwest with the incorporation of guidance from the Recovery Plan and the Management Recommendations for the Northern Goshawk in the Southwestern United States (Reynolds et al. 1992). While the direction in the actual 1996 amendment is presented in an abbreviated form, it instructs habitat managers to be consistent with recovery plans. In addition, individual forest plans direct managers to “follow,” “conform with,” and “consult” recovery plan direction (USDA 1987, 2014).

The 1996 ROD and individual forest plans describe the different levels of MSO habitat management, including protected, restricted, and other forest and woodland types. The stated objectives for managers are to ensure a sustained level of owl nest/roost habitat well distributed across the landscape and create replacement owl nest/roost habitat where appropriate while achieving a diversity of stand conditions across the landscape to ensure habitat for a diversity of prey species.

The 1996 ROD referenced and incorporated the 1995 MSO Recovery Plan. The 1995 MSO Recovery Plan formed the basis of the MSO analysis in the 4FRI Coconino NF Kaibab NF DEIS which was released for a 60-day comment period in March of 2013. The DEIS included plan amendments that were developed to ensure the preferred alternative (alternative C) would better match the measures in the new MSO 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 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. Shortly after the 4FRI DEIS was sent to the government printer in December 2012, which was the culmination of about two years of developing treatment strategies, building databases, summarizing treatment effects, and analyzing model outputs, the FWS completed the Revised Recovery Plan (USDI 2012b). Because of the enormity of this effort and the fact that the project was caught between recovery plans, the FWS agreed to retaining the wording and metrics of the original MSO recovery plan in the 4FRI documents. The Biological Assessment was submitted to the FWS in February of 2014. While the analysis below 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 MSO Recovery Plan was documented in the effects analysis of the preferred alternative and the corresponding Biological Opinion as part of consultation with the FWS (appendix 2). All three MSO recovery plans (i.e., the original, the draft, and the revised) were used in the development and analysis of treatments. A crosswalk between the 1995 and 2012 MSO Recovery Plans can be found in appendix 3 of this report.

Protected areas include: PACs established around all known MSO sites located during surveys and management activities since 1989; mixed conifer and pine-oak forests with slopes greater than 40 percent where timber harvest has not occurred in the last 20 years; and reserved lands which include wilderness, research natural areas, wild and scenic rivers, and congressionally recognized wilderness study areas. Prescribed fire is allowed in these areas where appropriate. PACs are 600 acres or more and typically include one or more nest sites. In the absence of a known nest, the activity center should be defined as a roost grove commonly used during breeding. In the absence of a known nest or roost, the activity center should be defined as the best nest/roost habitat (e.g., the Bill Williams Mountain PAC).

Restricted areas include all mixed-conifer, pine-oak, and riparian forests outside of protected areas. Restricted areas should be managed to ensure a sustained level of owl nest/roost habitat well distributed across the landscape. Replacement nest/roost habitat should be created where appropriate within restricted habitat while still providing a variety of stand conditions across the landscape to ensure habitat for a diversity of prey species.

While the 1996 ROD and respective forest plans provide managers with guidelines for achieving the objectives of designated MSO habitat, readers must turn to the Recovery Plan itself for the biological and ecological intent of these designations. The latter provides the context for applying the guidelines and informs management planners and decision makers as to the intended function of the habitat. Treatments in MSO habitat under the 4FRI were designed to meet forest plan direction, as amended. Accordingly, much of the following discussion on existing conditions and the environmental effects of proposed 4FRI actions in MSO habitat follow the detail and context described in the MSO Recovery Plan, i.e., forest plan direction would be met by design, but the effects to MSOs are assessed relative to the biology and ecology of the species as described in the Recovery Plan.

### *Mexican Spotted Owl Habitat Definitions in the 1995 Recovery Plan*

Three levels of habitat management are described in the Recovery Plan: protected areas, restricted areas; and other forest and woodland types. Protected areas receive the highest level of protection. Guidelines for restricted habitat are variable and operate in conjunction with ecosystem management and existing agency management guidelines. The underlying objective in restricted habitat is to manage the landscape to maintain and create replacement nesting and roosting habitat where appropriate while providing a diversity of stand conditions and stand sizes across the landscape. The recovery team assumed that the primary limiting factor for MSOs is nesting habitat. A logical conclusion from this premise is that the landscape should be managed to sustain owl nesting habitat well distributed spatially to mimic natural landscape patterns.

Protected habitat consists of PACs, slopes greater than 40 percent where timber harvest has not occurred in the last 20 years (steep slopes), and reserved lands which include wilderness, research natural areas, wild and scenic rivers, and congressionally recognized wilderness study areas. Recovery Plan guidelines take precedence over other agency management guidelines in protected habitat. Core areas are 100-acre or greater areas within PACs that encompass known nest or roost sites or the best nesting and roosting habitat available. The primary objective for protected habitat is the protection of the best available habitat for MSOs. It was assumed that the best available owl habitat is currently or was recently (since 1989) occupied by MSOs during the nesting season.

PACs should be at least 600 acres in size and should provide for nesting and roosting. Habitat near nests and roosts are the most proximal and highly used foraging areas. The MSO Recovery Team assumed that existing management guidelines and those identified for areas outside of PACs will ensure the existence of additional habitat appropriate for foraging. The management objective on steep slopes is the retention of additional nesting/roosting habitat. Steep slopes were included as protected habitat because mature and old growth stands are more commonly found there as a result of past management actions.

Categories of restricted habitat include target, threshold, and “other” restricted habitat. Management guidelines within restricted habitat are derived from principals of ecosystem management. The Recovery Team concluded that not all lands require equal protection and that recovery of spotted owls requires the future use of currently unoccupied areas. The underlying objectives for restricted habitat is to maintain or create potential nesting and roosting habitat while providing a diversity of stand conditions to support foraging and movements of owls.

Restricted habitat is not considered occupied by MSOs, but is assumed to be used or potentially used by MSOs.

Target and threshold habitats represent potential future nesting/roosting habitat. They have certain identifiable features including high tree basal area dominated by large trees, multi-storied canopy, high canopy cover, snags and downed logs. Threshold habitat represents forest structure simultaneously meeting nesting and roosting criteria (Table 2). By definition (table III.B.1 of the Recovery Plan), at least 10 percent of pine-oak habitat must meet threshold conditions before a surplus can exist. Management activities can occur within threshold stands. However, management activities cannot lower the identified habitat elements below threshold values unless a surplus has been achieved. Examples of why management would occur in threshold stands include reducing the risk of undesirable fire behavior/effects, lessening insect or disease problems, or to meet other ecosystem objectives such as retaining large trees and increasing tree growth rates. Retaining large trees is important because they are impossible to replace quickly, they are common features of nesting and roosting habitat for the owl, and because they are in short supply across the landscape. Large trees and large snags are required by MSOs and will continue to be needed in the future.

**Table 2. Minimum values for threshold habitat defined in the forest plans as amended in 1996**

| Upper Gila Mountain Recovery Unit | Percent of Restricted Habitat | Percent of total SDI* by trees 12-18" d.b.h. | Percent of total SDI by trees 18-24" d.b.h. | Percent of total SDI by trees >24" d.b.h. | Stand Basal area | Trees per acre >18" d.b.h. | Basal area of oak > 5" d.r.c. |
|---|---|---|---|---|---|---|---|
| Pine-oak forest | 10 | 15 | 15 | 15 | 150 | 20 | 20 |

> = greater than; " = inch; d.r.c. = diameter at root collar

*SDI is the stand density index. It is used here to track the percent of the overall forest stand density in specific d.b.h. size-classes as described in the 1995 Recovery Plan.

If less than 10 percent of restricted habitat meets threshold conditions, than an appropriate amount of the next best habitat should be identified as target habitat. These stands are also targeted for the development of potential future nesting/roosting habitat. Target habitat should be managed to achieve threshold conditions as rapidly as possible.

Other restricted habitat equals MSO habitat intended to provide foraging opportunities and support dispersal and seasonal movements by owls. Providing future nesting and roosting habitat requires maintaining stands in various stages of ecological succession. The landscape mosaic or mixture of habitat conditions resulting from the different MSO habitat allocations should ensure adequate nesting, roosting, and foraging habitat for the owl, and available habitat for the variety of MSO prey species.

Critical Habitat was also designated for the MSO. Critical habitat designations are intended to identify, to the extent known, areas that provide essential life cycle needs of the species and that contain the primary constituent elements (PCEs) defined by the FWS in the Federal Register (USDI 2004). The PCEs are considered essential to the conservation of the owl and include those physical and biological features that support nesting, roosting, and foraging and that may require special management considerations or protection. State and private lands are not essential to the conservation of the owl and so were not designated as critical habitat, even if they occur within mapped Critical Habitat boundaries (USDI 2004).

### *Delineating MSO Habitat in the 4FRI Treatment Area*

The Recovery Plan estimated that, pre-1995, most Forest Service project planning in the southwestern region addressed about 10,000 acre at a time. This was described as a “limited spatial scale” that precluded a review of MSO habitat at more meaningful ecological scales (USDI 1995). Following Recovery Plan direction, the 1996 ROD and individual forest plans direct managers to conduct a district-wide or larger landscape analysis to ascertain whether minimum recommendations for threshold habitat exist across the forest. One of the strengths of landscape-scale planning is the ability to compare habitat across ecological scales as encouraged in the Recovery Plan and described in the 1996 ROD.

Working closely with the FWS and wildlife biologists from both National Forests, we reviewed restricted habitats in the greater 4FRI area. The area under consideration constituted all or most of 3 ranger districts across much of two National Forests. A new restricted layer was created within the 4FRI treatment area, including designation of target and threshold habitat as described in the Recovery Plan. This landscape scale approach better meets the goal of providing continuous replacement nesting and roosting habitat over space and time, as described in the Recovery Plan and the 1996 ROD.

In order to identify the best candidate stands as restricted habitat, data from the Kaibab and Coconino NFs (based on polygons) were merged with pine-oak data from the Lab of Landscape Ecology and Conservation Biology (raster data; Dr. Steve Sesnie and Jill Rundall, Northern Arizona University) to create one GIS layer (see project record for additional information). Ponderosa pine stands with Gambel oak 5 inches diameter or greater diameter at root crown (DRC) occurring as at least 10 percent of the trees or 10 BA of the stand was the base for the new pine-oak layer. Additional queries for restricted habitat included:

- Stands with 150 BA or greater
- Stands with oak 5 inches diameter or greater at root crown (DRC) occurring as at least 10 percent of the BA of the stand
- Percent of trees 12 to 18 inches d.b.h. and trees greater than18 inches d.b.h.
- At least 20 tpa 18 inches d.b.h. or greater
- Stands with northerly aspects (assumed to be more sustainable), ranging from 292 degrees to 67 degrees (WNW to ENE)

This subset of stands was then further stratified to identify target and threshold (i.e. future nesting and roosting) habitat by querying stand data in terms of:

- Trees 18 to 24 inches d.b.h. and trees greater than 24 inches d.b.h.
- Oak 5-12 inch d.r.c. and oak greater than 12 inch d.r.c.
- At least 20 percent BA for oak greater than five inches d.r.c.
- Identifying slopes 0-20 percent, 20-40 percent, and slopes greater than 40 percent (steeper slopes were assumed to support moister site conditions that would be more sustainable for dense forests through time; slopes greater than 40 percent were separated out as protected habitat).

The results of the queries were reviewed on March 11th, 2011 by biologists with on-the-ground familiarity for both the Coconino and Kaibab NFs. This review was to ensure that: stands also provided the best functional habitat, e.g., stands were dropped from consideration when:

- remotely-sensed data was found to misidentify juniper as oak in the understory (this was a problem on the Williams RD near Sycamore Canyon);
- adjacent to newly designated 300 foot parking areas for campers on the Coconino NF under the Travel Management Rule finalized in September, 2011;
- apparently contiguous blocks of habitat were fragmented by roads and/or power-lines, or;
- if stands were adjacent to likely haul routes for removing logs and forest products during 4FRI project implementation (the assumption being that in addition to disturbance from future 4FRI activities, these would be roads that were either in good condition or presented more direct routes to off-forest roads and would therefore have more traffic than other roads).

This effort started with a meeting held among wildlife biologists from the FWS, both NFs, and members of the 4FRI team on March 4th, 2011. We placed emphasis on developing future nesting and roosting habitat on the Coconino NF, which supports some of the highest numbers of resident owl pairs in the Region. In contrast, the Kaibab NF supports very few owl pairs. Although the Kaibab and Coconino NFs share a common border across much of the 4FRI project area, the quality of pine-oak habitat changes on either side of this administrative line. Pine-oak forests on the Coconino NF frequently produce large diameter oak suitable for MSO nesting and roosting. Gambel oak trees large enough for MSO nesting are uncommon on the Kaibab NF where oak most frequently occurs in a shrubby form (Chambers 2002). Along with this habitat difference is a clear shift in MSO occupancy. There are over 190 PACs entirely on or overlapping with Coconino NF lands. In contrast, the Kaibab NF has seven identified PACs distributed in patches across the Williams Ranger District (these numbers include three PACs that overlap the Coconino NF as well). PACs and/or core areas on the Kaibab NF occur either on the mountainous cinder cones or in canyons. While PACs on the Kaibab contain individual stands of pine-oak habitat, they principally consist of mixed-conifer forest. In contract, pine-oak forest on the Coconino NF occurs in relatively large, contiguous patches of habitat.

The strategy in designating target and threshold habitat was to provide well distributed habitat to aid in dispersal and seasonal movements of owls across the landscape and that also included strategically located blocks that could potentially function as future PACs (i.e., “ensure a sustained level of owl nest/roost habitat” and “[c]reate replacement owl nest/roost habitat where appropriate” per the amended forest plans). Blocks of habitat were also designated with the intent of providing “stepping-stones” to facilitate owl dispersal and connect areas capable of supporting future nesting and roosting habitat, per the Recovery Plan, to support landscape connectivity for MSOs. Some small, scattered stands of isolated habitat occurring in a matrix of non-MSO habitat would not be expected to support nesting owls or provide connectivity and were dropped from further consideration, i.e., results from the above criteria were assessed in terms of ecological function in addition to meeting query criteria.

Proximity to PAC habitat was also an evaluation criterion. We sought to either augment PAC habitat or designate restricted habitat in previously undesignated pine-oak stands. The assumption was that known or suspected owl use indicated higher quality habitat. Areas ranging from the northwest to the southeast of PACs received close evaluation for inclusion with the idea they represented stands that could sustain higher density forest due to microsite conditions. Fire potential was also considered in developing the spatial configuration of MSO habitat on the landscape. Predominant winds are from the southwest, so we rarely identified additional MSO habitat southwest of existing PACs unless stands were on northerly aspects. Because of the fire potential, areas southwest of PACs were revaluated for treatments that would reduce the risk of high-severity fires entering PACs. A final emphasis was placed on removing stands misclassified as restricted habitat so that designated areas would function as MSO habitat. A subset of selected stands was reviewed in the field in autumn, 2011 as quality control. This new layer better met the biological needs of MSOs than past efforts that were either much more limited in scale or were based on much older data.

The oak component quickly diminishes north of Interstate 40, so the majority of the habitat occurs south of I-40 (Figure 3). Over 12 percent of the new restricted habitat layer was designated as target and threshold habitat. Iterative data reviews, field visits, and familiarity of ground conditions by district personnel eventually lowered this value to about 11.6 percent of available restricted habitat. Only about 1,977 acres simultaneously met the habitat criteria for threshold habitat as described in the amended forest plans and 6,736 acres was designated as target habitat as defined in the Recovery Plan.

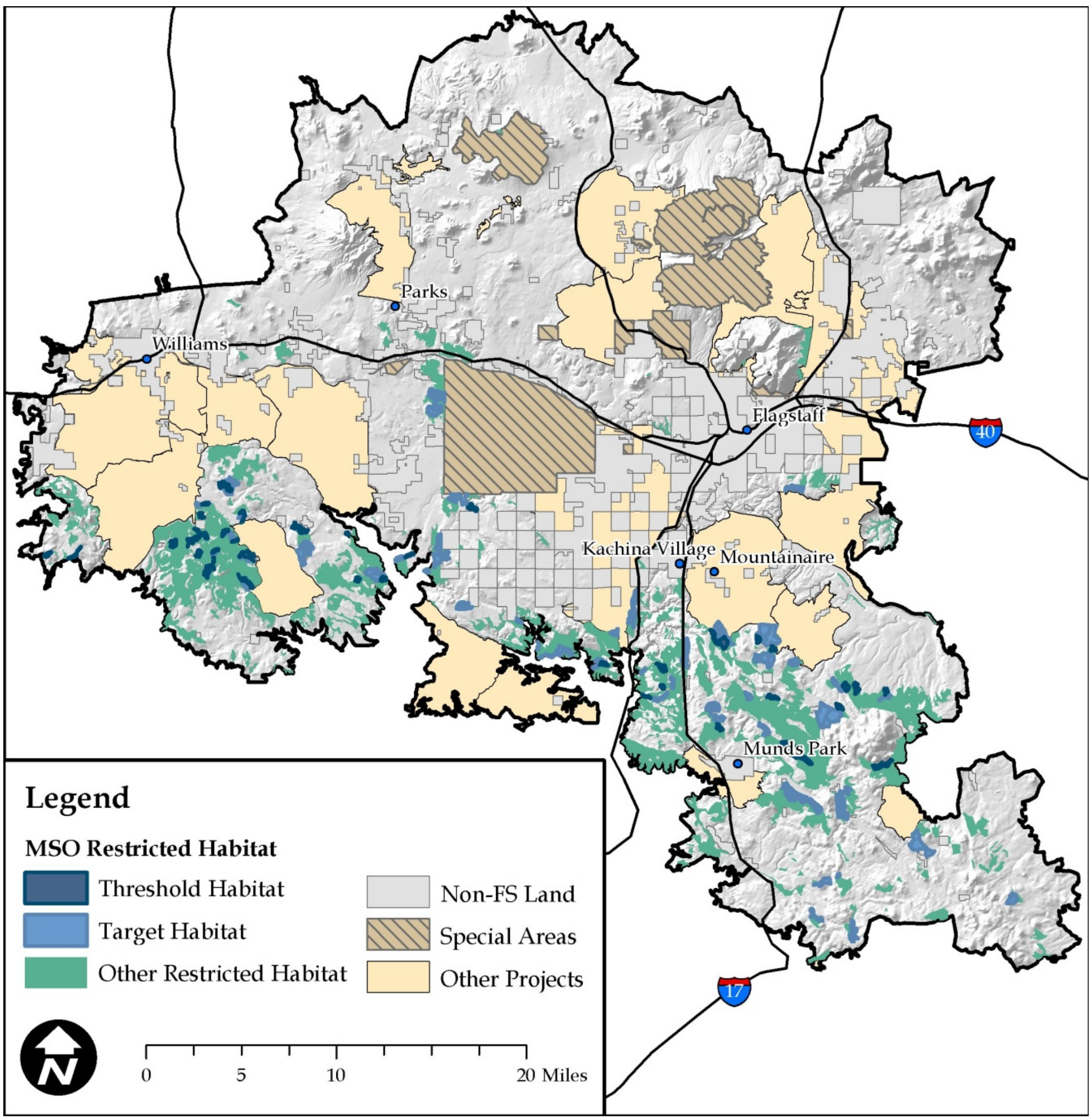


**Figure 3. Restricted habitat for the 4FRI treatment area**

To accomplish this effort, a strategy was developed from these meetings for designating new target and threshold habitat across the 4FRI treatment area. This effort did not include habitat in current or recent projects or within mixed conifer habitat because those acres are not part of the 4FRI treatment area.

Following Recovery Plan guidelines, we identified the best restricted habitat as target and threshold habitat across the 4FRI landscape. This effort started at a meeting held among wildlife biologists from the FWS, both NFs, and members of the 4FRI team starting on March 4th, 2011. We placed emphasis on developing future nesting and roosting habitat on the Coconino NF, which supports some of the highest numbers of resident owl pairs in the Region. In contrast, the Kaibab NF supports very few owl pairs. Although the Kaibab and Coconino NFs share a common border across much of the 4FRI project area, the quality of pine-oak habitat changes on either side of this administrative line. Pine-oak forests on the Coconino NF frequently produce large diameter oak suitable for MSO nesting and roosting. Gambel oak trees large enough for MSO nesting are uncommon on the Kaibab NF where oak most frequently occurs in a shrubby form (Chambers 2002). Along with this habitat difference is a clear shift in MSO occupancy. There are 190 PACs entirely on or overlapping with Coconino NF lands. In contrast, the Kaibab NF has six identified PACs distributed in patches across the Williams Ranger District (these numbers include three PACs that overlap the Coconino NF as well). PACs on the Kaibab NF either occur on the mountainous cinder cones or in canyons; While PACs on the Kaibab NF contain individual stands of pine-oak habitat, they principally consist of mixed-conifer forest. In contract, pine-oak forest on the Coconino NF occurs in relatively large, contiguous patches of habitat.

**Table 3. Acres of Mexican spotted owl habitat within the treatment area**

| MSO Habitat | Habitat Acres by Restoration Unit | | | | | |
|---|---|---|---|---|---|---|
| | RU 1 | RU 3 | RU 4 | RU 5 | RU 6 | Total |
| **Protected Habitat** | | | | | | |
| Protected Activity Center | 28,457 | 4,555 | 555 | 859 | 0 | 34,426 |
| Pine Oak >40% Slope | 595 | 238 | 3 | 0 | 0 | 836 |
| **Total MSO Protected Acres:** | **29,052** | **4,793** | **558** | **859** | **0** | **35,262** |
| **Restricted Habitat – Pine Oak** | | | | | | |
| Threshold | 873 | 1,104 | 0 | 0 | 0 | 1,977 |
| Target | 3,920 | 2,795 | 0 | 0 | 0 | 6,715 |
| Restricted Other | 25,710 | 38,527 | 1,576 | 606 | 0 | 66,419 |
| **Total MSO Restricted Acres:** | **30,503** | **42,426** | **1,576** | **606** | **0** | **75,111** |
| **Total MSO Habitat Acres** | **59,555** | **47,219** | **2,134** | **1,465** | **0** | **110,373** |

MSO densities tend to be greatest in the center of the range and decrease toward the range periphery (USDI 1995). The Williams RD is at the extreme western edge of the species range across the Mogollon Plateau. Over 20 years of project surveys have never resulted in a detection of MSOs in the pine-oak forests on the Williams RD, other than the last detection of a bird previously associated with mixed-conifer forest on Bill Williams Mountain in 1994. A new pair of owls was detected between Bill Williams Mountain and Hell Canyon in 2013. However, occupancy was not confirmed in 2014. The PAC includes pine-oak habitat, but the nest site is in canyon habitat. Because of the marked difference between MSO occupancy on the 2 NFs, we assumed the disparity in use by nesting MSO indicated better habitat conditions on the Coconino

NF. Therefore, we designated more target and threshold habitat on the Coconino NF where MSOs are common in pine-oak habitat.

A similar process was initiated to consider the potential for specialized treatments inside PACs. This process was initiated before 4FRI project boundaries existed. Working closely with the FWS and wildlife biologists from both NFs, we reviewed each individual PAC occurring in the area under consideration by 4FRI. This effort evaluated 117 PACs of the 195 total PACs on the two NFs. PACs were assessed in terms of dominant forest type (e.g., pine-oak, mixed conifer, or canyons), habitat structure, available demographic data (based on ongoing occupancy surveys or past research), topographic attributes (e.g., aspect and slope), human access, designated wilderness boundaries, recent and ongoing projects affecting PAC habitat, fire history, status of current habitat, and whether mechanical treatments could move the habitat towards the desired conditions described in the Recovery Plan. It was agreed no mechanical treatments would occur in core areas.

Once the status of the PAC was determined, potential mechanical treatments were considered in terms of whether they could:

- Decrease the amount of time required for increasing tree height and diameter;
- Decrease overall tree density while maintaining the density of large trees, and
- Increase canopy base height to improve flight zone (i.e., improve owl foraging ability) and also reduce the threat of surface fires becoming crown fires.

We concluded 99 of the 117 PACs assessed did not need mechanical treatments and concluded mechanical treatments were possible in 18 PACs (Figure 4). PACs were not considered for treatment if they were treated in previous projects (n = 32), habitat was not suitable for 4FRI treatments (PACs occurred in habitats outside the scope of 4FRI such as mixed conifer, designated wilderness, or canyon habitat; n = 20), habitat had been previously burned (n = 10), habitat conditions inside PACs were such that treatment was not necessary (n = 11), the balance of conditions inside and outside PACs were such that treating outside the PACs would be adequate and active management would not be necessary inside the PACs (n = 24), or there simply was not enough information available to identify a need for treatment (n = 2). Prescribed fire was recommended for all PACs that were evaluated, including a preliminary recommendation for using prescribed fire in core areas.

This analysis was followed by field visits to a subset of PACs proposed for treatment (appendix 4). Vegetation simulation modeling was completed for potential treatments tailored to individual stand conditions within each PAC. Modeling indicated mechanical treatments could move 10,741 of 34,426 acres (31 percent of total PAC acres) onto a trajectory that better meets the above criteria for habitat within the 18 PACs (see Silviculture report).

This exercise essentially identified PACs in some of the worst conditions. While this was not the intention at the start, we filtered out all PACs known to be in good condition, known to have good reproduction or consistent occupancy, or PACs that had treatment intended to move them towards desired conditions. After this artifact of our criteria was realized it was confirmed during field reviews.

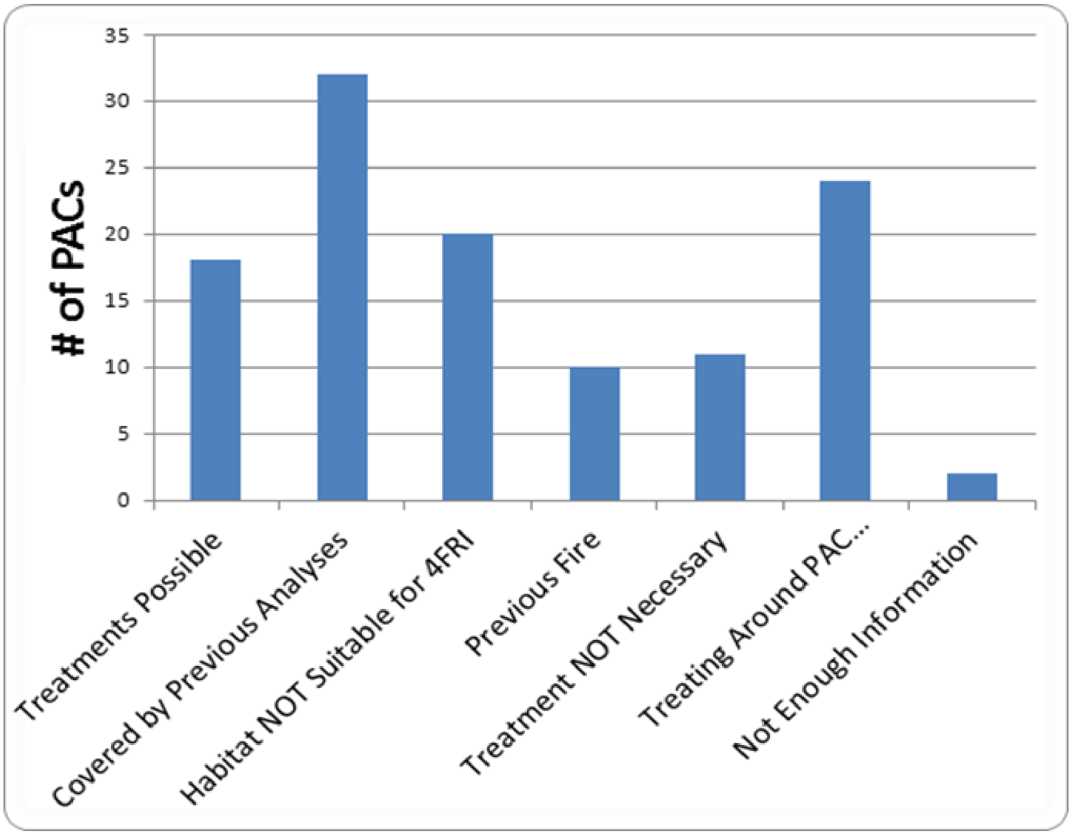


**Figure 4. 4FRI MSO PAC evaluation for mechanical treatments (2011-2012) (see text for legend definitions)**

### *Modeling Mechanical Treatments in PACs*

The original Recovery Plan (USDI 1995) set diameter limits for cutting trees in PACs at 9 inches d.b.h. The intent was to prevent commercial harvest of trees in nesting and roosting habitat. This limit was incorporated into the original forest plans. A concern was raised at a meeting of biologists from the Coconino and Kaibab NFs, the FWS, and the 4FRI that forests had become so dense that mechanical treatments restricted to trees less than 9 inches d.b.h. would not achieve desired conditions for PACs. Increased size-class limits were explored to evaluate how best to attain desired conditions for MSO habitat. An upper limit of 17.9 inches d.b.h. was chosen because trees 18 inches d.b.h. and larger are defined as large trees in the Recovery Plan (USDI 1995) and are a valuable component of owl nesting and roosting habitat. They are limited across the landscape (USDI 1995). Treatments in stands from all 18 PACs were modeled using each of the five different diameter caps (i.e., up to 9 inches d.b.h., 9+ to 12 inches d.b.h., 12+ to 14 inches d.b.h., 14+ to 16 inches d.b.h., and 16+ to 17.9 inches d.b.h.). Two thinning regimes, SDI 160 for strata 1 and SDI 200 for strata 2, were applied and outputs were compared for each individual stand under each of the d.b.h. simulations. Evaluation criteria for model selection was net growth 10 years after thinning, the highest number of TPA 18 inches d.b.h. and larger in the year 2050, and the highest percentage of trees in the mid-aged successional stage (12 to 18 inch d.b.h.) in 2050. The latter criterion was to ensure future recruitment into larger size classes. Individual stands had five model runs for each stratum. The diameter limit best meeting the evaluation criteria was selected. This approach allowed evaluating site-specific conditions: modeling was done at the stand scale, not the PAC scale. Any one PAC can have multiple size-limits among individual stands.

The modeling started removing trees in the smallest size classes first while also retaining trees in each size class. However, this was not modeled as a simple diameter cap where thinning from below removes important habitat components. Existing owl habitat characteristics were retained while evaluating improvements to potential future habitat. Stands with incomplete data were not proposed for thinning above the 9 inch d.b.h. Tree removal would target reducing competition between uncharacteristic densities of smaller size-class trees and presettlement pine and large oak trees. Treating up to 17.9 inch d.b.h. would allow a greater opportunity to retain these valuable components of MSO habitat while helping create uneven-aged, multi-storied stands.

After the PAC evaluation and modeling effort, a discussion on grasslands led to overlaying GIS layers for the Terrestrial Ecosystem Survey soil units and PACs. The 18 PACs selected for mechanical treatment averaged about 88 percent mollisol (grassland) and mollic intergrade (open forest/savanna) soil types (range = 57 to 100 percent mollisol and mollic intergrade). Conversely, on average about 12 percent of the area in the selected PACs have soils that developed under closed forest conditions. The predominance of open habitat soils within the PACs indicates current forest structure is much denser than historical conditions. Thinning in these PACs to develop and enhance retention of large trees over time would move forest structure towards the natural range of variability. Nevertheless, the scale of change would be minimal.

### *Smoke Effects on MSO*

Burning in PACs would occur outside the MSO breeding season (i.e., from September 1 through February 28) and would include core areas in alternative C, avoiding firelines construction inside most PACs (see below). Burning outside PACs could result in smoke setting in areas with nesting owls. Smoke emissions could damage lung function in adults and nestlings.

A series of meetings in 2012 and 2013 were held with fire experts from the Coconino and Kaibab NF and members of the 4FRI team to address the risk of smoke settling into PACs. Risk evaluations were based on landscape features, air movement, whether an area had burned in the last 20 years or whether a prescribed fire under 4FRI would be outside the normal fire return interval.

Vulnerability of each individual PAC to collect smoke was evaluated across the 4FRI project area in 2012. Smoke and air movement patterns were evaluated and landscape-scaled features that affect air movement patterns were evaluated in addition to drawing on expert experience. It was concluded that most PACs on cinder cones (e.g., Kendrick, Sitgreaves, Mormon Mountain, etc.) and other prominent, raised topographic features, and most PACs in or immediately adjacent to Sycamore Canyon, Oak Creek Canyon and the Mogollon Rim would not be expected to have smoke settle long enough to cause discernible effects to MSOs. Conversely, smoke is more likely to settle in PACs with core areas occurring in small canyons (e.g., James, Kelly, Walnut, etc.).

In 2013, fire and wildlife experts met again to evaluate landscape smoke patters. The effort in 2012 focused on areas where smoke tended to settle. In 2013 we looked at where smoke movement based on ignition sites. Areas outside of but upwind and in proximity to PACs (in terms of air flow, regardless of distance) were delineated across the project area. These buffer areas were identified as exclusion zones where burning would only occur outside the breeding season in order to minimize of the risk of smoke settling into downwind PACs. Exclusion zones included areas that had not been burned in the last 20 years and hence were outside characteristic surface fuel loading. Opportunity zones were delineated outside of PACs and which could be burned during the breeding season (March 1 – August 31). Opportunity zones are areas where smoke is unlikely to affect downwind PACs. Results were reviewed with the FWS. See appendix 5 for more details.

### *Vegetation Types in Restricted Habitat*

Treatments in non-MSO habitats were calculated differently in protected and restricted habitats. Acres of aspen or meadow treatments in protected habitat were tallied by individual PAC. Each PAC represents a discrete polygon or defined unit of area in the FS database. The polygons encompass designated MSO habitat as well as other vegetation types such as meadows, aspen, rock, etc. Therefore, identifying the associated acres of each vegetation type within individual polygons (i.e., within PAC habitat) was simply a matter of summing the acres associated with each non-MSO vegetation type occurring in a given PAC.

Meadows, grasslands, savannas, and aspen were problematic to summarize in restricted habitat. The restricted habitat data-layer is defined on a stand-by-stand basis. Restricted habitat boundaries are the actual stand boundaries, so other habitats do not occur "within" restricted habitat in the corporate database. Unlike PAC boundaries, a stand of non-MSO habitat such as grassland or aspen would not be included in a query of restricted habitat. There is no outer restricted habitat polygon within which non-MSO habitats such as meadows and aspen could be identified and summarized. Even where stands of restricted habitat are clustered, they are still defined by the individual stand boundaries. Therefore, meadows, aspen, or any other non-MSO vegetation type within restricted habitat could not be directly queried.

To account for this, we used CHU polygons as a proxy for assessing potential management impacts to stands between, adjacent, or near restricted habitat. The drawback to this approach is that Critical Habitat includes both protected and restricted habitat and both habitats also occur outside Critical Habitat. In addition, Critical Habitat boundaries include other non-MSO vegetation. However, CHUs on the 4FRI landscape encompass most of the MSO habitat and, on an area basis, most MSO habitat consists of restricted habitat. Therefore, we felt using Critical Habitat was a reasonable approximation for evaluating potential effects to restricted habitat. See individual alternatives for effects of grassland, savanna, and meadow treatments in restricted.

## Roads for Hauling Forest Materials in Wildlife Habitat

A 5-day review involving the 4FRI assistant team lead, 4FRI biologists, and the 4FRI GIS specialist was conducted to identify a functional road system for hauling harvested materials off forest while avoiding or minimizing impacts to MSOs and northern goshawks. Haul routes were evaluated across the entire project area relative to each of the 70 MSO PACs and XX PFAs and dPFAs across the treatment area. This broad scale effort was evaluated in a site-specific manner as roads around each individual PAC and PFA were examined in terms of meeting operational needs in a manner that avoided disturbance to MSOs and goshawks. We defined and assessed blocks of commercial treatment areas ranging from 100s to 1000s of acres and identified routes between these treatment blocks and major transportation corridors. A haul road network was identified, including secondary roads associated with harvest units, and primary roads leading off-forest. The following criteria were used to select haul routes:

1. Roads were selected to avoid PACs and PFAs;
2. Where hauling in PACs or PFAs could not be avoided, roads greater than a ¼ mile from core areas and nest stands were selected;
3. Where these criteria could not be met, timing restrictions were applied to prevent disturbance during the nesting season.

## Understory Biomass

Understory as used in this report refers to the herbaceous component of the forest. Specifically, the grasses, forbs, sedges, and shrubs are considered “understory” because these elements represent the preferred foods of most herbivores. As used here, understory does not include tree seedlings or saplings. A relative index of understory biomass was developed to compare understory response among the proposed alternatives. Equations describing the relationship between overstory canopy and understory development were reviewed. Equations representing basalt and limestone soils developed in northern Arizona ponderosa pine forests were selected. Cinder soils were not included in this because representative equations were not found for this distinct soil type. Soils were grouped based on basalt or limestone parent materials by the soil scientists from the Coconino and Kaibab NFs. The selected models were incorporated into the 4FRI forest database, generating individual stand values pre- and post-treatment for each alternative. The models were intended to be calibrated by using site specific variables. This could not be done on a stand-by-stand basis for each of the more than 30,000 stands in the 4FRI database. Therefore, the understory values are not predictions, but represent a consistently derived relative change in herbaceous biomass. Details on how the index was developed and the science behind the relationships between overstory and understory vegetation (and between understory vegetation and arthropod response) can be found in appendix 6. Biomass indices comparing trajectories of each action alternative were graphed by individual subunit and can also be found in appendix 6, pages 48 to 58. These values do not include the nutrient pulse or the reduction in duff and litter resulting from prescribed fire. Both factors increase understory yield but were beyond the scope of the modeling. The potential to increase understory biomass is considered to be a foundational improvement to wildlife habitat under the 4FRI. Increasing forage cover and production directly benefits arthropods (including pollinators), herbivores (including key prey species for MSO and goshawks), granivores (including key prey species and migratory birds), insectivores (including key prey species and migratory birds), and omnivores (including meso-predators and black bears).

## Goshawk Habitat

Coconino NF and Kaibab NF forest plans define goshawk habitat as nest stands, post-fledging family areas (PFAs), and lands outside of PFAs (LOPFAs), based on the management recommendations for managing goshawk habitat developed by Reynolds et al. (1992). Based on research conducted by Reynolds on the North Kaibab ranger district, PFAs could be expected to occur in a grid-like fashion about every 2 – 2.5 miles if existing habitat is adequate and about equal across the landscape. Because of this, forest plan direction states that site quality should be evaluated to identify and manage dispersal post-family fledging area (dPFAs) at a 2 - 2.5 mile spacing across the landscape. The intent is to retain potential habitat in areas that appear suitable but where surveys for resident goshawk pairs were never completed in areas that might be affected by proposed management. In general, PFAs are designated where resident goshawks are known to occur. In contrast, dPFAs are designated in areas where resident goshawks are suspected to occur but where occupancy surveys have never been completed.

The process of identifying dPFAs across the 4FRI project area started with a meeting of wildlife biologists from both National Forests and the 4FRI team on February 2, 2011. A follow-up meeting occurred on February 14, 2011. The following criteria were identified for designating dPFAs in areas of high quality habitat potentially capable of supporting a breeding pair of goshawks:

- Only include areas within ponderosa pine or pine/oak cover types consisting of uneven aged forest
- Buffer existing PFAs 1.25 miles
- Blocks of habitat occurring with less than or equal to 50 percent overlap with the above PFA buffers qualified for evaluation as dPFA habitat; by default, if areas occurring between known PFAs overlapped the PFA buffers by more than 50 percent, they were not carried forward as potential dPFA habitat
- Exclude areas within: existing projects with completed NEPA; designated wilderness areas; private and State lands ; and mollisol soils (indicating historic grasslands)
- Use FFE tree and fuels data to select for: Vegetation Structural Stages 4s, 5s, and 6s; TPA 18 inches d.b.h. and larger; numbers of large (greater than or equal to 18 inches d.b.h.) snags; and canopy base height to identify potential goshawk habitat
- Compare data query results with orthoquad photos and topographic maps

Once areas were identified that met the above criteria, the delineation of dPFA boundaries incorporated the use of a new goshawk-habitat relationships model developed in an independent process. A spatially explicit landscape-scale predictive model of the relationships between northern goshawks and their habitat was being developed at the Lab of Landscape Ecology and Conservation Biology, Northern Arizona University (Dr. Brett Dickson). This model is under review and will be submitted for publication in a scientific journal. The model was used to assess the habitat blocks resulting from the above queries and allowed a detailed evaluation of an assortment of habitat associations identified as important to goshawks. This focused use of the best science available helped in locating the most effective habitat within the identified habitat blocks. Once identified, dPFAs were carried forward into the 4FRI analyses as if they were occupied and silvicultural treatments assigned to them were the same as known occupied PFAs.

A description of the development of the silviculture database can be found in the silviculture specialist's report. Model outputs from mechanical thinning and prescribed fire were incorporated into this analysis. Details on the models can be found in the respective specialist's reports. The exercise resulted in the designation of 19 dPFAs totaling 11,279 acres.

## Habitat Connectivity

An emerging strategy in landscape management is to move altered landscapes back towards something resembling the structure, composition, and function of the original landscape. A component of landscape restoration is ecological connectivity. Habitat fragmentation, a frequent consequence of habitat loss, is a primary threat to wildlife populations because the loss of dispersal between populations can lead to greater risks of extirpation (Gilbert-Norton et al. 2010). Avoiding population isolation means maintaining gene flow. Corridors for increasing movements of invertebrates, non-avian vertebrates, and plants were shown to be important for maintaining connectivity between habitat fragments (Gilbert-Norton et al. 2010).

Closed-canopy, high-density forest conditions are currently common in the 4FRI analysis area. To achieve ecological objectives and modify landscape-scale fire effects, the prevalence of those dense forests must be significantly reduced. Given the evolutionary history of canopy-dependent wildlife on this landscape, we can assume that closed-canopy conditions were present within the natural range of variability. The question of how much of the pre-settlement landscape was in this condition remains unanswered, but the scientific literature, historic accounts, and historic and repeat photography all indicate that the northern Arizona ponderosa pine forests were dominated by more open conditions. Nevertheless, it is the intent of the 4FRI project to provide bridge habitat for canopy-dependent wildlife (appendix 7). “Bridge habitat” would consist of more densely forested areas that would remain available to wildlife adapted to closed forest conditions during the period of time between 4FRI treatments and the actual attainment of desired conditions across the broader landscape. About 13 percent of the landscape within the 4FRI project boundary would be deferred from treatment. Nearly 42 percent of the ponderosa pine treatment area would have a moderately-closed canopy, and another 17 percent would remain in a closed condition after treatment. An additional 17 percent of the treated area would have a mix of open and closed conditions. RUs near the Mogollon Rim would provide the greatest percentage of bridge habitat after treatment. Old growth allocations account for 38 percent of the ponderosa pine treatment area and are well-distributed across the landscape. A patch-mosaic of small deferrals would be created in stands all across the 4FRI treatment area to provide safeguards for wildlife features such as nests and roosts and unique features such as caves and sinkholes. Implementation guidance in MSO and northern goshawk habitats includes provisions for higher density and canopy cover relative to the surrounding landscape. It is our assumption that all of these measures would provide adequate bridge habitat for canopy-dependent wildlife and serve as hiding cover for black bears and other species. Monitoring would be an important test of this assumption and adaptive management would be employed if outcomes prove otherwise. A full discussion of bridge habitat for canopy-dependent wildlife is presented in appendix 7.

AGFD provided GIS files of habitat linkages developed as part of the Coconino County Wildlife Connectivity Assessment: Report on Stakeholder Input (AGFD 2011). Working with AGFD, proposed 4FRI treatments were evaluated within priority linkage areas in terms of wildlife connectivity concerns for both closed canopy/interior habitat species and open habitat species. Maps of proposed linkages from the AGFD were overlaid with other GIS data layers to inform discussions of stand treatments. “Closed/interior” corridors were evaluated individually across the entire analysis area. Stands within, overlapping, or proximate to each corridor were reviewed one at a time to identify the best and most sustainable closed forest habitat and associated treatments. Typically, treatment intensity was modified to meet the intent of the linkage corridor, e.g., lower intensity treatments were assigned to leave more trees and smaller openings within closed canopy/interior corridors. Changes to proposed treatments of stands within interior corridors frequently changed the percent opening from 40 to 55 percent openings post-treatment to either 10 to 25 percent or 25 to 40 percent openings. On occasion, the corridor itself was adjusted so that target conditions did not go against the ecology of the site. For example, if a true mollisol soil occurred within an intended “closed corridor,” the corridor was shifted to other soil types. In this way, ecologically-based, site-specific decisions were used to create connectivity at landscape scales, including movement corridors around the city of Flagstaff for black bears and other species. In addition to the corridors provided by AGFD, Hell Canyon, an east-west feature crossing much of the Williams RD, was recognized as a wildlife corridor. Treatments were revised, as described above, in assessable forested areas to retain wildlife cover. Past field reviews conducted by the Kaibab NF identified abundant wildlife sign in Hell Canyon, indicating its use as a movement corridor (B. Noble, personal observation). Similarly, treatments would be feathered around canyon features to provide cover for animals moving along the rims.

“Open” corridors typically fit within or among (i.e., connecting) mollisol and mollic intergrade soils. Higher intensity treatments were used to leave fewer trees and larger openings within open habitat corridors. The intent was to restore and connect historic grassland and savanna habitats. Seedling establishment rates were unusually high in 1919, contributing to today’s forest densities and similar, lesser seed crops in 1910, 1914, and 1929 also increased tree recruitment (Arnold 1950). This, combined with the disruption of the natural fire regime, led to an 8 to 21-fold increase in tree densities in northern Arizona ponderosa pine forests relative to pre-settlement times (Fulé´ et al. 2002a). This increase in tree recruitment and survival filled-in open forests and invaded grasslands and savannas. Savanna treatments are designed to restore an open reference condition within ponderosa pine forest using occurrence of mollic-intergrade soils as a guide. Open corridors were designed to provide landscape connectivity for species that have been losing key habitats over the last century and a half. In open corridors, treatments designed to provide 40 to 55 percent openings were typically increased to savanna treatments in areas that overlapped mollic-intergrade soils. Additionally, prescribed fire-only treatments on true mollisol soils were changed under alternative C to include mechanically cutting invading pines and pine plantations. Closed and open corridors were incorporated into alternatives C and E and are displayed in appendix 8.

In a response to public comments, treatments in over 10,000 acres of open corridor habitat were re-designated to provide closed canopy conditions. This would decrease corridor effectiveness for pronghorn and other grassland-associated species in both the potential I-40 crossing and in the landscape-scale connectivity corridors. This change was incorporated into alternatives C and E where the low end of the range in treatment intensity would be emphasized. See the silviculture report, alternative descriptions, and the MIS pronghorn effects analysis for details

## Bridge Habitat

The homogeneous, closed-canopy, high-density, mid-aged forest conditions that dominate the forested ponderosa pine forests of northern Arizona would persist without management action. There would be less movement towards the natural range of variability, with decreasing forest resiliency and large tree growth rates, and decreasing resistance to beetles, disease, high-severity fire, and within stand mortality.

At the landscape scale, alternatives B-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 (table 1). 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 were included 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 MSO 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 will 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 the 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 appendix 7 for details.

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 BA and TPA in large size classes would result in high SDI within these stands. The average SDImax would be at the threshold of “extremely high density,” resulting in competition-induced mortality and stagnating diameter growth (Table 5). 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.

## Forest Attributes and Wildlife Needs (FAAWN)

Forest Attributes and Wildlife Needs is a national-scale model with a supporting relational database that was published in the book Forest Wildlife Ecology and Habitat Management by Dr. David Patton (2011). FAAWN is a model that uses wildlife biology and habitat relationships data. It includes data from R3HARE, a model originally developed for southwestern national forests in Region 3 of the FS by School of Forestry Faculty at Northern Arizona University, Flagstaff. Dr. Patton has served as Dean of the School of Forestry at Northern Arizona University on three separate occasions, has worked in wildlife and ecological planning around the world, and early in his career worked for the research branch of the FS. He formatted and enhanced FAAWN specifically for use by 4FRI.

## Habitat Capability

NFMA directs National Forest managers to maintain enough habitat adequately distributed across each forest to maintain populations of designated MIS. Wildlife theories such as carrying capacity and habitat effectiveness were adopted in the respective forest plans to assist forest managers in meeting this direction. Habitat capability models were originally developed to inform managers on the amounts, distributions, and kinds of habitat needed to maintain populations of MIS (Hurley et al. 1982). The output from habitat capability models is an index ranging from zero to one. A habitat capability index (HCI) of zero means an area does not support the resources necessary to maintain a given species and a value of one equals optimal habitat for that species. The word “optimum” is important because the intent of the modeling was to estimate the optimum density or carrying capacity of a species in a given area without deteriorating its environment (USDA 1987). Carrying capacity is a theoretical value influenced by a variety of factors, including weather, human activities, other wildlife populations, and stochasticity. Since the forest plans were published in the late 1980s, the concepts of habitat capability indices and defining the carrying capacity of an area has largely fallen out of favor.

HCI models are based on a limited number of variables that influence the habitat needed to maintain a reproductive pair of a given species (Hurley et al. 1982). HCI models provide a simple form for understanding major environmental factors thought to be the most influential on the occurrence and abundance of a wildlife species. Each habitat variable is defined as a range of values. While many of the habitat variables are not difficult to identify, defining a numeric range of values for each habitat component can be highly subjective. Each range of values is then broken down into expected ranges of low, medium, or high value to each particular species. Frequently a species’ habitat requirements are represented by two broad habitat categories: forage (any habitat where a species may obtain food, including vegetation for herbivores and prey for predators) and cover (including thermal, nesting, denning, hiding, etc.) (Hurley et al. 1982). It is assumed that the HCI represents the final response of a wildlife species to the combination of environmental variables included in the model (Morrison et al. 2006). However, HCI models do not provide information on population size, trend, or behavioral response of animals to shifting conditions (Morrison et al. 2006). Reviews of this model construct have shown they tend to perform poorly and should be viewed as only presenting a hypothesis on species – habitat relationships and not casual functions (Morrison et al. 2006). They provide purely deterministic predictions with no statements of uncertainty leading to results that are not particularly interpretable and which should be viewed with caution (Morrison et al. 2006).

The Coconino forest plan adopted the HCI approach in the 1980s when these approaches were new to managers. The intent was to estimate the carrying capacity of each MIS and assign an HCI target for maintaining appropriate habitats on the landscape (USDA 1987). HCI modeling was not used in the 4FRI wildlife analyses because the HCI approach does not meet direction for use of the best available science. Instead, ecosystem management can be viewed in terms of the evolutionary environment or range of natural variability under which habitats and their associated species evolved (Fulé et al. 2002b, Abella 2008).

The desired conditions for the 4FRI project are intended to move forest structure towards the historical range of variation and therefore represent the evolutionary environment of ponderosa pine forest in northern Arizona. Meeting or moving forest conditions towards desired conditions are expected to result in more resilient wildlife communities and more sustainable wildlife habitat. This follows the recommendations by Abella (2008) for managing wildlife communities within an ecosystem context which therefore promotes more vigorous plant communities, healthy soil processes, and overstory tree structures reasonably consistent with the evolutionary environment under which the communities evolved. This approach has been incorporated into the MIS analyses contained in this report by comparing habitat elements such as early seral-habitat, late-seral habitat, or large snags, to the desired conditions specifically developed to represent the historical range of variation.

The comparison of habitat elements is done among alternatives and through time. The landscape was grown into future years using the Forest Vegetation Simulator (FVS). FVS is a model used for predicting forest stand dynamics throughout the United States and is the standard model used by various government agencies including the USDA Forest Service, USDI Bureau of Land Management, and USDI Bureau of Indian Affairs (Dixon 2012). The FVS is an individual tree, distance independent growth and yield model with linkable modules called extensions, which simulate various insect and pathogen impacts, fire effects, fuel loading, snag dynamics, and development of understory tree vegetation. FVS can simulate a wide variety of forest types and stand structures has been used extensively to summarize current stand conditions, predict future stand conditions under various management alternatives (Dixon 2012). FVS is continually updated to correct known deficiencies, take advantage of technological advances, incorporate additional data into model relationships, and improve default values and surrogate species assignments (Dixon 2012).

This process allows comparisons of alternatives, including alternative A. While still a modeling-based approach to changes in wildlife habitat, this approach provides much more rigor than comparing an estimated habitat capability index to a theoretical carrying capacity with no evaluation criteria to assess how well the model functions. This approach better meets the intent of the forest plans. Although the HCI model was not specifically used (forest-specific models are no longer available on either the Coconino or Kaibab NFs), the approach used in this analysis is consistent with the intent of the forest plans in terms of maintaining appropriate habitats on the landscape. The goal of assessing habitat capability is to maintain and benefit wildlife, including those specifically identified on the species lists addressed in this document and other species as well from song birds to black bears. All data related to assessing a surrogate for HCI is located in the MIS effects analysis.

## Hiding and Thermal Cover

Providing for hiding and thermal cover is required by the Coconino forest plan. Hiding cover is intended to conceal animals from observation to mitigate potential human disturbance. It is defined as enough vegetative cover to hide 90 percent of a standing elk at a distance of 200 feet or less. Thermal cover is intended to ameliorate weather effects and consists of coniferous trees with a high degree of crown closure. The plan directs retention of at least 10 percent hiding cover and 10 percent thermal cover in assessment areas. The Coconino forest plan calls for an additional 10 percent be provided for in either form of cover unless the needs of a threatened or endangered species listed under the ESA conflicts with this direction (USDA 1987). Wildlife cover on the Coconino NF should be assessed in 10,000 acre. To avoid concentrating hiding and thermal cover in some areas and having it absent from others, the plan stipulates that cover be provided across the area of consideration. However, relative to the 4FRI treatment area, ten thousand acre blocks are small and the 4FRI analysis area is too large to do a meaningful evaluation as one block. Therefore, wildlife cover will be evaluated at the subunit scale, allowing for an assessment of unit areas distributed across the treatment area.

The plan was written before the 1996 amendment that moved management from relatively even-aged stand-based objectives to an interspersion of various-aged groups of trees defined by surrounding openings. Sizes of tree groups and canopy cover objectives developed for the 4FRI are from the scientific literature. The resulting forest structure is expected to meet or move towards forest plan direction. Treatments would move towards forest plan direction where existing conditions consist of even-aged stands. One entry into the stand (i.e., implementing the 4FRI) would not achieve the desired uneven-aged forest conditions, but it can create another tree age-class and move towards forest plan direction.

In the context of the 4FRI cover assessment, stands that meet the following conditions were defined as hiding cover:

1. Ponderosa pine stands that average VSS 2-4 B or C (B = canopy cover of 40 to 60 percent and C = canopy cover greater than 60 percent); the underlying assumption is that denser canopy cover values indicate denser forest structure
2. All MSO protected habitat outside PACs – by definition these are slopes greater than 40 percent and have not been harvested in the last 20 years (field reviews of PACs indicated they are too variable to generalize as meeting hiding cover; appendix 4)
3. All MSO restricted habitat (because of the oak component)
4. Pine-oak with 500 TPA or greater of oak less than five inches d.b.h. (note: this is outside restricted habitat but can include elements of PAC habitat)
5. All pine-sage habitat (Tusayan ranger district)
6. Ponderosa pine with pinyon pine and/or alligator, one-seed, and/or Utah junipers 500 trees per acre or greater and less than five inches d.b.h.
7. Ponderosa pine stands with10 BA or 10 percent BA of pinyon pine and/or alligator, one-seed, and/or Utah junipers greater than five inches d.b.h.

However, if the above conditions are met in UEA, (uneven-aged) , IT (intermediate thin), or SI (stand improvement) 40-55 treatments, only half the acres would count due to the higher intensity treatments creating more open space. The underlying assumption here is that stands would still be dominated by dense trees or support a woody understory (i.e., there would still be hiding cover), but the amount of openings would prevent the whole stand from functioning as hiding cover.

The rationale for numbers 1 through 7 above is that, regardless of the VSS class, the understory, including tree boles in dense stands, would be developed enough to provide hiding cover. The canopy conditions in number one are such that, even if the woody understory is lacking, the forest would be dense enough in these smaller diameter classes to break up sight distance.

Thermal Cover was simply defined as VSS 4BC, 5BC, and 6BC, except for the treatments resulting in 40-55 percent openings. If UEA, IT, and SI 40-55 treatments meet these classifications, only half the acres would count towards thermal cover due to the higher intensity of the treatments resulting in increased open space. Stands would still be dominated by groups of larger trees with dense canopies, but the amount of openings would prevent the whole stand from functioning as thermal cover.

### *Hiding and Thermal Cover Assumptions*

One of the design criteria with the 4FRI project is that no oak, and limited pinyon, or juniper will be cut. However, trees would be lost due to mechanical damage and fire. The FVS modeling accounts for some loss of trees through the burning prescriptions. If the modeled stands meet the above criteria, they will be counted as providing cover.

Whenever a modeled stand drops from canopy categories B or C to A (less than 40 percent canopy cover), it is assumed that there would not be adequate tree densities to provide cover. Similarly, if the VSS class for a stand drops from 3 or more to a 1 (seedlings), it will not count as cover. Treatments designed to meet wildlife-urban interface, open-habitat corridors, or savanna objectives will not count towards cover. Slope by itself does not contribute to cover.

The following assumptions were made for treatment intensities:

- Stands designed to have 10 to 25 percent openings (i.e., no trees) are relatively closed forests
- Stands designed to have 25 to 40 percent openings are relatively open forests in the short-term (see definition of short term provided earlier in this report), but ), but are only moderately open forests in long-term
- Stands designed to have 40 to 55 percent openings are relatively open forests

In summary, wildlife cover evaluations include a combination of treatment intensity, VSS category, canopy cover, slope, and woody plant species composition. Data and documentation related to hiding and thermal cover is located in appendix 9. Maintaining adequate cover ratios is expected to benefit most wildlife species, including those on the various species lists addressed in this document and other species as well from song birds to black bears.

## Surveys

Wildlife surveys have been conducted on the two Forests since the late 1980s. Surveys specific to the 4FRI analysis began in 2010 and are continuing. Surveys for particular species or species group follow approved protocol or follow the recommendations of the FWS and/or the AGFD:

- MSO surveys utilized the survey protocol developed by the FWS. The MSO survey protocol was first developed in 1988 by the Southwest Region of the FS and has been revised several times, most recently by the FWS in 2003

- Surveys for northern goshawks use the Southwestern Region Protocol
- Northern leopard frog surveys follow the recommendations of the FWS and the AGFD
- Personnel from the Kaibab South Zone and Flagstaff Ranger Districts carry out surveys along established routes for wintering bald eagles each year in January and these efforts are coordinated with the Arizona Game and Fish Department
- Game surveys are conducted by the AGFD
- Forestwide landbird surveys, including many MIS and migratory bird species, were initiated on the Kaibab NF in 2005 and on the Coconino NF in 2006. Rocky Mountain Bird Observatory (RMBO) took the lead for this effort in 2007. This effort became part of the "Integrated Monitoring in Bird Conservation Regions" (IMBCR) project which uses a spatially balanced sampling design to allow inferences to avian species occurrence and population sizes from local scales to entire Bird Conservation Regions (http://www.rmbo.org/public/monitoring/). Data will continue to be collected in 2012
- Tassel-eared squirrel surveys were incorporated into the landbird surveys starting in 2005. Statistical problems were discovered in the study design when data analysis was initiated in 2010. The survey methodology was adjusted and implemented with the 2011 surveys. Preliminary results from the 2010 analysis are presented in this report.

Additional survey information can be found in the individual species sections and in appendix 10.

## Field Reviews

Field reviews specific to 4FRI were conducted to verify conditions in MSO habitat and cave resources within the 4FRI treatment area. Seven separate trips were made to select PACs to evaluate the potential for mechanical treatments to improve nesting and roosting habitat. Trips were made by the wildlife biologists, silviculturist, fire ecologist, and team lead from the 4FRI planning team. Trips also included district personnel from the Coconino and Kaibab NFs, including people from the wildlife and fire programs. Also participating in joint and in separate PAC field reviews were personnel from the Flagstaff Ecological Field Office of the FWS.

Field visits were done to evaluate the designation of target and threshold habitat. The wildlife crew from the Flagstaff Ranger District reviewed a selection of stands in the field. Field checks on MSO habitat were conducted in September and October of 2011 after other survey obligations were met for the season. Field teams were able to review 84 individual stands designated as target or threshold habitat, including 23 on the Coconino NF and 61 on the Kaibab NF. Data was recorded in each stand visited, including total BA, average d.b.h., slope, aspect, and the percent of overstory by species. The stands were ranked from "bad" to "very good" along with comments on the general habitat viewed. A series of photos were taken in just over half of the stands. Overall, 91 percent of the stands ranked as "Okay" (n = 15) or "Good" (n = 61). Seven stands were considered "Bad" and one stand was "Very Good."

A total of 34 caves occur in the treatment area or within 300 feet of treatment boundaries. The subterranean program director for Bat Conservation International (Jason Corbett), has visited caves in cooperation with the 4FRI planning team. He has surveyed a total of 42 natural caves on the Kaibab and Coconino NFs since January of 2010 through April of 2012. The purpose of the visits is to establish baseline data and assess biological significance of these features. Four field trips were conducted to evaluate potential relationships between forest restoration and cave management. Visits to basalt and limestone features revealed direct and unintended impacts of mechanical treatments were possible. Future cave resource reviews by Bat Conservation

International will better determine use by roosting bats. As a result of these investigations, we determined a 300-foot no-harvest buffer (about 6.5 acres) will be designated around each cave to prevent siltation and exposure of cave entrances, protect cave invertebrates and ensure exogenous energy sources (Taylor et al. 2005), and protect cave micro-climates and hydrology. Exposing entrances that currently have vegetative cover can put cultural and biological values at risk and alter the basic function of the cave twilight zone by increasing direct sunlight and temperatures and decreasing humidity. Some of the initial portions of caves are shallow with exposed roots hanging from the ceiling. The risk of heavy machinery collapsing passageways and potentially risking human safety would be avoided by restricting mechanical manipulation of vegetation in the area surrounding cave entrances. Prescribed fire would be allowed within cave buffers, but no high-severity fire would take place within the buffers so that adequate vegetative cover would remain to prevent potential sedimentation into caves and sinkholes.

### Scientific Literature

Scientific literature citations for references used in the development of this analysis are listed at the end of the document. The main text of the wildlife report includes focused literature reviews on specific topics such as noise disturbance to MSOs, wildfire effects to MSOs and their habitat, and road effects to small mammals.

Additional literature sources can be found in the appendices. Understory Response to Changes in Overstory Cover (appendix 6) summarizes literature pertinent to soil resources, plant community structure and composition, water and nutrient cycles, forage production, biodiversity, wildlife habitat, and fire effects across the 4FRI landscape. Appendix 6 is the basis for developing an understory index for comparing herbaceous response to proposed treatments. Interrelationships of arthropod and prey species (for MSO and goshawks) response to changes in understory vegetation are also reviewed. A review of MSO biology, ecology, and habitat components is presented in appendix 11. Appendices 6 and 11 both present syntheses of scientific literature to better define species and ecological responses to management actions.

# Affected Environment

A diverse assemblage of wildlife were identified for analysis under the proposed 4FRI, including species listed under the ESA, Forest Service sensitive species, MIS, and migratory birds. Species that were evaluated here are ones known to occur within or have habitat within or adjacent to the treatment area. Each species from the above groups (i.e., ESA, MIS, etc.) that occurs or has potential to occur within the analysis area was analyzed according to the applicable law, regulation, or policy. In some cases, surveys for these species have confirmed their presence in or near the analysis area. In cases where a species has not been detected, the presence of suitable habitat indicates they could be present and therefore their presence was assumed under this analysis. Aquatic TES and MIS are addressed in the Fisheries Specialist Report. Sensitive plant species are addressed in the Botany Specialist Report. The effects to MSO are also analyzed in a separate Biological Assessment (BA) for the purpose of section 7 consultation with the FWS.

## Location and Setting

See the FEIS for descriptions of the project’s location and acres that have been excluded from the analysis area.

# Coconino and Kaibab Forest Plan Direction

The analysis area includes 23 management areas (MA) as described in the Coconino NF Plan (pages 46 to 206–113). Chapter 1 of the EIS displays MAs located within the analysis area, forest plan MA emphasis, and the relationship between MA total acreage to the project. The MA direction for the Flagstaff/Lake Mary Ecosystem Analysis Area (FLEA) MA is displayed throughout the 10 MAs that make up the FLEA.

A revised forest plan was published in February of 2014. The FEIS has been updated to reflect new management direction. On the Kaibab NF, the analysis area is primarily within the ponderosa pine major vegetation type and the following management and/or designated areas: WUI (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.

For additional information, see chapter 4 of the Coconino National Forest Plan, page 98 to page 206 and page 85 to page 107 of the (revised) Kaibab National Forest Land Management Plan where detailed descriptions of forestwide resource direction specific to the management areas is located. A summary of management emphasis specific to wildlife is presented in the appendix 1. The FEIS displays the acreage associated with the MAs by NF in the analysis area where the majority of restoration actions are proposed.

# Vegetation Cover Types Within the Analysis Area

The 4FRI analysis area is approximately 988,674 acres. The analysis area contains state, private, and Federal lands, including lands managed by the National Park Service. Also within the analysis area are recent and ongoing vegetation management projects excluded from 4FRI planning. The 4FRI acres analyzed for treatment equal about 507,839 acres of predominantly ponderosa pine forest (“treatment area”). Grasslands, aspens, oak woodland, and pinyon-juniper are included in the 4FRI treatment area (Table 4). Other lands managed by the FS within the analysis area but outside the treatment area are designated wilderness, current and recent projects on the individual ranger districts, mixed conifer vegetation, etc.

**Table 4. Vegetation cover type acres by restoration unit (RU)**

| Cover Type | RU 1 | RU 3 | RU 4 | RU 5 | RU 6 | Total | Percent of Area |
|---|---|---|---|---|---|---|---|
| **Non-Vegetated** | | | | | | | |
| Barren | 120 | 134 | 129 | 1,301 | 48 | 1,732 | 0.3 |
| **Non-Forest Communities** | | | | | | | |
| Grassland | 8,226 | 12,796 | 22,661 | 4,927 | 93 | 48,703 | 8 |
| **Forest Communities** | | | | | | | |
| Pinyon Juniper Woodland | 1,428 | 5,884 | 7,283 | 8,845 | 2,219 | 25,658 | 4 |
| Oak Woodland | 287 | 1,633 | 926 | 386 | 30 | 3,262 | 0.5 |
| Aspen | 420 | 202 | 497 | 403 | | 1,522 | 0.3 |
| Pine Oak[1] | 59,555 | 47,219 | 2,134 | 1,465 | | 110,373 | 19 |
| Ponderosa Pine | 84,559 | 82,006 | 132,144 | 57,568 | 41,189 | 397,466 | 68 |
| **Total Forested Acres:** | **146,248** | **136,944** | **142,983** | **68,668** | **43,437** | **538,281** | **91** |
| **Total Treatment Area Acres:** | **154,594** | **149,874** | **165,774** | **74,895** | **43,579** | **588,716** | **100** |

1. Pine-oak is a subset of the ponderosa pine forest type

## Ponderosa Pine Forest

The ponderosa pine forest vegetation community is dominated by ponderosa pine but includes other species such as oak, junipers, and pinyon. Species such as aspen, Douglas-fir, white fir, and blue spruce may also be present, but occur infrequently as small groups or individual trees. This forest vegetation community typically occurs with an understory of grasses and forbs and sometimes includes shrubs. There are 507,839 acres of ponderosa pine forest in the treatment area.

The ponderosa pine forest includes two major associations or sub-types: Ponderosa pine-bunchgrass and ponderosa pine-Gambel oak. Associations are named for the most shade tolerant understory species successfully regenerating and which are most diagnostic for these sites.

Ponderosa pine commonly grows in pure stands and currently is found in even-aged and uneven-aged structural conditions across the area (see the silviculture report for details). The common, open park-like characteristic of reference conditions for ponderosa pine forests (Swetnam and Baisan 1996) promoted greater faunal diversity and were better adapted to fire than the dense stands of today. Ponderosa pine forests within the project are generally denser and more continuous than in reference conditions and accumulations of forest litter and woody debris are much higher than would have occurred under the historic disturbance regime. Lack of fire disturbance has led to increased tree density and fuel loads that increase the risk of uncharacteristically severe wildfire and drought-related mortality. There is a moderate risk of insect and/or disease outbreak, which is also a function of increased tree density.

See Vegetation Structure in Goshawk and MSO Habitat below and the silviculture report for details.

### Ponderosa Pine – Understory Vegetation

Understory vegetation beneath ponderosa pine represents nearly all the vegetation species richness and diversity that occurs in southwest ponderosa pine forests. In this report, “understory” refers to grasses, forbs, sedges, and shrubs. The manner in which understory is discussed, measured, and evaluated in this report does not typically include tree seedlings and saplings, although they do contribute to hiding and thermal cover. The herbaceous vegetation and shrubs provide the primary foods for herbivores, including vertebrates and arthropods.

The Woolsey Plots represent the oldest known forest inventory plots in the American Southwest. These long-term research plots were established in northern Arizona ponderosa pine forest, including the 4FRI area. Originally established between 1909 and the 1920s, these plots were used to evaluate changes in forest structure and ecosystem function, including understory production. Plot readings were consistently taken from 1910 through 1950. Moore et al. (2004) relocated and re-measured a subset of the Woolsey Plots and used the data to develop models displaying changes in forest structure, including understory (Figure 5). Algometric equations based on the historic ponderosa pine tree mapping were used to estimate understory production in 1870 (presettlement conditions) and in 1910 (after tree harvest). Understory production peaked with the timber harvest and continually declined thereafter as basal area increased. Density and basal area have increased to levels greatly exceeding those found in 1876 (Moore et al. 2004). Understory production and was lower in 2002 than any previous date. The decline would be expected to continue, minimizing food and cover for wildlife in general and MSO and goshawk prey species specifically if the current trend continues (Figure 6).

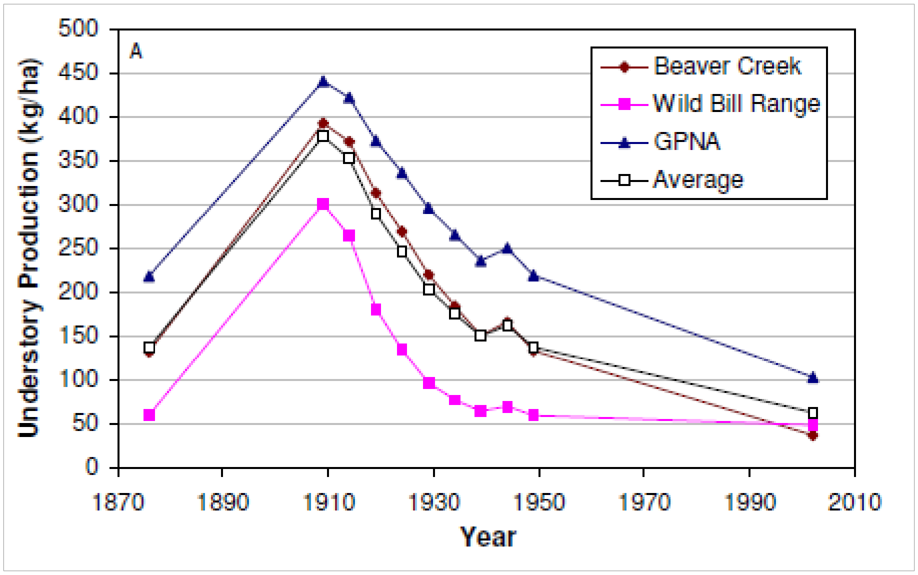


**Figure 5. Changes in understory production from 1876 to 2002 (from Moore et al. 2004); all models were developed within or adjacent to the 4FRI analysis area**

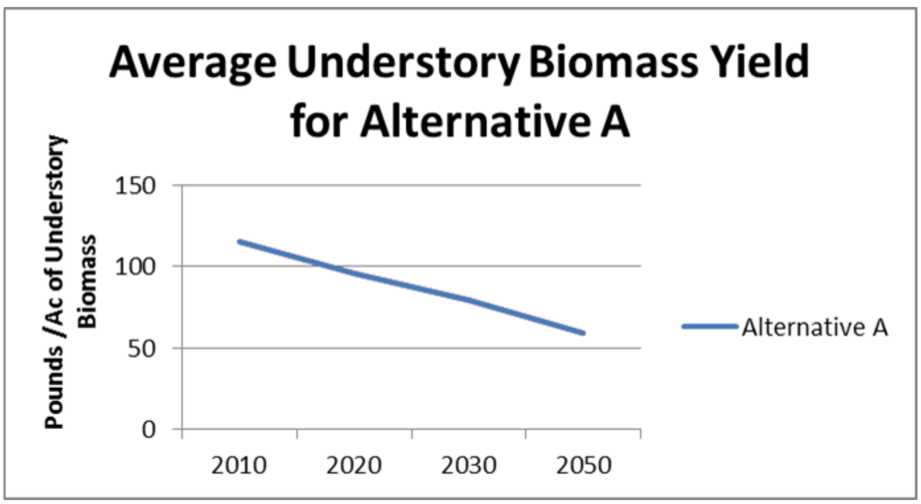


**Figure 6. Relative changes in biomass indices within the 4FRI treatment area under alternative A (see appendix 6 for details)**

Research conducted within the current 4FRI treatment boundaries has shown substantial declines in herbaceous vegetation diversity and biomass over the past century due to increased tree density, increased canopy cover, and increased litter depth. This trend indicates a shift away from a more diverse and abundant understory community as vegetative productivity became dominated by post-settlement pine trees. The ponderosa pine analysis area supports high stand densities and closed tree canopies, locking up many nutrients that were historically available to herbaceous plants. The relative density of young to mid-aged trees is uncharacteristically high (see silviculture report, USDI 1995, and appendix 6), creating closed canopy conditions that suppress understory growth. Current understory conditions represent a fraction of the herbaceous biomass that used to occur within the proposed 4FRI treatment area and declines are expected to continue with time (appendix 6).

The arthropod community is tied directly to understory vegetation. Arthropods provide multiple ecosystem services, e.g., pollination, pest control, soil health services, food for vertebrate wildlife, etc. The summary of relationships between overstory cover and response of understory includes a review of effects to arthropods from changes in the vegetation (appendix 6). Arthropods, their associated habitat support a wide range of small mammals and birds. Many of the small mammals and birds are the prey species that sustain MSOs and northern goshawks. Because so many ecological relationships that span trophic levels are tied to understory development, and hence to forest canopy conditions, an understory response index was developed to facilitate comparisons of proposed treatments. The understory index provides an evaluation of relative changes in biomass of grasses, forbs, sedges, and shrubs after treatment implementation. These ecological relationships are discussed in appendix 6 and incorporated here.

## Ponderosa Pine – Gambel Oak

The ponderosa pine-Gambel oak association is a major sub-type of the ponderosa pine forests of northern Arizona. Gambel oak is a common understory species with ponderosa pine, but the forest plan and MSO Recovery Plan (Recovery Plan) provide definitions of the ponderosa pine-Gambel oak association based on basal area and/or percent of total trees. Gambel oak is frequently the only deciduous tree in the relatively pure southwestern ponderosa pine forests. It is commonly provides food (including hard mast) and cover for a wide range of species such as prey species for raptors, landbirds including turkeys (*Meleagris gallopavo*), and black bears (*Ursus americanus*). Gambel oak is frequently found in rocky areas where few or no other trees grow, providing additional wildlife cover. Its presence adds diversity to forest structure and habitat, understory vegetation, and soil microflora (appendix 6). Similar to pure ponderosa pine forests, pine-Gambel oak forests have been altered since Euro-American settlement in the late 1800s. These changes have resulted in an overall increase in small- and medium-sized Gambel oak stems and a more simplified forest structure (Abella 2008). Fire, along with bunch grass competition, helps Gambel oak compete with potential pine encroachment (Abella 2008, Reynolds et al. 1992).

Gambel oaks provide important elements of wildlife habitat. The bottom-up resource input of mast production influences ecological interactions of wildlife species at multiple trophic levels and can be a driver of abundance and dynamics of small mammals and birds (Kelly et al. 2013). Small, brushy growth forms provide hiding cover; intermediate sizes have the highest mast production, and larger diameter trees (greater than 10 inches d.r.c.) provide a range of nesting substrates, including large cavities. Pine encroachment will eventually lead to a reduction of Gambel oak in general and a loss of large diameter oak specifically. These changes in forest structure are expected to negatively affect wildlife in northern Arizona, including Management Indicator Species and migratory birds. Species likely affected include: elk (*Cervus elaphus*), mule deer (*Odocoileus hemionus*), black bear, wild turkeys, Abert's squirrels (*Sciurus aberti*), acorn woodpeckers (*Melanerpes formicivorus*), band-tailed pigeons (*Columba fasciata*), and many songbirds that derive part of their diet from Gambel oak. Some bat species occur more frequently in ponderosa pine-Gambel oak forests than ponderosa pine forests, including southwestern myotis (*Myotis auriculus*), Allen's lappet-browed bat (*Idionycteris phyllotis*), and red bats (*Lasirurs blossevillii*) (reviewed in Chambers 2002). Gambel oak is also an important component of MSO habitat. Ponderosa pine – Gambel oak habitat is managed as protected and restricted habitat under the MSO Recovery Plan (USDI 1995). MSO occupancy, nest success, and viability of prey populations are positively associated with the presence of large Gambel oak (May and Gutierrez 2002, May et al. 2004, USDA 2010a). Oak management strategies within this project includes conservation of all existing large, old oaks, maintaining a variety of growth forms and managing for densities similar to the historical range of variability for oak.

## Pine-Sage

Pine-sage is another subset of the ponderosa pine forest in northern Arizona. Sagebrush communities in northern Arizona represent the southernmost reach of the greater sagebrush biome that covers much of the western United States and parts of southwestern Canada. The Kaibab NF contains a disproportionate amount of sagebrush compared to the greater ecoregions (KNF 2009). Pine-sage includes a ponderosa pine overstory with Wyoming big sagebrush (*Artemisia tridentate, ssp. wyomingensis*) as the most common in sage the understory. Also potentially present, but much less common, is black sage (*A. nova*), Basin big sagebrush (*A. t. ssp. tridentata*), Bigelow sagebrush (*A. bigelovii*), black sagebrush (*A. nova*), and sand sagebrush (*A. filifolia*). Other species growing in association with sage include rabbitbrush (*Chrysothamnus spp., Ericameria spp*.), saltbush (*Atriplex spp*.), and succulents (e.g., yucca [*Yucca ssp*.], cactus [*Opuntia ssp.*]). Understory vegetation includes tall- and low-growing grasses and forbs and well-developed cryptobiotic crusts. Species composition varies by location. Plant cover is usually not continuous. Fire disturbance is highly variable in type and frequency across elevation and moisture gradients and site productivity.

Sagebrush provides habitat for migratory bird species, many of which are in decline across the country. Overall, wildlife species diversity may be lower in sagebrush systems than in habitat types with greater vertical complexity, but the species that occur in sagebrush systems often occur nowhere else. Populations of many bird species that depend on these ecosystems are in decline, and many have special conservation status. On the Kaibab NF, species that depend on shrub steppe habitat include Brewer's sparrow, vesper sparrow, sage sparrow, and sage thrasher (AZGF species of greater conservation needs), green-tailed towhee, black-throated sparrow, and gray vireo (USFWS species of management concern).

There are approximately 16,000 acres of potential pine-sage vegetation type in RU6 according to the Terrestrial Ecological Survey (Brewer et al. 1991). Desired conditions are to maintain and enhance the sage understory and restore the historic overstory/understory pattern within the pine-sage mosaic. Maintaining and promoting pine-sage, along with Gambel oak, aspen, and grasslands, will move towards desired conditions for vegetation diversity. A study that included one of the four main soil types for pine-sage suggests that ponderosa pine density has increased substantially since 1887 (Huffman et al. 2006). Vegetation conditions are variable, depending on soil depth, type, and productivity in this dry plant type. Overtopping of sage by pine is probably a result of fire exclusion while frequent fire would likely suppresses big sagebrush establishment.

Currently, sage cover under ponderosa pine varies from approximately 2 percent cover where it burned with high intensity surface fire, or where it has been shaded out by pine, to well over 35 percent cover in areas where fire has been excluded.

About 5,260 acres of pine-sage thinning treatments are proposed in the action alternatives are designed to remove post settlement pine that are currently overtopping and shading out the sage and to manage fire to improve sage extent. These treatments would result in enhancement of the sage component and restore the historic pattern within the pine-sage mosaic.

## Summary

The above information describes several key habitat features outside the historical range of variation. Ponderosa pine forests within the 4FRI treatment area have less structural diversity due to more acres occurring as even-aged forest compared to historical conditions. Structure is also limited by the abundance of young and mid-aged trees and the decrease in mature and old-growth trees. These conditions do not meet forest plan direction for the ratio of age-classes interspersed across the landscape. The abundance of younger, continuous forest reduces canopy gaps. The loss of solar radiation reaching the forest floor, along with infilling of meadows, savannas, and grasslands, reduces understory vegetation. Habitat structure within the treatment area can determine the present or absence of wildlife species. Many wildlife species select habitat provided by large and old trees, including bark gleaners (e.g., pygmy nuthatches and hairy woodpeckers which are both MIS), cavity nesters (e.g., MSO which is a Threatened Species), communal roosting species (e.g., Allen’s lappet-browed bats, a Sensitive Species), and larger/heavier nesting species (e.g., northern goshawks, a MIS and Sensitive Species). Simplifying structure and declines of habitat features like aspen, Gambel oak, and the herbaceous community reduce habitat for an array for wildlife species from multiple trophic levels, including invertebrate communities and larger carnivores.

## Quaking Aspen

Within the treatment area, quaking aspen (*Populus tremuloides Michx*.) is limited to small patches within a larger forest matrix dominated by ponderosa pine or mixed conifer vegetation. Aspen is an early seral component of the ponderosa pine ecosystem and a species that provides for habitat diversity. Similar to Gambel oak, aspen provides diversity within the relatively homogeneous forest conditions of southwestern ponderosa pine. The leaf litter changes soil chemistry and micro-flora. Aspen snags provide nesting and foraging sites, creating habitat that sustains a diversity of avian species.

Aspen reproduces by seed or asexually through root suckers that are a clone of the original parent tree. Fire, insect, disease, wind and human disturbances regenerate this shade-intolerant species by opening up the canopy and removing conifers from the understory. Without disturbance, conifers gradually overtop aspen, close the canopy, and eventually kill the mature trees and reduce regeneration.

Recent aspen mortality had been linked to drought stress and elevated temperatures, similar to conditions predicted by regional climate change models. Contrary to many late-successional tree species, slow initial growth rates may predispose aspen to earlier mortality (Ireland et al. 2014). Aspen is also highly susceptible to browsing and disease or death due to bark injuries. Elk are particularly damaging to aspen, browsing on aspen suckers, rubbing antlers on mid-sized trees and eating bark from larger trees. Aspen patches are regenerating successfully where ungulates are excluded by fencing.

There are unique wildlife habitat features associated with islands of (deciduous) aspen within a (coniferous) sea of ponderosa pine that are being lost and the loss is expected to continue under current conditions. Conifer encroachment, where conifer trees gradually succeed aspen trees through competition for space, light, and water is a major cause of aspen decline (Johnson 2010). In northern Arizona, regional avifauna can reach higher densities and species richness in aspen than in general ponderosa pine forest (Griffis-Kyle and Beier 2003). Although disappearing from the landscape, small aspen stands may be crucial to birds in years of resource scarcity (Griffis-Kyle and Beier 2003). Conifer encroachment can increase nest predator richness and abundance in aspen stands, including Steller’s jays, ravens, chipmunks, and tree squirrels (Johnson 2010). Decreasing aspen stand size and aspen tree density within a stand decreased bird diversity and reproductive success (Johnson 2010). A negative exponential relationship between conifer cover and understory biomass was demonstrated in aspen stands where understory production begins to decline under very low levels (10 percent to 20 percent) of conifer encroachment (Stam et al. 2008). Understory biomass provides the food and cover to support small mammals, birds, and arthropods, including pollinators (appendix 6).

Aspen was designated as a priority habitat in the implementation plan for bird conservation in northern Arizona developed by the Intermountain West Joint Venture Arizona Steering Committee (IWJV 2005). The objective is to permanently protect, enhance, and/or restore approximately 10,000 acres of aspen habitat in northern Arizona. This would be accomplished by managing for aspen stands with a range of aspen age-classes within a larger forest complex to ensure recruitment of older aspen trees and snags.

There are approximately 1,522 acres of aspen in the treatment area. Most aspen within the treatment area show signs of decline. Aspen is dying or rapidly declining on both forests due to the combined effects of conifer encroachment, browsing, insect, disease, severe weather events, and lack of fire (Griffis-Kyle and Beier 2003, USDA 2008, 2009). The desired condition is to maintain and/or regenerate aspen. Where possible, there is a need to stimulate growth and increase individual recruitment of aspen. Ungulate browsing has nearly eliminated aspen regeneration and insects, disease, and overtopping by pine is causing mortality and crown dieback in older trees. A study by Fairweather et al. (2008) on the Coconino NF indicates that aspen on low-elevation dry sites (less than 7500 feet) has sustained 95 percent mortality since 2000. Mortality on these sites is expected to continue as many live trees currently have only 10 to 30 percent of their original crown.

## Pinyon – Juniper Woodlands

The pinyon-juniper cover type is collectively composed of the pinyon-juniper grassland, pinyon-juniper sagebrush, pinyon-juniper evergreen shrub, and pinyon-juniper persistent woodland communities. Two-needle pinyon pine is common; as well as one-seed, Utah, Rocky Mountain, and alligator juniper. Species composition and stand structure vary by location primarily due to precipitation, elevation, temperature, and soil type. There are 25,658 acres of pinyon-juniper habitat within the analysis area.

Most of the pinyon-juniper vegetation communities are currently younger and denser than they were historically, because of changes in wildfire occurrence and past grazing. Greater tree density has increased competition for water and nutrients. This, in turn, has caused a reduction in understory plant cover and diversity, a loss of ground cover, and subsequent increases in soil erosion. Pinyon-juniper woodland supports a wider array of birds and mammals than ponderosa pine forest. Several species of birds are directly associated with pinyon-juniper habitats, including pinyon jays and juniper titmice, and woodlands provide key winter habitat for a range of species including ungulates and raptors. The pinyon-juniper communities produce hard mast that support high densities of small mammals, making them important foraging areas for carnivorous species, including black bears, birds, and snakes. Many species of wildlife select for large trees for foraging and large snags for nesting. Current conditions slow growth rates of trees, prolonging the time required to develop old and large trees. Slowed growth rates can also leave large and old trees more vulnerable to short- and long-term weather and climate trends (Kane and Kolb 2014). The delay in replacing this component of woodland habitat also delays future large diameter snag recruitment.

## Grasslands, Savannas, and Meadows

More than 97 percent of the native grasslands of the U.S. have been lost, mostly because of conversion to agriculture. Less than 2 percent of U.S. grasslands are publicly owned and managed primarily for conservation (North American Bird Conservation Initiative 2011). Many wildlife issues are associated with grasslands, including population declines of several grassland wildlife species. Species with documented declines include prairie dogs (Cynomys gunnisoni) a keystone species that provides important ecological functions (Rickel 2005). Grassland birds are among our nation's fastest declining species. Grassland bird populations have declined further from historical levels than any other group of birds (North American Bird Conservation Initiative 2011). They have been described as having experienced steeper, more consistent and more geographically widespread declines than any other behavioral or ecological guild with 48 percent of grassland-breeding bird species of conservation concern (Merola-Zwartjes 2005, North American Bird Conservation Initiative 2011).

Grasslands within the treatment area are typically categorized as the productive Montane/Subalpine and the more arid Colorado Plateau/Great Basin and total 48,703 acres. In addition, nearly 60,000 acres of ponderosa pine forest occurs on soil types that developed under grassland or savanna conditions (mollisol and/or mollic-intergrades). Grasslands vary in size from just a few acres ("meadows") to well over 1,000 acres and support a wide variety of grasses, forbs, shrubs and/or trees that vary by soil type, soil moisture, and temperature. Historically, grasslands typically had less than 10 percent tree cover. Savannas generally supported 10 to 30 percent tree cover and could appear as grasslands with scattered groups of and individual trees. Technically, savannas are open forest but from the wildlife perspective they can function more like grasslands in terms of the habitat and its associated wildlife species. The use of the term meadow in this report references dry meadows that are proposed for restoration treatments. Historically, tree regeneration was regulated by the fire regime (pattern, frequency, severity).

The vegetation within the 4FRI landscape has been described as a zonal pattern of grasslands within woodland and forest cover types (USDI 1995). Combined with the effects of diverse topography, there was an interspersion of grasslands, savannas, and meadows creating abundant and widespread forest-meadow interfaces (USDI 1995). Grasslands, savannas, and meadows provide valuable habitat for many wildlife species including pronghorn antelope (MIS), Bendire's thrasher and grasshopper sparrows (migratory birds), raptors such as burrowing owls (Sensitive Species), Swainson's hawks, and ferruginous hawks (migratory birds) and an abundance of small mammals including Navajo Mogollon voles (Sensitive Species) and a range of important prey species for both MSOs and northern goshawks. Edge habitat is related to spotted owl fitness (Franklin et al. 2000). Mature and old-growth forests balanced with convoluted edges may function as better spotted owl habitat than contiguous blocks of old-growth (Franklin et al. 2000). The reliance of MSOs on voles and mice as major prey species may reflect the abundant edge habitat that occurred in the UGM (USDI 1995). Savannas and meadows are used by game species such as elk and black bears. Changes in wildlife populations within grasslands, savannas, and meadows since Euro-American settlement in northern Arizona include: one species extirpated as a direct result of human activities (black-footed ferret [Mustela nigripes]); seven species, including birds and mammals, have decreased in abundance; and two species have increased in abundance (Brown and Davis 1998).

Impacts from grazing, logging, and fire suppression practices that started in the late1800s are still discernible on the landscape today. These practices reduced or eliminated the vegetation necessary to carry low-severity surface fires across the landscape, thereby altering the natural fire regimes and allowing uncharacteristic forest succession to take place. Ponderosa pine and other woody vegetation encroached upon or invaded the once open grasslands, savannas, and meadows due to disruption of the historic fire regimes and historic grazing patterns. Many of the pre-settlement trees that grew along the edges of these grasslands were removed historically. These edges as well as much of the interior of the grasslands have become stocked by sapling and young to mid-aged trees. These trees are growing rapidly due to the developed soils, open growing conditions and a lack of competition. As tree canopy increases, understory productivity decreases.

These conditions have been further exacerbated by recent increases in invasive, nonnative plants, soil erosion, and low-density rural home development.

Over half of the total grassland acres across the Coconino NF and Kaibab NF have become encroached with trees and converted to forest. This represents a direct reduction in habitat for many grassland species. An assessment completed in 2008 found that within ponderosa pine on the Coconino NF, grasslands have decreased from approximately 8 to 3 percent since historic conditions (generally pre-1900). On the Kaibab NF, grasslands have decreased from approximately 15 percent to 7 percent. In addition to loss of habitat, pine encroachment decreases habitat effectiveness of remaining habitat. Tree encroachment changes the pH balance of soils and increases total lignin component, slowing decomposition rates. Increased shading reduces solar radiation reaching the ground and the trees out-compete understory vegetation for water and nutrient. The sum of these effects reduces biomass and decreases species richness in the herbaceous layer (see appendix 6). The declining trend in the plant community can decrease hiding cover, forage, including arthropod biomass, affecting a broad range of vertebrate species. Many of the species affected by loss of meadows include important prey species for MSO and northern goshawks.

The vegetation database does not include “meadows” as a separate cover-type from grasslands. Meadows are smaller scale open areas within forest habitat while, due to their inherent size, grasslands are a separate vegetation type. Some species are common in meadows but may avoid extensive grasslands (e.g., long-tailed voles) while others are common in grasslands but are not typically found in meadows (e.g., burrowing owls). Acreage summaries are based on and dominated by actual grassland habitat, although some of the wildlife discussions below focus on meadow habitat and meadow restoration. Sometimes acres of meadow can be identified because grassland acres are limited to small patches. All or nearly all “grassland” values in MSO protected habitat can be assumed to be meadows. Other times actual meadow acreage is unknown as in MSO restricted habitat where grasslands can be intermixed with MSO habitat and cannot be accurately identified as a stand-alone habitat component in the database. Because grassland habitat is classified differently from forest habitats, a query of grassland acres within restricted habitat could not be accomplished. Therefore, acres of grassland and meadow treatments in restricted habitat were estimated by calculating those acres occurring within Critical Habitat boundaries. This is expected to provide a reasonable estimate to evaluate effects to restricted habitat.

Grasslands above 5,000 feet elevation were designated a priority habitat in the implementation plan for bird conservation in northern Arizona, developed by the Intermountain West Joint Venture Arizona Steering Committee (IWJV 2005). The stated objective is to permanently protect, enhance, and/or restore over 500,000 acres of grassland in northern Arizona. This would be accomplished by managing for grass and forb cover capable of carrying fire. Restoration of natural fire regimes would reduce invasion of meadows, savannas, and grasslands by woody species.

The 4FRI treatment area includes over 48,000 acres of existing grasslands that, to varying degrees, are encroached by ponderosa pine trees. More than 56,600 additional acres of encroached grassland, savanna, and meadows are currently dominated by ponderosa pine forest.

## Springs and Ephemeral Channels

Springs and ephemeral channels represent important sources of ecological heterogeneity in the ponderosa pine forests of northern Arizona. Although limited in scale, they are areas of biodiversity within a relatively homogeneous landscape. They are also areas of concentrated wildlife use from invertebrates to large mammals. Ecological processes within both habitat features have been compromised, e.g., water availability is reduced at many springs and some ephemeral stream channels are heavily eroded with excessive bare ground, denuded vegetation, and head cuts.

The desired condition for springs is to have the healthy soil, water, and vegetation attributes so they function at or near potential. Spring restoration would move water flow patterns, recharge rates, and geochemistry towards historical levels. Water quality and quantity would maintain native aquatic and riparian habitat and designated beneficial uses, consistent with water rights and site capability.

Ephemeral streams are important for hydrological function of watersheds and provide important seasonal habitat for a variety of wildlife, including MSO prey species. Ephemeral stream channels proposed for restoration include those with and without actual riparian vegetation. About 39 miles of ephemeral stream channel restoration are proposed across the 4FRI treatment area.

The objectives for spring and ephemeral channel restoration are to: move flow patterns, recharge rates, and geochemistry towards historical levels; native biological diversity and pre-settlement tree patterns should be conserved or recovered in soil types that are regularly moist to avoid shading and uncharacteristic translocation of water and nutrients from affected soils; plant distribution and species composition should be resilient to natural disturbances. Improving water quality and quantity would improve riparian habitat for wildlife, consistent with water rights and site capability. Restoration of springs and ephemeral channels would be evidence-based and designed to improve native vegetation species composition. Pre-settlement trees would be retained where present. The largest trees available would be left where only evidence of pre-settlement trees remains. Areas without evidence of pre-settlement trees would be treated to provide forest interspace. Restoration activities proposed for springs and ephemeral channels would include prescribed first-entry and maintenance burning. Design features associated with spring and ephemeral channel restoration include:

- All restored spring and ephemeral channel sites would be protected from ungulate browsing.
- Using soil and water BMPs to minimize the impacts of management activities within riparian areas
- Retain large snags and logs on site
- Avoid wire fencing (to exclude ungulates)in PACs
- Apply northern leopard frog mitigation where breeding habitat occurs

All restoration activities would occur outside the MSO breeding season.

## Tree Density

Euro-American settlement in northern Arizona has altered wildlife populations indirectly through uncharacteristic changes in forest structure. Ponderosa pine forests within the treatment area are generally denser and more continuous than in reference conditions. The density of the forests and the continuous nature of the canopy simplifies forest structure from the perspective of wildlife habitat. Forest gaps or interspaces between tree groups are largely grown in with trees, limiting understory development (Silviculture report; appendix 6). The abundance of trees and lack of fire have allowed an uncharacteristic build-up of surface and canopy fuels that suppresses understory development and sets up high-severity fire, including active crown fire. The combination of these characteristics reduces habitat both directly (effects vary by species) and indirectly (limiting forage for most species, including herbivores, granivores, insectivores, carnivores, and omnivores; appendix 6) while maintaining a higher risk from high-severity fire.

Stand density is relevant to wildlife because it integrates forest structure and forest health. In terms of wildlife habitat, this relates to habitat structure and resiliency. Common measures of stand density are basal area (BA), TPA, and stand density index (SDI). BA is the cross-sectional area of all trees, measured in square feet per acre. TPA is simply a count of the total number of trees on an acre. These summary statistics do not give an indication of tree sizes and therefore can be biased when used alone to determine site conditions. For example, seedlings have little influence on BA, but a strong influence on TPA. Using BA alone does differentiate between a stand with many small trees or a stand with few big trees. Very different forms of wildlife habitat could have the same BA value. TPA alone does not reveal much information either. TPA by size-class is more informative, but without a reference to site potential, it does not address issues related to the health of the stand. However, SDI is a relative measure of tree density based on the number of TPA and the mean diameter of the tress (Reineke 1933). SDI expresses tree size and density relative to the theoretical maximum density possible for trees of a given diameter and species. SDI is a good indicator of how trees use site resources and so provides insight into habitat conditions such as open or closed growing conditions and susceptibility to stochastic events. Maximum SDI (SDImax) is where competition induced mortality exists. Stands can be managed for denser conditions, but the higher the SDImax, the more prone forests would be to succumbing to stress from events like drought, insects, disease, or warming average temperatures and drier seasons, i.e., the less resilient forests become to surviving stochastic events.

Long (1985) divided SDI percentages into four zones which consider the percent of an area occupied by trees relative to a maximum density possible for a given tree species of a particular diameter (Table 5). Each zone describes the relationship between tree growth, competition, and potential mortality, which all relate to habitat resiliency. Based upon established forest density/vigor relationships, density-related mortality begins to occur once the forest reaches 45-50 percent of maximum stand density (zone 3), and mortality is likely at density levels of 60 percent and above of maximum stand density (zone 4).

**Table 5. Relationships of forest density to forest stand development and tree characteristics**

| Percent Maximum SDI* | Zone | Forest Stand Development and Tree Characteristics |
|---|---|---|
| 0 – 24 percent<br>Low Density | 1 | Less than full site occupancy, maximum understory forage production.<br>No competition between trees, little crown differentiation.<br>Maximum individual tree diameter and volume growth.<br>Minimum whole stand volume growth. |
| 25 – 34 percent<br>Moderate Density | 2 | Less than full site occupancy, intermediate forage production.<br>Onset of competition among trees, onset of crown differentiation.<br>Intermediate individual tree diameter and volume growth.<br>Intermediate whole stand volume growth. |
| 35 – 55 percent<br>High Density | 3 | Full site occupancy, minimum forage production.<br>Active competition among trees, active crown differentiation.<br>Declining individual tree diameter and volume growth.<br>Maximum whole stand volume growth.<br>**Upper range of zone marks the threshold for the onset of density-related mortality.** |
| 56+ percent<br>Extremely High Density | 4 | Full site occupancy, minimum forage production.<br>Severe competition among trees, active competition-induced mortality.<br>Minimum individual tree diameter and volume growth, stagnation.<br>Declining whole stand volume growth due to mortality |

* SDImax for ponderosa pine is 450

Understanding these forest density relationships allows managers to better evaluate existing conditions and identify options for achieving desired conditions. For example:

- Grassy stands of open canopy, large-diameter trees with long, heavy-limbed crowns will develop by maintaining densities in zones 1 and 2.
- Stands of moderately dense canopies with intermediate-sized trees retaining live-crown ratios of 40 to 60 percent exhibiting self-pruning would maintain densities in the upper half of zone 2 and the lower half of zone 3.
- Clumpy, irregular stands containing groups of varying ages will develop by periodically making openings (regeneration group openings) where growing space is available for seedling establishment. Growing space areas would fall into zone 1.
- Longevity of existing old-growth trees would be enhanced by reducing competition with smaller, more vigorous trees to create micro-site growing conditions equivalent to zones 2 or 3.
- Reducing density-related mortality will maintain forest vigor and resiliency and can be achieved by maintaining densities at or below the lower half of zone 3.

Forest developmental stages are typically classified by dominant diameter classes of live trees on FS lands in Arizona and New Mexico. Each size class represents a generalized description of forest age and tree size from seedling to old forests. It is an integrative approach, combining vegetation and forest growth, to describe southwestern forests. Six vegetation structural stages (VSS) have been defined primarily on tree diameters and are based on the time it takes seedlings to become established and subsequent growth rates. These stages are: VSS 1, forests dominated by grasses, forbs and shrubs and trees less than an inch in diameter; VSS 2, forests dominated by seedlings and saplings, ranging from 1 to 4.9 inches d.b.h.; VSS 3 are young forests with trees 5 to 11.9 inches d.b.h.; VSS 4 are mid-aged forests with trees 12 to 17.9 inches d.b.h.; VSS 5 are mature forests with trees 18 to 23.9 inches d.b.h.; VSS 6 are old forests with trees greater than 24 inches d.b.h. (Reynolds et al. 1992). The VSS classification is based on the tree size class with the highest square foot of basal area. Basal area includes all tree species. Because stand-level structural stage is based on the tree size classes with the highest square foot of basal area, it provides a true description of age class diversity in even age stands. In uneven-age stands, which consist of three or more age classes, it identifies the age-class with the highest basal area.

The VSS classification system also includes measures for tree canopy density and age class heterogeneity. Tree canopy density is a relative measure of tree density based on SDI. Age class is a measure of the variety of age classes present in relation to the dominant age class and is an indication of canopy layers. Tree canopy density is broken out into three categories: A = Open; B = Moderately Closed; and C = Closed. A single storied stand (SS) resembles even-aged condition while multiple storied stands (MS) are considered uneven-aged. Much of the landscape consists of closed-canopy forest dominated by a single canopy layer and one age class (Table 6). Approximately 57 percent of the 4FRI analysis area has a closed tree canopy density, and 46 percent is single storied. The young and mid-age structural stages account for approximately 82 percent of the ponderosa pine analysis area while the grass/forb and seedling saplings stages are approximately 2 percent, the mature tree stage is 10 percent and the old forest stage is 6 percent. The low representation in the seedling/sapling, mature and old classes indicates limited structural stage diversity across the landscape.

**Table 6. Existing forest structure by restoration unit in the 4FRI ponderosa pine analysis area (see text for dominant class definitions)**

| Dominant d.b.h. Class | RU 1 | RU 3 | RU 4 | RU 5 | RU 6 | Total Acres | Percent of Analysis Area |
|---|---|---|---|---|---|---|---|
| 1 and 2 (SS) | 1,547 | 1,405 | 3,271 | 160 | 1,521 | 7,905 | 2% |
| 3 A or B MS | 1,099 | 616 | 2,859 | 7,329 | 7,100 | 19,003 | 4% |
| 3 A or B SS | 8,925 | 5,525 | 11,207 | 860 | 4,514 | 31,031 | 6% |
| 3 C MS | 12,489 | 13,018 | 7,438 | 1,636 | 6,307 | 40,888 | 8% |
| 3 C SS | 36,120 | 26,833 | 23,766 | 7,574 | 12,243 | 106,537 | 21% |
| 4 A or B MS | 12,361 | 15,288 | 26,003 | 11,558 | 6,216 | 71,426 | 14% |
| 4 A or B SS | 9,111 | 3,035 | 10,891 | 1,407 | 0 | 24,444 | 5% |
| 4 C MS | 27,121 | 23,459 | 14,215 | 2,950 | 97 | 67,842 | 13% |
| 4 C SS | 19,894 | 20,934 | 14,709 | 1,110 | 0 | 56,646 | 11% |
| 5 A or B MS | 6,819 | 8,840 | 13,993 | 8,420 | 0 | 38,072 | 7% |
| 5 A or B SS | 46 | 975 | 602 | 0 | 0 | 1,623 | <1% |
| 5 C MS | 3,587 | 4,729 | 2,219 | 529 | 0 | 11,064 | 2% |
| 5 C SS | 804 | 1,177 | 1,494 | 173 | 0 | 3,648 | 1% |
| 6 A or B MS | 2,210 | 1,974 | 1,127 | 15,174 | 3,057 | 23,542 | 5% |
| 6 A or B SS | 73 | 27 | 3 | 0 | 65 | 167 | <1% |
| 6 C MS | 1,884 | 1,391 | 481 | 152 | 69 | 3,977 | 1% |
| 6 C SS | 25 | 0 | 0 | 0 | 0 | 25 | <1% |

The risk of insect and/or disease outbreak is also a function of increased tree density. Endemic forest insects and pathogens are important disturbance agents that do not threaten long-term stability and productivity of forests (Reynolds et al. 2013). However, when large or uncharacteristic disease and insect outbreaks occur, profound changes to the composition, structure, processes, and functions of forests often take place (Reynolds et al. 2013). Dense conditions (e.g., Zones 3 and 4) facilitate the outbreak of insects and disease, moving the forest further from the historical range of variation. Insects, disease, fire, and competition tend to disproportionately kill older trees. Large (greater than 18 inches d.b.h.), old trees are already deficit on the landscape and take longer to replace (USDI 1995), so current SDI values indicate the forest is moving away from desired conditions at an accelerating rate. Overall, forest resiliency has decreased with the changes in forest structure over the last century.

Euro-American settlement in northern Arizona has also directly altered wildlife populations. These changes include: three mammal species (two apex predators and one herbivore) were extirpated as a direct result of human activities (grizzly bear (*Ursus arctos*), gray wolf (*Canis lupus*), and Merriam's elk (*Cervus elaphus*)); six species of birds and mammals have decreased in abundance; and nine species of birds and mammals have increased in abundance, including Abert's tree squirrels (Brown and Davis 1998). Gray wolves have since been reintroduced near the Arizona-New Mexico border and Rocky Mountain elk were introduced to Arizona in 1912.

The review of the existing conditions above illustrates the need to move vegetation structure and diversity towards desired conditions by creating a mosaic of interspaces and tree groups of varying sizes and shapes. Diversity in forest structure is lacking under existing conditions. Key components such as large trees, open meadows, and pockets of aspen are decreasing across the landscape. Moving towards a desired condition where forest structure consists of sustainable ratios all age and size classes would improve northern goshawk and MSO habitat, as identified in the 1996 forest plan amendment.

The above changes, along with maintaining areas of dense forest and connected forest canopy, would provide a range of wildlife habitats. Species associated with forest openings or deciduous woody species in association with pine currently have only a portion of their historic habitat available.

## Vegetation Structure in Goshawk and MSO Habitat

The northern goshawk standards and guidelines apply to the forest and woodlands that are outside of MSO Protected and Restricted areas. MSO standards and guidelines take precedence over the northern goshawk standards and guidelines within MSO habitat, leading to dichotomy in desired conditions in the ponderosa pine forest. One or the other set of standards or guidelines apply to all forest and woodland communities, but the MSO standards always take precedence in areas of overlap. This dichotomy in management direction applies to the 4FRI analysis area and determines treatment types within the ponderosa pine forest (Figure 7).

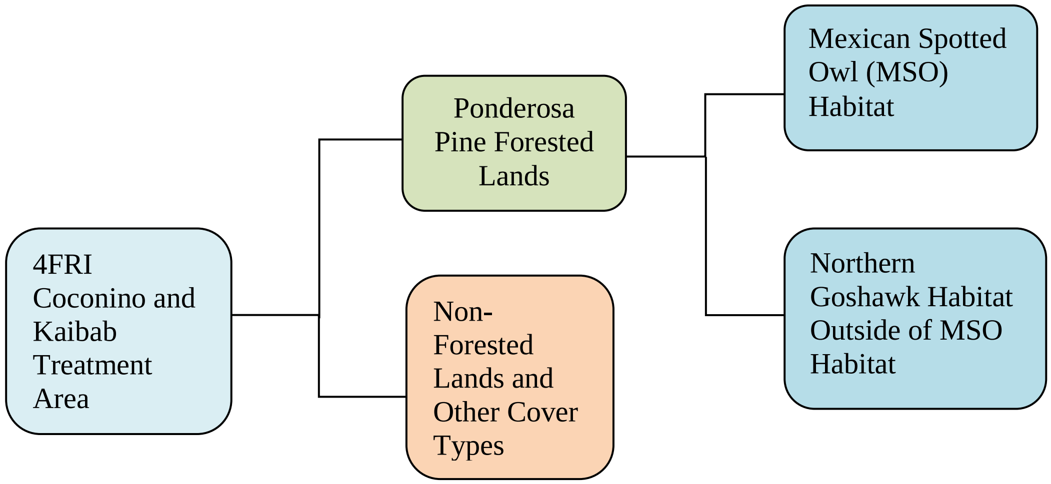


**Figure 7. Stratification of ponderosa pine forested lands, other cover types and non-forested land within the treatment area**

**Table 7.Goshawk and MSO habitat within the 4FRI treatment area**

| Habitat Type | Acres |
|---|---|
| Goshawk Post-Fledging Family Area (PFA)[1] | 40,033 |
| Goshawk non-PFA | 467,806 |
| **Goshawk habitat total acres** | **507,839** |
| MSO Protected Activity Area (PAC) | 34,426 |
| Protected greater than 40 percent slope | 836 |
| MSO Restricted | 66,419 |
| MSO Target | 6,715 |
| MSO Threshold | 1,975 |
| **MSO habitat total[2]** | **110,373** |

1. Includes dispersal PFAs and nest stands within PFAs
2. Goshawk and MSO acres overlap and are not additive

Ponderosa pine typically grows in pure or nearly pure stands in northern Arizona. Historical descriptions refer to open forests dominated by older and larger trees typically growing in groups (see silviculture report and appendix 6). Openings defined the groups and supported denser understories. Ponderosa pine is currently structured as even-aged and uneven-aged conditions across the treatment area (Table 8). The former is largely a result of past timber management (see silviculture report for additional baseline information) and the latter frequently lacks the interspersion of openings. Over 50 percent of the treatment area lacks age and size class diversity and is in an even-aged structure (silviculture report). Older trees no longer dominate the forest, instead, 36 percent is young forest and 47 percent is mid-aged, leaving a deficit in seedlings and saplings as well as mature and old forest (silviculture report).

**Table 8. Distribution of even-aged stands in goshawk habitat outside of post-fledging family areas within the 4FRI treatment area**

| Vegetation Structural Stage (VSS) | Tree Diameter (d.b.h.) | Even-Aged Existing % of Area | Coconino Forest Plan Desired % Distribution* |
|---|---|---|---|
| 1 – Grass/Forb/Shrubs | 0.0 – 0.9” | 8 | uneven-aged in all VSS classes |
| 2 – Seedling/Sapling | 1.0 – 4.9” | 0 | |
| 3 – Young Forest | 5.0 – 12” | 36 | |
| 4 – Mid-age Forest | 12.0 – 17.9” | 47 | |
| 5 – Mature Forest | 18.0 – 23.9” | 8 | |
| 6 – Old Forest | 24”+ | 1 | |

*The Coconino NF and Kaibab NF forest plan standards and guidelines do not describe desired even-aged stand conditions for goshawk non-PFA area habitat.

Approximately 44 percent of northern goshawk (*Accipiter gentilis*) habitat outside of PFAs is in an even-aged stand condition. The desired condition is to convert all even-aged stands outside of PFAs to uneven-aged structural conditions. Current uneven-aged forests are dominated by young and mid-aged stands, lacking mature and old-aged trees and lacking regeneration for future recruitment into older age-classes. About 77 percent of all goshawk habitat outside of PFAs is currently comprised of young to mid-aged forest (Table 9). The open park-like tree groups characteristic of the reference conditions for ponderosa pine forests promoted greater diversity of flora and faunal and greater resilience to wildfire than the dense forests of today.

**Table 9. Forest structure in goshawk Post-fledging family areas/nest stands in the treatment area**

| Vegetation Structural Stage (VSS) | Tree Diameter (d.b.h.) | Existing % of Area | Coconino Forest Plan Desired % Distribution |
|---|---|---|---|
| 1 – Grass/Forb/Shrubs | 0.0 – 0.9” | 2 | 10 |
| 2 – Seedling/Sapling | 1.0 – 4.9” | 1 | 10 |
| 3 – Young Forest | 5.0 – 12” | 34 | 20 |
| 4 – Mid-age Forest | 12.0 – 17.9” | 46 | 20 |
| 5 – Mature Forest | 18.0 – 23.9” | 11 | 20 |
| 6 – Old Forest | 24”+ | 6 | 20 |

Forest structure in MSO pine-oak habitat has undergone a similar change as the ponderosa pine forest in general. MSO habitat can be evaluated by comparing the percent SDI by size class to the desired percent of SDI by size class and TPA greater than 18 inches d.b.h. The MSO Recovery Plan puts emphasis on retaining and developing large trees to maintain MSO habitat. The ponderosa pine forested landscape is dominated by single story young to mid-aged trees (see silviculture report). MSO pine-oak restricted habitat has an abundance of five to 18 inch d.b.h. trees and is lacking in trees 18 inches d.b.h. and larger, particularly trees greater than 24 inches d.b.h. (Table 10). The deficit in large trees limits the distribution of potential nesting and roosting habitat. The preponderance of single-storied young and mid-aged trees limits or prolongs, depending on the stand, recruitment of suitable future nesting habitat. The dominance of closed forest conditions in young to mid-aged trees limits development of food and cover in prey habitat by shading out understory growth (appendix 6).

**Table 10. Existing MSO habitat forest structure and habitat components by restoration unit (RU)**

| Habitat | RU | Basal Area | % Max SDI | Average Percent of Total SDI by Size Class | | | TPA ≥18" d.b.h. | % Gambel Oak BA | TPA CWD >12" | Snags ≥18" d.b.h. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 12.0 – 17.9" | 18.0 – 23.9" | 24.0"+ | | | | |
| Desired | | >150 | NA | 15 | 15 | 15 | 20 | 10 | 5-10 | ≥2/ac |
| **Restricted Threshold** | RU 1 | 204 | 101 | 25 | 24 | 3 | 28 | 29 | 2.0 | 0.5 |
| | RU 3 | 185 | 99 | 26 | 19 | 8 | 24 | 33 | 0.6 | 0.7 |
| | **All** | **193** | **100** | **25** | **21** | **6** | **26** | **31** | **1.2** | **0.6** |
| **Restricted Target** | RU 1 | 156 | 81 | 30 | 12 | 7 | 14 | 20 | 1.5 | 0.5 |
| | RU 3 | 148 | 79 | 26 | 13 | 7 | 13 | 24 | 0.8 | 0.7 |
| | **All** | **152** | **80** | **28** | **13** | **7** | **14** | **22** | **1.2** | **0.6** |
| **Restricted Other** | RU 1 | 138 | 68 | 30 | 12 | 7 | 12 | 15 | 0.3 | 0.4 |
| | RU 3 | 137 | 70% | 29 | 13 | 7 | 12 | 21 | 0.5 | 0.4 |
| | RU 4 | 129 | 67 | 28 | 13 | 8 | 12 | 24 | 0.4 | 0.5 |
| | RU5 | 102 | 51 | 24 | 10 | 9 | 8 | 15 | 0.2 | 0.4 |
| | **All** | **137** | **69** | **29** | **13** | **7** | **12** | **19** | **0.4** | **0.4** |
| **Protected** | RU 1 | 154 | 78 | 31 | 13 | 8 | 15 | 14 | 0.7 | 0.6 |
| | RU 3 | 170 | 82 | 31 | 15 | 9 | 19 | 12 | 1.2 | 0.7 |
| | RU 4 | 100 | 49 | 33 | 9 | 5 | 9 | 8 | 0.4 | 0.4 |
| | RU 5 | 132 | 64 | 34 | 14 | 8 | 13 | 10 | 1.1 | 0.6 |
| | **All** | **155** | **78** | **31** | **14** | **8** | **15** | **13** | **0.8** | **0.6** |

Additional detail on habitat components such as large snags, downed logs, old growth, springs and ephemeral channels, along with effects of forest structure, fire, and the transportation system are addressed by individual species or species assemblages below.

# Climate Change Common to All Alternatives

Much of the following information was taken primarily from FS Southwestern Region May 2010 document entitled: Southwestern Region Climate Change Trends and Forest Planning – A Guide for Addressing Climate Change in Forest Plan Revisions for Southwestern National Forests and National Grasslands. Also referenced is a climate change review document developed for forest plan revision for the Kaibab NF (Leonard 2012). This document can be found at: http://www.fs.usda.gov/detail/kaibab/landmanagement/planning/?cid=STELPRDB5106605.

## Background

Most climate scientists agree that the earth is undergoing a warming trend and that human-caused elevations in atmospheric concentrations of carbon dioxide (CO2) and other greenhouse gases are among the causes of global temperature increases. The observed concentrations of these greenhouse gases are projected to increase, increasing the average temperature. Climate models are more accurate in terms of temperature changes versus precipitation changes (Furniss et al. 2010). Warmer air holds moisture which itself can act as a greenhouse gas, further contributing to temperature increases (Furniss et al. 2010). Climate change may intensify the risk of ecosystem change for terrestrial and aquatic systems, affecting ecosystem structure, function, and productivity.

The worst drought ever recorded in the Colorado River Basin since Euro-American settlement occurred between 2000 and 2010 (National Fish, Wildlife, & Plants Climate Adaption Partnership [NFWPCAP] 2012). Between 1984 and 2006, an estimated 18 percent of southwestern coniferous forest has been lost to uncharacteristic wildfire and bark-beetle outbreaks likely resulting from drought and higher average temperatures (Williams et al. 2010). Climate models predict this drought may be the norm by the end of this century, leading to potential changes in the distribution, abundance, and phenology of species and on ecosystem structure and function (NFWPCAP 2012). Climate change can amplify natural and human-induced changes that are already occurring such as habitat loss and degradation, fragmentation, spread of invasive species, altered fire behavior, and increases in forest pest damage (Committee on Environment and Natural Resources 2008, NFWPCAP 2012). For example, wildfires and bark beetles are principle drivers of change in western North American forests and both have increased in severity and extent in recent years (Jenkins et al. 2014). Pine beetles affect wildfires by modifying the moisture content, chemistry, structure, and amount of forest fuels while fires can weaken trees, promoting bark beetle attack and increasing beetle populations (Jenkins et al. 2014). Adding climate change to this situation creates a complex and synergistic interaction.

Southwestern forests are particularly sensitive to drought and increasing temperatures (Williams et al. 2010). It is expected that large changes in plant community structure and species composition would occur due to the warming air temperatures and altered hydrological cycles. An overall decrease in forest productivity could ensue as a result of reduced precipitation (USDA 2010). If temperature and aridity continue to rise as projected, trees will experience substantially reduced growth rates this century with ecotones and dense forest stands particularly vulnerable to fire mortality and drought-induced die-offs (Williams et al. 2010, Kane and Kolb 2014). Similarly, declines in deciduous trees and shrubs have occurred within the coniferous forests of Arizona as snowfall has declined (Martin and Maron 2012). Major long-term decreases in stem densities of deciduous woody plants were strongly associated with 25 years of declining snowfall (Martin and Maron 2012). The additive effects of multiple years of declining snowfall accounted 85 percent of the documented decline in plant densities. Declines in woody plants, in turn, were associated with declines in five of six songbird species that nest on the ground or in the understory (Martin and Maron 2012).

In the Southwest, intense debate is likely to occur over resource allocation and conservation of available water supplies. Populations in Arizona and New Mexico are growing at an unprecedented rate. As of the latest American Communities Survey in 2006, Arizona's population was over 6 million. The total increase between 1980 and 2006 in human population for Arizona was 123 percent. Population growth will likely exacerbate climatic effects, putting even greater pressure on wildlife and wildlife habitat. Climate change could have long-term impacts on many of the amenities, goods, and services from forests, including: productivity of locally harvested plants such as berries or ferns; local economics through land use shifts from forest to other uses; forest real estate values; and tree cover and composition in urban areas and associated benefits and costs (Leonard 2011).

## Ecological Impacts of Climate Change in the Southwest

A 2007 assessment for restoring forest health in Arizona stressed the need to anticipate the effects of climate change and focus on maintaining the resilience and adaptability of Arizona's forests and woodlands (Governor's Forest Health Councils 2007). Climate influences the distribution and abundance of plant and animal species through changes in resource availability, habitat connectivity, fecundity, and survivorship. Between 1984 and 2006, an estimated 18 percent of southwestern coniferous forest has been lost to uncharacteristic wildfire and bark-beetle outbreaks likely resulting from drought and higher average temperatures (Williams et al. 2010). Long-term shifts in vegetation patterns are expected as a result of climate change (Westerling et al. 2006, Millar et al. 2007), including greater vulnerability to other disturbances, including fire and biological invasion (Committee on Environment and Natural Resources 2008). New environmental conditions can lead to a different mix of species that tend to favor plants and animals that can adapt their biological functions or are aggressive in colonizing new territories. Locally, nonnative invasive species, such as cheatgrass are expected to continue to increase in numbers and extent (Leonard 2011). Cold-tolerant vegetation may move upslope or disappear in some areas. Migration of some tree species to the northern portions of their range may occur (CLIMAS 2011) while other species' ranges may become a patchwork mosaic where only suitable micro-climates are occupied. An overall decrease in forest productivity could ensue as a result of reduced precipitation (USDA 2010c). Shifts in the timing of snowmelt have already been observed which, along with increases in summer temperatures, may seriously impact survival of riparian and wetland species and challenge efforts to reintroduce species into their historic range (Committee on Environment and Natural Resources 2008, Millar et al. 2007)

Climate change can potentially affect biodiversity by pressuring the distribution, viability, and migration patterns of wildlife populations through increasing temperatures, water shortages, and changing ecological conditions (USDA 2010c, Leonard 2011). Some species are inherently more vulnerable than others, particularly species with specialized niches, limited mobility, and limited physiological adaptability. Certain habitats are more vulnerable to a changing climate. For example, springs are a valuable natural water source for a variety of birds and mammals, particularly in arid environments. These areas may offer critical refugia for rare and narrow endemic species. However, springs are sensitive to variable precipitation and the potential to dry up during prolonged drought. As such, the unreliability of natural water resources would make it harder for wildlife species to persist, pushing the limits of their natural range.

The FS Southwestern Region includes a high degree of biodiversity and an unusually large number of plant and animal species that are endemic (USDA 2010c). It is expected that large changes in the structure and species composition of plant communities would occur due to the warming air temperatures and altered hydrological cycles. Many of the region's plant, animal, and insect species depend on precise phenological events based on climatic conditions for migration, flowering, and timing for foraging and reproductive activities. It is currently unknown how many species will successfully adapt to changing conditions. The ability of plant and animal species to migrate under climate change would be strongly influenced by their dispersal abilities and by disturbances to the landscape

Current knowledge of possible climate change impacts on specific vegetation types remains limited. However, projected and observed climate change effects are being studied at the broad-scale habitat level throughout the Southwest. The mild nature of climate gradients among lower life zones of the Southwest, and protracted ecotonal bands, make woodland plant communities particularly vulnerable. Many of the Southwestern Region's plant and animal species are associated with these key habitats, and are therefore important when considering the potential impacts of climate change on ecosystems managed by the FS in the southwest. Southwestern forests are sensitive to drought and increasing temperatures (Williams et al. 2010, Kane and Kolb 2014). Declines in deciduous trees and shrubs have already occurred within the coniferous forests of Arizona as snowfall has declined (Martin and Maron 2012). Major long-term decreases in stem densities of deciduous woody plants were strongly associated with 25 years of declining snowfall (Martin and Maron 2012). The additive effects of multiple years of declining snowfall accounted

85 percent of the documented decline in plant densities. Declines in woody plants, in turn, were associated with declines in five of six songbird species that nest on the ground or in the understory (Martin and Maron 2012).

Currently there appears to be broad agreement among climate modelers that the Southwestern U.S. is experiencing a warming trend with a shift from winter to summer precipitation that will continue well into the later part of the 21st century. The Kaibab NF considered the following potential climate effects locally:

- Increased extreme weather related forest disturbances (floods, drought, wind-throw)
- Water stresses (groundwater, runoff, and timing), aquatic biota
- Risk of high-severity fire
- Shifts in major vegetation types for the Southwest
- Threatened, endangered, and sensitive species
- Forest insects and disease
- Weather related stresses on human communities (temperature, air quality)
- Outdoor recreation
- Wildlife movement and biodiversity

Based on current projections, the primary regional-level effects of climate change most likely to occur in the Southwest that will have an effect on forest vegetation include warmer temperatures, decreasing precipitation, and increased extreme weather events (USDA 2010c). These changes could result in immediate vegetation disturbance due to wind or flooding, increased risk of large, high-severity wildfires, increased outbreaks of insects, diseases, and spread of invasive species, increased drought related mortality and changes in plant species composition.

## Potential Climate Change Strategies for the Kaibab NF

In developing strategies for managing future changes, the range of possible approaches could be quite broad. The strategies which follow are focused on recommendations from recent research studies, including the U.S. Climate Change Science Program which balances effectiveness, feasibility, and available resources, and is appropriate for the Southwestern Region. Although some strategies contain new ideas, most of these management strategies include practices that are already in effect, can serve multiple needs, and may just need to be adjusted or expanded to respond to climate changes during the next 15 years. Using an adaptive management approach will allow NF managers to adopt and adjust strategies as new information is available, conditions change, and staff and resources are available.

Key concerns for the effects of climate change on wildlife habitat are the impacts of decreased water availability and the effects of habitat changes on wildlife connectivity (Leonard 2011). Managing for landscape connectivity will be important, as connectivity facilitates movement of species among habitats. “Connectivity” includes structural and biological components. Structural connectivity addresses the spatial structure of a landscape and can be described from map elements. Biological connectivity is the response of individuals to the scale of the landscape features. Reducing fragmentation and planning at landscape scales to maximize habitat connectivity will become increasingly important.

Actions to address climate change factors of most concern locally are those that:

- Reduce vulnerability by restoring and maintaining resilient native ecosystems;
- Anticipate increases in forest recreation;
- Use markets and demand for wood and biomass for restoration, renewable energy, and carbon sequestration;
- Enhance adaptation by anticipating and planning for intense disturbances;
- Conserve water; and
- Monitor climate change influences.

Restoring and maintaining resilience would likely improve the potential for ecosystems to retain or return to desired conditions after being influenced by climate change related impacts and variability. Managing for resistance (e.g., maintenance thinning to prevent undesirable fire behavior and effects, forest insect or disease pandemics) and resilience (e.g., noxious weed control) offer meaningful responses to climate change.

## Potential Climate Change Strategies for the 4FRI

Expected changes in the 4FRI landscape related to climate change include: an increase in cheatgrass (*Bromus tectorum*) and loss of herbaceous palatability (Leonard 2012, NFWPCAP 2012). Cheatgrass is not native to the United States and is a threat to ecosystem function through direct competition with native herbaceous species. It is largely unpalatable and can decrease habitat suitability for a wide range of wildlife species. Cheatgrass is highly flammable and can alter fire regimes, resulting in understory monocultures that further degrades habitat. The spread of cheatgrass is expected to be favored by the current increase in atmospheric carbon dioxide ($CO_2$) as a result of greenhouse gas accumulation (NFWPCAP 2012). Increased $CO_2$ may also lead to an additional decline in forage quality by increasing the carbon-to-nitrogen ratio in native plants and lowering available crude protein in grass (NFWPCAP 2012).

The change in understory structure and palatability affects a wide array of wildlife from elk to arthropods, including a suite of prey species for goshawks and MSO. Climate change is predicted to lead to changes in fire patterns, increased evaporation and drought stress, reduced snowpack, and alters hydrologic timing and quantity (Marlon et al. 2009, NFWPCAP 2012).

Climate change can synergistically alter the overstory as well. Large, old trees are stressed from competition with uncharacteristic quantities of mid-aged trees, leaving them disproportionately susceptible to mortality from insects and disease (Negrón and Popp 2004, silviculture report). The change in forest structure leaves the forest vulnerable to larger fires that burn largely as high severity crown fires (e.g., Rodeo-Chediski and Wallow fires) and climate change can exasperate this situation (Marlon et al. 2009). Each of these factors, working alone and synergistically, may lead to disproportionate mortality in the largest tree size-classes. However, thinning can benefit large trees more than small trees in terms of post-treatment response, particularly in dry years (Kerhoulas et al. 2013b).

In addition to density-related stress, winter precipitation is the dominant water source for large and old ponderosa pines in northern Arizona (Kerhoulas et al. 2013a). Large and old trees depend on water from snowmelt and are not as strongly affected by summer monsoon rains. Climate change is predicted to reduce snowpack and increase evaporation and drought stress (NFWPCAP 2012). If this occurs, large and old trees will be more susceptible to stress and likely suffer increased mortality. Shifts in the timing of snowmelt have already been observed (Millar et al. 2007).

Certain habitats are more vulnerable to a changing climate. For example, springs are a valuable natural water source for a variety of birds and mammals, particularly in arid environments. These areas may offer critical refugia for rare and narrow endemic species. However, many springs in the 4FRI area are sensitive to variable precipitation and likely to dry up during prolonged drought. Along with increases in summer temperatures, climate change effects may make it harder for some riparian and wetland species to survive and challenge efforts to reintroduce some species into their historic range (Committee on Environment and Natural Resources 2008).

The Nature Conservancy (TNC) hosted a series of climate change workshops in southwestern states in 2010. The Arizona workshop was held in Flagstaff on 7-8 April, to help inform the 4FRI planning effort. The Flagstaff workshop was attended by 44 representatives from 15 state and federal agencies, local governments and non-governmental organizations. The objective was to address climate change questions related to forest and wildlife health and impacts to communities within the 4FRI area. Speakers from TNC, the University of Arizona, the Wildlife Conservation Society, National Center for Atmospheric Research, US Geological Survey Colorado Plateau Research Station, Merriam Powell Center for Environmental Research and the Ecological Restoration Institute at Northern Arizona University, and the FS Rocky Mountain Research Station led presentations on changes in local climate that have contributed to increases in wildfire frequency and severity, tree mortality, and insect outbreaks, and declines in quality of wildlife habitat and watersheds. Attendees then participated in a formal decision-support framework to develop a set of strategic actions that can be implemented to promote resilience and realignment of ponderosa pine forests and their fire regimes, watershed function, and resident MSOs.

Long-term (2040 – 2060), high priority strategic recommendations from the workshop included:

- Thin to create a mosaic of clumps and groups of trees with intermixed openings
- Treat more acres with prescribed fire
- Allow more wildland fires to burn

Each of these points would be addressed by implementing the 4FRI.

## Summary

Climate change represents a clear threat to the ponderosa pine forests of northern Arizona. The uncharacteristic structure now common in these forests exasperates these risks. By managing for resistant and resilient ecosystems, promoting landscape connectivity, and implementing concepts of adaptive management, land and resource managers can respond to new information and changing conditions related to climate change (Furniss et al. 2010). Endangered, threatened, candidate, and sensitive species in the 4FRI area are at particular risk. The FS Southwestern Region and the Kaibab NF have developed guidance for addressing climate change which is broad and general in scope and which relies on adaptive management as climate change science evolves. Recent work locally that focused on the 4FRI landscape supported these findings. Implementation of the 4FRI would be in alignment with these recommendations.

# Wildlife Species Analyzed in This Report

The following list of federally Threatened, Endangered and Proposed species is adopted from the FWS web-page (http://www.fws.gov/southwest/es/arizona), accessed on March 22, 2012). This list includes all federally Threatened, Endangered, Candidate, and Proposed species in Coconino County. For the purpose of this analysis, only those Federally listed threatened, endangered, candidate species and their critical habitat are analyzed below. In addition, FS sensitive species that are known or have potential to occur within the 4FRI analysis area are also analyzed. Species that are not present or do not have potential habitat in the analysis area were dismissed from further analysis as the project would have no effects on these species (Table 12). MIS from both forest plans and migratory birds are included in these lists as well.

There are 38 species of special status addressed by this analysis (Table 11). Several species are analyzed more than once if more than one status applies. For example, red-naped sapsuckers are addressed as both MIS and migratory birds. An Important Bird Area is also analyzed in the migratory bird section. One terrestrial threatened species with critical habitat, the MSO, occurs in the treatment area. This report excludes fish, aquatic invertebrates, mussels, snails, and plants, as these are addressed in the fisheries and botany specialists' reports for this project.

**Table 11. Threatened, endangered, candidate, sensitive, migratory bird and management indicator species evaluated in this analysis[1]**

| Common Name | Scientific Name[1] | Status[2] |
|---|---|---|
| **Amphibians (1)** | | |
| **Northern Leopard Frog** | ***Lithobates pipiens*** | **S** |
| **Birds (26)** | | |
| **Mexican Spotted Owl** | ***Strix occidentalis lucida*** | **T** |
| **Bald Eagle** | ***Haliaeetus leucocephalus*** | **S** |
| California Condor | *Gymnogyps californianus* | E/10j population |
| **Northern Goshawk** | ***Accipiter gentilis*** | **S/MIS/Mig Bird** |
| **American Peregrine Falcon** | ***Falco peregrinus anatum*** | **S** |
| **Burrowing Owl (western)** | ***Athene cunicularia hypugaea*** | **S/Mig Bird** |
| Pygmy nuthatch | *Sitia pygmaea* | MIS |
| Turkey | *Meleagris gallopavo* | MIS |
| Hairy Woodpecker | *Picoides villosus* | MIS |
| Western Bluebird | *Sialia mexicana* | MIS |
| Red-naped Sapsucker | *Sphyrapicus nuchalis* | MIS/**Mig Bird** |
| Juniper Titmouse | *Baeolophus ridgwayi* | MIS/**Mig Bird** |
| **Flammulated Owl** | ***Otus flammeolus*** | **Mig Bird** |
| **Olive-sided Flycatcher** | ***Contopus cooperi*** | **Mig Bird** |
| **Cordilleran Flycatcher** | ***Empidonax occidentalis*** | **Mig Bird** |
| **Grace's Warbler** | ***Dendroica graciae*** | MIS/**Mig Bird** |
| **Lewis's Woodpecker** | ***Melanerpes lewis*** | **Mig Bird** |
| **Purple Martin** | ***Progne subis*** | **Mig Bird** |
| **Cassin's Finch** | ***Carpodacus cassinii*** | **Mig Bird** |
| **Gray Vireo** | ***Vireo vicinior*** | **Mig Bird** |

| Common Name | Scientific Name[1] | Status[2] |
|---|---|---|
| **Pinyon Jay** | ***Gymnorhinus cyanocephalus*** | **Mig Bird** |
| **Black-throated Gray Warbler** | ***Dendroica nigrescens*** | **Mig Bird** |
| **Gray Flycatcher** | ***Empidonax wrightii*** | **Mig Bird** |
| Swainson's Hawk | *Buteo swainsoni* | Mig Bird |
| Grasshopper Sparrow | *Ammodramus savannarum* | Mig Bird |
| **Bendire's Thrasher** | ***Toxostoma bendirei*** | **Mig Bird** |
| **Mammals (10)** | | |
| Black-footed Ferret | *Mustela nigripes* | E |
| **Navajo Mogollon Vole** | ***Microtus mexicanus Navaho*** | **S** |
| **Western Red Bat** | ***Lasiurus blossevillii*** | **S** |
| **Spotted Bat** | ***Euderma maculatum*** | **S** |
| **Allen's Lappet-browed Bat** | ***Idionycteris phyllotis*** | **S** |
| **Pale Townsend's Big-Eared Bat** | ***Corynorhinus townsendii pallescens*** | **S** |
| Abert's squirrel | *Sciurus aberti* | MIS |
| Rocky Mountain elk | *Cervis elaphus* | MIS |
| Mule deer | *Odocoileus hemionus* | MIS |
| **Pronghorn** | ***Antilocapra americana*** | **MIS** |
| **Reptiles (1)** | | |
| Narrow-headed Gartersnake | *Thamnophis rufipunctatus* | T |

1. Species in bold font apply to both the Coconino and Kaibab NFs. Species in plain text only apply to the Coconino NF. Species underlined only apply to the Kaibab NF
2. Status: E = Federally Endangered; T = Federally Threatened; E/10j population = Endangered/Experimental population (section (10)(j) of the ESA; Eagle Protection Act = Bald and Golden Eagle Protection Act; S = Forest Service Sensitive; MIS = Management Indicator Species; Mig Bird = Migratory Birds

**Table 12. Threatened, endangered, candidate, sensitive, and management indicator species not addressed in this analysis**

| Common Name | Scientific Name | Rationale for Dropping | Status[1] |
|---|---|---|---|
| **Amphibians (2)** | | | |
| Chiricahua Leopard Frog | *Lithobates chiracahuensis* | Neither the species nor its habitat occurs in the analysis area | T |
| Lowland Leopard Frog | *Lithobates yavapaiensis* | Neither the species nor its habitat occurs in the analysis area | S |
| **Birds (9)** | | | |
| Southwestern Willow Flycatcher | *Empidonax traillii extimus* | Neither the species nor its habitat occurs in the analysis area | E |
| Ruby-crowned kinglet | *Regulus calendula* | Indicator habitat does not occur in analysis area | MIS |
| Yuma Clapper Rail | *Rallus longirostris yumanensis* | Neither the species nor its habitat occurs in the analysis area | E |
| Yellow-breasted chat | *Icteria virens* | Indicator habitat does not occur in analysis area | MIS |

| Common Name | Scientific Name | Rationale for Dropping | Status[1] |
|---|---|---|---|
| Lucy's warbler | *Oreothlypis luciae* | Indicator habitat does not occur in analysis area | MIS |
| Lincon's sparrow | *Melospia lincolnii* | Indicator habitat does not occur in analysis area | MIS |
| Cinamon teal | *Anas cyanoptera* | Indicator habitat does not occur in analysis area | MIS |
| Western Yellow-billed Cuckoo | *Coccyzus americanus occidentalis* | Neither the species nor its habitat occurs in the analysis area | PT |
| Mexican spotted owl | *Strix occidentalis lucida* | Indicator habitat does not occur in analysis area | MIS |
| **Mammals (1)** | | | |
| Red squirrel | *Tamiasciurus hudsonicus* | Indicator habitat does not occur in analysis area | MIS |
| **Insects (1)** | | | |
| Aquatic Insetcs[2] | *Various Species* | Not Addressed in the Terrestrial Wildlife Species Report | S/MIS |

1. STATUS: E = Federally Endangered; T = Federally Threatened; E/10j population = Endangered/Experimental population (section (10)(j) of the ESA; P = Federally Proposed; S = Forest Service Sensitive; MIS= Management Indicator Species;
2. Analyzed in the Fisheries Report

# Federally Listed Threatened, Endangered, Proposed and Candidate Species and Critical Habitat

## Mexican Spotted Owl Habitat

### Introduction

The MSO was listed as a threatened species under the ESA in March 1993 (USDI 1993). A detailed account of the taxonomy, biology, and reproductive characteristics of the MSO is found in the Final Rule listing the MSO as a threatened species (FWS 1993), in the Recovery Plan (FWS 1995), and in the Revised Recovery Plan (FWS 2012). Information on MSO in the Upper Gila Mountain Recovery Unit (UGM) is also summarized in Ganey et al. (2011). The information provided in these documents is incorporated here by reference as summarized below.

Definitions of MSO habitats were provided above in the Methodology section (see MSO Habitat Definitions in the 1995 Recovery Plan). The 1995 MSO Recovery Plan formed the basis of the MSO analysis in the 4FRI Coconino NF Kaibab NF DEIS when it was released for a 60-day comment period in March of 2013. The DEIS included plan amendments that were developed to ensure the preferred alternative (alternative C) would better meet the direction in the new MSO 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 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. Shortly after the 4FRI DEIS was sent to the government printer in December 2012, which was the culmination of about two years of developing treatment strategies, building databases, summarizing treatment effects, and analyzing model outputs, the FWS completed the Revised Recovery Plan (USDI 2012b). Because of the enormity of this effort and the fact that the project was caught between recovery plans, the

FWS agreed to retaining the wording and metrics of the original MSO recovery plan in the 4FRI documents. The Biological Assessment was submitted to the FWS in February of 2014. While the analysis below 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 MSO Recovery Plan was documented in the effects analysis of the preferred alternative and the corresponding Biological Opinion as part of consultation with the FWS (appendix 2). A crosswalk between the 1995 and 2012 MSO Recovery Plans can be found in appendix 3 of this report.

MSOs occur in forested mountains and canyons in Utah, Colorado, Arizona, New Mexico, and the western portions of Texas south into several states of Mexico. However, MSOs do not occur uniformly across their range. Instead, they inhabit disjunct localities, including isolated forested mountain systems and steep, rocky canyons. In addition to natural variability in habitat, anthropomorphic actions have affected MSO occupancy across their range. The inherent variability in occupancy was one of the reasons the Recovery Plan subdivided the range of the MSO into smaller areas called recovery units (USDI 1995). The 4FRI treatment area falls within the western portion of the UGM Recovery Unit. Owls in this part of the Recovery Unit primarily nest and roost in mixed conifer and pine-oak forests. The only MSO habitat located within the 4FRI treatment area is pine-oak forest. Although mixed-conifer habitat occurs within the greater 4 FRI analysis area, no mixed conifer forest would be treated under the 4FRI.

MSO occupy and breed in canyons, mixed conifer, and pine-oak vegetation types within the 4FRI analysis area. Their habitat contains high canopy closure, high tree density, large trees, multi-layered canopies, and snags and down woody material. MSOs are primarily nocturnal predators that hunt with a “perch and pounce” technique. They commonly eat small- and medium-sized rodents but also consume bats, birds, reptiles, and arthropods. Primary MSO prey in the 4FRI treatment area largely consists of mice and voles. Owls typically nest in large trees (greater than 24 inch d.b.h.) and will roost in both large and small trees. Owls use a broader range of habitat for foraging, including intensive use of areas around nest and roost sites during the nesting season and habitats with more variable forest structure. More open canopies allow more understory vegetation development which benefits most of the MSO prey species in the pine-oak forests of the UGM Recovery Unit (appendix 6). MSOs generally lay eggs in late March or early April and the young fledge July to August, with a majority dispersing out of the nesting area in September.

The proposed 4FRI occurs entirely within the western portion of the UGM. Effects of management and effects from a lack of management within the UGM can impact MSO recovery. Consequently, the 4FRI team met with the USDA FS Rocky Mountain Research Station (RMRS) and requested a summary and synthesize of existing knowledge on the status and ecology of MSOs within this EMU. Dr. William Block, Program Manager and Supervisory Research Wildlife Biologist at the RMRS and also senior author of the Recovery Plan for the MSO, and Dr. Joseph Ganey, Research Wildlife Biologist at the RMRS, member of the MSO recovery team, and lead scientist on multiple MSO research projects, agreed to our request. Dr. Ganey and other MSO experts published the “Status and ecology of Mexican spotted owls in the Upper Gila Mountains Recovery Unit, Arizona and New Mexico” in 2011 (General Technical Report RMRS-GTR-256). This report was created to aid planners in evaluating potential benefits or impacts of management actions on MSOs and their habitat. Information on MSO biology, ecology, and habitat use was extracted from this report and can be found in appendix 11. Both the General Technical Report and appendix 11 are incorporated into this report.

The FWS recommends recovery actions concentrate on recovery units with the highest owl populations (USDI 1995). The UGM supports over half the known population of MSOs (Ganey et al. 2011). Owls appear to be more continuously distributed in the UGM, relative to other Recovery Units, and the central location of the UGM within the overall range of the MSO facilitates gene flow across their range (Figure 8). Therefore this EMU is important to the overall range-wide stability of MSOs. The FWS also recommends recovery actions concentrate on recovery units where significant threats exist and that management should emphasize alleviating the greatest threats and be tailored to the needs of the area under analysis (USDI 1995). The UGM is at significant risk of uncharacteristically high-severity wildfire (USDI 1995). Lands managed by the USDA Forest Service account for 42 percent of the UGM, putting the FS in a position to aid in the recovery of the species in part by decreasing the threat of high-severity fire in MSO habitat. More information on the status of the UGM can be found in appendix 11.

The 4FRI project would conduct restoration activities on approximately 586,110 acres, including about 507,839 acres of ponderosa pine forest. About 22 percent of the ponderosa pine forest in the treatment area is designated as MSO habitat (110,373 acres). Some areas are centers of concentrated use by MSOs (e.g., Mormon Mountain, Bar M Canyon), use is widely scattered in other areas (Williams RD), and some areas have never had documented use and have no designated MSO habitat (Tusayan RD/ RU 6). Patterns in habitat conditions and resulting changes from proposed alternatives are similar at both sub-unit and RU scales. Therefore, habitat patterns are typically summarized at the PAC scale or RU scale for MSO restricted and Critical habitats to facilitate the discussion at the scale of the 4FRI analysis. Details at the subunit level can be found in appendices 12, 13, and 14.

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 35,262 acres of MSO protected habitat (Figure 9), of which 34,426 acres are within designated PAC’s 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. See Methodology section and appendix 4 for the process used to identify PACs that could potentially be improved from vegetation treatments, the existing condition, and need for habitat improvement.

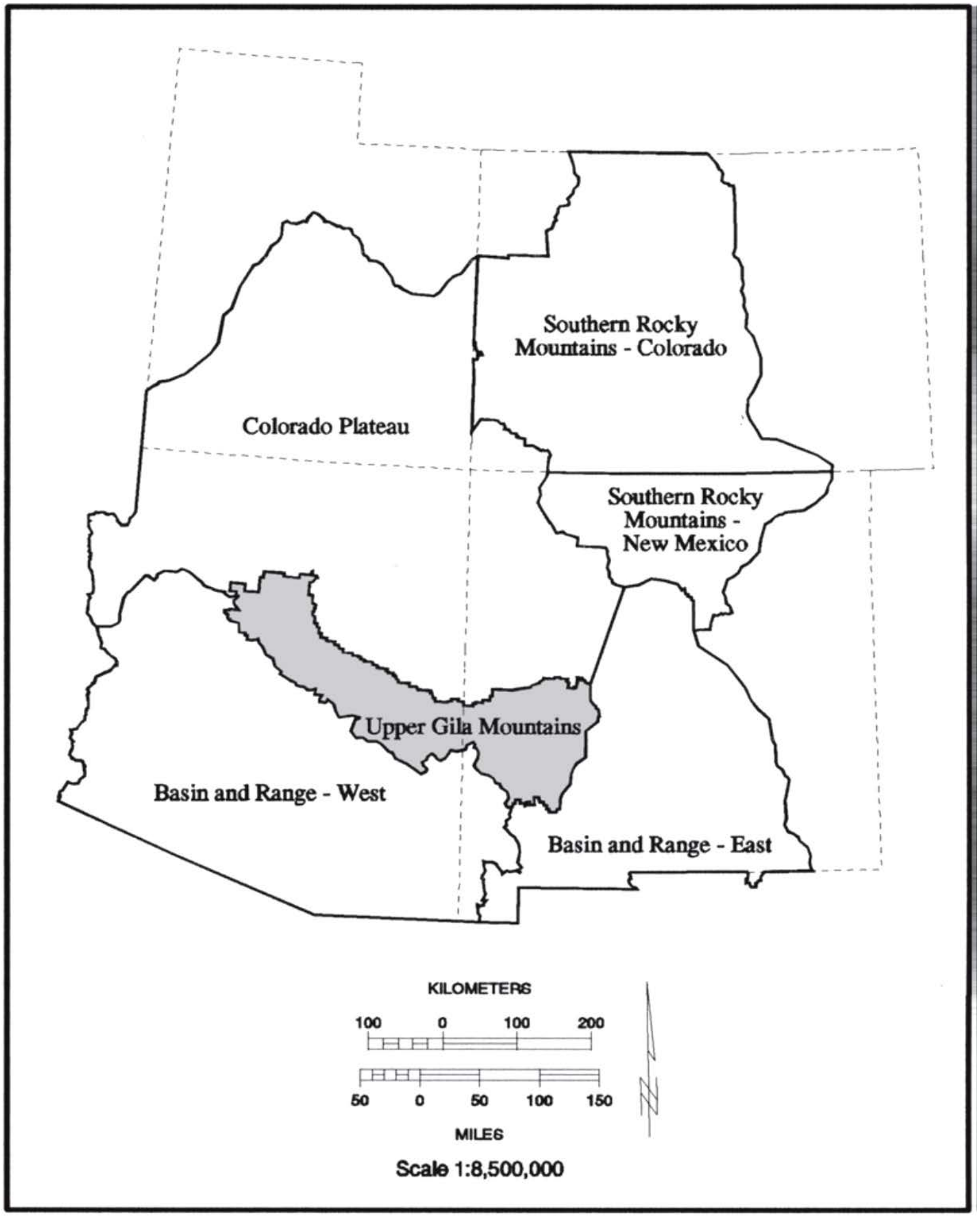


**Figure 8. Recovery units designated in the MSO Recovery Plan (USDI 1995)**

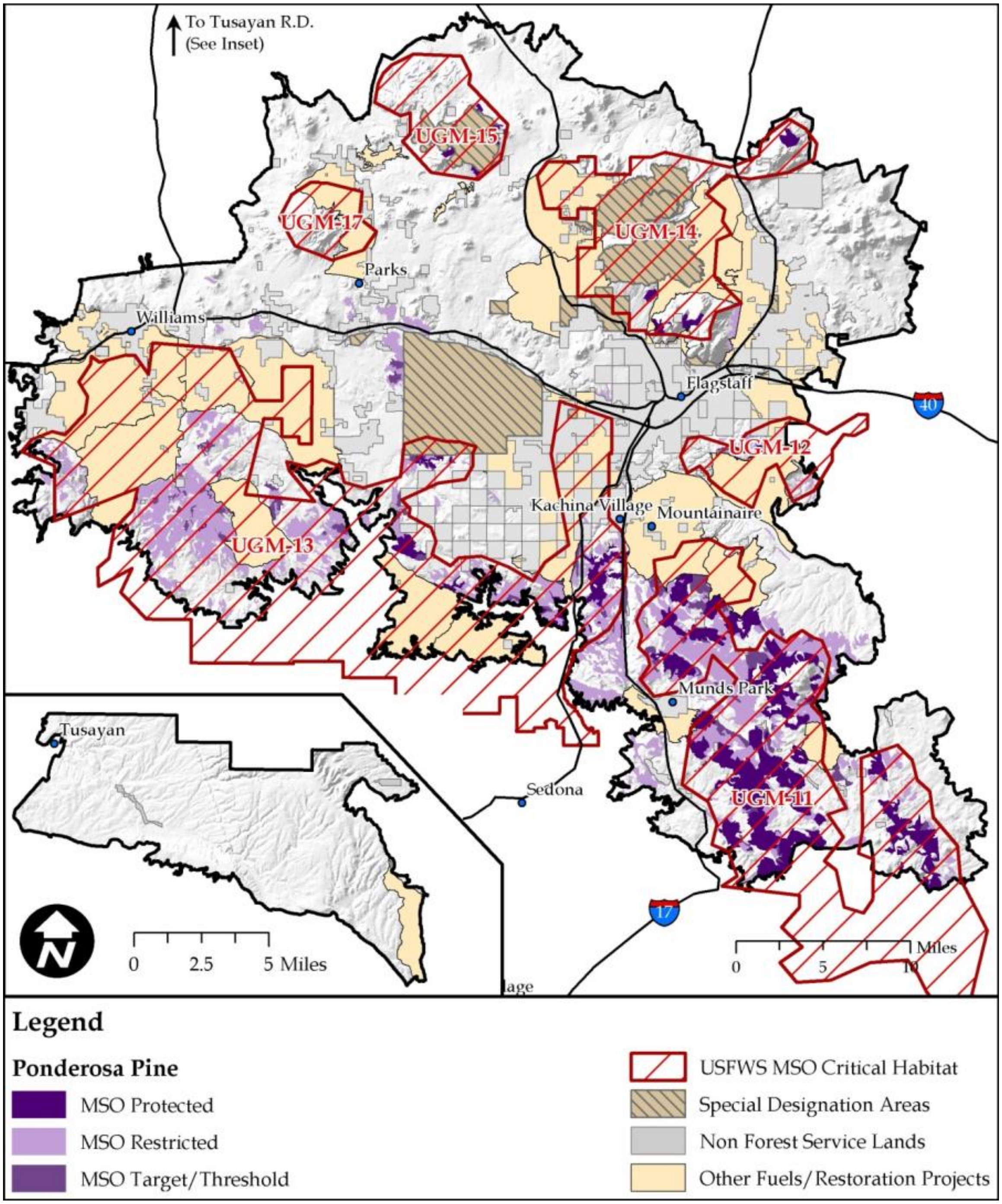


**Figure 9. Mexican spotted owl habitat and critical habitat boundaries in the 4FRI project area**

Currently, MSO habitat occurs in all RUs except for RU 6, the Tusayan RD. Approximately 75,111 acres of MSO restricted habitat exists within the treatment area, including 1,977 threshold acres and 6,715 target acres (Table 3).

MSO critical habitat was designated by the FWS in 2004 (USDI 2004). Critical habitat is defined as protected and restricted habitats within designated areas which contain the PCEs necessary for conservation of the species (USDI 2004). Critical habitat boundaries can include non-MSO habitat, including federally managed lands that do not function as owl habitat and private and state lands. Protected and restricted MSO habitat within designated critical habitat must be managed to maintain or enhance primary constituent habitat elements. PCEs in pine-oak forest provide for MSO habitat needs including, but are not limited to, nesting, roosting, foraging, dispersing, and elements of prey habitat (USDI 2004). A detailed list of PCEs can be found in the Evaluation Criteria section below.

Six Critical Habitat Units (CHUs) occur partially or completely within the 4FRI analysis area (Table 13). They encompass 488,974 acres of Forest Service land, including mixed-conifer forest, but do not include State, private, Naval Observatory, or certain WUI areas. A total of 88,915 acres of MSO habitat occurs within the CHs in the 4FRI treatment area. In addition, non-MSO habitat occurs within CHUs and designated MSO habitat occurs outside of CHUs.

**Table 13. Critical habitat units (CHUs) occurring in the 4FRI treatment area**

| Critical Habitat Unit | Total Acres | Acres of MSO Habitat | National Forest(s) | Approximate Location Description |
|---|---|---|---|---|
| UGM 11 | 144,790 | 48,677 | Coconino | South-southeast of Mountainaire, encompassing: Howard, Mormon, and Hutch Mountains; Interstate 17 to Happy Jack; excluding Mormon Lake and Stoneman Lake |
| UGM 12 | 17,359 | 1,150 | Coconino | East of Flagstaff |
| UGM 13 | 238,092 | 37,609 | Coconino, Kaibab, and Prescott | Between Flagstaff and Williams, from Camp Navajo to the Mogollon Rim, including Bill Williams Mountain, Sycamore Canyon Wilderness, and Volunteer Canyon |
| UGM 14 | 55,533 | 908 | Coconino | Due north of Flagstaff, encompassing the San Francisco Peaks, Hochderffer Hills, O'Leary Peak, the Dry Lake Hills, and Elden Mountain |
| UGM 15 | 22,286 | 570 | Kaibab | Northwest of Flagstaff, west of Hwy 180, encompasses Kendrick Peak northwest to Wild Horse Canyon |
| UGM 17 | 10,914 | 0 | Kaibab | North of Parks, including Sitgreaves Mountain, RS Hill, and Government Hill |

## Surveys and Monitoring

Annual MSO monitoring on the Coconino and Kaibab NFs is highly variable. Some PACs are rarely monitored while others are monitored nearly every year. Well over 50 percent of known territories have been monitored annually to assess occupancy and reproductive status on the Coconino NF. However, the data collected was not designed to estimate population trend. 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 MSOs 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 MSOs since the 1990s given how little work was typically done in MSO habitat.

MSO surveys started on the Kaibab NF in 1978. Although surveys were not all to protocol, repeat visits were initiated in1994 and have been used each year since then. Results indicate that 1 to 5 PACs out of the 6 managed by the Kaibab NF are typically occupied in a given year (USDA 2010b). Owls have not been confirmed in the Bill Williams PAC since 1994. Most of the pine-oak forest has been surveyed for MSO within the 4FRI treatment area according to FWS protocols. However, some surveys are years old. Most unsurveyed habitat occurs in remote wilderness or in marginal potential habitat. Monitoring summaries for each forest are presented in Table 14 and Table 15. The highest concentrations of PACs in the treatment area occur in RU 1, specifically in sub-units 1-3 (Bar-M watershed) and 1-5 (Mormon Mountain, Hutch Mountain, and near the southern boundary of the treatment area). Smaller groups of PACs occur around the edges of Oak Creek Canyon (subunit 3-3) and the larger cinder cones in RU 4 (including Kendrick Mountain).

**Table 14. Coconino NF summary of PACs monitored 1987 to 2011**

| Year | Number of PACs Monitored | Percent Occupied | PACs with Adult Pairs | Pairs with Young | Total Young Known | Young per Reproductive Pair (Average) |
|---|---|---|---|---|---|---|
| 1987 | 10 | 100 | 7 | 3 | 5 | 1.7 |
| 1988 | 27 | 100 | 15 | 2 | 4 | 2 |
| 1989 | 49 | 98 | 30 | 19 | 32 | 1.7 |
| 1990 | 92 | 96 | 59 | 21 | 27 | 1.3 |
| 1991 | 105 | 82 | 66 | 42 | 73 | 1.7 |
| 1992 | 121 | 79 | 82 | 40 | 69 | 1.7 |
| 1993 | 121 | 87 | 91 | 44 | 88 | 1.8 |
| 1994 | 127 | 83 | 75 | 8 | 15 | 1.9 |
| 1995 | 91 | 64 | 35 | 11 | 16 | 1.5 |
| 1996 | 97 | 60 | 32 | 7 | 11 | 1.6 |
| 1997 | 114 | 46 | 40 | 11 | 17 | 1.6 |
| 1998 | 94 | 52 | 33 | 21 | 30 | 2 |
| 1999 | 109 | 47 | 43 | 21 | 54 | 2.6 |
| 2000 | 97 | 61 | 47 | 8 | 13 | 1.6 |
| 2001 | 108 | 56 | 41 | 1 | 2 | 2 |
| 2002 | 51 | 86 | 32 | 20 | 34 | 1.7 |
| 2003 | 41 | 68 | 14 | 5 | 6 | 1.2 |
| 2004 | 33 | 73 | 16 | 5 | 7 | 1.4 |
| 2005 | 28 | 71 | 13 | 9 | 16 | 1.8 |
| 2006 | 29 | 79 | 15 | 6 | 10 | 1.7 |
| 2007 | 18 | 72 | 10 | 3 | 5 | 1.7 |
| 2008 | 39 | 51 | 15 | 0 | 0 | 0 |
| 2009 | 26 | 46 | 9 | 4 | 5 | 1.25 |
| 2010 | 20 | 65 | 4 | 0 | 0 | 0 |
| 2011 | 27 | 41 | 6 | 2 | 4 | 2 |

| Year | Number of PACs Monitored | Percent Occupied | PACs with Adult Pairs | Pairs with Young | Total Young Known | Young per Reproductive Pair (Average) |
|---|---|---|---|---|---|---|
| 2012 | 48 | 71 | 16 | 8 | 15 | 0.53 |
| 2013 | 39 | 82 | 28 | 13 | 16 | 1.2 |

**Table 15. Kaibab NF summary of PACs monitored 1978 to 2011**

| Year | PACs Surveyed | PACs with MSO | Known Percent Occupied | Detections | |
|---|---|---|---|---|---|
| | | | | Adult(s) | Number of Young |
| 1978 | 1 | 1 | 100 | 1 | Unknown |
| 1979 | 1 | 1 | 100 | 1 | Unknown |
| 1983 | 1 | 1 | 100 | 1 | Unknown |
| 1984 | 1 | 1 | 100 | 1 | 1 |
| 1990* | 3 | 3 | 100 | 2 Pairs + 1 Male | 2 |
| 1991 | 4 | 4 | 100 | 3 Pairs + 1 Female | 3 |
| 1992 | 2 | 2 | 100 | 2 Pairs | 1 |
| 1993 | 4 | 4 | 100 | 3 Pairs + 1 Single | 1 Sub-adult & 2 young |
| 1994 | 6 | 6 | 100 | 4 Pairs + 1 Male + 1 Single | 3 |
| 1995 | 6 | 3 | 50 | 2 Pairs + 1 Male | Unknown |
| 1996 | 6 | 5 | 83 | 3 Pairs + 2 Males | Unknown |
| 1997 | 6 | 3 | 50 | 2 Pairs + 1 Female | Unknown |
| 1998 | 6 | 5 | 83 | 4 Pairs + 1 Single | Unknown |
| 1999 | 2 | 1 | 50 | Unknown | Unknown |
| 2000 | 6 | 2 | 33 | 1 Pair + 1 Male | 2 |
| 2001 | 6 | 4 | 66 | 3 Pairs + 1 Single | 3 |
| 2002 | 6 | 1 | 17 | Pair | Unknown |
| 2003 | 4 | 2 | 50 | 2 Pairs | Unknown |
| 2004 | 3 | 2 | 66 | 1 Pair & 1 Single | Unknown |
| 2005 | 3 | 1 | 33 | 1 Single | Unknown |
| 2006 | 3 | 2 | 66 | 2 Singles | Unknown |
| 2007 | 6 | 5 | 83 | 3 Pairs + 1 Male + 1 Single | Unknown |
| 2008 | 6 | 4 | 66 | 2 Pairs + 1 Single | Subadult |
| 2009 | 6 | 5 | 83 | 2 Pairs + 1 Male + 1 Female + 1 Single | Unknown |
| 2010 | 6 | 1 | 17 | Male | Unknown |
| 2011 | 3 | 2 | 66 | 1 Pair + 1 Male | Unknown |
| 2012 | | | | 2 Pairs + 2 Males | Unknown |
| 2013 | 7 | 3 | 43 | 3 Pairs | Unknown |

*Previous to 1990 surveys were not organized by the Forest and available results are intermittent

## Forest Structure in MSO Habitat

Key features of MSO habitat described in the Recovery Plan include:

- a range of tree sizes and ages with a preponderance of trees greater than 12 inches d.b.h.,
- BA and density of pine and Gambel oak,
- canopy cover and structure,
- tree sizes suggestive of uneven-aged management, and
- large dead trees (snags) with a diameter of 12 inches or greater.

MSO populations are influenced by prey availability. Key features of prey habitat include:

- high volume of fallen trees (mid-point diameter of 12 inches or greater) and other woody debris
- plant species richness, including woody species
- residual plant cover to maintain fruits, seeds, and regeneration to provide needs of MSO prey species, and
- other improvements to prey habitat

These forest structure elements are reflected in the evaluation criteria and are used to describe the existing condition of the habitat and the effects of the proposed activities.

Existing MSO 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 TPA 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 (Table 16). Acres of protected habitat are primarily within PACs. PACs provide nesting and roosting habitat and are assumed to be occupied. The Recovery Plan assumes that adequate nesting and roosting habitat is important in achieving MSO recovery.

**Table 16. Existing spotted owl habitat forest structure and habitat components**

| Protected Habitat | RU | Average Percent of Total Pine SDI by d.b.h. Size Class | | | Average TPA 18"+ | Average Gambel Oak BA (percent of Total BA) |
|---|---|---|---|---|---|---|
| | | 12.0 – 17.9" | 18.0 – 23.9" | 24.0" + | | |
| **Forest Plan/Recovery Plan Desired Conditions** | All | 15 | 15 | 15 | ≥20 | ≥20 |
| **Restoration Unit (RU) Existing Conditions** | RU 1 | 31 | 13 | 8 | 14.6 | 14 |
| | RU 3 | 31 | 15 | 9 | 18.5 | 12 |
| | RU 4 | 33 | 9 | 5 | 8.6 | 8 |
| | RU5 | 34 | 14 | 8 | 13.2 | 10 |
| | **Averaged Total** | 31 | 14 | 8 | 15.0 | 13 |

Rather than using the density of trees by size-class (i.e., percent SDI), the relative distribution of tree size-classes can be described by averaging the diameter of all *individual* trees per acre (TPA; Table 17). Note that this table was not updated since the development of the draft EIS because there are so many individual trees on the landscape that minor boundary adjustments would not be expected to alter the ratio of trees per acre at this scale. Similar to using a density metric (Table 16), comparing existing and desired conditions based on TPA again demonstrates forests deficit in regeneration (0 to 4.9 inches d.b.h.), deficit in mature and old trees (greater than 18 inches d.b.h.), and excess in mid-sized trees (5 to 17.9 inches d.b.h.). This describes habitat that currently lacks one of the most important aspects of nesting and roosting habitat (i.e., large trees), that will be slow to develop large trees because of the abundance of mid-sized trees (see below), and will likely undergo a future bottleneck in the recruitment of trees into larger sizes classes because of the current lack of trees less than 5 inches d.b.h.

**Table 17. Desired and existing conditions based on trees per acre (rather than stand averages) by size class in the treatment area**

| Condition | Average Percent (%) Trees Per Acre by Size Class (d.b.h.) | | | | |
|---|---|---|---|---|---|
| | **0-4.9”** | **5-11.9”** | **12-17.9”** | **18-23.9”** | **24”+** |
| Desired | 45%<br>(40 to 50) | 30%<br>(25 to 35) | 12%<br>(10 to 14) | 8%<br>(7 to 9) | 5%<br>(4 to 6) |
| Existing | 38% - | 39% + | 17% + | 4% - | 1% - |

### *Forest Density within MSO Protected Habitat*

Forest density is a combination of BA and TPA values. BA within MSO protected habitat is variable across RUs, but average values are consistently high (Table 16). Silviculture data for protected habitat indicate that much of the BA is within young to mid-aged tree size-classes. Table 5 describes the effects of different categories of SDImax. Table 18 shows that, on average, three of four RUs supporting protected habitat are in zone 4 where trees are in severe competition and minimize the ability to produce understory vegetation (Long 1985). The remaining RU with protected habitat (RU 4) averages 55 percent of SDImax, where zone 3 merges into zone 4, marking the onset of density-related mortality. On average, protected habitat is undergoing active competition-induced mortality in stands where the goal is to retain and create large trees in dense forest conditions. Because young trees grow more vigorously than older trees, ongoing mortality can be expected to be disproportionately concentrated in the larger diameter size-classes (Ganey and Vojta 2011). Current forest densities will minimize individual tree diameter and volume growth, leading to stagnation or declines in whole stand volume growth due to individual tree mortality. These conditions can lead to an unraveling of MSO habitat and loss of stand resiliency. Combined, protected habitat will be at increasing risk of loss from stochastic events such as fire, insects, and disease.

**Table 18. Existing forest density by restoration unit in MSO PACs**

| Restoration Unit | Acres | Basal Area | | TPA | | SDI % of Maximum | |
|---|---|---|---|---|---|---|---|
| | | **Range** | **Avg** | **Range** | **Avg** | **Range (%)** | **Avg (%)** |
| 1 | 28,457 | 31 to 270 | 154 | 73 to 8,850 | 1,097 | 20 to 192 | 78 |
| 3 | 4,555 | 14 to 216 | 169 | 176 to 1,385 | 989 | 10 to 97 | 82 |
| 4 | 556 | 13 to 177 | 117 | 59 to 1,385 | 702 | 6 to 88 | 57 |
| 5 | 859 | 95 to 180 | 129 | 534 to 1,179 | 773 | 46 to 90 | 63 |
| **Total** | **34,426** | **13 to 270** | **155** | **59 to 8,850** | **1,066** | **6 to 192** | **78** |

### *Canopy Cover*

Canopy cover is an important feature of nesting and roosting habitat. All overstory trees contribute to canopy cover and about 90 percent of the overstory is commonly comprised of ponderosa pine trees within the 4FRI analysis area (appendix 6). Although deciduous species are a small component of the overstory, they affect understory vegetation and soil characteristics differently than pure conifer canopies and are an important component of other ecosystem processes. Canopy cover of 40 percent or greater generally provides closed canopy conditions. Canopy cover in habitat selected by MSOs is higher than average forest values and can range from 50 percent to greater than 80 percent (USDI 1995). On average, canopy cover is currently high across the 4FRI landscape (see Silviculture report). Local variation in canopy cover results from changes in forest structure, the interspersion of non-pine tree species, meadows, savannas, and forest density. The information presented above regarding BA and TPA indicates forests are dominated by trees 5 to 18 inches d.b.h. Key components of MSO habitat are the TPA 18 inches and larger d.b.h. High canopy closure in smaller diameter trees creates dense conditions with low canopy base height. The dense canopy restricts development of the herbaceous biomass, limiting prey habitat, and low branching limits flight ability for owls foraging in the subcanopy. In the field review of PACs proposed for treatment (appendix 4), closed canopy conditions created by dense, mid-aged trees were contributing to loss of large pine and large oak trees. Other habitat features like small meadows, springs, and aspen patches were also being compromised by encroaching young to mid-aged trees. The percent SDImax is currently 69 in restricted “other” habitat, 85 in target and threshold habitat, and 78 in protected habitat. All three values fall within the “extremely high density” category, indicating severe competition among trees, competition-induced mortality, and minimal or stagnating tree growth rates. In addition, surface fuels are building and there is little understory development. While canopy cover is a key attribute of MSO habitat, it must be balanced with other MSO habitat components.

### *MSO Prey Habitat*

#### Understory Development

Canopy cover has a direct influence on understory development. Once a threshold level in canopy cover is reached, herbaceous cover declines rapidly. The following summary is from appendix 6, which is incorporated by reference into this wildlife analysis:

> Dense groups of young pine trees limit sunlight, compete for water, and act as strong nitrogen sinks, creating unfavorable growing conditions for many understory species. More nutrients are translocated into forest canopies while slower nitrogen mineralization and nitrification rates occur beneath the forest floor. Combined with slower decomposition rates and allelopathic qualities associated with ponderosa pine litter, current forest floor conditions are creating selection pressure for a different suite of herbaceous species than what occurred here presettlement, causing changes to the understory community. Declines in total cover and species richness resulting from current forest conditions have been documented throughout the 20th century. The decrease in total cover and species richness resulting from current forest conditions includes selection pressures that limit total foliar production, flower production, and seed production. The net effects to wildlife are changes in vegetative cover and food quantity and quality, including reduced arthropod availability. Negative impacts reflected in the arthropod community can directly influence wildlife by reducing food availability for insectivores and omnivores. In the long-term, reduced arthropod populations can exert secondary limits or selection pressures on the plant community by decreasing the pollinator assemblage. This can further limit the potential understory community with potential impacts moving up through community trophic levels (page 8).

Conditions in dense groups of trees designated for nesting and roosting habitat precludes much understory development. However, small, scattered canopy gaps can create patches of food and cover for MSO prey species. Aspen and meadows within MSO habitat and patches of Gambel oak can also provide prey habitat while still managing pine-oak forest on a trajectory for nesting and roosting habitat.

**Snags, Down Logs, and Coarse Woody Debris**

Another identifiable feature of nesting and roosting habitat is the presence of down logs and large snags. MSOs and key prey species are associated with habitat containing numerous logs and large snags (Ganey et al. 2011). The Coconino and Kaibab forest plans call for an average of two large snags per acre in ponderosa pine forests, with large snags defined as 18 inches or larger d.b.h. and 30 feet tall or higher. However, these forest plan specifications may be unrealistic. Ganey (1999) found only 30 percent of ponderosa pine plots in un-logged sites met or exceeded FS snag guidelines and Waskiewicz et al. (2007) found pine snag densities well below FS guidelines in relatively undisturbed forests in northern Arizona. Ganey et al. (2014) concluded snag densities were low in ponderosa pine forests and that current guidelines may be unrealistic.

Fire promotes recruitment of large snags, although results from prescribed fire may be very different from wildfire. Randall-Parker and Miller (2002) concluded managers should expect only a few logs or snags to be created immediately after a burn. Their findings are encouraging given few prescribed fires include snag and log creation as an objective. They did report about a 20 percent decrease in snags and a 50 percent decrease in logs. However, their results were based on five plots. The methods were questionable and changed during the course of reading the five plots. There was no discussion on how the plot locations were selected, the size of the fires being monitored, or how representative each plot was in regards to the fire monitored. However, they described their results as preliminary and inconclusive (Randall-Parker and Miller 2002).

In a study on wildfire conducted locally, 40 percent of snags resulting from high-severity fire fell within seven years (Chambers and Mast 2005). Over 80 percent of ponderosa pine snags created by high-severity fire fell within 10 years post-fire (Chambers personal communications 2008, Mast personal communications 2008). Similar fall rates appear to occur for beetle-killed ponderosa pine trees (Chambers and Mast 2014). Chambers and Mast (2005) found greater densities of large diameter snags in unburned plots vs. burned plots on the Coconino and Kaibab NFs. Similarly, Holden et al. (2006) found significantly lower snag densities in the Gila NF (New Mexico) where fire had occurred 2-3 times since 1946 compared to areas that had only burned once. Bagne et al. (2008) found that in forests experiencing fire suppression for long periods of time, the greatest loss of snags occurred during first-entry burns (the first fire in a given location after missing three or more fire-cycles), but the long-term rate of loss decreased and eventually leveled off during subsequent burns.

Ganey and Vojta (2005) documented an increase in snag recruitment, but the greatest increase was among smaller-sized trees. This pattern is reflected in Forest Inventory Analysis (FIA) data collected between 1995 and 2007 showing an overall increase in ponderosa pine snag density on the Kaibab NF, similar to results reported by Ganey and Vojta (2005) (Table 19). In 2011, Ganey and Vojta reported a 74 percent increase in ponderosa pine mortality from 2002 to 2007 compared to mortality between 1997 and 2002. This may have been the result of a drought-mediated pulse in tree mortality (Ganey and Vojta 2011). While more trees were dying in the smaller size-classes, proportions of dying trees were greatest in the largest size classes. The pulse in large snags was a result of a mortality pulse in large trees. Both large trees and large snags are important to the MSO (USDI 1995). Mortality of aspen and Gambel oak in pine-oak forests were also proportionally greater than expected, relative to species composition of live tree forests (Ganey and Vojta 2011). This short-term increase in large snags reduces large snag recruitment in the long-term as fewer large trees are available through time.

**Table 19. Average ponderosa pine snag density on the Kaibab NF portion of the 4FRI (FIA unpublished data, 1995 to 2007)**

| Kaibab NF Ranger District | Dead Trees Per Acre (No.) by Tree Size Class (d.b.h.) | | |
|---|---|---|---|
| | 5"-10.9" | 11"-14.9" | >=15" |
| **1995** | | | |
| Tusayan | 0.39 | 0.00 | 0.11 |
| Williams | 0.99 | 0.00 | 0.24 |
| Total | 2.49 | 0.00 | 0.49 |
| **2007** | | | |
| Tusayan | 0.33 | 0.16 | 0.33 |
| Williams | 2.18 | 0.60 | 0.79 |
| Total | 5.00 | 1.50 | 1.20 |

The present density of snags 18 inches d.b.h. or greater is well below Coconino forest plan guideline of two snags per acre in ponderosa pine forest and even the Kaibab forest plan guideline of one to two snags per acre. In MSO Critical Habitat, snags important to owls and their prey species are defined as 12 inches d.b.h. or greater. The combination of snag size classes above 12 inches d.b.h. exceeds two per acre. This should provide habitat for MSO prey species, but still does not meet forest plan direction. The Recovery Plan used the combination of BA, large (greater than 18 inches d.b.h.) tree density, and tree size-class distribution as surrogates for availability of snags and downed logs. The assumption was that if these live tree attributes are at adequate levels across the landscape, than adequate amounts of snags and downed logs should also be present (USDI 1995). In terms of snags greater than 12 inches d.b.h. as well as general forest dynamics, MSO habitat criteria are currently being met. The deficit in snags is primarily a forest plan issue. Information on snag recruitment and retention can be found in appendix 11.

The range in snag values indicate that the distribution of snags is patchy and while guidelines may be met at some scales, snags could still be lacking within a given stand (Table 20). The distribution of snags relates to how they are formed. Individual snags may be a result of natural causes, but tree mortality resulting from beetles, fire, mistletoe, etc., tend to result in patches or small groups of snags. This emphasizes that, even where snag numbers may exceed forest plan guidelines in a given area, snag retention may still be important on a stand by stand basis.

**Table 20. Existing snags and coarse wood greater than 12 inches diameter in MSO by restoration unit (RU)**

| Habitat | RU | Acres | Snags 12 - 17.9” Per Acre | | Snags ≥18” Per Acre | | Coarse Wood (Tons per Acre) | | Logs | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Range | Avg | Range | Avg | Range | Avg | Range | Avg |
| MSO - Protected PACs & Protected Outside of PACs | 1 | 29,052 | 0 to 11.4 | 2.9 | 0 to 5.3 | 0.6 | 0.2 to 20.5 | 5.4 | 0 to 22.1 | 2.1 |
| | 3 | 4,793 | 0 to 8.2 | 2.9 | 0 to 2.5 | 0.7 | 0.9 to 16.1 | 6.3 | 0 to 41.7 | 3.6 |
| | 4 | 558 | 0.3 to 4.5 | 2.0 | 0.1 to 1 | 0.4 | 2.4 to 6.6 | 5.7 | 0 to 5.2 | 1.3 |
| | 5 | 859 | 1.5 to 4.5 | 2.7 | 0.3 to 0.9 | 0.6 | 3.2 to 6.5 | 5.6 | 0.4 to 5.2 | 3.3 |
| | **All** | **35,262** | **0 to 11.4** | **2.8** | **0 to 5.3** | **0.6** | **0.2 to 20.5** | **5.6** | **0 to 41.7** | **2.3** |
| MSO - Restricted Threshold | 1 | 872 | 0.6 to 6.1 | 2.0 | 0.2 to 0.7 | 0.5 | 5.7 to 9 | 7.1 | 1.2 to 12.8 | 6.1 |
| | 3 | 1,105 | 0.6 to 6.1 | 3.0 | 0.2 to 1.4 | 0.7 | 3.2 to 9 | 4.4 | 0.5 to 12.8 | 1.8 |
| | **All** | **1,977** | **0.6 to 6.1** | **2.5** | **0.2 to 1.4** | **0.6** | **3.2 to 9** | **5.6** | **0.5 to 12.8** | **3.7** |
| MSO - Restricted Target | 1 | 3,920 | 1.7 to 3.3 | 2.5 | 0.2 to 1.4 | 0.5 | 5.6 to 6.4 | 6.0 | 2.9 to 9.6 | 4.6 |
| | 3 | 2,795 | 0.9 to 3.3 | 2.2 | 0.1 to 1.4 | 0.5 | 2.1 to 6.4 | 4.8 | 0.2 to 9.6 | 2.5 |
| | **All** | **6,715** | **0.9 to 3.3** | **2.4** | **0.1 to 1.4** | **0.5** | **2.1 to 6.4** | **5.5** | **0.2 to 9.6** | **3.7** |
| MSO - Restricted Other | 1 | 25,710 | 0.4 to 3.9 | 1.7 | 0.2 to 0.8 | 0.4 | 2.1 to 5.9 | 4.3 | 0.2 to 3.2 | 1.0 |
| | 3 | 38,527 | 0.4 to 3.9 | 1.8 | 0.2 to 1.1 | 0.4 | 1.4 to 7.4 | 3.9 | 0.2 to 12.5 | 1.4 |
| | 4 | 1,576 | 0.5 to 3.7 | 1.7 | 0.2 to 1.1 | 0.5 | 1.4 to 5.9 | 3.2 | 0.4 to 2.6 | 1.1 |
| | 5 | 606 | 0.6 to 2.9 | 1.1 | 0.2 to 0.8 | 0.4 | 2.1 to 5.4 | 3.2 | 0.2 to 1.9 | 0.6 |
| | **All** | **66,419** | **0.4 to 3.9** | **1.8** | **0.2 to 1.1** | **0.4** | **1.4 to 7.4** | **4.0** | **0.2 to 12.5** | **1.3** |

Coconino forest plan direction for woody debris is to leave three large downed logs per acre and five to seven tons of CWD per acre. The Kaibab forest plan calls for an average of three logs and three to 10 tons of CWD. Downed logs are defined as 12 inches in diameter and at least 8 feet long and CWD is 3 inches or larger on the forest floor. Ganey and Vojta (2012) documented increased fall rates of trees in plots across the Coconino and Kaibab NFs since 2004. Plots with logs present increased by over eight percent between 2004 and 2009 and log length, density, volume, and area covered all increased significantly (p less than 0.001) during that same period. These changes represent initial results from a drought-mediated pulse in tree mortality (Ganey and Vojta 2011).

Traditional stand data collection does not include log length, which is part of the definition of a log in the forest plan compliance. However, Brown et al. (2003) developed a conversion factor for this kind of stand data and derived an average bole weight of .332 tons for a dead 12 inch d.b.h. ponderosa pine. Knowing the diameter of downed wood and using this conversion allows an estimate of how many logs are included in the tonnage value. This report uses this log equivalent conversion. The equivalent levels of logs based on CWD greater than 12 inches diameter exceeds forest plan direction (Table 20).

### *Thinning and Timber Harvest in Spotted Owl Habitat*

No empirical data exists on the effects of thinning or other mechanical forest treatments on MSOs. The absence of information complicates planning for restoration of ponderosa pine forests while simultaneously conserving MSOs and their habitats. The following summarizes published research on habitat treatments within the range of spotted owls, including the northern and California sub species.

Meiman et al. (2003) used radio telemetry to follow a single male northern spotted owl before, during, and after a 237 acre commercial thinning. The owl shifted its breeding-season home range to exclude part of the thinned area and used additional unthinned areas instead. However, results are difficult to interpret, in part because they are based on habitat use of a single owl. Also, information about temporal variation in space and stand use is lacking (USDI 2012b). As the authors noted, “Because this was a case study involving one owl, we are unable to apply our findings to spotted owls in general; however, we believe that our results highlight important issues that need to be addressed…” The thinning intensities varied from about 90 to 170 square feet BA and do not reflect the site-specific treatments used in the 4FRI that were designed for improving MSO habitat rather than as a commercial thinning.

Seamans and Gutiérrez (2007) modeled the probability of territory colonization, territory extinction, and breeding dispersal in relation to the amount of mature forest within and among territories. They included a covariate to evaluate the effects of changes in mature conifer forest habitat after timber harvest. The amount of untreated mature conifer forest was positively related to the top models for colonization and the probability of occupancy. The top model for colonization indicated that territories in which greater than or equal to 20 hectares (49 acres) of mature conifer forest habitat was altered by timber harvest experienced a 2.5 percent decline in occupancy probability. Territory extinction was inversely related to the amount of mature forest within a territory. The amount of mature forest treated was also related to breeding adults abandoning their territory and dispersing to other areas. However, Seamans and Gutiérrez (2007) did not provide details on the types of treatments implemented in this study and how the habitat was altered. This lack of information makes it difficult to compare their results with the specific management proposals of 4FRI.

Lee and Irwin (2005) looked at effects to California spotted owl (CSO) habitat from reducing risk of high-severity fire while maintaining forest canopy conditions. Their 60-year simulations concluded mechanical thinning with or without fuel breaks did not degrade canopy conditions in productive owl territories and did not impede attainment of improved forest structure in non-productive territories. Prather et al. (2008) looked at fuels reduction treatments in fire-excluded forest in MSO habitat. They used spatially-explicit modeling at a landscape scale to evaluate impacts of restoration-based treatments. They concluded that forest restoration was compatible with MSO conservation in at least 2/3 of the 2 million-plus acres analyzed across northern Arizona. Both Lee and Irwin (2005) and Prather et al. (2008) had a fuels reduction emphasis in their modeled treatments. That was not a treatment design objective in MSO habitat for the 4FRI.

The purpose behind the effort of Prather et al. (2008) was to evaluate the perceived conflict between forest restoration and MSO conservation in what is now the 4FRI area. They concluded that active restoration of dry forests from which fire has been excluded can be compatible in many areas with the conservation and recovery of MSOs. Not only can both objectives be met, but a restoration emphasis could also improve currently unsuitable forest for MSO. There is both agreement and disagreement between their results and the management actions proposed by the 4FRI in MSO habitat. Both Prather et al. (2008) and the 4FRI planning team emphasize carefully designed thinning and prescribed fire treatments. Both reference more aggressive treatments in forest stands adjacent to MSO habitat (especially to the southwest of PACs in the 4FRI). Both identify the application of treatments to improve marginal stands (e.g., the 18 PACs selected for mechanical treatments) and create future owl habitat (target and threshold treatments in the 4FRI). Both identify benefits to owl prey species by changing existing forest structure. Finally, both identify the benefit of a landscape that post-treatment is more resilient to fire and the associated reduction in uncharacteristically severe fire. The main discrepancy between the proposed management strategies are the constraint of restoration treatments by Prather et al. (2008) and the fact that the 4FRI acknowledges up front that the treatments proposed in MSO habitat are not restoration. The MSO treatments proposed by the 4FRI are minimally intrusive and the light intensity results in changes that fall short of accomplishing restoration (see the environmental consequences section below. The goal in the proposed 4FRI treatments are to simply increase tree growth rates to develop large trees sooner and to be able to retain large through time. Treatment intensity would have to be heavier to accomplish restoration.

The Pacific Southwest Research Station of the FS conducted a large scale monitoring effort on the Plumas and Lassen NFs (USDA 2010d). They monitored movements and habitat use of radio-marked CSOs in a portion of the northern Sierra Nevada Mountain Range modified by fuels treatments. Treatments included defensible fuel profile zones, understory thin, understory thin followed by underburn, and group selection. Treatment objectives were to reduce fuel continuity across the landscape. Treatments were typically located along roads and ridge tops to provide a defensible zone for fire suppression activities. Understory thinning treatments allowed removal of trees less than 10 inch d.b.h. Radio-marked owls avoided the defensible fuel profile zones. Use of other treatments was variable, but owls did not avoid the other fuels treatment types. Owl home ranges contained fuels treatments in proportion to their availability on the landscape. One owl strongly selected underburn treatments over untreated forest for foraging; limited availability of this treatment type within the study area prevented further analysis of this relationship. In three-years post-treatment CSOs were distributed similarly to the pre-treatment landscape. The authors concluded that the results provide empirical support that CSOs persist in landscapes treated for fuels or restoration treatments.

Irwin et al. (2004) found northern spotted owls on the eastside of the Cascade Mountains abandoned 45 territories that had abundant pole-sized trees and limited seedling and sapling-aged trees. In addition, northern spotted owl reproductive rates were lower in territories with more pole-sized trees. The most productive owl pairs occurred in forests most at risk to uncharacteristic wildfire. They recommended managers prioritize treatments in dry forests most at risk of uncharacteristically intense wildfire. Four FRI treatments in MSO protected habitat would only remove pole-sized and smaller trees (5-17.9 inch d.b.h.). MSO in treatments in restricted habitat outside of target and threshold habitat could remove trees up to 24 inch d.b.h. However, treatments would still include the large and old tree strategies and meet the intent of the revised MSO Recovery Plan (USDI 2012b).

Blakesley et al. (2005) examined habitat composition around 67 CSO nest sites and its relationship with reproduction. Site occupancy was positively associated with the amount of the nest area dominated by large trees with high canopy cover within the nest area. It was negatively associated with the amount of non-habitat (non-forested areas and forest cover types not used for nesting or foraging) and with medium-sized trees with high canopy cover. Nest success was positively associated with the presence of large remnant trees within the nest stand. Reproductive output for northern spotted owls was negatively associated with interior forest, but positively associated with edge between mature and old-growth conifer forest and other vegetation types (Franklin et al. 2000). May and Gutierrez (2002) looked at nest and roost sites in northern Arizona. MSOs occupied areas of predominantly younger forests if residual large (greater than or equal to 18 inch d.b.h.) trees were present. Residual large trees, especially Gambel oaks, are important microhabitat components in younger forests. May et al. (2004) recommend management for mature and old-growth trees and for large (greater than or equal to 18 inch d.b.h.) oak trees in particular. In addition to retaining and protecting large pine, no oak would be cut in any of the 4FRI action alternatives. Tree removal in protected, target, and threshold habitats would focus on reducing competition between large oak and pine and smaller ponderosa pine.

The literature is mixed in terms of spotted owl response to thinning and fuels treatments. However, there is support for reducing the risk of future high-severity fire in occupied spotted owl habitat. Unfortunately, there is no clear guidance relative to types of treatments, extent/intensity of treatments, or spatial arrangements of treatments that would minimize negative impacts to owls. Available data is largely from CSOs and northern spotted owls, with little information specific to MSOs. Lacking such information, the MSO recovery team recommended that managers proceed cautiously in terms of treatment intensity and extent and should be aimed at balancing reduced risk of high-severity fire with maintaining the mature forest structure that seems to be favored by spotted owls. Given the uncertainty, they concluded treatments in MSO habitat should include rigorous monitoring (USDI 2012b). It is important to note the differences between treatment objectives modeled or monitored in the literature and the restoration-based activities proposed by the 4FRI. Treatments in MSO habitat in the 4FRI were developed in cooperation with the FWS. In addition, the proposed actions include an Old Tree Implementation Plan that protects all trees exhibiting old tree characteristics regardless of their d.b.h. (some old trees have large diameters and some have relatively small diameters due to competition from young, vigorous trees). Alternatives C and E include a Large Tree Implementation Plan that protects trees 16 d.b.h. and larger unless circumstances fit specific exemption categories developed by the 4FRI collaborative group.

### *Forest Structure Summary for MSO Habitat*

The 4FRI database (see silviculture report) and PAC reviews indicated a number of consistent issues relative to MSO habitat in the 4FRI treatment area, including:

- An imbalance in tree size-classes leading to a lack of diversity in tree ages and structural diversity, with an abundance of mid-aged trees and a lack of large, old trees;
- Threats to existing big and old trees because of competition from smaller trees;
- Decreased quality in prey habitat due in part to uncharacteristic canopy cover from ingrowth of trees in mid-size classes that block direct sun, , alter soil chemistry, and compete for water and nutrients (see appendix 6);
- Overall decline in forest resilience due to competition among trees and, indirectly, from the risk of high-severity fire, insects, and disease resulting from the uncharacteristic levels of tree competition;

- Snags greater than 18 inches d.b.h. are deficit across the landscape relative to forest plan direction; combined with snags 12 to 18 inches d.b.h. MSO habitat needs may be met, but snags numbers vary considerably;
- CWD and logs tend to be abundant and meet forest plan direction, although stand-by-stand variation exists;
- The risk of high-severity fire in dense forest conditions within the ponderosa pine forest type remains high and outside desired conditions, threatening the ability to maintain MSO habitat components through time.

Habitat loss from high-severity wildland fire was identified as a primary risk in the Recovery Plan in 1995, yet the three most active fire seasons in Arizona history have occurred since 2008, with nearly a million acres burned in 2011 alone (Paxon 2011). Because of the nature of closed canopy, dense forest structure, the risk of high-severity fire is high in MSO habitat. Minimum requirements for habitat components in MSO habitat, as outlined in the forest plans and Recovery Plan, do not allow the same flexibility in management as in ponderosa pine forest outside MSO habitat. The higher risk of high-severity fire is acknowledged in the Recovery Plan and the scale of 4FRI allows a strategic reduction of risk in areas adjacent to owl habitat.

## Fire

### *Historic and Current MSO Habitat Conditions*

Before Euro-settlement, Southwestern ponderosa pine forests supported frequent, low severity surface for at least the last 1,400 years (Swetnam and Baisan 1996, Roos and Swetnam 2012). The historic fire regime both shaped and maintained the largely open-grown, groupy nature of the forest. The lack of fire has allowed surface fuels to accumulate for over a century instead of burning under a frequent fire-return interval. The amount of fuel now feeding surface fires affects burn severity and flame length, thereby increasing the risk of fire burning into the canopy. Rather than fire predominantly consuming surface fuels such as litter, duff, woody debris, and dried herbaceous materials, fires are now uncharacteristically prone to crown fire (Roos and Swetnam 2012). Continuing changes in climate, invasive species, and consequences of past fire management, added to the impacts of larger, more frequent fires, will drive disruptions to fire regimes of the western U.S. (Dennison et al. 2014).

More acres of PACs and critical habitat have been lost to high-severity fire within the U.S. portion of the range of the MSO than by management actions such as forest management, livestock grazing, recreation, etc. (USDI 2012b). Most MSO habitat lost to high-severity fire has been within the UGM Recovery Unit (e.g., Rodeo-Chediski and Wallow Fires on the Apache-Sitgreaves NF; the Schultz and Slide fires on the Coconino NF) and Basin and Range West Recovery Unit (e.g., Horseshoe 2 Fire on the Coronado NF). Other Recovery Units have also been impacted by high-severity fire such as the Southern Rocky Mountains Recovery Unit (e.g., the Las Conchas Fire on the Santa Fe NF) and the Colorado Plateau Recovery Unit (e.g., the Warm Fire on the Kaibab NF) (USDI 2012b). In their review of the risk to MSO habitat from high-severity fire, the MSO recovery team concluded that:

- The amount of MSO habitat affected by high severity fire from 1995 to 2008 (i.e., not including the 538,000+ acre Wallow Fire of 2011) was not offset by restored or newly developed habitat;
- These data and climate-warming modeling suggest that MSO habitat degradation could escalate in most portions of the range in the foreseeable future;

- Alternatively this undesirable habitat loss could potentially be mitigated if future wildfire effects are moderated under wetter decadal-climate regimes and more effective at reducing forest fuels and opening forest canopies rather than replacing them, and if strategically placed treatments across the landscape are more influential in slowing and reducing the size of future high-severity fire patches;
- Projections about extent of high-severity fire effects… during the next century Projected future losses of MSO habitat, assuming a 1 percent-exponentially increasing rate of high-severity fire effects indicated that by 2110 nearly 80 percent of the PAC area in the UGM could be burned by high-severity fire. Under the more extreme scenario of a 4 percent annual exponential increase, 100 percent of the PAC area would be affected by high-severity fire in the UGM by 2075.

Normandin (2014) completed an unpublished white paper assessing wildfire effects in MSO PAC habitat within the greater 4FRI/Mogollon Rim area, including the Tonto and Apache-Sitgreaves NFs. The focus of the review was on fires in PACs exceeding 1,000 acres. Data was collected for wildfires from 1992 through 2011. He identified 153 PACs burned by high severity fire, or about 20,763 acres of PAC habitat. More acres of PAC habitat continue to burn and more acres of high severity fire are occurring in PACs (Figure 10). Over a 20-year period an average of about 6.2 fires per year burned within PACs across this area. However, when the study time is split in half, the first ten years (1992-2001) averaged 2.9 fires per year while the second half of the study period (2002-2011) averaged 9.5 fires per year. The average weighted patch size for high severity was 54 acres, ranging from less than 5 acres to over 600 acres (Normandin 2014). MSOs have not been documented using open habitat greater than 10 acres (Ganey et al. 2011).

As wildfires increase in size, so does the threat of high-severity fire (Normandin 2014). A fire greater than 5,000 acres is almost three times more likely to burn in a PAC with high-severity fire than a fire less than 5,000 acres in size. About 25 percent of fires less than 10,000 acres included high-severity effects in PACs while 93 percent of fires over 10,000 acres included high severity fire in PACs (Normandin 2014).

Abundant research exists with consistent conclusions regarding current fuel loading and fire behavior relative to the historical range of variation for ponderosa pine forests in general and in northern Arizona specifically (see for instance Covington and Moore 1994, Dahms and Geils 1997, Smith 2006, and Fulé et al. 2013). The preponderance of science agrees that ponderosa pine and ponderosa pine-Gambel oak forests are highly departed from the historical fire regime (Fire Specialists report). Current conditions in the pine-oak component of the treatment area are outside of the historical range of variability (Abella 2008). Frequent fire was part of the historic environment, with fire return intervals often averaging less than 10 years (Abella and Fulé 2008). The small tree form of Gambel oak dominates the oak growth form along the Mogollon Rim which is different from the shrubby type that is found further east. In the absence of high-severity fire, Gambel oak reaches maturity in 60 to 80 years. Fire exclusion has contributed to a shift in oak densities, with increases in oak density and BA since the late 1800s (Abella 2008, Fulé et al. 1997). The majority of this increase is from small and medium-sized stems. Prescribed fire will reduce densities of small-diameter oak while treating surface fuels, but Gambel oak resprouts vigorously the 1st growing season following fire (Ffolliott and Gottfried 1991, Kunzler and Harper 1980). Prescribed fire may be used to reestablish oak within the range of historical variability (Abella 2008). Fire response in mature oak is similar to that in young trees: A severe fire will recycle the stand; low-severity fires create openings for resprouts.

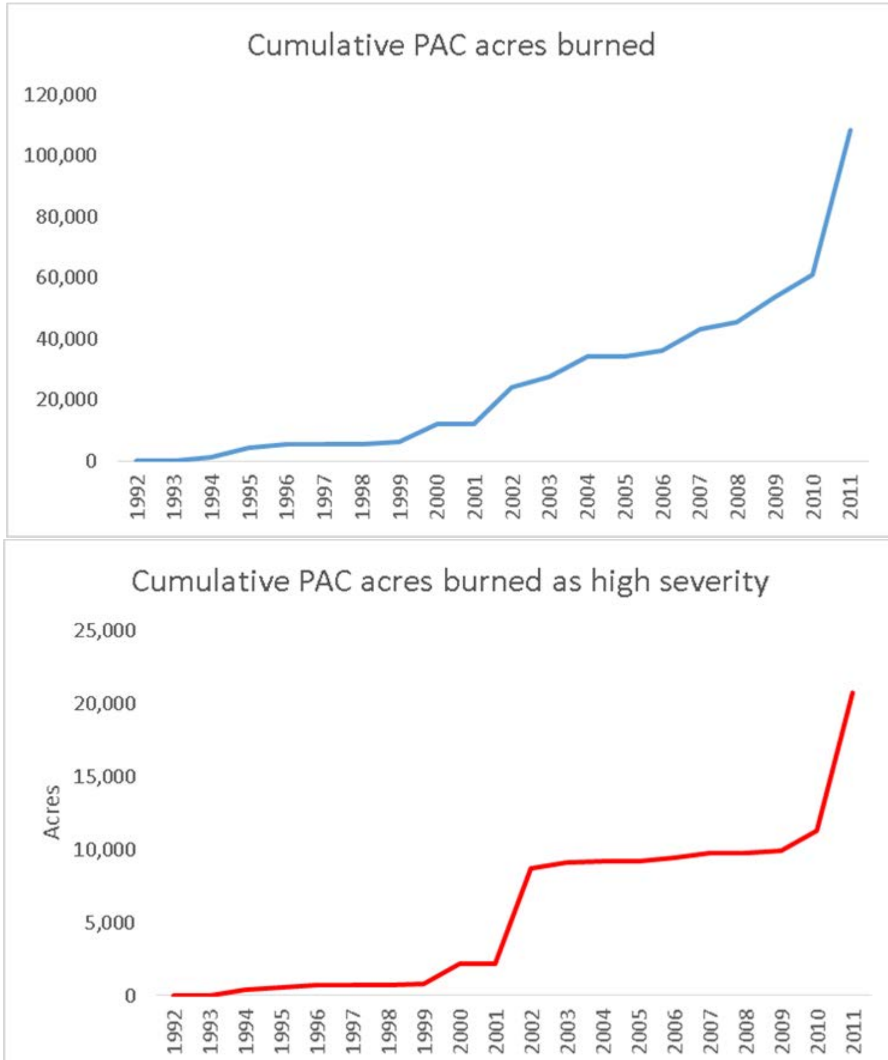


**Figure 10. Total acres burned (top) and acres of high severity fire in PACs in the 4FRI and along the Mogollon Rim in Arizona, 1992 to 2011**

The 4FRI fire modeling and analysis was conducted at several scales, from the treatment area (the largest scale) to individual forest type and habitat classifications (e.g., MSO habitats). However, individual PACs were not modeled. Fire effects to protected habitat are presented in the Environmental Consequences section.

Nearly 200,000 acres of ponderosa pine forest is at risk of crown fire across the treatment area (Table 21). Some surface fire included in the ponderosa pine fire behavior represents savanna habitat where fire would be expected to burn differently from the typical forest structure. While technically forest habitat, savanna is, by definition, very open habitat. Although the acres of savanna habitat could not be modeled separately from the rest of the ponderosa pine, it does bias the results by implying more fire would burn as surface versus crown fire. Desired conditions are for no more than 10 percent of the ponderosa pine in the analysis area to be prone to crown fire (under modeled conditions) and the crown fire distributed spatially (Swetnam and Baisan 1996, Roccaforte et al., 2008). Pine- oak forest structure corresponds to the overall conditions of general ponderosa pine forest in terms of fire behavior (Fire Ecology Report).

**Table 21. Current fire behavior in ponderosa pine, pine-oak, and savanna as modeled under Schultz Fire conditions across the treatment area by restoration unit**

| Existing Conditions | RU1 | RU 3 | RU 4 | RU 5 | RU 6 | Totals |
|---|---|---|---|---|---|---|
| **Total acres** | **144,113** | **129226** | **134,278** | **59,034** | **41,189** | **507,839** |
| Surface fire (acres) | 80,257 | 72,776 | 83,449 | 41,109 | 33,673 | **311,313** |
| Passive crown fire (acres) | 15,784 | 12,594 | 10,590 | 6,821 | 2,233 | **48,023** |
| Active crown fire (acres) | 47,553 | 43,256 | 39,763 | 7,376 | 5,238 | **143,186** |
| Surface fire percent | 56 | 56 | 62 | 70 | 82 | **61** |
| Passive crown fire percent | 11 | 10 | 8 | 12 | 5 | **9** |
| Active crown fire percent | 33 | 33 | 30 | 12 | 13 | **28** |

Crown fire can be active, where it advances from crown to crown in the tops of trees, or passive where ladder fuels carry a fire into the canopy, igniting individual trees or groups of trees without spreading into neighboring trees or groups of trees. According to fire modeling, nearly half of the total MSO habitat in the treatment area (48 percent) would support some form of crown fire with over a third of MSO habitat (42,344 acres) at risk of active crown fire (Table 22).

**Table 22. Predicted fire behavior in existing (year 2010) Mexican spotted owl habitat**

| MSO Habitat | Habitat Acres | Surface Fire (Acre) | Passive Crown Fire (Acre) | Active Crown Fire (Acre) | 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 |

Crown fire is, by definition, high-severity. It generally consumes the entire tree crown in ponderosa pine, producing 100 percent mortality. Acres within or adjacent to MSO habitat are also at risk from high-intensity surface fire that can result in high-severity effects. High-intensity surface fires that burn through areas of heavy surface fuels with dense canopies and low canopy base height can scorch the canopy sufficiently to cause widespread mortality (Van Wagner 1973). After large-scale crown fires, the landscape is vulnerable to second-order fire effects such as flooding, erosion, and weed infestations. More information on existing fire conditions as related to canopy conditions and fuel loading can be found in the 4FRI fire specialist’s report.

The risk of crown fire also means potential loss of the large tree-sized component of Gambel oak. Larger sized oak boles often have heart rot and provide substrate for nesting MSOs and a host of other cavity nesting birds and mammals. While oak would remain on the landscape, high-severity fire could lead to losses in the larger diameter tree form of oak while maintaining the shrubby oak form in MSO habitat. This would decrease potential nesting habitat for MSOs and also decrease prey habitat.

The existing condition for surface fuels within the 4FRI treatment area is directly related to forest density: ponderosa pine forests outside MSO habitat generally supports less total tonnage of surface fuels than restricted habitat and restricted habitat typically has less surface fuel than protected habitat (Table 23). Tree size-classes can be used as a surrogate for tree density (younger and mid-aged trees established in the absence of fire are, in general, denser than groups of older/larger trees on this landscape). In addition to denser forests and canopies, Litter primarily consists of pine needles and conifer litter and duff, which can alter soil chemistry. These changes can affect MSO prey habitat by eventually altering the composition of the understory community (appendix 6). Additionally, high litter levels increases the consumption of logs and CWD in fires, presenting another threat to maintaining habitat for MSO prey species. High-severity surface fire can change post-fire understory response and alter micro-flora communities (appendix 6). Although the desired condition is returning fire behavior to predominantly surface fire, current fuel loading presents threats to MSO and prey habitats from both the risk of crown fire and uncharacteristically severe surface fire.

**Table 23. Surface fuel loading by tree size-classes (d.b.h.) within forested habitats**

| Habitat by d.b.h. Size Classes | Fuels (tons per acre) | | |
|---|---|---|---|
| | Large woody debris | Duff | Litter |
| **Ponderosa Pine** | | | |
| 12 to 18 " | 4.0 | 3.5 | 3.5 |
| 18 to 24" | 3.7 | 3.1 | 2.6 |
| ≥ 24" | 2. 8 | 2.4 | 2.1 |
| **Restricted** | | | |
| 12 to 18 " | 4.2 | 3.4 | 4.3 |
| 18 to 24" | 4.0 | 3.0 | 2.8 |
| ≥ 24" | 2.6 | 2.5 | 2.3 |
| **PACs** | | | |
| 12 to 18 " | 4.8 | 3.8 | 4.6 |
| 18 to 24" | 4.1 | 7.6 | 2.8 |
| ≥ 24" | 3.9 | 2.8 | 3.1 |

Forested stands adjacent to and southwest of MSO PACs were reviewed on a PAC-by-PAC basis across the treatment area by the 4FRI silviculturist, GIS specialist/data manager, and 4FRI wildlife biologists. Treatments in these stands were reviewed and increasing the intensity of treatments was evaluated to reduce the risk of high-severity fire in neighboring PACs. Treatment intensity was frequently increased 1 level in these areas, e.g., a UEA 10 to 25 would be changed to a UEA 25 to 40. This was done after the initial treatment types were assigned with the goal of better safeguarding the stand conditions in PAC habitat.

### *Fire Effects and MSO*

Fire effects to MSOs and their habitat are mixed and not always clear as described in the literature. One issue is that few studies have evaluated fire effects in relation to occupancy of spotted owl sites (Lee et al. 2012). In addition, different studies have reached different conclusions when assessing the literature. One review of fire effects to owls found 3 examples of negative effects on occupancy (Bond et al. 2009) while another review reported “The few existing studies of fire’s effects on rates of occupancy of spotted owl sites have found no significant effects” (Lee et al. 2012)

Interpreting the literature is complicated by small sample size, comparisons of studies from different regions of the western US involving different subspecies of spotted owls in different forest types, and inconsistent use or omission of key descriptors of fire effects. Effectiveness of limited sample sizes is further reduced by the degree data is stratified. Bond et al. (2002) evaluated 3 fire severity classes on 8 CSO territories, leading to few data points per fire severity category. Bond et al. (2009) examined effects of fire on 7 radio-marked CSO (4 males and 3 females) from 4 territories. The 4 territories occurred in 2 different study areas which again left few data points per analysis category. In addition, the research was only conducted for a single breeding season. The more specific the datum, the more difficult it is to generalize the data. They concluded a larger sample of spotted owls could illuminate why results on fire impacts were “equivocal.”

Forest types are highly variable among spotted owl subspecies. Dominant tree species within the range of one subspecies are absent in the range of other subspecies. For example, red fir and incense cedar are common trees in CSO habitat, where much of the fire effects research has been conducted, but are absent in the ponderosa pine – Gambel oak forests used by MSOs. Roberts et al. (2011) identified differences in forest structure between study areas used in the same project where 1 area was historically managed for timber harvest and the other area was in a National Park. They identified a potential bias in their results from treating the 2 study areas as the same in their analysis. The bias within a single study area can be amplified when extrapolated to totally different forest types in different parts of the country.

Forest structure defines prey habitat as well as habitat selected by spotted owls. Flying squirrels (*Glaucomys sabrinus*), a key prey species for both the California and northern spotted owls, do not occur within the range of the MSO. Wood rats are a key prey species for all three spotted owl sub-species, but mice and voles dominate the diets for MSOs in the 4FRI area (Ganey et al. 2011). Extensive forest patches of interlocking crowns benefit flying squirrels but can reduce food and cover for mice and voles.

Weather, fire return intervals, ladder fuels, fuels accumulation, and how each of these have been affected since Euro-settlement can all vary by forest type. Each of these factors influences forest structure and fire behavior. For example, forest type affects fire return intervals and fire return intervals can shape fire effects on forest structure (Bonds et al. 2002). The interactions of these features can affect fire severity and influence forest structure in different ways in different regions. The inherent synergy of these factors further complicates comparisons among owl subspecies ranging from the Pacific Northwest (northern spotted owl), the mountains of central California (California spotted owl), and the forests and canyons of Arizona and New Mexico (MSO).

Differences in behavior and habitat use among owl subspecies can relate to forest structure. For instance, nesting and roosting habitat used by MSOs is thought to provide thermal cover and reduce the owl’s evaporative water loss (Ganey et al. 1993). This may partially explain the MSOs tendency to use cooler microhabitats and might affect post-fire forest use by the owl. The need for thermal cover has not been documented for California spotted owls which is where much of the research on post-fire habitat use has been conducted.

Bond et al. (2009) reviewed habitat use by California spotted owls and found 4 nest sites occurring in 3 burn classifications, making any generalizations of post-fire nesting habitat difficult based on sample size alone. Roosting habitat indicated a selection for low-severity burned forest and avoidance of high-severity burns. Unburned roost sites were used in proportion to their availability. Foraging spotted owls selected burned forest patches over unburned forest, with the greatest selection for high-severity burned areas. However, 31 percent of the foraging area was unburned, creating a mix of habitat conditions (Bond et al. 2009). Roosting and foraging locations were based on habitat use by 7 individual owls, so they do not represent independent data points.

Whereas Bond et al. (2009) concluded foraging spotted owls selected for areas with high-severity fire, Call et al. (1992) found foraging California spotted owls used habitats with more open canopy closure less frequently than expected. The apparent discrepancy may relate to the interspersion of vegetation conditions, described by Bond et al. (2009) as a mosaic of burn severities. This emphasizes the complexity of an old-growth-associated species that feeds on prey associated with open habitats when generalizing about the use of post-fire landscapes.

Roberts and North (2008) concluded spotted owls select habitat at multiple scales, with less flexibility in nesting and roosting habitat requirements and more flexibility in foraging habitat. Use of post-fire forest after low- to moderate-severity fire relates to the retention of numerous large trees and areas of high canopy closure (Roberts and North 2008). Both of these attributes are severely reduced or eliminated by high-severity fire.

Another common issue in the literature addressing fire effects and forest use by spotted owls is the mixing of or failure to recognize different classes of fire severity. Bond et al. (2002) concluded "… studies on impacts of wildfires on spotted owls have been equivocal." The seemingly inconsistent results are described as negative effects associated with large stand-replacing wildfires and low to moderate severity wildfires that did not adversely affect spotted owls. These results are equivocal only if fire is considered in a binary sense, i.e., the presence or absence of fire. However, forest fire effects are generally defined in terms of changes to vegetative structure. The difference between a surface fire (low severity) and overstory removal (high-severity) is the difference between potentially improving owl prey habitat and removing owl nesting and roosting habitat. This could only be deemed "equivocal" if no difference is acknowledged between enhancing and eliminating a species' habitat.

Another source of variation is how each burn category is classified. The scale of the patch size being measured can influence results. Is the patch size for units of burn severity at the stand scale or some larger unit of area? Are there inclusions of other burn severities within each category or are they areas drawn to only include a specific burn severity category? For instance, does "low severity" mean 100 percent of the area burned at low severity or simply that the majority of the area burned as low severity? If it is a majority of the area, is "majority" 51 percent of the area, 95 percent, etc.? These same questions apply to high-severity and illustrate part of the challenge of summarizing burn conditions. Bond et al. (2009) defined moderate-severity as "areas between low- and high-severity classes and representing a mixture of effects on dominant vegetation." Because of this variability, the mixed-severity category may not even equal the same habitat effects within the same study and can certainly vary among studies, particularly among studies in different forest types. Roberts et al. (2011) added an "unchanged" category for burned areas with no documented changes in forest structure. Each source of variability reflects differences in post-fire habitat structure. This inherent variability complicates defining cause and effect relationships, particularly if the study has a small sample size or combines fire severity classes.

While these classification issues may not be as critical in large, contiguous areas of overstory removal such as the post Rodeo- Chediski fire in MSO habitat, it can be very important in CSO habitat where fires commonly result in an interspersion of varied fire severities, including unburned areas (Lee et al. 2012). This mosaic, including patch sizes, patch configuration, and amount of resulting edge habitat produced, defines the resulting habitat for spotted owls and their prey (Bond et al. 2009, Roberts et al. 2011). Bond et al. (2009) concluded future investigations may provide insight into the probability of post-fire occupancy by spotted owls if characteristics such as patch size and shape are described.

Even when fire variables can be clearly classified on the ground they may be used differently in different analyses. Roberts et al. (2011) combined prescribed fires ignited by managers, wildfires managed for resource benefits, and wildfires suppressed by firefighters into one category called ‘‘burned’’ forest. Each fire type represents varying degrees of control and severity which can reflect greater variability in the resulting fire effects. Roberts et al. (2011) also combined variable fire severities into a single fire severity index value they described as “burned mosaics.” Bond et al. (2002) reported on spotted owl site fidelity “after large ( greater than 1,334 acres) wildfire.” They stated “Relatively large wildfires that burned nest and roost areas appeared to have little short-term effect on survival, site- and mate-fidelity, and reproductive success.” Fire size is irrelevant without accompanying descriptions of severity classes and pattern. A small high-severity fire could have a greater impact on resident owls than a large low-severity fire. Extrapolating the results is further restricted by the fact that burn patterns in Sierran mixed-confer forests appear similar to the patterns that existed before Euro-settlement (Roberts et al. 2011). This is very different from the preponderance of science demonstrating the marked departure in post-settlement burn patterns documented in Arizona (see for instance Covington and Moore 1994, Dahms and Geils 1997, Smith 2006, Fulé et al. 2013, and the fire ecology report).

Lee et al. (2012) compared fire effects at 41 burned CSO sites and 145 unburned CSO control sites. The research was conducted in Sierran mixed-conifer forest characterized by mixed-severity fire regimes at intermediate scales (Lee et al. 2012). Owl site classifications were based on whether the best pre-fire owl locations were inside or outside mapped burn perimeters. They found that “even fire that burns on average 32 percent of suitable habitat at high-severity within a CSO site does not threaten the persistence of the subspecies on the landscape.” They also found “Over 50 percent of suitable vegetation was burned at high-severity at only 9 of 41 sites” suggesting that 32 sites (78 percent) had less than or equal to 50 percent of the area burn at high-severity. The focus on high-severity patches was “because this level most concerns managers as being a threat to CSO.” However, this focus excluded analysis of burn patch size, the interspersion of high-severity patches with other burn severity categories, and unburned areas within each owl site. Roberts et al. (2011) had previously reported post-fire heterogeneity may be one of the most important aspects of the burned landscape to spotted owls.

Summarizing effects of high-severity fire by reporting the average is also misleading given high-severity fire ranged from nearly absent (0.1 percent) to nearly the entire owl site (93 percent; Lee et al. 2012). Lee et al. (2012) acknowledged California spotted owls are associated with older forest and nesting and roosting is not associated with high-severity burn patches. Therefore, if nesting and roosting habitat did not burn at high-severity and the remaining portion of owl sites consisted of a mix of burned severities, then conditions would be similar to pre-settlement forest patterns (Roberts et al. 2011). Continued occupancy would be expected, given these patterns resemble the evolutionary landscape of California spotted owls. Departure from presettlement conditions in MSO habitat is the basis of 4FRI management.

### *Fire Effects Literature and 4FRI*

Lee et al. (2012) hypothesized that there could be a critical threshold for high-severity fire that, if exceeded, could adversely affect owl occupancy rates. They cited Seamans and Gutiérrez (2007) who identified such a threshold for “logging.” Lee et al. (2012) concluded that legacy snags or other habitat components that result from fire, but are generally absent with “logging,” may play an important role in maintaining habitat suitability for spotted owls. Logging, as used by Seamans and Gutiérrez (2007), referred to clearcutting and salvage logging, neither of which are a part of the 4FRI nor resemble the thinning proposed in MSO habitat. The 4FRI incorporates an old tree implementation plan, regardless of d.b.h. and a large tree implementation plan in alternatives C and E. No trees greater than 18 inches d.b.h. would be removed in MSO protected, target, or threshold habitats. No trees greater than 24 inches d.b.h. would be removed in restricted “other” habitat. In general, mechanical operations would avoid snags and there are design features in place to minimize the loss of snags from operations. Snags would be reduced due to prescribed fire, but prescriptions would focus on low-severity fire that reduces surface fuels. The goal of MSO treatments is to retain and promote key elements of MSO habitat vulnerable to high-severity fire. Prescribed fire generally creates a mosaic that includes unburned areas. Mechanical and fire treatments are expected to improve MSO habitat, particularly through time if climate predictions add further stress to forest structure with high SDI values that correlate with active to severe within stand competition.

There is also a temporal component to post-fire habitat characteristics. Fire-created snags can be a short-term legacy in ponderosa pine forest types. A study within the 4FRI boundary documented over 40 percent of high-severity fire-killed snags fell within 7 years (Chambers and Mast 2005). Over 80 percent of ponderosa pine snags created by high-severity fire fell within 10 years post-fire (Chambers personal communications 2008). Surviving trees are susceptible to bark beetles post-fire (Christiansen et al. 1987, Amman 1991) and beetle-killed snags are even more ephemeral, with less than 20 percent of beetle-created snags standing after 7 years (Chambers and Mast 2014). High-severity fire is defined as creating high to complete mortality of overstory vegetation (Bond et al. 2009), i.e., green forests become blackened snags. Future snag recruitment would not occur until new forest is established, grows, ages, and large trees die. The time lag between the fall of fire- or beetle-created snags and the reestablishment of large, dead trees represents the period of time where this habitat component for owls and their prey would be absent within the high-severity fire footprint.

High-severity fire can produce an abundance of down woody material, another key component of MSO habitat. However, more is not always better. Roberts et al. (2011) found a negative effect between woody debris and nest and roost occupancy. While many owl prey species respond positively to overstory removal and subsequent understory development, nesting and roosting habitat still correlates with an abundance of large trees and an inverse relationship with down woody material (Roberts et al. 2011, Lee et al. 2012).

As indicated above, detailed conclusions from California spotted owl research are not always applicable to MSOs and their habitat. Studies in the Sierra Range in California have frequently been limited by small sample sizes and ill-defined fire variables. Extrapolating results involves different forest types used by different subspecies of owls with different prey species. Nevertheless, some general patterns have emerged regarding fire severity and owl behavior. Spotted owls appear adapted to surviving wildfires of various sizes and severities (Bond et al. 2009). California spotted owls are known to have high site fidelity (Blakesley et al. 2006) and MSOs are presumed to as well (Hedwall personal communications 2011). However, high-severity fire can kill or displace California, Mexican, and northern spotted owls (Gaines et al. 1997, Jenness et al. 2004, Clark et al. 2011). Post-fire habitat heterogeneity may be one of the most important aspects of a burned landscape to spotted owls (Roberts et al. 2011). Low- to moderate-severity fire retains or improves California owl habitat (Bond et al. 2002, Roberts et al. 2011). Fire producing a mosaic of lightly to severely burned patches at intermediate scales and retains residual habitat features can benefit spotted owls (Roberts et al. 2011, Lee et al. 2012). This mosaic pattern may resemble the evolutionary landscape of California spotted owls (Bond et al. 2009).

Large-scale prescribed fire could be an effective tool in restoring habitat to natural conditions with minimal short-term impact on resident spotted owls (Bond et al. 2002, Roberts et al. 2011). Landscape-scaled prescribed fire and wildland fire use programs that emulate the historic fire regime could protect nesting and roosting habitat (Roberts et al. 2011). Fire management could create landscapes that maintain spotted owl habitat and also protect habitat from future high-severity fire effects (Roberts et al. 2011). Conversely, ignoring the risk of high-severity fire to MSOs and their habitat does not represent a long-term plan for recovery of the species, even if site-fidelity maintains occupancy after high-severity fire events. Roberts and North (2008) summed-up California spotted owl, fire, and habitat relationships in the following manner:

1. Spotted owls select habitat at multiple scales, with less flexibility in the nesting and roosting habitat requirements, and more flexibility in the foraging habitat.
2. Foraging habitat appears to have more moderate canopy closure and is still associated with large trees, possibly because of their importance as nest sites for northern flying squirrels, an important prey species for spotted owls in mesic Sierra Nevada forests.
3. Low- to moderate-severity fire does not reduce the probability of spotted owl occupancy if numerous large trees and areas of high canopy closure remain after a fire.
4. A dense understory of regenerating trees can interfere with owl foraging. Low- to moderate-severity fire reduces the density of small trees and may improve the habitat quality of spotted owl nesting or foraging habitat.
5. Forest heterogeneity, with various vegetation communities or fire severities infused into late-successional forest, may improve spotted owl fitness.
6. Fire effects on foraging habitat are not well understood, and future research needs to be directed toward owl foraging use patterns in a burned landscape.

Spotted owl site fidelity may not be good for spotted owl populations. Reports of post-fire site fidelity in the literature seldom address predation rates. The MSO Recovery Plan states predation is a common mortality factor of spotted owls, accounting for at least 19 of 40 documented deaths and may account for more deaths than indicated (USDI 2012b). Suspected predation was the leading cause of death when generating survival estimates in MSO modeling (USDI 2012b). Specific predators are typically unknown, but avian predators are suspected to represent the main form of predation (USDI 2012b). Potential avian predators of MSOs include great horned owls, northern goshawks, red-tailed hawks, and golden eagles (USDI 2012b). Post-high-severity fire landscapes are, by definition, largely devoid of living trees and within the decade, snags as well. Great-horned owls, red-tailed hawks, and golden eagles preferentially forage in open habitat and northern goshawks hunt in open habitat if prey is available. The MSO recovery team suspected that predation may have localized effects on spotted owl abundance, particularly on post-fledging juvenile survival. While predation is a documented fatality factor, there is no evidence that current predation rates are abnormally high (USDI 2012b). However, “current predation rates” are based on contiguous forest conditions (USDI 2012b). Habitat alteration resulting from large-scale crown fire can favor potential spotted owl predators and was not part of the Recovery Plan predation assessment. Extensive patches of high-severity fire could not only remove nesting and roosting habitat, but also leave spotted owls more vulnerable to predation.

Gutierrez et al. (1995) considered great-horned owls a primary source of spotted owl mortality. They hunt by sight in open habitats and along edges (Houston et al. 1998). Because mature and old-growth forest structure is vertically complex, the auditory morphology of the spotted owls may provide a benefit over sight-dependent hunters like great-horned owls while also providing cover to avoid predation (Franklin et al. 2000). Mature and old-growth forest appears positively associated with spotted owl survival (Franklin et al. 2000). Reproductive output is enhanced by edge with little interior habitat. Fitness represents a balance of both older forest and other vegetation types (Franklin et al. 2000). This mosaic was expressed as small patches of other vegetation types with convoluted edges, dispersed within and around a main patch of mature and old-growth forest for northern spotted owls (Franklin et al. 2000). Similar to findings for the California spotted owl, patches of different vegetation types and seral stages within a matrix of mature and old-growth forest may provide a stable prey resource that also buffers against the risk of predation (Franklin et al. 2000). The apparent selection by MSOs for cooler microclimates when nesting and roosting also aids in temperature regulation, but may limit food and cover for prey species. Extensive areas of high-severity burn within an owl territory may promote high fecundity due to enhanced prey biomass, but does not necessarily promote high fitness. Roberts and North (2008) concluded that forest heterogeneity, with various vegetation communities or fire severities infused into late-successional forest may improve spotted owl fitness. They also emphasized the importance of forest structural elements lost in high-severity fires.

Selection of foraging habitat is not clearly understood. Call et al. (1992) concluded that foraging California spotted owls selected macrohabitats composed of larger trees and higher canopy closure. They used forests composed of medium trees less frequently than expected. Fewer than two percent of telemetry locations occurred in clearcut/shrub/plantation habitat which represented 30 percent of available habitat. Foraging microhabitat was characterized by multiple vegetative strata, large tree size classes, high tree basal areas and woody debris. These results are very different from those in post-burn landscapes and indicate a complex interaction between owls and their habitat. A study on the Plumas and Lassen NFs (USDA 2010d) concluded “Wildfire effects can vary depending on fire severity patterns and the resulting post-fire vegetation conditions. California spotted owls are able to persist in landscapes that experience primarily low- to moderate-severity wildfires. In contrast, high-severity wildfires appear to have negative effects on California spotted owls and their habitat.”

Spotted owl habitat loss due to fire has been documented in other dry forest systems. A fire in eastern Washington affected six northern spotted owl activity centers with an average habitat loss of 31 percent of each owl site (range 8 percent to 45 percent). Four of six sites (67 percent) were not occupied the next year and adult owls may have died in the rapidly advancing fire (Gaines et al. 1997). Jenness et al. (2004) reviewed other instances of spotted owls abandoning or shifting territories and concluded stand-replacing wildfire remains a significant- threat to owls and their habitat. Gaines et al. (2010) recommended a landscape restoration approach for dry forest systems within spotted owl habitat.

Lee and Irwin (2005) advocated a different approach by recommending the incorporation of fire and fuels strategies into spotted owl management rather than a restoration approach. They conducted 60-year simulations using predictions of mechanical thinning or mechanical thinning plus fuel-break treatments. They evaluated these treatment states in combination with either no fire or mixed-lethal fire scenarios and concluded treatments would not degrade canopy conditions in productive owl territories nor impede improvement of non-productive territories. In contrast, lethal fire simulations produced a pronounced and lasting negative effect. They concluded habitat needs for owl reproduction can be incorporated into effective fire and fuels management strategies that lessen the chances of uncharacteristic wildfire.

The summaries and modeled scenarios debated in the scientific literature typically do not include climate change (Spies et al 2010). Forest changes resulting from climate can affect spotted owl energetics and the synergistic effects of climate change on insect and disease outbreaks and the incidence of fire in dry landscapes could further compromise the ability to maintain nesting and roosting habitat over time (Spies et al 2010).

### *Smoke Effects and MSO*

In addition to potential direct habitat loss from fire, smoke could also affect owls. Dense smoke settling for multiple consecutive nights could affect the lungs of incubating adults and nestlings. Japanese quail continuously exposed to ozone for seven days and nights had lung damage when concentrations were maintained at 0.15 ppm (Rombout et al. 1991). Ozone concentrations of 1.50 ppm led to statistically significant damage to a critical portion of quail lungs on the region where gas exchange occurs. Effects were potentially life-threatening after seven days of exposure at this level (Rombout et al. 1991). Avian lung design is similar across species in that they are composed of interconnecting air sacs that create unidirectional air flow which, combined with blood flow, contribute to the remarkable efficiency in gas exchange (Maina 1988). This efficiency could increase susceptibility to lung damage. Mammalian airways form a tree-like branching pattern that terminate in alveoli rather than forming a unidirectional air flow. Japanese quail also appear to lack the morphological and biochemical repair ability observed in mammals (Rombout et al. 1991). Therefore, it is assumed that prolonged exposure to smoke would cause permanent lung damage to MSO nestlings from ozone and, presumably, from particulate matter. Causing irreparable lung damage to adults or juveniles would be a long-term adverse effect.

On the Coconino and Kaibab NFs, smoke settling into low-lying areas in association with prescribed fire typically does not last more than 1 or 2 nights. Limited smoke within PACs would be expected to repeat an aspect of the evolutionary environment for wildlife in northern Arizona and so result in negligible effects to MSO (Horton and Mannan 1988, Prather et al. 2008). Dense smoke from first-entry burns (defined as areas that have not burned in 20 or more years) could result in smoke levels exceeding historical levels. Adult females incubating eggs are not likely to flush from the nest. This is based on observations of nesting goshawks that, in terms of ecological niche, are similar to a diurnal equivalent of spotted owls. Incubating goshawks are tolerant of low levels of human disturbance and smoke, but are notoriously aggressive once the nestlings are older (Reynolds personal communications 2013). While there are no equivalent observations of MSOs in regards to smoke, adult owls did respond to noise disturbance in a similar fashion as goshawks in that they only flushed after juveniles had left the nest (Delaney et al. 1999). This at least does not conflict with observations of goshawks. Therefore, it is reasonable to assume that smoke settling into core areas early in the nesting season (March through June) could affect lungs of brooding females. If adult owls did flush, unattended eggs would be at risk of cooling or predation. Nestlings would be at potential risk of lung damage if smoke settled after hatching (Rombout et al. 1991). Recognition of the risks of unintended smoke effects led to the designation of Exclusion and Opportunity Zones defining areas available for prescribed fire outside or inside the MSO nesting season, respectively (see methodology above). More detail can be found in appendix 5.

### *Change in Conditions from the Slide Fire*

The Slide Fire burned about 21,227 acres between May 20th and June 4, 2014. The Slide Fire occurred entirely within the Oak Creek watershed affecting roughly 15 percent of the watershed upstream of the City of Sedona. Burn severity was assessed via Rapid Assessment of Vegetation Condition After Wildfire (RAVG) and soil severity was estimated by Burned Area Reflectance Classification (BARC).

High-severity vegetation effects include areas with greater than 75 percent of the dominant overstory vegetation killed (or topkilled). In these areas, crown fire consumed the crowns of trees and/or surface fire produced sufficient heat to lethally scorch the crowns of trees. This usually includes 100 percent consumption of surface fuels, leaving bare, exposed soil. Herbaceous and especially shrubby species are already resprouting in areas of high severity fire. In particular, Gambel oak and New Mexican locust (*Robinia neomexicana*) were seen in recent visits. However, most of the surface area within high-severity burn areas is bare of vegetation. In many areas the organics in the soil were also consumed. Onsite testing indicated both moderate and high soil burn severity classes have hydrophobic soil tendencies that could have high hydrologic response. Heat from the fire created a water repellent layer that could result in accelerated soil erosion following precipitation until the layer breaks down. Habitat recovery in these areas would be slower than in areas with lower burn severity. Steeper slopes are especially subject to debris flows, rockslides, overland flow and accelerated erosion that could become concentrated flow.

It is expected that some trees that appear to be dead now may recover and some trees that survived the fire will die from insects and additional stressors over the next few years. The largest degree of change in the overstory is likely to occur in the areas with mixed severity fire effects. Most of the high-severity burn area has moved away from desired conditions. The forest overstory is now predominantly dead trees that are expected to fall in the next 5 – 10 years (Chambers and Mast 2005). Across much of the fire area, particularly the high severity areas, effects of the fire over the next 5 – 10 years will depend largely on subsequent environmental conditions such as precipitation, temperature, and wind. There are about 1,100 acres of seeding and mulching treatments being implemented to mitigate second order fire effects (e.g., flooding, erosion, debris flows). The effectiveness of these treatments depends largely on the timing of their application and succeeding precipitation events.

Approximately 3,115 acres (14 percent) of the area burned at high soil burn 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) remain unburned or burned at very low severity. Collectively, about 46 percent of the fire burned in the moderate or high soil burn severity class. Soil burn severity is often used as an indicator of post-fire runoff response. The distribution and severity of fire effects to soil and vegetative ground cover affect this response. Undisturbed forest soils are generally characterized by high infiltration rates requiring rainfall events as high as 1-inch or more before producing measurable runoff. This, in part, is a function of the amount of effective ground cover associated with forest soils. Exposed soils frequently develop a crust which reduces the ability of water to enter the soil. In addition, the exposure of soil to the heat of wildfire can lead to water repellency in the upper several inches of the soil profile. Combined with reduced infiltration from surface crusting, this amplified water repellency can result in accelerated erosion during rain events starting at ¼-inch (Runyon 2014). Repeated onsite soil testing after the Slide Fire burned indicated both moderate and high soil burn severity classes have hydrophobic soil tendencies that could have high hydrologic response. Most or all of the protective vegetative cover was consumed in soils classified with high or moderate soil burn severity, leaving the soil exposed to the erosive effects of rainfall. Modeling results indicate that post-fire peak rainfall discharge could increase by a factor of up to eight (Runyon 2014).

Tree needles that fall in areas where surface fire (sometimes interspersed with passive crown fire) produced sufficient heat to lethally scorch tree crowns may provide some degree of soil protection. They could also support low intensity/low severity (short flame lengths and of a short duration) surface fire. Future fires could ignite snags, logs, and CWD, but the overall effects would be low severity because of a lack of fuel. Ladder fuels and surface fuel loading were decreased in areas that burned with low and/or mixed severity fire effects (approximately 6,500 acres). The fuel consumed would decrease potential fire intensity (i.e., lower flame lengths), reducing the potential for surface fire to transition into crown fire. Additionally, where there was low to moderate crown scorch, the increase in canopy base height would further decrease the potential for surface fire to transition into crown fire and the decrease in canopy bulk density would decrease the potential for active crown fire. Acres of very low to low severity effects (about 4,700 acres) and about half of the acres with mixed severity effects (~2,300 acres) were moved towards desired conditions (Fire Ecology report).

### Effects to MSO PACs within the 4FRI Area

Most of the Slide Fire area was within RU3 of the 4FRI, with the majority of the burn area in SU3-5 (Figure 11). Almost 8,000 acres burned within the 4FRI treatment in area above the Mogollon Rim. Twelve PACs were affected by the fire (Table 24). The 4FRI portion of the Slide Fire is above the Mogollon Rim where fire severity was ameliorated by topography and suppression activities (Table 24). Much of the high-severity burn occurred in canyons, along canyon walls where the fire made runs upslope, and on top of the Rim near the canyon edges. About 800 acres within the 4FRI area burned with high-severity effects, including about 440 acres within PACs.

**Table 24. Vegetation severity for all PACs burned in the Slide Fire**

| PAC Name | Area Burned | Unchanged | Low Severity | Moderate Severity | High Severity | Acres Burned |
|---|---|---|---|---|---|---|
| Bridge | Total PAC | 42 | 296 | 256 | 11 | 605 |
| | w/in 4FRI | 9 | 107 | 132 | 3 | 251 |
| Casner Cabin | Total PAC | 86 | 404 | 118 | 2 | 610 |
| | w/in 4FRI | 15 | 115 | 41 | 0 | 171 |
| Cave Springs | Total PAC | 215 | 214 | 243 | 116 | 788 |
| | w/in 4FRI | 3 | 27 | 104 | 70 | 204 |
| Harding Point | Total PAC | 84 | 222 | 266 | 81 | 653 |
| | w/in 4FRI | 0 | 31 | 68 | 35 | 134 |
| Sterling | Total PAC | 16 | 96 | 278 | 232 | 622 |
| | w/in 4FRI | 2 | 25 | 111 | 121 | 259 |
| Upper West Fork | Total PAC | 5 | 2 | 0 | 0 | 7 |
| | w/in 4FRI | <1 | <1 | <1 | 0 | <1 |
| Banjo Bill[1] | Total PAC | 64 | 77 | 106 | 205 | 452 |
| Barney Springs[1] | Total PAC | 65 | 278 | 220 | 70 | 633 |
| Buckhead Point[1] | Total PAC | 60 | 117 | 186 | 195 | 558 |
| Loy Tank[1] | Total PAC | 40 | 288 | 239 | 73 | 640 |
| East Buzzard[1] | Total PAC | 61 | 211 | 284 | 37 | 593 |
| West Buzzard Pt[1] | Total PAC | 59 | 332 | 203 | 7 | 601 |

[1]Outside the 4FRI treatment area

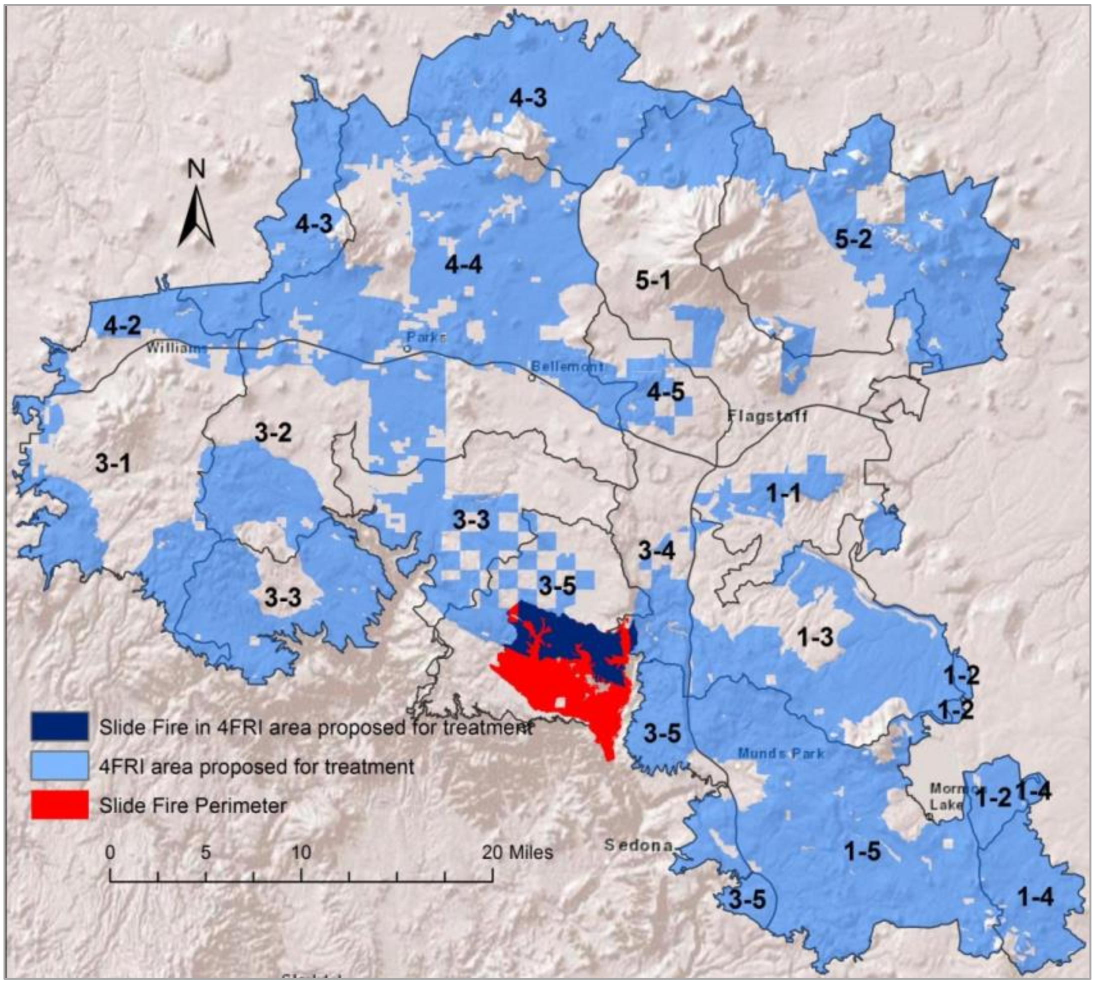


**Figure 11. Overlap between the 4FRI treatment area and the Slide Fire (about 7,884 acres)**

Six PACs in the 4FRI treatment area burned with highly variable vegetation severity (Figure 12). After omitting Upper West Fork from consideration, which had about 0.01 percent of the PAC burned, high- severity fire effects ranged from nearly zero to 29 percent of individual PACs within the 4FRI treatment area (Table 25). When combining unchanged, low, and moderate severities (i.e., moderate severity or less), the area burned within individual PACs ranged from about ½ to nearly 100 percent.

More PAC acres burned with high soil severity within the 4FRI treatment area than with high vegetation severity (Table 26). Five PACs had over 200 acres in the moderate to high severity categories and, of these, Harding Point and Sterling PACs were over 400 acres. Restricted habitat was also affected by the Slide Fire (Table 27).

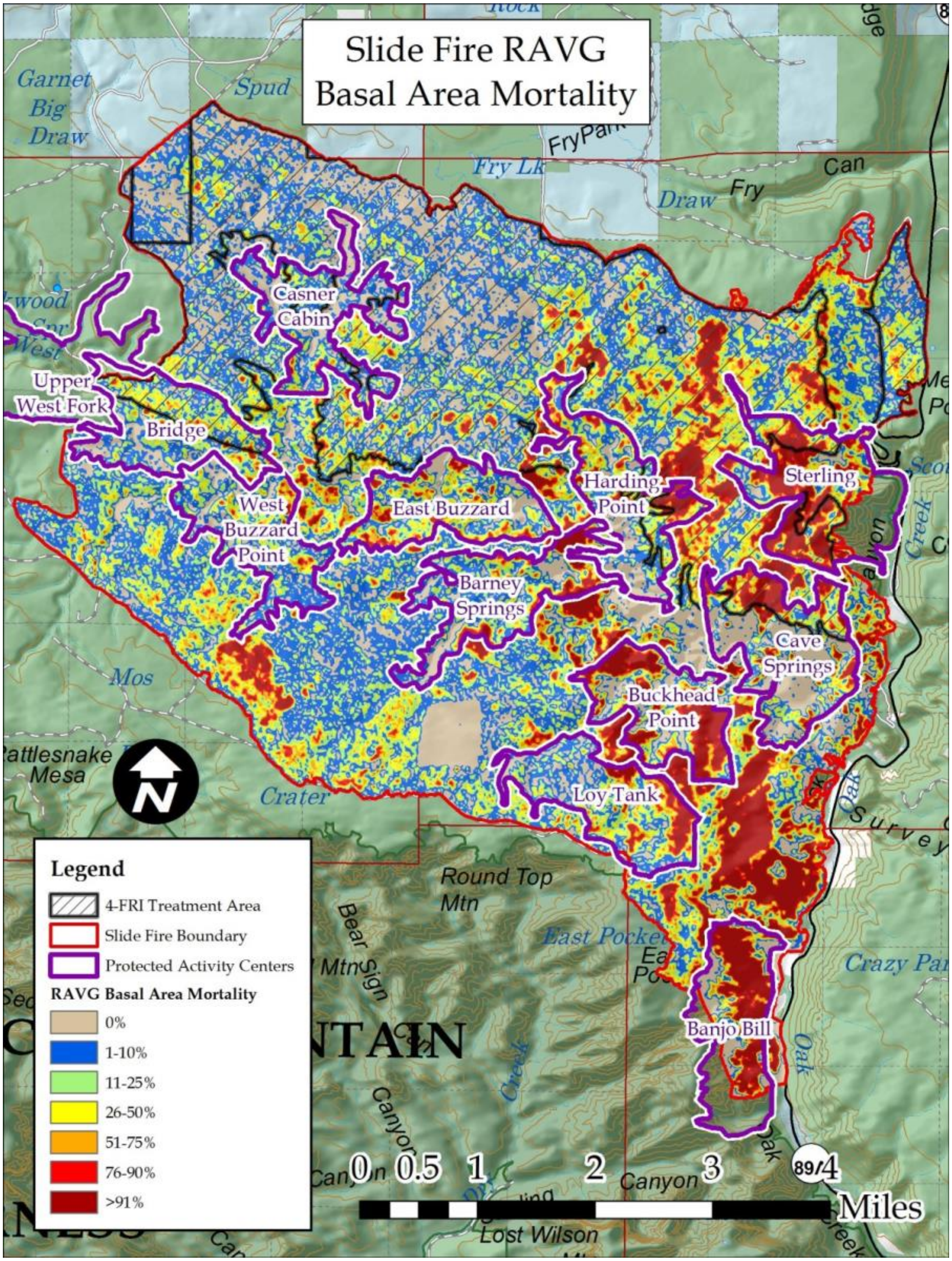


**Figure 12. MSO PACs and burn severity in the Side Fire, June 2014**

**Table 25. Vegetation severity in PACs proposed for prescribed fire-only (Rx fire) in the 4FRI**

| PAC Name | Area | Burned but Unchanged | Low Severity | Moderate Severity | High Severity | Acres Burned | Total PAC Acres | % of PAC Burned | % Of PAC Unchanged to Moderate Severity | % Of PAC High Severity | % of PAC Proposed for Rx Fire |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bridge | Total PAC | 42 | 296 | 256 | 11 | 605 | 637 | 95 | 93 | 2 | 45 |
| | w/in 4FRI | 9 | 107 | 132 | 3 | 251 | | 39 | 39 | <1 | |
| Casner Cabin | Total PAC | 86 | 404 | 118 | 2 | 610 | 610 | 100 | ≈100 | <1 | 28 |
| | w/in 4FRI | 15 | 115 | 41 | 0 | 171 | | 28 | 28 | 0 | |
| Cave Springs | Total PAC | 215 | 214 | 243 | 116 | 788 | 788 | 100 | 85 | 15 | 26 |
| | w/in 4FRI | 3 | 27 | 104 | 70 | 204 | | 26 | 17 | 9 | |
| Harding Point | Total PAC | 84 | 222 | 266 | 81 | 653 | 653 | 100 | 88 | 12 | 21 |
| | w/in 4FRI | 0 | 31 | 68 | 35 | 134 | | 21 | 15 | 5 | |
| Sterling | Total PAC | 16 | 96 | 278 | 232 | 622 | 795 | 78 | 49 | 29 | 33 |
| | w/in 4FRI | 2 | 25 | 111 | 121 | 259 | | 33 | 17 | 15 | |
| Upper West Fork | Total PAC | 5 | 2 | 0 | 0 | 7 | 658 | 1 | 0.01 | 0 | 42 |
| | w/in 4FRI | <1 | <1 | <1 | 0 | <1 | <1 | <0.01 | <0.01 | 0 | |

**Table 26. Soil severity in PACs proposed for prescribed fire-only (Rx fire) in the 4FRI**

| PAC Name | Area | Unburned/ Very Low Severity | Low Severity | Moderate Severity | High Severity | PAC Name | Unburned/ Very Low Severity | Low Severity | Moderate Severity | High Severity |
|---|---|---|---|---|---|---|---|---|---|---|
| Bridge | Total PAC | 57 | 338 | 216 | 27 | Harding Point | 55 | 195 | 284 | 120 |
| | W/in 4FRI | 7 | 126 | 110 | 6 | | 1 | 25 | 68 | 41 |
| Casner Cabin | Total PAC | 38 | 397 | 167 | 8 | Sterling | 105 | 143 | 235 | 312 |
| | W/in 4FRI | 5 | 109 | 55 | 2 | | 2 | 19 | 85 | 153 |
| Cave Springs | Total PAC | 136 | 267 | 233 | 153 | Upper West Fork | 597 | 60 | 0 | 0 |
| | W/in 4FRI | 6 | 25 | 84 | 89 | | 1 | 0 | 0 | 0 |

**Table 27. Acres of restricted habitat in the 4FRI treatment area burned in the Slide Fire**

| Proposed Treatments | Acres | Number of Stands | Outside Fire Perimeter | Vegetation Severity | | | |
|---|---|---|---|---|---|---|---|
| | | | | Unchanged | Low | Moderate | High |
| MSO Restricted | 3,793 | 58 | 1 | 255 | 1,747 | 1,463 | 327 |
| MSO Target | 318 | 10 | 0 | 26 | 135 | 120 | 38 |
| MSO Threshold | 32 | 1 | 0 | 0 | 14 | 13 | 4 |

Effects of high severity fire are considered the leading threat to MSOs (USDI 2012b).However, research evaluating effects of mixed-severity fires on spotted owls has largely been conducted in the Sierra Nevada Mountains. The California spotted owl is a different sub-species from the MSO 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 Fire Effects and MSO in the Affected Environment section for a more complete literature review. The discussion below is focused on specific elements of this research as it applies to post-Slide Fire conditions within the 4FRI treatment area.

Lee et al. (2012) compared burned and unburned sites used by owls. They found no significant effects of fire on the probabilities of local extinction and colonization at burned and unburned sites under these conditions. They determined that high severity fires that burn on average 32 percent of suitable habitat within a California Spotted Owl site does not threaten the persistence of the subspecies on the landscape. Conversely, Bond et al. (2002) looked at all three subspecies of spotted owls one year after wildfire. They accounted for 18 of 21 owls and evaluated eight territories in regards to fire severity. They concluded that wildfires may have little short-term impact on survival, site fidelity, mate fidelity, and reproductive success of spotted owls when greater than 50 percent of a territory burns with low to moderate severity. Similar to Lee et al. (2012), they determined that when less than 30 percent of a territory burns with high severity owls were similarly unaffected. Bond et al. (2002) acknowledged that large stand-replacing wildfires appear to negatively impact owl occupancy. Further, they suggested prescribed burning could be an effective tool in restoring habitat to natural conditions with minimal short-term impact on resident spotted owls.

Four of six PACs in the 4FRI treatment area burned with 85 to 100 percent moderate- or less severity in the Slide Fire. About ½ the area (49 percent) in the Sterling PAC burned with moderate- or less severity and about 22 percent of this PAC did not burn all. The Upper West Fork PAC only had seven acres burn and all were moderate- or less severity. Percent of high-severity fire ranged from zero to about 29. Based on the research presented above, population metrics such as survival, site fidelity, mate fidelity, and reproductive success should continue to be supported. the combination of unchanged to moderate severity fire and high-severity fire are within the stated thresholds for supporting owl occupancy. (Bond et al. 2002, Roberts and North 2008, Bond et al. 2009, Roberts et al. 2011, Lee et al. 2012).

When assessing behavior, Bond et al. (2009) concluded California spotted owls selected low-severity burned forest for roosting but avoided moderate- and high-severity burned areas; unburned forest was used in proportion to its availability: Owls selected all severities of burned forest for foraging, avoiding unburned forest within 1 km of the center of their foraging areas. Beyond 1.5 km there were no discernible differences in use patterns among burn severities (Bond et al. 2009). Roberts et al. (2011), also working with California spotted owls, concluded that low to moderate severity fires maintain habitat characteristics essential for spotted owl site occupancy. Key to habitat use of post-fire landscapes by California spotted owls was the resulting mosaic of burn severities, including unburned areas (Roberts and North 2008, Bond et al. 2009). However, there was no quantification of the interspersion of burn severities and unburned habitat. There is no spatial component to the Slide Fire data either. However, fire frequently results in a patch mosaic of burn severities. It is therefore assumed that post-Slide Fire conditions should continue to support MSOs.

## Road Systems

Roads created to facilitate implementation of the 4FRI would only be temporary and would be decommissioned after protect treatments are completed. Additional roads selected for decommissioning were those evaluated and identified for decommissioning under Travel Management Rule (TMR). No additional roads are proposed for decommissioning.

### *Road Maintenance, Decommissioning, Construction, and Relocation*

About 2,817 miles of road would be needed to implement the project. Of this total, approximately 2,297 miles are existing, open roads. However, portions of these existing roads have resource concerns, which require maintenance or reconstruction prior to project use. There is no existing access in some parts of the treatment area.

The Coconino and Kaibab National Forests identified the road system needed for public and administrative motorized use through the TMR (see the transportation specialist report for details on forestwide transportation analyses). Within the 4FRI treatment area, the TMR process identified a need to decommission approximately 726 miles of existing system and unauthorized roads on the Coconino National Forest. About 134 miles of unauthorized roads (often referred to as user-created routes) were recommended for decommissioning on the Kaibab NF within the 4FRI area (Table 28). The desired condition is for soils that 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 consist of a variety of cool and warm season vegetation.

**Table 28. Approximate miles of road work in the 4FRI area**

| General Location | Temporary Construction and Decommission | Reconstruction/ Improvement | Relocation | Existing Road Decommission |
|---|---|---|---|---|
| Treatment Area | 520 | ≤ 30 | ≤ 10 | 860 |
| MSO Habitat1 | 74 | 8.1 | 1.5 | 153 |

1. MSO Habitat represents a subset of total project acres

There is a need to have adequate access to the treatment area for implementation. Adequate access includes utilizing existing roads and temporarily creating roads that can be returned to their natural state (decommissioned) at the completion of project activities. Additional maintenance, reconstruction, and restoration actions would be designed to meet site-specific conditions where possible and practicable.

Road decommissioning could take many forms, from simply adding signage, placing boulders to obstruct access, to ripping and re-contouring roadbeds. Road decommissioning under 4FRI could take many forms, including one or more of the following:

1. Reestablishing former drainage patterns, stabilizing slopes, and restoring vegetation;
2. Blocking the entrance to a road or installing water bars;
3. Removing culverts, reestablished drainages, removing unstable fills, pulling back road shoulders, and scattering slash on the roadbed;
4. Completely eliminating the roadbed by restoring natural contours and slopes; and
5. Other method designed to meet the specific condition associated with the unneeded roads.

Road access provided by roads can affect elements of MSO habitat. While limits exist on the legal removal of snags and logs, a direct correlation was identified between snag availability and road access. Snags were nearly 3-times more abundant in stands away from roads as they were in stands with roads and snags were less abundant in stands closer to towns or in flatter topography (Wisdom and Bates 2008). A similar relationship between human access and decreased snag and log availability was recognized in northern Arizona pine-oak habitat within the 4FRI treatment area (Chambers 2002, Ganey et al. 2014). Road decommissioning within MSO habitat should help retain snags and logs for MSOs and their prey. About 74 miles of road is proposed for decommissioning within MSO habitat. Roads proposed for decommissioning by MSO habitat type and total miles of proposed road decommissioning are the same in each action alternative.

Nearly 100 miles of road maintenance and temporary road construction would occur in protected habitat (Table 29). Road maintenance and temporary construction would occur pre-harvest. A detailed table showing road maintenance and construction by PAC can be found in appendix 15. The term “temporary roads” in protected habitat consists of non-system roads that currently exist as open roads on the landscape. They would be roads authorized by contract, permit, lease, or other written authorization but are not a forest road and are not included in a forest transportation atlas. Therefore, temporary road construction would be variable and can encompass little to no work on the ground. Alternately, temporary road construction could require widening, tree removal, fill, and grading. Site-specific assessments have not been made, but a design feature for road work includes minimizing tree removal (see soils report). Temporary road construction/ road maintenance within PACs would take place outside of the nesting season. Temporary roads would typically function for 3 to 6 months before decommissioning. In addition, about 43 miles of existing road would be decommissioned in 52 PACs. This represents about 29 percent of existing roads currently within these PACs and about 67 percent of open roads in the core areas of 13 PACs. Decommissioning would occur outside the nesting season, avoiding potential noise disturbance to nesting MSOs. Owls roosting or foraging in PACs are also unlikely to be disturbed during nesting season. MSOs foraging or roosting outside of PACs or those that remain in the PAC vicinity outside of nesting season may be disturbed by noise disturbance from hauling and road maintenance, construction, and decommissioning activities. Details on disturbance effects from road maintenance, construction, and decommissioning can be found in appendix 2.

**Table 29. Road-related mileage in Mexican spotted owl protected habitat**

| MSO Habitat | Road Maintenance | Temporary Roads | Road Relocation | Total Miles of Road Work |
|---|---|---|---|---|
| Protected Total | 92.7 | 6.7 | <0.1 | 99.4 |

About 355 miles of road maintenance would occur in restricted habitat, including about 41 miles in target and threshold habitats (Table 30). New temporary road construction would total about 69 miles in restricted habitat, with over 5 miles constructed in target and threshold habitat. The majority of these miles are known to currently exist as open non-system roads. An undetermined amount of temporary road could require blading a new grade. Temporary roads would again typically function for 3 to 6 months before decommissioning. Over a mile of road would be relocated to protect ephemeral stream channels in restricted habitat. One road segment would be relocated in target and 1 segment in threshold habitat, totaling less than 0.1 miles in length. Remaining relocated road segments would be in restricted "other" habitat.

**Table 30. Road-related mileage in Mexican spotted owl restricted habitat**

| MSO Restricted Habitat | Road Maintenance | Temporary Roads | Road Relocation | Total Miles of Road Work |
|---|---|---|---|---|
| Target/Threshold | 40.9 | 5.3 | <0.1 | 46.2 |
| Restricted "Other" | 314.5 | 62.5 | 1.4 | 378.2 |
| Total | 355.4 | 67.8 | <1.5 | 424.4 |

The 4FRI proposes a maximum of about 431,049 acres of mechanical treatment. This number is expected to be well above the number of acres actually treated under 4FRI. A review of FS NEPA determined that, on average, about 40 percent of acres approved for treatment actually get treated (Hampton et al. 2008). In the case of 4FRI, this would equal about 172,420 acres of treatment. The contract awarded for 4FRI includes treatment on 249,600 acres, or nearly 57 percent of the treatment acres. More acres could be added to the contract under a variety of potential situations, although there are no expected changes at this time. Road disturbance and traffic volume would be directly related to total acres treated. Therefore, it was assumed that all 431,049 would be treated in order to be conservative (i.e., describe the largest estimated impact to owls) given the uncertainty in this analysis. A detailed description on potential road-related effects is presented in appendix 2.

### *Collisions*

The risk of collisions between MSOs and trucks (and of disturbance in general) relates to total traffic levels and miles of open roads. The following discussions reviews the fundamental assumptions were made to evaluate this risk.

In general, 1 acre of treatment would yield enough harvested material to fill one logging truck. About every 3 acres of treatment would fill 1 chip van. Accordingly, it is assumed that each acre treated would require 2 and 2/3 truck trips per acre to drive to the appropriate site, load logs and chips, and deliver the load off-forest. Because of variability in forest conditions and changing market values, more product may be chipped, reducing log truck trips and overall projected truck traffic. Assuming 2.67 truck trips per acre acknowledges site variability but ensures road traffic estimates are at the high end of potential effects to owls from hauling. Total project implementation would take 10 or more years. The uncertainty in the lifetime of the project is addressed here by assuming 10 years for completion, thereby assuming a higher number of average truck trips.

On average, hauling occurs about 9 months out of the year, with roads typically closed February through April. Sometimes heavy monsoon rains also close areas to truck traffic during the summer. However, weather can be highly variable across the landscape during monsoons. The scale of 4FRI would create flexibility in moving the emphasis area, allowing hauling to continue if some areas become unavailable due to monsoonal storms. Under this scenario, road activities would consistently occur May 1 through January 31, totaling 276 days.

Based on implementation of the maximum acreage, about 43,100 acres of tree harvest would occur each year for 10 years. With 2.67 truck trips required per acre of treatment, this would result in an estimated average of about 115,077 truck trips annually. On average, this would total about 417 truck trips per day across the 4FRI landscape during a 276-day hauling season. While the actual numbers would vary, we feel this represents the likely maximum number of truck trips per day. If fewer acres were treated, more product was chipped, or shorter winters extended the hauling season, this number of truck trips per day would be smaller.

Harvest units would be managed by assigning task orders to contractors. Task orders would focus the annual harvest to areas within 4FRI subunits, shifting the focus area as new task orders are issued. Task orders would be assigned annually and would typically require 2 to 3 years to complete. Road-related activities would therefore be concentrated in relatively small portions of the treatment area (there are 21 separate sub-units). Road maintenance, decommissioning, construction, relocation, and dust abatement is discussed by individual MSO habitat type below More detail on potential disturbance from these activities can be found in appendix 2.

### *Dust Abatement*

Dust abatement would occur when hauling during dry conditions (Table 31) Treatments would be temporary and only used during active hauling on the identified road segment. Eight road segments have been identified for dust abatement, totaling less than 7 miles in length. Six of 8 segments are outside of MSO habitat and 2 segments occur in restricted “other” habitat, totaling less than 1 mile in length. Neither segment includes stream channel crossings.

**Table 31. Road segment lengths proposed for dust abatement in MSO restricted “other” habitat**

| Road Number | Segment Length (miles) | General Location | Wildlife Habitat |
|---|---|---|---|
| 140 | 0.5 | Big Spring Canyon | MSO restricted |
| 141 | 0.3 | Pitman Valley | MSO restricted |

An expert panel sponsored by the U.S. Environmental Protection Agency conducted a literature review of dust suppressants (Piechota et al. 2004) Magnesium chloride ($MgCl_2$) is the most widely used salt for suppressing dust. Salts move through soil easily with water and negatively impact plant growth near application sites. Salts can brown needles on live pine trees and, with repeated applications, increases tree mortality. Lignin, another common dust inhibitor, has been found to cause weight gain and colon ulcers in lab testing of rodents. Overall, lignin may be the most environmentally compatible dust suppressant and did not prevent seed germination in field trials (Piechota et al. 2004).

Piechota et al. (2004) concluded that determining environmental effects of dust must be based on assessing site-specific conditions. Dust abatement treatments would be limited in the 4FRI, occurring in selected areas where private landownership concerns could arise. The effectiveness of $MgCl_2$ increases with increasing humidity levels (Piechota et al. 2004). However, humidity is low in northern Arizona outside of the monsoon season and there would be little or no need for dust abatement during the monsoon rains. Therefore, lignin would probably be used most often on the 4FRI landscape. Because of the limited application both 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 MSO.

### *Noise Disturbance*

Noise disturbance to owls has typically been a concern with road-related activities. In response, disturbance researchers have monitored owl response to different noise sources and volumes. Experiments have been conducted at varying distances from known nest and roost sites, correlating noise levels with the biology and/or behavior of owls. A simple but consistent relationship has been identified between noise and distance to birds: as stimulus distance decreased, spotted owl response increased, regardless of stimulus type or season (Wasser et al. 1997, Delaney et al. 1999). A literature review of noise disturbance studies and spotted owls can be found in appendix 2.

While these studies are not definitive, the impacts of low level repeated noise do not appear to affect reproduction. Based on these observations, 4FRI-related vehicle noises, including regular truck traffic occurring further than 0.25 miles from owls, might not cause a detectable stress response in nesting and roosting MSOs.

Available research does not address effect of noise to owls foraging outside of PACs or to owls outside the breeding season. Owls can be active during crepuscular hours and could, on occasion, forage during daylight, increasing the risk of noise disturbance from road activities to individual foraging MSOs. In addition, hauling of forest materials is also likely to occur at night. Disturbance to foraging owls would be site-specific and could cause owls to shift to areas that provide undisturbed foraging opportunities. There could be energetic costs and increased risk of predation associated with displacement of foraging owls. The likelihood of this occurring is unknown as are the actual effects.

### *Habitat Loss and Fragmentation Due to Roads*

Roads (versus road work) could potentially affect MSOs through impacts to prey species. Roads can both directly and indirectly affect individual wildlife species and their associated habitats. Roads can cause a decline in habitat effectiveness in addition to the outright loss of habitat. Roads can also present barriers to some species, potentially affecting a species' persistence of occupancy in fragmented habitats. A detailed literature review on road effects to wildlife can be found in appendix 2.

Over half of the needed temporary roads already exist as functional roads on the landscape. They are not part of the FS system road network and so are considered temporary. All proposed temporary roads in protected habitat currently exist on the ground. Temporary roads in restricted habitat would be a mix of existing and constructed roads. About 68 total miles of temporary roads would occur in restricted habitat. The exact breakdown of existing temporary roads and those requiring new construction are not known a priori. A conservative approach to estimating habitat loss (i.e., one that reflects the greatest impact to habitat) is to assume all temporary roads in restricted habitat would require new construction. Assuming all temporary roads would require a 25 foot wide disturbance zone (the actual impact to the ground would range between 18 to 25 feet), 68 miles of new road construction would lead to the loss of about 204 acres of forest in the short-term. However, no new permanent roads would be constructed in MSO habitat and all temporary roads would be decommissioned when treatments are complete, including currently existing temporary roads. In the long-term, available habitat would increase as a result of road decommissioning.

While roads are barriers to animal movement and could affect population persistence for some species, this by itself is a very broad generalization. The literature indicates that relatively small, unpaved roads are not likely to affect populations of small mammals, including MSO mammalian prey species (Jaeger et al. 2005, McGregor et al. 2008, Bissonette and Rosa 2009, Fahrig and Rytwinski 2009). While individual animals may be killed by vehicles while they are crossing the road, overall effects to small mammals are not likely to occur at a scale that would affect MSOs. Decommissioning over about 860 miles of currently open roads across the 4FRI treatment area would further benefit owls and their prey in the long-term by restoring habitat.

## Narrow-headed Gartersnake (Threatened)

Data Sources for this analysis include and incorporate the analyses from the following Specialist Reports:

- Final Rule for listing in the Federal Register (USDI 2014)
- Proposed Final Rule for listing with Critical Habitat in the Federal Register (USDI 2013a).
- Fisheries and Aquatics Specialist Report
- Water Quality and Riparian Report
- Soils Specialist Report

Narrow-headed gartersnakes are the most aquatic of the gartersnakes, seldom found far from quiet, rocky pools in large streams and rivers. Food items include fish (native species preferred), frogs, tadpoles, and salamanders. It is primarily a Mexican species, but occurs in various areas along the Rim. On the Coconino NF, narrow-headed gartersnakes are currently known from Oak Creek Canyon and a few sightings from the East Verde River approximately five and eight miles respectively from the treatment 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 gartersnake within the treatment 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.

### Narrow-headed Gartersnake Proposed Critical Habitat

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 gartersnake was listed in the Federal Register on July 10, 2013 (USDI 2013a; Figure 13). PCEs are developed based on current knowledge of the physical or biological features and habitats characteristics required to sustain the species’ life history processes. The PCEs in relation to the project are discussed in the effects of the action below.

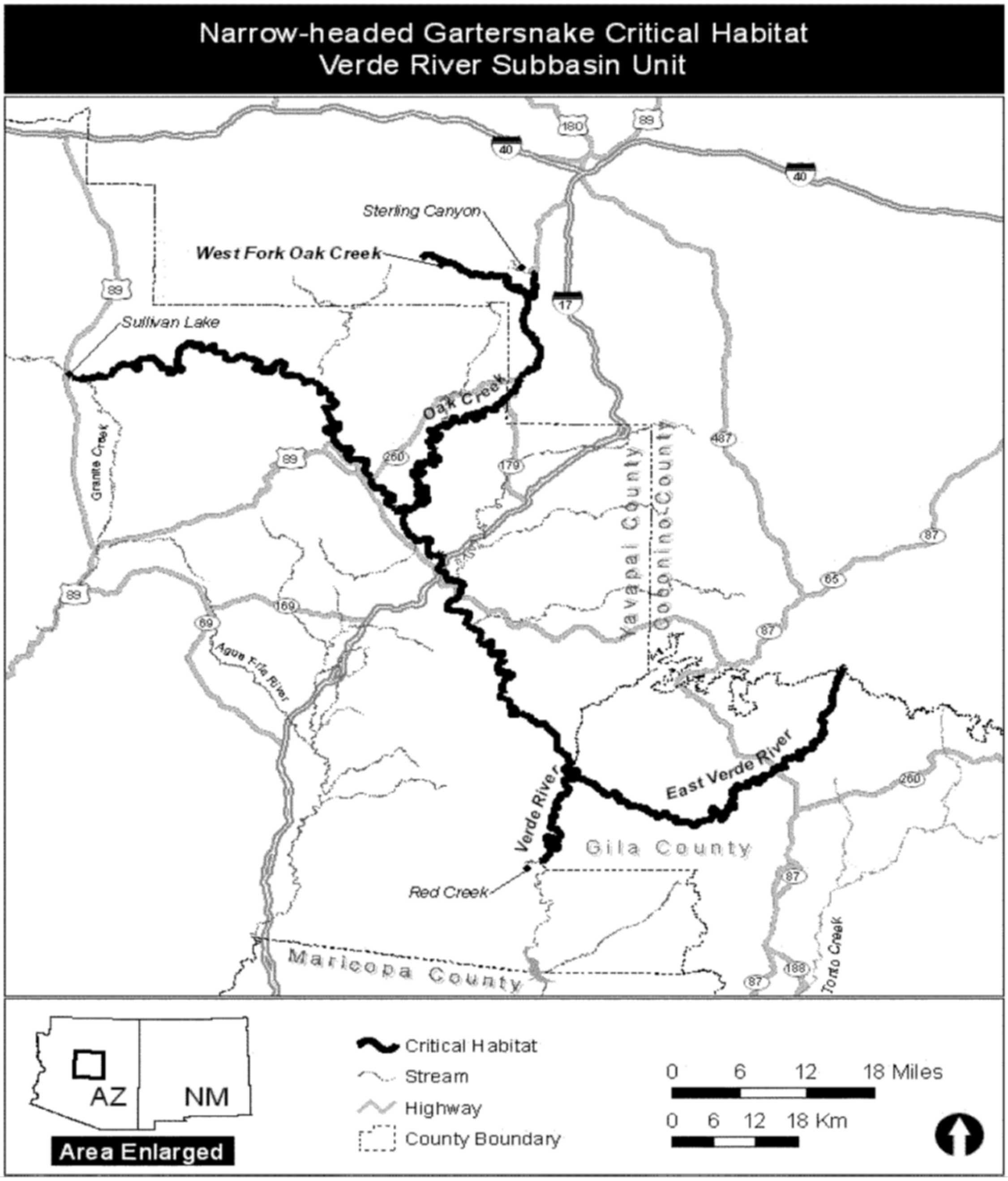

**Figure 13. Proposed critical habitat for narrow-headed gartersnake on or near the Four Forest Restoration Initiative footprint (USDI 2013a)**

### *Narrow-Headed Gartersnake's PCEs:*

Based on current knowledge of the physical or biological features and habitat characteristics required to sustain the species' life-history processes, the primary constituent elements specific to narrow-headed gartersnakes are:

1. Stream habitat, which includes:
    a. Perennial or spatially intermittent streams with sand, cobble, and boulder substrate and low or moderate amounts of fine sediment and substrate embeddedness, and that possess appropriate amounts of pool, riffle, and run habitat to sustain native fish populations;
    b. A natural, unregulated flow regime that allows for periodic flooding or, if flows are modified or regulated, a flow regime that allows for adequate river functions, such as flows capable of processing sediment loads;
    c. Shoreline habitat with adequate organic and inorganic structural complexity (e.g., boulders, cobble bars, vegetation, and organic debris such as downed trees or logs, debris jams), with appropriate amounts of shrub- and sapling-sized plants to allow for thermoregulation, gestation, shelter, protection from predators, and foraging opportunities; and
2. Aquatic habitat with no pollutants or, if pollutants are present, levels that do not affect survival of any age class of the narrow-headed gartersnake or the maintenance of prey populations.
3. Adequate terrestrial space (600 feet (182.9 meter) lateral extent to either side of bankfull stage) adjacent to designated stream systems with sufficient structural characteristics to support life-history functions such as gestation, immigration, emigration, and brumation.
4. A prey base consisting of viable populations of native fish species or soft-rayed, nonnative fish species.
5. An absence of nonnative fish species of the families Centrarchidae and Ictaluridae, bullfrogs (*Lithobates catesbeianus*), and/or crayfish (*Orconectes virilis, Procambarus clarki,* etc.), or occurrence of these nonnative species at low enough levels such that recruitment of narrow-headed gartersnakes and maintenance of viable native fish or soft-rayed, nonnative fish populations (prey) is still occurring.

Narrow-headed gartersnake is now listed as a threatened species (effective August 7, 2014) and the USFWS has proposed critical habitat (USDI 2014, 2013, respectively). The gartersnake population and habitat is located within the Slide fire perimeter in West Fork of Oak Creek and in Oak Creek.

## California Condor (Endangered/Experimental Population)

### Data Sources

The following discussion is based on: the Federal Register Notice for the Establishment of a Nonessential Experimental Population of California Condors in Northern Arizona, Final Rule (USDI 1996); the Recovery Plan for the California Condor (USDI 1996); and the second and third 5-year reviews of the California condor reintroduction program in the Southwest (USDI 2007a and 2012). These documents are all available on the FWS condor webpage (http://www.fws.gov/southwest/es/arizona/ CA_Condor.htm, accessed February 27, 2013). These sources are incorporated here by reference.

## Life History

Condors require open habitat with three basic habitat elements: adequate food, roost sites, and nest sites. Condors are strict scavengers and primarily feed on the carcasses of large mammals. Condors, unlike vultures, depend on sight rather than smell for locating food. Open country makes food easier to detect and ensures an easier approach and takeoff. In the inland west, they require foraging habitat such as grasslands, savannas, and meadows. A typical roost site has cliffs, rock outcrops, large conifer snags, or a combination of these characteristics, located in an isolated or semi-secluded area. Condors use a variety of nest types, including caves, crevices, protected ledges, and large tree cavities. All known nests in the southwest were in cliff-side caves or protected ledges. Paired birds begin courting as early as October and lay their eggs between February and May. Juveniles depend on the adults well into the following calendar year, decreasing a pair's reproductive output. Breeding adults and immature condors forage near nesting areas yearlong. Non-breeding condors leave nesting areas in March and April and return again in the fall.

## Distribution

The historical distribution of the condor was along the Pacific coast from Canada to Mexico, including isolated regions of the California Coast, Sierra Nevada and Transverse Ranges, western Texas, Arizona, Utah, New Mexico, and Baja California, Mexico.

Little information exists on past causes of condor mortality, but threats include shooting, egg and quill collection, and ceremonial use. By 1982 there were only 22 condors left in the wild and by 1987 their range was reduced to 6 counties north of Los Angeles, California. Condors were captured and removed from the wild in 1987. A network of zoos and The Peregrine Fund established a captive breeding program, producing the first captive breed chick in 1988. Re-release of condors back into the wild started in 1992. The original release site was on the Los Padres NF, California. Current free-flying condor populations are limited to three geographically separate reintroduction sites: coastal California, Baja California, and northern Arizona.

The northern Arizona population is classified as nonessential/experimental, based on section 10(j) of the ESA. The nonessential/experimental population status applies to all condors within the geographic bounds of the designated 10(j) recovery area (Figure 14). The area is defined by: Interstate 70 on the north, U.S. Highway 191 on the east (parallel to the New Mexico and Colorado state borders), Interstate 40 on the south, and Interstate 15 and U.S. Highway 93 on the west. Protections for endangered species are relaxed within a designated 10(j) area, where listed species are treated similar to species proposed for listing. This provides greater flexibility for managing the recovery of a listed species. Outside the 10(j) area condors have the full protection of endangered species listed under the ESA.

## Existing Conditions

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.


**Figure 14. California condor nonessential experimental population [10(j)] area**

The total number of living condors reached 410 in 2013 (Table 32). Condor reproduction in the wild has been fraught with difficulty as new pairs learn parenting skills. Eggs have failed to hatch and nestlings and fledglings have died. Nevertheless, recruitment of wild-born birds into the population has occurred and the hope is that success rates will continue to increase through time. Because of births and deaths, including adult mortalities, population numbers change throughout the year.

**Table 32. California condor population numbers range-wide as of January 31, 2013**

| Population | Total |
|---|---|
| **Captive** | 178 |
| **Wild** | |
| Arizona | 75 |
| California | 129 |
| Baja | 28 |
| *Wild Total* | *232* |
| **Total** | **410** |

Source: The Condor Program Monthly Status Report & Locations, AGFD

The Southwest condor working group includes the FWS, FS, Bureau of Land Management, National Park Service, AGFD, Utah Division of Wildlife Resources, and The Peregrine Fund (a private, nonprofit organization).

Condors are capable of long distance flights, but through time their movements have become more restricted and more predictable. Some birds initiated extended flights soon after their release early in the southwest reintroduction program. Wide-arching loops were made into eastern Nevada, southern Arizona, along the Mogollon Rim to the New Mexico border, and as far north as Flaming Gorge, Wyoming (310 miles from the release site). However, long-range movements have been rare since the establishment of resident birds. Multiple breeding pairs maintaining seasonal territories seem to limit the movements of newly released birds. Newly released birds now use a well-established primary range extending out in about a 70 mile-radius from the Vermillion Cliffs release site. Condors now commonly travel between the Grand Canyon Ecoregion/Colorado River corridor in Arizona and the Kolob Terrace/Zion National Park area in southern Utah.

Released condors spend most of their time near the Vermillion Cliffs, in or near Grand Canyon National Park, or on the Kaibab Plateau. As condors became more self-sufficient, their patterns of seasonal movement have been more predictable. They typically use the Colorado River corridor and South Rim of the Grand Canyon in early spring. Condor activity in Zion National Park and southern Utah has increased considerably throughout the 2000s (approximately 70 miles north of the release site). Groups of condors regularly move to southern in Utah in late spring when domestic sheep are moved into the high country and take advantage of this ongoing source of carrion. It is likely only a matter of time before breeding occurs in Utah. They use the Kaibab Plateau and southern Utah during the months of November and December to feed on carcasses and gut piles during the hunting season. The Vermilion Cliffs release site still receives heavy use by the majority of condors during winter months.

By August 2012, 74 free-flying condors were in the southwest population. Lead toxicity from ingested lead bullet fragments embedded in carcasses is the leading cause of condor mortality. Without eliminating or substantially reducing the amount of lead ammunition used within the California condor’s range, and thus the high percentage of lead-poisoned condors, it is unlikely that the recovery program in northern Arizona will realize a self-sustaining condor population (USFWS 2012b).

The 4FRI 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. Condors have rarely been documented using areas south of Interstate 40 for flight or foraging. Between 2002 and 2006 The Peregrine Fund obtained more than 50,000 relocation fixes from an average of 17 GPS-equipped condors (USDI 2007a). Condor focused their habitat use on the North and South rims and river corridor of the Grand Canyon, the Kaibab Plateau, and the Kolob area in southern Utah. Condors do not spend much time south of the Grand Canyon. When they have travelled into the southern extent of the designated recovery zone they head back north relatively rapidly. There are few reports of condors on Coconino NF or the Williams or Tusayan Ranger Districts of the Kaibab NF (Parrish, personal communications 2012).

### *Threats*

Threats to the condor are taken from the 2012 Southwest Condor Working Group’s report titled A Review of the Third Five Years of the California Condor Reintroduction Program in the Southwest (USDI 2012c). In this report, the southwest condor interagency working group determined that major threats include collisions with human-made structures, electrocution on powerlines, and ingestion of trash, and poisoning from lead, DDT, cyanide, and anti-freeze.

There were 18 fatalities in the first 5-year period, 20 in the second 5-year period, and 28 throughout the third 5-year period. There have been a total of 69 known condor mortalities within the southwest population, including 8 wild-hatched chicks. Circumstantial evidence suggests that 2 undiagnosed fatalities in the first 5-year period were lead-caused. Predation and lead poisoning continued to be the prominent mortality factors, but the birds in the "missing" and "unknown" mortality categories continued to increase. Of the 44 cases where diagnoses were possible since release began in 1996, 21 (48 percent) died of lead poisoning, 12 (27 percent) from predation, 3 (7 percent) from starvation, 3 (7 percent) from shooting, 2 (5 percent) from impaction, 2 (5 percent) from collisions, and 1 (2 percent) from infection. By applying the known rate of diagnosed fatalities identified as lead poisoning to the missing category (17 birds), it is reasonable to estimate that an additional 8 condors likely succumbed to lead poisoning. Further analysis of location data, age structure, and seasonally available lead at the time birds went missing is underway to better identify the likelihood of lead poisoning in this category.

Lead exposure had been highest during the fall deer hunt on the Kaibab Plateau. The AGFD initiated a voluntary lead reduction effort that significantly reduced the amount of lead available to condors on the Kaibab Plateau. This voluntary program achieved hunter participation rates of 80 percent to 90 percent since 2007. Hunter participation rates in lead reduction programs in southern Utah, where condor foraging has been increasing since 2004, are significantly lower. Overall, the southwest reintroduction program has yet to observe a reduction in condor lead exposure (USFWS 2012b). The shift in condor movements is likely why overall lead exposure levels have remained essentially static rather than declining for this reporting period (USFWS 2012b).

The third five-year review (USFWS 2012b) notes that lead poisoning is the leading impediment to condors becoming a reproductively self-sustaining population. While it was expected that deaths from lead and other sources of mortality would occur when the condors were released, it was noted these deaths would be compensated by natural and captive reproduction (USFWS 1996a). To date, this compensation has come primarily from captive reproduction. Any change to the hunting regulations in the experimental population area in Arizona or Utah would require action by the individual states (USFWS 2012b).

## Direct and Indirect Effects

There would be no direct effects in alternative A. Indirect effects are unlikely because condors so seldom use this portion of the landscape. However, ongoing projects with thinning and prescribed fire that achieved interspace and restoration of meadows, savannas, and grasslands would open line-of-sight, potentially making it easier for foraging condors to spot carcasses (appendix 17). The cumulative acres moving towards desired conditions has not, and so would likely continue to not keep pace with the untreated acres moving away from desired conditions. Tree encroachment within stands, meadows, savannas, grasslands, aspen, ephemeral channel reaches, and annual risk of high-severity fire would continue to dominate vegetation across the 4FRI area under alternative A.

Alternatives B-E would maintain presettlement trees and retain most large post-settlement trees as restoration goals are achieved. However, there are no known roost sites within the 4FRI boundary. No 4FRI activities would affect cliff habitat. Therefore, nesting or roosting habitat would not be affected by the implementation of 4FRI. Indirect effects to condors could potentially occur because of nearly 48,800 acres of grassland and savanna restoration, improving potential foraging habitat. However, alternative E would not include the 28,650 to nearly 30,000 acres of grassland restoration, thereby limiting potential foraging habitat that would be created in the other action alternatives. Nevertheless, condors rarely fly over the analysis area, much less forage within it, so no measureable direct or indirect effects to condors are expected. Therefore, no cumulative effects would occur under the action alternatives.

Should a condor appear at a 4FRI work site, the following design features have been incorporated into the project:

- All contractors would be instructed to avoid interacting with condors and to immediately contact the appropriate FS personnel.
- Sighting locations would be forwarded to the Peregrine Fund and the FWS
- Any project activity that may cause imminent harm to condors would temporarily cease until permitted personnel determine the correct course of action
- Project-related work areas would be kept clean (e.g., trash disposed of, scrap materials picked-up, etc.) in order to minimize the possibility of condors accessing inappropriate materials. The FS will conduct site visits to ensure clean-up is adequate.
- A hazardous material spill plan would be developed and implemented with details on how each hazardous substance will be treated in case of leaks or spills.

No further analysis will be conducted for California condors.

## Black-footed Ferret (Endangered)

### Data Sources

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).

### Life History

The black-footed ferret depends almost exclusively on prairie dog colonies for food, shelter, and denning. They are nearly always associated with prairie dogs, typically living in prairie dog towns and raising their young in prairie dog burrows. They are primarily a solitary, nocturnal animal, actively hunting in the crepuscular hours. Ferrets avoid spending long periods of time above ground. They run in zigzag fashion from burrow to burrow, visiting as many as 400 burrows a night. This behavior helps ferrets dodge a multitude of predators, including: coyotes, badgers, golden eagles, great horned owls, and other raptors. Prairie dogs make up 91 percent of their diet, only feeding on alternate prey such as ground squirrels, cottontail rabbits, and deer mice when necessary.

Ferrets prefer arid prairies. In Arizona, the habitat in the occupied Aubrey Valley is characterized as Plains and Great Basin Grassland where annual precipitation averages about 10 to 12 inches. An estimated 99 to 148 acres of prairie dog colony is required to support one ferret. Therefore, large complexes of prairie dog colonies are needed to support a self-sustaining population of ferrets. Prairie dogs typically occupy grassland-savanna. Common vegetation in Aubrey Valley includes blue gramma (*Bouteloua gracilis*), broom snakeweed (*Gutierrezia sarothrae*), sagebrush (*Artemisia* sp.), four-wing saltbush (*Atriplex canescens*), and winter fat (*Eurotia lanata*), interspersed with forbs and bounded by pinyon-juniper (*Pinus edulis*-*Juniperus* spp.) ridges. The common plant species at prairie dog colonies in New Mexico include blue grama grass, crested wheatgrass (*Agropyron cristatum*), red three-awn (*Aristida longiseta*), cheatgrass (*Bromus tectorum*), sixsweeks fescue (*Vulpia octoflora*), Indian ricegrass (*Oryzopsis hymenoides*), squirreltail grass (*Sitanion hystrix*), sagebrush, broom snakeweed, and rabbitbrush (*Chrysothamnus* sp.).

### Distribution

Black-footed ferrets formerly occurred across the Great Plains from southern Alberta and Saskatchewan to western Oklahoma, Texas, New Mexico and Arizona. They occupied mountain basins, and semi-arid grasslands throughout much of North America, but were extirpated from virtually all of their range because of prairie dogs and predator control programs. Reintroduced populations currently occur in Arizona, Colorado, Montana, South Dakota, Utah, and Wyoming.

### Range Within Arizona

In Arizona, the black-footed ferret was associated with Gunnison's prairie dog (Cynomys gunnisoni) before being extirpated from the state. Arizona encompasses about 30 percent of the historic range of Gunnison's prairie dog (Knowles 2002), but only about eight percent of the historical range of black-footed ferrets (USDI 2013b). There are no known records of black-footed ferrets on the Coconino NF, but one historic report of black-footed ferrets was from 12 miles west of Winona, close to Flagstaff (Cockrum 1960). There are also historic records from 7 miles northeast of Williams and the last known record of a ferret in Arizona came from Government Prairie (within the treatment area) in 1931 (USDI 2007b).

Ferrets were reintroduced as an experimental nonessential population in the Aubrey Valley near Seligman, Arizona, in 1996 (USDI 1996). A second experimental non-essential population was reintroduced onto the Espee Ranch in 2007, about 20 miles from the Kaibab NF boundary, making it the closest population to the 4FRI treatment area.

### Existing Conditions

All black-footed ferrets are located either in captive breeding facilities or at managed reintroduction sites. It is very unlikely that any undiscovered wild populations of ferrets exist and searching for new wild populations is no longer considered relevant by the black-footed ferret recovery team (Hanebury and Biggins 2006, Lockhart et al. 2006). Ferrets do not have designated critical habitat (USDI 2013b). Of the reintroduced populations in Arizona: the Aubrey Valley population has had successful reproduction for years. The Espee Ranch site is on private land and is based wholly on prairie dog colonies within the Ranch. The AGFD would attempt to capture and return any ferrets that move off the Espee Ranch or relocate ferrets to areas deemed suitable for recovery (USDI 2007b). Ferret dispersal from the Espee Ranch would not likely happen until ferrets fully occupy available habitat on the ranch. The FWS anticipates uncaptured ferrets dispersing from the Espee Ranch would be lost due to natural causes (starvation or predation) or possibly incidental take due to the lack of habitat outside the Espee Ranch (USDI 2007b).

Evaluation of suitable ferret relocation sites is based on characteristics of prairie-dog colonies. Black-footed ferrets are nearly obligate predators on prairie dogs. The evaluation of prairie-dog colonies includes size of colony, distance between colonies, density of prairie dog burrows, and threats from disease. Essentially, larger colonies in close proximity to other colonies with a high density of prairie dogs and which are isolated from disease are more likely to support black-footed ferrets through time. Prairie-dog colonies that are less than 4.3 miles apart are considered to be in close proximity. Colonies in close proximity are called complexes. Habitat for black-footed ferrets in Arizona has been described as an active prairie dog complex greater than 200 acres with a density of greater than eight burrows per acre (Mikesic and Nysted 2001). Disease is a more difficult evaluation due to prairie dog susceptibility to sylvatic plague and ferret susceptibility to plague and canine distemper.

Based solely on distance between colonies and total acreage, two Gunnison's prairie dog complexes were mapped within the treatment area (Table 33). This designation does not include prairie-dog activity or burrow density. Plague outbreaks, eradication efforts and drought have contributed to the lack of Gunnison's prairie-dog activity in northern Arizona. Many previously active colonies had few to no surviving prairie dogs after plague outbreaks (Fitzgerald 1993, Wagner et al. 2006). Complex 1 includes Flagstaff, Kachina, Mountainaire, Bellmont, and other private inholdings extending most of the way towards Williams. Urban development throughout much of the complex increases risk of transmission of canine distemper. Interstate-40 and the parallel Burlington Northern Santa Fe Railroad, running east and west, and Interstate-17 running north and south inhibit connectivity within the complex. Average colony size is about 50 acres for this complex. Because prairie dog activity and burrow density are not currently known, prairie dog surveys would be completed prior to implementing the 4FRI within these complexes. If colonies are active and burrow densities adequate, black-footed ferret surveys would be completed prior to implementation.

**Table 33. Prairie dogs complexes/colonies within the treatment area by subunit**

| Complex | Subunit | Acres | Number of Colonies |
|---|---|---|---|
| Complex 1 | 1-1 | 175 | 2 |
| | 1-3 | 7 | 1 |
| | 1-5 | 20 | 1 |
| | 3-2 | 503 | 7 |
| | 4-2 | 17 | 1 |
| | 4-3 | 376 | 5 |
| | 4-4 | 727 | 22 |
| | 4-5 | 128 | 2 |
| | 5-1 | 60 | 5 |
| **Total** | | **2,187** | **46** |
| Complex 2 | 1-2 | 181 | 2 |
| **Total** | | **181** | **2** |

### *Threats*

The historical decline of black-footed ferrets was largely a result of habitat loss and prairie dog and predator control programs (USDI 2013b). Existing threats to reintroduced populations of black-footed ferrets are continued habitat loss, flea-borne sylvatic plague and canine distemper. Plague can be transmitted pneumonically and via consumption of contaminated tissues. This hampers black-footed ferret recovery efforts both directly (infections/mortality) and indirectly (loss of the primary prey base). Gunnison's is the only prairie dog sub-species in Arizona. Both Gunnison's and black-tailed prairie dogs are particularly susceptible to plague (Cully 1993, Fitzgerald 1993, Knowles 2002) and plague is the most important factor negatively impacting

Gunnison's prairie dog populations in Arizona (Wagner et al. 2006). Plague routinely causes 100 percent mortality in infected colonies. Prairie dog activity decreased from 270 active areas to 71 when they were resurveyed in a large-scale effort conducted in 2000 and 2001 (Wagner et al. 2006). An estimated 280,565 prairie dogs were killed from recreational shooting from 2000 to 2004, but plague was considered the primary cause behind the overall decrease in numbers (Wagner et al. 2006). In addition to local extinctions, the area occupied by individual colonies can vary dramatically over time as occupancy rates change (Wagner et al. 2006).

The black-footed ferret recovery team concluded that even a temporal loss of prairie dog habitat can create a population bottleneck for ferrets, even with subsequent partial recovery of prairie dog populations. Plague-free areas within the historical range of black-footed ferrets are especially valuable to black-footed ferret recovery (USDI 2013b).

The conversion of native prairie to cropland is the primary, largely permanent cause of black-footed ferret habitat destruction (USDI 2013b). Overall, the FWS estimates that there has been about a 96 percent decrease of prairie dog habitat within the historical range of black-footed ferrets (USDI 2013b). Estimates of existing habitat for Gunnison's prairie dog range from 340,000—500,000 acres across the Colorado Plateau.

## Direct and Indirect Effects

### *Alternative A*

Potential habitat conditions for black-footed ferrets would change slowly. Current and future foreseeable grassland treatments would include 6,933 acres of grassland thinning and 6,505 acres of grassland prescribed fire within the 4FRI project area and including a ½ mile buffer around the area. Note that most grassland acres treated would include both thinning and fire (appendix 17). Because there are no known black-footed ferrets in the analysis area, the probability of direct effects to black-footed ferrets from maintaining or improving existing conditions is low. Most acres of grasslands, savannas, and meadows would continue to be invaded by trees and canopy cover development would continue to lead to decreases in understory biomass (appendix 6). This in turn would lead to less available habitat for species such as ferrets and prairie dogs. This would also reduce connectivity between suitable habitat because thinning and burning in forest stands would cumulatively be less than that proposed under the 4FRI. This would limit dispersal probability and so reduce the likelihood of maintaining all the existing prairie dog towns as well limit the establishment of new colonies. Alternative A would result in the least acres of functional grassland, savanna, and meadow habitats and thus would have the greatest negative effect on potential black- footed ferret habitat.

### *Alternatives B-E*

There are no known black-footed ferrets in the treatment area. It is also unlikely viable habitat exists because of effects of epizootic plague outbreaks, potential disease transmission from domestic animals associated with urban development within forest boundaries, and effects of transportation networks. Grassland, savanna, and meadow improvement and restoration is not expected to negatively affect prairie dogs in the short-term and would provide indirect long-term benefits. This could benefit ferrets in the future if progress is made on controlling disease transmission. However, alternative E would not include the 28,650 to nearly 30,000 acres of grassland restoration present in the other action alternatives. The 4FRI implementation includes a design feature for surveys of adequate prairie dog complexes, and potentially for ferrets as well, to ensure that no direct or indirect effects to ferrets would occur from 4FRI implementation. Consultation with the FWS would be reinitiated if ferrets were discovered.

### *Cumulative Effects – All Alternatives*

The area analyzed for cumulative effects to black-footed ferret encompasses grassland, savanna, and meadow habitat within the treatment area and associated prairie dog complexes. Direct and indirect effects are unlikely to occur since there are no known locations of black-footed ferrets in the treatment area and potential habitat would be surveyed prior to implementation. Restoration of prairie dog habitat would continue with other projects (see alternative A above) and the action alternatives would maintain existing habitat or restore new areas suitable for prairie dogs. However, there are known black-footed ferrets within the project area, no expectation of undiscovered populations existing in the project area (USDI 2013b), and no known plans to reintroduce ferrets on either NF. Therefore, there are no cumulative effects to ferrets.

# Forest Service Sensitive Species

Sensitive species are defined 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 (FSM 2670.5(19)).” It is the policy of the Forest Service regarding sensitive species to: (1) assist states in achieving their goals for conservation of endemic species; (2) as part of the National Environmental Policy Act process, review programs and activities, through a biological evaluation, to determine their potential effect on sensitive species; (3) avoid or minimize impacts to species whose viability has been identified as a concern; (4) if impacts cannot be avoided, analyze the significance of potential adverse effects on the population or its habitat within the area of concern and on the species as a whole (the line officer, with project approval authority, makes the decision to allow or disallow impacts, but the decision must not result in loss of species viability or create significant trends toward Federal listing); and (5) establish management objectives in cooperation with the state when projects on National Forest System lands may have a significant effect on sensitive species population numbers or distributions. Establish objectives for Federal candidate species, in cooperation with the FWS and state of Arizona (FSM 2670.32).

The most recent Regional Forester’s Sensitive Species list was transmitted to Forest Supervisor’s in September 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. The presence of species carried forward for analysis were determined by consulting forest records, results of surveys conducted on the forest, and use of the FAAWN database (Patton 2011). Table 11 and Table 12 display sensitive species carried forward for analysis and species dropped from further consideration.

## 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 and the respective forest-wide MIS reports.

## Forest Plan Compliance and Analysis Framework

Forest plan direction for northern goshawks applies to goshawk habitat outside of Mexican spotted owl habitat. In ponderosa pine forest, one or the other set of guidance applies and Mexican spotted owl guidance takes precedence in areas of overlap. See appendix 1 for details.

## Habitat Strata and Scales of Analysis

Goshawk habitat was evaluated in terms of post fledgling family areas (PFA)/dispersal PFA (dPFA) and landscapes outside of PFAs (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. PFAs were considered occupied.  Dispersal PFAs are approximately 600 acre areas that are currently unoccupied could potentially support nesting goshawks but have not been surveyed. The Coconino Forest Plan (1987) and the Kaibab Forest Plan (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 (USDA Forest Service 1987).

The Coconino Forest Plan has a guideline that states that distribution of habitat structures 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 inch), tons per acre of logs, snags greater than 18 inches 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.

## Surveys and Monitoring

### *Kaibab National Forest*

Although the North Kaibab Ranger District appears to be at carrying capacity, goshawk reproduction on the Kaibab Plateau has been highly variable over 15 years and overall showed a significant decline from 1991 to 2005, including the portions of the Plateau within the Grand Canyon National Park (USDA Forest Service 2010a) . Data for the rest of the Forest show a similar decline in occupied territories, although trend lines do not denote statistical significance (Figure 15).

While a decline in territories does not translate directly into reproductive effort, it does indicate that the number of adults that could be breeding on the Forest is decreasing and that this decrease would result in less offspring recruited into the population. Data should be interpreted cautiously as the number of nests with unknown occupancy does vary by year and ingress of birds is unknown. Goshawk surveys were conducted in 2011, 2012, 2013, and 2014 (Keckler personal communications 2014). Previously unsurveyed areas meeting habitat and distance from occupied PFAs criteria were designated as dispersal PFAs (see Modeling and Habitat methodology above).

Given the information above, northern goshawks are assumed to be declining on the Kaibab NF. However, if future weather patterns produce good precipitation, the population could stabilize or increase. Only precipitation can fuel forest productivity in terms of abundant seed crops which result in prey population increases that occur at greater frequencies. Continued reduction of forest stem density and basal area should ameliorate the stochastic nature of weather by reducing the threat of large-scale, high-severity crown fire, thereby helping stabilize the population.

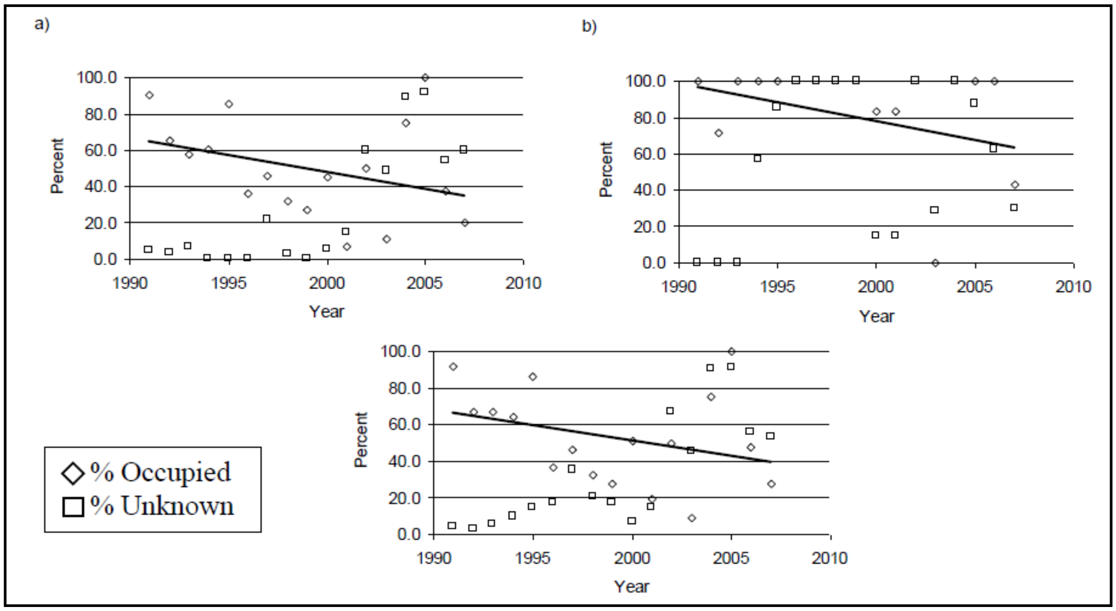


**Figure 15. Percent of surveyed and occupied goshawk territories present on the Kaibab National Forest (1990 to 2010) : a) Williams Ranger District, b) Tusayan Ranger District, and, c) South Zone (William's and Tusayan Ranger Districts combined)**

### *Coconino National Forest*

Most of the ponderosa pine, ponderosa pine/Gambel oak and mixed-conifer habitats on the Coconino Forest have been surveyed according to FS Regional protocol for the northern goshawk (USDA Forest Service 2013). Goshawk territories have been established based on the results of surveys. The earliest record for a goshawk on the forest was from 1972, and by 1987, 11 goshawk territories were known on the Forest. Survey efforts increased in the early 1990's using standardized protocols, primarily in advance of habitat altering projects to determine if goshawks are present with a project area. As a result of surveys, the number of known territories increased between 1991 and 2013.

In addition to new territories found, some existing territories are monitored annually. The number of territories monitored per year has been declining, particularly since the early 2000's. The percent of known territories occupied has fluctuated between nine and 88 percent since 1991. Occupancy was defined as at least one goshawk detected within a post-fledging family area (PFA). 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 2013).

Trends derived from surveys and monitoring results should be interpreted with caution because the purpose is to determine occupancy in advance of habitat altering activities. Consequently, surveys and monitoring are done non-randomly and there is no sampling design or statistical rigor related to trend estimates associated with data obtained from these surveys.

### *Goshawks and 4FRI*

There are 247 PFAs on the Coconino and Kaibab National Forests totaling 159,926 acres and 87 of these (53,439 acres) are with the 4-FRI treatment area. Note that the Walker Hill PFA is counted twice because a portion of the PFA occurs on each forest. There are 26 dPFAs (16,106 acres) on the two forests and 19 of these (11,272 acres) are within the 4-FRI analysis area (Table 34). Figure 16 shows the distribution of goshawk PFAs in the 4FRI analysis area.

**Table 34. Occupied and unoccupied goshawk habitat on two forests and in 4FRI**

| Area | PFA Type | Coconino National Forest | | Kaibab National Forest | | Total | |
|---|---|---|---|---|---|---|---|
| | | Number | Total Acres | Number | Total Acres | Total Number | Total Acres |
| Forest | PFA | 68 | 44,938 | 180 | 114,986 | 247* | 159,924 |
| | Dispersal PFA | 15 | 9,319 | 11 | 6,787 | 26 | 16,106 |
| Within 4-FRI Analysis Area | PFA | 47 | 29,445 | 41 | 23,994 | 87* | 53,439 |
| | Dispersal PFA | 11 | 6,791 | 8 | 4,480 | 19 | 11,272 |

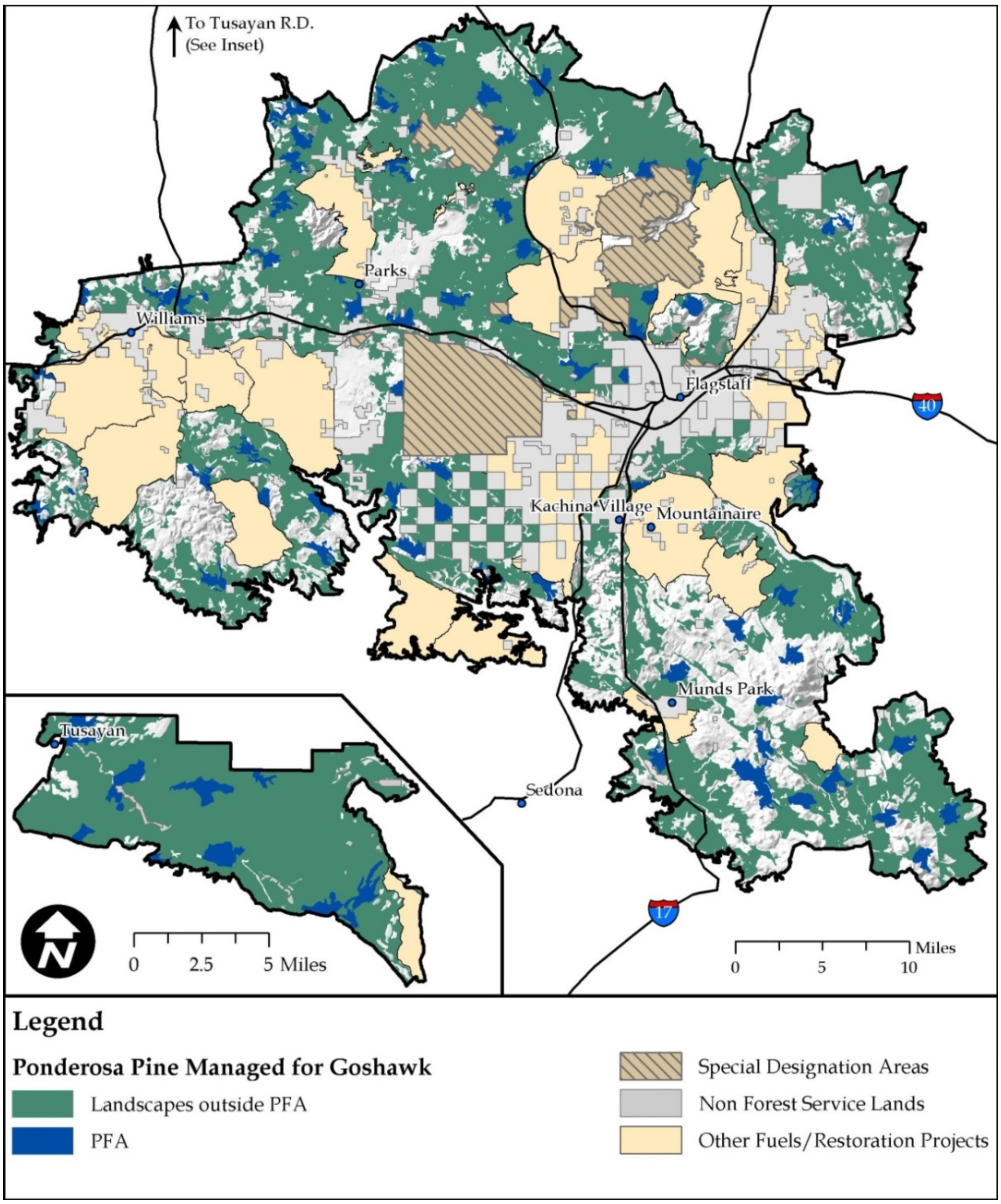


**Figure 16. Ponderosa pine managed for goshawks in the 4FRI analysis area**

## Issues in Goshawk Habitat in the 4FRI Treatment Area

The 4FRI database (see silviculture report) indicated a number of consistent issues relative to northern goshawk habitat in the 4FRI treatment area, including:

- An imbalance in tree size-classes and recruitment into larger size classes leading to a lack of diversity in tree sizes and structural diversity, with an abundance of mid-aged trees and a lack of younger age classes and large, old trees;
- Threats to existing big and old trees because of competition from smaller trees;
- Decreased quality in prey habitat due in part to uncharacteristic canopy connectivity from ingrowth of trees in smaller size classes;
- Overall decline in forest resilience due to competition among trees and, indirectly, from the risk of high severity fire, insects, and disease resulting from the uncharacteristic levels of tree competition;
- Snags greater than 18 inches d.b.h. are deficit across the landscape relative to forest plan direction;
- Coarse woody debris and logs are generally less than that recommended in forest plan direction, although some variation exists;
- Understory development is generally low in PFA/dPFA and LOPFA habitat and is a reflection of moderate to high tree density;
- The risk of high severity fire in dense forest conditions within the ponderosa pine forest type remains high and outside desired conditions, threatening the ability to maintain northern goshawk habitat components through time

## Goshawk Habitat Requirements

In the southwest, goshawks use ponderosa pine extensively. Breeding goshawks use a variety of horizontal and vertical vegetation structure. Goshawk nest areas are consistently located in mature and older forests. Typical nest areas are composed of large, dense trees, closed canopies created by a variety of tree sizes, and open understories, but exact structure depends on forest type, elevation, and growth site potential. Goshawks construct stick nests in the lower third of the largest tree available. Nest height is significantly correlated with nest-tree height, thus tree size and structure may be more important than tree species.

Overall, goshawks are closely tied to prey resources and less so to forest habitat type. Goshawks like to forage in habitat with relatively open understories so they can easily see and pursue their prey, or use open forest habitats because they can hunt from perch trees for rabbits or ground squirrels in openings between trees. The variety of foraging habitat lends to the variety of prey items taken. In general, goshawks primarily eat medium-sized birds (e.g., woodpeckers and jays) and small mammals (e.g., squirrels and rabbits). Inter-annual fluctuations in precipitation and conifer seed production are correlated with, and may be responsible for, variation in prey abundance which in turn is strongly associated with goshawk reproduction (Salafsky et al. (2005). This suggests that goshawk demography is a complex interaction between vegetation composition and structure and natural variation in goshawk food resources, all of which may be influenced by weather and climate.

The conditions in those portions of northern goshawk habitat in MSO habitat would tend to be older forests with more dense canopies and larger trees. These areas would provide quality nesting habitat for goshawks and snags, large trees, and down logs for certain goshawk prey species. Habitat conditions in MSO habitat are not projected to change as much from the existing conditions. However, moving the remaining portions (70 – 78 percent) of the respective goshawk habitat strata towards desired conditions would have positive impacts to both the northern goshawks and their prey species on the majority of their corresponding habitats.

### *Vegetation Structural Stage*

Desired conditions for northern goshawk habitat are uneven-aged forests with balanced age class distribution. About 46 percent of LOPFA habitat and about half of PFA/dPFA are in uneven-aged condition. Even-aged structure limits habitat diversity and does not meet the desired condition for goshawk habitat or for forest structure in general.

The desired distribution of vegetation structural stages (VSS) for ponderosa pine, mixed conifer and spruce-fir is 10 percent grass/forb/shrub (VSS 1), 10 percent seedling-sapling (VSS 2), 20 percent young forest (VSS 3), 20 percent mid-aged forest (VSS 4), 20 percent mature forest (VSS 5), 20 percent old forest (VSS 6). VSS is not the only way to display age class diversity but is the method used in this report.

Table 35 and Table 36 show that goshawk habitat is generally dominated by VSS 3 and VSS 4 size trees in both even-aged and uneven-aged condition. In 2010, uneven-aged stands in PFA/dPFA habitat were dominated by the young and mid-aged forest structural stages with a combined overall distribution of 80 percent. In PFA/dPFA habitat, overall distribution of VSS 1 in even-aged stands is deficit by 10 percent, VSS 2 is deficit by 9 percent, VSS 5 is deficit by 13 percent and VSS 6 is deficit by 19 percent. Overall distribution of VSS 1 and VSS 2 in uneven-aged stands is deficit by about 10 percent, VSS 5 is deficit by 6 percent and VSS 6 is deficit by 15 percent.

PFA/dPFA and LOPFA habitat are deficit in the younger age classes at all scales. This would impede growth into larger age classes and habitat sustainability. These tables also show that on the average, large size classes are lacking as well. At the Restoration Unit level in uneven-aged PFA/dPFA and LOPFA, Restoration Units 4 and 5 have slight excess in VSS 5. Restoration Unit 3 has a slight excess in uneven-aged VSS 5 in PFA/dPFA habitat and Restoration Unit 5 has nearly twice the desired amount of VSS6 in uneven-aged LOPFA habitat.

Even-aged PFA/dPFA habitat is dominated by the young and mid-aged forest structural stages with a combined overall distribution of 90 percent, more than twice the desired however distribution is variable. The young forest stage ranges from a low of 0 percent in SU 3-4 to a high of 83 percent in SU 1-4. The mid-age forest stage ranges from a low of 0 percent in SU 1-1 and SU 6-2 to a high of 100 percent in SU 3-4 (Table 36). SU 6-2 is the only subunit to have excess in large size classes (more than twice the desired in VSS5).

In 2010 PFA/dPFA uneven-aged stands were dominated by the young and mid-aged forest structural stages with a combined overall distribution of 80 percent, about twice the desired. In PFA/dPFA uneven-aged stands, the young forest stage ranges from a low of 0 percent in SU 4-5 to a high of 84 percent in SU 1-1. The mid-age forest stage ranges from a low of 6 percent in SU 1-2 to a high of 82 percent in SU 6-2. SU 1-2 is the only subunit to have excess in large size classes (29 percent in VSS5).

**Table 35. 2010 VSS distributions by restoration unit**

| Restoration Unit | VSS 1 10% desired | VSS 2 10% desired | VSS 3 20% desired | VSS 4 20% desired | VSS 5 20% desired | VSS 6 20% desired | Total Acres |
|---|---|---|---|---|---|---|---|
| | 2010 | 2010 | 2010 | 2010 | 2010 | 2010 | |
| **PFA/dPFA** | | | | | | | |
| **EvenAge** | **0%** | **1%** | **37%** | **53%** | **7%** | **1%** | **19,876** |
| 1 | 0% | 0% | 53% | 44% | 0% | 2% | 3,794 |
| 3 | 0% | 0% | 30% | 61% | 8% | 0% | 4,760 |
| 4 | 0% | 0% | 33% | 57% | 9% | 1% | 9,014 |
| 5 | 0% | 0% | 34% | 55% | 11% | 1% | 1,414 |
| 6 | 0% | 18% | 55% | 11% | 0% | 15% | 893 |
| **UnevenAge** | **0%** | **< 1%** | **35%** | **45%** | **14%** | **5%** | **20,707** |
| 1 | 0% | < 1% | 34% | 54% | 5% | 6% | 6,781 |
| 3 | 0% | 0% | 24% | 47% | 24% | 5% | 4,212 |
| 4 | 0% | 0% | 28% | 47% | 24% | 1% | 5,360 |
| 5 | 0% | 0% | 15% | 61% | 23% | 1% | 1,140 |
| 6 | 0% | 1% | 71% | 17% | 0% | 11% | 3,214 |
| **LOPFA** | | | | | | | |
| **EvenAge** | **1%** | **1%** | **41%** | **48%** | **8%** | **1%** | **255,310** |
| 1 | 0% | 1% | 43% | 50% | 5% | 2% | 64,143 |
| 3 | 1% | 1% | 36% | 53% | 10% | < 1% | 69,122 |
| 4 | 2% | 2% | 34% | 52% | 9% | < 1% | 80,930 |
| 5 | 0% | 1% | 47% | 43% | 7% | 2% | 26,793 |
| 6 | 0% | 5% | 82% | 8% | 0% | 5% | 14,323 |
| **UnevenAge** | **0%** | **1%** | **37%** | **36%** | **14%** | **11%** | **213,861** |
| 1 | 0% | 1% | 39% | 45% | 11% | 4% | 69,868 |
| 3 | 0% | < 1% | 37% | 42% | 15% | 6% | 51,493 |
| 4 | 0% | 1% | 34% | 40% | 22% | 4% | 39,594 |
| 5 | 0% | 0% | 14% | 14% | 23% | 49% | 30,090 |
| 6 | 0% | 3% | 69% | 20% | 0% | 9% | 22,816 |

**Table 36. 2010 VSS distributions by subunit in PFA/dPFA habitat**

| Subunit | VSS 1 10% desired 2010 | VSS 2 10% desired 2010 | VSS 3 20% desired 2010 | VSS 4 20% desired 2010 | VSS 5 20% desired 2010 | VSS 6 20% desired 2010 | Grass Cover Type | Total Acres |
|---|---|---|---|---|---|---|---|---|
| **PFA/dPFA Even aged** | | | | | | | | |
| 1-1 | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 324 |
| 1-2 | 0% | 0% | 71% | 29% | 0% | 0% | 0% | 345 |
| 1-3 | 0% | 0% | 39% | 59% | 0% | 0% | 1% | 736 |
| 1-4 | 0% | 0% | 83% | 17% | 0% | 0% | 0% | 573 |
| 1-5 | 0% | 0% | 37% | 57% | 0% | 4% | 2% | 1,818 |
| 3-1 | 0% | 0% | 44% | 47% | 10% | 0% | 0% | 655 |
| 3-2 | 0% | 0% | 16% | 65% | 15% | 0% | 3% | 759 |
| 3-3 | 0% | 0% | 40% | 51% | 9% | 0% | 0% | 2,232 |
| 3-4 | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 1 |
| 3-5 | 0% | 0% | 11% | 87% | 0% | 0% | 1% | 1,114 |
| 4-2 | 0% | 0% | 29% | 36% | 34% | 0% | 0% | 721 |
| 4-3 | 0% | 0% | 28% | 66% | 5% | < 1% | < 1% | 4,506 |
| 4-4 | 0% | 0% | 42% | 47% | 9% | 1% | 1% | 3,121 |
| 4-5 | 0% | 0% | 34% | 61% | 5% | 0% | 0% | 665 |
| 5-1 | 0% | 0% | 47% | 49% | 3% | 0% | 0% | 827 |
| 5-2 | 0% | 0% | 15% | 62% | 22% | 1% | 0% | 588 |
| 6-2 | 0% | 3% | 58% | 0% | 0% | 40% | 0% | 76 |
| 6-3 | 0% | 20% | 55% | 12% | 0% | 13% | 0% | 817 |
| **UnevenAge** | **0%** | **< 1%** | **35%** | **45%** | **14%** | **5%** | **0%** | **20,707** |
| 1-1 | 0% | 0% | 84% | 16% | 0% | 0% | 0% | 265 |
| 1-2 | 0% | 0% | 38% | 6% | 27% | 29% | 0% | 338 |
| 1-3 | 0% | 0% | 19% | 74% | 6% | 1% | 0% | 1,661 |
| 1-4 | 0% | 0% | 46% | 50% | 0% | 3% | 0% | 465 |
| 1-5 | 0% | 1% | 35% | 53% | 4% | 7% | 0% | 4,053 |
| 3-1 | 0% | 0% | 37% | 45% | 18% | 0% | 0% | 310 |
| 3-2 | 0% | 0% | 9% | 70% | 8% | 13% | 0% | 1,237 |
| 3-3 | 0% | 0% | 27% | 33% | 39% | 1% | 0% | 2,111 |
| 3-5 | 0% | 0% | 40% | 49% | 9% | 2% | 0% | 554 |
| 4-2 | 0% | 0% | 40% | 25% | 35% | 0% | 0% | 701 |
| 4-3 | 0% | 0% | 33% | 50% | 15% | 2% | 0% | 2,663 |
| 4-4 | 0% | 0% | 18% | 51% | 31% | 0% | 0% | 1,936 |
| 4-5 | 0% | 0% | 0% | 34% | 66% | 0% | 0% | 60 |
| 5-1 | 0% | 0% | 18% | 74% | 7% | 0% | 0% | 546 |
| 5-2 | 0% | 0% | 11% | 48% | 38% | 2% | 0% | 594 |
| 6-2 | 0% | 1% | 6% | 82% | 0% | 11% | 0% | 238 |
| 6-3 | 0% | 1% | 76% | 12% | 0% | 11% | 0% | 2,977 |

Overall, VSS 3 and VSS4 total more than 89 percent of the area in even-aged LOPFA habitat – over twice the desired amount of these size classes. Young even-aged VSS 3 stage ranges from a low of 18 percent in SU 3-2 to a high of 89 percent in SU 6-2. The mid-age forest stage ranges from a low of less than 1 percent in SU 6-2 to a high of 56 percent in SU 3-5. Overall distributions of VSS 1 and VSS 2 are each deficit by 10 percent VSS 5 is deficit by 12 percent and VSS 6 is deficit by 19 percent. Two subunits meet or exceed desired condition for VSS 5: Subunits 3-2 and 4-2.

In LOPFA, young uneven-aged VSS 3 stage ranges from a low of 13 percent in SU 5-2 to a high of 78 percent in SU 6-4. Mid-aged uneven-aged VSS 4 stage ranges from a low of 5 percent in SU 6-4 to a high of 50 percent in SUs 4-2 and 4-5. VSS 1 in uneven-aged condition does not exist, VSS 2 is deficit by 9 percent, VSS 5 is deficit by 6 percent and VSS 6 is deficit by 9 percent. Several individual subunits meet or exceed desired condition for VSS 5: Subunits 3-2, 4-2, 4-3, and 5-2. Several individual subunits meet or exceed desired condition for VSS 6: Subunits 5-1, 5-2, and 5-3.

**Table 37. VSS distribution by subunit in LOPFA habitat**

| Subunit | VSS 1 10% desired | VSS 2 10% desired | VSS 3 20% desired | VSS 4 20% desired | VSS 5 20% desired | VSS 6 20% desired | Total Acres |
|---|---|---|---|---|---|---|---|
| **LOPFA Even age** | **2010** | **2010** | **2010** | **2010** | **2010** | **2010** | **2010** |
| 1-1 | 0% | 2% | 37% | 49% | 2% | 9% | 3,431 |
| 1-2 | 0% | 4% | 36% | 55% | 4% | 0% | 3,526 |
| 1-3 | 0% | 1% | 44% | 50% | 3% | 2% | 15,953 |
| 1-4 | 0% | 2% | 50% | 45% | 3% | 0% | 8,235 |
| 1-5 | 0% | 1% | 41% | 51% | 6% | 1% | 32,999 |
| 3-1 | 1% | 1% | 37% | 53% | 10% | 0% | 9,280 |
| 3-2 | 1% | 2% | 18% | 58% | 20% | < 1% | 11,335 |
| 3-3 | 1% | 1% | 41% | 48% | 8% | 1% | 22,617 |
| 3-4 | 0% | 0% | 45% | 48% | 7% | 1% | 4,606 |
| 3-5 | 0% | 1% | 37% | 56% | 6% | < 1% | 21,284 |
| 4-2 | 0% | 4% | 23% | 47% | 26% | 0% | 3,456 |
| 4-3 | 3% | 2% | 36% | 51% | 8% | < 1% | 31,402 |
| 4-4 | 1% | 2% | 33% | 55% | 9% | < 1% | 41,466 |
| 4-5 | 0% | 0% | 46% | 47% | 7% | 0% | 4,605 |
| 5-1 | 0% | < 1% | 62% | 29% | 8% | 1% | 11,229 |
| 5-2 | 0% | 1% | 36% | 54% | 7% | 3% | 15,563 |
| 6-2 | 0% | 9% | 89% | < 1% | 0% | 1% | 1,034 |
| 6-3 | 0% | 5% | 81% | 9% | 0% | 5% | 12,331 |
| 6-4 | 0% | 3% | 87% | 10% | 0% | 0% | 958 |

| Subunit | VSS 1 10% desired | VSS 2 10% desired | VSS 3 20% desired | VSS 4 20% desired | VSS 5 20% desired | VSS 6 20% desired | Total Acres |
|---|---|---|---|---|---|---|---|
| **Uneven Age** | **2010** | **2010** | **2010** | **2010** | **2010** | **2010** | **2010** |
| 1-1 | 0% | 2% | 32% | 49% | 10% | 7% | 4,895 |
| 1-2 | 0% | 3% | 46% | 42% | 9% | 0% | 2,309 |
| 1-3 | 0% | 3% | 36% | 40% | 15% | 6% | 18,210 |
| 1-4 | 0% | < 1% | 57% | 35% | 6% | 2% | 8,013 |
| 1-5 | 0% | 1% | 36% | 49% | 11% | 3% | 36,441 |
| 3-1 | 0% | < 1% | 50% | 34% | 12% | 4% | 8,769 |
| 3-2 | 0% | < 1% | 26% | 39% | 29% | 6% | 9,639 |
| 3-3 | 0% | 1% | 37% | 47% | 13% | 2% | 17,517 |
| 3-4 | 0% | 0% | 29% | 45% | 18% | 8% | 4,313 |
| 3-5 | 0% | < 1% | 41% | 39% | 7% | 12% | 11,255 |
| 4-2 | 0% | 0% | 26% | 50% | 24% | 0% | 2,504 |
| 4-3 | 0% | 0% | 38% | 33% | 26% | 3% | 17,061 |
| 4-4 | 0% | 1% | 32% | 44% | 18% | 4% | 18,768 |
| 4-5 | 0% | 0% | 34% | 50% | 11% | 6% | 1,261 |
| 5-1 | 0% | 0% | 22% | 39% | 14% | 25% | 5,830 |
| 5-2 | 0% | 0% | 13% | 8% | 25% | 55% | 24,260 |
| 6-2 | 0% | < 1% | 59% | 17% | 0% | 23% | 3,721 |
| 6-3 | 0% | 4% | 69% | 22% | 0% | 5% | 16,569 |
| 6-4 | 0% | 0% | 78% | 5% | 0% | 17% | 2,526 |

### *Old Growth*

Currently, VSS 5 and 6 (which represent large and old trees) are underrepresented in ponderosa pine and occur in predominantly closed and dense conditions. Consequently, there are threats to the sustainability of these trees due to competition, density related mortality, and the threat of uncharacteristic fire. It is desired to have large and old trees, including presettlement trees, scattered across an uneven-aged condition landscape that is comprised of a balance of structural stages. Old forest structure should be sustained over time across the landscape. Old growth habitat overlaps goshawk habitat, but it is recognized that it provides habitat for a variety of wildlife species, from song birds to black bears.

The distribution of large trees in goshawk habitat is overall deficit in both even-aged and uneven-aged conditions. However, localized areas meet or exceed desired conditions for VSS 5 or 6 trees (Restoration Units 3, 4, and 5). These are shaded in Table 38.

**Table 38. 2010 distribution of VSS 5 and VSS 6 by restoration unit in goshawk habitat**

| LOPFA | | | PFA/dPFA | | |
|---|---|---|---|---|---|
| **Restoration Unit** | **VSS 5** | **VSS 6** | **Restoration Unit** | **VSS 5** | **VSS 6** |
| **Even Age** | **8%** | **1%** | **Even Age** | **7%** | **1%** |
| 1 | 5% | 2% | 1 | 0% | 2% |
| 3 | 10% | < 1% | 3 | 8% | 0% |
| 4 | 9% | < 1% | 4 | 9% | 1% |
| 5 | 7% | 2% | 5 | 11% | 1% |
| 6 | 0% | 5% | 6 | 0% | 15% |
| **Uneven Age** | **14%** | **11%** | **Uneven Age** | **14%** | **5%** |
| 1 | 11% | 4% | 1 | 5% | 6% |
| 3 | 15% | 6% | 3 | 24% | 5% |
| 4 | 22% | 4% | 4 | 24% | 1% |
| 5 | 23% | 49% | 5 | 23% | 1% |
| 6 | 0% | 9% | 6 | 0% | 11% |

Although distribution of large trees in goshawk habitat is generally deficit in both even-aged and uneven-aged conditions, localized subunits meet or exceed desired conditions for VSS 5 or 6 trees (ten subunits in PFA/dPFA habitat and 8 subunits in LOPFA habitat). These are shaded in Table 39.

**Table 39: Distribution of VSS5 and VSS6 by subunit in goshawk habitat**

| LOPFA | | | PFA/dPFA | | |
|---|---|---|---|---|---|
| **Sub Unit** | **VSS 5** | **VSS 6** | **Sub Unit** | **VSS 5** | **VSS 6** |
| 1-1 | 2% | 9% | 1-1 | 0% | 0% |
| 1-2 | 4% | 0% | 1-2 | 0% | 0% |
| 1-3 | 3% | 2% | 1-3 | 0% | 0% |
| 1-4 | 3% | 0% | 1-4 | 0% | 0% |
| 1-5 | 6% | 1% | 1-5 | 0% | 4% |
| 3-1 | 10% | 0% | 3-1 | 10% | 0% |
| 3-2 | 20% | < 1% | 3-2 | 15% | 0% |
| 3-3 | 8% | 1% | 3-3 | 9% | 0% |
| 3-4 | 7% | 1% | 3-4 | 0% | 0% |
| 3-5 | 6% | < 1% | 3-5 | 0% | 0% |
| 4-2 | 26% | 0% | 4-2 | 34% | 0% |
| 4-3 | 8% | < 1% | 4-3 | 5% | < 1% |
| 4-4 | 9% | < 1% | 4-4 | 9% | 1% |
| 4-5 | 7% | 0% | 4-5 | 5% | 0% |
| 5-1 | 8% | 1% | 5-1 | 3% | 0% |
| 5-2 | 7% | 3% | 5-2 | 22% | 1% |
| 6-2 | 0% | 1% | 6-2 | 0% | 40% |
| 6-3 | 0% | 5% | 6-3 | 0% | 13% |

| LOPFA | | | PFA/dPFA | | |
|---|---|---|---|---|---|
| **Sub Unit** | **VSS 5** | **VSS 6** | **Sub Unit** | **VSS 5** | **VSS 6** |
| 6-4 | 0% | 0% | NA | | |
| **UnevenAge** | **14%** | **11%** | **UnevenAge** | **14%** | **5%** |
| 1-1 | 10% | 7% | 1-1 | 0% | 0% |
| 1-2 | 9% | 0% | 1-2 | 27% | 29% |
| 1-3 | 15% | 6% | 1-3 | 6% | 1% |
| 1-4 | 6% | 2% | 1-4 | 0% | 3% |
| 1-5 | 11% | 3% | 1-5 | 4% | 7% |
| 3-1 | 12% | 4% | 3-1 | 18% | 0% |
| 3-2 | 29% | 6% | 3-2 | 8% | 13% |
| 3-3 | 13% | 2% | 3-3 | 39% | 1% |
| 3-4 | 18% | 8% | NA | NA | NA |
| 3-5 | 7% | 12% | 3-5 | 9% | 2% |
| 4-2 | 24% | 0% | 4-2 | 35% | 0% |
| 4-3 | 26% | 3% | 4-3 | 15% | 2% |
| 4-4 | 18% | 4% | 4-4 | 31% | 0% |
| 4-5 | 11% | 6% | 4-5 | 66% | 0% |
| 5-1 | 14% | 25% | 5-1 | 7% | 0% |
| 5-2 | 25% | 55% | 5-2 | 38% | 2% |
| 6-2 | 0% | 23% | 6-2 | 0% | 11% |
| 6-3 | 0% | 5% | 6-3 | 0% | 11% |
| 6-4 | 0% | 17% | NA | NA | NA |

### *Density*

The existing condition for percent of maximum stand density index within the PFA and LOPFA is considered to be high density or Zone 3 (see silviculture report). Resulting habitat dynamics include minimum forage production, severe competition among trees and declining tree diameter growth.

The existing condition for trees per acre across the ponderosa pine landscape is high density, about 200 trees per acre. Trees per acre would eventually be reduced through density induced mortality from competition for limited space and resources.

Because forests are so dense, canopy cover is also dense. The recurring theme in a literature review of the Ecological Relationships between Overstory and Understory Vegetation in Ponderosa Pine Forest of the Southwest (Smith 2011) focused on the ponderosa pine overstory having a strong inhibitory effect on the abundance and richness of understory species. See appendix 6 for additional details. Dense canopy would mean less grasses, forbs and shrubs would be produced as food and habitat for prey species.

### *Goshawk Prey Species*

The Management Recommendations for the Northern Goshawk (MRNG) reviewed habitat needs and food habitats of important goshawk prey species based on reviews of relevant scientific literature (Reynolds et al. 1992). This assessment of the life history needs of these prey species identified physical habitat features associated within the forested environment. These physical habitat features were then used as the basis for developing desired conditions for each species. The assumption was that, by providing for the needs of an array of important prey species, goshawk populations can be sustained as well.

There are 14 key prey species that were identified for northern goshawks in the southwestern United States (Reynolds et al. 1992):

- 12 prey species are associated with the ponderosa pine vegetation type
- All 12 species would be expected to occur within the analysis area (Patton 2011).
- Large trees are high/medium importance to 10 species
- Interspersion of VSS is high/medium importance to 10 species
- Herb, shrub, understory is of high/medium importance to 9 species

A simple, subjective rating system was used by Reynolds et al. (1992) to evaluate the importance of various habitat components to primary goshawk prey species in the southwest (Table 40). Eleven of the twelve prey species listed for the northern goshawk in the Management Recommendations for the Northern Goshawk (MRNG) are associated with large tree vegetative structural stages (VSS 5 and 6). Large trees are of medium/high importance as habitat components to ten of the twelve prey species for maintaining sustainable populations. Openings are important for maintaining sustainable populations for half of the twelve prey species associated with ponderosa pine. Herbaceous and shrub components are of medium/high importance for nine of the twelve prey species. For ten of the twelve prey species in the pine type, an interspersion of VSSs is of medium/high importance to maintain sustainable populations. Interspersion is more prevalent in uneven-aged conditions than even-aged conditions. Large trees and/or herb/shrub/understory are of medium to high importance for all 12 prey species.

**Table 40. Rating of habitat component importance for twelve goshawk prey species**

| Species | Forest Type1 | Snags | Downed Logs | Woody Debris | Openings | Large trees3 | Herb, Shrub, Understory | Interspersion4 of VSS |
|---|---|---|---|---|---|---|---|---|
| American robin | PP,MS,SF | None | None | Low | Medium | Low | High | High |
| Band-tailed pigeon | PP,MS | Low | None | None | High | Medium | Medium | Medium |
| Chipmunks | PP,MS,SF,PJ | Medium | High | High | Medium | Medium | High | Medium |
| Cottontails | PP,MS,PJ | Low | Medium | High | Medium | None | High | High |
| Hairy woodpecker | PP,MS,SF | High | Medium | Medium | None | High | None | Medium |
| Mantled ground squirrel | PP,MS,SF | Low | High | High | Medium | Medium | High | Medium |
| Mourning dove | PP,MS,SF | Low | None | Low | High | Medium | High | High |
| Northern flicker | PP,MS,SF,PJ | High | High | Low | Low | High | Medium | High |
| Red-naped sapsucker | PP,MS | High | Low | Low | None | Medium | Medium | Medium |
| Steller's jay | PP,MS,SF | Low | Low | Low | None | High | Low | Low |
| Tassel-eared squirrel | PP,MS | Low | Medium | Low | None | High | Low | Medium |
| Williamson's sapsucker | PP,MS | High | Medium | Medium | None | High | Medium | Low |
| **Summary:** | 12 species associated with PP | 4 – high<br>1-medium<br>6 – low<br>1 - none | 3 - high<br>4-medium<br>2 – low<br>3 - none | 3 – high<br>2-medium<br>6 – low<br>1 - none | 2 – high<br>4-medium<br>1 – low<br>5 - none | 5 – high<br>5-medium<br>1 – low<br>1 - none | 5 – high<br>4-medium<br>2 – low<br>1 - none | 4 – high<br>6-medium<br>2 – low<br>0 - none |

1. PP – ponderosa pine / MS – mixed species / SF – spruce-fir / PJ – pinyon-juniper (from MRNG)
2. Large trees = live greater than 18 inches d.b.h. (MRNG)
3. Interspersion measures the degree of intermixing of vegetation structural stages (MRNG)

### *Snags, Logs, and Coarse Woody Debris*

Snags, logs, and coarse woody debris are key components for goshawk prey species. These attributes are represented by snags greater than or equal to 18 inch d.b.h. per acre, logs 12 inch d.b.h. and greater per acre, and coarse woody debris greater than 3 inches in tons per acre in table 6. According to the respective forest plans, it is desired to have at least 2 snags greater than 18 inch d.b.h. per acre (Coconino plan) or an average of 1-2 snags per acre in the Kaibab plan; at least 3 logs greater than 12 inch d.b.h. per acre in the Coconino plan and an average of 3 per acre in the Kaibab plan, and 5-7 tons per acre of coarse woody debris greater than 3 inch d.b.h. in the Coconino plan or a range of 3-10 tons per acre in the Kaibab plan.

Table 41 shows that none of the Subunits or Restoration Units meets the desired snags per acre in LOPFA or PFA/dPFA habitat.

The three subunits that meet the desired conditions for logs per acre are shaded in Table 41 but overall the 4FRI landscape is deficit in logs per acre in goshawk habitat.

The desired conditions for coarse woody debris in the Kaibab forest plan (but not the Coconino forest plan) are mostly met, on the average and in the Restoration Units, in both PFA/dPFA and LOPFA habitat (Table 41). In LOPFA habitat, Restoration Units 1, 3, 4, and 5 meet Kaibab plan CWD desired conditions but not the Coconino’s. Restoration Unit 6 does not meet either plan’s direction in the LOPFA. In PFA/dPFA habitat, Kaibab forest plan direction for coarse woody debris is met Restoration Units 3, 4, and 5 (but not the Coconino’s). Restoration Unit 1 meets direction in both plans while Restoration Unit 6 meets neither.

Most subunits in LOPFA and PFA/dPFA habitat meet or exceed desired conditions for coarse woody debris in the Kaibab plan. Only three subunits (dark shading in Table 41) meet both Coconino forest plan and Kaibab forest plan desired conditions.

The overall quality of prey habitat is lacking in some key metrics. Forest structure such as snags and logs that provide nest and denning sites, and foraging substrate for prey are deficit. Coarse woody debris volumes do not meet guidance in the Coconino forest plan at the scales analyzed.

**Table 41. Existing snags, coarse woody debris and logs in goshawk habitat by restoration unit and subunit**

| | | Snags/Acre | Coarse Woody Debris tons/acre | Logs/Acre |
|---|---|---|---|---|
| Restoration Unit/Subunit | Acres | 2010 | 2010 | 2010 |
| LOPFA | 467,806 | 0.40 | 3.70 | 1.45 |
| 1 | 133,591 | 0.44 | 4.42 | 1.80 |
| 1-1 | 8,326 | 0.36 | 3.72 | 1.40 |
| 1-2 | 5,835 | 0.33 | 3.29 | 0.98 |
| 1-3 | 34,075 | 0.38 | 4.23 | 1.83 |
| 1-4 | 16,247 | 0.41 | 4.06 | 1.57 |
| 1-5 | 69,108 | 0.50 | 4.78 | 1.96 |
| 3 | 120,414 | 0.41 | 3.91 | 1.57 |

| | | Snags/Acre | Coarse Woody Debris tons/acre | Logs/Acre |
|---|---|---|---|---|
| Restoration Unit/Subunit | Acres | 2010 | 2010 | 2010 |
| 3-1 | 17,958 | 0.40 | 2.98 | 0.91 |
| 3-2 | 20,916 | 0.39 | 2.85 | 0.94 |
| 3-3 | 40,084 | 0.39 | 3.78 | 1.55 |
| 3-4 | 8,919 | 0.49 | 5.03 | 2.10 |
| 3-5 | 32,538 | 0.44 | 4.95 | 2.22 |
| 4 | 120,106 | 0.37 | 3.33 | 1.29 |
| 4-2 | 5,959 | 0.32 | 2.47 | 0.68 |
| 4-3 | 48,291 | 0.39 | 3.17 | 1.30 |
| 4-4 | 60,000 | 0.35 | 3.47 | 1.33 |
| 4-5 | 5,855 | 0.35 | 4.02 | 1.33 |
| 5 | 56,556 | 0.43 | 3.10 | 1.23 |
| 5-1 | 16,743 | 0.40 | 3.24 | 1.05 |
| 5-2 | 39,813 | 0.45 | 3.04 | 1.30 |
| 6 | 37,139 | 0.23 | 2.57 | 0.70 |
| 6-2 | 4,755 | 0.23 | 2.32 | 0.84 |
| 6-3 | 28,899 | 0.21 | 2.55 | 0.64 |
| 6-4 | 3,484 | 0.39 | 3.07 | 1.00 |
| PFA/dPFA | 40,033 | 0.42 | 4.11 | 2.02 |
| 1 | 10,523 | 0.52 | 5.11 | 2.49 |
| 1-1 | 588 | 0.38 | 4.36 | 0.84 |
| 1-2 | 682 | 0.40 | 3.62 | 1.54 |
| 1-3 | 2,386 | 0.36 | 4.38 | 1.01 |
| 1-4 | 1,037 | 0.37 | 7.14 | 9.99 |
| 1-5 | 5,828 | 0.63 | 5.30 | 2.03 |
| 3 | 8,811 | 0.38 | 3.85 | 1.06 |
| 3-1 | 847 | 0.42 | 3.26 | 0.84 |
| 3-2 | 1,969 | 0.38 | 3.07 | 0.89 |
| 3-3 | 4,343 | 0.38 | 4.01 | 1.06 |
| 3-4 | 1 | 0.26 | 4.91 | 1.05 |
| 3-5 | 1,652 | 0.38 | 4.67 | 1.34 |
| 4 | 14,171 | 0.40 | 3.94 | 2.43 |
| 4-2 | 1,422 | 0.36 | 2.85 | 0.62 |
| 4-3 | 7,021 | 0.40 | 3.74 | 2.06 |
| 4-4 | 5,003 | 0.40 | 4.51 | 3.59 |
| 4-5 | 726 | 0.39 | 4.16 | 1.67 |
| 5 | 2,478 | 0.47 | 4.57 | 3.11 |
| 5-1 | 1,296 | 0.43 | 5.17 | 4.46 |

| | | Snags/Acre | Coarse Woody Debris tons/acre | Logs/Acre |
|---|---|---|---|---|
| Restoration Unit/Subunit | Acres | 2010 | 2010 | 2010 |
| 5-2 | 1,182 | 0.51 | 3.91 | 1.64 |
| 6 | 4,050 | 0.31 | 2.40 | 0.81 |
| 6-2 | 314 | 0.30 | 1.92 | 0.55 |
| 6-3 | 3,736 | 0.31 | 2.44 | 0.83 |

## Opposing Science

The 1992 MRNG synthesized current information on goshawk nesting habitat, foraging behavior, and food and habitats of selected goshawk prey. The MRNG provided management objectives, desired forest conditions, and management recommendations to guide managers as they dealt with forest environments influenced by human activities (such as fire exclusion) that might be affecting goshawk populations.

In 1996, all forest plans in the Southwestern Region were amended with updated direction for Mexican spotted owls and northern goshawks. The intent of this amendment was to integrate multiple use and sustained yield of goods and services from the forests, in an environmentally sound manner, while still conserving goshawks in the southwest.

This amendment and the MRNG technical report 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 2006). This direction guides projects and activities on the ground unless forest plans are amended.

A technical team made up of members of The Wildlife Society and the American Ornithologist's Union reviewed the MRNG (Braun et al. 1996). They concluded that the scope and the review of the biology of northern goshawks in the MRNG was "excellent' and an innovative approach to forest management because they encouraged consideration of an assemblage of species, including plants and prey species. The MRNG represented a major step toward research and management of ecosystems at a landscape scale. In the absence of frequent ground fire, the MRNG would provide for healthy ponderosa pine forest with significant areas attaining and sustaining late-successional forest. They endorsed the fact that this was not a single species approach, particularly because they determined there was no evidence that goshawk populations were declining. They also concluded that information must be made available to interested public groups that ponderosa pine forests in the Southwest were open and park-like in the presettlement period, which formed a goal for desired conditions for forest management. They called for more research, particularly on habitat and prey requirements, and standardized survey techniques.. Because goshawks are adaptable to local conditions they are forest and prey specialists across their range, but can specialize in terms of nesting habitat, foraging habitat, and prey selection locally. Their primary criticism was the lack of substance in evaluating effectiveness and testing the consequences of implementation. Finally, the complexity of the MRNGs would also make them difficult to implement.

However, 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 their criticism of 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. Understanding that the MRNG was a food web approach and not a single species strategy, Braun et al. (1996) determined that implementation should contribute to a healthy, heterogeneous forest.

In 2008, Beier et al. compared goshawk reproduction at 13 nest sites located among three different management scenarios, using a small sample size in an observational rather than an experimental approach. Each management scenario defined desired conditions for forest structure differently using recommendations developed by the Ecological Restoration Institute (Northern Arizona University), an advocacy group (Greenwald et al. 2005) and the MRNG. Beier et al. concluded that goshawk reproduction declined as breeding areas more closely resembled habitat described in the MRNG.

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 supported by a review of additional literature in the Final Supplement to the Final Environmental Impact Statement for Amendment of Forest Plans (USDA 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. After an extensive literature review, Braun et al. (1996) concluded goshawks were specialists in that they adapted to local conditions, but range-wide goshawks were considered forest and prey generalists. They also noted that even goshawk nesting habitat was diverse, listing 10 distinct habitat associations for nesting, ranging from contiguous forest to a rural mix of woodlands and agricultural areas (Braun et al. 1996).

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).

In response to this investigation, 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 Research Institute describes similar forest structure (Ray 2011).

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."

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 forest structure resulting from each modeled treatment type. All three strategies showed a decrease in the probability of estimated goshawk occurrence. 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 personal communications 2011). In a follow-up publication of this work, Ray et al. (2014) concluded that it is prudent to interpret results from this study in the context of tradeoffs between wildfire risk reduction and wildlife habitat quality.

The model Ray used to predict changes in goshawk occupancy was described in another publication (Dickson et al. 2014). Dickson et al. (2014) identified canopy bulk density and canopy base height as important variables in predicting goshawk occupancy by using multiple regression within an expert-driven, spatially balanced, and information-theoretic framework. They concluded thinning activities are likely to increase canopy bulk density by removing trees with less canopy bulk and providing a growing environment conducive to canopy development in the remaining overstory. Intensive thinning could result in large, long-term reductions in canopy bulk density, reducing the likelihood of goshawk territories. The association of goshawk territories with intermediate values of canopy-base height in these forests suggests minimal conflict with restoration thinning practices that remove mostly younger trees with lower canopy-base height.

A joint review by the Raptor Research Foundation and The Wildlife Society on the status of goshawks in the western United States concluded goshawk-habitat relationships are not currently known to allow use of trends in habitat as a surrogate for trends in goshawk populations (Anderson et al. 2004). Dickson et al. (2014) recommended forest managers favor retention of trees that disproportionately contribute to the higher levels of canopy biomass at the nest site scale. Managers should also facilitate or mimic the effects of low-intensity surface fire at the territory scale (Dickson et al. 2014).

## Slide Fire

The Slide Fire started on May 20, 2014. It burned approximately 22,000 acres on the Flagstaff and Red Rock Districts of the Coconino National Forest in north central Arizona roughly along and west of State Route 89a and Oak Creek Canyon from Sterling Springs Hatchery to Slide Rock State Park. It burned across moderate to very steep chaparral and ponderosa pine and mixed conifer covered slopes and slopes less than about 40 percent in ponderosa pine dominated vegetation types. The steeper slopes are especially subject to debris flows, rockslides, overland flow and accelerated erosion that could become concentrated flow and in defined drainages potentially producing large floods that could damage and pose risk to life, property, natural and cultural resources.

As of June 10, 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 4FRI area, Casner Canyon PFA represents 1.7 percent of PFA s and Dispersal 23 represents 5.5 percent of dispersal PFA s.

Vegetation burn severity was assessed using RAVG (Rapid Assessment of Vegetation Condition) and soil burn severity was assessed using BARC (Burned Area Reflectance Classification). RAVG data was used to estimate changes in tree basal area and tree canopy cover as a result of the fire. BARC data was used to estimate fire impacts to soil. Repeated onsite tests indicate both moderate and high soil burn severity classes have hydrophobic soil tendencies that could have high hydrologic response. This means that heat from the fire created a water repellent layer that could result in accelerated soil erosion following precipitation until the layer breaks down. Habitat recovery in these areas would be slower than in areas with lower burn severity. Inferences about the ability of habitat to recover from the fire and effects to prey habitat came from both these data sources. The effects of the Slide Fire are summarized below and incorporated into the remainder of the goshawk analysis.

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 (Runyon 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.

Table 42 shows the acreage in the PFA and dispersal PFA by soil burn severity. There was about 19 percent high to moderate soil burn severity in Casner Cabin PFA. Fifty percent of Dispersal PFA 23 was classified as moderate to high soil severity burn.

Table 43 shows that Casner Cabin PFA had about 96 acres of moderate to high vegetation burn severity (58 acres in 4FRI treatment acres) and Dispersal PFA 23 had about 329 acres of moderate to high burn severity to vegetation (330 acres in the 4FRI treatment area).

**Table 42. High and moderate soil burn severity in northern goshawk habitat**

| Northern goshawk habitat | PFA Acres (in fire perimeter) | High severity acres | Moderate severity acres | Low severity acres | Unburned acres |
|---|---|---|---|---|---|
| PFA Casner Cabin 030402003 | 652 | 3 | 121 | 501 | 27 |
| PFA-D Dispersal23 | 611 | 63 | 244 | 293 | 12 |
| **Grand Total** | 1,263 | 66 | 365 | 794 | 210 |

**Table 43. Vegetation burn severity in PFA/dPFA habitat from the Slide Fire**

| PFA Name | Area | Unchanged | Low Severity | Moderate Severity | High Severity | Outside of Fire Perimeter |
|---|---|---|---|---|---|---|
| **Casner Cabin** | Total Area | 100 | 456 | 95 | 1 | 0 |
| | Treatment Area | 40 | 236 | 58 | 0 | 0 |
| **Dispersal 23** | Total Area | 30 | 253 | 268 | 61 | 4 |
| | Treatment Area | 29 | 253 | 270 | 60 | 0 |

Table 44 shows that Casner Cabin PFA had more than 50 percent basal area mortality in 10 acres of the PFA (7 acres within the 4FRI treatment area). Dispersal PFA 23 had more than 50 percent basal area mortality in 141 acres of the PFA (141 acres within the 4FRI treatment area).

**Table 44. Basal area mortality in PFA/dPFA habitat from the Slide Fire**

| PFA Name | Area | Basal Area Mortality | | | | | | | Outside of Fire Peri-meter |
|---|---|---|---|---|---|---|---|---|---|
| | | 0% | 1-10% | 11-25% | 26-50% | 51-75% | 76-90% | 91-100% | |
| **Casner Cabin** | Total Area | 285 | 260 | 70 | 27 | 8 | 1 | 1 | 0 |
| | Treatment Area | 127 | 142 | 42 | 17 | 6 | 1 | 0 | 0 |
| **Dispersal 23** | Total Area | 102 | 174 | 99 | 95 | 55 | 25 | 61 | 4 |
| | Treatment Area | 100 | 174 | 100 | 96 | 55 | 26 | 60 | 0 |

Table 45 shows that Casner Cabin PFA had more than 50 percent canopy cover mortality on 10 acres (7 acres in the treatment area). Dispersal PFA 23 had more than 50 percent canopy cover mortality on 144 acres (143 in the treatment area). Areas of moderate to high burn severity would have accelerated erosion and take longer to recover than that portion with low or very low burn severity.

**Table 45. Canopy cover mortality in PFA/dPFA habitat from the Slide Fire**

| PFA Name | Area | Canopy Cover Mortality | | | | | Outside of Fire Perimeter |
|---|---|---|---|---|---|---|---|
| | | 0% | 1-25% | 26-50% | 51-75% | 76-100% | |
| Casner Cabin | Total Area | 272 | 341 | 28 | 8 | 2 | 0 |
| | Treatment Area | 120 | 190 | 17 | 6 | 1 | 0 |
| Dispersal 23 | Total Area | 95 | 277 | 96 | 57 | 87 | 4 |
| | Treatment Area | 93 | 277 | 98 | 56 | 87 | 0 |

## Northern Leopard Frog

In northern Arizona, the northern leopard frog usually occurs in northeastern Arizona, usually in montane streams and wetlands that have aquatic vegetation, and also in wet meadows at higher elevations. This leopard frog is generally restricted to permanent waters, but is also found in semi-permanent and seasonal waters. In Arizona, northern leopard frogs are absent from most historical locations; other than the livestock tanks at and near Stoneman Lake (Subunit 1-6). Following metamorphoses, northern leopard frogs disperse away from their natal wetlands, and can move up to 800 meters in 2 to 3 days and have a tendency to move to the edges of permanent bodies of water. Mass emigrations can follow heavy rains. During dispersal, juvenile frogs can be found in upland forests, meadows and temporary water sources, whereas adult frogs remain closer to original water sources. Northern leopard frogs typically hibernate in ponds and lakes where they may sit on the bottom under rocks or logs, or in depressions in silty substrates. They may bury themselves in the mud or may aggregate over underwater springheads. They are intolerant of freezing and low oxygen levels.

Although migration patterns in leopard frogs are not well understood, they are presumed to actively move between aquatic habitats. These movements are an important component of metapopulation dynamics for these species, promoting increased genetic flow and colonization of new habitats. Appropriate levels of cover are important, however, for migrating frogs, which are dependent upon cover to avoid desiccation and escape from predators (Chan-McLeod 2003 as cited in USDI 2007c, Chan-McLeod and May 2007). Leopard frogs have been shown to avoid areas lacking cover and experience higher water loss when in disturbed areas lacking cover (Mazerolle and Desrochers 2005 as cited in USDI 2007c). Cover is therefore an important component of overland habitats when it does not present a physical barrier to movements.

The Coconino Wildlife Connectivity Assessment: Report on Stakeholder Input (AGFD 2011) identified one amphibian travelway (referred to herein as linkage) within the treatment area. The Ashurst/Kinnikinick – Mormon Lake linkage connects permanent and ephemeral lakes and wetlands. Northern leopard frogs are one of the amphibians identified within this linkage. Current threats/barriers within the linkage are off highway vehicle use and Lake Mary road. The linkage is within Subunits 1-2, 1-4 and 1-5. Appendices 3, 4, and AGFD (2011) describe this linkage.

Chytrid fungus was identified by the Chiricahua Leopard Frog Recovery Plan (USDI 2007c) as posing a high threat to systems supporting Chiricahua Leopard Frogs, and, presumably, NLFs. This fungus has been identified as causing the decline and extinction of frog populations (USDI 2007c). The presence of chytrid fungus in the action area is unknown. Transfer of Chytrid can occur when contaminated wet equipment or muddy vehicle tires are in contact with multiple aquatic sites. Risk of transfer can be reduced with the use of proper decontamination procedures.

Northern leopard frogs were reported from 11 Subunits (1-2, 1-3, 1-4, 1-5, 1-6, 3-4, 3-5, 4-4, 4-5, 5-1) in the treatment area (appendix 16). Their range within the project boundary is now limited to permanent waters around Stoneman Lake. A number of water bodies within the treatment area that may have provided suitable breeding habitat historically now have resident non-native predators such as bullfrog, green sunfish, or crayfish populations. There are six occupied/critical breeding sites and ten potential breeding sites in the project or within a ¼ mile of the treatment area boundary and they occur within subunits 1-2, 1-5 and 1-6. Coleman Lake in subunit 3-1 is being considered for a reintroduction site. Best potential habitat within the treatment area is tanks and springs that provide permanent water. Potential threats to local populations of Northern leopard frogs include changes in wetlands, especially the alteration of marshy ponds to reservoirs and natural local extirpations as ponds dry up during years of low precipitation. Other threats include alteration of riparian vegetation by grazing, predation and competition by introduced bullfrogs and other non-native aquatic species and chytrid fungus. Although potential habitat occurs in livestock waters in all cover types within RUs 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.

## Bald Eagle

The FWS removed the bald eagle in the lower 48 States of the United States from the Federal List of Endangered and Threatened Wildlife, as of August 8, 2007 (USDI 2007d). Eagles are currently protected under the Golden and Bald Eagle Protection Act and are a Forest Service Sensitive species.

The FWS recommends using the Conservation Assessment and Strategy for Bald Eagles in Arizona (Driscoll et al. 2006) in conjunction with the Bald Eagle National Management Guidelines (USDI 2007e) to protect bald eagles in Arizona. These guidelines were incorporated into the 4FRI as either design features or mitigation.

Bald eagles in central Arizona prefer to nest on cliff ledges or pinnacles or in tall trees (USDI 1982). Bald eagles are habitat generalists and opportunistic feeders, typically taking the easiest and most abundant prey, regardless of whether it is dead or alive (Joshi 2009). They mainly forage on waterfowl and fish found along major streams, however, they do hunt in the uplands and forage on various mammal species, especially in the winter.

### Nesting

There are two nesting pairs of bald eagles within the project boundary. One breeding area occurs above the Rim near Lower Lake Mary. The same pair has used two different nest locations along Lower Lake Mary. The area at the most consistently and recently used nest is naturally protected due to limited access to the area and 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 Forest. This nest was first documented in May of 2012 and is located in an area of high recreation use. The nest was monitored by AGFD and confirmed active with 2 young nestlings. 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.

### Wintering

Bald eagles occurring on the Coconino and Kaibab NFs are primarily winter visitors. Bald eagles overwintering in northern Arizona are primarily migratory individuals that breed in the northern U.S. and Canada (Grubb et al. 1989). They are often seen scavenging on carrion, including large and small mammals, or around some of the waters supporting fish and waterfowl such as Lake Mary, Mormon, Ashurst and Kinnickinick Lakes on the Coconino NF and Kaibab Lake, White Horse Lake, and Sholz Lake on the Kaibab NF. Small to moderate-sized groups of bald eagles (typically 2-48) roost in clumps of large trees in protected locations such as drainages and hillsides (Grubb and Kennedy 1982, Dargan 1991, Grubb 2003). Bald eagle winter night roosts typically consist of clumps of large (average d.b.h. of 30 inches) trees on steep slopes that tend to occur on east facing aspects (Joshi 2009). Group sites are typically in stands of ponderosa pine trees less than an acre up to 43 acres, most often on north or northeast-facing slopes close to daytime foraging areas (Dargan 1991). Day roosts are often trees or snags near water or roadways. Bald eagles are highly mobile in the winter and can fly great distances in search of aquatic or terrestrial prey and suitable nighttime roosting habitat. There are currently 38 eagle roosts spatially identified in GIS for the analysis area, of which 19 have confirmed use by bald eagles. The remaining 19 roosts are identified as characteristics roosts and do not have documented use by bald eagles. Bald eagle confirmed and characteristic winter roosts are found in 7 of the 23 subunits. With the assistance of a grant from the American Eagle Foundation a biologist working with the Four Forest Restoration Initiative is currently surveying and assessing characteristic bald eagle roosts to determine bald eagle use and the need for vegetation treatments and fuel reduction.

Coconino forest plan direction for Management Area (MA3) states that on less than 40 percent slopes bald eagle winter roosts are to be protected in ponderosa pine and mixed conifer habitats. In addition to the actual roost trees, a 300-foot radius no-cut zone should be delineated. Road development should avoid the roost and uncut zone and human disturbance at roost sites should be avoided from October 15 to April 15 (Driscoll et al. 2006). Kaibab forest plan guideline requires that activities occurring near areas used by bald eagle should follow recommendations identified in the National Bald Eagle Management Guidelines and Arizona Conservation Assessment and Strategy for the Bald Eagle. The Arizona Conservation Assessment and Strategy guidelines restrict human activity within 500 feet of a roost but allows for thinning to promote growth of large trees within roosts that are becoming less suitable due to loss of trees or snags (Driscoll et al. 2006). Potential habitat within the treatment area is 507,839 acres of ponderosa pine but its 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).

## American Peregrine Falcon

The essential habitat for peregrine falcon includes rock cliffs for nesting and a large foraging area. Suitable nesting sites on rock cliffs have a mean height of 200 to 300 feet. The subspecies *anatum* breeds on selected isolated cliff ledges and is a permanent resident in the treatment area. Peregrines prey mainly on birds found in wetlands, riparian areas, meadows, parklands, croplands, mountain valleys, and lakes within a 10 to 20 mile radius from the nest site. There are 20 confirmed nesting pairs of peregrine falcons within the analysis area. Nests occur in 8 subunits (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. Forest plan guidelines prohibit activities that can potentially disturb in the vicinity of occupied peregrine falcon nesting habitat between March 1 and August 15. Foraging habitat in the treatment area is primarily 48,703 acres of grassland, 39 miles of riparian habitat and ephemeral streams, 74 springs and wetlands.

## Western Burrowing Owl

Burrowing owls are found in flat, open, low-stature grasslands, sparsely vegetated desert shrub, and edges of human disturbed land. These owls take over burrows of prairie dogs and ground squirrels, and dens of coyote, fox and badger. They are also known to use artificial burrows. These owls also need perches, such as mounds and fence posts. They primarily eat insects and small mammals, but are known to take other small-sized species. Breeding Bird Atlas surveys confirmed nesting from approximately 100 feet elevation near Gladsden to 6,600 feet elevation in a prairie dog colony near Flagstaff however burrowing owls have not been confirmed within the treatment area. Similar to prairie dogs, burrowing owls are associated with the Great Basin/Colorado Plateau grassland and steppe, montane subalpine and semi-desert grasslands. There are 48,703 acres of grassland habitat within the treatment area that provide potential habitat for prairie dogs and consequently, burrowing owls. There is no specific forest plan direction for burrowing owls or prairie dogs however guidelines for mountain grassland are to evaluate the need to maintain and improve meadows by eliminating competing conifers, stabilizing gullies to restore waters tables, and reseeding with desirable species.

## Navajo Mogollon Vole

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 towards the town of Williams and up to the Tusayan Ranger District. They live in a variety of habitats from 3,800 to 9,700 feet in elevation, including ponderosa pine forest and montane subalpine grasslands. Whether or not Navajo Mogollon voles are found in forests, shrublands, or grasslands, they are associated with grassy vegetation (Hoffmeister 1971). They select drier habitats than long-tailed voles, which typically occupy moister habitats (Hoffmeister 1971). 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). They typically nest underground with runways leading from the burrow entrance out to their foraging areas. They preferentially forage on cool season or C-3 photosynthesis grasses (Chambers and Doucett 2008, Ganey and Chambers 2011). Other grasses can also provide food and voles rely on other herbaceous species for cover. In a study evaluating understory vegetative cover, clumpy tree distribution, decreased pine basal area and snags greater than 16 inches in diameter were identified as strong drivers for Mogollon vole occupancy (Kalies et al.2010). There are 507,839 acres of ponderosa pine and 48,703 acres of grassland within the treatment area.

## Western Red Bat

The western red bat is thought to be a summer resident of northern Arizona. It primarily occurs along riparian corridors among oaks, sycamores, and cottonwoods at low elevations but may occur up to 7,200 feet where they roost in dense clumps of foliage. In the Grand Canyon Hoffmeister (1971) reports they were only known from the bottom of the Canyon near Phantom Ranch and along Bright Angel Creek approximately 6 miles from the treatment area. Summer habitat associations include coniferous forest (Western Bat Working Group 2005a). Although generally solitary, western red bats forage in close association with one another in summer and may migrate in groups. They typically feed along forest edges or in small openings. Large lepidopterons are considered main prey items, but homopterans, coleopterans, hymenopterans, and dipterans have also been reported in their diets (Western Bat Working Group 2005a). 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 treatment area. One bat was radio-tracked near Kachina Village within the treatment area and roosted in a clump of Gambel oak in dry ponderosa pine forest (Chambers, personal communications 2010). They roost primarily in the foliage of trees or shrubs but also occasionally use caves. 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 RDs failed to produce records of western red bats.

Forest management treatments potentially benefiting bats and their prey include group selection – small groups of trees removed for regeneration of new age classes results in a mosaic of roosting habitat, small to medium gaps for foraging, and single tree selection - individual trees of all size classes removed fairly uniformly. These treatments maintain diverse forest structure and roost trees; create gaps which enhance edge habitat, and provide diverse vegetation structure increasing herbaceous vegetation important for bats' insect prey (Taylor 2006).

There are 34 caves within 300 feet of the treatment area boundary. Coconino forest plan guidelines recommend a 300 foot buffer around caves entrances and sinkhole rims. This is a design feature at all known cave locations for all action alternatives. Potential foraging habitat within the treatment area includes 507,839 acres of ponderosa pine and 48,703 acres of grassland. Roosting habitat may occur along the 39 miles of riparian habitat and ephemeral streams.

## Allen's Lappet-browed Bat

Allen's lappet-browed bat is known to occur in a wide variety of habitats in the southwestern U.S. and Mexico. They are known to occur within the 4FRI area (Patton 2011). In Arizona, Allen's lappet-browed bats have been found in ponderosa pine, pinyon-juniper, Mexican woodland, white-fir forests and Mohave desert scrub. They are often associated with water. Hoffmeister (1986) documents Allen's lappet-browed bats occupying mine shafts or rocky areas and cliffs for roosts. A study conducted within the treatment area (RUs 1, 3, and 6) documented lappet-browed bats using snags for maternity roosts. It appears that males segregate during the maternity season and use cliff habitat while females typically select taller snags with sloughing bark closer to forest roads for raising their pups (Solvesky and Chambers 2009). While snags are not a long-lasting form of forest structure, snags with sloughing bark are even more ephemeral. Female roosts were all within ponderosa pine forest. Allen's lappet-browed bats feed on flying insects, often over open water bodies (including stock tanks) and wetlands where flying insects are abundant. However, foraging habitat can be diverse and includes ponderosa pine forest, forest openings, wet soils, and diverse herbaceous ground cover. They occur across the ponderosa pine belt on the Coconino and Kaibab NFs and have been documented in the treatment area in Subunits 1-5, 3-3, 5-1 and 6-3. Potential habitat within the treatment area is 507,839 acres of ponderosa pine and 25,658 acres of pinyon-juniper.

Forest management treatments potentially benefiting bats and their prey include group selection – small groups of trees removed for regeneration of new age classes which results in a mosaic of roosting habitat, small to medium gaps for foraging, and single tree selection - individual trees of all size classes removed fairly uniformly. This would ensure a consistent source of large diameter snags by maintaining recruitment of trees into larger size classes. These treatments would maintain diverse forest structure, including snags and gaps that enhance edge habitat, create diverse vegetation structure, and increase herbaceous vegetation important for bats' insect prey (Taylor 2006).

## Pale Townsend’s Big-eared Bat

Townsend’s big-eared bat occurs across a broad range in western North America. 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 (Subunits 4-3, 5-2, 3-3, 1-3 and 3-5. They use a wide range of habitats, including ponderosa pine forest. Townsend’s big-eared bats typically roost in rock structures (e.g., caves, mines, and lava tubes), and abandoned buildings, but will also use hollow trees. Pale Townsend’s big-eared bats are apparently secure although loss of cave and mine habitat may be causing a decline in numbers and there is concern over loss of genetic variability within populations (Western Bat Working Group 2005b). Townsend’s big-eared bats are sensitive to disturbance and roost sites have been abandoned because of human recreation. They feed on flying insects and often forage across over water bodies and wetlands where flying insects are abundant. The species is a moth specialist with over 90 percent of their diet composed of lepidopterans. They travel long distances while foraging and use edge habitat adjacent to or within forest habitat (Western Bat Working Group 2005b). Habitat features potentially benefiting prey species include pools, stock tanks, wet ground, herbaceous ground cover, and edge habitat. Forest management treatments potentially benefiting bats and their prey include group selection, small groups of trees removed for regeneration of new age classes results in a mosaic of roosting habitat, small to medium gaps for foraging, and single tree selection, individual trees of all size classes removed fairly uniformly. These treatments maintain diverse forest structure and roost trees; create gaps which enhance edge habitat, and provide diverse vegetation structure increasing herbaceous vegetation important for bats’ insect prey (Taylor 2006). Potential habitat includes 507,839 acres of ponderosa pine and 48,703 acres of grassland within the treatment area.

There are 34 caves within 300 feet of the treatment area boundary. Coconino forest plan guidelines recommend a 300 foot buffer around caves entrances, sinkhole rims and drainages leading to these features. This is a design feature for all known caves within the treatment area for all action alternatives.

## Spotted Bat

Historic records suggest that the spotted bat is widely distributed, rare across its range, but can be locally abundant. The historic range of the spotted bat includes Mexico and the Southwest and north up to Canada. In Arizona, spotted bats commonly roost singly in crevices in rocky cliffs and they have also been found in caves (Chambers, personal communications 2009). Cliff habitat and surface water are characteristic of localities where they occur. Spotted bats are lepidopteran specialists and will forage in upland meadows. Meadows, openings, and open forests with diverse herbaceous ground cover provide habitat for prey species. There are 507,839 acres of ponderosa pine and 48, 703 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 did not result in captures on the Coconino NF or the Williams RD, but spotted bats were captured on the Tusayan RD, RU 6, (Solvesky, personal communications2008). 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).

# Bald and Golden Eagle Protection Act

All golden and bald eagles, regardless of status, are protected under the Bald and Golden Eagle Protection Act. This analysis determines if take is likely to occur with implementation of the action alternatives. Take is defined as to “pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb”. Disturb is further defined “to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.”

The FWS recommends using Conservation Assessment and Strategy for Bald eagles in Arizona (Driscoll et al. 2006) in conjunction with the Bald Eagle National Guidelines (USDI 2007e) to protect bald eagles in Arizona. For golden eagles, the FWS has issued a report titled “Interim Golden Eagle Technical Guidance: Inventory and Monitoring Protocols; and Other Recommendations in Support of Golden Eagle Management and Permit Issuance” (Pagel et al. 2010).

For bald eagles, details of the existing condition can be found is this document where bald eagles are addressed as a Forest Service Sensitive species.

Golden eagles are found nesting in a wide variety of habitats from arid desert scrub to open conifer forests. No matter what habitat they choose in the state, topography features include tall cliffs or canyon in which to construct a nest and nearby large open areas to forage for prey (Driscoll et al. 2006). Most golden eagles nesting in Arizona are primarily residents, remaining within or near their home range throughout the year. In Arizona, cliff ledges are the most common nesting substrate used by golden eagles, but they will also use tall trees (especially ponderosa pine), junipers, rock outcrops, and in rare cases, transmission towers (Glinski et al. 1998 in AGDF 2005).

Sightings of golden eagles have been documented, and winter surveys are conducted annually on the Flagstaff and Williams Ranger Districts 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. 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 48,703 acres of grassland.

# Forest Service Management Indicator Species

The 1987 Coconino forest plan identified 17 wildlife species as MIS to monitor ecosystem health. The Kaibab NF revised their forest plan since the 4FRI draft DEIS was completed,. The Kaibab forest plan changed the MIS list for the forest in two ways: The species list changed with: Grace’s warbler and western bluebird for ponderosa pine stands, ruby-crowned kinglets for mixed conifer (frequent fire), and pronghorn were retained as indicators of grasslands; the calculation of forestwide MIS habitat acres also changed. For the three birds, the whole 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.

The proposed project would affect ponderosa pine, aspen, pinyon-juniper, ephemeral streams, and spring habitats. MIS or their respective habitat components that do not occur within the proposed 4FRI treatment area will not be analyzed in this report (Table 46). The presence of species carried forward for analysis was determined by surveys conducted on the forest and the FAAWN database (Patton 2011).

**Table 46. MIS and associated habitats not analyzed in the 4-Forest Restoration Initiative Project**

| Management Indicator Species | Forest | Key MIS Habitat Component Indicator | Comments |
|---|---|---|---|
| Mexican spotted owl (*Strix occidentalis lucida)* | Coconino | Late-seral mixed conifer and spruce-fir | There is no mixed conifer or spruce fir habitat being treated in the proposed treatment area. |
| Red squirrel (*Tamiasciurus hudsonicus*) | Coconino | Late-seral mixed conifer and spruce-fir | There is no mixed conifer or spruce fir habitat being treated in the proposed treatment area. |
| Yellow-breasted chat (*Icteria virens*) | Coconino | Late-seral, low-elevation, riparian habitat (less than 7,000 feet) | There are 6 miles of proposed ephemeral stream channel restoration with ripar ian vegetation; 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 will not remove woody riparian vegetation. Thinning and burning could increase water-yield for up to 5 years. This would not affect the late-serial riparian habitat. |
| Lucy's warbler (*Oreothlypis luciae)* | Coconino | Late-seral, low-elevation, riparian habitat (less than 7,000 feet) | There are 6 miles of proposed ephemeral stream channel restoration with riparian vegetation; 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 burning could increase water-yield for up to 5 years (see watershed report). This would not affect the late-seral riparian habitat. |

| **Management Indicator Species** | **Forest** | **Key MIS Habitat Component Indicator** | **Comments** |
|---|---|---|---|
| Lincoln's sparrow (*Melospiza lincolnii*) | Coconino | Late-seral, high-elevation riparian habitat (greater than 7,000 feet) | There are 6 miles of proposed ephemeral stream channel restoration with riparian vegeation; 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 burning could increase water-yield for up to 5 years (see watershed report). This would not affect the late-seral riparian habitat. |
| Cinnamon teal (*Anas cyanoptera*) | Coconino | Wetlands | 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 burning could increase water-yield for up to 5 years. This would not affect the wetland habitat. |
| Ruby-crowned kinglet *(Regulus calendula)* | Kaibab | Mixed-conifer | There is no mixed conifer being treated in the proposed treatment area. |

Thirteen MIS whose distribution on the forest encompasses part or all of the treatment area were included in the terrestrial effects analysis (Table 47). The analysis is based also on the forest plans and projected changes in acreage of quality habitat under all of the alternatives.

**Table 47. MIS analyzed for the Four-Forest Restoration Initiative Project**

| **Management Indicator Species** | **Forest(s)** | **Key MIS Habitat Component Indicator** | **Habitat within analysis (project) area** |
|---|---|---|---|
| Aquatic macroinvertaebrates | Coconino | Riparian | See fisheries MIS section |
| Northern goshawk (*Accipiter gentilis*) | Coconino | Late-seral ponderosa pine | Ponderosa pine |
| Pygmy nuthatch (*Sitta pygmaea*) | Coconino | Late-seral ponderosa pine | Ponderosa pine |
| Turkey (*Meleagris gallopavo merriami*) | Coconino | Late-seral ponderosa pine | Ponderosa pine |
| Abert's squirrel (*Sciurus aberti*) | Coconino | Early seral ponderosa pine | Ponderosa pine |
| Rocky Mountain elk (*Cervus elaphus*) | Coconino | Early seral ponderosa pine, mixed conifer, and spruce-fir | Ponderosa pine |
| Hairy woodpecker (*Picoides villosus*) | Coconino | Snags in ponderosa pine, mixed conifer and spruce-fir | Snags in ponderosa pine |
| Red-naped sapsucker (*Sphyrapicus nuchalis*) | Coconino | Late-seral aspen and snags in aspens | Aspen and aspen snags |

| Management Indicator Species | Forest(s) | Key MIS Habitat Component Indicator | Habitat within analysis (project) area |
|---|---|---|---|
| Mule deer (*Odocoileus hemionus*) | Coconino | Early seral aspen and pinyon-juniper | Aspen and pinyon-juniper |
| Juniper titmouse (*Baeolophus ridgwayi*) | Coconino | Late-seral pinyon-juniper, and snags in pinyon-juniper | Pinyon-juniper and pinyon-juniper snags |
| Pronghorn (*Antilocapra americana*) | Coconino and Kaibab | Early and late seral grasslands<br>For Kaibab - grasslands | Grassland |
| Grace's warbler (*Setophaga graciae*) | Kaibab | Indicates clumps of mature ponderosa pine/pine-oak forests with mature (yellow) pine similar to reference conditions | Ponderosa Pine |
| Western bluebird (*Sialia mexicana*) | Kaibab | Indicates understory development within openings in ponderosa pine stands | Ponderosa Pine |

MIS and the habitats they represent are listed in the most recent Coconino NF (USDA 2013) Forestwide Management Indicator Species reports. Information on species, their population trends, and habitat trends presented in the Coconino NF MIS Forestwide report (USDA 2013) and is incorporated by reference here. 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. The wildlife specialist report for the revised plan is incorporated by reference into this document. 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 RMBO 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 4FRI (appendix 10). These updates by individual game species and initial assessment of 4FRI-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.

## MIS for the Coconino NF

### Late-seral Ponderosa Pine Species Indicators

The northern goshawk, pygmy nuthatch and wild turkey are all indicators for late-seral ponderosa pine cover type. There are documented goshawks nesting territories within the analysis area (see the Sensitive Species section). Pygmy nuthatches were recorded in the analysis area during forestwide surveys for both forests. Wild turkeys have been seen within the analysis area during the RMBO forestwide surveys and during survey efforts coordinated by AGFD (appendix 10).

**Coconino NF late-seral ponderosa pine habitat trend:** The forestwide habitat trend for late-seral ponderosa pine is slightly upward since 1996 due to the shift in forest emphasis for the retention of groups of large trees and increasing the amount of old growth that is retained and developed . The age class distribution of ponderosa pine has remained essentially the same, dominated by mid-seral stage, with some increases of old-growth and older trees, and some increases in early-seral stage habitat created by wildfire (USDA 2013). There are about 253,407 acres of late-seral ponderosa pine available forestwide (USDA 2013). Within the analysis area there is approximate 55,956 acres of late-seral ponderosa pine, which is about 22 percent of this age class across the Forest.

#### *Northern Goshawk*

Northern goshawks occupy nearly every forest and woodland habitat type that occurs within the hawk’s geographic range. This species is primarily found in ponderosa pine forests in the southwestern United States (Reynolds et al. 1994). The descriptions of forests and woodlands used by breeding goshawks have shown great variation in horizontal and vertical vegetation structures. Typical nest areas are composed of large, dense trees, closed canopies created by a variety of tree sizes, and open understories, but exact structure depends on forest type, elevation, and growth site potential. Overall, goshawks are closely tied to prey resources and less so to forest habitat type (USDA 2010a). Goshawks like to forage in habitat with relatively open understories so they can easily see and pursue their prey, or use open forest habitats so they can hunt from perch trees for rabbits or ground squirrels (USDA 2010a).

Goshawks like to forage relatively open forest or forests with open understories so they can easily see and pursue their prey, including rabbits or ground squirrels (USDA 2010a). They are known as “perch and pounce predators” because of their use of perch trees for hunting, moving to a new perch if prey is not readily sighted (Reynolds et al. 1992).

**Coconino NF goshawk population trend:** There are 71 PFAs on the Coconino NF and 32 of them are within the analysis area. The forestwide trend appears to be stable to declining. Although the Forest has information on territory occupancy and reproduction, surveys and monitoring are not designed to detect changes in population trend and are generally done in a nonrandom fashion. Typically the priority for surveys is to determine occupancy relative to upcoming projects. The total number of territories has increased from 42 in 1991 to 71 in 2011. Monitoring and surveys are ongoing on the Forest and effort has decreased since about 2001. The percentage of occupied northern goshawk territories has ranged from near 90 percent in 1991 to near 30 percent in 2011 with both increases and decreases in percent occupation in the intervening years (USDA 2013).

### *Pygmy Nuthatch*

Pygmy nuthatches use snags or trees with dead portions suitable for excavation for nesting. They are primarily insectivorous. During the breeding season their diet consists of 60 to 85 percent insects. They seem to prefer heterogeneous stands of well-spaced, old pines and vigorous trees of intermediate age. Little information is available on populations of pygmy nuthatches prior to fire suppression policies, but evidence from Arizona and New Mexico suggests that the species was abundant. Management strategies that move ponderosa pine forest closer to the historic range of variation should positively affect the species (USDA 2010b).

**Coconino NF pygmy nuthatch population trend:** The forestwide trend is stable to slightly declining. Monitoring conducted by the RMBO from 2009-2011 suggests pygmy nuthatches are declining. Results from a long-term bird research project on the Mogollon Rim Ranger District showed an increase in the number of pygmy nuthatch nests on the study sites between 1991 and 1996 then a crash in 1997 from which there has been a slight recovery in recent years. The crash was apparently related to an interactive effect on the habitat as a result of declining snowfall and heavy winter elk herbivory on the study site (Martin and Moran 2012). NatureServe data suggests that Arizona populations are secure (USDA 2013).

### *Turkey*

Turkeys were selected as an indicator for late-seral ponderosa pine which they use for nesting and roosting. However, many different factors of the proposed project could affect turkey population trends. Turkey population trends are strongly impacted by the state hunting structure, including number of tags and timing of hunts. Turkey roosts and nests are associated with groups of large pine trees on steep slopes. They select foraging and loafing habitats within a mix of meadows, oak, and juniper. Turkeys roost in tree groups averaging 36 trees 16 inches d.b.h. or greater. The roost tree itself is often greater than 24 inch d.b.h. The high tree and canopy density within roosts is important for thermal protection, particularly in the winter. Uneven-aged canopy structure also helps provide thermal protection, although roosting turkeys select for a higher canopy base height (greater than 24 feet).

Clumpy-groupy forest structure is also important for turkeys in their foraging habitats, where they feed in small forest openings (0.28-0.31 acres). Turkeys select areas with a higher percent cover of forbs and grasses for feeding and they select areas with a higher plant and invertebrate richness during the poult-rearing phase. Acorn mast from Gamble oak can significantly increase the probability of overwinter survival and is connected to productivity the following year.

Forage includes cone crops produced by mature ponderosa pine trees, hard mast from oak trees, juniper berries, seeds from grasses and forbs in early seral habitat, and invertebrates. Pine-oak habitats are particularly important for turkeys in the winter. Core home range size for turkeys is roughly 26-30 square miles. Since turkeys are relatively wide-ranging, they are likely to respond to changes in forest management at both small and large spatial scales.

**Coconino NF turkey population trend:** The forestwide population trend is stable. The trend was variable in the early part of forest plan implementation period (late 80s and early 90s), although AGFD standard survey procedures did not provide good data due to low number of observations on survey routes. AGFD improved their index of turkey populations in the mid-1990s. In 2011, the percentage of archery hunters that observed turkeys increased in all the GMUs (on the forest) compared to 1997. In this same time period, annual harvest rates for turkey increased in GMU 5A (compared to 1997) and declined in the other GMUs. It is considered secure in Arizona according to NatureServe (USDA 2013; also see appendix 10).

## Species Indicators for Early-seral Ponderosa Pine

Elk and Abert's squirrels are indicators for early-seral ponderosa pine habitat. Abert's squirrels have been sighted in the treatment area during forestwide bird surveys on both forests. Because both species are hunted, the state permitted hunt structure will affect population trends of both species at the state and local levels. Elk forestwide populations are managed primarily by the state through their permitted hunt structures.

**Coconino NF early-seral ponderosa pine habitat trend:** The forestwide trend for early-seral ponderosa pine is increasing slightly (USDA 2013). Based on the MIS report, there are approximately 93,443 acres of early-seral ponderosa pine available forestwide. Within the analysis area there is approximate 13,331 acres of early-seral ponderosa pine, which are about 14 percent of this age class across the forest. However, the analysis occurs on 322,772 acres of ponderosa pine habitat which is approximately 41 percent of the ponderosa pine acreage for the forest.

### *Elk*

Elk are indicators of early-seral ponderosa pine, mixed conifer and spruce fir forest which is used for foraging. However, many different apects of the project would affect elk population trends. Elk are habitat generalists. In addition to the above forest types, elk graze grassland and woodland habitats as well as aspen and riparian areas. Elk occupy mountain meadows and forests in summer and generally move pinyon-juniper woodland, conifer forest, and grasslands in winter, depending on snowfall. Only ponderosa pine habitat will be considered for this project.

Forage availability is important to maintaining overall body condition. Foraging areas are primarily associated with openings in the forest canopy where perennial grasses and forbs are more available. Elk also forage in stands dominated by Gambel oak and quaking aspen where they feed on sprouts and ramets. Forest management practices that create an interspersion of tree groups and openings tend to improve elk habitat by increasing understory productivity while still providing nearby hiding and thermal cover.

According to the AGFD, the 4FRI project area includes portions of four elk herds (Figure 17). One herd includes Game Management Units (GMUs) 5A/5B/6A and occurs on the Coconino NF. The second herd includes GMUs 6B, 8, and Camp Navajo, which overlaps with both forests. The third is contained within GMU 7, which overlaps with both forests. GMU 7 has some population exchange with a fourth herd in GMU 9, which occurs primarily on the Tusayan Ranger District of the Kaibab NF. It is important to note that when elk intermix among herds they do not always go back to their respective GMUs after winter. This complicates interpretation of both population- and habitat-utilization data for this species.

**Coconino NF Elk Population trend:** The forestwide population trend is increasing based on the Coconino NF MIS report (USDA 2013) and Region 2 of the AGFD objectives to maintain a stable or slightly increasing population. However AGFD analysis suggests a decreasing trend (Figure 18, appendix 10). Elk numbers on the Forest increased in the early to mid-1990s and again in the late 1990s. A gradual decline then occurred so that 2009 levels roughly equaled populations levels in the 1980s (USDA 2013).

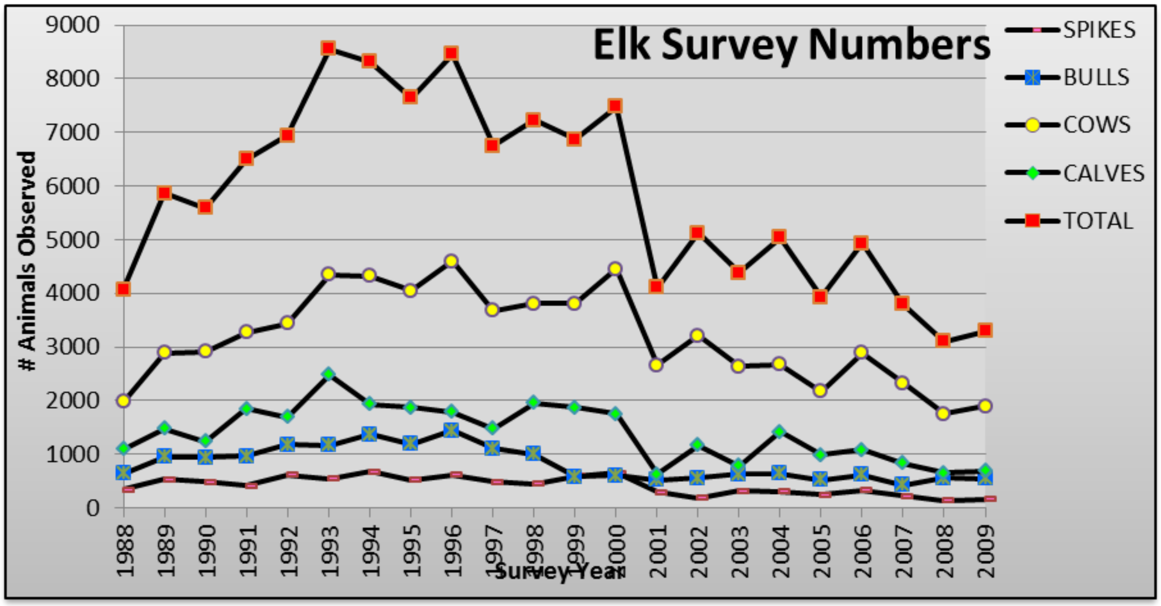


**Figure 17. Elk population trends on the Coconino and Kaibab National Forests based on survey data for GMUs 5A, 5B, 6A, 6B, Camp Navajo, 7, 8, and 9. All data are available from AGFD Flagstaff Regional Office.**

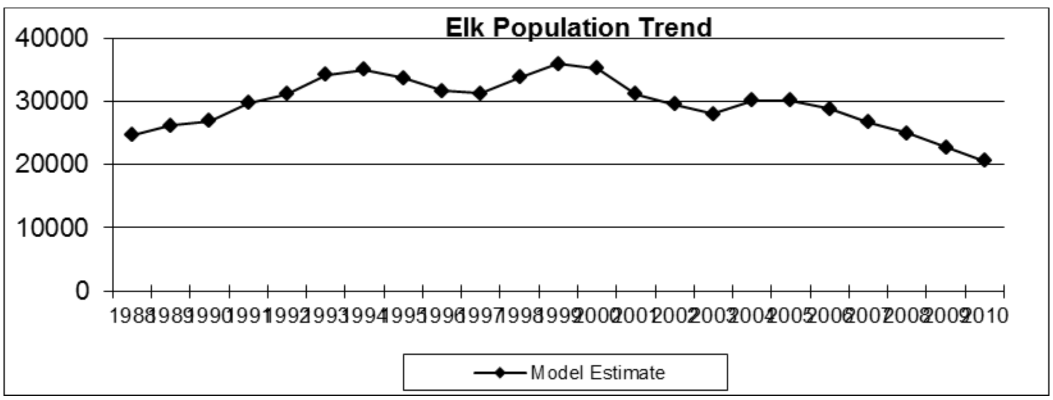


**Figure 18. Elk survey trends on the Coconino and Kaibab National Forests, 1988 – 2009**

### *Abert's Squirrel*

Although Abert's squirrels were selected for early-seral ponderosa pine, their preferred habitat structure is composed of intermediate to older aged forest (trees 9-22+ inches d.b.h.). Forest structure and composition is probably the most important habitat attribute for tassel-eared squirrels. AGFD feeding sign survey data suggests that areas with higher basal area and canopy cover with interlocking canopies contain the highest densities of squirrels. The squirrel's ability to access growing pine shoots for food and its ability to escape predators depends on interlocking tree canopies, especially during winter when snow accumulation can impede ground travel. When snow is absent, tassel-eared squirrels will forage on the forest floor primarily for mycorrhizal fungi ('truffles') associated with pine tree roots. Tassel-eared squirrels also depend on ponderosa pine cones to meet their nutritional demand.

Prather et al. (2006) found that local basal area explained squirrel density in nine northern Arizona studies, and Dodd et al. (1998) estimated optimal tree basal area for squirrels to be greater than 150 square feet per acre. Stand-level canopy cover of 40-50 percent probably represents a threshold for optimal tree squirrel habitat and is particularly important for recruitment. At the scale of the stand and the RU, a continuously dense forest is not required for squirrels as long as denser patches of forest are retained for foraging, nesting, and escaping predators.

**Coconino NF Abert's Squirrel Population trend:** Forestwide population trend is assumed to be stable (USDA 2013). Statewide hunter harvest indicates an overall stable population trend (USDA 2013). Additional population trend information is available for the Coconino NF where AGFD feeding sign surveys were conducted from 2005 – 2010 (Figure 19). These surveys were done in association with multiple FS vegetation management projects in the Flagstaff wildland-urban interface (appendix 10). This study also resulted in an apparent stable trend.in Fort Valley (FV), Kachina North (KN), Kachina South (KS), Mountainaire (MN), Woody Ridge (WD), and Airport (AP) study sites. Treatments had a fuels reduction emphasis, including mechanical thinning and/or prescribed fire. "Untreated" refers to data collected before fuels reduction treatments were conducted.

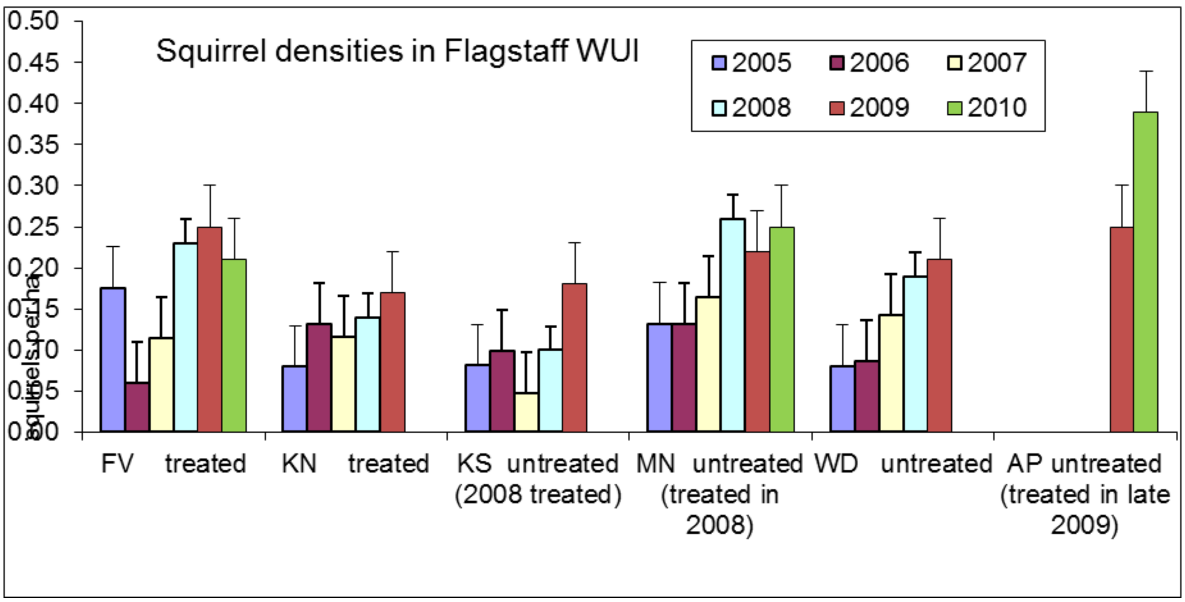


**Figure 19. Feeding sign survey results in the Flagstaff wildland-urban interface (WUI )(2005 - 2010)**

## Species Indicators for Snags in Ponderosa Pine

### *Hairy Woodpecker*

Hairy woodpeckers were selected as an indicator for snags in ponderosa pine, mixed conifer, and spruce-for forest types (USDA 2013). Hairy woodpeckers are common in ponderosa pine forests as well as other forest and woodland types on the both forests. Hairy woodpeckers were identified within the analysis area during forestwide surveys on both forests. For this project only ponderosa pine habitat will be discussed.

The hairy woodpecker is widely distributed wherever there are mature forests with substantial snags. The species are strongly associated with burned areas, an important historical component of northern Arizona's forests resulting from a frequent fire interval. As primary cavity nesters, hairy woodpeckers are dependent on snags and dead and dying portions of live trees for nesting.

Preferred nest tree size varies but 13.8 inch d.b.h. is typical in western conifer forests (USDA 2010a).

**Coconino NF Hairy Woodpecker Habitat and Population Trends:** In 2013, the Forest estimated that ponderosa pine snags were increasing overall and the large snag component was stable (USDA 2013). Ganey and Vojta (2007) suggested that within ponderosa pine and mixed conifer habitats snag numbers will continue to increase and densities of large snags will increase based on modeling from data collected on the Coconino NF. Despite these increases, densities of snags greater than 18 inch d.b.h. would remain below forest plan guidelines. The PNVT data for acreage in ponderosa pine, mixed-conifer and spruce-fir for the forest is approximately 900,426 acres. The project area contains 318,432 acres for ponderosa pine, which is approximately 35 percent of the PNVT for the three cover types across the forest.

Forestwide population trends for hairy woodpeckers are slightly increasing based on available data from the Coconino NF as well as statewide data (USDA 2013).

## Species Indicators for Late-seral Aspen and Snags in Aspen

### *Red-naped sapsucker*

The red-naped sapsucker was selected as an indicator for late-seral aspen forest and snags (USDA 2013). This species has a limited distribution on the both forests because the distribution of aspen and because many aspen stands in the ponderosa pine are small in size. The red-naped sapsucker has been recorded during forestwide surveys for both forests in the project area. Red-naped sapsuckers use both snags and live trees with heart rot, with an average minimum tree d.b.h. of 10 inches or greater. Larger trees are preferred, possibly because they allow sapsuckers to excavate more cavities up the bole of the tree in successive years. The rate of aspen regeneration loss is estimated at 97 percent for sites below 7,500 feet elevation, 50 percent at 7,500-8,500 feet and 25 percent above 8,500 feet. Much of the older aspen is now dying due to weather and insect interactions or from competition with overtopping conifers due to a lack of natural disturbance agents, especially fire (USDA 2010a).

**Coconino NF Red-Naped Sapsucker Habitat and Population Trends:** The forest plan lists 10,000 acres of aspen habitat on the forest (USDA 1987). Larger stands of aspen are located primarily within the mixed conifer PNVT. A small proportion of aspen is found as small, localized patches within the ponderosa pine PNVT. The forestwide habitat trend is declining. This decline is primarily related to fire suppression over the last century. Some early seral stage stands are being created through wildfire and management activities, but recruitment is primarily limited by grazing by animals. Ungulate browsing, infections from wounds inflicted by animals eating bark, and rubbing of aspen regeneration is present in all stands. Successful regeneration is occurring in higher elevations. Aspen clones at lower elevations have limited regeneration success and some stands are becoming old and decadent (USDA 2013). Aspen occurs mostly at higher elevations in the analysis area. Alternatives B and E would treat approximately 1,063 acres and alternative C would treat 1,082 acres of aspen within the project area, which is approximately 11 percent of the aspen habitat forestwide. Alternative D would treat 874 acres of aspen, which is approximately 9 percent of aspen forestwide (see silviculture report).

The forestwide population trend for the red-naped sapsucker is declining (USDA 2013).

## Species Indicators for Early-seral Aspen and Pinyon-juniper

### *Mule Deer*

Mule deer were selected as indicators for early-seral aspen and early seral pinyon-juniper (USDA 2013). Mule deer typically summer at higher elevations in aspen, mixed conifer, and ponderosa pine forests, and transition to lower elevations in winter. Mule deer are browsers, preferring leaves and twigs from shrubs and trees over grazing grasses. Home range size varies, depending upon availability of forage and cover. The Coconino forest plan identified fawning dates for mule deer as May 15 to August 31, but the AGFD corrected those dates in their comments on the 4FRI DEIS, identifying instead June 15 to August 31. Mule deer in and around the Tusayan and Williams Ranger Districts (Kaibab NF) have an estimated home range 141.1 mile2 (±48.3). Since mule deer are a relatively wide-ranging species they are likely to respond to changes in forest management at small and large spatial scales. Forestwide and local population trends for mule deer are influenced more by hunting than by forest management.

While mule deer are indicators of early-seral aspen and pinyon juniper, they are affected mainly by other proposed activities. High diversity and productivity of shrubs and young trees are important habitat components for mule deer, best represented within early-successional forests and maintained by natural disturbances such as fire (appendix 10).

Carrying capacity of winter range habitats is often the limiting factor for mule deer populations. Winter range for mule deer occurs primarily in pinyon-juniper habitat which are largely outside the scope of the 4FRI project. The 4FRI includes approximately 2 percent of the pinyon-juniper communities occurring on each forest. However, summer range for mule deer is throughout the project areas in ponderosa pine, pine-oak, pine-sage, aspen, and at springs and ephemeral channels, particularly when water is available (appendix 10).

High levels of interspersion of forest and openings are favored by mule deer, particularly when a shrub, oak, or aspen component is present. When openings or low-density forests are present in a matrix of higher-density forest patches, mule deer will forage in open and sparsely-treed areas at night but spend the majority of their daylight hours on bedded within denser hiding and thermal cover. In addition, mule deer prefer smaller openings and show fidelity to forested edge. As such, landscape-scale forest restoration practices that favor heterogeneity in forest opening ratios and promote oak, sage, and aspen should improve habitat for mule deer in the short and long term.

**Coconino NF Mule Deer Habitat and Population Trends:** The forest plan (USDA 1987) lists 10,000 acres of aspen habitat on the forest. The forestwide trend for aspen is declining (USDA 2013). A limited proportion of aspen occurs as small, localized patches within the ponderosa pine PNVT. Aspen occurs mostly at higher elevations within the analysis area and in cooler, moister sites on north-facing slopes and in canyons. Aspen in lower elevations is in poor condition unless it has been protected from browsing and/or treated to remove encroaching conifers and stimulate suckering or regenerated through wildfire. The poor condition is primarily due to ungulate browsing of aspen suckers, which results in little to no regeneration. In addition, ponderosa pine are shading and competing with aspen in these areas, resulting in old and decadent stands (USDA 2013). Alternative B and E would treat approximately 1,063 acres and alternative C 1,082 acres of aspen within the project area which is approximately 11 percent of the aspen habitat forestwide for the three alternatives. Alternative D would treat 874 acres of aspen, which is about 9 percent of aspen forestwide (see silviculture report).

There are approximately 600,660 acres of pinyon-juniper habitats on the forest. The age class distribution of pinyon-juniper was relatively stable until record drought conditions in 2002 caused high levels of pinyon mortality. Loss of pinyon was further exacerbated by outbreaks of the Ips beetle. The majority of the pinyon-juniper on the Coconino NF (65.2 percent) is in the late seral stage with 26.1 percent in early seral, and 8.7 percent in mid-seral stages. Early seral pinyon juniper is increasing slightly (USDA 2013). There is approximately 10,786 acres of pinyon-juniper habitat within the analysis area, which is approximately 2 percent of the pinyon-juniper forestwide. Of this, about 8,311 acres or approximately 1 percent of the forestwide acreage of pinyon-juniper would be managed as early-seral stage (see silviculture report).

A generally declining forestwide trend in mule deer numbers has been observed on the Coconino NF over the life of the forest plan. Some modest recovery has occurred since populations hit lows in the mid-2000. The number of fawns per 100 does varied from 1985 through 2001, with declining ratios in the early 2000s. There has been a slightly increasing trend from 2003 through 2010. The overall trend since the forest plan has been implemented has been declining. Although numbers of mule deer observed and fawn:doe ratios have been trending upwards slightly in the last few years, analysis of data from AGFD seems to support the forestwide trend (appendix 10).

Overall, the declining to stable trend for mule deer surveyed on the Coconino and Kaibab NFs over the last decade is consistent with the statewide trend. Fawn:doe ratios indicates relatively stable trends in doe productivity over time across both NFs, but survey data suggest that overall mule deer populations are lower than they were a decade ago. Regional experts have attributed contemporary mule deer population trends to declines in their habitat quality (appendix 10).

## Species Indicators for Late-seral Pinyon-Juniper and Snags in Pinyon-Juniper

### *Juniper Titmouse*

The Juniper titmouse was selected as an indicator for late-seral pinyon-juniper woodland and snags in pinyon-juniper woodland (USDA 2013). The juniper titmouse has been found in the general area of the project area during the forest wide surveys for birds. Juniper titmice are most common where juniper is dominant and large, mature trees are present to provide natural cavities for nesting. Tree density used by breeding juniper titmice ranged from 155 to 380 trees per hectare. Mature stands of pinyon-juniper are characterized by low densities of mature trees, which allows for a developed understory. The birds tend to favor habitat with areas of high densities of dead limbs and a high level of ground cover. Fire suppression has changed some pinyon-juniper communities from open woodlands with heterogeneous tree structure and well developed understories to dense woodlands. High tree densities limit the development of large, mature trees and the subsequent creation of snags, limiting breeding habitat (USDA 2010a). These conditions also limit understory development. Conversely, this uncharacteristic structure has led to large acreage, high-severity fires in pinyon-juniper woodlands in recent years (e.g., Mormon, Lizard, Jacket, Canyon, and Jack’s fires on the Coconino NF).

**Coconino NF Juniper Titmouse Habitat and Population Trends:** There are approximately 600,660 acres of pinyon-juniper habitats on the forest. The age-class distribution of pinyon-juniper was relatively stable until record drought conditions in 2002 caused high levels of pinyon mortality which was further exacerbated by outbreaks of the Ips beetle. The majority of the pinyon-juniper on the Coconino NF is in the late seral stage (65.2 percent) with 26.1 percent in early seral, and 8.7 percent in mid-seral stages (USDA 2013). Late-serial pinyon-juniper habitat is considered stable.

Since the age class distribution of pinyon-juniper has been altered by bark beetle outbreaks, the snag component has increased. Firewood cutting continues to reduce snag densities of both pinyon and juniper snags, especially close to Flagstaff where “poaching” of large, live juniper is common. The loss of older pinyon pine trees due to drought and bug-kill has created new snags, but insect attacks can result in rapid deterioration of snags, affecting their longevity and value to wildlife. Overall, the density of pinyon-juniper snags in all age-classes is increasing but the quality and longevity of snags is decreasing (USDA 2013). There are approximately 10,786 acres of pinyon-juniper habitat within the analysis area, which is approximately 2 percent of the pinyon-juniper forestwide. Of this acreage approximately 8,311 acres is to be managed as late-seral stage, or about 1 percent of the forestwide acreage of pinyon-juniper (silviculture report).

The forestwide population trend for the juniper titmouse is stable based on available data. Breeding bird survey data for Arizona indicates a slightly increasing trend between 1987 and 2010. Christmas bird count data indicate a variable but fairly stable trend for wintering juniper titmice on the Forest. RMBO monitoring results do not indicate a clear trend. However, The Arizona Breeding Bird Atlas documents widespread breeding on the Forest within juniper habitat and populations in Arizona appear to be secure and stable (USDA 2013).

## Species Indicators for Early and Late-seral Grasslands

### *Pronghorn*

Pronghorn were selected as an indicator species for early- and late-seral grassland (USDA 2013). Pronghorn have been seen in the analysis area. Pronghorn populations in Arizona have declined substantially from historic times for a combination of reasons. Forestwide and local populations are also affected through state permitted hunt structure (appendix 10).

Pronghorn are associated with grasslands, meadows, and savannas on the Coconino NF and are typically found in flat or rolling areas, along foothills, in mountain valleys, and on plateaus. Pronghorn prefer ecosystems with a mixture of grasses, forbs, and shrubs to provide for forage requirements and fawning areas. They evolved to avoid predation through sight and flight; habitats with low-growing vegetation and/or sparse tree densities are important for pronghorn. Pronghorn typically avoid areas with high tree density and cover. Several local studies have recognized the importance of grass, forb, and shrub diversity for sustaining pronghorn nutritional needs throughout the year as well as providing hiding cover for fawns. These studies recommend removal of encroaching woody tree species from grasslands and savannas as well as prescribed fire to reinvigorate production and diversity of understory forbs which have the highest nutritional value during fawning. Since pronghorn are relatively wide-ranging species, they are likely to respond to changes in forest management at small and large spatial scales.

Pronghorn avoid areas of high tree and/or tall shrub density, preferring areas with less than 30 percent tree/shrub cover and where vegetation height is less than two feet (0.61 meters) tall. Woody plant invasion into grasslands and meadows has been identified as one of the leading factors reducing habitat quality for pronghorn, sometimes leading to isolation of populations when combined with other sources of habitat fragmentation such as fences and roads.

**Coconino NF Pronghorn Habitat and Population Trends:** The trend in habitat is stable to declining. Although the total amount of grassland habitat has generally remained stable, habitat quality is stable to declining due to shrub and tree encroachment, lack of fire, long term climatic changes, short term drought, and ungulate grazing (USDA 2013). There are approximately 206,025 acres of grassland habitat on the Forest. There are about 22,672 acres of grassland within the analysis area (9 percent of total grassland acres) proposed for treatment under all alternatives.

The forestwide population trend for pronghorn appears relatively stable with fawn:doe ratios increasing somewhat over about the last 10 years (USDA 2013). Pronghorn population indicators have fluctuated since the late 1980s, with fawn:doe ratios showing greater fluctuation than number of pronghorn observed per hour. This is supported by AGFD data that used number of fawns per 100 does observed during annual surveys. The relevant GMUs are 5A, 5B, 6A, 6B, and 7 for the Coconino NF. Population models for these GMUs (with the exception of Unit 6A where information is unavailable) also indicate a stable trend over the last decade (appendix 10).

## MIS for the Kaibab NF

### Ponderosa Pine Indicators

#### *Grace's Warbler and Western Bluebird Habitat Trends*

On the Kaibab NF there are approximately 541,000 acres of ponderosa pine PNVT (Keckler and Foster 2013). There are 189,407 acres of ponderosa pine within the analysis area on the Kaibab NF. This is approximately 37 percent of the ponderosa pine PNVT on the forest.

Grace's warbler is an indicator for groups of mature ponderosa pine. Occupancy modeling results for the ponderosa pine vegetation type on the Kaibab NF indicate about 245,417acres are of high quality habitat and 132,161 acres are of moderate quality habitat, totaling about 377,578 acres of potentially occupied habitat. Model outputs shade areas of high occupancy probability in blue (output value of 1) and areas not likely to be occupied colored orange (a value of 0; Figure 20).

The western bluebird is primarily a ground forager, depends largely on the understory for invertebrate prey. They are therefore indicators of understory development associated with openings in mature ponderosa pine forest. Occupancy model results for the western bluebird indicate that about 417,111 acres within the ponderosa pine are high quality habitat while 64,315 acres are of moderate habitat quality, for a total of 481,426 acres with potential occupancy (Figure 21).

The ponderosa pine forest on the Kaibab NF is highly departed from reference condition (Keckler and Foster 2013). The amount and arrangement of forest developmental stages, and increased tree density/canopy cover are the primary characteristics that are departed. Only 19 percent of the PNVT is currently in the reference condition. The reference condition is defined as mature to old forest with various-sized patches of young regenerating forest. While the Kaibab NF is out of reference condition, the previous rate of treatment within ponderosa pine has kept the habitat condition at a stable trend.

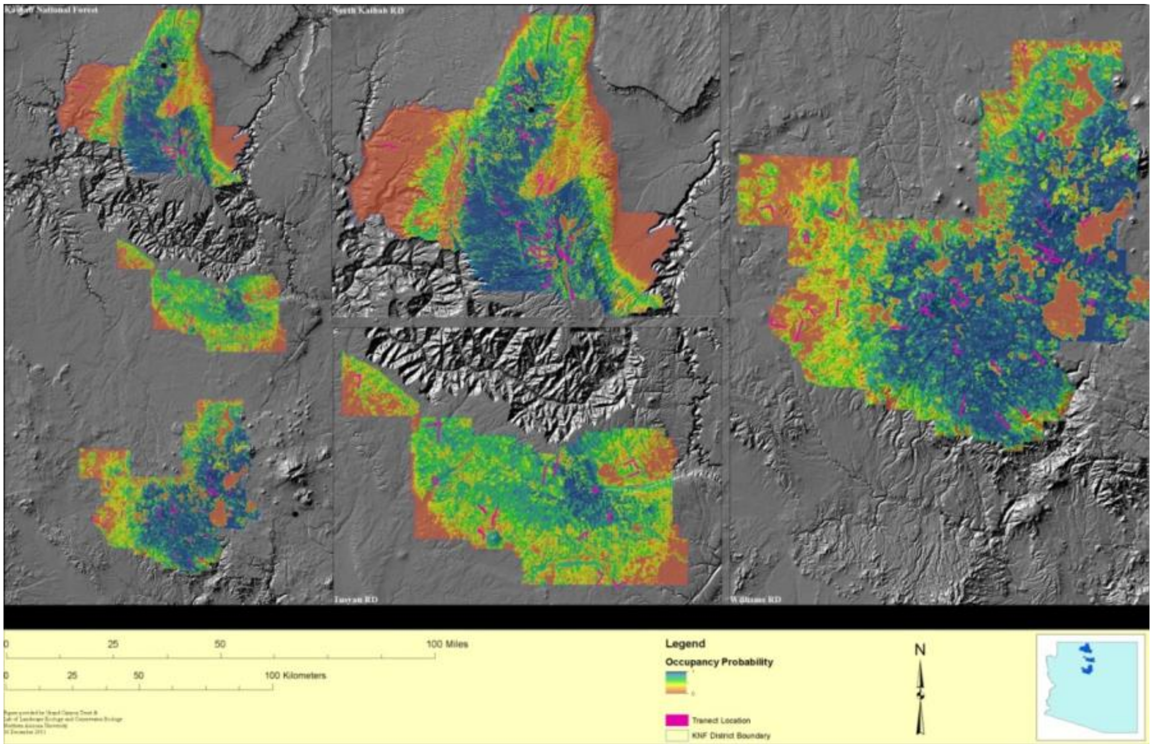


**Figure 20. Spatially explicit model of Grace's warbler occupancy on the Kaibab National Forest, 2010 (Keckler and Foster 2013)**

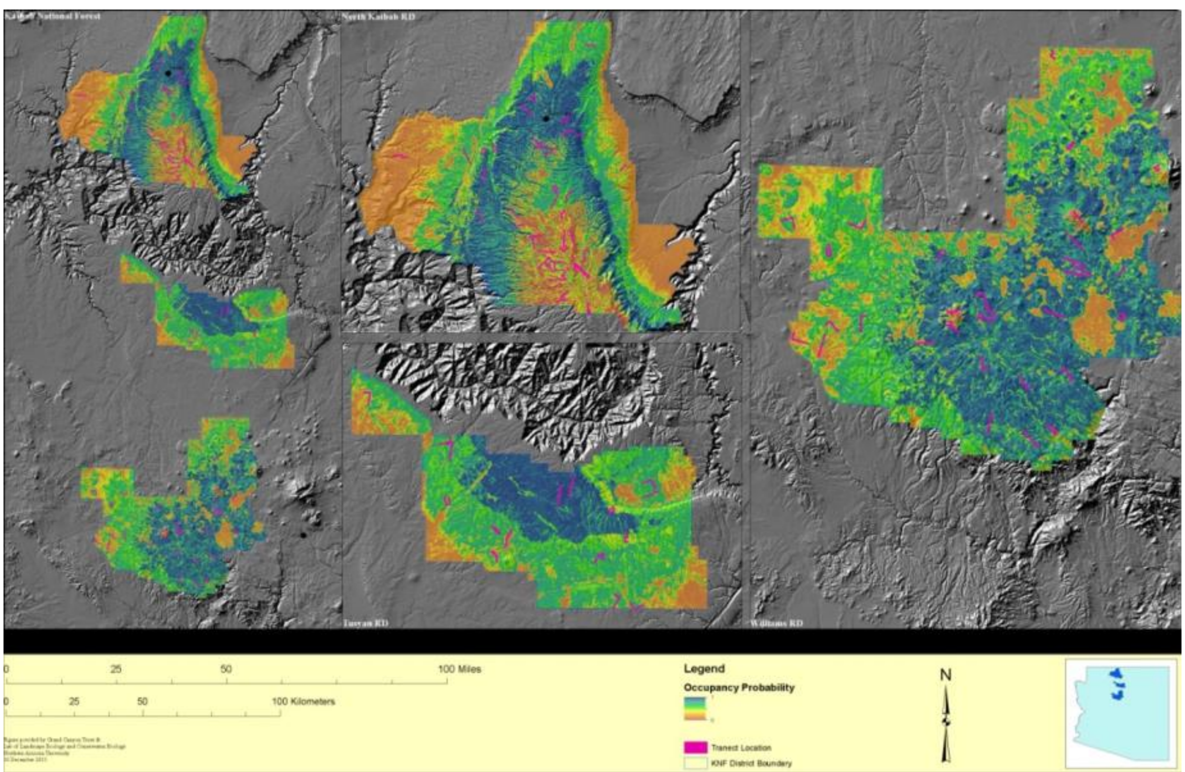


**Figure 21. Spatially explicit model of western bluebird occupancy on the Kaibab and Coconino National Forests (Arizona, USA), 2010 (Keckler and Foster 2013)**

### *Grace's Warbler*

Habitat alteration and fragmentation are key concerns for Grace's warblers rangewide. Existing ponderosa-pine forests differ greatly from presettlement forests as a result of logging, fuelwood harvest, fire suppression, grazing, and urban development. Tree size-class distributions are now skewed towards small diameter trees, with more closed canopy conditions, higher levels of disease, depleted understories, leaving forests susceptible to high-severity fire (Stacier and Guzy 2002). These conditions are more prevalent on the Williams and Tusayan Ranger District than on the North Kaibab Ranger District on the Kaibab NF. Previously, park-like forests with clumps of large trees and grassy openings were maintained by low-intensity ground fires every 2 to 20 years, limiting survival of young pine trees. Grace's warblers rely on large trees is likely less common in ponderosa-pine forests now than they were historically because of the change in habitat conditions over the last century. Information suggests that pine forests that more closely mimic naturally open parklands with stands of large, mature trees will eventually benefit Grace's warblers. Previous research suggests that manipulation of dense, nonvirgin stands may be benefit this species. In northern Arizona, Grace's warblers were most abundant in of mixed-age and heterogeneous vertical and horizontal structure stands thinned to 95.5 trees per acre (236 trees per hectare) than in unthinned, dense forest stands of 261 trees per acre (646 trees per hectare). However, thinning to 73 trees per acre (181 trees per hectare) resulted in lower abundance (Stacier and Guzy 2002).

#### Population Trend

The Kaibab NF has conducted bird surveys on the forest since 2005. Surveys have been done by contract with RMBO since 2007. The RMBO incorporated data collected by the forest in 2005 and 2006 with their survey data since 2007. Population trends based on forest monitoring appear to be stable within ponderosa pine habitats (Keckler and Foster 2013).

Annual estimates of occupancy for Grace's Warbler were highest in 2006, lowest in 2007, and appeared to increase slightly between 2008 and 2009. Similarly, this species displayed annual increases in colonization while local extinction rates were similar across years. Multi-season occupancy models indicated increasing (although variable) trends for Grace's warbler (Keckler and Foster 2013).

In summary the current forestwide habitat and population trend for the Grace's warbler is stable.

### *Western Bluebird*

Western bluebirds commonly prefer ponderosa pine forests with open canopies and understory development across much of their range. They are abundant in moderately disturbed areas, including moderately logged forests, and burned areas, where sufficient nest sites and foraging perches are available. Western bluebirds may benefit from forest thinning. Guinan et al. (2008) concluded that moderate logging increased densities of breeding western bluebirds in northern Arizona. Western bluebirds increased from 8 pairs per 40 hectare to 31 pairs per 40 hectare in thinned forests supporting 225 trees per hectare (91 trees per acre) and 35 pairs per 40 hectare in open forest 69 trees per hectare (28 trees per acre). In that study, the restoration of ponderosa pine forests by thinning of dense stands, followed by controlled burns and reseeding, increased nest and fledgling success, and decreased predation. The effects of fire and salvage logging in burned forests however are unclear. In some areas, there is a higher abundance of birds in areas of low snag density, but with more nests in areas of medium to high snag density. In other areas, there are more nests in areas of low – medium snag density than in areas with higher snag density (Guinan et al. 2008).

Long-term measures proposed to develop and provide habitat for the western bluebird include: Controlled and natural burning to prevent dense forest growth and overgrowth of open areas; retention of snags and preservation of older, large, and partially dead trees. Silvicultural practices that retain snags, leave sufficient numbers of mature trees to ensure adequate snag recruitment for the future, and retain smaller saplings and scattered shrubs for cover and foraging perches should benefit bluebirds. Recommendations developed from research on habitat restoration treatments and nesting success includes: increasing herbaceous ground cover and reducing of ponderosa pine stem densities to less than 109 trees per acre (less than or equal to 270 stems per hectare). No lower threshold in trees per acre was established, but a suggested range was 23 to 61 trees per acre (57 to 150 stems per hectare); and retain Gambel oak trees and snags where present (Guinan et al. 2008).

Recommendations for fire-management included: mimicking natural fire regimens in terms of size, timing, frequency, and severity) and allowing for consideration of historic effects relative to burn geometry (size, heterogeneity in burn severity, and burn-to-edge ratio) in management policies (Guinan et al. 2008).

**Population Trend**

The 2009 RMBO forestwide surveys yielded a density of 33.6. The 2010 surveys showed the western bluebird had a .626 occupancy probability, the 5th highest occupancy rate out of 62 species that occupancy could be estimated for. Due to a change in sample design methodology, the density number for 2010 is not comparable to the previous data. There was a reduction of transects within the ponderosa pine habitat. Population trends based on forest monitoring appeared to be stable (Keckler and Foster 2013).

Trends in occupancy for the western bluebird indicated an initial decrease in occupancy from 2006 to 2007, followed by an increase in subsequent years. Western bluebird occupancy was also fairly steady throughout the analysis period, with the exception of a decline in 2007 followed by an increase in 2008 (Keckler and Foster 2013).

In summary, the current forestwide habitat and population trend for the western bluebird is stable.

## Grassland Indicator

### *Pronghorn Habitat Trend*

During forest plan revision, the grassland PNVT included all grasslands including montane/subalpine grassland, a habitat type that is not suitable for pronghorn. As such, montane/subalpine grasslands will not be included as part of the habitat trend analysis. Within the PNVTs there is approximately 112,250 acres of grassland habitat on the Kaibab NF. Not all of these acres provide habitat for the pronghorn at this time. Currently, forestwide pronghorn habitat appears to be stable (Keckler and Foster 2013). There is approximately 25,871 to 26,152 acres of grassland treatments (mechanical and burning) proposed within the different alternatives, representing about 23 percent of the forestwide pronghorn grassland acreage.

### *Pronghorn Population Trend*

Causes of decline in pronghorn herds across Arizona are numerous, but generally consistent. Paramount to the persistence of any wildlife species is presence of quality habitat. Continued urban sprawl and associated roads and fencing has fragmented and damaged quality pronghorn habitat. Highway construction continues to cause direct mortality via collision with vehicles and barriers to movement. Grasslands on the forest have been reduced in size by invasion of conifers and shrub species as a result of decades of fire suppression. Past livestock grazing and historic fencing practices have reduced habitat quality and created barriers to pronghorn movement and migration routes. Finally, persistent drought and predation has impacted pronghorn populations to varying degrees statewide. The combination of these factors has led to a reduction in habitat availability and quality, a substantial decline in fawn recruitment, and a correlated increase in efficiency of pronghorn predators (Keckler and Foster 2013).

A recent study of habitat quality in and around Camp Navajo Army National Guard, which is centrally located within the 4FRI project area, found that pronghorn habitat quality was significantly limited by high ponderosa pine densities and encroachment into meadows and grasslands (Waddell et al. 2005). Of particular note was the encroachment of pine trees into Garland Prairie; a critically important grassland used for pronghorn fawning (appendix 10).

Modeling by the AGFD sets mortality rates of the initial population estimates so that the predicted annual male-female ratios match those recorded on pronghorn surveys. The AGFD Region 2 office provides the following summary (Table 48) for the units overseen by their region. The 3-year trends are for 2011-2013and 10-year for 2004-2013.

**Table 48. Trends in Pronghorn Populations based on AGFD data (McCall 2014)**

| Unit | 3-Year | 10-Year |
|---|---|---|
| **7** | Stable | Stable |
| **8** | Increasing | Increasing |
| **9** | Increasing | Increasing |
| **10** | Stable | Increasing |

Beside the above listed GMUs, pronghorn are also found in 12A on the forest. All of these game units have a portion of the unit on the forest. Pronghorn numbers on GMU 12A appear to be sustaining an increasing trend. An assessment of the overall forest contribution to the pronghorn population trend suggests the forestwide population trend appears to be stable at this time (Keckler and Foster 2013).

In summary, current forestwide habitat and population trends for pronghorn are stable.

# Migratory Birds and Important Bird Areas

## Affected Environment

Arizona Partners in Flight (APIF) 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 2008). This analysis considered high priority bird species from both the APIF and the FWS birds of conservation concern (Table 49). The Coconino and Kaibab NFs occur within two bird conservation regions (BCRs): the Southern Rockies/Colorado Plateau (BCR number16) and Sierra Madre Occidental (BCR number 34). For the Kaibab NF, the analysis area only occurs within BCR number 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).

**Table 49. Priority bird species analyzed under the Migratory Bird Treaty Act**

| PIF High Priority Species and FWS BCC | Important Habitat Features and Life History Considerations |
|---|---|
| **Ponderosa Pine Forest** | |
| Northern Goshawk | See “Sensitive Species” section for effects to pine habitat and to the species. |
| Flammulated Owl | Secondary cavity nester.<br>Most closely associated with open ponderosa pine forest.<br>Almost exclusively insectivorous. |
| Olive-sided Flycatcher | Multi-level, mature forest, fairly open canopy, prefers tree “groupiness” that creates forest edges and openings.<br>Dead branches are used for perches while foraging. Often occur at edge of early post-burned areas for foraging and singing.<br>Live mature pines for nesting. Snags are an important habitat feature. |
| Cordilleran Flycatcher | Prefers moist and shaded forest for breeding habitat. Nest sites include rock crevices, hollows formed by scars in trunks, exposed tree roots, cavities in small trees, and in forks of small branches.<br>Most abundant in stands with greater than 50 percent canopy cover. Abundance increase with snag density.<br>Habitat strategy is to maintain dense canopy closure in mid- to late-successional stages of dense, shady forest with an understory of oak and sufficient dead and down trees for nesting. |
| Grace’s Warbler | Prefers ponderosa pine forest, sometimes with a scrub oak component. Considered a mature pine obligate.<br>Feeds in the upper portions of robust pines on branches; nests found in trees from 20 to 60 feet (6 to 18 meters) above the ground.<br>Prefers mature ponderosa pine savanna; open meadow; and uneven-aged ponderosa pine, including other tree species with an oak understory.<br>Research notes pine forests that mimic naturally open parklands with stands of large, mature trees, will eventually benefit this species. |
| Lewis’s Woodpecker | Uses open pine savanna habitat. Breeding habitat includes open canopy, bushy understory offering ground cover, dead or down woody material, available perches and abundant insects.<br>Logged or burned pine forests are also preferred habitat for breeding.<br>Diet varies with seasonal abundance of food items, primarily selects free-living (non-wood boring) insects, acorns and other nuts, and fruit. |
| Purple Martin | Open canopy; often prefers habitat near open water; nests in tree cavities excavated by woodpeckers<br>Open mid-story cover and open understory cover.<br>Prefers high snag density and tall snags adjacent to open areas. |
| Cassin’s Finch | Nesting preference is for open coniferous forests.<br>Dry, relatively open mature ponderosa pine forest.<br>Nests tend to be placed greater than 16 feet above ground, often out on lateral branches or near the trunk within about 3 feet of tree tops. |

| PIF High Priority Species and FWS BCC | Important Habitat Features and Life History Considerations |
|---|---|
| **Aspen** | |
| Red-naped sapsucker | Preferred nest sites are live trees with heart-rot, which facilitates excavation and leaves the nest cavity enclosed in harder surrounding wood. Will also use dead trees for nesting.<br>Minimum d.b.h. for nest tree is 10 inch and minimum height is usually 15 feet.<br>Manage for groups of aspen stands of different age classes, in a larger forest complex, to ensure continual availability of older trees and snags for nesting. Use fire or silvicultural treatments to ensure continual regeneration of new stands. |
| **Pinyon-Juniper Woodland** | |
| Gray Vireo | Uses open mature pinyon-juniper woodlands, typically with a broadleaf shrub component.<br>Nests low in a small tree or shrub 2 to 6 feet above ground.<br>Fire can be used to maintain existing habitat matrix and to prevent stands from becoming too dense. |
| Pinyon Jay | Pinyon cone crop is important factor for successful breeding. Needs mature trees for cone production<br>Nests are typically 3 to 26 feet high and tend to be south-facing.<br>Pairs will renest up to 5 times in a breeding season if earlier nesting attempts fail. |
| Juniper Titmouse | Restricted to pinyon-juniper woodlands. Uses late successional pinyon-juniper woodlands.<br>Tends to favor areas with a high density of dead limbs and high degree of ground cover.<br>An obligate secondary cavity nester.<br>Nest cavity height ranges from 4 to 15 feet above ground. Nest tree d.b.h. ranges from 5 to 18 inch. |
| Black-throated Gray Warble | Primarily associated with pinyon pine and juniper woodlands in northern Arizona. Canopy cover of 13 to 26 percent in mid to late successional woodlands.<br>Breeding habitat is frequently characterized by a brushy undergrowth of scrub oak, ceanothus, manzanita, or mountain mahogany.<br>Nests are typically placed on a horizontal tree branch or near the main stem of a shrub. Nest height varies from 2 to 15 feet above ground. |
| Gray Flycatcher | Most common in larger and taller stands of pinyon pine and/or juniper with open understory.<br>May need some ground cover to support insect populations for foraging.<br>Nest are placed primarily 2 to 11 feet high in a shrub or crotch of a juniper or pinyon pine. |
| **High Elevation Grasslands** | |
| Swainson's Hawk | Stick nests constructed in scattered, lone trees within grasslands. Typical nest trees in Arizona are cottonwood, juniper, mesquite, ironwood and oak.<br>Primary feeds on insects. They also eat small mammals, lizards, and snakes, especially during breeding season.<br>Prefer open grassland for foraging, shrubs/brushy areas are not preferred habitat. |
| Ferruginous Hawk | See "Sensitive Species" section for effects to nesting habitat and to the species. |
| Burrowing Owl | See "Sensitive Species" section for effects to nesting habitat and to the species. |

| PIF High Priority Species and FWS BCC | Important Habitat Features and Life History Considerations |
|---|---|
| Grasshopper Sparrow | Prefers pure grassland habitat without trees or woody shrubs. Requires abundant thatch and dry grass for concealment. Apparent low site-fidelity. May avoid recently burned grassland sites for greater than or equal to 2 years post-burning.<br>Nests are often partially domed with dry grass and placed in a depression on the ground at the base of vegetation so the rim is nearly flush to the ground. This species often raises two broods per year.<br>Primarily feeds on insects during the breeding seasons. Grass seeds are important in colder months when insect activity is low. |
| Bendire's Thrasher | Prefers relatively open grassland with large scattered shrubs and/or trees (cholla, junipers, or sagebrush are usually present); may use dense vegetated washes or riparian areas.<br>Breeds in relatively open, degraded grasslands with a moderate to dense shrub component.<br>Nests below 6,000 feet elevation, typically 2 to 5 feet above ground in semi-desert shrubs, cacti, or trees. |

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 will not affect these habitat types.

## Ponderosa Pine Habitat Type

For the purpose of Arizona Partners in Flight (APIF), pine forest refers to northern Arizona ponderosa pine forests, including pure ponderosa pine and pine with Gambel oak (Latta et al. 1999). 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 507,839 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.

## 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.

## 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 one percent of the pinyon-juniper habitat on both forests.

### High Elevation Grasslands Habitat Type

The High Elevation Grassland habitat type is defined in APIF 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.

### 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. More than 230 avian species occur in the area. Drought is listed as the highest threat to the IBA. Other threats include: fire, invasive plants, some timber harvest projects, disturbance to birds, certain recreation activities, and water transfer through surface water abstraction. See the Arizona Important Bird Areas Program website for more information at http://aziba.org.

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.

Wildlife design features will help mitigate impacts from treatments and hauling harvested materials from other treatment areas and include:

- Bald eagle winter concentration areas, retain the tallest snags greater than 18 inch d.b.h.
- No vegetation treatments would occur within a ½ mile (2,500 feet) of an occupied bald or golden eagle nest, unless mitigated by topography, between March 1 and August 31. Other project activities would be assessed by the district biologist and limited activities may be acceptable.
- No mechanical treatments would occur around confirmed bald eagle roost sites (300’ radius around roosts on the Coconino NF).
- No project activities would occur within 500 feet of confirmed bald eagle communal roosts from October 15 – April 15.
- Raptor nests located during project surveys would be monitored prior to project activities. Known nest trees for any raptor species would be prepped prior to prescribed fire. Buffers will be provided if nests are active:

- ♦ Sharp-shinned hawk = no mechanical treatment buffer of 10 acres around occupied nests;
- ♦ Cooper's hawk = no mechanical treatment buffer of 15 acres around occupied nests;
- ♦ Osprey = no mechanical treatment buffer of 20 acres around nest sites (occupied or unoccupied) and all logging activities will be restricted within ¼ mile of active nests from March 1 to August 15;
- ♦ Other raptors = 50 feet around occupied nest;

- Great blue herons: No dominant or co-dominant trees would be cut in rookeries. Known sites will be prepped prior to prescribed fire and fire ignition mitigations would apply. Timing would avoid mechanical tree harvest while birds are in the nest. Activities would be coordinated with the local biologist.

# Other Species of Concern

## Rare and Narrow Endemic Species for the Kaibab NF

The Kaibab forest plan (USDA 2014) provides desired conditions and guideline for the protection of rare and endemic species on the forest. Most of the terrestrial species considered rare and endemic on the forest are outside the 4FRI analysis area. No further documentation is required for the following species except for Arizona black rattlesnakes (Table 50).

**Table 50. 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 | X | | Yes | Covered in the TES section |
| Apache trout | X | | No | Only found on North Kaibab ranger district |
| Arizona black rattlesnake | X | | Yes | Additional analysis provided |
| Utah Mountain kingsnake | X | | No | Only found on North Kaibab ranger district |
| Persephone's darner | X | | No | Riparian habitat required – not affected by project activities |
| Kaibab fairy shrimp | | X | No | Only found on North Kaibab ranger district |
| Kaibab variable tiger beetle | | X | No | Only found on North Kaibab ranger district |
| Kaibab Indra swallowtail | | X | No | No habitat within the analysis area |
| House Rock Valley chisel-toothed kangaroo rat | | X | No | Only found on North Kaibab ranger district |
| Kaibab least chipmunk | | X | No | Only found on North Kaibab ranger district |
| Kaibab tree squirrel | | X | No | Only found on North Kaibab ranger district |
| Kaibab northern pocket gopher | | X | No | Only found on North Kaibab ranger district |

## Arizona Black Rattlesnake

The following behavior and natural history was extracted from Bergamini et al. (2014): The Arizona black rattlesnake is almost exclusively endemic to Arizona. This species occurs at elevations ranging from about 2,900-9,900 feet. Its range roughly follows the Mogollon Rim, extending from mountains in central Mojave County, to the southern portion of Coconino County south of the San Francisco Peaks, to the White Mountains in Apache County and south to the spatially isolated mountain ranges in Cochise, Graham, Pima and Pinal counties. Populations exhibit a patchy distribution in isolated canyons and mountain ranges; the patchiness of their distribution is likely associated concomitantly with favorable habitat and suitable hibernacula.

The Arizona black rattlesnake is usually found in mesic habitats but also dry rocky slopes and rock slides. Volcanic rock outcrops and talus slopes appear to provide hibernacula at elevations between about 6,900-9,850 feet. The species is also strongly associated with downed woody debris, and this association may be more important than tree species associations

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 elevations 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. Arizona black rattlesnakes individually or communally den in hibernacula during cold, winter months, but emerge from dens and become active from late April or May to October. Ingress into dens at these sites occurred in early October; however, Arizona black rattlesnakes have been observed inside or near the opening of dens in March and in November.

In Coconino County, home ranges for males averaged 27.1 hectares with a range of 21-91.2 hectares. Females appear to have much smaller ranges than males, perhaps slightly less than 10 percent of a male's range.

4FRI 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 under the 4FRI would be protected (fencing, jackstrawing, etc.) to minimize risk of ungulate grazing post-treatment (see wildlife and soil and watershed design features). In order to protect hibernacula the following design features 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 0.25 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 if they occur within treatment area.

## Black Bears

The Coconino forest plan provides management direction for black bears and questions regarding bear habitat were identified in comments during scoping. While black bears were considered during project planning, they were not directly addressed in the draft wildlife report. Therefore, they are identified here as a species of interest. Black bears are a generalist species and, unlike other wildlife relationships such as cavity nesters and snags or pygmy nuthatches and large trees, the presence or absence of bears is not tied to a specific habitat feature. In general, bears use areas with hiding and thermal cover when traveling, bedding, and loafing. They use both closed and open areas for foraging, depending on seasonal food availability. They prefer mixed conifer forest in Arizona and appear to select against ponderosa pine, relative to its availability (LeCount and Yarchin 1990, Sitko and Hurteau 2010). Because proposed treatments do not include mixed conifer habitat we do not expect to directly affect bears. If indirect effects occur, they should largely be positive. Any movements or foraging in ponderosa pine would be enhanced by the interspersion of tree groups, including multiple design features to ensure dense tree groups are retained (LeCount and Yarchin 1990; also see Description of Alternatives below and appendix 7). In addition, hiding and thermal cover considerations have been included in all treatment alternatives (see Methodology above and appendix 9). Avoidance of diameter caps outside of MSO habitat would ensure movement towards multi-storied stands which are preferred by bears compared to “thin from below” treatments that have typically yielded single-storied stands (LeCount and Yarchin 1990). Landscape corridors with closed canopy conditions were incorporated into project planning, including corridors to facilitate wildlife movements around Flagstaff based on known black bear movements (Reif personal communications 2011, appendix 8). Obliteration of 860 miles of road would also maintain or improve bear habitat.

Black bears graze heavily in spring, particularly in wet soils that enhance grass and forb digestibility. The proposed 4FRI treatments should enhance understory production (appendix 6) and includes spring and ephemeral stream restoration where digestibility would be higher. Ants and beetles are seasonally important food and all action alternatives include guidelines for creating openings and retaining logs. Bears frequently create day beds near large trees and all action alternatives include an Old Tree Implementation Plan (appendix D of the EIS). However, alternative E would not include the 28,650 to nearly 30,000 acres of grassland restoration found in the other action alternatives. Groups of large and old trees would be retained where they occur on mollic-intergrade soils. The results of these treatments would increase foraging habitat while retaining patches of hiding and thermal cover. Hard mast is important to bears and all action alternatives include a design feature to avoid cutting Gambel oak. Management objectives in MSO habitat include retaining and creating large oak. Small oak may be lost to prescribed fire, but mast production is predominantly in the medium to large size classes (Abella 2008a and b). Bears are carnivores and the increased understory development should benefit deer and elk. If the no action alternative were selected current conditions would be maintained. A design feature was added to ensure any known maternal den sites are not disturbed during thinning operations. Because there are no direct effects and the limited use of ponderosa pine by bears makes indirect effects questionable, no cumulative effects would not be expected to occur.

## Golden Eagles

Effects to golden eagles are addressed in the Bald and Golden Eagle Protection Act sections.

# Description of Alternatives

Six alternatives were considered but eliminated from detailed study and five alternatives, including alternative A, were evaluated in detail in response to public comment (Table 51). Details on alternatives considered but eliminated from detailed study can be found in Chapter 2 of the FEIS. Alternative E was added in response to comments on the DEIS. This alternative would not require forest plan amendments. Mechanical and prescribed fire treatments would be conducted annually under the action alternatives.

The 1995 MSO Recovery Plan formed the basis of the MSO analysis for this project. It was the only Recovery Plan existing at the time of the DEIS development. Completion of the 4FRI DEIS, which was sent to the government printer in December 2012, was the culmination of about two years of developing treatment strategies, building databases, summarizing treatment effects, and analyzing model outputs. During this time some adjustments were made to alternative C, the preferred alternative, based on ongoing discussions with the FWS and the draft MSO recovery plan (USDI 2011). The Revised Recovery Plan was available shortly after the DEIS was sent to the government printer (USDI 2012b). Because of the enormity of this effort and the fact that the project was caught between recovery plans, the FWS agreed to retaining the wording and metrics of the original MSO recovery plan in the FS 4FRI documents. While the analysis below 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 MSO Recovery Plan was documented in the effects analysis of the preferred alternative and the corresponding Biological Opinion as part of consultation with the FWS (appendix 2). A crosswalk between the 1995 and 2012 MSO Recovery Plans can be found in appendix 3 of this report. Alternatives B, C, and D include plan amendments that were developed to ensure the preferred alternative (alternative C) would better match the measures in the new MSO Recovery Plan. The 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.

## Alternative A - No Action

Alternative A is the no action alternative as required by 40 CFR 1502.14(c). There would be no changes in current management; ongoing projects would continue to implement the forest plans. 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 (appendix 17). 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; see appendix C of the EIS and appendix 17 for individual project descriptions). Alternative A is the point of reference for assessing action alternatives B through E.

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 MSO 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.

## 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 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 thinning trees up to 16-inch d.b.h. within 18 MSO PACs.
- Apply prescribed fire on approximately 384,966 acres where mechanical treatment occurs and use low severity prescribed fire within 70 MSO PACs (excluding core areas).
- Manage prescribed fire only on approximately 198,364 acres.
- Construct approximately 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/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 and appendix 1). Three non-significant forest plan amendments would be required on the Coconino NF to implement alternative B:

**Amendment 1** would add language to allow mechanical treatments up to 16-inch d.b.h. to improve habitat structure (nesting and roosting habitat) in 18 MSO PACs The amendment would remove language that limits PAC treatments in the recovery unit to 10 percent increments and language that requires the selection of an equal number of untreated PACs as controls. The amendment would remove language referencing monitoring (pre and post treatment, population, and habitat monitoring). Replacement language would defer final project design and monitoring to the FWS biological opinion specific to MSO for the project. The amendment, which is specific to restricted habitat in pine-oak, would 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. 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 – 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 forests (within the treatment area). Up to two prescribed fires[1] 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) thinning trees up to 17.9-inch d.b.h. and managing for a minimum BA of 110 ft2 in 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 areas (including 54 core areas).
- Utilize prescribed fire only on approximately 155,061 acres.
- Construct approximately 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.

[1] 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.

- 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/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.
- As a result of responding to public comments, manage 38,256 acres in 1,069 stands for the low end of the proposed treatment intensity and maintaining high numbers/densities of trees 16 inches d.b.h. and larger.

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 non-significant 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-inch d.b.h. to improve habitat structure (nesting and roosting habitat) in 18 MSO PACs. These PACs would be managed for a minimum basal area of 110. It would allow low-intensity prescribed fire within 54 MSO PAC core areas. The amendment would remove language that limits PAC treatments in the recovery unit to 10 percent increments and language that requires the selection of an equal number of untreated PACs as controls. The amendment would remove language referencing monitoring (pre- and post-treatment, population, and habitat). Replacement language would defer final project design and monitoring to the FWS biological opinion specific to MSO for the project.

The amendment, which is specific to restricted habitat in pine-oak, would 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 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.

**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.

Alternatives C (and E) would actively support two research projects: (1) an effort led by AGFD and the Grand Canyon Trust testing the effects of tree group size on wildlife abundance and occupancy, and (2) an evaluation of the effects of vegetation treatments on water yield and water balance conducted by the Ecological Restoration Institute (see bullet on the Paired Watershed Study above).

The AGFD-led effort would experimentally examine the relationships between tree group size and occupancy/abundance of a variety of songbirds and small mammals, including tassel-eared squirrels. Species were selected for monitoring based on known associations with closed canopy conditions. The proposed management experiment would focus on tree groups in areas with a well-represented large tree component. It would use replicated treatment and control groups using a Before-After-Control-Impact design. Selected tree groups would include varying group sizes and tree densities. The study would: inform and refine predictive models used to assess treatment effects on species at local and broad scales; test for non-linear relationships between tree group size and occupancy/abundance of selected wildlife species; and identify potential thresholds in those relationships useful in understanding wildlife community responses to restoration.

The paired watershed study would collect comprehensive water, mass, and energy balance data from 12 watersheds in a paired watershed study design to quantify the benefits of various restoration treatments (see Soil Resource Report). Implementation of all components and instruments in the proposed would disturb a combined area of about 2.4 acres of soil within three 6th code HUC watersheds. This represents up to 0.004 percent of all soil disturbance if all instruments are deployed and implemented in the proposal. It is probable that not all the components or instruments would be implemented due to the costs associated with portions of the proposed study. Soil disturbance would not be site specific and distributed across different watersheds. All instruments would be constructed on relatively flat (less than 15 percent) slopes and located on soils with slight erosion hazard, therefore, accelerated erosion and runoff is greatly minimized. Soil erosion would not occur above threshold levels and does not pose a risk to soil productivity or water quality downstream.

Both projects were incorporated into the development and design of the silvicultural treatments. The silviculture data output reflect the effects of the research.

## 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 MSO PACs would be mechanically treated but would not be treated with prescribed fire. All other components of the alternative are the same as described in alternative B.

The Coconino and Kaibab NFs would conduct restoration activities on approximately 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 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) thinning trees up to 16-inch d.b.h. within 18 MSO PACs, and, (2) disposing of slash through various methods including chipping, shredding, mastication, and removal of biomass off-site
- Manage 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/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 non-significant forest plan amendments (see appendix B) would be required on the Coconino NF to implement alternative D:

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

The amendment, which is specific to restricted habitat in pine-oak, would 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 E

Alternative E responds to Issue 5 (Alternatives) by removing all forest plan amendments. Eighteen MSO PACs would be mechanically treated to 9-inch d.b.h. No prescribed fire would be utilized within MSO PAC core areas. No acres would be managed for an open reference condition[2]. No treatments would occur within the Garland Prairie management area. MSO population and habitat monitoring would follow current forest plan direction and the FWS biological opinion. Watershed research would occur.

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 to 60,000 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) thinning trees up to 9-inch d.b.h. within 18 MSO 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.
- Manage 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/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.
- As a result of responding to public comments, manage 38,256 acres in identified 1,069 stands for the low end of the proposed treatment intensity and maintaining high numbers/densities of trees 16 inches d.b.h. and larger (this represents no change to the current Coconino NF forest plan).

[2] 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.

**Table 51. Summary of action alternatives**

| Proposed Activity | Alternative A (No Action) | Alternative B (Proposed Action) | Alternative C (Preferred Alternative) | Alternative D | Alternative E |
|---|---|---|---|---|---|
| Vegetation Mechanical Treatment (acres) | 0 | 384,966 | 431,049 | 384,966 | 403,500 |
| Prescribed Fire (acres)* | 0 | 583,330 | 586,110 | 178,441 | 581,301 |
| MSO PAC Habitat Treatments | 0 | Mechanically treat up to16-inch d.b.h. in 18 PACs (excluding core areas)<br>Utilize prescribed fire in 70 MSO PACs (excluding core areas) | Mechanically treat up to18-inch d.b.h. in 18 PACs. Utilize prescribed fire in 54 MSO PACs (including core areas)<br>Utilize prescribed fire in 16 MSO PACs (excluding core areas) | Mechanically treat up to 16-inch d.b.h. in 18 PACs (excluding core areas)<br>Utilize prescribed fire in 70 MSO PACs (excluding core areas) | Mechanically treat up to 9-inch d.b.h. in 18 PACs (excluding core areas)<br>Utilize prescribed fire in 70 MSO PACs (excluding core areas) |
| Total Grassland Treatments: | 0 | 56,590 | 104,532 | 56,590 | 47,880 |
| Within existing grasslands | 0 | 0 | 48,161 | 0 | 48,161 |
| Restoration within existing forest | 0 | 11,185 | 11,230 | 11,185 | 0 |
| Savanna restoration | 0 | 45,405 | 45,142 | 45,405 | 0 |
| Springs Restored (number) | 0 | 74 | | | |
| Springs Protective Fence Construction (miles) | 0 | Up to 4 | | | |
| Aspen Protective Fencing (miles) | | Up to 82 | | | |
| Ephemeral Stream Restoration (miles) | 0 | 39 | | | |
| Temporary Road Construction and Decommission (miles) | 0 | 520 | | | |

| Proposed Activity | Alternative A (No Action) | Alternative B (Proposed Action) | Alternative C (Preferred Alternative) | Alternative D | Alternative E |
|---|---|---|---|---|---|
| Road Reconstruction/ Improvement (miles) | N/A | Up to 30 | | | |
| Road Relocation (miles) | N/A | Up to 10 | | | |
| Existing Road Decommission (miles) | N/A | 726 | | | |
| Unauthorized Route Decommission (miles) | N/A | 134 | | | |

*Two fires would be conducted over the 10-year period on acres proposed for prescribed fire.

## Actions Common to Alternatives B–E

All action alternatives (B–E) propose restoration of springs and ephemeral channels and restoring or improving aspen stands, and grasslands, savanna, and meadows. Although small in scale, restored springs, ephemeral channels, meadows, and aspen provide greater herbaceous biomass relative to the currently common, closed canopy conditions that dominant the ponderosa pine forests. These microhabitats occur as islands within the greater ponderosa pine forest and can provide concentrated areas of water, food, and cover for MSO prey species. Proposed spring and ephemeral stream channel restoration treatments are the same in all alternatives. Twenty three springs (29 percent) are in MSO habitat, including protected and restricted habitats. Nearly five miles of ephemeral stream channel restoration is proposed within MSO habitat.

Grassland mechanical treatments would occur in existing grasslands (mollisol soils) and include mechanical and prescribed fire combined or prescribed fire-only treatments. Objectives for grassland mechanical treatments would include removal or reduction of litter and removal of encroaching trees. Restoration treatments would use both mechanical tree removal and prescribed fire to return currently treed stands to an open reference condition. Fire objectives in restoration treatments would include deliberate tree mortality intended to restore the function of the meadow and grassland habitat.

The restoration of springs, ephemeral channels, grasslands, savanna, and meadows, and aspen stands would support herbaceous understory at local (e.g., springs) and mid-scale (e.g., grasslands and savannas) patches. Aspen could contribute to understory development at both scales. Combined with the forest interspace and canopy gaps and prescribed fire, this would create an interconnected network of habitat for arthropods. Supporting diverse arthropod communities would benefit native pollinators like bumblebees (*Bombus* spp) and monarch butterflies (*Danaus plexippus*). It would also support herbivores, insectivores, omnivores, and eventually carnivorous species including MSO and goshawks.

Aspen treatments would occur in protected and restricted habitat. Approximately 1,177 acres of aspen occur in MSO habitat within the treatment area. Treatment objectives vary from aspen improvement using prescribed fire-only in PACs to aspen restoration using mechanical tree removal and prescribed fire to restore habitat function in restricted habitat. Aspen restoration would include post-settlement conifer removal inside aspen clones and within 100 feet surrounding treated clones. Some removal of aspen and ground disturbing activities may occur to stimulate suckering. Each clone would be evaluated as to the need for fencing or creation of other barriers to reduce ungulate browsing of regenerating aspen. The 4FRI aspen treatments would meet the intent of the aspen objective as described in the priority habitats description in the Intermountain West Joint Ventures northern Arizona bird conservation plan (IWJV 2005). Aspen restoration would improve overall habitat diversity for MSOs.

Outside of a wildlife-urban interface area, pinyon-juniper treatments include direction for evaluating the community before developing prescriptions to ensure desired conditions are met, including retention of mature tree groups, habitat components like snags and logs, and development of the herbaceous growth (silviculture report). In addition to maintaining overstory structure, additional considerations include providing for habitat diversity such as openings and travel corridors.

All action alternatives incorporate key components of the Old Tree Implementation Plan into the alternative’s design features (volume 1 of the FEIS, appendix C), implementation plan (volume 1 of the FEIS, appendix D), and monitoring and adaptive management plan (volume 1 of the FEIS, appendix E). The Forest Service worked collaboratively with stakeholders to develop the final monitoring and adaptive management and implementation plan. All action alternatives include monitoring and adaptive management actions that would be implemented as needed.

## 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 CWD. 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. (2007) 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 MSO habitat in both the short- and long-term. However, it can also modify and/or destroy key habitat components that comprise MSO 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 MSO habitat by creating canopy gaps and enriching soils. However, impacts to MSO habitat could also create adverse effects.

## Design Features, Best Management Practices, and Mitigation

Applicable forest plan desired conditions, standards and guidelines, Best Management Practices, Forest Service Manual and Handbook direction, and an adaptive management component will be incorporated in project design and implementation. Additional vegetation design features result from the 4FRI being an ecologically based project with partial funding from the Collaborative

Forest Landscape Restoration Program (Pub. L. 111-11 Title IV March 30, 2009). This program is a science-based ecosystem restoration effort for treatments on National Forest system lands. As such, the intent of the Recovery Plan would be met through pro-active design rather than after the fact mitigation. See appendix C of the FEIS for a complete list of design features and associated BMPs.

Design features guiding project implementation in all treatment types include:

- Treatments designed to move vegetation toward the desired condition as outlined in the Coconino NF and Kaibab NF forest plans.
- Treatments designed to create tree groups and interspaces that stimulate grass, forbs and increase residual tree growth.
- Priority location for interspace would be in currently non-stocked areas and in areas that lack pre-settlement evidence.
- Treatments designed to manage for old age trees and maintain old forest structure across the landscape. Old trees would not be targeted for cutting. Action alternatives would incorporate the “old tree implementation plan” developed by the 4FRI collaborative group.
- Treatments designed to decrease the potential for undesirable fire behavior and effects.
- Prescribed fires designed to maintain desired forest structure, tree densities, snag densities and CWD levels.
- Treatments would focus on reducing the most abundant tree size classes and maintaining the under-represented tree size classes in order to achieve and/or set the project area on the trajectory to attain greater diversity (heterogeneity) in spatial patterns and size class distribution.
- Snags would be managed to meet forest plan requirements and move towards desired conditions.
- Live conifer trees with potential to provide habitat for cavity nesting species (dead tops and lightning strikes) would be favored for retention.
- Course woody debris (CWD) would be managed to meet applicable forest plan direction.
- Gambel oak, juniper and pinyon species greater than 5 inch d.r.c. may be considered as residual trees in the target group spacing and stocking.
- The 3 forest weed FEIS has been incorporated into the 4FRI to help ensure accelerated understory development contributes to ecosystem function (botany report).

## Design Features Common to all Treatment Types within MSO Habitat

Spotted owl research has shown occupancy and nest success tied to the amount of large, old trees present (May and Gutierrez 2002, May et al. 2004, Blakesley et al. 2005). Site occupancy was negatively associated with an abundance of medium-sized trees (Irwin et al. 2004, Blakesley et al. 2005). Owl occupancy, nest success, and abundance of prey species have been associated with large Gambel oak trees (May and Gutierrez 2002, May et al. 2004, USDA 2010a). Uncharacteristically dense forests also increase the risk of high-severity fire in owl habitat (Everitt et al. 1997). Agee (2002) recommended treating vegetation to reduce flame lengths of surface fires and raising the live canopy base height. Both actions would reduce the risk of surface fires becoming crown fires. He noted that doing nothing in owl habitat is a choice of action given the increasing pattern of increasing large, high-severity fires in dry forest types. Mechanical thinning and prescribed fire treatments were designed to meet the objectives of the respective MSO habitat classification under consideration.

The following design features have been incorporated into alternative development as have site-specific features listed in Table 52.

- Manage for 15 percent or more of the SDI in ponderosa pine trees between 12 and 18 inch d.b.h., 15 percent or more of the SDI in ponderosa pine trees between 18 and 24 inch d.b.h., 15 percent or more of the SDI in ponderosa pine trees greater than or equal to 24 inch d.b.h., and greater than or equal to 20 TPA greater than or equal to 18 inch d.b.h.
- No trees 24 inches d.b.h. or larger would be removed.
- Manage for snags greater than or equal to 12 inch d.b.h. with an emphasis on snags greater than or equal to 18 inch d.b.h. and down logs greater than or equal to 12 inch.
- Gambel oak, juniper and pinyon species would not be cut as part of the treatments. These species may only be cut as necessary to facilitate logging operations (skid trails and landings).

Designated core areas would not receive mechanical treatments. Outside core areas, trees may be thinned in selected PACs. The following vegetation design features would apply to PACs:

- Thinning objectives would be the release of large pine and Gambel oak from uncharacteristic densities of young pine trees, reduce fuels and mitigate fuel hazards where feasible, release young oak, move stands towards uneven-aged conditions, and improve prey habitat
- In stands where thinning has been identified as potentially improving MSO habitat, each stand within each PAC treated would have an upper diameter limit ranging from 9 to 18 inches d.b.h., depending on alternative And the stand itself. All trees above that limit would be retained
- Treatments are designed to increase residual tree health and vigor and maintain greater than or equal to 150 BA where present (110 minimum BA in alternative C)
- Irregular tree spacing would be used to create canopy gaps to move toward or facilitate stand conditions that improve forest resiliency and create conditions more conducive to low severity prescribed fire treatment. Canopy gaps would enhance understory development and enhance prey habitat
- Low severity prescribed fires to treat fuels and mitigate fuel hazards would be conducted where feasible. The objectives of prescribed fires in PACs are to reduce surface fuels and raise canopy base height. Results would include reduced surface fire intensity and flame lengths, thereby reducing the potential for crown fire and high-severity surface fire. Prescribed fire would reduce CWD, total oak BA, and snags, but these losses would be mitigated through burn prescriptions, ignition techniques, or other techniques.

Treatments in target and threshold habitat were designed to maintain existing elements of MSO habitat where they exist and move forests towards those habitat features where they are lacking. Treatments are designed to be in accord with Recovery Plan objectives by retaining oak and large trees, improving MSO habitat through increased tree growth rates, increased stand resiliency, improved prey habitat, and reduced risk of undesirable fire behavior and effects. **Treatments in target and threshold habitats are designed to achieve the following:**

- Increase residual tree health and vigor and reduce the potential for undesirable fire behavior and effects through intermediate thinning
- maintain, where present, BA greater than or equal to 150, with a portion of the acres totaling 170 or greater BA
- Irregular tree spacing would be used to create canopy gaps to move toward or facilitate stand conditions that may be more conducive to low severity fire and to provide food and cover for prey species
- At least 20 trees or more per acre measuring 18 inches d.b.h. or greater would be retained or moved towards that goal in shorter timeframes than if left untreated

Treatments are designed to achieve the following in MSO **restricted habitat outside of target and threshold habitats:**

- Develop uneven-aged forest structure, irregular tree spacing and variable patch size by thinning tree groups and establishing interspace openings adjacent to tree groups to improve forest resiliency; these actions will move forest structure towards the historical range of variation and move towards or create stand conditions more conducive to low-severity fire.
- Crown spacing between tree groups (interspace) would average 25 to 60 feet distance, providing for forest health, prey habitat development, and to move towards or facilitate stand conditions more conducive to low severity fire.
- On average, tree groups would range from 0.1 to 1 acre in size; northerly aspects and highly productive microsites would have larger average group sizes compared to southerly aspects.
- Tree thinning on southerly aspects would target 60 to 80 BA; thinning on northerly aspect would target 80 to 100 BA. The goal is manage for a sustainable range of density and structural characteristics.
- In order to recruit new age classes and move towards or maintain uneven-aged conditions, regeneration openings would be created on 10 to 20 percent of the area; openings would average 0.3 to 0.8 acres in size. However, in specific areas where ponderosa pine mistletoe infections are heavy, openings may extend up to 4 acres.
- Manage for uneven-aged conditions by retaining individual trees and clumps of vigorous ponderosa pine seedlings, sapling and poles within larger mid-aged, mature or old tree groups.
- Manage moderate to heavy dwarf mistletoe infection centers that are not intended for regeneration openings for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees with the least amount of mistletoe to retain current habitat diversity through time.
- No trees greater than 24 inches d.b.h. would be cut and existing old growth attributes would be retained
- To maintain and develop large Gambel oak trees, conifers up to 18 inches d.b.h. that do not meet the “old tree” definition would be removed within 30 feet of oak greater than or equal to10 inches d.r.c. to reduce competition for moisture, nutrients, and sunlight from ponderosa pine trees established after wildfire was limited or eliminated from the landscape.
- Low severity prescribed fire to treat fuels and mitigate fuel hazards would be conducted where feasible. The objectives of prescribed fires in PACs are to reduce surface fuels and raise canopy base height, thereby reducing flame length and surface fire intensity. Prescribed

fire would reduce CWD, total oak BA, and snags, but these losses would be mitigated through burn prescriptions, ignition techniques, or other techniques.

The following features are design elements that further detail management actions, mitigate environmental consequences, and establish priorities for implementation relative to wildlife (Table 52). Environmental consequences have been evaluated with all features, practices, and mitigation considered.

**Table 52. Wildlife design features incorporated into 4FRI implementation planning**

| Species | Location | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| Wildlife associated with old tree characteristics | 4 FRI treatment area | The stakeholder-developed old tree implementation plan was incorporated into all action alternatives, the implementation plan and the monitoring and adaptive management plans. | Silviculture | No |
| Mexican Spotted Owl | Restricted and protected habitat | Survey all potential spotted owl areas including protected, restricted, and other forest and woodland types within the implementation area plus the area 1/2 mile beyond the perimeter of the proposed treatment area. Surveys in the year of implementation or one year prior to determine if new areas are occupied by owls. | Silviculture | Yes |
| Mexican Spotted Owl | Restricted and protected habitat | Establish a protected activity center at all new Mexican spotted owl sites located during project surveys | Silviculture and Fire | Yes |
| Mexican Spotted Owl | Restricted and protected habitat | All contractors associated with project implementation, research, or restoration activities would be briefed on MSOs, reporting sightings, avoid harassing owls, and are informed as to who to contact and what to do if an owl is incidentally harmed or found injured or dead. | Silviculture and Fire | Yes |
| Mexican Spotted Owl | Protected Activity Centers | Coordinate and implement management activities within PACs to reduce potential disturbance and minimize the frequency and duration of operations within and immediately adjacent to these areas. | Silviculture and Fire | Yes |
| Mexican Spotted Owl | Restricted and protected habitat | Trees greater than 24 inch d.b.h. would not be harvested. | Silviculture | Yes |
| Mexican Spotted Owl | Restricted and protected habitat | Develop and implement a monitoring plan in coordination with the FWS designed to evaluate the effects of thinning and prescribed fire on owls as described in the MSO Recovery Plan (see Appendix E). | Monitoring | Yes |

| Species | Location | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| Mexican Spotted Owl | Restricted and protected habitat | Pre-and post-treatment habitat monitoring would occur in MSO restricted and protected habitat to ensure retention or development of desired habitat conditions (see Appendix E). | Monitoring | Yes |
| Mexican Spotted Owl | Protected Activity Centers | Spring restoration will not occur during the breeding season (March 1 to August 31), if occupied, in Rocktop, Sawmill Spring, Red Raspberry and Weimer Spring PACs (i.e., 5 out of 74 proposed spring restoration sites will be affected). | Watershed | Yes |
| Mexican Spotted Owl | Protected Activity Centers | Ephemeral stream restoration will not occur during the breeding season (March 1 to August 31), if occupied, in Bear Seep, Clark, Holdup, Coulter Ridge and Meadow Tank MSO PACs. | Watershed | Yes |
| Mexican Spotted Owl | Protected Activity Centers | Temporary road construction, obliteration, relocation, and maintenance would not occur during the breeding season (March 1 to August 31) if occupied. | Engineering | Yes |
| Mexican Spotted Owl | Protected Activity Centers | No treatments would occur in PACs during the breeding season (March 1 to August 31) if occupied. | Fire and Silviculture | Yes |
| Mexican Spotted Owl | Protected Activity Centers | Hauling will generally avoid PACs during the breeding season (March 1 to August 31) unless specific analysis has documented that impacts will not lead to adverse effects. If hauling does occur in a PAC during nesting season vehicles would remain greater than or equal to 0.25 miles from cores areas and trucks would drive less than or equal to 25 miles per hour in PACs. | Silviculture | Yes |
| Mexican Spotted Owl | Protected Activity Centers | No new wire fencing will be constructed in PACs to minimize the risk of owls colliding with new fences. Other alternatives will be used for aspen, seep, spring and ephemeral drainage restoration exclosures. Alternatives will be coordinated with other specialists. If suitable alternatives cannot be identified restoration work will be postponed. | Watershed and Silviculture | No |
| Mexican Spotted Owl | Protected Activity Centers | Coordinate burning spatially and temporally to limit smoke impacts to nesting owls, particularly for PACs with nests in low-lying area (Effective March 1 to August 31). | Fire | Yes |
| Mexican Spotted Owl | Protected Activity Centers | All stands included in the proposed mechanical treatments for 18 PACs would be marked for harvest by hand and marking would be coordinated with the US Fish and Wildlife Service | Silviculture | No |

| Species | Location | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| Mexican Spotted Owl | Protected Activity Centers | Fireline associated with preventing fire from entering PACs and/or core areas will be constructed outside the nesting season. Alts B D and E. | Fire | Yes |
| Mexican Spotted Owl | Protected Activity Centers | Nest trees will be protected in the design and implementation of prescribed fires. | Fire | Yes |
| Mexican Spotted Owl | MSO Habitat | Burn plans in MSO habitat will include mitigations to minimize smoke impacts to nesting birds. | Fire | Yes |
| Mexican Spotted Owl | MSO habitat | Implementation would be phased in across the landscape so that not all MSO Habitat would be treated in 1 year | Fire and Silviculture | Yes |
| Mexican Spotted Owl | MSO habitat | Meet annually with the FWS to discuss planned management activities, review past activities in MSO habitats, and report any known incidental take in the project area. These results will also be provided in a written annual report. | Wildlife | Yes |
| Mexican Spotted Owl & Northern Goshawk | PACs, target, threshold, and PFAs | No old trees would be cut during rehabilitation of temporary roads. | Engineering | No |
| Northern Goshawk | Nest Stands | Burn plans covering areas with nesting goshawks and/or known nest trees will include mitigations to minimize smoke impacts to nesting birds and nest trees will be protected. | Fire | Yes |
| Northern 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. | Fire | Yes |
| Northern Goshawk | Nest Stands | Mechanical treatments will not occur within nest stands, or within replacement nest stands. | Silviculture | No |
| Northern Goshawk | Post-Fledging Family Areas | Harvest Activities will not occur in occupied PFAs during the breeding season unless specific analysis has documented impacts will not trend to listing or loss of viability. PFAs can be cleared for treatment if pre-treatment surveys determine the area is no longer occupied. | Silviculture | Yes |

| Species | Location | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| Northern Goshawk | Post-Fledging Family Areas | 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 to September 30) if occupied. However, work could potentially occur on an individual basis through coordination with the District biologist if specific analysis has documented that impacts will not trend to listing or loss of viability. | Watershed | Yes |
| Northern Goshawk | Post-Fledging Family Areas | Hauling will not occur within pfas during the breeding season (March 1 through September 30) unless monitoring determines the pfa is not occupied. Exceptions are the Devil Dog PFA (030701015), Barney PFA (030701011), and Black Mesa Tank PFA (030701017) in which there would be no timing restrictions. | Silviculture | No |
| Northern Goshawk | Post-Fledging Family Areas | Logging trucks will not exceed 25 miles per hour when traveling through PFAs during the breeding season (March 1 to September 30). | Silviculture | No |
| Northern Goshawk | Post-Fledging Family Areas | Road construction, obliteration, relocation, and maintenance would not occur during the breeding season (March 1 to September 30) if occupied. | Engineering | Yes |
| Northern Goshawk | Post-Fledging Family Areas | Created openings will not exceed 2 acres in goshawk PFAs | Silviculture | No |
| Northern Goshawk | Home range | Burn units will not include more than 5,000 acres of a goshawk pair's home range as per applicable forest plan guidance. | Fire | Yes |
| Bald Eagles | Bald eagle winter concentration areas | Retain the tallest snags greater than 18 inch d.b.h. | Silviculture and Fire | Yes |
| Bald Eagles | Nest sites | No mechanical treatments will occur within a 300 feet radius of bald eagle nest trees (there are 3 bald eagle nest within 300 feet of the project analysis boundary). | Silviculture | Yes |

| Species | Location | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| Bald and Golden Eagles | Nest sites | No vegetation treatments would occur within a buffer of up to ½ mile (2,500 feet), unless mitigated by topography, of an occupied bald or golden eagle nest between March 1 and August 31 (there are 3 bald eagle nests and 19 golden eagle nests within a ½ mile of the project analysis area). Other project activities will be assessed by the district biologist and limited activities may be acceptable. | Silviculture and Fire | Yes |
| Bald and Golden Eagles | Nest sites | Burn plans within subunits 1-1, 1-3, 3-5 and 5-2 will be coordinated with the district wildlife biologist to insure nesting eagles will not be adversely impacted from smoke | Fire | No |
| Bald Eagles | Winter Roost sites | No mechanical treatments will occur around confirmed bald eagle roost sites (300 feet radius around roosts on the Coconino NF and a 10 chain radius on the Kaibab NF). | Silviculture | Yes |
| Bald Eagles | Communal Roost sites | No project activities will occur within 500 feet of confirmed bald eagle communal roosts from October 15 – April 15. | Silviculture and Fire | Yes |
| Bald Eagles | Winter Concentration Areas | Retain the tallest snags with diameters greater than or equal to 18 inches. | Silviculture and Fire | Yes |
| Condor | Treatment Area | All contractors will be instructed to avoid interacting with condors and to immediately contact the appropriate FS personnel if occurs in the project area. Sighting locations will be forwarded to the Peregrine Fund and the USFWS. | Potentially all on-the-ground activities | Yes |
| Condor | Treatment Area | Any project activity that may cause imminent harm to condors will temporarily cease until permitted personnel determine the correct course of action. | Potentially all on-the-ground activities | Yes |
| Condor | Treatment Area | Project-related work areas will be kept clean (e.g., trash disposed of, scrap materials picked-up, etc.) in order to minimize the possibility of condors accessing inappropriate materials. The FS will complete site visits to ensure clean-up is adequate. | Potentially all on-the-ground activities | Yes |
| Condor | Treatment Area | A hazardous material spill plan will be developed and implemented with details on how each hazardous substance will be treated in case of leaks or spills. | Potentially all on-the-ground activities | Yes |

| Species | Location | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| Condor | Treatment Area | Pesticide use will follow the guidelines for California condors as described in the April 2007 Recommended Protection Measures for Pesticide Applications in Region 2 of the U.S. Fish and Wildlife Service. | Potentially all on-the-ground activities | Yes |
| Turkey | Foraging and roosting cover | Retain medium to high canopy cover in ponderosa pine stringers in the pinyon-juniper transition zone and retain clumps of large and old trees along ridges and slopes above the pine and pinyon-juniper transition zone. Target low severity fire to retain yellow pine and roosting cover. | Silviculture and Fire | Yes |
| Great blue herons | Rookeries | No dominant or co-dominant trees will be cut in rookeries. Nest trees will be prepped prior to implementing prescribed fire and ignition mitigations will apply. Timing will avoid mechanical tree harvest while birds are in the nest. Activities will be coordinated with the local biologist. | Silviculture and Fire | No |
| Other raptors | Nest sites | Forest plan direction will be met for all raptor species:<br>Raptor nests located during project surveys will be monitored prior to project activities. Known nest trees for any raptor species would be prepped prior to implementing prescribed fire. Forest plan buffers will be provided if nests are active:<br>Sharp-shinned hawk: no mechanical treatment buffer of 10 acres around occupied nests;<br>Cooper's hawk: no mechanical treatment buffer of 15 acres around occupied nests;<br>Osprey: no mechanical treatment buffer of 20 acres around nest sites (occupied or unoccupied) and all logging activities will be restricted within ¼ mile of active nests from March 1 to August 15; Use site specific analysis to determine no-treatment zone around nest site; restrict activities within ¼ mile of nest sites from March 1 to August 15; | Silviculture and Fire | Yes |

| Species | Location | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| | | American Peregrine falcons: Restrict human activities within approximately one-half (½) mile of occupied peregrine falcon nest sites March 1st through August 15th. The ½ mile protection distance may vary depending on local topography, potential for disturbance, and location of important habitat components. Coordinate with local biologist to monitor peregrine nesting success to determine if restrictions are effective.<br>Other raptors: 50 feet buffer around occupied nests would be left uncut. | | |
| Deer | Known fawning areas | Because of declining trends in populations, defer logging activities between June 15 and August 31. | Silviculture | Yes |
| Pronghorn | Migration routes | Avoid thinning and burning in the east-west seasonal travel way on the Williams RD during the 1st major snowfall of a given year to allow for unimpeded seasonal migration | Silviculture and Fire | No |
| Pronghorn | Fawning Habitat | Prescribed fire in Garland Prairie would not occur during May when most fawning occurs (see appendix 10). | Fire | No |
| Black-footed Ferrets | Prairie dog towns | Prairie dog surveys would be completed in documented prairie dog towns within treatment areas to determine if towns are active. If active towns form a large enough complex to support ferrets, black-footed ferret surveys will be completed prior to implementation within prairie dog towns. Coordinate with local biologists. | Silviculture and Fire | ESA Compliance |

| Species | Location | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| Bats | Caves and sink holes | A 300-feet no mechanical treatment buffer would be designated around 34 cave entrances and around sink hole rims (i.e., karst) to protect cave ecosystems from siltation, protect human health and safety, and reduce potential disturbance to roosting bats. Existing roads could be used for mechanical harvest but no new skid trails would be created. Ignition and other management actions associated with prescribed fire would maintain existing vegetation patterns and follow forest plan guidance for snags and logs while reducing potential for undesirable fire behavior and effects. The intent is to avoid changing the cave/karst microclimate, (including altering vegetation near the inside and outside of the entrance/rim), hydrology, and prevent sedimentation while reducing surface fuels. | Silviculture and Fire | Yes |
| Tassle-eared Squirrels | Nest Stands | Operators would avoid felling trees with active squirrel nests | Silviculture | No |
| Northern Leopard Frogs | Designated occupied/ critical breeding sites (6 sites) | A no-treatment buffer (no thinning, no direct ignition) ¼ mile distant from tanks or designated along logical topographic breaks (appendix 16). In some cases, the district wildlife biologist may work with implementation teams to determine the habitat protection buffer boundary | Silviculture and Fire | Yes |
| Northern Leopard Frogs | Potential breeding sites | Seasonal restrictions (April 15 through September 15) for all proposed activities will be implemented within a 200 feet buffer (or along logical topographic breaks) at all designated important water sites (i.e., 10 sites in RU 1; appendix 16). In some cases, the district wildlife biologist may work with implementation teams to determine the habitat protection buffer boundary. | Silviculture and Fire | Yes |
| Northern Leopard Frogs | Dispersal habitat | A 200-feet protection zone (100 feet either side of the stream) will be established around designated stream courses (appendix 16). There would be no thinning and no direct ignition within the protection zones. Designated skid trail crossings through the buffer zone are allowed. Fall burning and burn plans should be coordinated with district wildlife biologists in Subunits 1-2, 1-4, 1-5 and 1-6. | Silviculture and Fire | Yes |

| Species | Location | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| Northern Leopard Frogs | Designated occupied/ critical breeding sites (6 sites) | Mechanized equipment would avoid wetted soils in northern leopard frog habitat unless decontamination practices for Chytrid are employed first. | Silviculture and Fire | No |
| Northern Leopard Frogs | Springs identified for restoration | Springs would be surveyed prior to implementation of restoration activities | Watershed | No |
| Northern Leopard Frogs | Open waters | Do not use tanks for water sources that are known to have populations of northern and Chiricahua leopard frogs as water sources for prescribed fire activities. Activities in and around natural or constructed waters will use decontamination procedures to prevent the spread of chytrid (Bd) fungus and other invasive aquatic species, unless an evaluation by a forest biologist determines it unnecessary. | Fire | Yes |
| AZ Black Rattlesnake | Occupied den sites | Avoid management practices with potential to impact to hibernacula. | Silviculture and Fire | Yes |
| AZ Black Rattlesnake | Occupied den sites | Avoid temporary road construction within 300 feet of identified hibernacula locations. | Engineering and Silviculture | Yes |
| AZ Black Rattlesnake | Within ¼ mile of occupied den sites | Conduct prescribed fires from November 1 to March 31 (denning season) within ¼ mile of den sites to minimize impacts to snakes. Avoid prescribed fire within ¼ mile of dens outside the denning season. | Silviculture and Fire | Yes |
| AZ Black Rattlesnake | Within ¼ mile of occupied den sites | 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 Rattlesnake from April 1 to September 30 | Fire | Yes |
| General | Dependable waters | Do not create interspaces and openings where hiding cover exists near dependable waters identified by the Arizona Game and Fish Department (e.g. stock tanks, lakes, and riparian stream reaches) and through implementation of watershed BMPs. | Silviculture and Fire | Yes |
| General | Snags & logs | Protect snags and logs wherever possible by placing landings in existing openings or in areas where snags and/or logs, and old trees would be minimally impacted. | Silviculture | Yes |

| Species | Location | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| General | Snags & logs | Protect/provide snags and logs wherever possible through site prep, implementation planning, green tree selection, and ignition techniques to retain greater than 2 snags per acre greater than or equal to 30 feet high and greater than or equal to 18 inch d.b.h. + greater than or equal to 3 logs greater than or equal to 8 feet long and greater than or equal to 12 inch mid-point diameter + 5-7 tons of CWD (greater than 3 inch diameter) per acre in pine and pine-oak habitat. | Silviculture and Fire | Yes |
| General | Snags | Retain trees greater than or equal to 18 inch d.b.h. with dead tops, cavities, and lightning strikes wherever possible to provide cavity nesting/foraging habitat (i.e., the living dead) in ponderosa pine habitat. | Silviculture and Fire | No |
| General | Snags & logs within the pinyon-juniper cover type | Snags would be managed for at least 1 per acre over 75 percent of the area (current direction is 1 per acre over 65 percent of the area) and course woody debris would be managed for an after treatment average of 1 - 3 tons per acre. Where available, woody debris would include 2 logs greater than or equal to 10 inches mid-point diameter and greater than or equal to 10 feet in length. | Silviculture and Fire | No |
| General | Snags | Emphasize retention of snags exhibiting loose bark to provide habitat for roosting bats. | Silviculture and Fire | No |
| General | VSS 4s, 5s, & 6s | Within Group Density - - Manage mid-aged tree groups for a range of density and structural characteristics by thinning approximately 50 percent of the mid-aged groups to the lower range of desired stocking conditions, approximately 20 percent each to the middle and upper range of desired stocking conditions and approximately 10 percent remain unthinned. | Silviculture | No |
| General | VSS 4s, 5s, & 6s | Within Group Structure - Enhance and maintain mid-aged, mature or old group structure by retaining individual and clumps of vigorous ponderosa pine seedlings, sapling and poles within the larger group | Silviculture | No |

| Species | Location | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| General | Wildlife cover and stand heterogeneity in ponderosa pine cover type | Gambel oak, juniper and pinyon species would not be cut with the following exceptions: seedling/sapling, young and mid-aged pinyon and juniper up to 11 inch DRC may be cut within a 50 feet radius of individual or groups of old ponderosa pine (as defined in the old tree implementation strategy); and when there is no other option to facilitate logging operations (skid trail and landing locations). Gambel oak, juniper and pinyon species greater than 5 inch d.r.c. (diameter root collar) may be considered as residual trees in the target group spacing and stocking.<br>Manage for large oaks (10 inch d.r.c. or larger) by removing ponderosa pine up to 18 inch d.b.h. that do not meet the “old tree” definition and do not have interlocking crown with oaks and occur within 30 feet of base of oak 10 inch d.r.c. or larger:<br>In areas of savanna restoration and WUI PJ mechanical treatment, seedling/sapling, young and mid-aged pinyon and juniper may be cut. | Silviculture | No |
| General. | Burn Plans & Ignition techniques | Apply fire prescriptions to maintain Forest plan levels of coarse woody debris and to maintain the sage in the understory community in pine-sage habitat. | Fire | CWD = Yes<br>Sage = No |
| General | Burn Plans | Ensure that the potential cumulative effects of multiple fires burning in a given area do not produce negative effects to local wildlife; coordinate burning between administrative units and between wildlife and fire management to minimize potential disturbance. | Fire | No |
| General | Mixed conifer | 4FRI activities will not include mechanical or fire treatments in mixed conifer habitat. Mixed conifer stands occurring as inclusions within ponderosa pine forest will not be treated, (e.g., nest and roost buffers in Bear Seep and Red Raspberry PACs). Similarly, islands of pine occurring within mixed conifer forest will not be treated. For example, the MSO PAC on Sitgreaves Mtn was dropped from treatment consideration; although there are contiguous stands of ponderosa pine within the PAC, they are surrounded by mixed conifer forest. | All | No |

| Species | Location | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| Black bears | Occupied den sites | Defer logging in a ¼ mile radius around known den sites from April 15 to June 30. | Silviculture | Yes |

# Assumptions Used to Evaluate No Action and Action Alternatives Common to All Species Analyses

Unknown or open-ended elements of the project had to be defined to facilitate the analysis alternative effects. The following assumptions were identified and agreed to by the IDT:

- Grazing management would be in compliance with the respective Annual Operating Plan and Allotment Management Plan
- AGFD would adjust harvest levels where elk impacts hinder meeting resource objectives
- “Short Term” would be 1 to 10 years in length
- “Long Term” would, in general, be 11 to 30 years, unless under specific circumstances, it is defined differently
- The probability of uncharacteristically large high-severity wildfires would continue to increase in light of climate change and if no action occurred under the 4FRI
- Understory development would be maximized if BA is less than or equal to 50 $ft^2$/ac

Treatment effects have been modeled and assessed in the following manner:

- Forest stand characteristics were equilibrated for the year 2010, therefore 2010 represents time zero in modeling (i.e., “existing conditions”)
- Mechanical treatments would be complete within a 10-year period and would average 45,000 acres treated per year, the modeled year for tree cutting was 2012
- VSS 1 resulting from group selection would move to VSS 2 in year 2040 and from VSS 2 to VSS 3 in year 2060
- The 1st prescribed fire would occur in 2015 after mechanical treatments are completed; the 2nd (maintenance) prescribed fire would occur in 2019; on average, 40,000 to 60,000 acres of prescribed fire would be implemented annually within the treatment area; note that aspen was modeled as only burning once (in 2012)
- Post-treatment vegetation condition trends would be displayed in 2020, 2030, and 2050
- Trees 18 inches d.b.h. and larger are assumed to be old
- No trees 24 inches d.b.h. or larger would be cut in any type of MSO habitat
- 15 percent of the bole wood and 10 percent of the branch wood would be left on site
- Snag and coarse wood estimates are based on inventory where available or FVS default values (adjusted for southwest forests) if data does not exist
- Prescribed fire in PACs was modeled for lower fire severity
- The old tree implementation plan developed by the 4FRI collaborative group was incorporated into all alternatives

- The large tree implementation plan developed by the 4FRI collaborative group was incorporated into alternatives C and E

In the ponderosa pine, Gambel oak, juniper and pinyon species would not be cut with the following exceptions: seedling/sapling, young and mid-aged pinyon and juniper up to 11 inch DRC may be cut within a 50 feet radius of individual or groups of old ponderosa pine (as defined in the old tree implementation strategy); and when there is no other option to facilitate logging operations (skid trail and landing locations). Gambel oak, juniper and pinyon species greater than 5 inch d.r.c. (diameter root collar) may be considered residual trees in target group spacing and stocking.

Treatments were analyzed as if all acres would be treated when evaluating wildlife species effects determinations. This represents a maximum impact scenario with the understanding that logistical concerns would limit or curtail treatments in some of the areas analyzed.

## Cumulative Effects for all Alternatives

Cumulative effects are the potential changes to existing conditions due to past, present, and future activities, including the effects of the alternative being discussed. The effects of past actions are incorporated into the description of existing conditions. Present and reasonably foreseeable actions that are relevant to wildlife resources are described below for all alternatives. The cumulative effects analysis area will be described by species. Projects listed within the 4 FRI Cumulative Effects Analysis Baseline were considered as reasonably foreseeable actions.

Present and reasonable foreseeable actions that can affect wildlife resources over space and/or time include the reauthorization of livestock grazing allotments, fuels reduction projects, forest thinning, prescribed fire, recreation management (obliteration of social trails and dispersed campsites, designation of trails and campsites), lands special use permits (new issuances and maintenance on existing structures), Travel Management Rule for Tusayan and Williams Ranger Districts and the Coconino NF, and aspen restoration. While these activities can directly and indirectly affect wildlife species and their habitats, these projects typically are planned to minimize or eliminate negative effects through design features, mitigation measures and Best Management Practices.

The spatial context being considered for the cumulative effects is the 988,764 acre project area, unless noted otherwise for individual species. Cumulative effects are discussed in terms of wildfire and vegetation management activities that have occurred in the past, are ongoing, or are reasonably foreseeable, including the effects of the alternatives discussed below. Reasonably foreseeable actions are considered for approximately 10 years into the future. At that time the majority of the actions proposed will have been completed and the vegetation response to these actions should have occurred. Effects can also be categorized temporally: in this analysis, short-term effects are those occurring within 10 years and long-term is 30 years. Project impacts to wildlife are summarized below (Table 53). These effects are summarized by project types and their potential effects on wildlife and wildlife habitat. Because effects from changes in habitat vary so much by species (e.g., opening the canopy can restore the habitat for one species while eliminating habitat for another species), cumulative effects to individual species are addressed in the respective species analysis. Additional information on the projects and their effects is available in appendix 17.

**Table 53. Cumulative effects to wildlife and habitat from present and reasonable foreseeable projects**

| Project Type | General Effects to Habitat | General Effects to Wildlife | Extent |
|---|---|---|---|
| Thinning without diameter limit | Move landscape toward desired conditions for interspersion age & size class distribution | Short-term spatial and temporal disturbance to wildlife; long-term improvements to habitat; forest plans include breeding season timing restrictions for MSO, goshawks, and fawning grounds | Occurs across both forests |
| Thinning with diameter limit | Typically results in even spacing ("jail bar spacing"), versus a groupy/clumpy structure, and lacks interspaces; with no open interspace between tree groups the benefits in understory response and decreased risk of high-severity fire are quickly lost due to resulting tree growth (less than 10 years); leads to loss of habitat structure | Short-term spatial and temporal disturbance to wildlife; long-term loss of habitat structure; forest plans include breeding season timing restrictions for MSO, goshawks, and fawning grounds | Occurs across both forests |
| Prescribed Fire | Reduces fine fuels, litter, and duff; provides a nutritional flush to trees and understory; decreases CWD (immediate response) and creates CWD (scorching and killing trees); may create canopy openings; short-term loss of snags with long-term increase in snag numbers, but includes replacing persistent snags with more ephemeral snags, long term decrease in large oaks, increased sprouting of shrubby oaks; mixed severity prescribed fire yield patchy mosaic of habitat; effective in grassland and meadow restoration; decreased threat of high-severity fire and subsequent habitat loss. | Short-term spatial and temporal disturbance to wildlife; maintenance of habitat aids in persistence of wildlife populations that evolved with frequent fire return intervals; increases in understory biomass benefits most landbirds and small mammals; Forest plan parameters including breeding season timing restrictions for raptors and ungulates | Occurs across both forests |
| TMR – Coconino | Habitat effectiveness increased across the forest due toscale of reductions in disturbance except in fall when big game retrieval is allowed | Habitat effectiveness improvements will benefit most wildlife species; increase in vehicular traffic directly related to 4FRI will be off-set from decrease in general vehicular traffic; decrease in illegal cutting of snags | 4,474 miles of roads and motorized routes are no longer open; off-road driving for camping limited to 30' of open roads except in designated camping corridors where the limit is 300 feet; motorized elk retrieval open across most of 4FRI area GMUs 5a & 5b closed to big game retrieval on the Mogollon Rim |

| Project Type | General Effects to Habitat | General Effects to Wildlife | Extent |
|---|---|---|---|
| TMR – Kaibab | Localized increases in habitat effectiveness, but little change overall, particularly during big game retrieval; exception is in in grasslands where motorized use will be decreased | Decrease in disturbance in grasslands combined with forest restoration could provide more contiguous swaths of functional habitat for grassland and savanna dependent species; other benefits to wildlife will be limited, localized, and very site specific; limited decrease in illegal cutting of snags | 143 miles of road on Tusayan have restricted use; 15 miles of road constructed; 380 miles of road on Williams have restricted use; 34 miles of road constructed; off-road driving associated with camping limited to within 30 feet of open roads; most of the 2 Districts are open to motorized big game retrieval |
| Private Land development | Net effect is loss in habitat and/or habitat effectiveness; private lands in grasslands and savannas are typically developed as home sights; GFFP works closely with the CNF and non-Federal land owners & managers | Net loss of habitat & displacement: open-habitat species tend to be displaced; land development within forest may shift habitat use, but impacts likely to be less than in open habitats | Occurs across both forests |
| Thinning and Burning on State, DOD, and private lands | Vegetation treatments on State, other federal and private lands typically reduce TPA, increase openings, increase biomass production, and decrease risk of high-severity fires. | Short-term spatial and temporal disturbance to wildlife; long-term improvements to habitat on State and DOD lands; thinning on private home sites (GFFP) not likely to provide much long-term habitat but would decrease the risk of high-severity fire to adjacent lands | GFFP – 635 ac<br>DOD – 19,816 ac |
| Forestwide dead and down fuel wood collection | Includes potential impacts from loss of snags, logs, and CWD; localized areas may be deficit in snags logs, and CWD; fuel wood activities may disturb wildlife in localized areas | Disturbance and displacement of animals spatially and temporally, including nesting and fawning seasons for a wide range of species; habitat loss for some species; | CNF: the public is not allowed to travel cross country to search for fuelwood, but may drive off-road to gather cut wood. KNF: the public is allowed to drive off-road to collect fuelwood within designated areas only. |
| Fuelwood sales | Habitat removal – generally used as a restoration tool such as cutting trees to restore grasslands; | Disturbance and displacement of animals spatially and temporally, including nesting and fawning seasons for a wide range of species; habitat loss for some species/habitat gain for others; | Occurs across both forests |

| Project Type | General Effects to Habitat | General Effects to Wildlife | Extent |
|---|---|---|---|
| Recreation | Localized decrease in habitat quality due to the loss of understory vegetation (trampling, removal) associated with camping; disturbance from motorized use and hikers | Localized disturbance and displacement of animals spatially and temporally, although many species have likely acclimated to areas with regular use ( | Occurs across both forests |
| Grazing | Ongoing and future grazing should maintain plant species composition and diversity; there may be short-term effects to plant height, except around water and key grazing areas where trampling and effects to plant height are long-term; elk use is factored into grazing utilization standards and is part of the baseline; grazing affects 80 percent of the project area | Pastures that are grazed in early summer may affect small mammal populations while animals are nesting or young are dispersing; pastures receiving spring use vary annually | 790,985 acres of 988,764 total acres within the project area are classified as grazing allotments |
| ROW clearing | Removes key habitat elements like snags and woody shrubs along right of way; maintains early seral vegetation, provides open habitat; and decreases connectivity of closed canopy habitat | Negatively affects cavity nesters, shrub nesters, Abert's squirrels, and deer; positively affects understory development, small mammals, arthropods, and elk. | Occurs across both forests with more activity on the CNF |
| Annual road maintenance | Maintenance of existing roads; noise disturbance likely lower in intensity than many mechanical sources of noise due to equipment staying on or adjacent to roads and typically slowly moving. | Timing restrictions on the Kaibab NF and Coconino NF in MSO PACs apply; potential noise disturbance to other wildlife | About 500 miles of road work per year across the 4FRI area |
| Aspen restoration | Removes snags and overstory trees in short-term; Improves and maintains aspen habitat in the long-term | Localized disturbance in short-term; long-term provides habitat heterogeneity in the overstory and understory within the relatively homogeneous ponderosa pine for a range of birds species and small mammals | Occurs across both forests |
| Grassland/ savanna restoration | Typically includes removing encroaching trees and prescribed fire for maintenance | Positively affects populations of grassland associated birds and small mammals; restores, maintains, and improves habitat for pronghorn | Occurs across both forests |
| Water development maintenance | Increase effective areas available for resident elk; impacts of elk browsing likely to increase in areas already impacted by elk | Oak, sage, and young conifers already clubbed from winter browsing; increased use likely to increase impacts to birds, small mammals, and deer | KNF = 24 recent waters on Tusayan RD |

| Project Type | General Effects to Habitat | General Effects to Wildlife | Extent |
|---|---|---|---|
| Weed treatments | Improving habitat quality by reducing/eliminating non-native plant species | – not related to elk trends as these are determined by state management – hunt guides overwhelm measureable effects of habitat changes; | Occurs across both forests |
| Pinyon-juniper thinning and burning | Removes woodland vegetation encroaching on grassland, shrubland, and savanna | Decreases habitat for woodland dependent species and increases habitat for open habitat-dependent species | Occurs across both forests |

1. CNF = Coconino National Forest; DOD = Dept of Defense; GFFP = Greater Flagstaff Forest Partnership; KNF = Kaibab National Forest

# Existing Conditions

Past actions include vegetation treatments and wildfires that have occurred within the project area from 2001 to 2013 (Table 54). In general, effects of mechanical treatments predating this time would not be expected to have much influence on wildlife habitat except for the deficit of large trees common across the analysis area. Mechanical vegetation management activities have mainly consisted of tree harvest. Projects include treatments with a fuels reduction emphasis (50,940 acres) and ponderosa pine restoration emphasis (15,700 acres) to improve forest structure, health and growth. There have 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 pronghorn travel corridors. Within the project area there have been 640 acres of tree and vegetation removal associated with powerline corridor management and protection.

**Table 54. Approximate acres of vegetation management activities and wildfire within the project area from 2001 to 2013**

| Treatment | Treatment Type | Approximate Acres |
|---|---|---|
| Mechanical Vegetation Management | Thinning – Fuels Reduction Emphasis | 50,940 |
| | Thinning – Restoration Emphasis | 15,700 |
| | Savanna/Grassland Restoration | 12,560 |
| | Sanitation/Salvage | 2,650 |
| | Aspen Restoration | 100 |
| | Habitat Improvement | 1,935 |
| | Powerline Hazard Tree Removal and Right of Way | 640 |
| **Total Mechanical**: | | **84,525** |
| Fuels Treatments (With Mechanical) | Mechanical Fuels Treatment | 3,910 |
| | Pile and Burn | 5,070 |
| | Broadcast Burn | 59,640 |
| **Total Fuels Treatments** | | **68,620** |
| **Prescribed Fire (Burn Only)** | | **47,970** |
| **Wildfire** | | 108,160 |

Fuels treatments that have been accomplished in association with the above listed mechanical treatments included 3,910 acres of mechanical fuels treatments (slash lopping, crushing, piling and jackpot burning), 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 fire proposed for 47,970 acres are intended to reduce fuels accumulations and/or reintroduce fire to fire adapted ecosystems. Wildfires from 2001 to 2010 have burned on approximately 108,160 acres of the project area. Of these acres, 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) 30 percent mixed severity, and 50 percent low severity (silviculture report). There is wide variability among these percentages from fire to fire.

Specific past projects and their associated management components are displayed in appendix 17.

## Forest Structure and Diversity - Mosaic of Interspaces and Tree Groups

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. Both categories of treatments lead to increased understory development, lasting until overstory canopies again close. Thinning treatments with restoration objectives are very similar to the goshawk habitat and MSO 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.

Fuels reduction, including prescribed precommercial and commercial thinning generally had a d.b.h. limit, resulting in a “thin from below” approach. The main objective of thinning with a fuels reduction emphasis was to reduce canopy fuels and the potential for crown fire initiation. Generally, this type of treatment focused on removal of trees in the subordinate crown positions and retaining those trees in dominate and co-dominate crown positions and any pre-settlement trees. This type of treatment resulted in a moderately open canopy, even aged forest structure with very little age and size class diversity. When treatments are based on tree diameters there is little to no consideration for tree grouping, spacing, and rooting space, typically resulting relatively evenly spaced and evenly sized trees. Post-treatment stands have limited tree size-classes and age-classes with a virtual removal of overstory habitat consisting of diameters below the specified limit. Understory response is typically limited and of short duration because the treatments were designed to maximize individual tree growth without providing for openings.

Mixed severity wildfires resulted in a mosaic of tree mortality and a pattern with indiscriminate interspaces and tree groups. The remaining treatments and low severity wildfire resulted in some irregular tree spacing.

## Forest Structure - All Age and Size Classes Represented

Prescribed fire and mechanical fuels treatments associated with the above thinning treatments resulted in periodic tree mortality of seedling/sapling size trees and susceptible pre-settlement trees further reducing age class diversity. Understory improvements would not be expected to last for more than a short-term boost in productivity. High- and mixed- severity wildfires caused large scale mortality across all age and size classes resulting in a non-stocked or single age class representation. Wildfires that burned with a low severity and prescribed fire only treatments had similar effects to forest structure as the post thinning prescribed fires.

Thinning treatments retained pre-settlement trees and the largest post-settlement trees. Sanitation treatments likely removed old forest structure. Prescribed fire and low severity wildfire resulted in periodic tree mortality of susceptible pre-settlement trees. Mixed- and high-severity wildfire killed a large proportion of the old forest structure. Powerline treatments removed any old forest structure that was a hazard to the powerline. Most of the managed acres retained large and old trees while wildfires would typically result in the loss of large and old trees.

## Forest Resilience

Thinning treatments resulted in low to moderate density forest density zones. This in turn had a beneficial effect of improved forest growth, reducing the potential for density and bark beetle related mortality. Thinning treatments also removed dwarf mistletoe infected trees reducing the percent of trees infected as well as creating conditions that slowed or inhibited mistletoe spread. Prescribed fire and low severity wildfire also led to localized reduction of forest density and dwarf mistletoe infection.

### Vegetation Diversity and Composition – Maintain and Promote

**Grasslands** – The savanna/grassland restoration treatments implemented restored historic grasslands, savannas and forest openings by removing ponderosa pine tree canopy that was shading out understory herbaceous vegetation. Thinning treatments with a restoration objective also restored historic forest openings.

**Oak** – Removing conifer competition with mid and understory oak as part of the thinning contributed to maintaining and improving oak growth and vigor. Mixed and high-severity wildfire killed large oaks that were replaced by oak sprouts thereby changing oak structure from old to young.

**Aspen** – Aspen restoration treatments were very similar to the aspen treatments proposed under this EIS and have resulted in aspen regeneration and age class diversity.

**Pine Sage** – Some of the fuels reduction thinning within pine sage on the Tusayan district removed overtopping young pines and improved conditions for understory sage.

# Current, Ongoing and Foreseeable Projects and Actions

There are many on-going or planned projects that thin ponderosa pine habitat (Table 55). These thinning treatments vary greatly and include noncommercial thinning, group selection, sanitation thinning, and shelterwood cuts (appendix 17). Typically the trees being removed are mid-aged. Re-creating interspaces and regeneration is a priority. Rarely are mature or old trees targeted for removal in ongoing or future thinning projects. There is an estimated 87,610 acres of thinning from other projects within the project area. There will also be 11,130 acres of ponderosa pine savanna restoration occurring in the project area. Grassland restoration treatments include removal of encroaching conifers and prescribed fire to rejuvenate grasses and forbs. Pinyon-juniper thinning and burning is occurring on both forests.

**Table 55. Approximate acres of present and foreseeable vegetation management activities within the project area**

| Treatment | Treatment Type | Approximate Acres |
|---|---|---|
| Mechanical Vegetation Management | Thinning – Fuels Reduction Emphasis | 10,340 |
| | Thinning – Restoration Emphasis | 77,270 |
| | Savanna/Grassland Restoration | 11,130 |
| | Sanitation/Salvage | 4,290 |
| | Aspen Restoration | 5,130 |
| | Habitat Improvement | 0 |
| | Powerline Hazard Tree Removal and Right of Way | 500 |
| **Total Mechanical:** | | **108,660** |
| **Broadcast Burn (Total Fuels Treatments)** | | **98,800** |
| **Prescribed Fire (Burn Only)** | | **5,950** |

Slash treatments associated with the above thinning consists of prescribed fire. In addition, there are also burn-only treatments within the ponderosa pine habitat. Many past projects have maintenance burns occurring on five to 20-year cycles and hence qualify as past and ongoing projects. There are an estimated 104,750 acres of burning in the treatment area.

Both forests are actively trying to restore aspen stands. The majority of the aspen on the Coconino NF is variable sized stands within wilderness areas. Aspen on the south zone of the Kaibab NF usually occurs in small patches scattered within the ponderosa pine forest. Aspen restoration is planned for high priority areas outside of wilderness. Cumulatively, restoration of these areas across both forests will treat stands that are at high risk of dying in the near future. There is a total of 5,130 acres of aspen treatments planned within the project area.

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 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 to be cut. This occurs closer to roads and decreasing miles of open road should decrease the loss of this resource.

The Kaibab NF will allow for large game retrieval during hunting season in all GMUs while the Coconino NF will allow for elk-only retrieval in all GMU except 5a and 5b (the Mogollon Rim District). The Coconino NF will allow people to park up to 300-feet away in designated corridors along roads for campers. Outside these designated areas campers can park up to 30-feet away from roads. The Kaibab NF will allow parking up to 30 feet away from all open roads and does not have designated areas for parking further in from roads.

Both forests have on-going maintenance of right of ways (ROW) for power, gas, and oil lines and associated infrastructure. This involves thinning and burning within the ROWs to keep the area clear of trees and shrubs. ROW maintenance prevents forest development, retaining early seral habitat in linear swaths across the landscape. ROWs include 32,344 acres with the majority of the area on the Coconino NF. Currently there are 500 acres proposed for ROW 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, 791,250 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. Of these 49 allotments, 40 permit cattle grazing and nine permit sheep grazing. The amount of each allotment lying within the project area averages 65 percent, and varies from less than one percent to 100 percent. There are 229 main pastures (i.e., large pastures that are used more than 30 days per year by livestock) located within the project area. 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 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 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 fire. 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.

# Environmental Consequences

A review of environmental consequences serves to highlight direct and indirect effects or unintended consequences that may occur from the proposed actions. These environmental consequences are presented below, starting with a discussion of climate change relative to the project alternatives. Species analyses begin with Federally Threatened and Endangered Species, followed by Forest Service Sensitive Species, Management Indicator Species, migratory birds and effects to Important Bird Areas. Following the analysis of direct and indirect effects for each species group is a review of cumulative effects. This section ends with a review of how treatments would affect hiding and thermal cover.

## Effects of Climate Change

Southwestern forests are particularly sensitive to drought and increasing temperatures (Williams et al. 2010, Kane and Kolb 2014). It is expected that large changes in plant community structure and species composition will occur due to the warming air temperatures and altered hydrological cycles in the southwest. An overall decrease in forest productivity could ensue as a result of reduced precipitation (USDA 2010c). If temperature and aridity continue to rise as projected, trees will experience substantially reduced growth rates this century with ecotones and dense forest stands particularly vulnerable to fire mortality and drought-induced die-offs (Williams et al. 2010). These potential effects would have a direct influence on the sustainability of MSO habitat and the potential recovery of the species. Declines in deciduous trees and shrubs have already occurred within the coniferous forests of Arizona (Martin and Maron 2012). Long-term decreases in stem densities of deciduous woody plants were strongly associated with 25 years of declining snowfall (Martin and Maron 2012). The additive effects of multiple years of declining snowfall accounted for 85 percent of the documented decline in plant densities. Declines in woody plants, in turn, were associated with declines in 5 of 6 songbird species that nest on the ground or in the understory (Martin and Maron 2012). While this study did not track changes in small mammal communities, loss or significant reduction of this component of the ponderosa pine forest could also affect the habitat of MSO prey species.

Compounding the density-related stress within forest stands is a predicted decrease in winter precipitation. Winter precipitation is the dominant water source for large and old ponderosa pines in northern Arizona (Kerhoulas et al. 2013a). Large and old trees depend on water from snowmelt and are not as strongly affected by summer monsoon rains. Climate change is predicted to reduce snowpack and increase evaporation and drought stress (NFWPCAP 2012). If this occurs, large and old trees will be more susceptible to stress and likely suffer increased mortality. Shifts in the timing of snowmelt have already been observed (Millar et al. 2007). Tree canopies intercept snowfall and moisture can then be lost to sublimation rather than soaking into the soil. Uncharacteristically dense forests can exasperate the effects of climate change on old and large trees.

Climate change can also work synergistically with forest insects and disease. Uncharacteristic densities of mid-aged trees already stress large, old trees through resource competition and make stands more vulnerable to beetle infestations. (see silviculture report for details). The consequences of these factors working alone and synergistically may lead to disproportionate mortality in the largest tree size-classes. The cumulative effects of climate change, forest structure, insects, disease, and weather patterns could lead to larger high-severity fires becoming more common in the southwest than they have been to date.

## Alternative A

Alternative A would not prevent, delay, or ameliorate predicted effects of climate change. The dense forest conditions resulting from alternative A are at a high risk to density related and bark beetle mortality and have limited resilience to survive and recover from potential large scale fire events and the interactions of these influences with climate change. Under drier and warmer weather conditions, the potential impacts of these risks to the ecosystem would be increased. Individual tree growth would be limited to the point of stagnation. As tree density increases, many areas would experience higher mortality. Species requiring closed canopy forest conditions or old or large tree, snag, and log structure would be negatively impacted in the long-term. Patches of open forest, savanna, and meadow and grassland habitats would potentially increase in the long-term as groups of dense forest succumb to the above mortality agents.

## Action Alternatives

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 proposed treatments. Individual tree growth rates would improve, creating and retaining more large and old trees. Habitat elements associated with closed canopy forest conditions would be reduced, but would be more sustainable. Risk from insects, fire, and their interactions with climate would be reduced. Because of law, regulation, and policy, more closed canopy habitat would be available than what likely occurred historically. At a landscape scale, tree growth rates are currently minimal (silviculture report). Ensuring the growth and retention of large trees would maintain large snag and log structure across the forest over time. Open forest, meadow, savanna, and grassland habitats would be enhanced and habitat effectiveness increased as encroaching trees were removed and habitat for grassland and pollinator species became less fragmented. These habitats would remain stable in the long-term. The increased acres of mechanical and prescribed fire under this alternative C would realize the most benefit in terms of forest health and resiliency. Alternative B would achieve less than C but more than alternatives D or E. The limited acres of prescribed fire under alternative D would be expected to maintain higher fuel loadings, resulting in more limited gains in forest resiliency due to increased flame lengths, lower canopy base height, and persistent ladder fuels. Alternative E would retain the densest forests and therefore achieve the least in terms of large tree growth rates and resilience.

# Federally Listed Threatened, Endangered, Proposed, and Candidate Species and Critical Habitat

## Mexican Spotted Owls (Threatened)

Definitions of MSO habitat follow the 1995 Recovery Plan terminology. Definitions of MSO habitat are provided in the Methodology section above ("MSO Habitat Definitions in the 1995 Recovery Plan"). Acres of MSO habitat within the treatment area were presented in Figure 7 and Table 7 above.

The 1995 MSO Recovery Plan forms the basis of the MSO analysis. It was the only Recovery Plan existing at the time of the DEIS development. Shortly after the 4FRI DEIS was sent to the government printer in December 2012, which was the culmination of about two years of developing treatment strategies, building databases, summarizing treatment effects, and analyzing model outputs, the FWS completed the Revised Recovery Plan (USDI 2012b). Because of the enormity of this effort and the fact that the project was caught between recovery plans, the FWS agreed to retaining the wording and metrics of the original MSO recovery plan in the 4FRI documents. The Biological Assessment was submitted to the FWS in February of 2014. While the analysis below 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 MSO Recovery Plan was documented in the effects analysis of the preferred alternative and the corresponding Biological Opinion as part of consultation with the FWS (appendix 2). A crosswalk between the 1995 and 2012 MSO Recovery Plans can be found in appendix 3 of this report. Alternatives B, C, and D include plan amendments that were developed to ensure the preferred alternative (alternative C) would better match the measures in the new MSO Recovery Plan. The 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.

Environmental consequences are based on the application of design features, mitigation, and assumptions described in this report. This includes incorporation of the old tree implementation plan and the inclusion of the large tree implementation plan in alternatives C and E. Environmental consequences are described by MSO habitat type (e.g., protected and restricted) and designated critical habitat. Proposed treatments are the same in target and threshold habitats, although the degree to which they are implemented would vary depending on specific stand conditions. Modeled results are based on stand-specific outputs and represent the variability in treatment implementation. Treatments in MSO habitat are designed to be light in intensity to move forest conditions towards desired conditions as described in the forest plans and Recovery Plan. This light approach is reflected in the minimal changes seen in the displayed forest metrics. The inverse relationship between tree density and understory development is another check on how aggressive MSO treatments are or are not. Small changes understory in the understory index (i.e., 10s of pounds per acre) indicates little change in the overstory. Larger changes in the index (i.e., 100s of pounds per acre) indicates opening of the forest canopy. The objectives of the treatments are to increase tree growth rates, retain large pine and oak trees, and increase forest resiliency. Target habitat would be managed to achieve threshold conditions sooner than if they were not treated. Forest conditions in threshold habitat would remain at or above threshold values after treatment as shown in the 1996 ROD and Table III.B.1 of the Recovery Plan. Existing threshold habitat accounts for only about 2.5 percent of the total restricted habitat and target habitat is about nine percent of restricted habitat. This analysis was developed under the 1995 MSO Recovery Plan. A draft MSO Recovery Plan was released in 2011 and elements of this plan were included in the 4FRI treatment objectives, per discussion with the FWS. The 1st Revision of the MSO Recovery Plan was released weeks after 4FRI DEIS was sent to the government printer in December, 2012. The 1995 Recovery Plan terminology and measures of effects to habitat structure were retained in the final EIS because changes would have required rerunning some of the models and rewriting much of this report, delaying the final EIS by months due to the scale, detail, and site specificity of this analysis. Similarly, the Biological Assessment kept the original terminology because it is directly tied to this same analysis. However, the Biological Opinion resulting from section 7(a) (2) consultation ties the results of these analyses to the current recovery plan and is included in appendix 2.

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

The 4FRI is proposing treatments on nearly 74,000 acres of MSO restricted habitat and over 34,000 acres of protected habitat. These treatments are fundamentally different from the restoration approach used outside of MSO habitat or the management activities in existing research in spotted owl habitat (see "Thinning and Timber Harvest in Spotted Owl Habitat" in the Affected Environment section above). The objective of the 4FRI treatments in MSO habitat is to improve forest structure for owls as defined in the Recovery Plan. This is profoundly different from an emphasis on fuels reduction. 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 MSO 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 MSO habitat (Irwin et al. 2004, Blakesley et al. 2005). Canopy gaps would increase understory production and benefit prey species (appendix 6). Treatment objectives include retaining Gambel oak and other non-ponderosa pine species to maintain overstory diversity. Improving meadows, riparian habitat, 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 MSO reproduction (Franklin 2000, May and Gutierrez 2002, May et al. 2004, Blakesley 2005). An artifact of these actions would be a reduction in risk of high-severity fire, but the intent of the treatment design is to improve MSO habitat by using the recovery plan as a guide. The landscape approach of 4FRI allows emphasizing fuels reduction treatments outside of protected habitat, particularly in stands southwest of PACs. Monitoring would be a key component of this work and success would be determined by conserving MSOs and their habitat. This analysis is based on the assumption that mechanical treatments and two low-severity fires would occur within the project timelines.

None of the treatments would include mixed-conifer habitat or MSO habitat in wilderness or canyon areas. The silviculture implementation plan includes direction to omit treatments in any area identified as ponderosa pine during planning, but which is discovered to be mixed-conifer vegetation during implementation.

### *Protected Habitat*

PAC treatments are described in detail for each proposed alternative. Steep-slope protected habitat (836 acres) would only receive prescribed fire treatments. No mechanical treatments are proposed on steep slopes in any of the alternatives. As with any proposed treatment, areas may be dropped from consideration due to operational concerns as areas are reconnoitered in preparation for or during implementation.

### Springs and Ephemeral Channels

Five springs are proposed for restoration in MSO protected habitat (Lee Spring, Mud Spring, Rock Top, Sawmill Springs, and Weimer Springs) (Table 56). All five springs are in PACs occurring in RU 1 on the Coconino NF. The springs in two PACs (Red Raspberry and Weimer Springs) are in meadows and two other PACs have springs in pine-oak forest (Rock Top and Sawmill Springs). A total of nearly 1.7 miles of ephemeral stream channel restoration would occur in six PACs on the Coconino NF (Bear Seep, Clark, Coulter Ridge, Holdup, Lucida, and Meadow Tank) (Table 56). Ephemeral stream reaches proposed for restoration average about 0.28 miles in length with a range of 0.02 to 0.72 miles. Only Holdup PAC has riparian vegetation within the ephemeral stream reach, but no woody vegetation is present. All springs and ephemeral channels restored in PACs would be protected from ungulate browsing by non-wire fencing to avoid unintentional harm to MSOs. All restoration activities would happen outside the breeding season. Recommended adaptive management actions for springs and ephemeral channels were reviewed and would not result in additional effects that are not already disclosed.

**Table 56. Springs and ephemeral channels proposed for restoration in protected activity centers (PAC), Coconino National Forest**

| PAC | Spring Name | | PAC | Channel Distance |
|---|---|---|---|---|
| Red Raspberry | Mud Spring | | Bear Seep | 0.46 |
| Rock Top | Lee Spring | | Clark | 0.30 |
| Rock Top | Rock Top | | Coulter Ridge | 0.72 |
| Sawmill Springs | Sawmill Springs | | Holdup | 0.08 |
| Weimer Springs | Weimer Springs | | Lucida | 0.08 |
| **-------** | **-------** | | Meadow Tank | 0.02 |
| **Total = 4 PACs** | **Total = 5 Springs** | | **Total = 6 PACs** | **Total = 1.66 miles** |

### Roads

About 44 miles of open roads in protected habitat would be decommissioned across 4 RUs and 12 different subunits. About 43 miles of roads would be decommissioned in 52 PACs, accounting for about 29 percent of the total road miles in those PACs (appendix 15). An average of 0.8 miles of road would be decommissioned per PAC (range = 0.02 to 3.8 miles in individual PACs). One PAC with road decommissioning is on the Kaibab NF (Sitgreaves with 0.8 miles proposed for decommissioning) and the remaining PACs are on the Coconino NF. All road decommissioning in PACs would occur outside the breeding season.

Road decommissioning would occur in 13 core areas, including about five out of about 7.6 total road miles (67 percent) in core areas (appendix 15). An average of 0.39 miles of road would be decommissioned per core area (range = 0.01 to 0.93 miles). All 12 core areas are on the Coconino NF. Timing restrictions would avoid potential noise disturbance to nesting and roosting owls.

Recommended adaptive management actions for road-related activities were reviewed and would not result in additional effects that are not already disclosed.

Nearly 100 miles of road maintenance and temporary road construction would occur in protected habitat (Table 57). Road maintenance and temporary construction would occur pre-harvest and outside of the nesting season. The term “temporary roads” in protected habitat consists of non-system roads that currently exist as open roads on the landscape. They would be roads authorized by contract, permit, lease, or other written authorization but are not a forest road and are not included in a forest transportation atlas. Therefore, temporary road construction would be variable and can encompass little to no work on the ground. Alternately, temporary road construction could require widening, tree removal, fill, and grading. Site-specific assessments have not been made, but a design feature for road work includes minimizing tree removal (see soils report). Temporary roads would typically function for 3 to 6 months before decommissioning.

**Table 57. Road-related mileage changes in Mexican spotted owl protected habitat**

| MSO Habitat | Road Maintenance | New Temporary Roads | Road Relocation | Total Miles of Road Work |
|---|---|---|---|---|
| Protected Total | 92.7 | 6.7 | <0.1 | 99.4 |

### *Restricted Habitat*

Restricted habitat was identified from multiple data layers and the experience and on-the-ground knowledge of several wildlife biologists. Some field review was also incorporated into delineating this habitat layer. However, once implementation begins errors could be discovered and acres adjusted to ensure the designated areas meet the objectives of MSO habitat.

#### Springs and Ephemeral Channels

Eighteen springs are proposed for restoration in MSO restricted habitat. Ten springs are proposed for restoration on the Coconino NF and eight springs on the Kaibab NF. All springs proposed for restoration occur in either RU 1 or 3. Just over 3.3 miles of ephemeral channel restoration would occur in restricted habitat. Approximately ¾ of a mile is in target and threshold habitat on the Coconino NF. About 2.4 of the 2.48 miles of ephemeral channel restoration in restricted “other” habitat is proposed for the Coconino NF and less than 1/10th of a mile is on the Kaibab NF. Recommended adaptive management actions for springs and ephemeral channels were reviewed and would not result in additional effects that are not already disclosed.

#### Aspen

All action alternatives propose 739 acres of mechanical and prescribed fire treatments plus seven acres of prescribed fire-only treatments in restricted habitat. Each action alternative therefore equals 746 acres of total aspen treatments.

Aspen restoration would mechanically remove all post-settlement pine inside of and within 100 feet of clones. Mechanical ground disturbance may be used along with prescribed fire to stimulate suckering. Aspen restoration would be expected to improve the health and resiliency of aspen clones and move towards multiple canopy layers. Aspen restoration would also create canopy gaps, allowing more sunlight to reach the understory layer. Mechanical thinning would increase surface fuels that would better carry fire and would subsequently create a stronger understory response. The resulting effects to prey habitat would include both short- and long-term improvements in aspen health and sustainability and in understory vegetation. Removal of competing pine in around aspen clones should improve growth rates across aspen diameter size-classes. Improving individual aspen tree's lifetime growth patterns can potentially delay effects of climate change, retaining aspen longer than with no treatment (Ireland et al. 2014).

Prescribed fire alone would decrease litter and duff, improving understory conditions by decreasing the pine needle content in the litter layer. Prescribed fire would also cause moderate mortality of encroaching conifers and increase nutrient availability, benefiting understory plants and the aspen clone itself. Fire disturbance would induce aspen suckering, aiding in the effort to create multiple tree size-classes. Prescribed fire without mechanical thinning would be expected to result in patchy burns. While this would contribute towards habitat heterogeneity for MSO prey species, it would also limit exposure of trees to fire, reducing overall mortality of competing conifers. Moderate pine mortality within clones would reduce but still maintain encroaching post-settlement pine. The pine overstory would continue to shade, contribute to needle accumulation in the litter, and maintain a seed source for the establishment of new pine trees within the clone. This would limit aspen and understory response in both the short- and long-term and would not be expected to improve aspen's response to drought and elevated temperatures (compare to Ireland et al. 2014).

### Roads

About 115 miles of roads in restricted habitat would be decommissioned across 15 different subunits, including nearly 17 miles within target and threshold habitat (Table 58).

About 360 miles of road maintenance would occur in restricted habitat, including about 41 miles in target and threshold habitat (Table 59). New temporary road construction would total about 69 miles, with over 5 miles constructed in target and threshold habitat. Over a mile of road would be relocated to protect ephemeral stream channels. Two road segments would be relocated in target (1) and threshold (1) habitat, totaling less than 0.05 miles in length and the balance would be in restricted "other" habitat.

**Table 58. Proposed road decommissioning in restricted habitat by subunit**

| | | Restricted Other Habitat | | | Target and Threshold Habitats | | |
|---|---|---|---|---|---|---|---|
| **Forest** | **Restoration Sub-unit** | **Road Miles Proposed for Decommissioned** | **Total Road Miles** | **Percent of Total Roads Decommissioned** | **Road Miles Proposed for Decommission** | **Total Road Miles** | **Percent of Total Roads Decommissioned** |
| CNF | 1-1 | 6.29 | 21.15 | 30 | 0.93 | 1.74 | 53 |
| | 1-**2** | 0.73 | 3.42 | 21 | | | |
| | 1-3 | 10.43 | 62.90 | 17 | 5.05 | 15.66 | 32 |
| | 1-4 | 0.27 | 2.97 | 9 | 0.11 | 0.11 | 100 |
| | 1-5 | 14.48 | 92.41 | 16 | 4.57 | 14.11 | 32 |
| | 3-3 | 2.82 | 9.68 | 29 | 0.54 | 2.04 | 26 |
| | 3-4 | 5.40 | 19.88 | 27 | 2.09 | 3.23 | 65 |
| | 3-5 | 29.00 | 133.06 | 22 | 1.00 | 20.76 | 5 |
| | 4-5 | 0.17 | 0.61 | 28 | | | |
| | 5-1 | 3.92 | 8.24 | 48 | 0.11 | 0.72 | 15 |
| | 5-2 | 3.19 | 9.96 | 32 | 0.68 | 1.29 | 53 |
| KNF | 3-1 | 8.24 | 126.05 | 7 | 0.07 | 7.01 | 1 |
| | 3-2 | 7.06 | 53.86 | 13 | 1.34 | 7.65 | 18 |
| | 3-3 | 4.39 | 70.23 | 6 | 0.43 | 7.47 | 6 |
| | 4-3 | 0.15 | 0.55 | 27 | | | |
| | 4-4 | 1.43 | 8.91 | 16 | 0.00 | 0.31 | 0 |
| **Total** | | 98.0 | 623.9 | 16 | 16.9 | 82.1 | 21 |

**Table 59. Miles of road work in restricted habitat**

| MSO Restricted Habitat | Road Maintenance | New Temporary Roads | Road Relocation | Total Miles of Road Work |
|---|---|---|---|---|
| Target/Threshold | 40.9 | 5.3 | <0.05 | 46.2 |
| Restricted “Other” | 319.1 | 63.5 | 1.0 | 383.6 |
| **Total** | **360** | **68.8** | **1+** | **429.8** |

### *Critical Habitat*

#### Springs and Ephemeral Channels

Restoration of springs and ephemeral channels would be evidence-based and designed to improve associated vegetation species composition. Pre-settlement trees would remain where present and the largest trees available would be left where evidence of pre-settlement trees exists. Areas without evidence of pre-settlement trees could be treated to provide forest interspace. The objectives in applying treatments are:

- Conserve or recover native biological diversity
- Remove post-settlement trees within soil types indicating regularly moist conditions around springs or ephemeral channels to avoid shading and uncharacteristic translocation of water and nutrients from affected soils.

Restoration activities proposed for springs and ephemeral channels would include two entries for prescribed fire. Design features associated with spring and ephemeral channel restoration include:

- Using soil and water best management practices to minimize the impacts of management activities within riparian areas
- Retain large snags and logs on site
- Avoid wire fencing (for excluding ungulates) in PACs
- Apply northern leopard frog mitigation where breeding habitat occur

Spring and channel restoration would occur in four of the six CHUs occurring within the treatment area (Table 60).

**Table 60. Number of springs and miles of ephemeral stream channel restoration proposed in MSO critical habitat units under the 4 Forest Restoration Initiatives**

| Feature | UGM-11 | UGM-12 | UGM-13 | UGM-14 |
|---|---|---|---|---|
| Spring (Coconino NF) | 8 | 0 | 9 | 0 |
| Ephemeral Stream | 1.9 | 0.48 | 0. 38 | 0.67 |

Spring restoration would occur in two CHUs: eight springs are proposed for restoration in UGM-11 and nine in UGM-13 (Table 61). Ephemeral stream channel restoration would occur in CHUs UGM-11, -12, -13, and -14 (Table 62). Ephemeral stream channel restoration in these Recovery Units would total 4.02 miles on the Coconino NF and 0.08 miles on the Kaibab NF (UGM-13). Recommended adaptive management actions for springs and ephemeral channels were reviewed and would not result in additional effects that are not already disclosed.

**Table 61. Proposed spring restoration by critical habitat unit (CHU) within the 4FRI treatment area**

| Forest | CHU | Name | Total |
|---|---|---|---|
| **Coconino** | **UGM-11** | Howard Spring | 1 |
| | | Lee Spring | 1 |
| | | Mud Spring | 1 |
| | | Rock Top springs | 1 |
| | | Sawmill Springs | 1 |
| | | Sedge Spring | 1 |
| | | Van Deren Spring | 1 |
| | | Weimer Spring | 1 |
| | | | **8** |
| | **UGM-13** | Lockwood Spring | 1 |
| | | Scott Spring | 1 |
| | | | **2** |
| **Kaibab** | **UGM-13** | Andrews Spring | 1 |
| | | Hat Tank lower unnamed spring | 1 |
| | | Hat Tank upper unnamed spring | 1 |
| | | Rocky Tule spring unnamed | 1 |
| | | Stewart Spring | 1 |
| | | Weed unnamed spring | 1 |
| | | Wild Horse Spring | 1 |
| | | | **7** |
| **Total** | | | **17** |

**Table 62. Miles of proposed ephemeral channel restoration by critical habitat unit (CHU) within the 4FRI treatment area**

| CHU | Miles |
|---|---|
| UGM-11 | 2.26 |
| UGM-12 | 0.48 |
| UGM-13 | 0.68 |
| UGM-14 | 0.67 |
| **Total** | **4.10** |

Meadow and aspen treatments in critical habitat are the same as those described above for restricted habitat.

## Roads

Nearly 110 miles of open roads would be decommissioned across 15 different subunits. Road decommissioning in MSO critical habitat would occur in restricted habitat, including about 16 miles (20 percent) within target and threshold habitat (Table 63). Road decommissioning in protected habitat would occur outside of critical habitat boundaries are is described in detail in the PAC by PAC descriptions in appendix 15

**Table 63. Proposed road decommissioning in restricted habitat by subunit on the Coconino (CNF) and Kaibab (KNF) National Forests**

| Forest | Restoration Subunit | Restricted Other Habitat | | | Target and Threshold Habitats | | |
|---|---|---|---|---|---|---|---|
| | | Road Miles Proposed for Decommissioning | Total Road Miles | Percent of Total Roads Decommissioned | Road Miles Proposed for Decommission | Total Road Miles | Percent of Total Roads Decommissioned |
| **CNF** | 1-1 | 6.0 | 21.6 | 28 | 0.9 | 1.7 | 55 |
| | 1-2 | 0.7 | 3.4 | 21 | 0 | 0 | 0 |
| | 1-3 | 8.6 | 62.9 | 14 | 5.0 | 15.7 | 32 |
| | 1-4 | 0.3 | 3.0 | 9 | 0.1 | 0.1 | 110 |
| | 1-5 | 14.1 | 92.4 | 15 | 4.3 | 14.1 | 30 |
| | 3-3 | 2.8 | 9.7 | 29 | 0.5 | 2 | 27 |
| | 3-4 | 5.4 | 19.9 | 27 | 2.1 | 3.2 | 65 |
| | 3-5 | 28.4 | 133.1 | 21 | 1.0 | 20.8 | 5 |
| | 4-5 | 0.2 | 0.6 | 29 | 0 | 0 | 0 |
| | 5-1 | 2.9 | 8.2 | 35 | 0 | 0.7 | 0 |
| | 5-2 | 2.5 | 10.0 | 25 | 0.4 | 1.3 | 32 |
| **KNF** | 3-1 | 8.2 | 126.1 | 7 | 0.1 | 7 | 1 |
| | 3-2 | 7.1 | 53.9 | 13 | 1.3 | 7.7 | 17 |
| | 3-3 | 4.4 | 70.2 | 6 | 0.4 | 7.5 | 6 |
| | 4-3 | 0.1 | 0.6 | 25 | 0 | 0 | 0 |
| | 4-4 | 1.4 | 8.9 | 16 | 0 | 0.3 | 0 |
| **Total** | | **93.1** | **623.9** | **15** | **16.3** | **82.1** | **20** |

About 355 miles of road maintenance would occur in restricted habitat, including about 41 miles in target and threshold habitats (Table 64). New temporary road construction would total about 68 miles in restricted habitat, with over 5 miles constructed in target and threshold habitat. The majority of these miles are known to currently exist as open non-system roads. An undetermined amount of temporary road could require blading a new grade. Temporary roads would typically function for 3 to 6 months before decommissioning. Over a mile of road would be relocated to protect ephemeral stream channels in restricted habitat. One road segment would be relocated in target and 1 segment in threshold habitat, totaling less than 0.1 miles in length. Remaining relocated road segments would be in restricted "other" habitat.

**Table 64. Road-related mileage in Mexican spotted owl critical habitat**

| MSO Restricted Habitat | Road Maintenance | Temporary Roads | Road Relocation | Total Miles of Road Work |
|---|---|---|---|---|
| Target/Threshold | 40.9 | 5.3 | <0.1 | 46.2 |
| Restricted "Other" | 314.5 | 62.5 | 1.4 | 378.2 |
| **Total** | **355.4** | **67.8** | **<1.5** | **424.4** |

Road maintenance could include a range of activities from blading the edges of a road and spot surfacing to culvert replacement and building turnouts. Temporary road construction and reconstruction of road segments could involve cutting and removing individual trees (although per the above referenced design feature this would be minimized), realigning the road prism, subgrade repairs, and widening roadway prisms, lanes, shoulders, or ditches. Road relocations can involve creating a new road alignment in an upland position, with proper drainage and surfacing. This would require removal of vegetation and decommissioning the old road alignment. These actions can commonly require heavy machinery such as bulldozers, front-end loaders, and dump trucks. Road activities occurring in a general area would be completed within a single season. Activities in specific locations could last from a day to weeks.

An expert panel sponsored by the U.S. Environmental Protection Agency conducted a literature review of dust suppressants (Piechota et al. 2004) Magnesium chloride ($MgCl2$) is the most widely used salt for suppressing dust. Salts move through soil easily with water and negatively impact plant growth near application sites. Salts can brown needles on live pine trees and, with repeated applications, increases tree mortality. Lignin, another common dust inhibitor, has been found to cause weight gain and colon ulcers in lab testing of rodents. Overall, lignin may be the most environmentally compatible dust suppressant and did not prevent seed germination in field trials (Piechota et al. 2004).

Piechota et al. (2004) concluded that determining environmental effects of dust must be based on assessing site-specific conditions. Dust abatement treatments would be limited to eight road segments in the 4FRI, occurring in selected areas where private landownership concerns could arise. Dust abatement treatment length would total less than seven miles in length, averaging about 0.9 miles (range = 0.3 to 2.5 miles per road segment). The effectiveness of $MgCl2$ increases with increasing humidity levels (Piechota et al. 2004). However, humidity is low in northern Arizona outside of the monsoon season and there would be little or no need for dust abatement during the monsoon rains. Therefore, lignin would probably be used most often on the 4FRI landscape. Because of the limited application both 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 MSO.

## Disturbance

Potential disturbance could occur from project implementation, such as noise from harvest-related machinery, transporting forest products, preparing for prescribed fire, and smoke settling during burning operations.

### Noise disturbance

Noise disturbance to owls has typically been a concern with road-related activities. In response, disturbance researchers have monitored owl response to different noise sources and volumes. Experiments have been conducted at varying distances from known nest and roost sites, correlating noise levels with the biology and/or behavior of owls. A simple but consistent relationship has been identified between noise and distance to birds: as stimulus distance decreased, spotted owl response increased, regardless of stimulus type or season (Wasser et al. 1997, Delaney et al. 1999).

In a study on helicopter and chainsaw disturbance, distance was a better predictor of spotted owl response to helicopter flights than noise levels (Delaney et al. 1999). MSO behavioral responses were minimal when helicopter and chainsaw noise disturbance stimuli were at least 115 yards per 0.06 miles away. At this distance, no birds flushed from their nest. An alert response (i.e., turning toward the source of the noise) was documented at 0.25 miles (Delaney et al. 1999). Delaney and Grubb (2003) determined that spotted owls appear to be capable of hearing sounds from road maintenance equipment at distances of at least 400 meters (0.25 miles). Wasser et al. (1997) found a statistically significant difference in levels of the stress hormone corticosterone in male northern spotted owls within 0.25 miles from a major logging road compared to owls greater than 0.25 miles from the disturbance. Owls further than 0.25 miles had lower levels of corticosterone. No difference between distances was apparent for female owls. Higher corticosterone levels were apparent for male owls in close proximity to clear cutting versus those near selectively logged areas (Wasser et al. 1997). All areas investigated by Wasser et al. (1997) were in the drier forest types on the east side of the Cascade Mountains. No nesting or roosting spotted owls flushed when motorcycles were beyond about 77 yards per 0.04 miles (Delaney and Grubb 2003).

Adults never flushed in response to noise testing during the nesting season until after juveniles had left the nest; no flushes were elicited during the incubation and nestling phases (Delaney et al. 1999). While no physical response was noted this does not address potential physiological responses in adult birds. However, flushing later in the reproductive cycle suggests a decrease in adult defensive or protective behavior as juveniles matured (Delaney et al. 1999). Similarly, mean fecal corticosterone levels more than doubled in adult females when young began to fledge in the absence of noise disturbance (Wasser et al. 1997). This pattern in female corticosterone levels was significant regardless of whether or not they nested. Spot samples collected ad libitum across Washington and Oregon revealed no effect of season on males (Wasser et al. 1997).

Flushing or displaying an alert response is a proximate behavior. More important is the effects of these behaviors on reproduction. Reproductive success, or the number of young fledged, did not differ between comparing manipulated and non-manipulated nest sites in noise experiments with helicopters and chainsaws (Delaney et al. 1999). While chainsaw noise elicited a stronger response than helicopter overflights (Delaney et al. 1999), chainsaw exposure did not result in a detectable increase in fecal corticosterone levels (Tempel and Gutiérrez 2003). All nesting spotted owls exposed to motorcycle testing successfully fledged young (Delaney and Grubb 2003). Noise from management activities conducted during the breeding season was evaluated using 19-years of demographic data for northern spotted owls and no direct effects were detected as measured by reproductive output (Damiani et al. undated). Although Damiani et al. (undated) hypothesized that it may take at least a decade for cumulative negative effects of disturbance to have an effect on reproductive output, the data did not support this hypothesis.

Another study used low-level flights over PACs (about 460 m above narrow, steep-walled canyon rims) by F-16 fighter jet aircraft (Johnson and Reynolds 2002). Trials consisted of a series of three 25-second sequential fly-bys, each at a greater speed and producing more noise. Behaviors of 4 adult and 1 juvenile MSO were monitored. Responses exhibited by owls during trials did not exceed behaviors observed during the 10-minute pre- and post-flight observation periods. Of 21 total fly-bys, 5 (about 24%) produced no response, 9 (about 43 percent) produced low responses, and 7 (about 33%) produced intermediate responses; none produced high responses. The owls that responded with low or intermediate responses quickly returned to normal behaviors such as sleeping, awake but quiet, or preening. The quick return to normal behavior was also noted by MSOs after helicopter disturbance (Delaney et al. 1999).

Spotted owls tend to be less affected by nonthreatening human activity occurring in close proximity to the birds than are most other raptor species (Delaney et al. 1999). Trend data suggests the likelihood of spotted owls habituating to repeated exposures to disturbance during the course of the nesting season, but sample sizes were too small to establish significance of the trends (Delaney et al. 1999, Johnson and Reynolds 2002). These findings corroborate the results of another study that suggested spotted owls can tolerate low-intensity human sound in their environment without eliciting a physiological stress response (Tempel and Gutiérrez 2003). Spotted owls are known to nest near roads with heavy truck traffic (Franklin personal communications 2013). While these studies are not definitive, the impacts of low level repeated noise do not appear to affect reproduction. Based on these observations, it is reasonable to expect that 4FRI-related vehicle noises, including regular truck traffic occurring further than 0.25 miles from owls, would not cause a detectable stress response in nesting and roosting MSOs.

Available noise disturbance research does not address effects to owls foraging outside of PACs and little information is available regarding owls outside the breeding season. Owls can be active during crepuscular hours and could, on occasion, forage during daylight, increasing the risk of noise disturbance from road activities to individual foraging MSOs. In addition, hauling of forest materials is also likely to occur at night. Disturbance to foraging owls would be site-specific and could cause owls to shift their foraging opportunities. There could be energetic costs and increased risk of predation associated with displacement of foraging owls. The likelihood of this occurring is unknown as is whether or not there are actual effects.

Transportation-related activities have timing or distance restrictions in or near PACs and core areas. The intent and expectation is to avoid all mechanized equipment in core areas and avoid working in PACs during the nesting season. Hauling would occur in 1 PAC and along the border of another PAC during the nesting season. In both cases the haul roads are greater than 0.25 miles from the core areas. An added mitigation factor would require trucks to drive less than 25 miles per hour within PAC boundaries. We expect to avoid noise disturbance to nesting and roosting owls as a result of preplanning, project design features, and mitigation. Foraging owls could be affected by noise, but based on research related to mechanical noise disturbance, we do not expect adverse effects. However, history has shown that timelines and circumstances can change in ongoing projects. It is not unreasonable to anticipate unforeseen circumstances leading to a need to conduct road work or hauling within a PAC during the breeding season. The risk of this occurring is exasperated by the spatial and temporal scales of the project. While this is not the intent of the project, if exceptions were to occur they would be limited in number and scale and the FWS would be notified.

#### Collisions

Road work and particularly hauling harvested materials out of the forest increases the risk of collisions between MSO and moving vehicles. While the risk is short-term, the effects could be long-term. There are documented mortalities of MSOs from collisions with moving vehicles, including on unpaved forest roads (USDI 2012b). Little information is available on how frequently collisions might occur and what conditions might relate to owls being more or less vulnerable. Birds migrating or dispersing through unfamiliar terrain may be at higher risk than resident birds (USDI 2012b).

Collisions are not typically analyzed in projects proposing vegetation manipulation. However, because of the scale of the 4FRI in terms of time, area, and the level of potential road traffic, this was identified as a potential risk. Based on a series of assumptions (see Methodology section above) we calculated that, on average, there would be a total of about 417 truck trips per day across the 4FRI landscape during a 276 day hauling season for the duration of the project. While actual numbers would vary, we feel this represents the likely maximum number of daily truck trips. If fewer acres were treated, more product was chipped, or shorter winters extended the hauling season, the actual number of truck trips per day would be less. A design feature specific to MSOs restricts hauling speeds in PACs to 25 miles per hour or less (a similar design feature applies to goshawk PFAs as well).

Task orders for implementing the 4FRI would be issued annually to work localized areas to facilitate efficiency of work on the ground. Work would occur in an incremental manner as new annual task orders are issued. Vehicular activity resulting from harvest operations would increase well above existing traffic levels for about 2 years before operations would shift to other areas. The level of short-term 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. Current road use includes little traffic through the night and this could shift to include hauling at night and during crepuscular hours, creating a higher risk of collisions with MSO. This localized, short-term risk would continue to move around the landscape for the duration of 4FRI-related harvest activities, although not all harvest and related actions would overlap with MSO 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 appendix 2 for more detail.

#### Habitat Loss and Fragmentation Due to Roads

Roads (versus road work) could potentially affect MSOs through impacts to prey species. Roads can both directly and indirectly affect individual wildlife species and their associated habitats. Roads can cause a decline in habitat effectiveness in addition to the outright loss of habitat. Roads can also present barriers to some species, potentially affecting a species' persistence of occupancy in fragmented habitats.

The footprint of a new road represents a direct loss of habitat. Temporary roads would be constructed with a minimum amount of disturbance because they would be decommissioned when treatments are completed, typically within months of road initiation. A temporary road requires on average, about an 18 feet wide travel way. Depending on site conditions, they could also require roadside work such as ditches, slope cuts, fill, berms, etc. This could enlarge the overall road disturbance to 25' wide. Some roadside work would still support grasses, forbs, and shrubs, thereby retaining habitat value (Bissonette and Rosa 2009, Conniff 2013). Because specific road locations are not known, an average width of 25 feet was assumed. One mile of road 25 feet wide would replace about 3 acres of habitat.

Over half of the needed temporary roads already exist as functional roads on the landscape. They are not part of the FS system road network and so are considered temporary. All proposed temporary roads in protected habitat currently exist on the ground. Temporary roads in restricted habitat would be a mix of existing and constructed roads. About 68 total miles of temporary roads would occur in restricted habitat. The exact breakdown of existing temporary roads and those requiring new construction are not known a priori. A conservative approach to estimating habitat loss (i.e., one that reflects the greatest impact to habitat) is to assume all temporary roads in restricted habitat would require new construction. Assuming all temporary roads would require a 25 feet wide disturbance zone, 68 miles of new road construction would lead to the loss of about 204 acres of forest in the short-term. However, no new permanent roads would be constructed in MSO habitat. In the long-term, available habitat would increase as a result of temporary road decommissioning.

In addition to direct habitat loss, wildlife species sensitive to road effects can potentially be affected by decreases in habitat quality near roads, risk of mortality from collisions with vehicles, loss of access to resources on the other side of the road (barrier effect), and loss of population/meta-population function as animals are split into smaller and more vulnerable fractions (i.e., loss of connectivity/habitat fragmentation; Jaeger et al. 2005). Roads will affect persistence of animal populations differently depending on (1) road avoidance behavior of the animals (e.g., noise avoidance, road surface avoidance, and car avoidance); (2) population sensitivity to road effects; (3) road size and type; and (4) traffic volume (Jaeger et al. 2005).

Bissonette and Rosa (2009) examined how roads affect habitat in vegetation zones adjacent to an Interstate highway in the Southwest. They evaluated road effects and habitat effectiveness by examining small mammal communities at increasing distances from the highway. They recorded 11 genera and 13 species, but detected no clear road effects on wildlife abundance, density, or diversity. Two of 13 species were never captured near roads. The abundance of the remaining 11 small mammal species was either similar at different distances from the road or increased closer to the road. Comparable results were documented by McGregor et al. (2008) who found small mammal densities did not decrease near roads and found no evidence for decreases in small mammal densities with increasing traffic levels. Bissonette and Rosa (2009) concluded that adjacent zones of vegetation often provide favorable microhabitat for many small mammals. In an unrelated study that quantified the relationship between road density and relative wildlife abundance, none of the habitat and vegetation variables measured showed a significant correlation with road densities and were dropped from further analysis (Rytwinski and Fahrig 2011). Managing for improved roadside and median vegetation was proposed as a way to increase beneficial aspects of wildlife habitat near roads (Conniff 2013).

Another study tested the hypotheses that mobile species should be more negatively affected by road mortality than less-mobile species (because they interact with roads more often) and that species with lower reproductive rates and longer generation times should be more susceptible to road effects because they are less able to rebound quickly from population declines (Rytwinski and Fahrig 2011). Low reproductive rates were the best predictor of negative population-level responses to roads, explaining nearly 70 percent of the variation in the coefficients relating mammal abundance to road density (Rytwinski and Fahrig 2011). Increasing body size and increasing home range area were also predictors of negative effects of road density on relative abundance of wildlife. None of the possible confounding vegetation and habitat variables they measured were significantly correlated with road density. The authors suggested priority should be placed on mitigating road effects on large mammals with low reproductive rates (Rytwinski and Fahrig 2011). The lack of negative effects for species with high reproductive rates, small body size, and smaller home range movements agree with the results described by McGregor et al. (2008) for small mammals and road densities. Some of the small mammals included in this study were of the same genera as MSO prey species.

Fahrig and Rytwinski (2009) completed a systematic review of 79 studies addressing road effects on wildlife. Interestingly, they never define “road” but the implication is that they are assessing highways. This implication is based on repeated references to traffic levels that present direct barriers, traffic noise levels that indirectly inhibit songbird communication, fencing along roadways that inhibit movement, effects of road surfaces inhibiting wildlife movements with associated figures displaying paved roads, and potential wildlife crossings (“ecopassages”) to mitigate road effects. This is an important point given the significant differences between highways and the temporary forest roads proposed in the 4FRI in regards to scale of the roadway footprint, native rock surfacing, lack of fencing, lower traffic volumes, and the ephemeral nature of 4FRI temporary roads.

Fahrig and Rytwinski (2009) concluded roads had negative effects on 114 species, positive effects on 22 species, and 56 species showed no effects. Patterns were apparent within taxa and based on body size. Amphibians and reptiles tended to show negative effects. Birds showed mainly negative or no effects, with a few positive effects for some small birds and for vultures. Small mammals generally showed either positive effects or no effect, mid-sized mammals showed either negative effects or no effect, and large mammals showed predominantly negative effects. General patterns for invertebrates were not apparent, because of the small number of studies for this group. The small mammal reviewed included some of the same genera and sometimes the same species as those preyed on by MSOs (Table 65). They concluded that some small mammal species that are not disturbed by road traffic, have small movement ranges, small territory sizes, and high reproductive rates are unlikely to be negatively affected by roads because road mortality is low and viable populations can exist within areas bounded by roads.

**Table 65. Small mammal response to roads, adapted from Fahrig and Rytwinski 2009**

| Common Name | Scientific Name | Response |
|---|---|---|
| Ground squirrel | *Ammospermophilus* | neutral |
| Voles | *Microtus* spp | neutral/positive |
| Woodrat | *Neotoma lepida* | neutral |
| Deer Mice | *Peromyscus* spp | neutral/negative, neutral, neutral/positive, and positive |
| Other Mice | *Ochrotomys* and *Mus* spp | neutral & positive |
| Chipmunk | *Tamias* spp | positive |

McGregor et al. (2008) looked specifically at road effects on small mammals and they did document avoidance behavior. They found no significant effects on small mammal densities near roads or in association with road traffic. When they experimentally translocated animals they did find that every intervening road reduced the probability of successful returns by 50 percent. They concluded that roads were partial barriers and also detected some indications that small mammals avoided cars. They also determined that small mammals were avoiding the road surface itself and not the traffic or traffic noise. All roads included in the study were paved. Road widths including shoulders ranged from 22 to 58 feet.

Jaeger et al. (2005) conducted a systematic review and meta-analysis of road effects on wildlife populations. They built a model addressing road effects and persistence of wildlife populations. The most vulnerable populations were those that avoided high noise and road surfaces. Small mammals do not seem to avoid road noise (McGregor et al. 2008). Road definitions for the model included small roads consisting of one lane in each direction and large roads with 2 or more lanes in each direction. All roads were assumed to be paved (Jaeger et al. 2005). Similar to McGregor et al. (2008), they found road effects strongly tied to the surface pavement. An additional finding of Jaeger et al. (2005) was that population persistence was tied more to traffic volume than road size. They assumed that a species avoiding noise would not live in a place adjacent to low traffic volumes. Conversely, a species with only slight noise avoidance would breed in appropriate habitat irrespective of distance from roads. As described above, no clear effects were detected for small mammal abundance, density, or diversity relative to distance from roads, including species and genera preyed on by MSOs.

While roads are barriers to animal movement and could affect population persistence for some species, this by itself is a very broad generalization. The literature indicates that relatively small, unpaved roads are not likely to affect populations of small mammals, including MSO mammalian prey species (Jaeger et al. 2005, McGregor et al. 2008, Bissonette and Rosa 2009, Fahrig and Rytwinski 2009). While individual animals may be killed by vehicles while they are crossing the road, overall effects to small mammals are not likely to occur at a scale that would affect MSOs. Decommissioning over 900 miles of currently open roads across the 4FRI treatment area would further benefit owls and their prey in the long-term by restoring habitat.

#### Smoke Disturbance

Burning in PACs would focus on reducing surface fuels, particularly pine litter, and increasing tree canopy base height while retaining adequate levels of CWD, down logs, and snags through prescription and ignition techniques. This should reduce future surface fire intensity and flame lengths. Prescribed fire across extensive acreages should move forests towards the desired condition of supporting frequent, low-severity fire. Increasing canopy base heights decreases the risk of crown fire. Because of the denser forest conditions in MSO habitat, prescriptions would be designed to burn at a lower severity than treatments outside MSO habitat. An expected outcome of this approach is patchier burning, attaining a broader mosaic of habitat conditions for MSOs and their prey. Burning in PACs would occur outside the MSO breeding season (i.e., September 1 through February 28).

Smoke settling into low-lying areas in association with prescribed fire typically does not last more than 1 or 2 nights. Limited smoke within PACs would be expected to repeat an aspect of the evolutionary environment for wildlife in northern Arizona and so result in negligible effects to MSO (Horton and Mannan 1988, Prather et al. 2008). Some first-entry burns would include fuel loads well above historical levels, creating quantities of smoke greater than what would likely have occurred during frequent fire return intervals. As a result, uncharacteristically dense smoke could settle into core areas on occasion. This should be minimized or avoided through the designation of Exclusion and Opportunity Zones for burning outside or inside the MSO nesting season (see methodology above).

If dense smoke from first-entry burns settled into nest areas early in the season (March through June), it could disturb brooding females. This could potentially result in loss of egg viability or chick mortality if the adult female flushed long enough to affect brooding or care of young nestlings. Dense smoke settling for seven or more consecutive nights could also affect developing lungs of nestlings or adults (Rombout et al. 1991). Causing the female to abandon egg incubation or affecting lung development of nestlings would cause long-term adverse effects. Prolonged exposure, here defined as more than three continuous days and nights of settling smoke, would have adverse effects to MSOs. However, this is unlikely to occur. Prescribed fire would typically result in short-term effects, with smoke patterns similar to the evolutionary environment in which owls evolved. Smoke settling into PACs less than three continuous days and nights would not be expected to cause adverse effects.

Smoke from prescribed fire would comply with Arizona Department of Environmental Quality requirements (ADEQ). Smoke effects are regulated and permits are required by ADEQ before ignition can begin. Air quality requirements specify management actions will meet air quality standards. ADEQ considers the cumulative effects of smoke emissions from multiple jurisdictions prior to approving daily prescribed fire activities. This mitigates the potential for severe smoke effects from multiple prescribed fire projects across the entire treatment area.

## Amendments Supporting the Action Alternatives

This analysis incorporated the proposed amendments to the Coconino forest plan, including:

- mechanical treatments in PACs (cutting trees up to 16-inches d.b.h. in alternatives B and D and cutting trees up to 18-inches d.b.h. in alternative C) to improve forest structure, including maintaining/developing uneven-aged and uneven-sized tree groups with multistory canopies, i.e., to better meet desired conditions for MSOs;
- prescribed fire in 54 core areas to improve prey habitat and reduce risk of high-severity fire in PACs;
- managing current and future nesting and roosting habitat according to the minimum BA guidelines in the Recovery Plan (USDI 2012b) rather than the BA guidelines described in the 1995 Recovery Plan so that stands would be more resilient while still retaining nesting and roosting habitat;
- restoring meadows in mollisol and mollic intergrade soils to improve prey habitat; and
- following a monitoring plan developed in collaboration with the FWS.

The amendments are designed to allow treatments that were developed to create and sustain nesting and roosting habitat. If the amendments were not included as part of this alternative, the results would the same as those in alternative E. Alternative E would do the least in terms of moving forest structure towards the desired conditions described in the recovery plan (see comparison of alternatives in the effects to MSO below). By the year 2050, the results from alternative E in terms of density of trees in the larger size classes, the percent of SDImax, and total BA in the 18 PACs proposed for mechanical treatments are not much better than taking no management action (see analysis below). Maintaining higher tree densities would maintain or increase the rate of density-dependent tree mortality in the largest tree size-classes and overstory mortality from insects and disease would continue to increase in PACs. The combined results would include a decreased potential to create and retain large pine and oak trees. A subsequent decrease would be expected in the future development of large snags and logs.

Without amendments, only alternative D, the alternative that minimizes prescribed fire, would do less than alternative E to reduce the risk of high-severity fire in protected habitat. On a finer scale, uncharacteristic surface fuels and ladder fuels would be maintained in 54 core areas. Fuels will continue to accumulate in core areas and so would the potential for crown fire in PACs.

Alternative E would not provide for grassland restoration or the creation of savannas. While much of these vegetation types would be outside of MSO habitat, it would include areas interspersed with protected and restricted habitats and meadows within MSO habitat. Some areas could function as foraging habitat for MSO and some as providing source populations of prey species, thereby enhancing MSO habitat.

The amendments proposed for managing canopy cover and open reference conditions in goshawk habitat, cultural resource determinations would not affect MSOs or their habitat.

## Evaluation Criteria – Protected, Restricted, and Critical Habitat

Large trees, including ponderosa pine and Gambel oak, large snags, and large logs are important to MSOs and many of their prey species. These structural elements need to be distributed both spatially and temporally. The spatial evaluation is to ensure MSO habitat elements occur across the pine-oak forest. A temporal distribution includes maintaining existing large and old trees while setting a trajectory for future tree recruitment into larger size classes. Habitat elements used to evaluate the alternatives for MSO include:

### *Forest Structure and Density*

- A range of tree sizes and ages emphasizing trees greater than 12 inches d.b.h. (at least 15 percent of the trees with a d.b.h. of 12 inches or greater, 15 percent of the trees with a d.b.h. of 18 inches or greater, and 15 percent of the trees with a d.b.h. of 24 inches or greater) in nesting, roosting, target, and threshold habitats and 30 to 45 percent of the trees with a d.b.h. of 12 inches or greater in other protected and restricted habitat and with an overall goal of uneven-aged structure)
- A preponderance of large trees ( greater than 18 inch d.b.h.) suitable for perching or roosting (goal of at least 20 per acre)
- BA and density of pine (goal of at least 150 square feet per acre in nesting and roosting habitat for alternatives B, D, and E and a BA of at least 110 square feet per acre in alternative C) and Gambel oak (goal of at least 20 square feet per acre) in MSO pine-oak habitats
- Closed canopy conditions (goal of 40 percent or more) with a diversity of tree sizes and species

### *MSO Prey Habitat*

- Large dead trees (snags with diameters of 18 inches d.b.h. or greater)
- Changes in prey habitat, including high volume of fallen trees and other woody debris, species richness in the herbaceous layer, plant abundance and the ability to regenerate and produce fruits and seeds, and other improvements to prey habitat

### *Fire Effects*

- Changes in fire severity and fire behavior (i.e., the ability to retain forest structure through time)

### *Other Habitat Changes*

- Springs, ephemeral channels, meadows, and aspen
- Road decommissioning, construction, and maintenance

### *Disturbance*

- Project duration and disturbance associated with project activities, including mechanical harvesting and hauling of materials out of the forest (spatial and temporal duration)
- Prescribed fire activities, including , preparation, implementation, smoke and fire effects (spatial and temporal duration)

### *Primary Constituent Elements in Critical Habitat*

PCEs essential to the conservation of the owl include those physical and biological features that support nesting, roosting, and foraging. PCEs for MSO habitat within pine-oak forest provide one or more habitat needs for nesting, roosting, foraging, and include:

### *Forest Structure*

- A range of tree species of different sizes and ages;
- Thirty to 45 percent of the trees with a d.b.h. of 12 inches or greater;
- Shade canopy of 40 percent or more;
- Snags of 12 inch or greater d.b.h.

### *MSO Prey Habitat*

- High volume of fallen trees and other woody debris;
- A wide range of tree and plant species, including hardwoods;
- Adequate levels of residual plant cover to maintain fruits, seeds, and plant regeneration.

Critical habitat generally includes a subset of both protected and restricted habitat, as defined in the Recovery Plan.

The Silviculture Report provides a complete description for silviculture treatments for alternatives B, C, D, and E and conifer removal within Garland Prairie (alternative C). Prescribed fire for alternatives B, C, D, and E is detailed in the Fire Report.

In the discussions within the action alternatives below, the proposed actions are first introduced by topic (e.g., thinning and/or burning, changes to roads, restoration of special habitats like meadows and springs, etc.). These proposed changes are then tracked sequentially within MSO habitat, i.e., the amount of thinning or burning or changes to roads is first reviewed in the context of protected habitat, then restricted habitat, etc. This includes the effects of the proposed activities on forest structure and prey habitat by individual MSO habitat. Each alternative concludes with a summary of the actions and an effects determination. Analyses are frequently presented at the RU level in an attempt to simplify reporting out of effects. More detail, e.g., effects to individual PACs or subunits, is presented in appendices 12 through 15.

A key component of prey habitat is the herbaceous understory. Understory vegetation provides food and cover for most small mammals and many avian species. It also supports the arthropod community that provides a direct source of food for many vertebrate species and, indirectly, provides ecosystem services such as pollination of flowering plants and parasitism of forest pest species. A review and evaluation of understory response to overstory treatments is presented in appendix 6. The evaluation includes a relative index of herbaceous biomass response to the various treatments using equations from the published literature. These biomass values are not predictions of actual biomass yield, but an index developed to compare the relative degree of change between alternatives. Background on how thinning, prescribed fire, and wildfire can affect understory vegetation and associated arthropods, along with the equations used to develop the index values, can be found in appendix 6.

## Alternative A (No Action)

Alternative A was analyzed to contrast the impacts of the action alternatives with current conditions and expected future conditions should the 4FRI project not occur. This alternative proposes no restoration treatments, but forest metrics are modeled the same as in the action alternatives, e.g., PACs are reported by management treatment types to facilitate comparisons among alternatives even though no treatments occur under this alternative.

### *Forest Structure and Density*

This alternative includes no new mechanical or prescribed fire under the 4FRI in any habitat, including ponderosa pine, pine-oak, aspen, meadows, springs, ephemeral channels. No road construction, maintenance, or decommissioning would occur within the treatment area. None of the associated wildlife habitats would be restored or moved towards restoration.

Alternative A would not decrease the overabundance of mid-aged trees, increase survival and growth rates of older trees, and would not create additional recruitment of young trees. The distribution of tree size classes remains highly skewed towards trees 12 to 17.9 inches d.b.h. in both the short- and long-term. Trees 18 to 23.9 inches d.b.h. are about at desired conditions by the year 2050. However, trees greater than 24 inches d.b.h. remain well below the distribution described in the Recovery Plan in both the short- and long-term (Table 66).

Numbers of TPA 18 inches d.b.h. and greater are below the recommended minimum of 20 or more across all RUs in 2020, although average values are close to the minimum in target and threshold habitats. Nearly all RUs are above 20 TPA by 2050. On average, BA approaches or exceeds the minimum recommended level of 150 square feet per acre for nesting and roosting habitat across all habitats (Table 66). The maximum BA for nesting and roosting habitat recommended in the Recovery Plan (170 square feet per acre) is met or exceeded in all RUs supporting target and threshold habitat and in three of four RUs containing protected habitat. These dense conditions are reflected in high percentage of SDImax occurring in MSO habitat. A sustainable percentage of SDImax is 55 or less and most MSO habitat would be above 75 percent of the SDImax by 2050 (Table 66).

Percent SDImax would increase to 80 in the protected habitat (about the upper range of the Extremely High Density category) and 86 in target and threshold habitat. At this level there would be severe competition among trees with active competition-induced mortality. Individual tree diameter and volume growth rates would stagnate and there would be minimal forage production (see Table 5). Restricted “other” habitat would be about 37 percent of SDImax or at the low end of the High Density category. There would be declining individual tree diameter and volume growth rates and minimal forage production. 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. MSO habitat would not be resilient to 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 (Table 66).

Based on the percent of SDImax, TPA greater than 18 inches d.b.h., and total BA, canopy structure would remain dense and canopy cover high. With no prescribed fire canopy base height would remain low, reducing flight space for foraging owls and maintaining a higher risk of future surface transitioning into crown fire (see fire effects below). New regeneration would be limited, delaying the time required for future recruitment into larger size-classes.

Tree growth rates in the large size-classes would be largely be limited or stagnant across the ponderosa pine forest based on percent SDImax. 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 MSO habitat.

**Table 66. Modeled changes in forest structure within MSO PACs in Alternative A**

| Forest Attributes | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative A (Year 2050) |
|---|---|---|---|
| **Mechanical and Prescribed Fire Treatment Group (n=18)** | | | |
| % of SDI 12-18” d.b.h. | 30 | 31 | 28 |
| % of SDI 18-24” d.b.h. | 14 | 16 | 23 |
| % of SDI >24” d.b.h. | 8 | 9 | 12 |
| % of Max SDI | 75 | 76 | 78 |
| TPA >18" | 15 | 18 | 27 |
| Ponderosa Pine BA | 124 | 129 | 137 |
| Gambel Oak BA | 19 | 20 | 26 |
| All BA | 148 | 157 | 174 |
| % Oak BA | 13 | 13 | 15 |
| **Prescribed Fire Only Treatment Group (n=52)** | | | |
| % of SDI 12-18” d.b.h. | 31 | 32 | 28 |
| % of SDI 18-24” d.b.h. | 13 | 16 | 22 |
| % of SDI >24” d.b.h. | 8 | 8 | 11 |
| % of Max SDI | 79 | 81 | 83 |
| TPA >18" | 15 | 18 | 28 |
| Ponderosa Pine BA | 120 | 124 | 127 |
| Gambel Oak BA | 22 | 24 | 27 |
| All BA | 159 | 168 | 185 |
| % Oak BA | 14 | 14 | 14 |

## MSO Prey Habitat

### Snags, Down Logs, and Coarse Woody Debris

All habitats and all RUs show an increase in CWD and snags greater than 18 inches d.b.h. (Table 67). While creation of large snags would continue, the decreasing numbers of large trees through time could maintain a deficit of large snags beyond the year 2050. Pulses of large snag creation may occur at any time as a result of fire, insects, and disease. Increases in large snags as an outcome of stochastic events would result in decreases of large trees. Large trees are already underrepresented across the landscape and generally would not be replaced due to the stagnant growth rates. Small mammal habitat would be maintained through time in terms of logs and CWD under this alternative. However, accumulated CWD could decrease MSO habitat effectiveness (Roberts et al. 2010)

#### Understory

Herbaceous forage and cover for prey species would be limited and declining in both the short- and long-term (Table 67). Canopy development combined with lack of fire and needle accumulation would cause a continued decline in understory through time. The continued loss of and fragmentation of understory vegetation would limit invertebrate populations, including pollinators. If this pattern continued over time, a potential cascading effect could occur as arthropod species richness and abundance declines, increasing the rate of decline in understory biomass and potentially causing an additive effect to MSO prey species (appendix 6). Combined, decreases in understory vegetation and associated arthropod communities could affect MSO directly (lack of flying insects as prey) and indirectly (food availability for prey species such as mice, voles, birds, and bats). Understory vegetation would remain at low levels of productivity and would continue to decrease through time, except in areas where fire, insect, and/or disease opened the canopy.

Recovery Plan direction is to sustain owl nesting habitat in such a way as to maintain and create replacement owl habitat where appropriate while providing heterogeneous forest conditions and across the landscape. The combination of owl habitats should result in a landscape mosaic that ensures adequate nesting, roosting, and foraging habitat for current populations of MSOs and their prey as well as for the eventual recovery of MSOs. A continuous supply of nesting and roosting habitat requires maintaining stands in different stages of ecological succession. Alternative A would maintain forest conditions dominated by dense, mid-aged trees. Tree densities would be expected to create severe competition among trees and restrict growth rates in mature trees. This would slow or prevent recruitment of trees greater than 24 inches d.b.h. The declining understory index values indicate prey habitat would continue to decline (appendix 6). Alternative A would not mimic the natural landscape, would not aid in the development of nesting and roosting habitat, and would do nothing to ensure future nesting and roosting habitat. Therefore, alternative A does not move MSO habitat towards the desired conditions described in the forest plans or the Recovery Plan.

**Table 67. Changes in prey habitat in MSO PACs under Alternative A**

| Forest Attributes | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative A (Year 2050) |
|---|---|---|---|
| **Mechanical Treatment and Prescribed Fire Group (n=18)** | | | |
| Snags >12" | 3.15 | 4.05 | 7.13 |
| Snags >12" and <18" | 2.59 | 3.40 | 5.64 |
| Snags >18" | 0.56 | 0.65 | 1.49 |
| CWD >3" | 4.71 | 6.22 | 10.33 |
| Logs | 1.31 | 2.27 | 5.81 |
| Understory Index | 37 | 31 | 23 |
| **Prescribed Fire Only Treatment Group (n=52)** | | | |
| Snags >12" | 3.64 | 4.61 | 8.08 |
| Snags >12" and <18" | 2.98 | 3.87 | 6.27 |
| Snags >18" | 0.66 | 0.74 | 1.81 |
| CWD >3" | 6.04 | 7.79 | 12.59 |
| Logs | 2.88 | 3.93 | 8.06 |
| Understory Index | 36 | 31 | 23 |

### Fire Effects

Maintaining the current trajectory for forest conditions would maintain the increasing risk of uncharacteristic fire. Ponderosa pine ecosystems would become increasingly departed from desired conditions in alternative A, increasing risks to ecosystem structure, pattern, composition, and function. FRCC in ponderosa pine would start and stay in condition class 3. Ponderosa pine starts in, and stays in an FRCC 3, as VCC, fire frequency, and fire severity become increasingly departed from the reference condition in alternative A (Table 68). Species composition would shift, affecting food and cover for wildlife and potentially affecting future fire behavior. More details on FRCC and VCC can be found in the Methodology section above.

Acres of grasslands in VCC1 would decrease in the absence of any type of treatment, as woody species continued to encroach and species composition shifted in favor of less fire adapted species. Acres of ponderosa pine in VCC 2 and 3 would continue to increase, leaving just 2% in VCC 1. Ponderosa pine in the project area would be at a high risk of losing key ecosystem components, should there be a disturbance event, such as fire or extended drought.

**Table 68. Modeled changes to fire regime condition class under Alternative A**

| | 2010 | | 2020 | | 2050 | |
|---|---|---|---|---|---|---|
| **VCC – Alternative A** | **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** | |

Surface fuel loading in protected habitat, including litter, duff, and CWD greater than 3 inches, is well above the conditions in general ponderosa pine forest (Figure 22). This is particularly true for core areas. Figure 22 represents treatments grouped by the degree of similarity in forest openness that would result post-treatment. Historical values for surface fuels were up to about 5 tons per acre for CWD and less than 2.5 tons per acre for duff (Brown et al, 2003). Assuming litter adds about 2.5 tons per acre (Fire Ecology report), none of the areas would be within the historical range of surface fuel loading in 2020 and levels would continue to increase through 2050. High surface fuel loading can burn with a higher severity and has potential to negatively impact understory resources such as seed banks, soil flora, and arthropod populations (appendix 6). Crown fire is more likely if surface fuel build-up continues, leading to increased flame lengths. High surface fuel loadings can negatively affect MSO prey populations by altering the understory vegetation response, negatively affecting food resources for prey species. See appendix 19 for maps comparing surface fuels across the 4FRI treatment area.

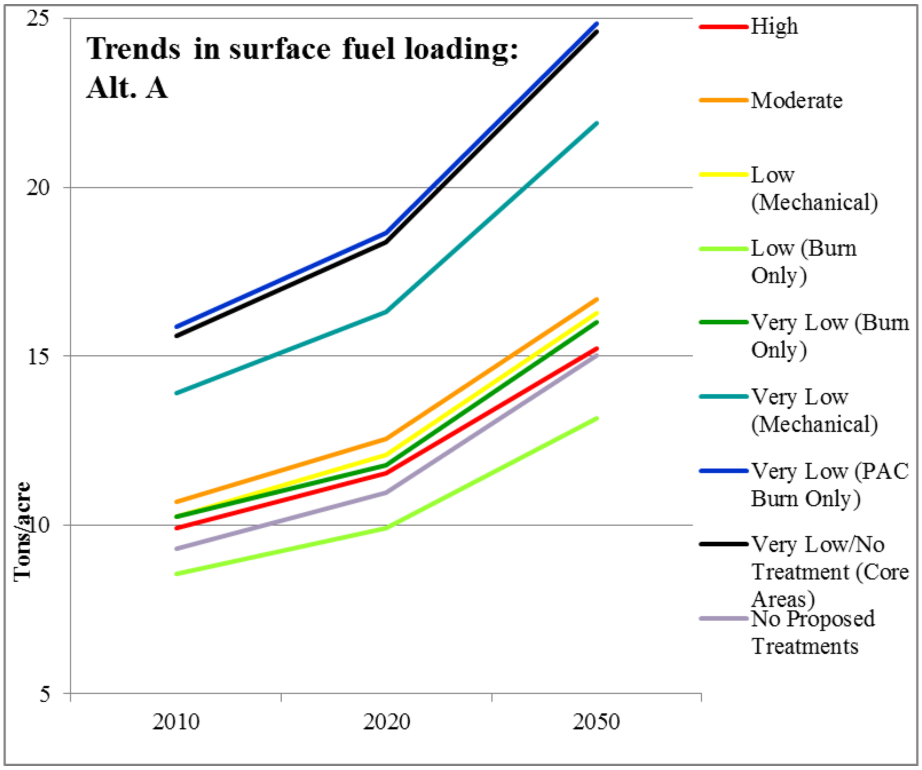


**Figure 22. Modeled changes in surface fuel loading grouped by management treatment intensity (note that no treatments would occur under alternative A)**

Maintaining current forest conditions would maintain a high risk of crown fire. Over 45 percent of MSO habitat would likely burn as crown fire under alternative A (Table 69). All crown fire would be expected to burn with high-severity (Fire Ecology report). The likelihood of high-severity fire and the size of wildfires producing undesirable effects would continue to increase. Alternative A does not follow Recovery Plan guidance for retaining management flexibility for abating risk of high-severity fire (USDI 1995 and USDI 2012). Note that fire modeling excluded nonburnable substrate such as water, rock, roads, cinders, areas of sparse vegetation, and other acres on which there were insufficient fuels to carry fire under the conditions modeled. These acres range from 44 acres (>1%) in RU6 to 3,746 acres (6%) in RU5 (fire ecology report).

Ponderosa-oak habitat does not meet desired conditions relative to fire behavior. The risk of undesirable fire behavior and effects would continue in 2020 with no management action. Maintaining a landscape in high density tree groups would lead to density-dependent mortality and increased risk of stochastic events such as uncharacteristic fire or outbreaks of forest pathogens (see the fire ecology and silviculture reports). Large-scale high-severity fire events can alter seral development, delaying pine-oak recruitment for decades to a century or longer (Savage and Mast 2005, Strom and Fulé 2007).

**Table 69. Modeled fire behavior in MSO habitat under current conditions and in 2020 under Alternative A[1]**

| MSO Habitat | Total (Acre) | Surface Fire (Acre) | Passive Crown Fire (Acre) | Active Crown Fire (Acre) | Surface Fire (%) | Passive Crown Fire (%) | Active Crown Fire (%) |
|---|---|---|---|---|---|---|---|
| **Existing Condition** | | | | | | | |
| Ponderosa Pine | 507,839 | 311,313 | 48,023 | 143,186 | 61 | 9 | 28 |
| 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 "Other" | 66,419 | 35,019 | 6,540 | 24,756 | 53 | 10 | 37 |
| **Alternative A** | | | | | | | |
| Ponderosa Pine | 507,839 | 309,651 | 45,331 | 147,588 | 61 | 9 | 29 |
| Protected | 35,262 | 16,963 | 2,522 | 15,611 | 48 | 7 | 44 |
| Target/ Threshold | 8,692 | 4,327 | 1,142 | 3,209 | 50 | 13 | 37 |
| Restricted "Other" | 66,419 | 35,188 | 6,767 | 24,379 | 53 | 10 | 37 |

[1]Acres by fire behavior- do not equal total acres due to areas of nonburnable substrate such as rock, cinders, and areas with insufficient fuels that would not support fire; nonburnable substrate totals <1% of the ponderosa pine treatment area.

Alternative A does not meet the purpose and need for the project. MSO habitat would continue to degrade over time in terms of forest structure and health. Development of the large tree component would continue to be compromised by density-dependent competition and mortality. Understory development would be maintained at uncharacteristically low levels and continue to decline. Other specialty habitats important to prey species such as meadows, aspen, springs, and ephemeral channels would continue to degrade or be lost entirely over the long-term. MSO habitats would be on a trajectory moving further from desired conditions as described in the Coconino and Kaibab forest plans.

### *Other Habitat Effects*

#### Springs, Ephemeral Channels, Grasslands, Savannas, Meadows, and Aspen

No spring or ephemeral stream channels would be restored. Twenty three springs and associated prey habitat would remain degraded within MSO habitat, including five springs in four different PACs. Similarly, wildlife habitat associated with almost 3.5 miles of ephemeral stream channels would remain degraded within MSO habitat, including about 1.7 miles of ephemeral stream channel in six PACs. The grasses, forbs, and shrubs that could potentially occupy these sites would remain absent or limited in both species richness and abundance.

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 MSO habitat. This would represent a decline in the quantity and quality of habitat for grassland associated species, including obligate migratory and sensitive avian species. As food and cover decline for small mammals, potential source populations of important MSO prey species would be expected to decline in the long-term. Overall, the landscape would move towards homogeneity as ponderosa pine continued to compromise or eliminate these key sources of heterogeneity.

Unique wildlife habitat features associated with 1,522 acres of aspen would decline or vanish as the loss continued under current conditions. Conifer trees would gradually succeed aspen trees through competition for space, light, and water is a major cause of aspen decline (Johnson 2010). Associated declines in regional avifauna would occur as a result of habitat loss (Griffis-Kyle and Beier 2003). The rate of avian decline could increase as habitat changes favored nest predators (Johnson 2010). Understory biomass would decrease exponentially as conifer cover increased (Stam et al. 2008). Understory biomass provides the food and cover to support MSO prey species, including small mammals, birds, and arthropods (appendix 6).

The impacts of these microhabitats are greater than their combined total acres. This is particularly relevant when these patches of heterogeneity occur in PACs where MSOs disproportionately forage during the nesting season.

**Roads**

Current road miles would not change under this alternative. Over 153 miles of roads would not be decommissioned in MSO habitat, including about 44 miles (29 percent) of roads within 52 PACs. About 75 miles of temporary road construction would not be required, including nearly 7 miles of temporary road that would not be constructed/improved in MSO protected habitat.

About 448 miles of roads currently on the landscape within MSO habitat would not receive maintenance. The lack of road maintenance would avoid disturbance from road equipment and, indirectly, potentially decrease long-term road use in MSO habitat, assuming public use would decrease as road conditions worsened. Approximately 1.5 miles of road currently impacting ephemeral stream channels in MSO habitat would not be relocated, thereby continuing the degradation of soil, vegetation, and watershed values associated with this limited but important prey habitat.

**Direct and Indirect Effects:** With no treatments occurring, there would be no direct increase or decrease in habitat quality of MSO protected, restricted, or Critical Habitat in the short-term. In the long-term, MSO habitat quality would decrease as a result of declines in forest health and resiliency.

The lack of mechanical thinning and low severity prescribed fire would allow the current forest trajectory to continue. Dense forests would maintain closed canopy conditions but continue to exhibit reduced growth rates. The abundance of young and mid-aged forest would continue to dominate the landscape because of stagnating growth rates and competition-induced mortality of large trees. Gambel oak, aspen, and meadows would decrease as pine encroachment continued. Spring function would decline and reaches of degraded ephemeral channels would increase. Competition for limited water and nutrients would continue and would increase in time as snow pack decreased with developing climate change.

Currently, about 309,782 acres of ponderosa pine forest, including all pine-oak habitat, are in VCC3. VCC3 will increase to about 350,409 acres by 2050 and the overall FRCC would return to FRCC3. This alternative will not reduce the threat of high-severity fire, which is a primary concern for recovery for this species. Surface fuels will continue to increase and understory vegetation will continue to decrease. Alternative A would not contribute to improving forest health or vegetation diversity and composition, or sustaining old forest structure over time, or moving forest structure toward the desired conditions.

**Disturbance**

No additional disturbance from noise, smoke, or other aspects of implementation activities would occur under this alternative.

## Alternative B – Proposed Action

Under alternative B, mechanical treatments would occur in portions of all MSO habitats except for core areas (see protected habitat below). Total treatments in MSO habitat include about 82,740 acres of mechanical thinning (about 75 percent of the total MSO habitat in the treatment area) and about 105,500 acres of low severity prescribed fire (about 95 percent of the total MSO habitat in the treatment area). This represents the second highest number MSO habitat acres treated with prescribed fire, after alternative C. However, alternatives B, D, and E have the same number of MSO habitat acres treated mechanically. The minimum post-treatment BA for nesting and roosting habitat would be 150 square feet per acre. Although this is not in line with the revised Recovery Plan (USDI 2012b), 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. Target habitat would be close to but below 150 square feet per acre. Target habitat in RU 1 would have the lowest BA at 138 square feet per acre. However, the intent and the direction in the implementation plan are to meet recovery plan guidelines. Adjustments would be made on the ground to retain a BA of at least 150. Low severity prescribed fire would be applied to all MSO habitats except core areas (Table 70). No trees greater than 24 inches d.b.h. would cut in MSO habitat. Trees up to 16 inches d.b.h. would be thinned in PACs. Group selection treatments would not occur in MSO habitat. Treatments in target habitat are designed to move forests towards threshold conditions. Treatments in threshold habitat would not lower forest structure values below the minimum threshold levels described in the forest plans and in Table III.B.1 of the Recovery Plan (USDI 1995). A comparison of treatments in MSO PAC habitat by alternative is displayed below (see Comparison of Alternatives after Alternative E effects). It is assumed that mechanical treatments and two low-severity fires would occur within the project timelines.

Increasing the diameter limit for trees that could be cut in PACs allows more flexibility to better create and maintain nesting and roosting conditions such as uneven sized/aged trees, multistory canopy, and increasing large tree growth rates. Firelines would be required around core areas, creating habitat disturbance in some of the most sensitive areas within MSO habitat. This could increase recreation (i.e., mimicking social trails) and erosion in nesting and roosting habitat. It would also increase the risk of illegal snag and oak cutting within this sensitive habitat. Precluding fire from core areas would do nothing to reduce the risk of future high-severity fire in key portions of the PACs.

Mechanical thinning and low-severity prescribed fire would take place at different times in different locations. MSO 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 will require 10 or more years to complete. If work were completed in 10 years, on average about 8,270 acres of MSO habitat would be mechanically treated and 10,600 acres of prescribed fire would occur each year under alternative B. No mechanical treatments would occur on slopes greater than 40 percent in MSO habitat.

**Table 70. Alternative B summary of treatments (acres) in MSO pine-oak habitat**

| Treatment Type | MSO Habitat Types | | | | Total Acres |
|---|---|---|---|---|---|
| | Protected[1] | Threshold | Target | Restricted | |
| Prescribed Fire Only[2] | 20,083 | 84 | 217 | 2,354 | 22,738 |
| MSO Restricted - Group Selection[3] & Intermediate Thinning[4] + Prescribed Fire | | | | 64,065 | 64,065 |
| MSO Target - Intermediate Thinning + Prescribed Fire | | | 6,497 | | 6,497 |
| MSO Threshold - Intermediate Thinning + Prescribed Fire | | 1,893 | | | 1,894 |
| PAC - Intermediate Thinning less than 18" d.b.h. + Prescribed Fire | 10,284 | | | | 10,284 |
| **Total Treatments** | **30,367** | **1,977** | **6,714** | **66,419** | **105,478** |
| No Proposed Treatments | 4,895 | 0 | 0 | 0 | 4,895 |
| **Total Analysis Acres** | **35,262** | **1,977** | **6,714** | **66,419** | **110,373** |

1. Includes PAC and steep slope habitats
2. 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.
3. Group selection is a cutting procedure which creates a new age class by removing trees in groups or patches to allow seedlings to become established in the new opening (SAF 1998)
4. Intermediate thinning is the cutting of trees to improve the composition, structure, condition, health, and growth of remaining trees (SAF 1998)

### *Protected Habitat*

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. Little change would occur in forest structure and MSO prey habitat from low-severity fire treatments and no mechanical treatments in steep slope habitat

Based on modeling (see methodology), field visits (appendix 4), and the combined expertise of biologists from the Coconino and Kaibab NFs, the FWS, and the 4FRI, modeling was done to explore optimal size classes for thinning trees in PACs. This collaborative working group of biologists had identified a concern that forests had become so dense, mechanical treatments restricted to trees less than 9 inches d.b.h. (as identified in the Recovery Plan and forest plans) would not achieve desired conditions in PACs. Therefore, alternative B would allow cutting trees up to 16 inches d.b.h. (Table 71). All stands identified for mechanical harvest would be marked by hand and marking would be coordinated with the FWS. No treatments would occur in core areas.

**Table 71. General description and acres of mechanical treatment in Alternative B by PAC (all mechanically treated PACs occur on the Coconino NF)**

| PAC Name | General Description | MSO PAC Mechanical Treatments (acres) | | | | |
|---|---|---|---|---|---|---|
| | | Treat up to 9" d.b.h. | Treat up to 12" d.b.h. | Treat up to 14" d.b.h. | Treat up to 16" d.b.h. | Total |
| Archies | Strong oak component but few large oak ; many pines less than 9 inch d.b.h. | 444 | 41 | 11 | | 495 |
| Bar M | Break up contiguous fuels in areas of pure pine, thin out dense clumps of pine to release oaks within clumps, provide openings for forage and grow larger trees | 119 | 149 | 199 | 66 | 533 |
| Bear Seep | PAC is pure ponderosa or oak, high density of trees greater than 9 inch d.b.h. | 453 | | | 144 | 596 |
| Bonita Tank | Treatments to grow larger trees and release oaks are needed in southern portion of PAC outside of ridges and draws | 37 | 203 | 429 | | 795 |
| Crawdad | Oak is supressed by high densities of pine, need for creating gaps around oak and releasing individual oak trees | 138 | | 343 | 120 | 601 |
| Foxhole | Dense thickets of pine with some oak, need for enhancing oak and thinning groups | 10 | 124 | 136 | 178 | 450 |
| Frank | PAC has areas of pure pine with dense pockets of 5-18 inch d.b.h. trees, need to release limited oaks and encourage recruitment of oaks, reduce pine densities and increase diameters of both pine and oak | 286 | 69 | 178 | 52 | 586 |
| Holdup | Most of PAC is pure pine, thin around any existing oak and provide areas for oak to establish | 57 | 197 | 264 | 18 | 535 |
| Iris Tank | Oak is present in all size classes but is suppressed by pine, need to release oaks and thin dense pockets of pine and reduce fuels southwest of the nest core | 172 | 13 | 261 | 141 | 587 |
| Knob | PAC is generally pure pine and open with dense dog-hair thickets | 273 | 26 | 252 | 114 | 665 |
| Lake No. 1/Seruchos | Dense thickets of young pine: need to grow larger trees over time, enhance/retain oaks, and create small openings | 123 | 66 | 50 | | 239 |

| PAC Name | General Description | MSO PAC Mechanical Treatments (acres) | | | | |
|---|---|---|---|---|---|---|
| | | Treat up to 9" d.b.h. | Treat up to 12" d.b.h. | Treat up to 14" d.b.h. | Treat up to 16" d.b.h. | Total |
| Lee Butte | Treat dense pine to increase oak, reduce tree density and increase tree diameter on slopes; Field review led to dropping 3 stands from treatment (457 acres) | 111 | 1 | 128 | | 306 |
| Mayflower Tank | PAC has steep slopes, heavy fuels, limited number of small trees | 257 | | 139 | 217 | 612 |
| Red Hill | Scrappy habitat, past overstory removal, dense pockets of pine with heavy mistletoe infection, thin pine to grow larger trees and reduce the potential for uncharacteristic wildfire, enhance oak where present, reduce competition with larger trees | 97 | 190 | 385 | | 672 |
| Red Raspberry | Protect microclimates from undesirable fire effects; Enhance openings, and create, retain, and enhance larger trees among the 5-18 inch d.b.h. pine | 387 | 19 | 203 | 55 | 664 |
| Rock Top | Treat in pure pine to increase oak and improve growth rates | 98 | 57 | 506 | 90 | 751 |
| Sawmill Springs | Thinning focus would be to enhance and maintain large d.b.h. size classes | 192 | 63 | 190 | | 515 |
| T-Six Tank | PAC has dense regeneration, need for removing dense patches of ponderosa pine, maintaining Gambel oak, and thinning dense pine doghair thickets | 126 | 116 | 279 | 160 | 680 |
| **Total Mechanical Treatment Acres** | | **3,378** | **1,335** | **3,951** | **1,621** | **10,284** |

Excluding fire from core areas would require strategic planning to incorporate natural fire breaks to minimize the need for firelines while also maximizing the amount of treated PAC habitat outside of core areas. Core areas have high amounts of surface fuel loading and ladder fuels. There would be potential for noise disturbance if chainsaws were needed to limb trees, or cut ladder fuels along firelines. Trying to keep fire out of core areas would increase risk to firefighters. If/where firelines were not constructed there would need to be strategic planning to incorporate natural fire breaks in a way that would maximize the area included in a prescribed fire while excluding the core area. The incorporation of natural firebreaks to exclude core areas from prescribed fire would almost always exclude additional acres that are not a part of the core area. Fireline creation would disturb soil, reduce herbaceous cover, potentially increase recreation due to trail-like scars after treatments (social trails), increase noise disturbance during operations and potentially afterwards as well (recreationists), and increased access could lead to a reduction in snags and logs (Chambers 2002, Wisdom and Bates 2008, Ganey et al. 2014). Precluding burning in core areas would inevitably reduce the number of PAC acres burned outside core areas as firelines followed topography and natural breaks. That would mean fewer acres treated in areas where it had been determined that treatment would benefit owls. Combined, 100+ acres within the average 600+ acre PAC would not have improvements to forest structure, improvements to prey habitat, or reductions in risk of crown fire.

Within 18 PACs proposed for mechanical treatment, 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 in alternative B). About 6,900 acres would be improved with mechanical treatments addressing trees greater than 9 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. Treatments were adjusted as follows to move PACs towards desired conditions for MSO habitat:

- Fifteen PACs (Archies, Bar M, Bonita Tank, Foxhole, Frank, Holdup, Iris Tank, Knob, Lake No. 1/Seruchos, Lee Butte, Red Hill, Red Raspberry, Rock Top, Sawmill Springs, and T6 Tank) would require thinning up to 12 inches d.b.h. on 1,335 acres;
- Seventeen PACs (Archies, Bar M, Bonita Tank, Crawdad, Foxhole, Frank, Holdup, Iris Tank, Knob, Lake No. 1/Seruchos, Lee Butte, Mayflower Tank, Red Hill, Red Raspberry, Rock Top, Sawmill Springs, and T6 Tank ) would require thinning up to 14 inches d.b.h. on 3,951 acres, and;
- Fifteen PACs (Bar M, Bear Seep, Bonita Tank, Crawdad, Foxhole, Frank, Holdup, Iris Tank, Knob, Lee Butte, Mayflower Tank, Red Raspberry, Rock Top, Sawmill Springs, and T6 Tank) would require thinning up to 16 inches d.b.h. on 1,621 acres.

Modeled treatments were developed to reduce BA, but remain at or above 150 feet2 per acre in forested areas currently supporting 150 BA or greater. Modeled tree removal started in the smallest size classes first. The vegetation model retained trees in each size class so that current owl habitat characteristics were retained while improving potential future habitat, i.e., modeling was not a simple thin from below exercise. Models were run at each of several size classes for each stand. Optimal treatments were defined as those that met the basal area target and produced the best growth rates. Stands with incomplete data were not proposed for thinning above 9 inches d.b.h.

Low severity prescribed fire would occur in 70 PACs (i.e., all PACs within the treatment area). Burn-only treatments would occur in 52 PACs, excluding core areas. Although the implementation schedule is not yet known, if 4FRI implementation lasted 10 years then, on average, 1.8 PACs would be mechanically treated per year, or about 2.6 percent of the 70 PACs in the 4FRI treatment in a given year. About 5.2 PACs (less than less than 7.5 percent of the 70 total PACs in treatment area) would, on average, be treated with prescribed fire each year. Affects to forest structure within individual PACs is summarized by alternative below.

Prescribed fire treatments in PACs would include the Kendrick PAC on the Kaibab NF. The wildlife analysis for the Kaibab forest plan, using a mid-scale analysis (100-1,000 acres) for evaluating effects of the proposed land management plan, concluded the Kendrick PAC consisted of mixed-conifer habitat. The 4FRI analysis is based on a finer scale and evaluated individual pine stands within the Kendrick PAC. About 173 acres of burn-only treatment is proposed for pine habitat outside the core area in alternative B. The nearby Stock Tank PAC, administered by the Coconino NF, has about 15 acres outside the core area and outside of the Kendrick Peak Wilderness Area on Kaibab NF lands.

## Forest Structure and Density

### Large Trees

Mechanical treatments would, by design, be conservative in protected habitat. Therefore, treatment results would be limited. None of the modeled forest structure attributes dropped below recommended levels immediately after treatment (Table 72). By the year 2050, percent SDI for trees greater than 18 inch d.b.h. would increase in both size-class categories as would total TPA greater than 18 inch d.b.h. The percentages of trees 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 (appendix 12). Old and large tree diameter growth and resistance to drought have been shown to increase after restoration treatments (Ericson and Waring 2013, Kerhoulas et al. 2013b). 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. Prescribed fire would contribute towards reducing competition with slight reductions in numbers of small trees. The percent distribution of larger tree size classes would remain unchanged in the burn-only PACs (Table 72), but risk from crown fire would decrease (see fire effects below). PAC habitat would remain in zone 4, or “extremely high density” where individual tree growth would be minimal due to within-stand competition, tree competition would be severe, and tree mortality would increase.

Thinning ponderosa pine in PACs would decrease competition with Gambel oak. Competition between mid-aged pine and Gambel oak for direct sunlight and water has contributed to the loss of larger diameter oak (greater than 10 inches d.r.c.). It is likely that there would be some mortality in large diameter oak from prescribed fire, particularly in first entry burns in areas where fire has been absent for 20 or more years. However, prescribed fire typically kills few oak stems greater than 6 inches d.r.c. (Abella, 2008a and b). The post-treatment results would be a decrease in oak BA, primarily in small diameter (less than 2 inches d.r.c.) trees. Prolific sprouting would be expected, maintaining hiding cover (Harrington 1985). Little effect to medium-sized oak trees would be expected, thereby maintaining mast production. In addition, the pulses of nutrients following prescribed fires would also benefit oak trees. Favoring large diameter oak and top-killing small oak would move forests towards presettlement conditions (Fulé et al. 2005). The overall effect of alternative B on Gambel oak would be to enhance survival of large diameter trees through site-specific thinning, maintaining mast production which is important to some prey species, and maintaining 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 MSOs.

### Basal Area

Total BA would be reduced below 150 square feet per acre minimum post-treatment in the mechanically treated PACs (Table 72). However, it would remain well above the minimum level identified in the revised Recovery Plan (USDI 2012b). Total BA would be reduced in the burn-only PACs and remain above the 150 square feet per acre (Table 72).

### Canopy Structure

The average canopy cover across stands would be greater than or equal to 50 percent, based on BA, TPA, tree d.b.h., and percent SDImax (Table 72). See “Affected Environment” above for discussions on existing conditions, tree densities, and forest conditions in MSO habitat and the silviculture report for the inter-relatedness of these variables. High canopy cover is also indicated by PACs remaining in zone 4 with full site occupancy, minimal understory development, and active competition-induced mortality (Table 5). Harvest would only target ponderosa pine, so while individual trees of other species could be affected by thinning and burning operations, the existing variability in overstory species would remain intact. Combined, these factors should maintain or enhance elements of canopy structure such as canopy cover, tree density, and overstory species diversity.

Overall, changes in the canopy structural elements would be limited, but would move PAC habitat towards desired conditions. The fact that treated PACs would show limited change is a reflection of treatment design in PAC habitat. Because treatments on the ground would be placed to release large oak and large and old pine from competition, improvements in the larger size classes would probably exceed modeled results. Changes in forest structure are summarized by individual PAC in appendix 12.

**Table 72. Modeled changes in forest structure within MSO PACs in Alternative B**

| Forest Attributes | Existing Conditions (Year 2010) | Alternative A[1] (Year 2020) | Alternative B[2] (Year 2020) | Alternative B (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Mechanical Treatment and Prescribed Fire Group (n=18)** | | | | | |
| % of SDI 12-18” d.b.h. | 30 | 31 | 33 | 27 | 28 |
| % of SDI 18-24” d.b.h. | 14 | 16 | 20 | 28 | 23 |
| % of SDI >24” d.b.h. | 8 | 9 | 10 | 14 | 12 |
| % of Max SDI | 75 | 76 | 61 | 65 | 78 |
| TPA >18" | 15 | 18 | 18 | 29 | 27 |
| Ponderosa Pine BA | 124 | 129 | 113 | 124 | 137 |
| Gambel Oak BA | 19 | 20 | 20 | 24 | 26 |
| All BA | 148 | 157 | 140 | 162 | 174 |
| % Oak BA | 13 | 13 | 14 | 15 | 15 |
| **Prescribed Fire Only Treatment Group (n=52)** | | | | | |
| % of SDI 12-18” d.b.h. | 31 | 32 | 32 | 28 | 28 |
| % of SDI 18-24” d.b.h. | 13 | 16 | 16 | 23 | 22 |
| % of SDI >24” d.b.h. | 8 | 8 | 8 | 12 | 11 |
| % of Max SDI | 79 | 81 | 79 | 82 | 83 |
| TPA >18" | 15 | 18 | 18 | 28 | 28 |
| Ponderosa Pine BA | 120 | 124 | 120 | 125 | 127 |
| Gambel Oak BA | 22 | 24 | 24 | 28 | 27 |
| All BA | 159 | 168 | 163 | 183 | 185 |
| % Oak BA | 14 | 14 | 14 | 15 | 14 |

1 = No Action Alternative

2 = No Treatments within Core Areas

## MSO Prey Habitat

### Snags, Logs and Coarse Woody Debris

Snags greater than 18 inch d.b.h. would change little (Table 73). Retaining large trees and improving growth rates would provide a more robust cohort of future large trees, eventually providing more large snags beyond 2050.

Logs would decrease after mechanical treatments but eventually exceed forest plan guidance (Table 73). On average, CWD would meet Kaibab forest plan direction but drop below Coconino forest plan direction immediately after treatment, but would also exceed these guidelines over time. Changes were variable by individual PAC (appendix 12).

Snags, logs, and CWD represent elements of small mammal habitat. While retaining adequate amounts of these habitat components is essential, site conditions are currently highly variable. We reviewed areas where downed wood was nearly absent across whole portions of stands and then encountered areas where a reduction in CWD would be desirable (e.g., in draws). Overall, restoration treatments can benefit the habitat of MSO prey species (Kalies et al. 2012, Martin and Maron 2012). Modeling results indicate treatments would sustain these habitat components in both the short- and long-term.

**Table 73. Changes in prey habitat in MSO PACs under Alternative B**

| Forest Attributes | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative B (Year 2020) | Alternative B (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Mechanical Treatment and Prescribed Fire Group (n=18)** | | | | | |
| Snags >12" d.b.h. | 3.2 | 4.1 | 4.5 | 5.9 | 7.1 |
| Snags >12" and <18" d.b.h. | 2.6 | 3.4 | 3.9 | 4.4 | 5.6 |
| Snags >18" d.b.h. | 0.6 | 0.7 | 0.6 | 1.5 | 1.5 |
| CWD >3" (tons per acre) | 4.7 | 6.2 | 3.3 | 6.9 | 10.3 |
| Logs | 1.3 | 2.3 | 1.7 | 5.1 | 5.8 |
| Understory Index | 37 | 31 | 42 | 28 | 23 |
| **Prescribed Fire Only Treatment Group (n=52)** | | | | | |
| Snags >12" d.b.h. | 3.6 | 4.6 | 5.9 | 7.7 | 8.1 |
| Snags >12" and <18" d.b.h. | 3.0 | 3.9 | 5.1 | 5.9 | 6.3 |
| Snags >18" d.b.h. | 0.7 | 0.7 | 0.7 | 1.8 | 1.8 |
| CWD >3" (tons per acre) | 6.0 | 7.8 | 3.9 | 9.1 | 12.6 |
| Logs | 2.9 | 3.9 | 2.6 | 7.1 | 8.1 |
| Understory Index | 36 | 31 | 34 | 24 | 23 |

### Understory Index

Understory response would be higher under alternative B compared to alternative A for PACs with thinning and prescribed fire (Table 73). The limited improvement is a reflection of the high canopy cover retained in protected habitat. The understory index does not include the nutrient pulse or benefits of reducing the pine litter layer that burning provides (appendix 6). Nor does it reflect the decreased competition for water and nutrients from tree roots. Increasing the soil nutrient pool would likely benefit overstory trees that would presumably increase their nutrient translocation into the canopy, potentially limiting understory response (appendix 6). Individual

PACs receiving both mechanical and prescribed fire treatments would show more variety in understory response (appendix 12).

### Fire Effects

Prescribed fire would occur in all 70 PACs in the treatment area. 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. Expected results from these burns would include lower levels of surface fuels, particularly reduction or elimination of accumulated pine needles. In addition, average canopy base height would likely increase. This would effectively raise the level of the lowest branches in the canopy, raising the canopy base height. 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 MSO prey habitat, and potentially improve the ability for MSOs to hunt these areas.

Under alternative B, FRCC would move from FRCC 3 to FRCC 2 post-treatment, achieving the desired conditions (Table 74). With no modeled disturbance (e.g., mechanical or prescribed fire treatments, wildfire, insects, disease, etc.), the effects of the treatments proposed in alternative B would persist, maintaining FRCC 2 after 30 years. In general, alternative B would significantly lower the risk to key ecosystem components.

With no modeled disturbance of any kind (mechanical or prescribed fire treatments, wildfire, insects, disease, etc.), acres of grasslands in FRCC 1 would decrease as woody species continued to encroach and species composition shifted in favor of less fire adapted species. Mechanical treatments combined with prescribed fire would not occur in grasslands under this alternative; existing encroachment by woody species (primarily ponderosa pine) would remain across 48,000 acres of grasslands and continue through time. Although treatments in grasslands under alternative B would only occur as operational burning, prescribed fire would improve the stability of key ecosystem elements. Details on FRCC and VCC can be found in the Methodology section above.

**Table 74. Vegetation condition class (VCC) ratings in ponderosa pine forest through time under alternative b**

| VCC | 2010 | | 2020 | | 2050 | |
|---|---|---|---|---|---|---|
| | Acres | % | Acres | % | Acres | % |
| 1 | 71,097 | 14 | 132,038 | 26 | 76,176 | 15 |
| 2 | 126,960 | 25 | 350,409 | 69 | 248,841 | 49 |
| 3 | 309,782 | 61 | 25,392 | 5 | 182,822 | 36 |
| **FRCC of treatment area =** | **3** | | **2** | | **2** | |

Elements of MSO prey habitat (surface fuels) change by canopy openness. Figure 23 represents the relative degree of canopy openness after treatment, e.g., “High” indicates open conditions achieved with a mosaic of tree groups and interspace. “Very low” indicates relatively connected canopies with little discernible interspace (Fire Ecology report). The lowest intensity treatments are associated with MSO protected habitat and would retain the highest fuel loading in all modeled years. Modeling assumptions include mechanical treatments and two prescribed fire treatments between 2010 and 2020 and that no further disturbances (fire, drought, insects, etc.) occur between 2020 and 2050.

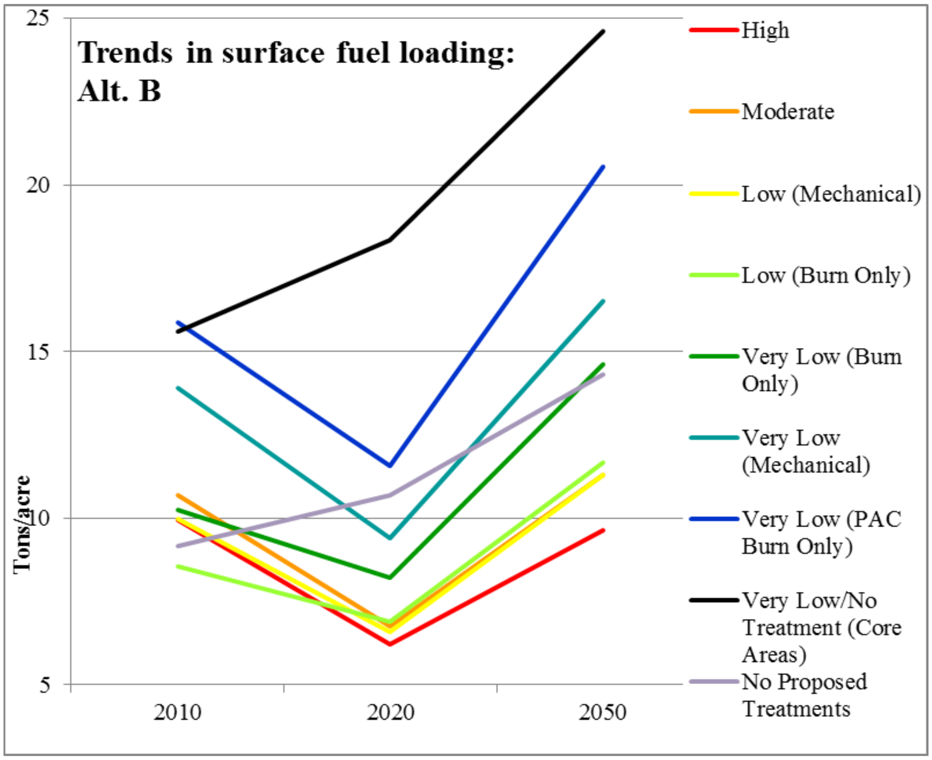


**Figure 23. Modeled changes in surface fuel loading (litter, duff, and CWD combined) by desired openness for Alternative B**

A direct effect of prescribed fires would be the consumption of some 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 are 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 for maps comparing surface fuels across the 4FRI treatment area. 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 in alternative B (20 tons per acre is the upper end of the recommended range for fuel loading in southwest ponderosa pine habitat [Fire Ecology report]).

Potential fire behavior would shift as a result of prescribed fires. Predicted surface fire would increase in protected habitat by about 10 percent (8,700 acres) in the year 2020 under alternative B (Table 75). The probability of active crown fire would decrease by 21 percent (about 7,796 acres) after treatments. All crown fires are considered high-severity (Fire Ecology report). Reducing the total acres of predicted crown fire would allow more flexibility in managing potential fire to better meet desired conditions, thereby enhancing and maintaining MSO habitat. Prescribed fire in PACs outside core areas would also lower the threat of potential fire behavior inside core areas.

**Table 75. Predicted fire behavior in protected habitat under current conditions and after implementation of Alternative B[1]**

| MSO Habitat | Total (Acre) | Surface Fire (Acre) | Passive Crown Fire (Acre) | Active Crown Fire (Acre) | Surface Fire (%) | Passive Crown Fire (%) | Active Crown Fire (%) |
|---|---|---|---|---|---|---|---|
| **Existing Condition (Year 2010)** | | | | | | | |
| Ponderosa Pine | 507,839 | 311,313 | 48,023 | 143,186 | 61 | 9 | 28 |
| Protected | 35,262 | 18,122 | 3,034 | 14,106 | 51 | 9 | 40 |
| **Alternative B (Year 2020)** | | | | | | | |
| Ponderosa Pine | 507,839 | 476,400 | 17,303 | 8,846 | 94 | 3 | 2 |
| Protected | 35,262 | 25,803 | 2,195 | 7,103 | 73 | 6 | 20 |

1. Acres by fire behavior-type do not equal total acres due to excluded areas that would not support fire such as rock, cinders, and areas with insufficient fuels.

### *Restricted Habitat*

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 (calculated from Table 70). 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 4FRI implementation was completed in 10 years.

### *Forest Structure and Density*

Thinning objectives in target and threshold habitat would maintain an overall BA of greater than 150 square feet per acre, as recommended in the Recovery Plans (USDI 1995). In addition, treatments in restricted habitat would provide a diversity of stand conditions and stand sizes across the landscape. By design, treatments in target and threshold habitats would affect less change than treatments in restricted "other" habitat.

#### Large Trees

Mechanical treatments in target and threshold habitat would focus on increasing both the percent area of trees in larger size-classes and increasing tree growth rates, as recommended in the Recovery Plan. This would be accomplished by thinning trees less than 18 inch d.b.h., which are over-abundant relative to desired conditions described in the Recovery Plan, in an effort to develop and retain trees greater than or equal to 24 inch d.b.h. Trees in this largest size-class are limited on the landscape and an important component of MSO habitat (USDI 1995). The response of trees 12-18 inch d.b.h. in threshold and target habitats is variable, depending on the RU (Table 76 and Table 77), indicating that much of the thinning would be trees less than 12 inch d.b.h. This is supported by a decline in trees 12-18 inch d.b.h. by 2050. By 2050 trees would have been growing into next larger size classes while fewer trees would be growing into this size class. Trees 18 inch d.b.h. and larger, particularly those greater than 24 inch d.b.h., would consistently increase (Table 76 and Table 77). Old and large tree diameter growth and resistance to drought have been shown to increase after restoration treatments (Ericson and Waring 2013, Kerhoulas et al. 2013b). Changes in individual subunits follow the same patterns (appendix 13).

Trees 12 to 17.9 inch d.b.h. would decrease in restricted "other" habitat while trees greater than or equal to 18 inch d.b.h. show a marked increase (Table 78 and appendix 13). Trees greater than or equal to 24 inch d.b.h. show the largest gains. Treatments would also create canopy gaps, irregular spacing, and diversify age-class distribution. Overall, TPA greater than 18 inch d.b.h. would decrease relative to no management actions (alternative A in Table 76, Table 77 and Table 78). These results were consistent across sub-units (appendix 13). 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 MSO restricted habitat by maintaining future nesting and roosting structure in some areas while also increasing prey habitat and potential MSO foraging opportunities in other areas.

#### Basal Area

Pine BA would decrease in all restricted habitats, meeting one of the fundamental objectives of the treatment (Table 76, Table 77 and Table 78). This would contribute towards increasing forest resiliency. It would also reduce the risk of undesirable fire behavior and effects in MSO habitat. Gambel oak BA would increase in target and threshold habitats and decrease in restricted “other” habitat (Table 76, Table 77 and Table 78). No oak would be selected for removal in restricted “other” habitat. The decrease in oak would relate to the direct loss of 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. Oak would not be targeted for removal; the decrease in restricted “other” habitat would result from increased operations. Treatments would increase canopy gaps, as described in the Recovery Plan. Total BA would move towards presettlement conditions in restricted “other” habitat (Table 78). These changes would reduce competition-induced mortality and increase resiliency to large-scale stochastic events.

#### Canopy Structure

Based on BA and percent SDImax, canopy cover would remain dense. Percent SDImax would decrease but remain in the “Extremely High Density Range for target and threshold habitats (Table 76 and Table 77). Percent SDImax would decrease to the “High Density” category in restricted “other” habitat (Table 78). Therefore, closed canopy conditions would remain within tree groups. Existing variability in overstory species diversity would remain by design. Prescribed fire would improve sub-canopy flight space for MSOs by lifting canopy base height. Combined, these factors should improve the elements of canopy structure such as cover, density, and maintain overstory species diversity in the overstory.

**Table 76. Modeled changes in forest structure for MSO threshold habitat in Alternative B**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative B (Year 2020) | Alternative B (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| % of SDI 12-18" d.b.h. | 25 | 24 | 27 | 23 | 26 |
| % of SDI 18-24" d.b.h. | 24 | 26 | 32 | 33 | 28 |
| % of SDI >24" d.b.h. | 3 | 3 | 4 | 8 | 6 |
| % of Max SDI | 100 | 100 | 85 | 93 | 100 |
| TPA >18" | 28 | 31 | 32 | 39 | 35 |
| Ponderosa Pine BA | 133 | 136 | 96 | 111 | 143 |
| Gambel Oak BA | 58 | 58 | 60 | 63 | 58 |
| All BA | 204 | 209 | 171 | 202 | 226 |

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative B (Year 2020) | Alternative B (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| % Oak BA | 29 | 28 | 35 | 31 | 26 |
| **Restoration Unit 3** | | | | | |
| % of SDI 12-18" d.b.h. | 26 | 25 | 22 | 17 | 19 |
| % of SDI 18-24" d.b.h. | 19 | 21 | 24 | 27 | 26 |
| % of SDI >24" d.b.h. | 8 | 8 | 10 | 13 | 11 |
| % of Max SDI | 99 | 99 | 90 | 96 | 100 |
| TPA >18" | 24 | 26 | 27 | 36 | 36 |
| Ponderosa Pine BA | 108 | 111 | 88 | 95 | 114 |
| Gambel Oak BA | 62 | 63 | 64 | 71 | 67 |
| All BA | 185 | 192 | 171 | 200 | 209 |
| % Oak BA | 33 | 33 | 37 | 36 | 32 |

**Table 77. Modeled changes in forest structure for MSO target habitat in Alternative B**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative B (Year 2020) | Alternative B (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| % of SDI 12-18" d.b.h. | 30 | 29 | 30 | 24 | 28 |
| % of SDI 18-24" d.b.h. | 12 | 14 | 17 | 23 | 19 |
| % of SDI >24" d.b.h. | 7 | 8 | 10 | 11 | 9 |
| % of Max SDI | 81 | 83 | 70 | 78 | 84 |
| TPA >18" | 14 | 16 | 17 | 26 | 24 |
| Ponderosa Pine BA | 118 | 123 | 94 | 105 | 128 |
| Gambel Oak BA | 32 | 34 | 35 | 44 | 40 |
| All BA | 156 | 165 | 138 | 169 | 184 |
| % Oak BA | 20 | 20 | 25 | 26 | 22 |
| **Restoration Unit 3** | | | | | |
| % of SDI 12-18" d.b.h. | 26 | 26 | 27 | 23 | 25 |
| % of SDI 18-24" d.b.h. | 13 | 15 | 17 | 19 | 17 |
| % of SDI >24" d.b.h. | 7 | 8 | 9 | 12 | 11 |
| % of Max SDI | 79 | 81 | 73 | 81 | 85 |
| TPA >18" | 13 | 16 | 16 | 23 | 22 |
| Ponderosa Pine BA | 102 | 107 | 88 | 99 | 113 |
| Gambel Oak BA | 35 | 37 | 38 | 47 | 43 |
| All BA | 148 | 158 | 141 | 173 | 181 |
| % Oak BA | 24 | 23 | 27 | 27 | 24 |

**Table 78. Modeled changes in forest structure for MSO restricted "other" habitat in Alternative B**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative B (Year 2020) | Alternative B (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| % of SDI 12-18" d.b.h. | 30 | 31 | 25 | 21 | 30 |
| % of SDI 18-24" d.b.h. | 12 | 14 | 21 | 20 | 20 |
| % of SDI >24" d.b.h. | 7 | 7 | 14 | 19 | 10 |
| % of Max SDI | 68 | 71 | 34 | 46 | 75 |
| TPA >18" | 12 | 14 | 11 | 17 | 23 |
| Ponderosa Pine BA | 111 | 118 | 52 | 71 | 129 |
| Gambel Oak BA | 21 | 23 | 16 | 25 | 29 |
| All BA | 138 | 148 | 74 | 106 | 170 |
| % Oak BA | 15 | 15 | 22 | 23 | 17 |
| **Restoration Unit 3** | | | | | |
| % of SDI 12-18" d.b.h. | 29 | 30 | 25 | 20 | 26 |
| % of SDI 18-24" d.b.h. | 13 | 15 | 21 | 21 | 21 |
| % of SDI >24" d.b.h. | 7 | 7 | 12 | 17 | 10 |
| % of Max SDI | 70 | 73 | 38 | 50 | 77 |
| TPA >18" | 12 | 14 | 11 | 17 | 23 |
| Ponderosa Pine BA | 98 | 104 | 51 | 68 | 113 |
| Gambel Oak BA | 30 | 32 | 22 | 33 | 39 |
| All BA | 137 | 148 | 80 | 114 | 170 |
| % Oak BA | 21 | 21 | 27 | 28 | 23 |
| **Restoration Unit 4** | | | | | |
| % of SDI 12-18" d.b.h. | 28 | 27 | 23 | 18 | 24 |
| % of SDI 18-24" d.b.h. | 13 | 15 | 21 | 19 | 20 |
| % of SDI >24" d.b.h. | 8 | 9 | 14 | 18 | 11 |
| % of Max SDI | 67 | 71 | 39 | 52 | 75 |
| TPA >18" | 12 | 14 | 11 | 16 | 22 |
| Ponderosa Pine BA | 86 | 92 | 47 | 63 | 101 |
| Gambel Oak BA | 33 | 35 | 24 | 37 | 45 |
| All BA | 129 | 141 | 80 | 115 | 165 |
| % Oak BA | 24 | 24 | 29 | 30 | 26 |
| **Restoration Unit 5** | | | | | |
| % of SDI 12-18" d.b.h. | 24 | 26 | 24 | 24 | 28 |
| % of SDI 18-24" d.b.h. | 10 | 10 | 15 | 16 | 15 |
| % of SDI >24" d.b.h. | 9 | 9 | 14 | 16 | 10 |
| % of Max SDI | 51 | 56 | 30 | 42 | 65 |
| TPA >18" | 8 | 9 | 8 | 13 | 16 |
| Ponderosa Pine BA | 80 | 88 | 45 | 63 | 103 |
| Gambel Oak BA | 15 | 18 | 12 | 22 | 28 |
| All BA | 102 | 116 | 64 | 98 | 147 |
| % Oak BA | 15 | 17 | 19 | 22 | 20 |

## MSO Prey Habitat

### Snags, Logs and Coarse Woody Debris

Snags generally show a slight tendency to decrease in both target and threshold habitat under alternative B (Table 79 and Table 80). The scale of change for snags greater than 18 inches d.b.h. might not be accurate in that it is likely beyond the ability of the models to accurately track 1/10 or 1/100 of a snag per acre. However, the fact that it is a relatively consistent trend suggests minor decreases could happen. The impact of low snag densities, relative to forest plan guidance, on prey habitat is unclear because of the uncertainty regarding natural snag levels in southwest ponderosa pine forests. Large snags are currently well below forest plan guidelines in even relatively "natural" areas (Ganey 1999, Waskiewicz et al. 2007, Ganey et al. 2014). However, increased drought and beetle activity could lead to levels above those modeled here (Ganey and Vojta 2012). Four FRI snag mitigation includes selecting for residual trees with dead tops and lightning strikes to retain elements of snag habitat in living trees (i.e., the living dead) that are more resistant to fire (Waskiewicz et al. 2007). Snags would increase substantially in restricted "other" habitat (Table 81).

Logs would decrease after treatment in threshold habitat, increase slightly in target habitat, and consistently increase in restricted "other" habitat (Table 79, Table 80, and Table 81). Amounts of CWD would decrease in all restricted habitats after treatment and then increase through time.

Snags, logs, and CWD represent elements of small mammal habitat. Snags, logs, and CWD would primarily be affected by burning. While retaining adequate amounts of these habitat components is essential, site conditions are currently highly variable. Treatment objectives include lowering surface fuels to allow fire to return to a more natural role in the ecosystem. Overall, restoration treatments can improve habitat for MSO prey species (Kalies et al. 2012, Martin and Maron 2012).

### Understory Index

Reduced BA and intermittent openings would increase light, moisture, and nutrient availability for herbaceous understory species. Understory yield would increase in all restricted habitats (Table 79, Table 80, and Table 81). Increases follow forest conditions with the smallest increases in stands meeting threshold values and index values doubling to tripling in restricted "other" habitat. Changes in the understory index (appendix 6) do not reflect additional benefits from litter reduction that would occur as a result of prescribed fire under alternative B.

Increased biomass production represents grass and forb development that would provide food and cover for arthropods, small mammals and birds. In turn, this can increase prey availability, diversity, and biomass for MSOs. Total prey biomass may be more influential on MSO fitness than the abundance of any one prey species (USDI 1995) and allows owls to shift prey if an individual prey species declines (Ganey et al. 2011). The Recovery Plan recommends managers provide diverse habitats to support a diverse prey base. However, assuming no additional treatments means improvements in understory production would gradually decline as overstory canopies expand and new trees became established.

**Table 79. Modeled changes in prey habitat attributes within MSO threshold habitat under Alternative B**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative B (Year 2020) | Alternative B (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| Snags >12" d.b.h. | 2.43 | 3.44 | 3.56 | 3.95 | 5.54 |
| Snags >12" and <18" d.b.h. | 1.97 | 2.93 | 3.12 | 2.82 | 4.30 |
| Snags >18" d.b.h. | 0.45 | 0.51 | 0.44 | 1.13 | 1.24 |
| CWD >3" (tons per acre) | 7.09 | 8.81 | 3.81 | 6.95 | 12.91 |
| Logs | 6.14 | 6.70 | 4.11 | 6.15 | 8.96 |
| Understory Index | 13 | 12 | 24 | 14 | 9 |
| **Restoration Unit 3** | | | | | |
| Snags >12" d.b.h. | 3.66 | 4.92 | 4.35 | 4.72 | 6.53 |
| Snags >12" and <18" d.b.h. | 2.97 | 3.90 | 3.42 | 2.57 | 4.39 |
| Snags >18" d.b.h. | 0.69 | 1.02 | 0.93 | 2.15 | 2.14 |
| CWD >3" (tons per acre) | 4.45 | 6.63 | 2.75 | 6.96 | 11.69 |
| Logs | 1.76 | 3.11 | 2.19 | 6.21 | 7.94 |
| Understory Index | 19 | 17 | 25 | 15 | 12 |

**Table 80. Modeled changes in prey habitat attributes within MSO target habitat under Alternative B**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative B (Year 2020) | Alternative B (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| Snags >12" d.b.h. | 3.01 | 3.81 | 4.30 | 5.24 | 6.77 |
| Snags >12" and <18" d.b.h. | 2.50 | 3.25 | 3.77 | 3.80 | 5.38 |
| Snags >18" d.b.h. | 0.52 | 0.56 | 0.52 | 1.44 | 1.39 |
| CWD >3" (tons per acre) | 6.02 | 7.49 | 3.26 | 6.84 | 11.84 |
| Logs | 4.64 | 5.25 | 3.34 | 6.18 | 8.13 |
| Understory Index | 33 | 28 | 45 | 26 | 20 |
| **Restoration Unit 3** | | | | | |
| Snags >12" d.b.h. | 2.73 | 3.30 | 4.00 | 4.65 | 5.89 |
| Snags >12" and <18" d.b.h. | 2.20 | 2.73 | 3.45 | 3.31 | 4.53 |
| Snags >18" d.b.h. | 0.53 | 0.58 | 0.55 | 1.34 | 1.36 |
| CWD >3" (tons per acre) | 4.79 | 6.30 | 2.62 | 6.42 | 10.51 |
| Logs | 2.47 | 3.18 | 2.06 | 4.94 | 6.07 |
| Understory Index | 44 | 37 | 50 | 29 | 25 |

**Table 81. Modeled changes in prey habitat attributes within MSO restricted "other" habitat in Alternative B**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative B (Year 2020) | Alternative B (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| Snags >12" d.b.h. | 2.09 | 2.83 | 4.03 | 2.05 | 5.86 |
| Snags >12" and <18" d.b.h. | 1.69 | 2.40 | 3.19 | 1.23 | 4.80 |
| Snags >18" d.b.h. | 0.40 | 0.43 | 0.84 | 0.82 | 1.06 |
| CWD >3" (tons per acre) | 4.26 | 5.46 | 3.38 | 5.66 | 8.86 |
| Logs | 1.04 | 1.66 | 2.22 | 4.46 | 4.14 |
| Understory Index | 46 | 38 | 150 | 82 | 26 |
| **Restoration Unit 3** | | | | | |
| Snags >12" d.b.h. | 2.24 | 2.95 | 4.84 | 2.18 | 5.63 |
| Snags >12" and <18" d.b.h. | 1.81 | 2.45 | 3.84 | 1.24 | 4.43 |
| Snags >18" d.b.h. | 0.43 | 0.49 | 1.00 | 0.94 | 1.20 |
| CWD >3" (tons per acre) | 3.88 | 5.12 | 3.31 | 6.18 | 8.70 |
| Logs | 1.45 | 2.06 | 2.39 | 5.02 | 4.64 |
| Understory Index | 49 | 41 | 135 | 74 | 27 |
| **Restoration Unit 4** | | | | | |
| Snags >12" d.b.h. | 2.20 | 2.78 | 4.56 | 2.07 | 5.18 |
| Snags >12" and <18" d.b.h. | 1.71 | 2.22 | 3.52 | 1.07 | 3.91 |
| Snags >18" d.b.h. | 0.49 | 0.56 | 1.05 | 0.99 | 1.27 |
| CWD >3" (tons per acre) | 3.17 | 4.30 | 2.75 | 5.73 | 7.85 |
| Logs | 1.05 | 1.68 | 2.03 | 4.68 | 4.34 |
| Understory Index | 52 | 42 | 127 | 67 | 27 |
| **Restoration Unit 5** | | | | | |
| Snags >12" d.b.h. | 1.43 | 1.67 | 3.01 | 1.61 | 3.57 |
| Snags >12" and <18" d.b.h. | 1.07 | 1.33 | 2.39 | 1.06 | 2.88 |
| Snags >18" d.b.h. | 0.36 | 0.35 | 0.62 | 0.55 | 0.68 |
| CWD >3" (tons per acre) | 3.16 | 3.79 | 2.24 | 4.14 | 6.02 |
| Logs | 0.57 | 0.99 | 1.25 | 2.90 | 2.52 |
| Understory Index | 85 | 66 | 172 | 92 | 37 |

Changes in forest structure and prey habitat are designed to balance the various functions of MSO habitat with the need to develop and maintain large trees. Developing and retaining large trees across all owl habitats is desirable because large trees are impossible to replace quickly, they are common features of owl habitat, and growth rates are much slower than for young or mid-aged trees (USDI 1995). As a result, some habitat components would decrease while others increase after treatment. Changes are subtle in target and threshold habitat because of the low intensity of treatments in these habitats. Overall, the action alternatives would create similar values for percent of SDImax, with values in the extremely high density category for target and threshold habitats (zone 4 – see Table 5) and values at the low end of the high density category for restricted "other" habitat (zone 3). 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.

Providing a continuous supply of nesting and roosting habitat requires maintaining a variety of succession stages across the landscape. Southwest ponderosa pine did not and cannot support tree densities required for nesting and roosting habitat everywhere. In addition to addressing nesting and roosting needs, restricted habitat would provide heterogeneous forest conditions across the landscape, as described in the Recovery Plan. Managing target and threshold habitat and restricted “other” habitat fits the landscape mosaic as described in the Recovery Plan. A mosaic of habitat features across the landscape would likely best support the small mammal community that serve as prey for the owl while also ensuring maintenance of other important ecological functions (Kalies and Chambers 2010). Designating target and threshold habitat in a large-scale analysis, as was done for the 4FRI, ensures future nesting and roosting will be well distributed spatially so as to mimic the natural landscape, provide connectivity for owl dispersal, and enhance ecosystem resiliency (USDI 1995).

Mechanical treatments in restricted habitats would be implemented during the nesting season. While most foraging is proximal to the nest site and would thus occur primarily in PACs, cutting in restricted habitat could disturb individual owls foraging or roosting outside PACs.

**Fire Effects**

Prescribed fire, along with mechanical treatments, would occur across 75,111 acres of restricted habitat, including 8,692 acres of target and threshold habitat. An additional 2,655 acres of burn-only treatments would occur in restricted habitat with just over 300 acres of burn-only prescriptions in target and threshold habitat.

The threat of crown fire in restricted habitat as modeled for the year 2020 would be reduced compared to existing conditions. Reductions of 37 and 46 percent are predicted in target/threshold and restricted “other” habitats, respectively (Table 82). All crown fire is expected to burn as high-severity in ponderosa pine (Fire Ecology report). The dominance of surface fire in restricted habitat (90 and 95 percent in restricted “other” and target and threshold habitats, respectively) reduces the risk of high-severity fire in MSO habitat. Overall, thinning and burning treatments are projected to move restricted habitat towards the restoration of low-severity fire. Appendix 19 displays surface fuel loading across the 4FRI landscape and in MSO habitat for each alternative.

More mechanical treatments and the more open nature of foraging habitat (versus nesting and roosting habitat) would allow fire to consume more fuels in restricted habitat outside of target and threshold habitat (66,419 acres). In addition, treated areas outside of MSO habitat would move closer towards the historical range of variation, thereby decreasing the threat of high-severity crown fire reaching MSO habitat.

**Table 82. Predicted fire behavior in restricted habitat under current conditions and after implementation of Alternative B[1]**

| MSO Habitat | Total (Acre) | Surface Fire (Acre) | Passive Crown Fire (Acre) | Active Crown Fire (Acre) | Surface Fire (%) | Passive Crown Fire (%) | Active Crown Fire (%) |
|---|---|---|---|---|---|---|---|
| **Existing Condition (Year 2010)** | | | | | | | |
| Ponderosa Pine | 507,839 | 311,313 | 48,023 | 143,186 | 61 | 9 | 28 |
| Target/ Threshold | 8,692 | 4,275 | 2,922 | 3,482 | 49 | 11 | 40 |
| Restricted "Other" | 66,419 | 35,019 | 6,540 | 24,756 | 53 | 10 | 37 |
| **Alternative B (Year 2020)** | | | | | | | |
| Ponderosa Pine | 507,839 | 476,400 | 17,303 | 8,846 | 94 | 3 | 2 |
| Target/ Threshold | 8,692 | 8,299 | 44 | 333 | 95 | <1 | 4 |
| Restricted "Other" | 66,419 | 57,785 | 8,483 | 58 | 87 | 13 | <1 |

1. Acres by fire behavior- do not equal total acres due to areas of nonburnable substrate such as rock, cinders, and areas with insufficient fuels that would not support fire; nonburnable substrate totals <1% of the ponderosa pine treatment area.

### *Other Habitat Effects*

Understory vegetation development is related to the amount of solar radiation reaching the ground. This creates a direct and inverse relationship between canopy closure and herbaceous cover. The uncharacteristic forest structure existing in the ponderosa pine forests of northern Arizona restricts herbaceous growth well below presettlement conditions (appendix 6). Ponderosa pine forests in Arizona are relatively homogeneous and the site-specific habitat variability that springs, streams, meadows, grasslands, savannas, and aspen represent are important to a wide array of wildlife, including MSO prey species. These distinct vegetation-types support understory vegetation that is typically denser, more continuous, and more diverse because of the soil types supporting them and the increased solar radiation and moisture availability compared to ground conditions in the general forest. Understory vegetation provides the food and cover that supports an array of wildlife, including many small mammals, birds, bats, and a variety of arthropods that serve as food for vertebrate species and pollinators to help maintain herbaceous diversity. These micro-habitats directly and indirectly support MSO prey species. Improvements to springs, ephemeral channels, meadows, and aspen can benefit MSOs in ways greater than simple area estimates indicate.

#### Springs and Ephemeral Channels

Springs and ephemeral channel restoration numbers per acres are the same for all action alternatives and described under Actions Common to Alternatives B, C, D, and E (above).

#### Grasslands, Savannas, and Meadows

Grassland, savanna, and meadow treatments would not include mechanical tree removal within PACs under alternative B. Operational burning would occur on about 130 acres of existing meadow habitat in 11 PACs (Table 83). This would represent an average of 11 acres of meadow burned in each PAC (range = 1 to 28 acres). Operational burn objectives would be to move fire between disjunct ponderosa pine stands without creating firelines in adjacent non-ponderosa pine habitat. Avoiding firelines would avoid the associated habitat disturbance, human disturbance (social trails), and potential indirect effects related to recreation and firewood gathering if people used fireline scars for hiking or driving. Operational burns would use prescribed fire with the objective of moving fire across open areas to burn into additional forested areas. This is different from treatments designed to change elements of habitat structure to attain desired objectives. Some, but not all encroaching trees would be removed from meadow habitats with operational burning. Nevertheless, meadow and grassland operational burns would improve understory response in MSO prey habitat resulting from the nutrient pulse and litter reduction after burning. All PAC treatments would occur outside of the nesting season.

**Table 83. Meadow treatments (prescribed fire only) within PACs (all are on the Coconino NF)**

| Protected Activity Center | Acres Treated |
|---|---|
| Frog Tank | 10 |
| Howard Mountain | 1 |
| Meadow Tank | 28 |
| Nestor | 8 |
| Powerline Tank | 14 |
| Racetrack Tank | 15 |
| Two Holes | 14 |
| Volunteer | 6 |
| Bear Seep | 10 |
| Iris Tank | 9 |
| Red Raspberry | 16 |
| Total (11 PACs) | 131 |

Alternative B would include about 16,736 acres of grassland, savanna, and meadow treatments which, along with alternative D, represents the most treatment in restricted habitat (Table 84). Grassland and savanna restoration would entail reestablishing openings dominated by herbaceous species in areas that have grown in with trees. Reclaiming these important habitats would occur on soil types developed primarily from grass, forb, and sedge input versus forest-based soils. Most acres would include mechanical removal of trees in currently forested areas followed by prescribed fire. Prescribed fire-only would consist of operational burning expected to cause limited tree mortality. Residual tree cover would continue to function as sources of seeds, needle cast, and shade, continuing the long-term degradation of grassland and meadow habitat. Nevertheless, meadows and grasslands would be improved in the short-term by reinvigorating understory response as a result of limited tree mortality, litter reduction, and the resultant nutrient pulse. In addition, this would preclude the need to create firelines to confine prescribed fire to the ponderosa pine. Improving grassland, savanna, and meadow habitats would benefit MSO directly and indirectly. Small grasslands can blend into large meadows, hence some of the grassland acreage would likely function as MSO foraging habitat. Larger open areas could support source populations for prey dispersal into surrounding pine-oak forest. Therefore, meadow and an unknown percentage of grassland treatments would be expected to improve understory conditions for MSO prey species.

**Table 84. Treatments in grass-dominated open habitats under Alternative B**

| Treatment Type | Acres |
|---|---|
| Grassland Restoration[1] | 2,254 |
| Savanna[2] | 10,791 |
| Grassland Burn-Only[3] | 3,691 |
| Grassland Mechanical[4] | 0 |
| **Total Acres** | **16,736** |

1. Pine-dominated mollisol soils
2. Pine-dominated mollic-intergrade soils
3. Operational burn (no prescription objectives)
4. Restoration of existing grassland

Continuing the decline in meadows and grasslands would continue the decrease in food and cover for MSO prey species. Prey numbers could also decline through time. A decrease in source populations dispersing from grasslands and meadows could decrease prey availability in the surrounding forest. In addition, habitat for arthropod prey such as beetles and moths would also continue to decrease. Therefore, the lack of meadow and grassland treatments would allow the continued deterioration of food and cover in key habitat for MSO prey species. Combined with the loss of interspace and other natural openings, this could prey species at population levels. In addition, this trend in habitat loss could also affect pollinator species, negatively affecting herbaceous diversity and habitat function, indirectly contributing to the decline in habitat for MSO and their prey.

### Aspen

Aspen treatments in protected habitat would consist of prescribed fire -only treatments on about 201 acres (Table 85). Burn-only treatments in aspen would average about 29 acres, ranging from 2 acres (Kendrick PAC on the Kaibab NF) to 61 acres (Red Raspberry PAC on the Coconino NF). All aspen treatments in PACs would occur outside the nesting season. Returning fire to these habitats would improve aspen health and understory cover. All aspen treatments would include fencing to exclude ungulate grazing of aspen.

**Table 85. Acres of aspen treatments in protected activity centers (PACs) in Alternative B**

| PAC | Acres |
|---|---|
| Jeep | 29 |
| Mayflower Tank | 55 |
| Mint Spring | 12 |
| Pierce Tank | 32 |
| Red Raspberry 9 | 61 |
| Weatherford 2 | 10 |
| Kendrick[1] | 2 |
| **Total** | **201** |

**1** = Kaibab National Forest

The FWS suggests that new structures (such as fences) constructed in an occupied owl territory puts the owl at risk of a potentially fatal collision (USDI 2012b). No wire fencing would be used for new fences in PACs. Instead, other fence designs such as double-welded pipe rail would be used. Fencing decisions would be made in collaboration with the FWS. If non-wire fencing options are not available, aspen treatments would not occur in PACs.

Prescribed fire in PACs would be conducted so that burn severity would remain low. Prescribed fire would have site-specific objectives in aspen (versus operational burning). Meeting the objectives would be affected by several factors. Because aspen typically constitutes limited acreage in any burn unit, the time for burning aspen would be determined by conditions in the surrounding ponderosa pine. Burn windows for ponderosa pine are much wider than for aspen, meaning aspen would typically be burned under less than ideal conditions, i.e., conditions which could create a patchy burn, leaving untreated areas within the clone. Basing ignition decisions on the surrounding ponderosa pine could also reduce fire intensity in aspen. Lack of mechanical manipulation and an inherently variable pine litter layer could also contribute to patchy results. While this kind of fire behavior could benefit aspects of small mammal habitat in the short-term, they could also limit the percentage of conifers exposed to fire. Combined, these factors reduce potential improvements to aspen by reducing mortality of encroaching pine and maintaining the effects of shading, needle cast, and competition for water and nutrients by encroaching pine. In short, prescribed fire-only treatments would likely improve aspen, but not restore aspen to long-term sustainability.

Aspen treatments in restricted habitat (746 acres) are consistent across alternatives and is described the Actions Common to Alternatives B, C, D, and E section above.

### *Summary*

At the scale of 4FRI, improvements to MSO prey habitat from meadow, aspen, spring, and ephemeral channel treatments within protected habitat would be limited and site specific. However, these collective treatments would enhance prey habitat within PACs where most foraging occurs during the nesting season (Ganey et al. 2011). Resident MSOs concentrate their use within PACs, even if they do not nest in a given year and MSO reproductive success appears tied to prey availability (Ganey et al. 2011). MSO prey selection in the UGM, primarily peromyscid mice and voles (Ganey et al. 2011), reflects abundant edge habitat (USDI 1995). Restoring/improving these habitats should also improve and increase edge habitat. Restoration treatments in general can benefit peromyscid mice and voles (Kalies et al. 2012, Martin and Maron 2012). Other small mammals, bats, birds, and nocturnal flying insects (primarily lepidopterons and coleopterans) are also prey for MSOs. This should be particularly true in key habitat components where a strong herbaceous response is expected. Overall prey abundance may be very important to nesting MSOs during years when individual prey species may be limited (Ganey et al. 2011). Providing localized patches of increased food and cover for prey species in the areas most heavily hunted during nesting season should directly benefit MSOs during energetically stressed times of the year, spanning egg-laying through fledging of juveniles.

While MSO treatments are similar between alternatives B and D, alternative B includes both aspen and meadow treatments in PACs. Improving and increasing key elements of prey habitat in PACs could be important to resident owls which do most of their foraging in areas proximal to the nest when raising young. Treatments in restricted habitat under alternative B (and D) would include more acres of meadow, grassland, and savanna habitat than the other alternatives. However, alternative B (and D) would treat over 3,690 acres of grassland with prescribed fire-only while alternatives C and E would use prescribed fire-only on 15 acres each. Conversely, alternative B (and D) would not include any grassland restoration (mechanical thinning and prescribed fire in existing grasslands) while alternatives C and E would each achieve nearly 3,660 acres of grassland restoration.

MSO primarily select for peromyscid mice and voles in the UGM (Ganey et al. 2011). The reliance on these species may reflect the historically abundant edge habitat in the UGM (USDI 1995). Alternative B should improve and increase edge habitat. Other small mammals, bats, birds, and nocturnal flying insects (primarily lepidopterons and coleopterans) are also prey for MSOs and would benefit from the proposed treatments. Overall prey abundance may be very important to nesting MSOs during years when individual prey species are be limited (Ganey et al. 2011). Providing localized patches of increased food and cover for prey species should directly benefit MSOs. Alternative B would result in improvements to more acres of MSO habitat in PACs and restricted habitat than any other alternative.

**Disturbance**

Disturbance could occur as a result of project-related activities including moving and operating harvest machinery, hauling forest materials, building fireline, managing prescribed fire, smoke, personnel in the field, and road maintenance and construction. Noise disturbance in regards to MSO is reviewed in the MSO section under Affected Environment (see above). More detail on noise-related activities is presented in alternative C and in appendix 2 as a result of consultation. Noise disturbance from project activities may affect foraging MSO, but are not expected to affect nesting or roosting owls due to design features and project planning (see Methodology above).

**Road-Related Disturbance**

Road maintenance and construction would have short-term negative effects to habitat and long-term beneficial effects from the decommissioning of 860 miles of roads designated by forest under the Travel Management Rule (appendix 2). Potential fragmentation of prey species populations was reviewed above under the Affected Environment section and was not considered a threat to MSOs or their prey.

**Fire-Related Disturbance**

Where there are no roads, trails, or natural barriers, new fireline would be built to prevent fire from entering core areas. Building fireline would occur outside the nesting season. Potential effects of fireline construction include effects to habitat such as erosion or loss of cover for prey species. Fireline “trails” (social trails) could increase recreation and access in PACs, increasing disturbance and potential loss of snags and logs. Building fireline would occur outside the nesting season.

Smoke is not expected to be a disturbance to MSOs for several reasons. Settling smoke has long been an issue that fire experts address on this landscape. This has led to knowledge of smoke patterns and developing ignition techniques to minimize undesirable smoke effects. Recognizing these issues led to the development of a strategy for prescribed fire specifically designed to minimize the risk of smoke settling into PACs (see the discussion on Exclusion and Opportunity Zones in the Methods section above and in appendix 5). Prescribed fire in PACs and exclusion zones would occur outside the breeding season. This would avoid the risk of adverse effects to eggs and nestlings and minimize the risk of adverse effects to adults and yearlings given the seasonal shift in site fidelity. In addition, smoke from prescribed fire would comply with Arizona Department of Environmental Quality requirements (ADEQ). Smoke effects are regulated and permits are required by ADEQ before burning is initiated. Air quality requirements specify management actions will meet air quality standards. ADEQ considers the cumulative effects of smoke emissions from multiple jurisdictions prior to approving daily prescribed fire activities. This mitigates the potential for severe smoke effects from multiple prescribed fire projects across the treatment area. Given the planning, design features, and ignition techniques, smoke from prescribed fire would not be expected to result in adverse effects to MSO. However, this cannot be guaranteed and adverse effects to owls could occur if smoke unexpectedly settled into PACs for three or more days and nights (see Methodology above).

#### *Alternative B - Determination of Effects*

An overview of immediate post-treatment results (year 2020) and long-term changes to habitat structure (year 2050) are displayed at the RU and subunit levels in appendices 12 and 13. Existing conditions and long-term changes with no management action are also presented for comparison. See Comparison of Alternatives for quantitative details comparing treatments among alternatives.

Forest structure would improve for MSO and their prey in 70 PACs and in about 8,692 acres of target and threshold habitats. Mechanical thinning in 18 selected PACs (outside of core areas) would include trees up to 16 inches d.b.h. The range in tree size-classes would allow creating/maintaining uneven-aged/uneven-sized trees and in so doing attain the multi-story canopy structure described in the Recovery Plan. Thinning only up to 9 inches d.b.h. would require removing all small trees, which, because small trees do not account for much of the BA, would require removing nearly all trees less than 9 inches d.b.h. This would simplify forest structure and have a very limited effect on the large trees retained. It would not move forest structure towards multi-story stands but would eliminate an entire cohort of trees. This, in turn, would interrupt future recruitment of trees into larger size-classes. In addition, retaining all trees 9 inches d.b.h. and larger would continue the uncharacteristically high probability of surface fire transitioning into high-severity crown fire in PACs through time. Thinning up to 16 inches d.b.h. would reduce the risk of high-severity crown fire in PACs, retain diversity in stand structure, and improve growth rates for developing and maintaining large trees.

The minimum BA target was 150 square feet per acre. PACs would average BA was 140 square feet per acre immediately after treatment and reach 162 square feet per acre by 2050. This alternative would move MSO habitat towards desired conditions as measured by improvements in the ratio of large trees, decreasing the percent of SDImax, releasing Gambel oak, and increasing herbaceous understory. The resulting values for these forest metrics would be similar in alternatives B, C, and D. Alternative B would consistently achieve lower results than alternative C and higher results than alternative D. Changes in numbers of large trees, understory response, and surface fuels would be more pronounced in restricted “other” habitat as a result of group selection versus intermediate thinning treatments in current and future nesting and roosting habitats. All treatments in MSO habitat would follow Recovery Plan direction. Treatments on 66,419 acres of restricted “other” habitat would provide for “groupy” tree structure and canopy gaps, resembling historical conditions and improving habitat for MSO prey species.

By design, mechanical thinning and low severity prescribed burning within MSO habitats would be minimal. Changes in forest structure in MSO habitats would be less than those in non-MSO forest types because of the small scale of change proposed in owl treatments. The limited intensity of treatments in MSO habitat is evidenced by the marginal change in forest attributes. Nevertheless, improving stand structure in terms of ratios of tree size-classes, density of trees, and maintenance of MSO prey species components would meet short-term objectives of improved forest health and long-term objectives of increased forest resiliency. Increasing growth rates of mature and old growth trees, including Gambel oak, and retaining existing large trees will indirectly contribute to maintaining large snags, logs, and CWD across the landscape in the long-term. The old tree implementation plan provides additional protection for smaller diameter old trees. No trees greater than 24 inches d.b.h. would be cut in any MSO habitats.

Alternative B (and E) would have the second largest number of acres of prescribed fire in MSO habitat. Prescribed fire would be used in all PACs occurring in the treatment area, although fire would be excluded from all 54 core areas occurring in the treatment area, and on 836 acres of steep slope habitat (about 31,043 total protected acres). Surface fuels would not be reduced within core areas. Preventing fire in core areas would require construction of firelines. Fireline construction would create soil and vegetation disturbance, creating trail-like scars around designated nesting and roosting habitat within PACs. This could increase disturbance from recreation and firewood cutting. Some percentage of each PAC would also be excluded to facilitate designating fireline around core areas. Risk of high-severity fire outside of core areas would decrease because of prescribed fire effects reducing surface fuels, decreasing litter layers, and increasing canopy heights. Prescribed fire would not be conducted in PACs or areas where resulting smoke could settle into PACs during the nesting season. Post-treatment (year 2020), alternative B would potentially produce the second most acres of surface fire and the second lowest amount of active crown fire of any alternative. Total treatments in alternative B would nearly double the acres within the historical range of variability (VCC1). The amount of forest land in a highly departed condition class would drop by 56 percent after treatment. Combined, this would increase the ability to retain MSO habitat in a landscape with frequent fire return intervals.

As a result of mechanical thinning and prescribed fire, future fires would be more likely to burn as surface fires rather than crown fires, more closely resembling the historical range of variation. The reduction in risk of habitat loss from high-severity fire would be greater in alternative B than the other alternatives except for C.

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, reducing vulnerability of snags to firewood collectors.

An additional indirect benefit of prescribed fire treatments is the resulting inputs of soil nutrients, benefiting both over- and understory vegetation and thereby improving the habitat of MSOs and their prey (appendix 6). Prescribed burning across MSO habitats would also reduce litter, further improving the potential response of understory plants. In addition, reductions in total BA, increasing relative contributions of Gambel oak to soil resources, and increasing solar radiation reaching the understory would all improve the herbaceous response. These improvements, not captured in the modeling, would occur in all 70 PACs outside core areas, benefiting owls. PACs and core areas are hunted more heavily than other portions of an owl pair’s territory during the nesting season. Understory biomass would potentially increase by 10s of pounds per acre in nesting and roosting habitats and over a 100 pounds of forage per acre in restricted “other” habitat. Understory response would persist longer in restricted “other” habitat due to creation of interspaces versus canopy gaps. Canopy gaps would re-close without future treatments as trees grow, particularly with increased tree growth rates post-treatment.

Road construction would only occur for new temporary roads. All temporary roads would be decommissioned after implementation is complete. This would be based on implementation of individual task orders, so completion would typically be within a year. All “new” temporary roads in PAC habitat already exist on the ground but are not part of the National Forest road inventory. These too will be decommissioned after treatments are completed. Construction, upgrading, and decommissioning of temporary roads would occur outside of the nesting season in PACs. Short-term disturbance could happen to foraging owls in restricted habitat or in protected habitat if foraging occurred in PACs outside the nesting season when project activities were occurring.

Improvements and restoration of key prey habitats (i.e., spring and channel restoration and meadow, savanna, grassland and aspen treatments) interspersed within the pine-oak forest would improve habitat for prey species. All alternatives would restore 23 springs and over 4 miles of ephemeral channels in MSO habitat. Alternatives B, C, and E would each improve over 130 acres of meadows within PACs. However, alternative B does not include any mechanical thinning in meadows within PACs like alternatives C and E do. Alternatives B and D would improve or restore 16,736 acres of grassland, savanna, and meadows interspersed with MSO habitat outside of PACs. This is 85 more acres than alternative C, but does not include any restoration of existing grasslands like alternative C does. All alternatives would restore about 739 acres of aspen and improve (prescribe fire-only) another 7 acres of aspen in MSO habitat outside of PACs. Alternative B (and D) would improve about 200 acres of aspen in PACs.

Restoration of key prey habitats would increase the area supporting herbaceous ground cover and better connect currently fragmented openings. Increasing openings dominated by grasses, sedges, forbs, and shrubs would improve habitat for small mammals, some bat species, and arthropods. In addition, improvements to pollinator habitat would also occur which could indirectly improve herbaceous undergrowth and indirectly benefit MSO prey species. These actions would improve vegetation heterogeneity and increase food and cover for prey species, presumably increasing total prey biomass. There is a strong link between raptors and their food and conserving and enhancing prey habitat is expected to benefit MSOs in the short- and long-term. Total heterogeneity in prey habitats improved or restored would be similar between alternatives B and D and less than alternatives C and E.

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 MSOs 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. This would be the same for all alternatives.

Amounts of hauling and individual haul routes would be similar between alternatives. Therefore the potential for collisions between owls and vehicles implementing the 4FRI would be similar across alternatives. The level of risk is considered to be low and is unquantifiable.

The amount of burning at the treatment area scale is similar between alternatives B, C, and E and all alternatives preclude prescribed fire in protected habitat during the nesting season. Therefore the risk of smoke settling into PACs is similar between alternatives B, C, and E but would remain lowest in alternative D. Smoke may have an adverse effect if predicted weather conditions were to change during burn operations and smoke settled into a low-lying PAC for 3 or more continuous days and nights. Fire and smoke from prescribed burning outside of PACs could disturb individual birds in and adjacent to treatment areas, but landscape assessments of smoke patterns and of PACs vulnerable to settling smoke, along with seasonal restrictions for burning, should minimize risk of disturbance to nesting and roosting owls. However, the amount of burning across the landscape under this alternative creates increased potential for smoke to unexpectedly settle into a PAC, potentially leading to adverse effects to individual nesting or roosting owls or nestlings. Potential disturbances to foraging owls should be limited to short-term effects. The risk of smoke to owls is considered low and is unquantifiable.

The use of prescribed fire brings inherent uncertainty. While this would be minimized through the use of ignition and control techniques, the sheer number of acres and years until implementation is complete, and the number of discrete applications of fire, could increase the risk of a fire burning outside of burn plan objectives. While torching of individual trees or pockets of trees could improve habitat conditions by adding diversity in dense, relatively homogeneous stands of pine-oak, torching could also create long-term adverse effects to MSO habitat. Adverse effects would only happen if fire severity exceeded burn plan objectives. This would be an unintended result and the risk of its occurrence is unknown. Based only on acres of prescribed fire, this potential risk is greater than in alternative D but less than alternative C.

The disturbance associated with mechanical thinning, prescribed fire, restoration activities, road maintenance, construction, decommissioning, and realignment, and hauling could result in short-term displacement of foraging owls and owls roosting outside the breeding season. Design features should ensure nesting and roosting MSOs are not disturbed during the breeding season.

Overall, alternative B would provide for a mosaic of desired stand structure conditions, improving habitat heterogeneity and vegetative diversity in MSO 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 in order to mitigate adverse effects associated with treatments.

## Alternative C – Preferred Alternative

Under alternative C, mechanical treatments would occur in portions of all MSO habitats except for core areas (see protected habitat below). Low severity prescribed fire would be applied to all MSO habitats, including core areas (Table 86). Total treatments in MSO habitat include about 81,500 acres of mechanical thinning (about 74 percent of the total MSO habitat in the treatment area) and 108,847 acres of low-severity prescribed fire (nearly 100 percent of the total MSO habitat in the treatment area). This represents the most acres of MSO habitat treated in any alternative but the fewest mechanically treated acres. No trees 18 inches d.b.h. or greater would be cut in protected habitat and no trees 24 inches d.b.h. or greater would be removed from restricted habitat. Trees up to 17.9 inches d.b.h. would be thinned in 18 PACs. Group selection treatments would not occur in MSO habitat. Treatments in target habitat are designed to move forests towards threshold conditions. Treatments in threshold habitat were designed to maintain or exceed forest structural values described in Table III B.1 of the Recovery Plan (USDI 1995) and Table C2 of the revised Recovery Plan (USDI 2012b). The minimum post-treatment BA used modeling thinning in current and future nesting and roosting habitat was 110 square feet per acre, as recommended in the draft recovery plan (USDI 2011a) and the revised Recovery Plan (USDI 2012b). However, total BA of 150 square feet per acre or greater would be maintained where present in areas with site potential capable of sustaining high tree densities. Comparisons of treatments in MSO habitat by alternative is displayed below (see Cumulative Effects for MSO).

Decreasing the minimum BA 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 trees, 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 MSO habitat. As in any prescribed fire, we would expect some areas would not burn, increasing forest heterogeneity while reducing the overall risk of future high-severity fire in PACs.

**Table 86. Alternative C summary of proposed treatments (Acres) in MSO pine-oak habitat**

| Treatment Type | MSO Habitat Types | | | | Total Acres |
|---|---|---|---|---|---|
| | Protected[1] | Threshold | Target | Restricted | |
| Prescribed Fire Only[2] | 24,735 | 84 | 217 | 2,354 | 27,390 |
| MSO Restricted - Group Selection[3] & Intermediate Thinning[4] + Prescribed Fire | | | | 62,785 | 62,785 |
| MSO Target - Intermediate Thinning + Prescribed Fire | | | 6,495 | | 6,495 |
| MSO Threshold - Intermediate Thinning + Prescribed Fire | | 1,893 | | | 1,892 |
| PAC - Intermediate Thinning less than 18 inch d.b.h. + Prescribed Fire | 10,284 | | | | 10,284 |
| **Total Treatments** | **35,019** | **1,977** | **6,713** | **65,139** | **108,847** |
| No Proposed Treatments | 244 | 1[5] | 2[5] | 1,280 | 1,527 |

1. Includes PAC and steep slope habitats
2. 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.
3. Group selection is a cutting procedure which creates a new age class by removing trees in groups or patches to allow seedlings to become established in the new opening (SAF 1998)
4. Intermediate thinning is the cutting of trees to improve the composition, structure, condition, health, and growth of remaining trees (SAF 1998)
5. These acres represent portions of stands occurring in a no-treatment control watershed as part of a paired watersheds study evaluating the effects of vegetation treatment on water yield and water balance.

Mechanical thinning and prescribed fire would take place at different times in different locations. Spotted owl habitat could be affected by mechanical treatments in one area and prescribed fire in another in any one time period. It is expected implementation of the entire project will require 10 or more years to complete. If work were completed in 10 years, on average about 8,150 acres of MSO habitat would be mechanically treated and 10,885 acres of prescribed fire would occur each year under alternative C. No mechanical treatments would occur on slopes greater than 40 percent in MSO habitat.

### *Protected Habitat*

Most (greater than 99 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. Little change would occur in forest structure and MSO prey habitat from low-severity fire treatments and no mechanical treatments in steep slope habitat

About 10,284 acres of PAC habitat would be treated mechanically (30 percent of the total 34,426 PAC acres in the treatment area). Approximately 3,378 acres (33 percent) of the mechanically treated acres would have a 9 inch d.b.h. limit (Table 87). About 6,900 acres would be improved with mechanical treatments addressing trees greater than 9 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. However, about 600 of these acres would include removing trees up to 17.9 inch d.b.h., resulting in increased habitat improvements in 8 individual PACs. Model results would be reassessed when site-specific silvicultural prescriptions are developed. At that time the silviculturist in the field would have the ability to decrease, but not increase, d.b.h. limits if it appeared that stand objectives could be met with smaller diameter limits. All stands identified for mechanical harvest would be marked by hand and marking would be coordinated with the FWS. Proposed treatments to move PACs towards desired conditions include:

- Fifteen PACs (Archies, Bar M, Bonita Tank, Foxhole, Frank, Holdup, Iris Tank, Knob, Lake No. 1/Seruchos, Lee Butte, Red Hill, Red Raspberry, Rock Top, Sawmill Springs, T-Six Tank) thinned up to 12 inches d.b.h. on 1,335 acres;
- Seventeen PACs (Archies, Bar M, Bonita Tank, Crawdad, Foxhole, Frank, Holdup, Iris Tank, Knob, Lake No. 1/Seruchos, Lee Butte, Mayflower Tank, Red Hill, Red Raspberry, Rock Top, Sawmill Springs, T-Six Tank) thinned up to 14 inches d.b.h. on 3,951 acres,
- Twelve PACs (Bar M, Bear Seep, Holdup, Crawdad, Foxhole, Frank, Holdup, Iris Tank, Knob, Mayflower Tank, Red Raspberry, Rock Top, and T-Six Tank) thinned up to 16 inches d.b.h. on 1,022 acres, and
- Eight PACs (Bonita Tank, Crawdad, Frank, Iris Tank, Lee Butte, Mayflower Tank, Sawmill Springs, and T-Six Tank) thinned up to 17.9 inches d.b.h. on 599 acres.

Under alternative C, mechanical treatments would take place in 18 of the 70 PACs (26 percent) occurring within the treatment area. Based on Terrestrial Ecosystem Survey soil units, the 18 PACs selected for mechanical treatment average about 88 percent mollisol (grassland) and mollic intergrade (open forest/savanna) soil types (range = 57 to 100 percent mollisol and mollic intergrade). Conversely, on average about 12 percent of the area in the selected PACs have soils that developed under closed forest conditions. The predominance of open habitat soils within these PACs indicates current forest structure is much denser than historical conditions. Adopting a lower total BA for thinning in these PACs would move forest structure towards the natural range of variability. Nevertheless, the scale of change would be minimal.

**Table 87. General description and acres of mechanical treatment in Alternative C by PAC (all mechanically treated PACs occur on the Coconino NF)**

| | | MSO PAC Mechanical Treatments[1] (acres) | | | | | |
|---|---|---|---|---|---|---|---|
| **PAC Name** | **General Description** | **Treat up to 9” d.b.h.** | **Treat up to 12” d.b.h.** | **Treat up to 14” d.b.h.** | **Treat up to 16” d.b.h.** | **Treat up to 17.9” d.b.h.** | **Total** |
| Archies | Strong oak component but few large oak ; many pines less than 9 inch d.b.h. | 444 | 41 | 11 | | | 495 |
| Bar M | Break up contiguous fuels in areas of pure pine, thin out dense clumps of pine to release oaks within clumps, provide openings for forage and grow larger trees | 119 | 149 | 199 | 66 | | 533 |
| Bear Seep | PAC is pure ponderosa or oak, high density of trees greater 9 inch d.b.h. | 453 | | | 144 | | 596 |

| PAC Name | General Description | MSO PAC Mechanical Treatments[1] (acres) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Treat up to 9" d.b.h. | Treat up to 12" d.b.h. | Treat up to 14" d.b.h. | Treat up to 16" d.b.h. | Treat up to 17.9" d.b.h. | Total |
| Bonita Tank | Treatments to grow larger trees and release oaks are needed in southern portion of PAC outside of ridges and draws | 37 | 203 | 429 | | 127 | 795 |
| Crawdad | Oak is supressed by high densities of pine, need for creating gaps around oak and releasing individual oak trees | 138 | | 343 | 99 | 21 | 601 |
| Foxhole | Dense thickets of pine with some oak, need for enhancing oak and thinning groups | 10 | 124 | 136 | 178 | | 450 |
| Frank | PAC has areas of pure pine with dense pockets of 5-18 inch d.b.h. trees, need to release limited oaks and encourage recruitment of oaks, reduce pine densities and increase diameters of both pine and oak | 286 | 69 | 178 | 19 | 33 | 586 |
| Holdup | Most of PAC is pure pine, thin around any existing oak and provide areas for oak to establish | 57 | 197 | 264 | 18 | | 535 |
| Iris Tank | Oak is present in all size classes but is suppressed by pine, need to release oaks and thin dense pockets of pine and reduce fuels southwest of the nest core | 172 | 13 | 261 | 48 | 93 | 587 |
| Knob | PAC is generally pure pine and open with dense dog-hair thickets | 273 | 26 | 252 | 114 | | 665 |
| Lake No. 1/Seruchos | Dense thickets of young pine: need to grow larger trees over time, enhance/retain oaks, and create small openings | 123 | 66 | 50 | | | 239 |
| Lee Butte | Treat dense pine to increase oak, reduce tree density and increase tree diameter on slopes; Field review led to dropping 3 stands from treatment (457 acres) | 111 | 1 | 128 | | 67 | 306 |

| PAC Name | General Description | MSO PAC Mechanical Treatments[1] (acres) Treat up to 9" d.b.h. | Treat up to 12" d.b.h. | Treat up to 14" d.b.h. | Treat up to 16" d.b.h. | Treat up to 17.9" d.b.h. | Total |
|---|---|---|---|---|---|---|---|
| Mayflower Tank | PAC has steep slopes, heavy fuels, limited number of small trees | 257 | | 139 | 118 | 99 | 612 |
| Red Hill | Scrappy habitat, past overstory removal, dense pockets of pine with heavy mistletoe infection, thin pine to grow larger trees and reduce the potential for uncharacteristic wildfire, enhance oak where present, reduce competition with larger trees | 97 | 190 | 385 | | | 672 |
| Red Raspberry | Protect microclimates from undesirable fire effects; Enhance openings, and create, retain, and enhance larger trees among the 5-18 inch d.b.h. pine | 387 | 19 | 203 | 55 | | 664 |
| Rock Top | Treat in pure pine to increase oak and improve growth rates | 98 | 57 | 506 | 90 | | 751 |
| Sawmill Springs | Thinning focus would be to enhance and maintain large d.b.h. size classes | 192 | 63 | 190 | | 71 | 515 |
| T-Six Tank | PAC has dense regeneration, need for removing dense patches of ponderosa pine, maintaining Gambel oak, and thinning dense pine doghair thickets | 126 | 116 | 279 | 72 | 88 | 680 |
| **Total Mechanical Treatment Acres** | | **3,378** | **1,335** | **3,951** | **1,022** | **599** | **10,284** |

1. Actual size-classes presented here are sometimes rounded off in the text to facilitate discussion. However, no trees 18 inch d.b.h. or larger would be cut in PAC habitat.

Low severity prescribed fire would occur in 70 PACs (i.e., all PACs within the treatment area), including core areas. Burn-only treatments would occur in 52 PACs. Although the implementation schedule is not yet known, if 4FRI implementation lasted 10 years then, on average, 1.8 PACs would be mechanically treated per year, or about 2.6 percent of the 70 PACs in the 4FRI treatment in a given year. About 5.2 PACs (less than less than 7.5 percent of the 70 total PACs in treatment area) would, on average, be treated with prescribed fire each year. Affects to forest structure within individual PACs is summarized by alternative in appendix 12.

Prescribed fire treatments in PACs would include the Kendrick PAC on the Kaibab NF. The wildlife analysis for the Kaibab forest plan, using a mid-scale analysis (100-1,000 acres) for evaluating effects of the proposed land management plan, concluded the Kendrick PAC consisted of mixed-conifer habitat. The 4FRI analysis is based on a finer scale and evaluated individual pine stands within the Kendrick PAC. About 173 acres of burn-only treatment is proposed for pine habitat outside the core area in this alternative. The nearby Stock Tank PAC, administered by the Coconino NF, has about 26 acres of pine habitat proposed for burn-only treatments, including about 11 acres in the core area and 15 acres outside the core area. All 26 acres occur on the Kaibab NF outside of the Kendrick Peak Wilderness Area.

## Forest Structure and Density

### Large Trees

Mechanical treatments would, by design, be conservative in protected habitat. Therefore, treatment results would be limited. None of the modeled forest structure attributes dropped below recommended levels immediately after treatment (Table 88). By the year 2050, percent SDI for trees greater than 18 inch d.b.h. would increase in both size-class categories as would total TPA greater than 18 inch d.b.h. The percentages of trees 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 (Table 88). Old and large tree diameter growth and resistance to drought have been shown to increase after restoration treatments (Ericson and Waring 2013, Kerhoulas et al. 2013b). 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. Prescribed fire would contribute towards reducing competition with slight reductions in numbers of small trees. The percent distribution of larger tree size classes would remain unchanged in the burn-only PACs (Table 88), but risk from high-severity fire would decrease (see fire effects below). PAC habitat would remain in zone 4, or “extremely high density” where individual tree growth would be minimal due to within-stand competition and tree mortality would increase. PACs with thin and burn treatments would be at the low end of zone.

In general, alternative C would have similar effects on Gambel oak as alternative B (see above). However, but 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.

### Basal Area

Ponderosa pine BA would be reduced post-treatment (Table 88). Ponderosa pine BA would be slightly reduced in the burn-only PACs and Gambel oak BA would have slight increases. Total BA would range from 134 to 157 over time, well above the minimum value of 110 square feet per acre (Table 88).

### Canopy Structure

The average canopy cover across stands would be greater than or equal to 50 percent, based on BA, TPA, and tree d.b.h. Percent SDImax would decrease relative to no action. Alternative C would decrease percent SDImax to the lowest values in the “extremely high density” category, minimizing competition-induced mortality. However, stands would still average full site occupancy and minimal understory development, further indicating high canopy cover. Harvest would only include ponderosa pine, so while individual trees of other species could be affected by thinning and burning operations, the existing variability in overstory species would remain intact. Combined, these factors should maintain or enhance elements of canopy structure such as canopy cover, tree density, and overstory species diversity. Prescribed fire would improve sub-canopy space, potentially improving flight space for foraging owls (see fire effects).

Overall, changes in the canopy structural elements would be limited, but would move PAC habitat towards desired conditions. The fact that treated PACs would show limited change is a reflection of treatment design in PAC habitat. Because treatments on the ground would be placed to release large oak and large and old pine from competition, improvements in the larger size classes would probably exceed modeled results. Changes in forest structure are summarized by individual PAC in appendix 12.

**Table 88. Modeled changes in forest structure within MSO PACs in Alternative C**

| Forest Attributes | Existing Condition (Year 2010) | Alternative A[1] (Year 2020) | Alternative C (Year 2020) | Alternative C (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **PACs With Thinning Outside Core Areas and Prescribed Fire (n=18)** | | | | | |
| 12 - 17.9" d.b.h. (%) | 30 | 31 | 33 | 26 | 28 |
| 18 - 23.9" d.b.h. (%) | 14 | 16 | 21 | 29 | 23 |
| ≥24" d.b.h. (%) | 8 | 9 | 11 | 15 | 12 |
| % of Max SDI | 75 | 76 | 57 | 63 | 78 |
| TPA >18" d.b.h. | 15 | 18 | 18 | 29 | 27 |
| Ponderosa Pine BA | 124 | 129 | 106 | 118 | 137 |
| Gambel Oak BA | 19 | 20 | 20 | 25 | 26 |
| All BA | 148 | 157 | 134 | 157 | 174 |
| % Oak BA | 13 | 13 | 14 | 16 | 15 |
| **PACs With Prescribed Fire Only (n=52)** | | | | | |
| 12 - 17.9" d.b.h. (%) | 31 | 32 | 32 | 28 | 28 |
| 18 - 23.9" d.b.h. (%) | 13 | 16 | 16 | 23 | 22 |
| ≥24" d.b.h. (%) | 8 | 8 | 8 | 12 | 11 |
| % of Max SDI | 79 | 81 | 78 | 82 | 83 |
| TPA >18" d.b.h. | 15 | 18 | 18 | 28 | 28 |
| Ponderosa Pine BA | 120 | 124 | 119 | 124 | 127 |
| Gambel Oak BA | 22 | 24 | 24 | 28 | 27 |
| All BA | 159 | 168 | 162 | 183 | 185 |
| % Oak BA | 14 | 14 | 14 | 15 | 14 |

1 = No Action Alternative

### *MSO Prey Habitat*

#### Snags, Logs and Coarse Woody Debris

Large snags are, and would remain low. The number of snags greater than 18 inch d.b.h. would decrease after treatment and slowly increase over time (Table 89). Retaining and improving growth rates of large trees would provide a more robust cohort of large trees and eventually provide more large snags beyond 2050.

Logs would decrease after mechanical treatments but increase over time in both treatment groups (Table 89). On average, CWD would drop immediately after treatment, but would more than double over time. Decreases were variable by individual PAC (appendix 12).

Snags, logs, and CWD represent elements of small mammal habitat. While retaining adequate amounts of these habitat components is essential, site conditions are currently highly variable. We reviewed areas where downed wood was nearly absent across whole portions of stands and also encountered areas where a reduction in CWD would be desirable (e.g., in draws). Overall, restoration treatments can benefit the habitat of MSO prey species (Kalies et al. 2012, Martin and Maron 2012). Modeling results indicate treatments would sustain these habitat components in both the short- and long-term.

### Understory Index

A muted understory response in PACs is a reflection of the high canopy cover remaining post-treatment (Table 89). Changes in understory index do not reflect the nutrient pulse associated with burning or the decrease in litter, suggesting results on the ground would be above those modeled here (appendix 6). However, much of the resulting nutrient pool would likely be absorbed by the overstory, given the dense tree structure remaining post treatment (appendix 6). Increases in biomass production would typically be limited in most PACs, but increases would vary by individual PAC and by site-specific conditions (appendix 12). Understory response would be greater in PACs receiving both mechanical and prescribed fire treatments and in PACs that included aspen, meadow, spring, and ephemeral channel treatments. Biomass indices comparing current trajectories and those of alternative C were graphed by individual subunit and can be found in appendix 6 of the wildlife report.

**Table 89. Changes in prey habitat in MSO PACs under Alternative C**

| Forest Attributes | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative C (Year 2020) | Alternative C (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Mechanical Treatment and Prescribed Fire Group (n=18)** | | | | | |
| Snags >12" d.b.h. | 3.2 | 4.1 | 4.4 | 5.9 | 7.1 |
| Snags >12" and <18" d.b.h. | 2.6 | 3.4 | 3.8 | 3.9 | 5.6 |
| Snags >18" d.b.h. | 0.6 | 0.7 | 0.6 | 1.6 | 1.5 |
| CWD >3" (tons per acre) | 4.7 | 6.2 | 2.8 | 6.2 | 10.3 |
| Logs | 1.3 | 2.3 | 1.6 | 4.9 | 5.8 |
| Understory Index | 37 | 31 | 48 | 31 | 23 |
| **Prescribed Fire Only Treatment Group (n=52)** | | | | | |
| Snags >12" d.b.h. | 3.6 | 4.6 | 6.1 | 7.6 | 8.1 |
| Snags >12" and <18" d.b.h. | 3.0 | 3.9 | 5.6 | 5.8 | 6.3 |
| Snags >18" d.b.h. | 0.7 | 0.7 | 0.7 | 1.8 | 1.8 |
| CWD >3" (tons per acre) | 6.0 | 7.8 | 3.2 | 8.5 | 12.6 |
| Logs | 2.9 | 3.9 | 2.5 | 7.0 | 8.1 |
| Understory Index | 36 | 31 | 34 | 24 | 23 |

1. Only prescribed fire would occur within core areas

### Fire Effects

Prescribed fire would occur in all 70 PACs in the treatment area, including 54 core areas. Prescribed fire would occur on over 99 percent of PAC acres in the treatment area. PAC acres in wilderness, mixed conifer forest, other project areas, or canyons would be excluded from treatment under the 4FRI. Expected results from the burning would include a reduction in surface fuels and an increase in average canopy base height. Reduction of surface fuels and raising canopy base height would reduce the risk of a surface fire becoming a crown fire. These changes would also reduce or eliminate accumulated pine needles, helping in the release of understory vegetation (appendix 6). Raising crown base height could improve sub-canopy flight space for MSOs. Combined, these changes would improve the ability to retain PAC habitat over time, improve MSO prey habitat, and potentially improve the ability for MSOs to hunt these areas.

Under alternative C, FRCC would move toward the desired condition of an overall rating of FRCC2 across the treatment area by 2020 (Table 90). Changes in grasslands are more subtle and, with the exception of woody encroachment, not as obvious because the matrix species dominance (grasses, as opposed to forbs) shifts occur slowly. Grassland treatments in alternative C include about 48,000 acres of both mechanical treatments and prescribed fire treatments, which should move the majority of grassland acres out of FRCC3. With no modeled disturbance beyond 2020 (e.g., mechanical or fire treatments, wildfire, insects, disease, etc.), effects of proposed treatments in alternative C would persist, maintaining an FRCC2 after 30 years. Similarly, while the amount of acres in VCC3 would increase by 2050, VCC2 would still have the most acres. The proposed treatments would improve the stability of key ecosystem elements. Treatments proposed under alternative C would shift of the ponderosa pine out of VCC3. More details on FRCC and VCC can be found in the Methodology section.

**Table 90. Fire regime condition class (FRCC) ratings in ponderosa pine forest through time under Alternative C**

| VCC | 2010 | | 2020 | | 2050 | |
|---|---|---|---|---|---|---|
| | **Acres** | **Percent** | **Acres** | **Percent** | **Acres** | **Percent** |
| 1 | 71,097 | 14 | 137,117 | 27 | 81,254 | 16 |
| 2 | 126,960 | 25 | 350,409 | 69 | 248,841 | 49 |
| 3 | 309,782 | 61 | 20,314 | 4 | 177,744 | 35 |
| **FRCC of treatment area =** | **3** | | **2** | | **2** | |

Elements of MSO prey habitat (surface fuels) change by canopy openness. Figure 24 represents the relative degree of canopy openness after treatment, e.g., “High” indicates open conditions achieved with a mosaic of tree groups and interspace. “Very low” indicates relatively connected canopies with little discernible interspace (Fire Ecology report). The lowest intensity treatments are associated with MSO protected habitat and would retain the highest fuel loading in all modeled years. Modeling assumptions include mechanical treatments and two prescribed fire treatments between 2010 and 2020 and that no further disturbances (fire, drought, insects, etc.) occur between 2020 and 2050.

A direct effect of prescribed fires would be the consumption of some 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). CWD would increase faster after treatment than it would with no management actions. Levels of CWD are 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 for maps comparing surface fuels across the 4FRI treatment area. 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 in alternative C (20 tons per acre is the upper end of the recommended range for fuel loading in southwest ponderosa pine habitat [Fire Ecology report]).

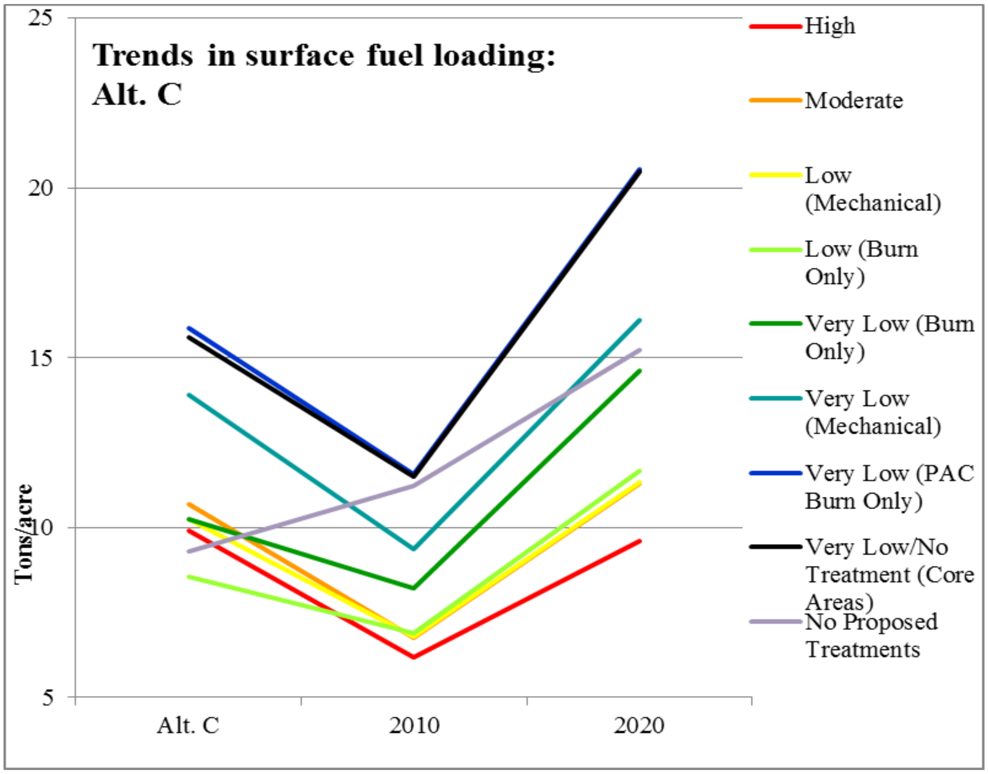


**Figure 24. Modeled changes in surface fuel loading (litter, duff and CWD combined) by desired openness for Alternative C**

Modeled fire behavior would shift as a result of prescribed fire. Predicted surface fire would increase in protected habitat by over 27 percent in the year 2020 under alternative C (Table 91). The probability of active crown fire would decrease by 23 percent after treatments. All crown fires are considered high-severity and lethal to ponderosa pine (Fire Ecology report). Reducing the acres of potential crown fire would increase flexibility for future fires to better meet desired conditions. Appendix 19 displays surface fuel loading across the 4FRI landscape and in MSO habitat for each alternative.

**Table 91. Predicted fire behavior in protected habitat under current conditions and after implementation of Alternative C[1]**

| MSO Habitat | Total (Acre) | Surface Fire (Acre) | Passive Crown Fire (Acre) | Active Crown Fire (Acre) | Surface Fire (%) | Passive Crown Fire (%) | Active Crown Fire (%) |
|---|---|---|---|---|---|---|---|
| **Existing Condition (Year 2010)** | | | | | | | |
| Ponderosa Pine | 507,839 | 311,313 | 48,023 | 143,186 | 61 | 9 | 28 |
| Protected | 35,262 | 18,122 | 3,034 | 14,106 | 51 | 9 | 40 |
| **Alternative C (Year 2020)** | | | | | | | |
| Ponderosa Pine | 507,839 | 476,369 | 17,323 | 8,894 | 94 | 3 | 2 |
| Protected | 35,262 | 26,953 | 1,896 | 6,247 | 76 | 5 | 18 |

1. Acres by fire behavior-type do not equal total acres due to excluded areas that would not support fire such as rock, cinders, and areas with insufficient fuels.

### *Restricted Habitat*

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 (calculated from Table 86). Prescribed fire would include over 98 percent of the restricted habitat, including nearly 100 percent of the target and threshold habitat. Although the implementation schedule is not yet known, on average about 7,120 acres would be treated per year if 4FRI implementation was completed in 10 years.

## Forest Structure and Density in MSO Habitat

Thinning objectives in target and threshold habitat would maintain an overall BA of greater than 125 square feet per acre, well above the minimum threshold recommended in the draft and revised Recovery Plans (USDI 2011a and 2012). In addition, treatments in restricted habitat would provide a diversity of stand conditions and stand sizes across the landscape. By design, treatments in target and threshold habitats would affect less change than treatments in restricted “other” habitat.

#### Large Trees

Mechanical treatments in target and threshold habitat would focus on increasing both the percent area of trees in larger size-classes and increasing tree growth rates, as recommended in the Recovery Plan. This would be accomplished by thinning trees less than 18 inch d.b.h., which are abundant relative to desired conditions described in the Recovery Plan, in an effort to develop and retain trees greater than or equal to 24 inch d.b.h. Trees in this largest size-class are limited on the landscape and an important component of MSO habitat (USDI 1995).

Overall, trees less than 18 inch d.b.h. would decrease after treatments in target and threshold habitats, but remain above recommended minimum levels (Table 92 and Table 93). Trees greater than 18 inches d.b.h. would increase in target and threshold habitats. Changes in individual subunits are variable (appendix 13). In target habitat, the percent SDImax for trees 12 to 17.9 inch d.b.h. would remain at 15 percent or higher for all but subunit1-4, which would drop to 11 percent post-treatment. Many subunits would continue to decline through 2050. Subunit 1-4 (target habitat) would decline to 10 percent post-treatment. However, trees greater than 24 inch d.b.h. would increase in subunit 1-4 by 6 percent in 2050 relative to alternative A. The value for TPA greater than 18 inch d.b.h. would increase in all subunits (appendix 13).

Treatments were designed to improve the ratios, growth rates, and sustainability of large trees. Declines in trees 12 to 17.9 inch d.b.h. would result from selecting trees less than 18 inch d.b.h. due to their uncharacteristic abundance. This would increase growth rates of neighboring trees, allowing them to achieve larger size-classes more quickly. Conversely, fewer small trees would then be recruited into the 12 to 17.9 inch d.b.h. range. Thinning smaller trees would also reduce density-dependent mortality of large trees, improving their resiliency and sustainability over time. Old and large tree diameter growth and resistance to drought have been shown to increase after restoration treatments (Ericson and Waring 2013, Kerhoulas et al. 2013b). Overall, the percent of SDImax would remain high in target and threshold habitats, indicating little change to the overall forest structure in this habitat.

Trees 12 to 17.9 inch d.b.h. would also decrease in restricted “other” habitat. This would result from targeting trees less than 18 inch d.b.h. to reduce competition with trees greater than or equal to 18 inch d.b.h. (Table 94 and appendix 13). Treatments would also create canopy gaps, irregular spacing, and diversify age-class distribution. Trees 18 to 23.9 inch d.b.h. would increase in the short-term. Trees greater than or equal to 24 inch d.b.h. would increase substantially (Table 94 and appendix 13). Overall, TPA greater than 18 inch d.b.h. would decrease relative to no management actions. These results were consistent across RUs: Removing mid-sized trees would reduce tree densities, improving overall forest resiliency while increasing growth rates for the largest size-classes. Increasing forest heterogeneity would improve MSO restricted habitat by maintaining future nesting and roosting structure in some areas while also increasing prey habitat and potential MSO foraging opportunities in other areas.

#### Basal Area

The objective of decreasing pine BA would be met in all restricted habitats (Table 95, Table 96, and Table 97). Total BA in target and threshold habitats would remain above 110 square feet per acre in all subunits and frequently be above 150 BA in 2020. Reducing BA in restricted "other" habitat represents a key contribution towards maintaining large trees and dense tree groups while improving forest resiliency and reducing the threat of high-severity fire. Gambel oak BA would increase in target and threshold habitat and decrease in restricted "other" habitat. No oak would be selected for removal in restricted "other" habitat. The decrease would result from increased operations leading to more individual trees lost from prescribed fire and inadvertent impacts from harvest activities. The decrease in oak would relate to the direct loss of 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 BA of Gambel oak ≥5 inch d.r.c. in the long-term in restricted "other" habitat, relative to alternative A, but may still be in line with presettlement conditions (Abella 2008). Treatments would move towards uneven spacing with canopy gaps as described in the Recovery Plan.

#### Canopy Structure

Based on BA and SDImax, canopy cover would remain dense (Table 95, Table 96, and Table 97). SDImax would remain in the "extremely high density" range in target and threshold habitat, but decrease to "high density" in restricted "other" habitat (Table 94). 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.

**Table 92. Changes in forest structure for MSO threshold habitat in Alternative C**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative C (Year 2020) | Alternative C (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| % of SDI 12-18" d.b.h. | 25 | 24 | 20 | 21 | 26 |
| % of SDI 18-24" d.b.h. | 24 | 26 | 32 | 30 | 28 |
| % of SDI >24" d.b.h. | 3 | 3 | 4 | 9 | 6 |
| % of Max SDI | 101 | 101 | 81 | 90 | 102 |
| TPA >18" | 28 | 31 | 30 | 34 | 35 |
| Ponderosa Pine BA | 133 | 136 | 86 | 102 | 143 |
| Gambel Oak BA | 58 | 58 | 60 | 63 | 58 |
| All BA | 204 | 209 | 161 | 195 | 226 |
| % Oak BA | 29 | 28 | 37 | 33 | 26 |

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative C (Year 2020) | Alternative C (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 3** | | | | | |
| % of SDI 12-18" d.b.h. | 26 | 25 | 19 | 17 | 19 |
| % of SDI 18-24" d.b.h. | 19 | 21 | 24 | 24 | 26 |
| % of SDI >24" d.b.h. | 8 | 8 | 10 | 14 | 11 |
| % of Max SDI | 99 | 99 | 87 | 95 | 100 |
| TPA >18" | 24 | 26 | 26 | 32 | 36 |
| Ponderosa Pine BA | 108 | 111 | 81 | 89 | 114 |
| Gambel Oak BA | 62 | 63 | 64 | 73 | 67 |
| All BA | 185 | 192 | 165 | 196 | 209 |
| % Oak BA | 33 | 33 | 39 | 37 | 32 |

**Table 93. Changes in forest structure attributes within MSO target habitat in Alternative C**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative C (Year 2020) | Alternative C (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| % of SDI 12-18" d.b.h. | 30 | 29 | 24 | 22 | 28 |
| % of SDI 18-24" d.b.h. | 12 | 14 | 17 | 19 | 19 |
| % of SDI >24" d.b.h. | 7 | 8 | 11 | 13 | 9 |
| % of Max SDI | 81 | 83 | 65 | 76 | 84 |
| TPA >18" | 14 | 16 | 16 | 22 | 24 |
| Ponderosa Pine BA | 118 | 123 | 81 | 94 | 128 |
| Gambel Oak BA | 32 | 34 | 35 | 47 | 40 |
| All BA | 156 | 165 | 125 | 161 | 184 |
| % Oak BA | 20 | 20 | 27 | 29 | 22 |
| **Restoration Unit 3** | | | | | |
| % of SDI 12-18" d.b.h. | 26 | 26 | 23 | 21 | 25 |
| % of SDI 18-24" d.b.h. | 13 | 15 | 17 | 17 | 17 |
| % of SDI >24" d.b.h. | 7 | 8 | 10 | 13 | 11 |
| % of Max SDI | 79 | 81 | 70 | 80 | 85 |
| TPA >18" | 13 | 16 | 15 | 21 | 22 |
| Ponderosa Pine BA | 102 | 107 | 80 | 91 | 113 |
| Gambel Oak BA | 35 | 37 | 38 | 48 | 43 |
| All BA | 148 | 158 | 133 | 169 | 181 |
| % Oak BA | 24 | 23 | 28 | 29 | 24 |

**Table 94. Changes in forest structure attributes for MSO restricted "other" habitat in Alternative C**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative C (Year 2020) | Alternative C (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| % of SDI 12-18" d.b.h. | 30 | 31 | 25 | 21 | 30 |
| % of SDI 18-24" d.b.h. | 12 | 14 | 21 | 20 | 20 |
| % of SDI >24" d.b.h. | 7 | 7 | 14 | 19 | 10 |
| % of Max SDI | 68 | 71 | 35 | 46 | 75 |
| TPA >18" | 12 | 14 | 11 | 17 | 23 |
| Ponderosa Pine BA | 111 | 118 | 52 | 71 | 129 |
| Gambel Oak BA | 21 | 23 | 16 | 25 | 29 |
| All BA | 138 | 148 | 74 | 107 | 170 |
| % Oak BA | 15 | 15 | 22 | 23 | 17 |
| **Restoration Unit 3** | | | | | |
| % of SDI 12-18" d.b.h. | 29 | 30 | 25 | 20 | 26 |
| % of SDI 18-24" d.b.h. | 13 | 15 | 21 | 21 | 21 |
| % of SDI >24" d.b.h. | 7 | 7 | 12 | 17 | 10 |
| % of Max SDI | 70 | 73 | 39 | 51 | 77 |
| TPA >18" | 12 | 14 | 12 | 17 | 23 |
| Ponderosa Pine BA | 98 | 104 | 52 | 69 | 113 |
| Gambel Oak BA | 30 | 32 | 23 | 33 | 39 |
| All BA | 137 | 148 | 82 | 116 | 170 |
| % Oak BA | 21 | 21 | 26 | 27 | 23 |
| **Restoration Unit 4** | | | | | |
| % of SDI 12-18" d.b.h. | 28 | 27 | 23 | 18 | 24 |
| % of SDI 18-24" d.b.h. | 13 | 15 | 21 | 19 | 20 |
| % of SDI >24" d.b.h. | 8 | 9 | 14 | 18 | 11 |
| % of Max SDI | 67 | 71 | 39 | 52 | 75 |
| TPA >18" | 12 | 14 | 11 | 16 | 22 |
| Ponderosa Pine BA | 86 | 92 | 47 | 63 | 101 |
| Gambel Oak BA | 33 | 35 | 24 | 37 | 45 |
| All BA | 129 | 141 | 80 | 115 | 165 |
| % Oak BA | 24 | 24 | 29 | 30 | 26 |
| **Restoration Unit 5** | | | | | |
| % of SDI 12-18" d.b.h. | 24 | 26 | 24 | 24 | 28 |
| % of SDI 18-24" d.b.h. | 10 | 10 | 15 | 16 | 15 |
| % of SDI >24" d.b.h. | 9 | 9 | 14 | 16 | 10 |
| % of Max SDI | 51 | 56 | 30 | 42 | 65 |
| TPA >18" | 8 | 9 | 8 | 13 | 16 |
| Ponderosa Pine BA | 80 | 88 | 45 | 63 | 103 |
| Gambel Oak BA | 15 | 18 | 12 | 22 | 28 |
| All BA | 102 | 116 | 64 | 98 | 147 |
| % Oak BA | 15 | 17 | 19 | 22 | 20 |

### *MSO Prey Habitat*

#### Snags, Logs, and Coarse Woody Debris

Under alternative C, snags greater than 18 inch d.b.h. would change little in the short-term in threshold and target habitats (Table 95 and Table 96) but would increase in restricted “other” habitat (Table 97). Snags greater than 18 inches d.b.h. would change little in the long-term. However, current values are and would continue to be consistently below forest plan direction. The impact of low snag densities, relative to forest plan guidance, is unclear because of the uncertainty regarding natural snag levels in southwest ponderosa pine forests (Ganey 1999, Waskiewicz et al. 2007, Ganey et al. 2014). However, increased drought and beetle activity could lead to levels above those modeled here (Ganey and Vojta 2012). Snag mitigation includes selecting for live residual trees with dead tops and lightning strikes to retain elements of snag habitat in living trees (i.e., the living dead) that are more resistant to fire (Waskiewicz et al. 2007).

Logs would decrease immediately above treatment in threshold and target habitats but attain and exceed forest plan direction with time (Table 95 and Table 96). Logs would increase in the short-term in restricted “other” habitat, but remains below forest plan direction (Table 97).

CWD is currently at the low end of or below the recommended range in all restricted habitats (Table 95, Table 96, and Table 97). CWD would decrease in the short-term as a result of prescribed fire, but would increase after treatments (Waltz et al. 2003).

Snags, logs, and CWD represent elements of small mammal habitat. Snags, logs, and CWD would primarily be affected by burning. While retaining adequate amounts of these habitat components is essential, site conditions are currently highly variable. Treatment objectives include lowering surface fuels to lower the risk of MSO habitat loss due to high-severity fire and thereby allow fire to play a more natural role in the ecosystem. Overall, restoration treatments can improve habitat for MSO prey species (Kalies et al. 2012, Martin and Maron 2012).

#### Understory Index

Reduced BA and intermittent openings would increase light and moisture availability for herbaceous understory species. Understory biomass is currently low in threshold habitat. Index values would increase, but remain low after treatment because of the minimal changes to the overall forest structure (Table 95). Understory response in target habitat would have similar results, although the index values would be higher than those for threshold habitat (Table 96). Biomass changes in restricted “other” habitat would have the strongest understory response (Table 97). These changes do not reflect the nutrient pulse associated with burning or the decrease in litter and decreased competition with active tree roots, suggesting results on the ground would be above those modeled here.

Increased biomass production represents grass and forb development during the growing season, providing food and cover for arthropods, small mammals and birds. In turn, this can increase prey availability, diversity, and biomass for MSOs. Total prey biomass may be more influential on MSO fitness than the abundance of any one prey species (Ganey et al. 2011). The recovery plan recommends managers provide diverse habitats to support a diverse prey base. However, improvements in understory production would gradually decline without future treatments as overstory canopies expand and new trees became established. Relative to alternative A, alternative C would represent both short- and long-term improvements to MSO habitat.

**Table 95. Changes in prey habitat attributes within MSO threshold habitat under alternative C**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative C (Year 2020) | Alternative C (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| Acres | 873 | | | | |
| Snags >12" | 2.4 | 3.4 | 2.8 | 3.3 | 5.5 |
| Snags >12" and <18" | 2.0 | 2.9 | 2.4 | 2.3 | 4.3 |
| Snags >18" | 0.5 | 0.5 | 0.5 | 1.0 | 1.2 |
| CWD >3" | 7.1 | 8.8 | 4.1 | 6.8 | 12.9 |
| Logs | 6.1 | 6.7 | 4.6 | 6.1 | 9.0 |
| Understory Index | 13 | 12 | 29 | 15 | 9 |
| **Restoration Unit 3** | | | | | |
| Acres | 1104 | | | | |
| Snags >12" | 3.7 | 4.9 | 4.1 | 4.2 | 6.5 |
| Snags >12" and <18" | 3.0 | 3.9 | 3.2 | 2.4 | 4.4 |
| Snags >18" | 0.7 | 1.0 | 0.9 | 1.8 | 2.1 |
| CWD >3" | 4.5 | 6.6 | 2.9 | 6.8 | 11.7 |
| Logs | 1.8 | 3.1 | 2.5 | 6.1 | 7.9 |
| Understory Index | 19 | 17 | 28 | 16 | 12 |

**Table 96. Changes in prey habitat attributes within MSO target habitat in Alternative C**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative C (Year 2020) | Alternative C (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| Acres | 3919 | | | | |
| Snags >12" | 3.0 | 3.8 | 3.6 | 4.2 | 6.8 |
| Snags >12" and <18" | 2.5 | 3.3 | 3.1 | 3.0 | 5.4 |
| Snags >18" | 0.5 | 0.6 | 0.5 | 1.2 | 1.4 |
| CWD >3" | 6.0 | 7.5 | 3.5 | 6.5 | 11.8 |
| Logs | 4.6 | 5.3 | 3.8 | 6.0 | 8.1 |
| Understory Index | 33 | 28 | 57 | 30 | 20 |
| **Restoration Unit 3** | | | | | |
| Acres | 2795 | | | | |
| Snags >12" | 2.7 | 3.3 | 3.5 | 4.0 | 5.9 |
| Snags >12" and <18" | 2.2 | 2.7 | 2.9 | 2.8 | 4.5 |
| Snags >18" | 0.5 | 0.6 | 0.6 | 1.2 | 1.4 |
| CWD >3" | 4.8 | 6.3 | 2.8 | 6.3 | 10.5 |
| Logs | 2.5 | 3.2 | 2.3 | 4.8 | 6.1 |
| Understory Index | 44 | 37 | 57 | 31 | 25 |

**Table 97. Changes in prey habitat attributes within MSO restricted "other" habitat under Alternative C**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative C (Year 2020) | Alternative C (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| Acres | 25,710 | | | | |
| Snags >12" | 2.1 | 2.8 | 4.0 | 2.1 | 5.9 |
| Snags >12" and <18" | 1.7 | 2.4 | 3.2 | 1.2 | 4.8 |
| Snags >18" | 0.4 | 0.4 | 0.8 | 0.8 | 1.1 |
| CWD >3" | 4.3 | 5.5 | 3.4 | 5.7 | 8.9 |
| Logs | 1.0 | 1.7 | 2.2 | 4.5 | 4.1 |
| Understory Index | 46 | 38 | 149 | 82 | 26 |
| **Restoration Unit 3** | | | | | |
| Acres | 38,527 | | | | |
| Snags >12" | 2.2 | 3.0 | 4.8 | 2.3 | 5.6 |
| Snags >12" and <18" | 1.8 | 2.5 | 3.8 | 1.3 | 4.4 |
| Snags >18" | 0.4 | 0.5 | 1.0 | 1.0 | 1.2 |
| CWD >3" | 3.9 | 5.1 | 3.4 | 6.3 | 8.7 |
| Logs | 1.5 | 2.1 | 2.4 | 5.0 | 4.6 |
| Understory Index | 49 | 41 | 131 | 72 | 27 |
| **Restoration Unit 4** | | | | | |
| Acres | 1,576 | | | | |
| Snags >12" | 2.2 | 2.8 | 4.6 | 2.1 | 5.2 |
| Snags >12" and <18" | 1.7 | 2.2 | 3.5 | 1.1 | 3.9 |
| Snags >18" | 0.5 | 0.6 | 1.1 | 1.0 | 1.3 |
| CWD >3" | 3.2 | 4.3 | 2.8 | 5.7 | 7.9 |
| Logs | 1.1 | 1.7 | 2.0 | 4.7 | 4.3 |
| Understory Index | 52 | 42 | 127 | 67 | 27 |
| **Restoration Unit 5** | | | | | |
| Acres | 606 | | | | |
| Snags >12" | 1.4 | 1.7 | 3.0 | 1.6 | 3.6 |
| Snags >12" and <18" | 1.1 | 1.3 | 2.4 | 1.1 | 2.9 |
| Snags >18" | 0.4 | 0.4 | 0.6 | 0.6 | 0.7 |
| CWD >3" | 3.2 | 3.8 | 2.2 | 4.1 | 6.0 |
| Logs | 0.6 | 1.0 | 1.3 | 2.9 | 2.5 |
| Understory Index | 85 | 66 | 172 | 92 | 37 |

Changes in forest structure and prey habitat were designed to balance impacts to the various measures of MSO habitat, including the need to develop and maintain large trees in a landscape dominated by mid-sized trees. Groups of large trees distributed across MSO habitat should improve dispersal habitat as well. Threshold habitat would maintain nesting and roosting conditions. These conditions would be achieved sooner in target habitat than if no action were taken.

Mechanical treatments in restricted habitats would be implemented during the nesting season. While most foraging is proximal to the nest site and would thus occur primarily in PACs, cutting in restricted habitat could disturb individual owls foraging or roosting outside PACs.

## Fire Effects

Prescribed fire in association with mechanical treatments would occur across about 75,111 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 (Table 98). Changes at this scale should decrease the risk of high-severity fire in MSO habitat. Similar changes would occur in restricted habitat. Currently, about ½ the target and threshold acres support surface fire. 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. By definition, all crown fire is high severity fire and, in ponderosa pine, is lethal (Fire Ecology report).

**Table 98. Predicted fire behavior in restricted habitat before and after implementation of Alternative C[1]**

| MSO Habitat | Total (Acre) | Surface Fire (Acre) | Passive Crown Fire (Acre) | Active Crown Fire (Acre) | Surface Fire (%) | Passive Crown Fire (%) | Active Crown Fire (%) |
|---|---|---|---|---|---|---|---|
| **Existing Condition (Year 2010)** | | | | | | | |
| Ponderosa Pine | 507,839 | 311,313 | 48,023 | 143,186 | 61 | 9 | 28 |
| Target/ Threshold | 8,692 | 4,275 | 922 | 3,482 | 49 | 11 | 40 |
| Restricted "Other" | 66,419 | 35,123 | 6,540 | 24,756 | 53 | 10 | 37 |
| **Alternative C (Year 2020)** | | | | | | | |
| Ponderosa Pine | 507,839 | 476,369 | 17,323 | 8,894 | 94 | 3 | 2 |
| Target/ Threshold | 8,692 | 8,260 | 87 | 331 | 95 | 1 | 4 |
| Restricted "Other" | 66,419 | 57,403 | 8,360 | 572 | 86 | 13 | 1 |

1. Acres by fire behavior- do not equal total acres due to areas of nonburnable substrate such as rock, cinders, and areas with insufficient fuels that would not support fire; nonburnable substrate totals <1% of the ponderosa pine treatment area.

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 (62,785 acres). Over a third of the total acres of restricted "other" habitat is currently at risk from active crown fire and most of that would move to surface fire by 2020. This, combined with the changes in fire behavior across the ponderosa pine forest in general would help maintain MSO habitat over time. Prescribed fire would result in reductions in surface fuels and an increase in the canopy base height, reducing the risk of future fires transitioning from surface fire into crown fires. This also increases sub-canopy flight space for foraging spotted owls. Fire treatments in restricted habitats would be implemented during the nesting season. While most foraging is proximal to the nest site and would thus occur in PACs, burning in restricted habitat could disturb individual owls foraging or roosting outside PACs. The emphasis on low severity fire would be expected to produce a patchier burn, resulting in a mosaic of habitat conditions for MSOs and their prey. Improvements to foraging (i.e., MSO prey) habitat and sub-canopy flight are expected to benefit MSOs.

### *Other Habitat Effects*

Understory vegetation development is related to the amount of solar radiation reaching the ground. This creates a direct and inverse relationship between canopy closure and herbaceous cover. The uncharacteristic forest structure existing in the ponderosa pine forests of northern Arizona restricts herbaceous growth well below presettlement conditions (appendix 6). Ponderosa pine forests in Arizona are relatively homogeneous and the site-specific habitat variability that springs, streams, meadows, grasslands, savannas, and aspen represent are important to a wide array of wildlife, including MSO prey species. These distinct vegetation-types support understory vegetation that is typically denser, more continuous, and more diverse because of the soil types supporting them and the increased solar radiation and moisture availability compared to ground conditions in the general forest. Understory vegetation provides the food and cover that supports an array of wildlife, including many small mammals, birds, bats, and a variety of arthropods that serve as food for vertebrate species and pollinators to help maintain herbaceous diversity. These micro-habitats directly and indirectly support MSO prey species. Improvements to springs, ephemeral channels, meadows, and aspen can benefit MSOs in ways greater than simple area estimates indicate.

#### Springs and Ephemeral Channels

Springs and ephemeral channel restoration numbers per acres are the same for all action alternatives and described under Actions Common to Alternatives B, C, D, and E (above).

#### Grasslands, Savannas, and Meadows

A little more than 130 acres of meadow treatments are proposed in 11 different PACs, including both prescribed fire-only (about 97 acres) and mechanical thinning and prescribed fire (35 acres) treatments (Table 99). All PACs with proposed meadow treatments are located on the Coconino NF. All meadow treatments in PACs would occur outside the nesting season.

Operational burns would occur in eight PACs with the goal of moving fire through meadows to burn in neighboring ponderosa pine habitat. Operational burns avoid constructing fireline between ponderosa pine stands and non-forest areas. This would reduce the habitat disturbance associated with implementing prescribed fire and avoid trail-like scars (potential social trails) that could encourage increased recreation and associated impacts such as disturbance and cutting of snags and logs. Operational burning would improve understory production and likely kill some encroaching conifers. The grass-forb response to burning would improve as a result of reduced shade and litter, reduced competition for water and nutrients, and a post-burn nutrient pulse. This would directly improve food and cover for MSO prey species. However, burning in PACs would be designed to minimize effects to the overstory, potentially leading to higher survival rates of encroaching pine. Surviving trees would continue to expand their canopy, serve as seed sources and compete for water and nutrients, all of which would lessen the length of time that improvements would benefit understory species.

Mechanical thinning with prescribed fire treatments would focus on meadow restoration in PACs (versus improvement) by mechanically removing encroaching post-settlement trees. Treatment design would retain presettlement trees, if present, and retain large post-settlement trees where evidence (e.g., stumps, logs) indicates past presence of presettlement trees. The combination of thinning and burning would stimulate grass-forb vegetation in the short-term and improve conditions over the long-term by reducing conifer competition and tree seed sources.

Grassland and meadow treatments in PACs would enhance and maintain the herbaceous layer, i.e., food and cover for MSO prey species, through time. Enhanced prey habitat would potentially improve prey numbers within meadows and increase small mammal dispersal into the surrounding forest. In addition, some bats, birds, and arthropod prey such as beetles and moths would benefit from these treatments, potentially increasing total prey biomass and diversity.

**Table 99. Treatments in grass-dominated open habitats under Alternative C**

| Protected Activity Center | Acres Treated |
|---|---|
| **Prescribed Fire Only** | |
| Frog Tank | 10 |
| Howard Mountain | 1 |
| Meadow Tank | 28 |
| Nestor | 8 |
| Powerline Tank | 14 |
| Racetrack Tank | 15 |
| Two Holes | 14 |
| Volunteer | 6 |
| Prescribed Fire Only Total | 97 |
| **Mechanical & Prescribed Fire** | |
| Bear Seep | 10 |
| Iris Tank | 9 |
| Red Raspberry | 16 |
| Mechanical & Prescribed Fire Total | 35 |
| **Total (11 PACs)** | **132** |

Grassland, savanna, and meadow treatments in restricted habitat would total about 16,651 acres (Table 100). Grassland and savanna restoration would entail reestablishing openings dominated by herbaceous species in areas that have grown in with trees on mollisol and mollic-intergrade soils. Reclaiming these important habitats would occur on the specific soil types that developed primarily from grass, forb, and sedge input versus forest-based soils. Most acres would include mechanical removal of trees in currently forested areas followed by prescribed fire. Prescribed fire-only would consist of operational burning expected to cause limited tree mortality. Residual tree cover would continue to function as sources of seeds, needle cast, shade, and competition for water and nutrients, continuing the long-term degradation of grassland and meadow habitat. Nevertheless, meadows and grasslands would be improved in the short-term by reinvigorating understory response as a result of limited tree mortality, litter reduction, and the resultant nutrient pulse. In addition, this would preclude the need to create firelines to confine prescribed fire to the ponderosa pine. Improving grassland, savanna, and meadow habitats would benefit MSO directly and indirectly. Small grasslands can blend into large meadows, hence some of the grassland acreage would likely function as MSO foraging habitat. Larger open areas could support source populations for prey dispersal into surrounding pine-oak forest. Therefore, meadow and an unknown percentage of grassland treatments would be expected to improve understory conditions for MSO prey species.

**Table 100. Treatments in grass-dominated open habitats under Alternative C**

| Treatment Type | Acres |
|---|---|
| Grassland Restoration[1] | 2,254 |
| Savanna[2] | 10,725 |
| Grassland Operational Burn-Only[3] | 15 |
| Grassland Mechanical[4] | 3,657 |
| **Total Acres** | **16,651** |

1. Pine-dominated mollisol soils
2. Pine-dominated mollic-intergrade soils
3. Operational burn (no prescription objectives)
4. Restoration of existing grassland

Grassland, savanna, and meadow treatments would improve habitat for small mammals, birds, and arthropods, thereby increasing prey biomass for owls. MSOs have not been observed in openings greater than or equal to 10 acres (Ganey et al. 2011), but these larger openings would improve potential source populations of prey species. Enhancing source populations could increase prey dispersal into MSO habitat, indirectly benefiting MSO. Restoration treatments occurring on meadow-derived soils within a forested matrix would also include areas smaller in scale (meadows). Meadow treatments less than 10 acre could directly benefit affect owls by increasing small mammal reproduction in areas used for foraging owls.

### Aspen

Aspen treatments in protected habitat would consist of prescribed fire -only treatments on about 219 acres in eight PACs (Table 101). Burn-only treatments in aspen would average about 27.5 acres, ranging from 2 acres (Kendrick PAC on the Kaibab NF) to 61 acres (Red Raspberry PAC on the Coconino NF). All aspen treatments in PACs would occur outside the nesting season. Burning outside the nesting season would typically reduce fire intensity in aspen because ignition decisions would be based on conditions in the surrounding ponderosa pine. Combined with patchier surface fuels in aspen, mortality of competing pine would be reduced in prescribed fire-only treatments. Returning fire to these habitats would still improve aspen health and understory cover. Some degree of suckering would still be expected and the reduction of litter, particularly needle cast, along with the accompanying nutrient pulse would benefit understory species. All aspen treatments would include fencing. The FWS suggests that new structures (such as fences) constructed in an occupied owl territory puts the owl at risk of a potentially fatal collision (USDI 2012b). No wire fencing would be used for new fences in PACs. Instead, other fence designs such as double-welded pipe rail would be used. Fencing decisions would be made in collaboration with the FWS. If non-wire fencing options are not available, aspen treatments would not occur in PACs.

**Table 101. Alternative C acres of aspen treatments in protected activity centers (PACs)**

| PAC | Acres |
|---|---|
| Jeep | 29 |
| Mayflower Tank | 55 |
| Mint Spring | 12 |
| Nestor | 19 |
| Pierce Tank | 32 |
| Red Raspberry | 61 |
| Weatherford 2 | 10 |
| Kendrick[1] | 2 |
| **Total** | **219** |

1 = Kaibab National Forest

Prescribed fire in PACs would be conducted so that burn severity would remain low. Prescribed fire would have site-specific objectives in aspen (versus operational burning). Meeting the objectives would be affected by several factors. Because aspen typically constitutes limited acreage in any burn unit, the time for burning aspen would be determined by conditions in the surrounding ponderosa pine. Burn windows for ponderosa pine are much wider than for aspen, meaning aspen would typically be burned under less than ideal conditions, i.e., when conditions could create a patchy burn, leaving untreated areas within the clone. Basing ignition decisions on the surrounding ponderosa pine could also typically reduce fire intensity in aspen. Lack of mechanical manipulation and an inherently variable pine litter layer could also contribute to patchy results. While these factors affecting fire behavior could benefit aspects of small mammal habitat in the short-term, they could also limit the percentage of conifers exposed to fire. Combined, these factors reduce potential improvements to aspen by reducing mortality of encroaching pine and maintaining the effects of shading and competition for water and nutrients by encroaching pine. In short, prescribed fire-only treatments would likely improve aspen, but not restore aspen to long-term sustainability.

Aspen treatments in restricted habitat (746 acres) are consistent across alternatives and is described the Actions Common to Alternatives B, C, D, and E section above.

### *Summary*

At the scale of 4FRI, improvements to MSO prey habitat from meadow, aspen, spring, and ephemeral channel treatments within protected habitat would be limited and site specific. However, these collective treatments would enhance prey habitat within PACs where most foraging occurs during the nesting season (Ganey et al. 2011). Resident MSOs concentrate their use within PACs, even if they do not nest in a given year and MSO reproductive success appears tied to prey availability (Ganey et al. 2011). MSO prey selection in the UGM, primarily peromyscid mice and voles (Ganey et al. 2011), reflects abundant edge habitat (USDI 1995). Restoring/improving these habitats should also improve and increase edge habitat. Restoration treatments in general can benefit peromyscid mice and voles (Kalies et al. 2012, Martin and Maron 2012). Other small mammals, bats, birds, and nocturnal flying insects (primarily lepidopterons and coleopterans) are also prey for MSOs. This should be particularly true in key habitat components where a strong herbaceous response is expected. Overall prey abundance may be very important to nesting MSOs during years when individual prey species may be limited (Ganey et al. 2011). Providing localized patches of increased food and cover for prey species in the areas most heavily hunted during nesting season should directly benefit MSOs during energetically stressed times of the year, spanning egg-laying through fledging of juveniles.

Alternative C would include both aspen and meadow treatments in PACs. It would have the most aspen improvements of any alternative, as much meadow restoration as alternative E, and more meadow restoration than either B or D. Alternatives B and D would have about 85 more acres of grassland, savanna, and meadow restoration in restricted habitat than alternative C. However, alternative C (and E) would achieve nearly 3,660 acres of grassland restoration versus the grassland improvements proposed in alternatives B and D.

MSO primarily select for peromyscid mice and voles in the UGM (Ganey et al. 2011). The reliance on these species may reflect the historically abundant edge habitat in the UGM (USDI 1995). Alternative C should improve and increase edge habitat at levels above the other alternatives. Other small mammals, bats, birds, and nocturnal flying insects (primarily lepidopterons and coleopterans) are also prey for MSOs and would benefit from the proposed treatments. Overall prey abundance may be very important to nesting MSOs during years when individual prey species are be limited (Ganey et al. 2011). Providing localized patches of increased food and cover for prey species should directly benefit MSOs. Overall, alternative C would achieve the most effective restoration and improvements of key prey habitats by accomplishing more work in PACs and more restoration in restricted habitat than any of the other action alternatives.

## Disturbance

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 in regards to MSO is reviewed in the MSO section under Affected Environment (see above). More detail on noise-related activities is presented in appendix 2. Noise disturbance from project activities may affect foraging MSOs, but are not expected to affect nesting or roosting owls due to design features and project planning (see Methodology above).

### Road-Related Disturbance

Road maintenance and construction would have short-term negative effects to habitat and long-term beneficial effects from the decommissioning of 860 miles of roads designated by forest under the Travel Management Rule (appendix 2). Potential fragmentation of prey species populations was reviewed above under the Affected Environment section and was not considered a threat to MSOs or their prey.

### Fire-Related Disturbance

No firelines would be built inside PACs. This would avoid potential effects such as noise disturbance, erosion, or loss of cover for prey species. No fireline “trails” would exist inside PACs, so no increase in recreation and access into PACs would occur. Therefore increasing disturbance or potential of increased loss of snags and logs would not be a concern.

Smoke is not expected to be a disturbance to MSOs for several reasons. Settling smoke has long been an issue that fire experts address on this landscape. This has led to knowledge of smoke patterns and developing ignition techniques to minimize undesirable smoke effects. Recognizing these issues led to the development of a strategy for prescribed fire specifically designed to minimize the risk of smoke settling into PACs (see the discussion on Exclusion and Opportunity Zones in the Methods section above and in appendix 5). Prescribed fire in PACs and exclusion zones would occur outside the breeding season. This would avoid the risk of adverse effects to eggs and nestlings and minimize the risk of adverse effects to adults and yearlings given the seasonal shift in site fidelity. In addition, smoke from prescribed fire would comply with Arizona Department of Environmental Quality requirements (ADEQ). Smoke effects are regulated and permits are required by ADEQ before burning is initiated. Air quality requirements specify management actions will meet air quality standards. ADEQ considers the cumulative effects of smoke emissions from multiple jurisdictions prior to approving daily prescribed fire activities. This mitigates the potential for severe smoke effects from multiple prescribed fire projects across the treatment area. Given the planning, design features, and ignition techniques, smoke from prescribed fire would not be expected to result in adverse effects to MSO. However, this cannot be guaranteed and adverse effects to owls could occur if smoke unexpectedly settled into PACs for three or more days and nights (see Methodology above).

### *Alternative C - Determination of Effects*

An overview of immediate post-treatment results (year 2020) and long-term changes to habitat structure (year 2050) are displayed at the RU and subunit levels in appendices 12, 13, and 14. Existing conditions and long-term changes with no management action are also presented for comparison. See Comparison of Alternatives for quantitative details comparing treatments among alternatives.

Forest structure would improve for MSO and their prey in 70 PACs and in about 8,693 acres of target and threshold habitats. Mechanical thinning in 18 selected PACs (outside of core areas) would include trees up to 17.9 inches d.b.h. Although the minimum BA used was 110 square feet per acre, the average BA was 134 square feet per acre after treatment. This alternative would achieve the most in terms of creating/maintaining uneven-aged/uneven-sized trees and in so doing attain the multi-story canopy structure described in the Recovery Plan. This is evidenced by improvements in the ratio of large trees, decreasing the percent of SDImax, releasing Gambel oak, and increasing herbaceous understory. Conversely, retaining all trees 9 inches d.b.h. and larger would continue the uncharacteristically high probability of surface fire transitioning into high-severity crown fire in PACs. Thinning only up to 9 inches d.b.h. would require removing all small trees, which, because small trees do not account for much of the BA, would require removing nearly all trees less than 9 inches d.b.h. This would simplify forest structure while still having a limited effect on the large trees retained. It would not move forest structure towards multi-story stands but would eliminate an entire cohort of trees. This, in turn, would interrupt future recruitment of trees into larger size-classes. In addition, retaining all trees 9 inches d.b.h. and larger would continue the uncharacteristically high probability of surface fire transitioning into high-severity crown fire in PACs through time. Thinning up to 17.9 inches d.b.h. allows much more flexibility in selecting trees for removal. The resulting flexibility allows retention of more diverse structure, as described in the Recovery Plan. Changes in numbers of large trees, understory response, and surface fuels would be more pronounced in restricted “other” habitat as a result of group selection versus intermediate thinning treatments in current and future nesting and roosting habitats. All treatments in MSO habitat would follow Recovery Plan direction. Treatments on 65,139 acres of restricted “other” habitat would provide for “groupy” tree structure and canopy gaps, resembling historical conditions and improving habitat for MSO prey species. Thinning up to 17.9 inches d.b.h. would reduce the risk of high-severity crown fire in PACs. Alternative C would move more MSO habitat closer to desired conditions.

Changes in forest structure in MSO habitats would be less than those in non-MSO forest types because of the small scale of change proposed in owl treatments. By design, mechanical thinning and low severity prescribed burning within MSO habitats would be minimal. Nevertheless, improving stand structure in terms of ratios of tree size-classes, density of trees, and maintenance of MSO prey species components would meet short-term objectives of improved forest health and long-term objectives of increased forest resiliency. Increasing growth rates of mature and old growth trees, including Gambel oak, and retaining existing large trees will indirectly contribute to maintaining large snags, logs, and CWD across the landscape in the long-term.

The Old and Large Tree Implementation Plans would have limited effect in MSO 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 MSO 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. No trees greater than 24 inches d.b.h. would be removed in any MSO habitats.

Alternative C would have the most acres of prescribed fire in MSO habitat. Prescribed fire would be used in all PACs occurring in the treatment area, including 54 core areas (i.e., all core areas occurring in the treatment area), and 836 acres of steep slope habitat (35,018 total protected acres). This is the only alternative to reduce surface fuels within core areas. Burning in core areas would prevent fireline construction, thereby preventing soil and vegetation disturbance and the creation of trail-like scars that could increase recreation and firewood cutting. Some percentage of each PAC outside of core areas would also be excluded to facilitate designating fireline around core areas. Risk of high-severity fire within MSO habitat would decrease because of prescribed fire effects reducing surface fuels, decreasing litter layers, and increasing canopy heights. Prescribed fire would not be conducted in PACs or areas where resulting smoke could settle into PACs during the nesting season. Post-treatment (year 2020), alternative C would produce the most surface fire and the least active crown fire of any alternative. Total treatments in alternative C would about double the acres within the historical range of variability (VCC1). The amount of forest land in a highly departed condition class would drop by 57 percent after treatment. Combined, this would increase the ability to retain MSO habitat in a landscape with frequent fire return intervals.

As a result of mechanical thinning and prescribed fire, future fires would be more likely to burn as surface fires rather than crown fires and would more closely resemble the historical range of variation. The reduction in risk of habitat loss from high-severity fire would be greatest in alternative C. This is based on greater flexibility in applying treatments in PACs (i.e., larger maximum tree diameter for thinning and lower minimum BA), and more acres treated (including core areas).

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, reducing vulnerability of snags to firewood collectors.

An additional indirect benefit of prescribed fire treatments is the resulting inputs of soil nutrients, benefiting both over- and understory vegetation and thereby improving the habitat of MSOs and their prey (appendix 6). Prescribed burning across MSO habitats would also reduce litter, further improving the potential response of understory plants. In addition, reductions in total BA, increasing relative contributions of Gambel oak to soil resources, and increasing solar radiation reaching the understory would all improve the herbaceous response. These improvements, not captured in the modeling, would occur in all 70 PACs, including core areas. PACs and core areas are hunted more heavily than other portions of an owl pair's territory during the nesting season. Understory biomass would potentially increase by 10s of pounds per acre in nesting and roosting habitats and over a 100 pounds of forage per acre in restricted "other" habitat. Understory response would persist longer in restricted "other" habitat due to creation of interspaces versus canopy gaps. Canopy gaps would re-close without future treatments as trees grow, particularly because tree growth rates would be expected to improve post-treatment.

Road construction would only occur for new temporary roads. All temporary roads would be decommissioned after implementation is complete. This would be based on implementation of individual task orders, so completion would typically be within a year. All "new" temporary roads in PAC habitat already exist on the ground but are not part of the National Forest road inventory. These too will be decommissioned after treatments are completed. Construction, upgrading, and decommissioning of temporary roads would occur outside of the nesting season in PACs. Short-term disturbance could happen to foraging owls in restricted habitat or in protected habitat if foraging occurred in PACs outside the nesting season when project activities were occurring.

Improvements and restoration of key prey habitats (i.e., spring and channel restoration and meadow, savanna, grassland and aspen treatments) interspersed within the pine-oak forest would improve habitat for prey species. All alternatives would restore 23 springs and over 4 miles of ephemeral channels in MSO habitat. Alternatives B, C, and E would all improve over 130 acres of meadows within PACs, although alternatives C and E include 35 acres of mechanical thinning in addition to burning. Alternative C would improve or restore 16,651 acres of grassland, savanna, and meadows interspersed with MSO habitat outside of PACs. This is 85 fewer acres than alternatives B and D but includes about 3,657 more acres of mechanical tree removal and prescribed fire in existing grasslands than alternatives B or D. Alternative E includes the mechanical tree removal and prescribed fire in existing grasslands but only adds 15 additional acres of prescribed fire only treatments in these habitats. All alternatives would restore about 739 acres of aspen and improve (prescribe fire-only) another 7 acres of aspen in MSO habitat outside of PACs. Alternative C would improve 219 acres of aspen in PACs, 18 acres more than alternatives B or E. Alternative D would not improve any acres of aspen within PAC habitat.

Restoration of key prey habitats would increase the area supporting herbaceous ground cover and better connect currently fragmented openings. Increasing openings dominated by grasses, sedges, forbs, and shrubs would improve habitat for small mammals, some bat species, and arthropods. In addition, improvements to pollinator habitats would also occur which could indirectly improve herbaceous undergrowth and indirectly benefit MSO prey species. These actions would improve vegetation heterogeneity and increase food and cover for prey species, presumably increasing total prey biomass. There is a strong link between raptors and their food and conserving and enhancing prey habitat is expected to benefit MSOs in the short- and long-term. Total heterogeneity in prey habitats improved or restored would be greatest in this alternative relative to alternatives B, D and E.

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 MSOs 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. This would be the same for all alternatives.

Amounts of hauling and individual haul routes would be similar between alternatives. Therefore the potential for collisions between owls and vehicles implementing the 4FRI would be similar across alternatives. The level of risk is considered to be low and is unquantifiable.

The amount of burning at the treatment area scale is similar between alternatives B, C, and E and all alternatives preclude prescribed fire in protected habitat during the nesting season. Therefore the risk of smoke settling into PACs is similar between alternatives B, C, and E but would remain lowest in alternative D. Smoke may have an adverse effect if predicted weather conditions were to change during burn operations and smoke settled into a low-lying PAC for 3 or more continuous days and nights. Fire and smoke from prescribed burning could disturb individual birds in and adjacent to treatment areas, but landscape assessments of smoke patterns and of PACs vulnerable to settling smoke, along with seasonal restrictions for burning, should minimize risk of disturbance to nesting and roosting owls. However, the amount of burning across the landscape under this alternative creates increased potential for smoke to unexpectedly settle into a PAC, potentially leading to adverse effects to individual nesting or roosting owls or nestlings. Potential disturbances to foraging owls should be limited to short-term effects. The risk of smoke to owls is considered low and is unquantifiable.

The use of prescribed fire brings inherent uncertainty. While this would be minimized through the use of ignition and control techniques, the sheer number of acres and years until implementation is complete and the number of discrete applications of fire could increase the risk of a fire burning outside of burn plan objectives. While torching of individual trees or pockets of trees could improve habitat conditions by adding diversity in dense, relatively homogeneous stands of pine-oak, torching could also create long-term adverse effects to MSO habitat. Adverse effects would only happen if fire severity exceeded burn plan objectives. This would be an unintended result and the risk of its occurrence is unknown. Based only on acres of prescribed fire, the potential risk would be greatest in alternative C followed by alternative B.

The disturbance associated with mechanical thinning, prescribed fire, restoration activities, road maintenance, construction, decommissioning, and realignment, and hauling could result in short-term displacement of foraging owls and owls roosting outside the breeding season. Design features should ensure nesting and roosting MSOs are not disturbed during the breeding season.

Overall, alternative C would provide for a mosaic of desired stand structure conditions, improving habitat heterogeneity and vegetative diversity in MSO 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. No treatments would occur in PAC habitat during the breeding season in order to mitigate adverse effects associated with treatments.

The following changes were made to the proposed action based on review of the draft BO for implementation of alternative C and coordination with the FWS:

- Disturbance from hauling was changed from a ¼ mile from core areas within PACs to the exterior boundaries of the PACs. Actual routes were reevaluated and little change was possible. Therefore, additional timing restrictions will be applied with the potential result of dropping some areas from treatment.
- Proposed treatments to PACs affected by the Slide Fire will 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.

- Proposed treatments in stands supporting bugbane that were affected by the Slide Fire will be re-evaluated in 5 years. If treatments were to occur, a monitoring plan was agreed to which would document effects of prescribed fire to bugbane.
- Additional details to the MSO monitoring plan were developed. Monitoring will be based on the two treatment types (i.e., mechanical and prescribed fire or prescribed fire-only) and both treatment types will have paired reference PACs. We expect to monitor 12 PACs and data collection will focus on occupancy, reproductive success, and changes to vegetation.

### Alternative D

Under alternative D, mechanical treatments would occur in portions of all MSO habitats except for core areas (Table 102). Total treatments in MSO habitat include about 82,740 acres of mechanical thinning (about 75 percent of the total MSO habitat in the treatment area) and 3,500 acres of low severity prescribed fire (about 3 percent of the total MSO habitat in the treatment area). This represents the least number of acres treated in any action alternative. However, alternative D and B share in having the highest number of acres treated mechanically as a result of limited acres treated with prescribed fire in MSO habitat. There would be no prescribed fire in any PAC habitat in this alternative and only about four percent of restricted habitat would be burned (Table 102). The minimum post-treatment BA for nesting and roosting habitat would be 150 square feet per acre. Although this is not in line with the revised Recovery Plan (USDI 2012b), 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. No trees greater than 24 inches d.b.h. would be removed. Group selection treatments would not occur in MSO habitat. Treatments in target habitat are designed to move conditions towards threshold habitat. Treatments in threshold habitat would not lower stand values below the threshold levels described in Table III.B.1 of the Recovery Plan and in the forest plans. A comparison of treatments in MSO habitat by alternative is displayed below (see Comparison of Alternatives after Alternative E effects). This analysis is based on the assumption that mechanical treatments and two low-severity fires would occur within the project timelines.

The minimum BA would remain high but the maximum diameter limit for trees that could be cut in PACs would increase. This allows more flexibility to better create and maintain nesting and roosting conditions such as uneven sized/aged trees, multistory canopy, and increasing large tree growth rates than 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 potential increases in 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 MSO habitat. Changes at the subunit levels are displayed in appendix 6.

**Table 102. Alternative D summary of treatments (acres) in ponderosa pine MSO habitat**

| Treatment Type | MSO Habitat Types | | | | Total Acres |
|---|---|---|---|---|---|
| | Protected[1] | Threshold | Target | Restricted | |
| Prescribed Fire Only[2] | 836 | 84 | 217 | 2,354 | 3,491 |
| MSO Restricted - Group Selection[3] & Intermediate Thinning[4] | | | | 64,065 | 64,065 |
| MSO Target - Intermediate Thinning | | | 6,497 | | 6,497 |
| MSO Threshold - Intermediate Thinning | | 1,893 | | | 1,894 |
| PAC - Intermediate Thinning less than 16 inch d.b.h. | 10,284 | | | | 10,284 |
| **Total Treatments** | **11,120** | **1,977** | **6,714** | **66,419** | **86,231** |
| No Proposed Treatments | 24,142 | 0 | 0 | 0 | 24,142 |

1. Includes PAC and steep slope habitats
2. 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.
3. Group selection is a cutting procedure which creates a new age class by removing trees in groups or patches to allow seedlings to become established in the new opening (SAF 1998)
4. Intermediate thinning is the cutting of trees to improve the composition, structure, condition, health, and growth of remaining trees (SAF 1998)

Mechanical thinning and prescribed fire would take place at different times in different locations. Spotted owl habitat could be affected by mechanical treatments in one area and prescribed fire in another in any one time period. It is expected implementation of the entire project will require 10 or more years to complete. If work were completed in 10 years, an average of about 8,270 acres of MSO habitat would be mechanically treated and 350 acres of prescribed fire would occur each year under alternative D. No mechanical treatments would occur on slopes greater than 40 percent in MSO habitat.

### *Protected Habitat*

Less than 1/3 of protected habitat (about 32 percent) would have vegetation treatments. Only about 2 percent of protected habitat (836 acres) would see a reduction in surface fuels as a result of prescribed fire (steep slope) in protected 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.

Based on modeling (see methodology), field visits (see appendix 4), and the combined expertise of biologists from the Coconino and Kaibab NFs, the FWS, and the 4FR, modeling was done to explore optimal size classes for thinning trees in PACs. Alternative D includes a size limit of trees 16 inches d.b.h. (Table 103). All stands identified for mechanical harvest would be marked by hand and marking would be coordinated with the FWS. No mechanical treatments would occur in core areas. Excluding fire from entering core areas would require strategic planning to incorporate natural fire breaks to minimize the need for firelines while also maximizing the amount of treated PAC habitat outside of core areas. Fireline creation would disturb soil, reduce herbaceous cover, potentially increase recreation due to trail-like scars (social trails) after treatments, increase noise disturbance during operations and potentially afterwards as well (recreationists), and increased access could lead to a reduction in snags and logs (Chambers 2002, Wisdom and Bates 2008, Ganey et al. 2014). Precluding burning in core areas would inevitably reduce the number of PAC acres burned outside core areas as firelines followed topography and natural breaks. Combined, 100+ acres within the average 600+ acre PAC would not have improvements to forest structure, improvements to prey habitat, or reductions in risk of crown fire.

Within 18 PACs proposed for mechanical treatment, 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. Limits on d.b.h. were adjusted as follows to move PACs towards desired conditions for MSO habitat:

- Fifteen PACs (Archies, Bar M, Bonita Tank, Foxhole, Frank, Holdup, Iris Tank, Knob, Lake No. 1/Seruchos, Lee Butte, Red Hill, Red Raspberry, Rock Top, Sawmill Springs, and T6 Tank) would require thinning up to 12 inches d.b.h. on 1,335 acres;
- Seventeen PACs (Archies, Bar M, Bonita Tank, Crawdad, Foxhole, Frank, Holdup, Iris Tank, Knob, Lake No. 1/Seruchos, Lee Butte, Mayflower Tank, Red Hill, Red Raspberry, Rock Top, Sawmill Springs, and T6 Tank ) would require thinning up to 14 inches d.b.h. on 3,951 acres, and;
- Fifteen PACs (Bar M, Bear Seep, Bonita Tank, Crawdad, Foxhole, Frank, Holdup, Iris Tank, Knob, Lee Butte, Mayflower Tank, Red Raspberry, Rock Top, Sawmill Springs, and T6 Tank) would require thinning up to 16 inches d.b.h. on 1,621 acres.

Modeled treatments were developed to reduce BA, but remain at or above 150 feet2 per acre in forested areas currently supporting 150 BA or greater. Modeled tree removal started in the smallest size classes first. The vegetation model retained trees in each size class so that current owl habitat characteristics were retained while improving potential future habitat, i.e., modeling was not a simple thin from below exercise. Models were run at each of several size classes for each stand. Optimal treatments were defined as those that met the basal area target and produced the best growth rates. Stands with incomplete data were not proposed for thinning above 9 inches d.b.h.

**Table 103. General description and acres of mechanical treatment in Alternative D by PAC (all mechanically treated PACs occur on the Coconino NF)**

| | | MSO PAC Mechanical Treatments(acres) | | | | |
|---|---|---|---|---|---|---|
| **PAC Name** | **General Description** | **Treat up to 9” d.b.h.** | **Treat up to 12” d.b.h.** | **Treat up to 14” d.b.h.** | **Treat up to 16” d.b.h.** | **Total** |
| Archies | Strong oak component but few large oak ; many pines less than 9 inch d.b.h. | 444 | 41 | 11 | | 495 |
| Bar M | Break up contiguous fuels in areas of pure pine, thin out dense clumps of pine to release oaks within clumps, provide openings for forage and grow larger trees | 119 | 149 | 199 | 66 | 533 |

| | | MSO PAC Mechanical Treatments(acres) | | | | |
|---|---|---|---|---|---|---|
| **PAC Name** | **General Description** | **Treat up to 9” d.b.h.** | **Treat up to 12” d.b.h.** | **Treat up to 14” d.b.h.** | **Treat up to 16” d.b.h.** | **Total** |
| Bear Seep | PAC is pure ponderosa or oak, high density of trees greater than 9 inch d.b.h. | 453 | | | 144 | 596 |
| Bonita Tank | Treatments to grow larger trees and release oaks are needed in southern portion of PAC outside of ridges and draws | 37 | 203 | 429 | | 795 |
| Crawdad | Oak is supressed by high densities of pine, need for creating gaps around oak and releasing individual oak trees | 138 | | 343 | 120 | 601 |
| Foxhole | Dense thickets of pine with some oak, need for enhancing oak and thinning groups | 10 | 124 | 136 | 178 | 450 |
| Frank | PAC has areas of pure pine with dense pockets of 5-18 inch d.b.h. trees, need to release limited oaks and encourage recruitment of oaks, reduce pine densities and increase diameters of both pine and oak | 286 | 69 | 178 | 52 | 586 |
| Holdup | Most of PAC is pure pine, thin around any existing oak and provide areas for oak to establish | 57 | 197 | 264 | 18 | 535 |
| Iris Tank | Oak is present in all size classes but is suppressed by pine, need to release oaks and thin dense pockets of pine and reduce fuels southwest of the nest core | 172 | 13 | 261 | 141 | 587 |
| Knob | PAC is generally pure pine and open with dense dog-hair thickets | 273 | 26 | 252 | 114 | 665 |
| Lake No. 1/Seruchos | Dense thickets of young pine: need to grow larger trees over time, enhance/retain oaks, and create small openings | 123 | 66 | 50 | | 239 |

| PAC Name | General Description | MSO PAC Mechanical Treatments(acres) | | | | |
|---|---|---|---|---|---|---|
| | | Treat up to 9" d.b.h. | Treat up to 12" d.b.h. | Treat up to 14" d.b.h. | Treat up to 16" d.b.h. | Total |
| Lee Butte | Treat dense pine to increase oak, reduce tree density and increase tree diameter on slopes; Field review led to dropping 3 stands from treatment (457 acres) | 111 | 1 | 128 | | 306 |
| Mayflower Tank | PAC has steep slopes, heavy fuels, limited number of small trees | 257 | | 139 | 217 | 612 |
| Red Hill | Scrappy habitat, past overstory removal, dense pockets of pine with heavy mistletoe infection, thin pine to grow larger trees reduce the threat of high-severity fire, enhance oak where present, reduce competition with larger trees | 97 | 190 | 385 | | 672 |
| Red Raspberry | Protect microclimates from undesirable fire effects; Enhance openings, and create, retain, and enhance larger trees among the 5-18 inch d.b.h. pine | 387 | 19 | 203 | 55 | 664 |
| Rock Top | Treat in pure pine to increase oak and improve growth rates | 98 | 57 | 506 | 90 | 751 |
| Sawmill Springs | Thinning focus would be to enhance and maintain large d.b.h. size classes | 192 | 63 | 190 | | 515 |
| T-Six Tank | PAC has dense regeneration, need for removing dense patches of ponderosa pine, maintaining Gambel oak, and thinning dense pine doghair thickets | 126 | 116 | 279 | 160 | 680 |
| **Total Mechanical Treatment Acres** | | **3,378** | **1,335** | **3,951** | **1,621** | **10,284** |

No prescribed fire would occur in any of the 70 PACs within the treatment area. Although the implementation schedule is not yet known, if 4FRI implementation lasted 10 years then, on average, 1.8 PACs would be mechanically treated per year, or about 2.6 percent of the 70 PACs in the 4FRI treatment in a given year. Affects to forest structure within individual PACs is summarized by alternative in appendix 12. Neither the Kendrick PAC (Kaibab NF) nor the Stock Tank PAC are proposed for treatment in alternative D.

## Forest Structure and Density

Mechanical treatments would, by design, be conservative in protected habitat and would also be identical as those in alternative B, using the same 16 inch d.b.h. limit and minimum BA value for the same mechanically treated PACs.

### Large Trees

Overall results for percent of tree size classes and TPA 18 inches d.b.h. and larger would be about the same as those discussed in alternative B (Table 104). 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 BA. MSO habitat would be improved 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. Old and large tree diameter growth and resistance to drought have been shown to increase after restoration treatments, although the degree of change may be less in this alternative due to the limited use of prescribed fire (Ericson and Waring 2013, Kerhoulas et al. 2013b).

### Basal Area

Total BA would be reduced below 150 square feet per acre minimum immediately post-treatment in the mechanically treated PACs (Table 104). Total BA would not be affected in the remaining 52 PACs (Table 104). Gambel oak BA would be about the same at the PAC and RU levels as alternative B. No treatment would occur in 52 PACs so BA would be the same as alternative A. Values for BA are well above the minimum BA identified in the revised Recovery Plan (USDI 2012b) and would continue to increase over time. The relatively high, post-treatment BA in alternative D would leave PAC habitat at risk to environmental perturbations in most PACs.

### Canopy Structure

Canopy cover would be highest in alternative D due to the lack of burning in PACs. Based on BA and percent SDImax, canopy cover would remain dense. Percent SDImax would decrease relative to alternative A, but would remain at about the middle of the Extremely High Density Range, retaining a higher value than alternatives B or C (Table 104). Average canopy cover would be at least 50 percent or greater, based on BA, TPA, and tree d.b.h. (see silviculture report for details). Therefore, canopy cover within trees alone would be higher. The existing variability in overstory species would reflect pretreatment conditions due to the minimal use of prescribed fire. PACs are the most proximal and highly used foraging areas during the nesting season. No burning in PACs would mean no change in the canopy base height and so no improvements to sub-canopy flight space. Therefore, the benefits to foraging MSOs included in the other action alternatives would not be a component of alternative D.

Overall, changes in the canopy structural elements would be limited, but would move PAC habitat towards desired conditions. Because treatments on the ground would be placed to release large oak and large and old pine from competition, improvements in the larger size classes would probably exceed modeled results in the 18 treated PACs. Changes in forest structure are summarized by individual PAC in appendix 12.

**Table 104. Modeled changes in forest structure within MSO PACs in Alternative D**

| Forest Attributes | Existing Conditions (Year 2010) | Alternative A[1] (Year 2020) | Alternative D (Year 2020) | Alternative D (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Mechanical Treatment Group (n=18)** | | | | | |
| % of SDI 12-18” d.b.h. | 30 | 31 | 33 | 28 | 28 |
| % of SDI 18-24” d.b.h. | 14 | 16 | 19 | 27 | 23 |
| % of SDI >24” d.b.h. | 8 | 9 | 10 | 14 | 12 |
| % of Max SDI | 75 | 76 | 63 | 67 | 78 |
| TPA >18" | 15 | 18 | 18 | 28 | 27 |
| Ponderosa Pine BA | 124 | 129 | 116 | 128 | 137 |
| Gambel Oak BA | 19 | 20 | 20 | 24 | 26 |
| All BA | 148 | 157 | 144 | 165 | 174 |
| % Oak BA | 13 | 13 | 13 | 14 | 15 |
| **No Treatment Group (n=52)[2]** | | | | | |
| % of SDI 12-18” d.b.h. | 31 | 32 | 32 | 28 | 28 |
| % of SDI 18-24” d.b.h. | 13 | 16 | 16 | 22 | 22 |
| % of SDI >24” d.b.h. | 8 | 8 | 8 | 11 | 11 |
| % of Max SDI | 79 | 81 | 81 | 83 | 83 |
| TPA >18" | 15 | 18 | 18 | 28 | 28 |
| Ponderosa Pine BA | 120 | 124 | 124 | 127 | 127 |
| Gambel Oak BA | 22 | 24 | 24 | 27 | 27 |
| All BA | 159 | 168 | 168 | 185 | 185 |
| % Oak BA | 14 | 14 | 14 | 14 | 14 |

1 = No Action Alternative

2 = No Burning Within PAC Habitat in Alternative D

### *MSO Prey Habitat*

#### Snags, Logs, and Coarse Woody Debris

Differences between alternative D and the other action alternatives would be expected in prey habitat metrics. By not using prescribed fire in PACs, snags (greater than 18 inches d.b.h.), logs and CWD would be the same or higher in this alternative than in any of the other action alternatives (Table 105). Without burning, 52 PACs would not receive any treatment, so logs and CWD would be the same as taking no action. The changes in attributes would vary slightly by individual PAC (appendix 12). The abundance in surface fuels could benefit prey habitat structure. However, the risk of high-severity fire would remain high within protected habitat and increase through time.

#### Understory Index

The lack of fire-induced mortality in small trees would minimize the amount of light of reaching the forest floor. Understory production would be the lowest in alternative D compared to all the other action alternatives post-treatment (Table 105). In addition, no fire-related nutrient pulses would occur and there would be no reduction in pine litter, limiting understory response beyond the modeled response (appendix 6). Benefits from additional logs and CWD would be limited by the lack of food production for most prey species. Effects to forest structure and prey habitat are summarized by PAC in appendix 12.

**Table 105. Changes in prey habitat in MSO PACs under Alternative D**

| Forest Attributes | Existing Conditions (Year 2010) | Alternative[1] A (Year 2020) | Alternative D[2] (Year 2020) | Alternative D (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Mechanical Treatment (n=18)** | | | | | |
| Snags >12" d.b.h. | 3.2 | 4.1 | 3.4 | 6.0 | 7.1 |
| Snags >12" and <18" d.b.h. | 2.6 | 3.4 | 2.8 | 4.5 | 5.6 |
| Snags >18" d.b.h. | 0.6 | 0.7 | 0.6 | 1.5 | 1.5 |
| CWD >3" (tons per acre) | 4.7 | 6.2 | 6.4 | 9.5 | 10.3 |
| Logs | 1.3 | 2.3 | 2.3 | 5.3 | 5.8 |
| CWD >12" | 3.2 | 4.1 | 3.4 | 6.0 | 7.1 |
| Understory Index | 37 | 31 | 40 | 27 | 23 |
| **No Treatment Group (n=52)** | | | | | |
| Snags >12" d.b.h. | 3.6 | 4.6 | 4.6 | 8.1 | 8.1 |
| Snags >12" and <18" d.b.h. | 3.0 | 3.9 | 3.9 | 6.3 | 6.3 |
| Snags >18" d.b.h. | 0.7 | 0.7 | 0.7 | 1.8 | 1.8 |
| CWD >3" (tons per acre) | 6.0 | 7.8 | 7.8 | 12.6 | 12.6 |
| Logs | 2.9 | 3.9 | 3.9 | 8.1 | 8.1 |
| CWD >12" | 3.6 | 4.6 | 4.6 | 8.1 | 8.1 |
| Understory Index | 36 | 31 | 31 | 23 | 23 |

1 = No Action Alternative
2 = No Burning Within PAC Habitat

### Fire Effects

Acres of ponderosa pine in VCC3 would decrease by over 25 percent after treatment under alternative D (Table 106). Ponderosa pine in the treatment area would move from FRCC3 towards the desired condition of FRCC2. Modeling indicates the 4FRI ponderosa pine area would revert to FRCC3 after 30 years of no disturbance after the proposed treatments. One of the important variables for determining FRCC is the fire return interval. There would be no prescribed fire across 70 percent of the treatment area. As the fire return interval gets longer, canopies close and encroachment and ladder fuels progress so, moving conditions back towards FRCC3. Most acres are currently within VCC3. Most acres that would move out of VCC3 would be in VCC2 by 2020. Conditions would be moving back towards VCC3 by 2050. The risk to nesting and roosting habitat would remain high given the limited changes in fire behavior within protected habitat and outside MSO habitat.

Expected results from prescribed burning would include a reduction in surface fuels and an increase in average canopy base height. Reduction of surface fuels and raising canopy base height would reduce the risk of a surface fire transitioning into crown fire. These changes would also reduce or eliminate accumulated pine needles, helping in the release of understory vegetation (appendix 6). Raising crown base height could improve sub-canopy flight space for MSOs. Combined, these changes would improve the ability to retain PAC habitat over time, improve MSO prey habitat, and potentially improve the ability for MSOs to hunt these areas.

With no modeled disturbance of any kind (mechanical or prescribed fire treatments, wildfire, insects, disease, etc.), acres of grasslands in FRCC1 would decrease as woody species continued to encroach and species composition shifted in favor of less fire adapted species. Mechanical treatments combined with prescribed fire would not occur in grasslands; existing encroachment by woody species (primarily ponderosa pine) would remain across 48,000 acres of grasslands and continue through time. Although treatments in grasslands under alternative D would only occur as operational burning, results of prescribed fire would improve the stability of some key ecosystem elements. Deterioration in key ecosystem components such as soil would be expected because so many acres would remain encroached by trees too big to kill with fire. More details on FRCC and VCC can be found in the Methodology section.

**Table 106. Vegetation condition class (VCC) and fire regime condition class (FRCC) ratings in ponderosa pine forest through time under Alternative D**

| VCC | 2010 | | 2020 | | 2050 | |
|---|---|---|---|---|---|---|
| | Acres | Percent | Acres | Percent | Acres | Percent |
| 1 | 71,097 | 14 | 81,254 | 16 | 45,706 | 9 |
| 2 | 126,960 | 25 | 248,841 | 49 | 233,606 | 46 |
| 3 | 309,782 | 61 | 177,744 | 35 | 228,528 | 45 |
| **FRCC of treatment area =** | **3** | | **2** | | **3** | |

Elements of MSO prey habitat (surface fuels) change by desired canopy openness in. Figure 25 represents the relative degree of canopy openness after treatment, e.g., “High” indicates open conditions achieved with a mosaic of tree groups and interspace. “Very low” indicates relatively connected canopies with little discernible interspace (Fire Ecology report). No prescribed fire would occur in PAC habitat under alternative D. Modeling assumptions include mechanical treatments and two prescribed fire treatments between 2010 and 2020 and that no further disturbances (fire, drought, insects, etc.) occur between 2020 and 2050.

Surface fuels in PAC habitat would be greatest under alternative D than in any other action alternative. Prey species would have evolved with frequent fire on the landscape and would presumably adapt to periodic decreases in CWD. Uncharacteristically high surface loading might benefit prey species in the short-term, but they would also increase the probability of surface fire transitioning into crown fire in the long-term. The rate of future recruitment of large logs would likely be little changed given the proposed management of the large tree cohort and large tree recruitment in alternative D. Levels of CWD in PACs would be expected to exceed the upper levels of recommended for southwest ponderosa pine habitat (Fire Ecology report) after treatment. See appendix 19 for maps comparing surface fuels across the 4FRI treatment area.

Although improvements are in terms of fire behavior across the ponderosa pine forest, changes in protected habitat would be minimal (Table 107). This is a result of light mechanical treatments in 18 PACs and no prescribed fire in PAC habitat. Prescribed fire-only prescriptions in protected habitat outside of PACs (836 acres) would be designed to support MSO habitat objectives. These treatments would reduce surface fuels, primarily litter, and raise canopy base height across limited acreage scattered across steep slopes. Predicted surface fire would decrease in protected habitat and the probability of active crown fire would increase by 2020 (Table 107). All crown fires are projected to burn as high-severity and alternative D would have the most predicted crown fire under any action alternative. Therefore, minimizing treatments in protected habitat does not meet desired conditions. The lack of treatment would retain abundant levels of prey habitat features (Table 107) but would also leave PACs, including core areas, vulnerable to the threat of future high-severity fire.

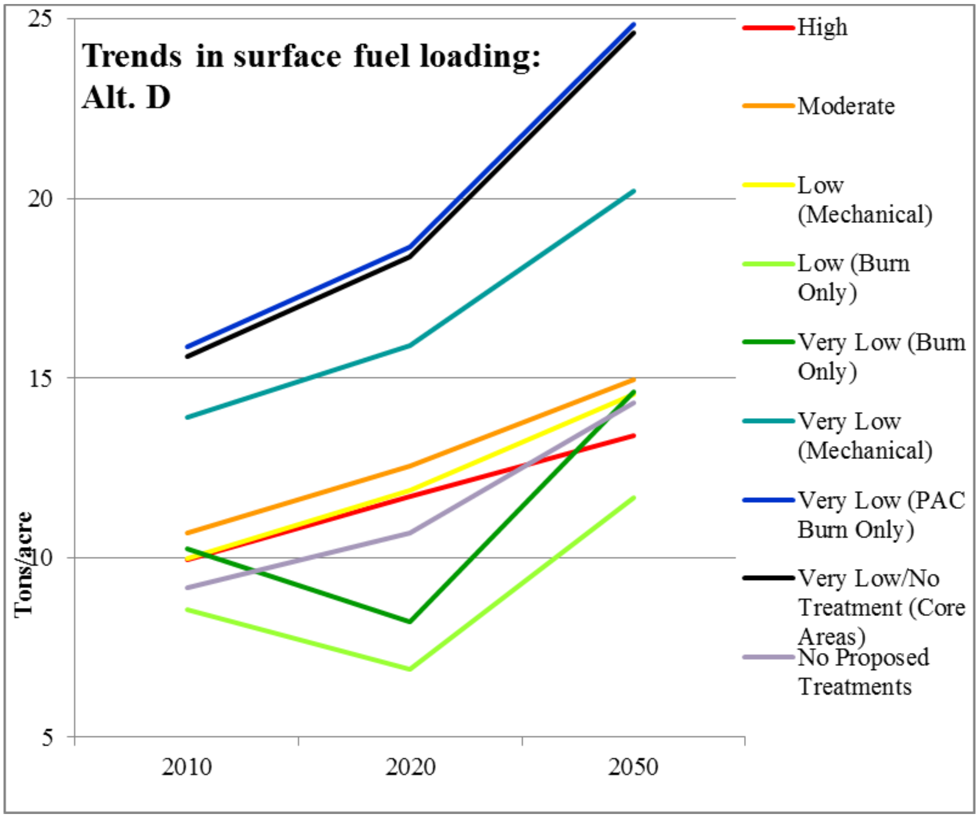


**Figure 25. Modeled changes in surface fuel loading (litter, duff, CWD combined) by desired openness for Alternative D**

**Table 107. Predicted fire behavior in protected habitat under current conditions and after implementation of Alternative D[1]**

| MSO Habitat | Total (Acre) | Surface Fire (Acre) | Passive Crown Fire (Acre) | Active Crown Fire (Acre) | Surface Fire (%) | Passive Crown Fire (%) | Active Crown Fire (%) |
|---|---|---|---|---|---|---|---|
| **Existing Condition (Year 2010)** | | | | | | | |
| Ponderosa Pine | 507,839 | 311,313 | 48,023 | 143,186 | 61 | 9 | 28 |
| Protected | 35,262 | 17,954 | 3,034 | 14,106 | 51 | 9 | 40 |
| **Alternative D (Year 2020)** | | | | | | | |
| Ponderosa Pine | 507,839 | 470,177 | 16,985 | 15,382 | 93 | 3 | 3 |
| Protected | 35,262 | 19,976 | 3,300 | 11,820 | 57 | 9 | 34 |

1. Acres by fire behavior-type do not equal total acres due to excluded areas that would not support fire such as rock, cinders, and areas with insufficient fuels.

### *Restricted Habitat*

All restricted habitat would receive treatments. Mechanical-only treatments would occur on about 72,456 acres of restricted habitat, or nearly 97 percent of total restricted acres in the treatment area (calculated from Table 102). This includes about 97 percent of the total target and threshold acres. About 2,655 acres of restricted habitat (about 3.5 percent) would have prescribed fire-only treatments. Although the implementation schedule is not yet known, on average nearly 7,250 acres of restricted habitat would be mechanically treated and about 265 acres treated with prescribed fire each year if 4FRI implementation lasted 10 years.

### Forest Structure and Density

Treatments in restricted habitat would follow forest plan guidelines and be expected to maintain existing nesting and roosting habitat conditions (threshold habitat) and create replacement nesting and roosting habitat (target habitat). Treatments in restricted habitat would also provide a diversity of stand conditions and stand sizes across the landscape. Results for many forest structure metrics are very similar to alternative B. The lack of prescribed fire had a limited effect on the modeling of the metrics displayed below.

#### Large Trees

Mechanical treatments in target and threshold habitat would focus on increasing both the percent area of trees in larger size-classes and increasing tree growth rates, as recommended in the Recovery Plan. This would be accomplished by thinning trees less than 18 inch d.b.h., which are over-abundant relative to desired conditions described in the Recovery Plan. Thinning smaller trees would result is an increase in trees greater than or equal to 24 inch d.b.h. The response of trees 12-18 inch d.b.h. is variable, depending on the RU (Table 108 and Table 109), indicating that much of the thinning would be trees less than 12 inch d.b.h. This is supported by a decline in trees 12-18 inch d.b.h. by 2050. By this time trees would have been growing out of this category and into larger size classes while fewer trees would be growing up into this size class. This reflects the inherent difficulty in meeting Recovery Plan objectives of increasing the number and growth rates of large trees (i.e., by thinning smaller trees) while keeping total BA high. Changes in individual subunits follow the same patterns (appendix 13). Modeling does not reflect the site specificity in tree selection. Trees to be thinned would be selected near and around large and old trees to reduce competition, thereby increasing growth rates and resiliency to environmental change. The emphasis on increasing tree growth rates and retaining large trees comes from the Recovery Plan which states "[r]etaining large trees is desirable because they are impossible to replace quickly and because they are common features of nesting and roosting habitats for the owl" (USDI 1995).

Trees 12 to 18 inch d.b.h. would decrease in restricted "other" habitat. 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 (Table 110 and appendix 13). This would result from thinning in the mid-sized classes which would reduce the numbers of trees growing into the 18 inches and above d.b.h. size-class. 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, TPA greater than 18 inch d.b.h. would decrease relative to no management actions. These results were consistent across sub-units (appendix 13). Increasing forest heterogeneity would improve MSO restricted habitat by maintaining future nesting and roosting structure in some areas while also increasing prey habitat and potential MSO foraging opportunities in other areas.

Old and large tree diameter growth and resistance to drought have been shown to increase after restoration treatments, although the degree of change may be less in this alternative due to the limited use of prescribed fire (Ericson and Waring 2013, Kerhoulas et al. 2013b).

#### Basal Area

Pine BA would decrease in all restricted habitats (Table 108, Table 109, and Table 110). Thinning objectives in threshold habitat would generally maintain the overall BA near or above 170 square feet per acre (Table 108), well above the minimum of 150 square feet per acre recommended in the Recovery Plan (USDI 1995). Total BA in target habitat would decrease in the short-term, but would remain above 140 and increase over time (Table 109). Total BA in restricted "other" habitat would be under 100 after treatment and then increase over time (Table 110). This represents a key contribution towards reducing the risk of high-severity fire in designated MSO habitat. Gambel oak BA 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 towards 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. However, BA would remain highest in this alternative as a result of the lack of fire.

#### Canopy Structure

SDI is an important measure of forest density and can inform canopy structure (see Tree Density discussion in Affected Environment above). SDImax would be in the 70 to 90 percentile after treatment, in the "extremely high density" range for target and threshold habitats (see Table 108 and Table 109). Restricted "other" habitat would range from moderate to extremely high densities (Table 110). This reflects the variable conditions/objectives desired in this habitat type. Canopy cover would be 50 percent or greater at the tree group level, based on BA, TPA, and tree d.b.h. (see silviculture report for details). Existing variability in overstory species diversity would remain by design. Limited prescribed fire would limit improvements to sub-canopy flight space for MSOs, thus voiding a potential improvement to foraging habitat present in the other action alternatives.

**Table 108. Modeled changes in forest structure attributes within MSO threshold habitat under Alternative D**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative D (Year 2020) | Alternative D (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| % of SDI 12-18" d.b.h. | 25 | 24 | 27 | 23 | 26 |
| % of SDI 18-24" d.b.h. | 24 | 26 | 32 | 33 | 28 |
| % of SDI >24" d.b.h. | 3 | 3 | 4 | 8 | 6 |
| % of Max SDI | 100 | 100 | 85 | 93 | 100 |
| TPA >18" | 28 | 31 | 32 | 39 | 35 |
| Ponderosa Pine BA | 133 | 136 | 99 | 113 | 143 |
| Gambel Oak BA | 58 | 58 | 60 | 62 | 58 |
| All BA | 204 | 209 | 173 | 203 | 226 |
| % Oak BA | 29 | 28 | 34 | 31 | 26 |
| **Restoration Unit 3** | | | | | |
| % of SDI 12-18" d.b.h. | 26 | 25 | 22 | 16 | 19 |
| % of SDI 18-24" d.b.h. | 19 | 21 | 24 | 27 | 26 |
| % of SDI >24" d.b.h. | 8 | 8 | 9 | 13 | 11 |

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative D (Year 2020) | Alternative D (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| % of Max SDI | 99 | 99 | 90 | 96 | 100 |
| TPA >18" | 24 | 26 | 27 | 36 | 36 |
| Ponderosa Pine BA | 108 | 111 | 90 | 97 | 114 |
| Gambel Oak BA | 62 | 63 | 64 | 70 | 67 |
| All BA | 185 | 192 | 173 | 200 | 209 |
| % Oak BA | 33 | 33 | 36 | 35 | 32 |

**Table 109. Modeled changes in forest structure attributes within MSO target habitat under Alternative D**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative D (Year 2020) | Alternative D (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| % of SDI 12-18" d.b.h. | 30 | 29 | 30 | 25 | 28 |
| % of SDI 18-24" d.b.h. | 12 | 14 | 17 | 23 | 19 |
| % of SDI >24" d.b.h. | 7 | 8 | 9 | 11 | 9 |
| % of Max SDI | 81 | 83 | 71 | 79 | 84 |
| TPA >18" | 14 | 16 | 17 | 26 | 24 |
| Ponderosa Pine BA | 118 | 123 | 98 | 108 | 128 |
| Gambel Oak BA | 32 | 34 | 35 | 44 | 40 |
| All BA | 156 | 165 | 141 | 171 | 184 |
| % Oak BA | 20 | 20 | 24 | 25 | 22 |
| **Restoration Unit 3** | | | | | |
| % of SDI 12-18" d.b.h. | 26 | 26 | 27 | 23 | 25 |
| % of SDI 18-24" d.b.h. | 13 | 15 | 17 | 19 | 17 |
| % of SDI >24" d.b.h. | 7 | 8 | 9 | 12 | 11 |
| % of Max SDI | 79 | 81 | 74 | 82 | 85 |
| TPA >18" | 13 | 16 | 16 | 23 | 22 |
| Ponderosa Pine BA | 102 | 107 | 91 | 101 | 113 |
| Gambel Oak BA | 35 | 37 | 38 | 46 | 43 |
| All BA | 148 | 158 | 143 | 174 | 181 |
| % Oak BA | 24 | 23 | 26 | 26 | 24 |

**Table 110. Modeled changes in forest structure attributes within MSO restricted "other" habitat under Alternative D**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative D (Year 2020) | Alternative D (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| % of SDI 12-18" d.b.h. | 30 | 31 | 23 | 20 | 30 |
| % of SDI 18-24" d.b.h. | 12 | 14 | 19 | 18 | 20 |
| % of SDI >24" d.b.h. | 7 | 7 | 12 | 16 | 10 |

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative D (Year 2020) | Alternative D (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| % of Max SDI | 68 | 71 | 43 | 56 | 75 |
| TPA >18" | 12 | 14 | 12 | 17 | 23 |
| Ponderosa Pine BA | 111 | 118 | 58 | 78 | 129 |
| Gambel Oak BA | 21 | 23 | 21 | 32 | 29 |
| All BA | 138 | 148 | 86 | 123 | 170 |
| % Oak BA | 15 | 15 | 23 | 25 | 17 |
| **Restoration Unit 3** | | | | | |
| % of SDI 12-18" d.b.h. | 29 | 30 | 23 | 19 | 26 |
| % of SDI 18-24" d.b.h. | 13 | 15 | 19 | 18 | 21 |
| % of SDI >24" d.b.h. | 7 | 7 | 11 | 15 | 10 |
| % of Max SDI | 70 | 73 | 48 | 60 | 77 |
| TPA >18" | 12 | 14 | 12 | 17 | 23 |
| Ponderosa Pine BA | 98 | 104 | 56 | 73 | 113 |
| Gambel Oak BA | 30 | 32 | 28 | 40 | 39 |
| All BA | 137 | 148 | 94 | 130 | 170 |
| % Oak BA | 21 | 21 | 28 | 29 | 23 |
| **Restoration Unit 4** | | | | | |
| % of SDI 12-18" d.b.h. | 28 | 27 | 21 | 18 | 24 |
| % of SDI 18-24" d.b.h. | 13 | 15 | 19 | 17 | 20 |
| % of SDI >24" d.b.h. | 8 | 9 | 12 | 16 | 11 |
| % of Max SDI | 67 | 71 | 50 | 61 | 75 |
| TPA >18" | 12 | 14 | 12 | 16 | 22 |
| Ponderosa Pine BA | 86 | 92 | 52 | 67 | 101 |
| Gambel Oak BA | 33 | 35 | 31 | 44 | 45 |
| All BA | 129 | 141 | 96 | 130 | 165 |
| % Oak BA | 24 | 24 | 31 | 32 | 26 |
| **Restoration Unit 5** | | | | | |
| % of SDI 12-18" d.b.h. | 24 | 26 | 22 | 23 | 28 |
| % of SDI 18-24" d.b.h. | 10 | 10 | 13 | 14 | 15 |
| % of SDI >24" d.b.h. | 9 | 9 | 12 | 13 | 10 |
| % of Max SDI | 51 | 56 | 38 | 52 | 65 |
| TPA >18" | 8 | 9 | 8 | 12 | 16 |
| Ponderosa Pine BA | 80 | 88 | 51 | 71 | 103 |
| Gambel Oak BA | 15 | 18 | 16 | 28 | 28 |
| All BA | 102 | 116 | 76 | 114 | 147 |
| % Oak BA | 15 | 17 | 21 | 24 | 20 |

### *MSO Prey Habitat*

**Snags, Logs and Coarse Woody Debris**

Snags 18 inches and larger d.b.h. show a tendency to decrease in both target and threshold habitat under alternative D (Table 111 and Table 112). The scale of change is suspect in that the accuracy of modeling 1/10th of a snag per acre might not be meaningful on the ground. However, the fact that it is a consistent change suggests minor decreases could happen. Snags greater 12- 18 inches d.b.h. would generally increase. The impact of low snag densities on prey habitat, relative to forest plan guidance (i.e., 2 snags per acre 18 inches d.b.h. and larger), is unclear because of the uncertainty regarding natural snag levels in southwest ponderosa pine forests. Large snags are currently well below forest plan guidelines in even relatively “natural” areas (Ganey 1999, Waskiewicz et al. 2007, Ganey et al. 2014). However, increased drought and beetle activity could lead to levels above those modeled here (Ganey and Vojta 2012). Four FRI snag mitigation includes selecting for residual trees with dead tops and lightning strikes to retain elements of snag habitat in living trees (i.e., the living dead) that are more resistant to fire (Waskiewicz et al. 2007). Snags would increase substantially in restricted “other” habitat (Table 113).

Logs and CWD would increase after treatment (Table 111, Table 112, and Table 113). The amount of increase varies by habitat and RU. However, with no accompanying reduction in surface fuels due to the lack of prescribed fire, the risk of surface fire transitioning into crown fire because of uncharacteristic fuel build-up would also increase.

Snags, logs, and CWD represent elements of small mammal habitat. While retaining adequate amounts of these habitat components is essential, site conditions are highly variable. There are no specific treatment objectives to reduce surface fuels under alternative D. This does not meet the objective of allowing fire to return to function in a manner similar to historical conditions.

**Understory Index**

Understory biomass would increase, particularly in restricted “other” habitat (Table 111, Table 112, and Table 113). Alternative D would consistently have the smallest understory response. The biomass index only accounts for soil and overstory BA, which should accurately reflect conditions in alternative D. Implementation of alternative D would decrease competition for water, nutrients, and light, but there would be no reduction in litter depth and no nutrient pulse, both of which would benefit understory production (appendix 6). Increased biomass production represents grass and forb development during the growing season, providing food and cover for arthropods, small mammals and birds. In turn, this can increase prey availability, diversity, and biomass for MSOs. These potential increases would be minimized in alternative D relative to the other action alternatives, i.e., this alternative would provide the least amount of herbaceous food and cover for MSO prey species.

**Table 111. Modeled changes in prey habitat attributes within MSO threshold habitat under Alternative D**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative D (Year 2020) | Alternative D (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| Snags >12" | 2.4 | 3.4 | 2.5 | 4.1 | 5.5 |
| Snags >12" and <18" | 2.0 | 2.9 | 2.1 | 3.0 | 4.3 |
| Snags >18" | 0.5 | 0.5 | 0.4 | 1.1 | 1.2 |
| CWD >3" | 7.1 | 8.8 | 9.6 | 11.9 | 12.9 |
| Logs | 6.1 | 6.7 | 6.8 | 8.3 | 9.0 |
| CWD >12" | 2.1 | 2.2 | 2.3 | 2.8 | 3.0 |
| Understory Index | 13 | 12 | 23 | 13 | 9 |
| **Restoration Unit 3** | | | | | |
| Snags >12" | 3.7 | 4.9 | 3.8 | 5.0 | 6.5 |
| Snags >12" and <18" | 3.0 | 3.9 | 2.9 | 2.7 | 4.4 |
| Snags >18" | 0.7 | 1.0 | 0.9 | 2.2 | 2.1 |
| CWD >3" | 4.5 | 6.6 | 6.7 | 10.5 | 11.7 |
| Logs | 1.8 | 3.1 | 3.4 | 7.2 | 7.9 |
| CWD >12" | 0.6 | 1.0 | 1.1 | 2.4 | 2.7 |
| Understory Index | 19 | 17 | 24 | 15 | 12 |

**Table 112. Modeled changes in prey habitat attributes within MSO target habitat under Alternative D**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative D (Year 2020) | Alternative D (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| Snags >12" | 3.0 | 3.8 | 3.1 | 5.6 | 6.8 |
| Snags >12" and <18" | 2.5 | 3.3 | 2.5 | 4.1 | 5.4 |
| Snags >18" | 0.5 | 0.6 | 0.5 | 1.5 | 1.4 |
| CWD >3" | 6.0 | 7.5 | 8.0 | 10.8 | 11.8 |
| Logs | 4.6 | 5.3 | 5.4 | 7.7 | 8.1 |
| CWD >12" | 1.6 | 1.8 | 1.8 | 2.6 | 2.7 |
| Understory Index | 33 | 28 | 43 | 25 | 20 |
| **Restoration Unit 3** | | | | | |
| Snags >12" | 2.7 | 3.3 | 3.0 | 5.0 | 5.9 |
| Snags >12" and <18" | 2.2 | 2.7 | 2.5 | 3.6 | 4.5 |
| Snags >18" | 0.5 | 0.6 | 0.6 | 1.4 | 1.4 |
| CWD >3" | 4.8 | 6.3 | 6.3 | 9.5 | 10.5 |
| Logs | 2.5 | 3.2 | 3.2 | 5.8 | 6.1 |
| CWD >12" | 0.8 | 1.1 | 1.1 | 1.9 | 2.0 |
| Understory Index | 44 | 37 | 480 | 28 | 25 |

**Table 113. Modeled changes in prey habitat attributes within MSO restricted "other" habitat under Alternative D**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative D (Year 2020) | Alternative D (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| Snags >12" | 2.1 | 2.8 | 1.8 | 2.4 | 5.9 |
| Snags >12" and <18" | 1.7 | 2.4 | 1.4 | 1.6 | 4.8 |
| Snags >18" | 0.4 | 0.4 | 0.4 | 0.8 | 1.1 |
| CWD >3" | 4.3 | 5.5 | 7.2 | 8.0 | 8.9 |
| Logs | 1.0 | 1.7 | 3.3 | 4.4 | 4.1 |
| CWD >12" | 0.4 | 0.6 | 1.1 | 1.5 | 1.4 |
| Understory Index | 46 | 38 | 119 | 61 | 26 |
| **Restoration unit 3** | | | | | |
| Snags >12" | 2.2 | 3.0 | 2.5 | 2.6 | 5.6 |
| Snags >12" and <18" | 1.8 | 2.5 | 1.9 | 1.7 | 4.4 |
| Snags >18" | 0.4 | 0.5 | 0.5 | 0.9 | 1.2 |
| CWD >3" | 3.9 | 5.1 | 6.4 | 7.9 | 8.7 |
| Logs | 1.5 | 2.1 | 3.4 | 4.9 | 4.6 |
| CWD >12" | 0.5 | 0.7 | 1.1 | 1.6 | 1.6 |
| Understory Index | 49 | 41 | 105 | 56 | 27 |
| **Restoration Unit 4** | | | | | |
| Snags >12" | 2.2 | 2.8 | 2.0 | 2.6 | 5.2 |
| Snags >12" and <18" | 1.7 | 2.2 | 1.5 | 1.5 | 3.9 |
| Snags >18" | 0.5 | 0.6 | 0.5 | 1.0 | 1.3 |
| CWD >3" | 3.2 | 4.3 | 5.4 | 7.1 | 7.9 |
| Logs | 1.1 | 1.7 | 3.0 | 4.4 | 4.3 |
| CWD >12" | 0.4 | 0.6 | 1.0 | 1.5 | 1.5 |
| Understory Index | 52 | 42 | 95 | 50 | 27 |
| **Restoration Unit 5** | | | | | |
| Snags >12" | 1.4 | 1.7 | 1.2 | 1.8 | 3.6 |
| Snags >12" and <18" | 1.1 | 1.3 | 0.9 | 1.3 | 2.9 |
| Snags >18" | 0.4 | 0.4 | 0.3 | 0.6 | 0.7 |
| CWD >3" | 3.2 | 3.8 | 4.8 | 5.6 | 6.0 |
| Logs | 0.6 | 1.0 | 1.8 | 2.7 | 2.5 |
| CWD >12" | 0.2 | 0.3 | 0.6 | 0.9 | 0.8 |
| Understory Index | 85 | 66 | 136 | 68 | 37 |

Changes in forest structure and prey habitat are designed to balance the various functions of MSO habitat with the need to develop and maintain large trees. Developing and retaining large trees across all owl habitats is desirable because large trees are impossible to replace quickly, they are common features of owl habitat, and growth rates are much slower than for young or mid-aged trees (USDI 1995). As a result, some habitat components would decrease while others increase after treatment. Changes are subtle in target and threshold habitat because of the low intensity of treatments in these habitats. Overall, the action alternatives would create similar values for percent of SDImax, with values in the extremely high density category for target and threshold habitats (zone 4 – see Table 5) and values at the low end of the high density category for restricted “other” habitat (zone 3). Threshold habitat would maintain nesting and roosting conditions and these conditions would be achieved sooner in target habitat under alternative D than if no action were taken.

Providing a continuous supply of nesting and roosting habitat requires maintaining a variety of succession stages across the landscape. Southwest ponderosa pine did not and cannot support tree densities required for nesting and roosting habitat everywhere. In addition to addressing nesting and roosting needs, restricted habitat would provide heterogeneous forest conditions across the landscape, as described in the Recovery Plan. Managing target and threshold habitat and restricted “other” habitat fits the landscape mosaic as described in the Recovery Plan. A mosaic of habitat features across the landscape would likely best support the small mammal community that serve as prey for the owl while also ensuring maintenance of other important ecological functions (Kalies and Chambers 2010). Designating target and threshold habitat in a large-scale analysis, as was done for the 4FRI, ensures future nesting and roosting will be well distributed spatially so as to mimic the natural landscape, provide connectivity for owl dispersal, and enhance ecosystem resiliency (USDI 1995).

Mechanical treatments in restricted habitats would be implemented during the nesting season. While most foraging is proximal to the nest site and would thus occur primarily in PACs, cutting in restricted habitat could disturb individual owls foraging or roosting outside PACs.

**Fire Effects**

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 (Table 102). 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 (Table 114). 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 MSO habitat in alternative D. While the thin-only treatments reduce the threat of active crown fire, mechanical treatments increase total surface fuel loading, including the litter component, adding to levels already outside the historical range of variation. Therefore, over time the risk of high-severity fire would be expected to increase over time. The increased litter layers would further suppress understory development and the lack of prescribed fire would retain current canopy base heights. The 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. However, much of the landscape outside of MSO habitat would be moved closer towards the historical range of variation, thereby decreasing the threat of high-severity fire reaching MSO 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. Treatments in restricted habitats would be implemented during the nesting season. While most foraging is proximal to the nest site and would thus occur in PACs, burning in restricted habitat could disturb individual owls foraging or roosting outside PACs. Appendix 19 displays surface fuel loading across the 4FRI landscape, including MSO habitat, by alternative.

**Table 114. Predicted fire behavior in restricted habitat under current conditions and after implementation of Alternative D[1]**

| MSO Habitat | Total (Acre) | Surface Fire (Acre) | Passive Crown Fire (Acre) | Active Crown Fire (Acre) | Surface Fire (%) | Passive Crown Fire (%) | Active Crown Fire (%) |
|---|---|---|---|---|---|---|---|
| **Existing Condition (Year 2010)** | | | | | | | |
| Ponderosa Pine | 507,839 | 311,313 | 48,023 | 143,186 | 61 | 9 | 28 |
| Target/ Threshold | 8,692 | 4,275 | 922 | 3,482 | 49 | 11 | 40 |
| Restricted | 66,419 | 35,019 | 6,540 | 24,756 | 53 | 10 | 37 |
| **Alternative D (Year 2020)** | | | | | | | |
| Ponderosa Pine | 507,839 | 470,177 | 16,985 | 15,382 | 93 | 3 | 3 |
| Target/ Threshold | 8,692 | 7,830 | 372 | 473 | 90 | 4 | 5 |
| Restricted | 66,419 | 63,149 | 3,080 | 96 | 95 | 5 | <1 |

1. Acres by fire behavior- do not equal total acres due to areas of nonburnable substrate such as rock, cinders, and areas with insufficient fuels that would not support fire; nonburnable substrate totals <1% of the ponderosa pine treatment area.

### *Other Habitat Effects*

Understory vegetation development is related to the amount of solar radiation reaching the ground. This creates a direct and inverse relationship between canopy closure and herbaceous cover. The uncharacteristic forest structure existing in the ponderosa pine forests of northern Arizona restricts herbaceous growth well below presettlement conditions (appendix 6). Ponderosa pine forests in Arizona are relatively homogeneous and the site-specific habitat variability that springs, streams, meadows, grasslands, savannas, and aspen represent are important to a wide array of wildlife, including MSO prey species. These distinct vegetation-types support understory vegetation that is typically denser, more continuous, and more diverse because of the soil types supporting them and the increased solar radiation and moisture availability compared to ground conditions in the general forest. Understory vegetation provides the food and cover that supports an array of wildlife, including many small mammals, birds, bats, and a variety of arthropods that serve as food for vertebrate species and pollinators to help maintain herbaceous diversity. These micro-habitats directly and indirectly support MSO prey species. Improvements to springs, ephemeral channels, meadows, and aspen can benefit MSOs in ways greater than simple area estimates indicate.

#### Springs and Ephemeral Channels

Springs and ephemeral channel restoration numbers per acres are the same for all action alternatives and described under Actions Common to Alternatives B, C, D, and E (above).

#### Grasslands, Savannas, and Meadows

No grassland, savanna, or meadow treatments would occur within PACs under alternative D. These habitats would continue to be degraded or lost due to tree encroachment and related effects on grasses and forbs from shading, moisture competition, needle cast, and changes to soil chemistry. Loss of prey habitat proximal to nesting and roosting owls could decrease foraging efficiency during the nesting season.

Alternative D would have the same grassland, savanna, and meadow treatments in restricted habitat as alternative B (Table 84). See “Grasslands, Savannas, and Meadows” in “Other Habitat Effects” under alternative B (above) for the effects analysis.

**Aspen**

There would be no aspen treatments in protected habitat. The primary objective in alternative D was to minimize prescribed fire and this is the only action alternative that does not treat aspen in PACs (the other action alternatives treat 201 to 219 acres of aspen in PACs). Aspen treatments in restricted habitat (746 acres) are consistent across alternatives and are described in the Actions Common to Alternatives B, C, D, and E section above.

*Summary*

At the scale of 4FRI, improvements to prey habitat from meadow, aspen, spring, and ephemeral channel treatments within MSO habitat would be limited and site specific. However, these collective treatments would enhance prey habitat in key locations. This is particularly important in PACs where resident MSOs concentrate their use even if they do not nest in a given year (Ganey et al. 2011). MSO reproductive success appears tied to prey availability (Ganey et al. 2011). Alternative D is the only alternative that would not improve or restore grassland, savanna, meadow, or aspen habitat in PACs.

Treatments in restricted habitat under alternative D (and B) would include more acres of meadow, grassland, and savanna habitat than the other alternatives. Alternative D (and B) would treat over 3,690 acres of grassland with prescribed fire-only while alternatives C and E would burn 15 acres each. Conversely, alternative D (and B) would not include any grassland restoration (mechanical thinning and prescribed fire in existing grasslands) while alternatives C and E would each achieve nearly 3,660 acres of grassland restoration.

MSO primarily select for peromyscid mice and voles in the UGM (Ganey et al. 2011). The reliance on these species may reflect the historically abundant edge habitat in the UGM (USDI 1995). Alternative D should improve and increase edge habitat. Other small mammals, bats, birds, and nocturnal flying insects (primarily lepidopterons and coleopterans) are also prey for MSOs and would benefit from the proposed treatments. Overall prey abundance may be very important to nesting MSOs during years when individual prey species are be limited (Ganey et al. 2011). Providing localized patches of increased food and cover for prey species should directly benefit MSOs. While alternative D would result in improvements to meadow, grassland, savanna, aspen, springs, and ephemeral channels, it would accomplish the least restoration of these habitats in PACs.

**Disturbance**

Disturbance could occur as a result of project-related activities including moving and operating harvest machinery, hauling forest materials, building fireline, managing prescribed fire, smoke, personnel in the field, and road maintenance and construction. Noise disturbance in regards to MSO is reviewed in the MSO section under Affected Environment (see above). Noise disturbance from project activities may affect foraging MSO, but are not expected to affect nesting or roosting owls due to design features and project planning (see Methodology above). See appendix 2 for details on disturbance factors associated with noise and spotted owls.

#### Road-Related Disturbance

Road maintenance and construction would have short-term negative effects to habitat and long-term beneficial effects from the decommissioning of 860 miles of roads designated by forest under the Travel Management Rule. Potential fragmentation of prey species populations was reviewed above under the Affected Environment section and was not considered a threat to MSOs or their prey. See appendix 2 for details on disturbance factors associated with implementing these operational aspects of the 4FRI.

#### Fire-Related Disturbance

Noise and smoke related to burning would be minimized, but could disturb foraging owls. Prescribed fire in PACs would occur outside the MSO breeding season (i.e., from September 1 through February 28). Prescribed fire could potentially disturb or effect owls due to smoke emissions. Prolonged exposure to ozone caused lung damage in Japanese quail after seven days of continuous contact. Here prolonged exposure is defined as three or more continuous days and nights of smoke contact. Smoke settling into PACs less than three continuous days and nights would not be expected to cause adverse effects.

Smoke is not expected to be a disturbance to MSOs for several reasons. Settling smoke has long been an issue that fire experts address on this landscape. This has led to knowledge of smoke patterns and developing ignition techniques to minimize undesirable smoke effects. Recognizing these issues led to the development of a strategy for prescribed fire specifically designed to minimize the risk of smoke settling into PACs (see the discussion on Exclusion and Opportunity Zones in the Methods section above and in appendix 5). Prescribed fire in PACs and exclusion zones would occur outside the breeding season. This would avoid the risk of adverse effects to eggs and nestlings and minimize the risk of adverse effects to adults and yearlings given the seasonal shift in site fidelity. In addition, smoke from prescribed fire would comply with Arizona Department of Environmental Quality requirements (ADEQ). Smoke effects are regulated and permits are required by ADEQ before burning is initiated. Air quality requirements specify management actions will meet air quality standards. ADEQ considers the cumulative effects of smoke emissions from multiple jurisdictions prior to approving daily prescribed fire activities. This mitigates the potential for severe smoke effects from multiple prescribed fire projects across the treatment area. Given the planning, design features, and ignition techniques, smoke from prescribed fire would not be expected to result in adverse effects to MSO. However, this cannot be guaranteed and adverse effects to owls could occur if smoke unexpectedly settled into PACs for three or more days and nights (see Methodology above).

Prescribed fire would include the construction of firelines in PAC habitat. Building fireline would occur outside the nesting season. Alternative D would result in the most habitat disturbance related to firelines. Potential effects of fireline construction include effects to habitat such as soil erosion and loss of cover for prey species. Fireline “trails” (social trails) could increase recreation and access in PACs, increasing disturbance and potential loss of snags and logs. Forest structure and surface fuels would remain unchanged in core areas and an unknown amount of surrounding PAC habitat outside of core areas (firelines would be based on roads and natural barriers, not on core area boundaries per se). Risk of surface fire transforming into crown fire would remain unchanged in core areas, or approximately 1/6th the area within 52 PACs.

### *Alternative D - Determination of Effects*

An overview of immediate post-treatment results (year 2020) and long-term changes to habitat structure (year 2050) are displayed at the Restoration Unit and subunit levels in appendices 15, 16, 17, and 18. Existing conditions and long-term changes with no management action are also presented for comparison. See Comparison of Alternatives for quantitative details comparing treatments among alternatives.

Forest structure would improve for MSO and their prey in 70 PACs and in about 8,692 acres of target and threshold habitats. Mechanical thinning in 18 selected PACs (outside of core areas) would include trees up to 16 inches d.b.h. The minimum BA target was 150 square feet per acre. Average BA for PACs with mechanical thinning and prescribed fire would be 144 square feet per acre immediately after treatment and 162 square feet per acre by 2050. This alternative would move MSO habitat towards desired conditions as measured by improvements in the ratio of large trees, decreasing the percent of SDImax, and increasing herbaceous understory. The resulting values for these forest metrics would be somewhat similar among alternatives B, C, and D. However, alternative D would consistently achieve the least amount of benefit in terms of resulting forest structure and reduced risk of high severity fire. Alternative B would consistently achieve better results, although results would also consistently be lower than alternative C (see comparison of alternatives below). Changes in numbers of large trees, understory response, and surface fuels would be more pronounced in restricted “other” habitat as a result of group selection versus intermediate thinning treatments in current and future nesting and roosting habitats. All treatments in MSO habitat would follow Recovery Plan direction. Treatments on 66,419 acres of restricted “other” habitat would provide for “groupy” tree structure and canopy gaps, resembling historical conditions and improving habitat for MSO prey species.

Changes in forest structure in MSO habitats would be less than those in non-MSO forest types because of the small scale of change proposed in owl treatments. By design, mechanical thinning and low severity prescribed burning within MSO habitats would be minimal. The limited intensity of treatments in MSO habitat is evidenced by the marginal change in forest attributes. This is particularly true in alternative D where use of prescribed fire would be limited in order to meet the alternative objectives. Nevertheless, improving stand structure in terms of ratios of tree size-classes, density of trees, and maintenance of MSO prey species components would meet short-term objectives of improved forest health and move towards achieving long-term objectives of increased forest resiliency. Increasing growth rates of mature and old trees and retaining existing large trees will indirectly contribute to maintaining large snags, logs, and CWD across the landscape in the long-term. However, implementation plan direction provides an additional measure of protection for smaller diameter old trees.

Alternatives D would have the least number of acres of prescribed fire in MSO habitat. Prescribed fire would not be used where mechanical treatments are proposed in MSO habitat. Less than 3,500 acres of prescribed fire are proposed in MSO habitat. Fire would be excluded from all PACs (and core areas). Protected steep slope habitat (836 acres), and limited acres of target (84), threshold (217), and restricted “other” (2,354) habitats are proposed for prescribed fire. Surface fuels would not be reduced within the remaining portions of MSO habitat, including most current and future nesting and roosting habitats. Fireline is required wherever fire is excluded. Fireline construction would create soil and vegetation disturbance and create trail-like scars around designated nesting and roosting habitat and in restricted habitats. The appearance of trails or roads could increase disturbance from recreation and firewood cutting. Because firelines would tie to roads or natural features that would facilitate controlling the spread of fire, additional acres adjacent to most MSO habitat would also be excluded from prescribed fire. Surface fuels would increase after treatment, litter layers would continue to increase, and canopy base heights would not be affected by proposed 4FRI treatments, leaving most MSO habitat as or more vulnerable to high-severity fire. The risk of smoke settling into PACs would be minimized under this alternative.

About 57 percent of the ponderosa pine treatment area would support surface fire in 2020 compared to 61 percent in 2010. Active crown fire would increase from 28 to 34 percent of the area under alternative D. This would result in more crown fire and less surface fire than any other alternative. Alternative D would maintain a highly departed condition class (VCC3) over 1/3 of the treatment area in 2020 and about 45 percent of the area by 2050. These are the highest percentages in VCC3 post-treatment of any alternative. would nearly double the acres within the historical range of variability (VCC1). This is the only alternative to have an increase in FRCC from 2020 to 2050. Combined, this would do the least to protect MSOs from unplanned fires ignited outside of MSO habitat.

As a result of mechanical thinning and prescribed fire, future fires would be more likely to burn as surface fires rather than crown fires, more closely resembling the historical range of variation. However, the reduction in risk of habitat loss from high-severity fire would be greatest in alternative D.

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. Fewer snags would be lost in MSO habitat due to operations under alternative D as a result of fewer acres treated with prescribed fire. While creation of firelines could lead to more snags cut by firewood collectors, the subsequent road decommissioning should reduce vulnerability of snags in the long-term.

An additional indirect benefit of prescribed fire treatments is the resulting inputs of soil nutrients, benefiting both over- and understory vegetation and thereby improving the habitat of MSOs and their prey (appendix 6). Prescribed burning would also reduce litter, further improving the potential response of understory plants. In addition, reductions in total BA, increasing relative contributions of Gambel oak to soil resources, and increasing solar radiation reaching the understory would all improve the herbaceous response. These improvements would be minimized in target, threshold, and restricted “other” habitats under alternative D. These benefits would not occur in PACs. PACs and core areas are hunted more heavily than other portions of an owl pair’s territory during the nesting season and food and cover for prey species would continue to decline.

Road construction would only occur for new temporary roads. All temporary roads will be decommissioned after implementation is complete. This would be based on implementation of individual task orders, so completion will typically be within a year. All “new” temporary roads in PAC habitat already exist on the ground but are not part of the National Forest road inventory. These too will be decommissioned after treatments are completed. Construction, upgrading, and decommissioning of temporary roads would occur outside of the nesting season in PACs. Short-term disturbance could happen to foraging owls in restricted habitat or in protected habitat if foraging occurred in PACs outside the nesting season.

Improvements and restoration of key prey habitats (i.e., spring and channel restoration and meadow, savanna, grassland and aspen treatments) interspersed within the pine-oak forest would improve habitat for prey species. All alternatives would restore 23 springs and about 4 miles of ephemeral channels in MSO habitat. Alternative D would not improve any acres of meadow vegetation in PACs. Alternatives B and D would improve or restore 16,736 acres of grassland, savanna, and meadows interspersed with MSO habitat outside of PACs. This is 85 more acres than alternative C, but does not include any restoration of existing grasslands that would occur under alternative C. All alternatives would restore about 739 acres of aspen and improve (prescribe fire-only) another 7 acres of aspen in MSO habitat outside of PACs. Alternative D would not improve any acres of aspen within PAC habitat.

Restoration of key prey habitats would increase the area supporting herbaceous ground cover and better connect currently fragmented openings. Increasing openings dominated by grasses, sedges, forbs, and shrubs would improve habitat for small mammals, some bat species, and arthropods. In addition, improvements to pollinator habitats would also occur which could indirectly improve herbaceous undergrowth and indirectly benefit MSO prey species in the long-term. These actions would improve vegetation heterogeneity and increase food and cover for prey species, presumably increasing total prey biomass. There is a strong link between raptors and their food and conserving and enhancing prey habitat is expected to benefit MSOs in the short- and long-term. Alternative D would improve or restore the fewest total acres of prey habitat and do the least in terms of recreating habitat heterogeneity.

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 MSOs 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. This would be the same for all alternatives.

Amounts of hauling and individual haul routes would be similar between alternatives. Therefore the potential for collisions between owls and vehicles implementing the 4FRI would be similar across alternatives. The level of risk is considered to be low and is unquantifiable.

The amount of burning at the treatment area scale in alternative D is less about 30 percent of that proposed in alternatives B, C, or E. All alternatives preclude prescribed fire in protected habitat during the nesting season. Therefore the risk of smoke settling into PACs is the lowest in alternative D. Smoke may have an adverse effect if predicted weather conditions were to change during burn operations and smoke settled into a low-lying PAC for 3 or more continuous days and nights. Fire and smoke from prescribed burning could disturb individual birds in and adjacent to treatment areas, but landscape assessments of smoke patterns and of PACs vulnerable to settling smoke, along with seasonal restrictions for burning, should minimize risk of disturbance to nesting and roosting owls. However, the amount of burning across the landscape under this alternative creates increased potential for smoke to unexpectedly settle into a PAC, potentially leading to adverse effects to individual nesting or roosting owls or nestlings. Potential disturbances to foraging owls should be limited to short-term effects. The risk of smoke to owls is considered low and is unquantifiable.

The use of prescribed fire brings inherent uncertainty. While this would be minimized through the use of ignition and control techniques, the sheer number of acres and years until implementation is complete and the number of discrete applications of fire could increase the risk of a fire burning outside of burn plan objectives. While torching of individual trees or pockets of trees could improve habitat conditions by adding diversity in dense, relatively homogeneous stands of pine-oak, torching could also create long-term adverse effects to MSO habitat. Adverse effects would only happen if fire severity exceeded burn plan objectives. This would be an unintended result and the risk of its occurrence is unknown. Based only on acres of prescribed fire, the potential risk would be minimized in alternative D.

The disturbance associated with mechanical thinning, prescribed fire, restoration activities, road maintenance, construction, decommissioning, and realignment, and hauling could result in short-term displacement of foraging owls and owls roosting outside the breeding season. Design features should ensure nesting and roosting MSOs are not disturbed during the breeding season.

Overall, alternative D would provide for a mosaic of desired stand structure conditions, but would likely result in the least amount of habitat heterogeneity and vegetative diversity in MSO habitat. Alternative D would 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. Prey habitat would also see the smallest improvements and the least reduction in the potential risk of high-severity fire and other stochastic events. No treatments would occur in PAC habitat during the breeding season in order to mitigate adverse effects associated with treatments.

## Alternative E

Mechanical treatments would occur in portions of all MSO habitats except core areas under alternative E (see protected habitat below). Low severity prescribed fire would be applied to all MSO habitats, excluding core areas (Table 115). Total treatments in MSO habitat include about 81,500 acres of mechanical thinning (about 74 percent of the total MSO habitat in the treatment area) with prescribed fire and 23,738 acres of only low severity prescribed fire (about 28 percent of the total MSO habitat in the treatment area). The minimum post-treatment BA used for modeling thinning in current and future nesting and roosting habitat was 150 square feet per acre, in line with the Recovery Plan (USDI 1995). No trees greater than 9 inches d.b.h. would be cut in protected habitat and no trees 24 inches d.b.h. or greater would be removed from restricted habitat. Tree groups would not be cut for regeneration in MSO habitat. Group selection treatments would not occur in MSO habitat. Treatments in target habitat are designed to move forests towards threshold conditions. Treatments in threshold habitat were designed to maintain or exceed forest structural values described in Table III B.1 of the Recovery Plan (USDI 1995). A comparison of treatments in MSO habitat by alternative is displayed below (see Comparison of Alternatives after Alternative E effects).

Alternative E would retain the highest density of trees by using a minimum of 150 BA combined with thinning up to 9 inches d.b.h. in PACs. Alternative E would also require firelines and the associated effects to habitat in PACs to exclude fire from core areas (see the related discussion in the previous alternatives). This would retain the highest potential for surface fire progressing into crown fire within occupied nesting and roosting habitat.

Treatments in restricted “other” habitat were designed to create canopy gaps, move towards uneven-aged structure, lower total BA, and accelerate tree growth rates. Treatments would decrease percent SDImax to the high density category, thereby improving resiliency and increasing large tree growth rates (Table 5). It would move more trees into larger size classes sooner. This meets the direction in the Recovery Plan to manage for a habitat mosaic to ensure adequate nesting, roosting, and foraging habitat for the owl and habitat for MSO prey.

Mechanical thinning and prescribed fire would take place at different times in different locations. Spotted owl habitat could be affected by mechanical treatments in one area and prescribed fire in another during any one time period. It is expected implementation of the entire project will require 10 or more years to complete. If work were completed in 10 years, on average about 8,150 acres of MSO habitat would be mechanically treated and 2,275 acres of prescribed fire would occur each year under alternative E. No mechanical treatments would occur on slopes greater than 40 percent in MSO habitat.

**Table 115. Alternative E summary of proposed treatments (acres) in MSO habitat**

| Treatment Type | MSO Habitat Types | | | | Total Acres |
|---|---|---|---|---|---|
| | Protected[1] | Threshold | Target | Restricted | |
| Prescribed Fire Only[2] | 20,083 | 84 | 217 | 2,354 | 22,738 |
| MSO Restricted - Group Selection[3] & Intermediate Thinning[4] + Prescribed Fire | | | | 62,222 | 62,222 |
| MSO Target - Intermediate Thinning + Prescribed Fire | | | 7,059 | | 7,059 |
| MSO Threshold - Intermediate Thinning + Prescribed Fire | | 1,893 | | | 1,892 |
| PAC - Intermediate Thinning less than 18 inch d.b.h. + Prescribed Fire | 10,284 | | | | 10,284 |
| **Total Treatments** | **30,367** | **1,977** | **7,276** | **64,576** | **104,195** |
| No Proposed Treatments | 4,895 | 1[5] | 2[5] | 1,280 | 6,178 |

1. Includes PAC and steep slope habitats
2. 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.
3. Group selection is a cutting procedure which creates a new age class by removing trees in groups or patches to allow seedlings to become established in the new opening (SAF 1998)
4. Intermediate thinning is the cutting of trees to improve the composition, structure, condition, health, and growth of remaining trees (SAF 1998)
5. These acres represent portions of stands occurring in a no-treatment control watershed as part of a paired watersheds study evaluating the effects of vegetation treatment on water yield and water balance.

### *Protected Habitat*

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

Unlike the other alternatives, all mechanical PAC treatments would have a 9 inch d.b.h. limit (Table 116). This would greatly limit the potential benefits of thinning by retaining the majority of the uncharacteristic competition with old and large trees. Stands identified for mechanical harvest would be marked by hand and marking would be coordinated with the FWS. Mechanical treatments would take place in 18 of the 70 PACs (26 percent) occurring within the treatment area. No treatments would occur in core areas.

**Table 116. General description and acres of mechanical treatment in Alternative E by PAC (all mechanically treated PACs occur on the Coconino NF)**

| PAC Name | General Description | MSO PAC Mechanical Treatments (acres) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Treat up to 9" d.b.h. | Treat up to 12" d.b.h. | Treat up to 14" d.b.h. | Treat up to 16" d.b.h. | Treat up to 17.9" d.b.h. | Total |
| Archies | Strong oak component but few large oak ; many pines less than 9 inch d.b.h. | 495 | | | | | 495 |
| Bar M | Break up contiguous fuels in areas of pure pine, thin out dense clumps of pine to release oaks within clumps, provide openings for forage and grow larger trees | 533 | | | | | 533 |
| Bear Seep | PAC is pure ponderosa or oak, high density of trees greater than 9 inch d.b.h. | 596 | | | | | 596 |
| Bonita Tank | Treatments to grow larger trees and release oaks are needed in southern portion of PAC outside of ridges and draws | 795 | | | | | 795 |
| Crawdad | Oak is supressed by high densities of pine, need for creating gaps around oak and releasing individual oak trees | 601 | | | | | 601 |
| Foxhole | Dense thickets of pine with some oak, need for enhancing oak and thinning groups | 450 | | | | | 450 |
| Frank | PAC has areas of pure pine with dense pockets of 5-18 inch d.b.h. trees, need to release limited oaks and encourage recruitment of oaks, reduce pine densities and increase diameters of both pine and oak | 586 | | | | | 586 |
| Holdup | Most of PAC is pure pine, thin around any existing oak and provide areas for oak to establish | 535 | | | | | 535 |

| PAC Name | General Description | MSO PAC Mechanical Treatments (acres) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Treat up to 9" d.b.h. | Treat up to 12" d.b.h. | Treat up to 14" d.b.h. | Treat up to 16" d.b.h. | Treat up to 17.9" d.b.h. | Total |
| Iris Tank | Oak is present in all size classes but is suppressed by pine, need to release oaks and thin dense pockets of pine and reduce fuels southwest of the nest core | 587 | | | | | 587 |
| Knob | PAC is generally pure pine and open with dense dog-hair thickets | 665 | | | | | 665 |
| Lake No. 1/Seruchos | Dense thickets of young pine: need to grow larger trees over time, enhance/retain oaks, and create small openings | 239 | | | | | 239 |
| Lee Butte | Treat dense pine to increase oak, reduce tree density and increase tree diameter on slopes; Field review led to dropping 3 stands from treatment (457 acres) | 306 | | | | | 306 |
| Mayflower Tank | PAC has steep slopes, heavy fuels, limited number of small trees | 612 | | | | | 612 |
| Red Hill | Scrappy habitat, past overstory removal, dense pockets of pine with heavy mistletoe infection, thin pine to grow larger trees reduce the potential for uncharacteristic wildfire, enhance oak where present, reduce competition with larger trees | 672 | | | | | 672 |
| Red Raspberry | Protect microclimates from undesirable fire effects; Enhance openings, and create, retain, and enhance larger trees among the 5-18 inch d.b.h. pine | 664 | | | | | 664 |
| Rock Top | Treat in pure pine to increase oak and improve growth rates | 751 | | | | | 751 |

| PAC Name | General Description | MSO PAC Mechanical Treatments (acres) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Treat up to 9” d.b.h. | Treat up to 12” d.b.h. | Treat up to 14” d.b.h. | Treat up to 16” d.b.h. | Treat up to 17.9” d.b.h. | Total |
| Sawmill Springs | Thinning focus would be to enhance and maintain large d.b.h. size classes | 515 | | | | | 515 |
| T-Six Tank | PAC has dense regeneration, need for removing dense patches of ponderosa pine, maintaining Gambel oak, and thinning dense pine doghair thickets | 680 | | | | | 680 |
| **Total Mechanical Treatment Acres** | | **10,284** | **0** | **0** | **0** | **0** | **10,284** |

Low severity prescribed fire would occur in 70 PACs (i.e., all PACs within the treatment area). Burn-only treatments would occur in 52 PACs, excluding core areas. Although the implementation schedule is not yet known, if 4FRI implementation lasted 10 years then, on average, 1.8 PACs would be mechanically treated per year, or about 2.6 percent of the 70 PACs in the 4FRI treatment in a given year. About 5.2 PACs (less than less than 7.5 percent of the 70 total PACs in treatment area) would, on average, be treated with prescribed fire each year. Affects to forest structure within individual PACs is summarized by alternative in appendix 12.

Prescribed fire treatments in PACs would include the Kendrick PAC on the Kaibab NF. The wildlife analysis for the Kaibab forest plan, using a mid-scale analysis (100-1,000 acres) for evaluating effects of the proposed land management plan, concluded the Kendrick PAC consisted of mixed-conifer habitat. The 4FRI analysis is based on a finer scale and evaluated individual pine stands within the Kendrick PAC. About 173 acres of burn-only treatment is proposed for pine habitat outside the core area during this analysis. The nearby Stock Tank PAC, administered by the Coconino NF, has about 15 acres outside the core area and outside of the Kendrick Peak Wilderness Area on Kaibab NF lands.

## Forest Structure and Density

### Large Trees

Mechanical treatments would, by design, be conservative in protected habitat, particularly under this alternative. Treatment would be limited and so would the results. None of the modeled forest structure attributes would drop below recommended levels immediately after treatment (Table 117). 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 TPA greater than 18 inch d.b.h. would have little to no change (Table 117). 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. Site-specific PAC visits identified density-dependent mortality as a current and ongoing threat to large pine and oak trees (appendix 4) and this would be expected to continue. Prescribed fire would contribute towards reducing competition with slight reductions in numbers of small trees. Effects to Gambel oak under alternative E 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 (Table 117), but risk from high-severity fire would decrease (see fire effects below). Because old and large tree diameter growth is not different from alternative A, resistance to drought is not expected to improve.

#### Basal Area

Ponderosa pine BA would remain high post-treatment in the mechanical treatment group and pine BA would be slightly reduced in the prescribed fire-only PACs (Table 117). Gambel oak BA 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. Total BA would be relatively unchanged. There would be little difference between the action and no action alternatives by 2050.

**Table 117. Modeled changes in forest structure within MSO PACs for Alternative E**

| Forest Attributes | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative E (Year 2020) | Alternative E (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Mechanical Treatment and Prescribed Fire Group (n=18)** | | | | | |
| % of SDI 12-18” d.b.h. | 30 | 31 | 34 | 31 | 28 |
| % of SDI 18-24” d.b.h. | 14 | 16 | 17 | 25 | 23 |
| % of SDI >24” d.b.h. | 8 | 9 | 9 | 12 | 12 |
| % of Max SDI | 75 | 76 | 67 | 70 | 78 |
| TPA >18" | 15 | 18 | 18 | 28 | 27 |
| Ponderosa Pine BA | 124 | 129 | 125 | 136 | 137 |
| Gambel Oak BA | 19 | 20 | 20 | 24 | 26 |
| All BA | 148 | 157 | 153 | 172 | 174 |
| % Oak BA | 13 | 13 | 13 | 14 | 15 |
| **Prescribed Fire Only Treatment Group (n=52)** | | | | | |
| % of SDI 12-18” d.b.h. | 31 | 32 | 32 | 28 | 28 |
| % of SDI 18-24” d.b.h. | 13 | 16 | 16 | 23 | 22 |
| % of SDI >24” d.b.h. | 8 | 8 | 8 | 12 | 11 |
| % of Max SDI | 79 | 81 | 79 | 82 | 83 |
| TPA >18" | 15 | 18 | 18 | 28 | 28 |
| Ponderosa Pine BA | 120 | 124 | 120 | 125 | 127 |
| Gambel Oak BA | 22 | 24 | 24 | 28 | 27 |
| All BA | 159 | 168 | 163 | 183 | 185 |
| % Oak BA | 14 | 14 | 14 | 15 | 14 |

1 = No Action Alternative

#### Canopy Structure

The average canopy cover across stands would, by design, be at or above 50 percent (Silviculture Report). Results for BA, TPA, and tree size-classes demonstrate the maintenance of high canopy cover. All are similar to alternative A. Percent SDImax would decrease relative to no action, but would remain well within the “extremely high density” range. Stands would continue with full site occupancy, minimal understory development, and active competition-induced mortality.

Harvest would only target ponderosa pine, so while individual trees of other species could be affected by thinning and burning operations, the existing variability in overstory species would remain intact. Combined, these factors should maintain or enhance elements of canopy structure such as canopy cover, tree density, and overstory species diversity. Prescribed fire would improve sub-canopy space (see fire effects below), potentially improving flight space for foraging owls.

Overall, changes in the canopy structural elements would be limited to the point where PAC habitat would not necessarily move towards 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 amendments (Coconino NF) when treating habitat well outside the historic range of variability. Changes in forest structure are summarized by individual PAC in appendix 12.

### *MSO Prey Habitat*

#### Snags, Logs and Coarse Woody Debris

Snags would decrease after treatment, although the scale of change is relatively small (Table 118). Patterns of change for logs and CWD vary between treatment groups. Both logs and CWD changed little in the mechanical and prescribed fire treatment group. Both metrics would decrease immediately after treatment and increase in the long-term. Decreases were variable by individual PAC (appendix 12).

Snags, logs, and CWD represent elements of small mammal habitat. While retaining adequate amounts of these habitat components is essential, site conditions are currently highly variable. We reviewed areas where downed wood was nearly absent across whole portions of stands and also encountered areas where a reduction in CWD would be desirable (e.g., in draws). Overall, restoration treatments can benefit the habitat of MSO prey species (Kalies et al. 2012, Martin and Maron 2012). However, changes are so slight in PAC habitat under alternative E that the treatments cannot be considered “restoration.” The establishment of a robust cohort of large trees cannot be assumed, therefore the rate of change in snags and logs would not likely change beyond 2050 unless insects, disease, or predicted long-term changes in snowpack increase mortality of large trees.

#### Understory Index

A muted understory response in PACs is a reflection of the high canopy cover remaining post-treatment (Table 118). Changes in understory index do not reflect the nutrient pulse associated with burning or the decrease in litter, suggesting results on the ground could be above those modeled here (appendix 6). However, much of the resulting nutrient pool would likely be absorbed by the overstory, given the dense tree structure remaining post treatment (appendix 6). Increases in biomass production would typically be limited in most PACs, but increases would vary by individual PACs and by site-specific conditions within PACs (see appendix 12 for individual PAC treatment summaries). Understory response would be greater in PACs receiving both mechanical and prescribed fire treatments and in PACs that included aspen, meadow, spring, and/or ephemeral channel treatments.

**Table 118. Changes in prey habitat in MSO PACs under Alternative E**

| Forest Attributes | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative E (Year 2020) | Alternative E (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Mechanical Treatment and Prescribed Fire Group (n=18)** | | | | | |
| Snags >12" d.b.h. | 3.2 | 4.1 | 3.6 | 7.0 | 7.1 |
| Snags >12 & <18" d.b.h. | 2.6 | 3.4 | 3.0 | 5.5 | 5.6 |
| Snags >18" d.b.h. | 0.6 | 0.7 | 0.6 | 1.5 | 1.5 |
| CWD >3" (tons per acre) | 4.7 | 6.2 | 6.3 | 9.8 | 10.3 |
| Logs | 1.3 | 2.3 | 2.7 | 6.7 | 5.8 |
| Understory Index | 37 | 31 | 34 | 24 | 23 |
| **Prescribed Fire Only Treatment Group (n=52)** | | | | | |
| Snags >12" d.b.h. | 3.6 | 4.6 | 5.9 | 7.7 | 8.1 |
| Snags >12 & <18" d.b.h. | 3.0 | 3.9 | 5.1 | 5.9 | 6.3 |
| Snags >18" d.b.h. | 0.7 | 0.7 | 0.7 | 1.8 | 1.8 |
| CWD >3" (tons per acre) | 6.0 | 7.8 | 3.9 | 9.1 | 12.6 |
| Logs | 2.9 | 3.9 | 2.6 | 7.1 | 8.1 |
| Understory Index | 36 | 31 | 34 | 24 | 23 |

### Fire Effects

Prescribed fire would occur in all 70 PACs in the treatment area, excluding all core areas. Prescribed fire would occur on over 95 percent of PAC acres in the treatment area. PAC acres in wilderness, mixed conifer forest, other project areas, or canyons would be excluded from treatment under the 4FRI. Under alternative E, FRCC would move toward the desired condition of an overall rating of FRCC2 for the treatment area and it would remain in this category through 2050 (Table 119). Most acres that would move out of VCC3 would be in VCC2 by 2020 about ½ the 4FRI landscape would remain in VCC2 by 2050.

Expected results from prescribed burning would include a reduction in surface fuels and an increase in average canopy base height. Reduction of surface fuels and raising canopy base height would reduce the risk of a surface fire transitioning into crown fire. These changes would also reduce or eliminate accumulated pine needles, helping in the release of understory vegetation (appendix 6). Raising crown base height could improve sub-canopy flight space for MSOs. Combined, these changes would improve the ability to retain PAC habitat over time, improve MSO prey habitat, and potentially improve the ability for MSOs to hunt these areas.

With no modeled disturbance of any kind (mechanical or prescribed fire treatments, wildfire, insects, disease, etc.), acres of grasslands in FRCC1 would decrease as woody species continued to encroach and species composition shifted in favor of less fire adapted species. Mechanical treatments combined with prescribed fire would not occur in grasslands under this alternative; existing encroachment by woody species (primarily ponderosa pine) would remain across 48,000 acres of grasslands and continue through time. More details on FRCC and VCC can be found in the Methodology section.

**Table 119. Fire regime condition class (FRCC) ratings in ponderosa pine forest through time under Alternative E**

| VCC | 2010 | | 2020 | | 2050 | |
|---|---|---|---|---|---|---|
| | Acres | Percent | Acres | Percent | Acres | Percent |
| 1 | 71,097 | 14 | 111,725 | 22 | 55,862 | 11 |
| 2 | 126,960 | 25 | 370,722 | 73 | 248,841 | 49 |
| 3 | 309,782 | 61 | 25,392 | 5 | 203,136 | 40 |
| **FRCC of treatment area =** | **3** | | **2** | | **2** | |

Elements of MSO prey habitat (surface fuels) change by canopy openness. Figure 26 represents the relative degree of canopy openness after treatment, e.g., "High" indicates open conditions achieved with a mosaic of tree groups and interspace. "Very low" indicates relatively connected canopies with little discernible interspace (Fire Ecology report). The lowest intensity treatments are associated with MSO protected habitat and these would retain the highest fuel loading in all modeled years. Modeling assumptions include mechanical treatments and two prescribed fire treatments between 2010 and 2020 and that no further disturbances (fire, drought, insects, etc.) occur between 2020 and 2050.

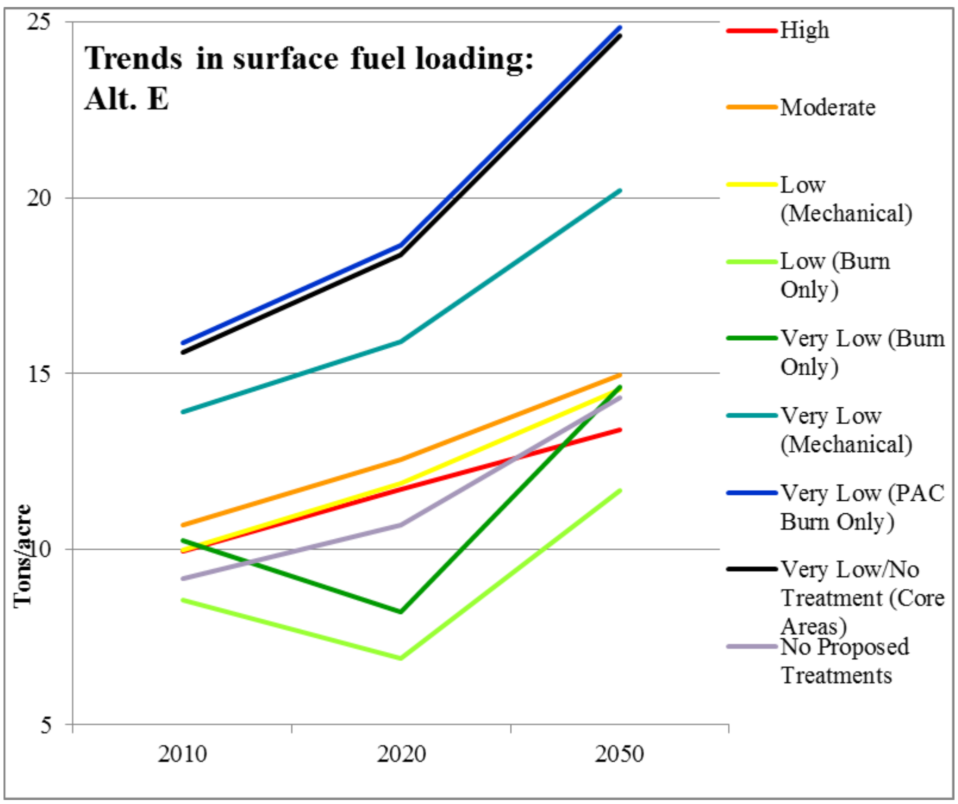


**Figure 26. Modeled changes in surface fuel loading (litter, duff, CWD combined) by desired canopy openness for Alternative E**

Under alternative E, surface fuel levels in PAC habitat would be greater than in any other alternative except for alternative D. Prey species would have evolved with frequent fire on the landscape and would presumably adapt to periodic decreases in CWD. Uncharacteristically high surface loading might benefit prey species in the short-term, but they would also increase the probability of surface fire transitioning into crown fire in the long-term. The rate of future recruitment of large logs would likely be little changed given the proposed management of the large tree cohort and large tree recruitment in alternative E. Levels of CWD in PACs would be expected to exceed the upper levels of recommended for southwest ponderosa pine habitat after treatment (Fire Ecology report). See appendix 19 for maps comparing surface fuels across the 4FRI treatment area.

Modeled fire behavior would shift as a result of prescribed fire. Predicted surface fire would increase in protected habitat by about 20 percent in the year 2020 under alternative E (Table 120). The probability of active crown fire would decrease by about 16 percent after treatments. All crown fires are considered high-severity and lethal to ponderosa pine (Fire Ecology report). Reducing the acres of potential crown fire would increase flexibility for future fires to better meet desired conditions. Appendix 19 displays surface fuel loading across the 4FRI landscape and in MSO habitat for each alternative.

**Table 120. Predicted fire behavior in protected habitat under current conditions and after implementation of Alternative E[1]**

| Forest Habitat | Total (Acre) | Surface Fire (Acre) | Passive Crown Fire (Acre) | Active Crown Fire (Acre) | Surface Fire (%) | Passive Crown Fire (%) | Active Crown Fire (%) |
|---|---|---|---|---|---|---|---|
| **Existing Condition (Year 2010)** | | | | | | | |
| Ponderosa Pine | 507,839 | 311,313 | 48,023 | 143,186 | 61 | 9 | 28 |
| Protected | 35,262 | 17,954 | 3,034 | 14,106 | 51 | 9 | 40 |
| **Alternative E (Year 2020)** | | | | | | | |
| Ponderosa Pine | 507,839 | 474,404 | 17,002 | 11,140 | 93 | 3 | 2 |
| Protected | 35,262 | 25,429 | 1,289 | 8,380 | 72 | 4 | 24 |

1. Acres by fire behavior-type do not equal total acres due to excluded areas that would not support fire such as rock, cinders, and areas with insufficient fuels.

Active crown fire areas are currently centered on MSO habitat and permeate much of the 4FRI treatment area (Figure 26). Fire behavior would shift dramatically across the landscape after treatment. Nevertheless, while existing active crown fire risk decreases across most of the treatment area, it would remain centered around PAC habitat (Figure 26). Restricted habitat would largely be a mix of surface and passive crown fire.

### *Restricted Habitat*

There are more acres of target and threshold habitat in alternative E than in the other alternatives because of dropping forest plan amendments. Less than 10 percent of the restricted acres on the Kaibab NF were designated as target and threshold habitat in alternatives B-D. Conversely, more than 13 percent of the restricted acres on the Coconino NF were designated as target and threshold habitat for a total of more than 11.5 percent target and threshold habitat acres project-wide. Because the evaluation process for identifying target and threshold habitat was both in-depth and thorough, acreage for all categories of designated restricted habitats on the Coconino NF were retained. However, 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 for alternative E.

Mechanical treatments would occur on about 71,173 acres of restricted habitat, or about 95 percent of the total 75,111 restricted acres in the treatment area. Treatments would include nearly 100 percent of the total target and threshold habitat (calculated from Table 115). Although the implementation schedule is not yet known, on average about 7,383 acres of restricted habitat would be treated per year if 4FRI implementation was completed in 10 years. Most restricted habitat (greater than 98 percent) would be treated with prescribed fire.

## Forest Structure and Density in MSO Habitat

Thinning objectives in target and threshold habitat were to maintain an overall BA of 150 square feet per acre or more, as recommended in the Recovery Plan (USDI 1995). In addition, treatments in restricted habitat would provide a diversity of stand conditions and stand sizes across the landscape. Treatment design would develop uneven-aged forest structure, irregular tree spacing and various patch sizes by thinning and reestablishing interspace adjacent to tree groups. By design, treatments in target and threshold habitats would affect less change than treatments in restricted "other" habitat.

### Large Trees

Mechanical treatments in target and threshold habitat would increase the percent area of trees in larger size-classes by increasing tree growth rates, as recommended in the Recovery Plan. This would be accomplished by thinning trees less than 18 inches d.b.h. to develop and retain trees greater than or equal to 24 inches d.b.h. Accordingly, trees less than 18 inches d.b.h. would decrease after treatments in target and threshold habitats, but remain above recommended minimum levels (Table 121 and Table 122). Trees greater than 18 inches d.b.h. would increase in target and threshold habitats. The degree of change is limited and would vary by individual subunit (appendix 13). In target habitat, the percent SDI for trees 12 to 18 inches d.b.h. would remain at 15 percent or higher for all but subunit1-4, which would be at 14 percent in 2020 and would continue to decline through 2050 (appendix 13). Trees greater than 24 inches d.b.h. would increase in subunit1-4 consistently through 2050 relative to alternative A (appendix 13). TPA greater than 18 inches d.b.h. would also increase.

Declines in trees 12 to 18 inches d.b.h. would result from selecting trees less than 18 inch d.b.h. due to their uncharacteristic abundance. This would increase growth rates of residual trees, resulting in more trees growing into the 18 to 24 inch d.b.h. category. Another effect of the proposed thinning would be fewer trees less than 12 inches d.b.h. growing into the 12 to 18 inch d.b.h. category. In addition to growing more large trees, thinning smaller trees would also reduce density-dependent mortality of large trees, improving their resiliency and sustainability over time. Overall, the percent of SDImax would remain in the "extremely high density" range in target and threshold habitats, indicating little change to the overall forest structure in these habitats.

Trees 12 to 18 inches d.b.h. would also decrease in restricted "other" habitat (Table 123 and appendix 13). Trees 12 to 18 inches d.b.h. would continue to decrease from 2020 to 2050. By 2050 trees 18 to 24 inches d.b.h. would show little change, while trees greater than 24 inches d.b.h. would show relatively large increases. This again reflects the dynamics of primarily selecting mid-sized and smaller trees for thinning and the resulting increases in growth rates relative to alternative A (Table 123). Treatments would also create canopy gaps, irregular spacing, and diversify age-class distribution. Overall, TPA greater than 18 inches d.b.h. would decrease relative to no management actions. These results were consistent across RUs. Combined with the results for d.b.h. size-classes, this indicates that TPA greater than 18 inches d.b.h. would be well represented by trees greater than 24 inches d.b.h. Reducing tree densities would improve overall forest resiliency. Increasing forest heterogeneity would improve MSO restricted habitat by maintaining future nesting and roosting structure while also increasing prey habitat and potential MSO foraging opportunities.

Old and large tree diameter growth and resistance to drought have been shown to increase after restoration treatments (Ericson and Waring 2013, Kerhoulas et al. 2013b).

#### Basal Area

The objective of decreasing pine BA would be met in all restricted habitats (Table 121, Table 122, and Table 123). Total BA in threshold habitats would remain above 150 square feet per acre in both RUs but would decrease below 150 square feet per acre in target habitat. Total BA in target habitat would consistently increase across RUs by 2050. Reducing BA in restricted “other” habitat represents a key contribution towards maintaining large trees and dense tree groups while improving forest resiliency and reducing the threat of high-severity fire. Gambel oak BA would increase in target and threshold habitat and decrease in restricted “other” habitat. No oak would be selected for removal in restricted “other” habitat. The decrease would result from increased operations leading to more individual trees lost from prescribed fire and inadvertent impacts from harvest activities. The decrease in oak would relate to the direct loss of 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). Expected results would be a decrease in small diameter oak (less than 2 inches 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 BA of Gambel oak ≥5 inch d.r.c. in the long-term in restricted “other” habitat, relative to alternative A, but may still meet or exceed presettlement conditions (Abella 2008). Treatments would move towards uneven spacing with canopy gaps as described in the Recovery Plan.

#### Canopy Structure

The average canopy cover across stands would, by design, be at or above 50 percent (Silviculture Report). Results for BA, TPA, and tree size-classes demonstrate the maintenance of high canopy cover (Table 121, Table 122, and Table 123). SDImax would remain in the “extremely high density” range in target and threshold habitat, and decrease to “high density” in restricted “other” habitat (Table 123). The exception to this pattern in restricted “other” habitat is restoration unit 5, where percent SDImax would be in the moderate density category. Canopy cover would be 50 percent or greater at the stand level and therefore much higher within individual tree groups in target and threshold habitat. Existing variability in overstory species diversity would remain by design. These factors should improve or maintain elements of canopy structure such as cover, density, and species diversity.

**Table 121. Changes in forest structure in MSO threshold habitat under Alternative E**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative E (Year 2020) | Alternative E (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| % of SDI 12-18" d.b.h. | 25 | 24 | 27 | 23 | 26 |
| % of SDI 18-24" d.b.h. | 24 | 26 | 32 | 33 | 28 |
| % of SDI >24" d.b.h. | 3 | 3 | 4 | 8 | 6 |
| % of Max SDI | 101 | 101 | 85 | 93 | 102 |
| TPA >18" | 28 | 31 | 32 | 39 | 35 |
| Ponderosa Pine BA | 133 | 136 | 96 | 111 | 143 |
| Gambel Oak BA | 58 | 58 | 60 | 63 | 58 |
| All BA | 204 | 209 | 171 | 202 | 226 |
| % Oak BA | 29 | 28 | 35 | 31 | 26 |
| **Restoration Unit 3** | | | | | |
| % of SDI 12-18" d.b.h. | 26 | 25 | 22 | 17 | 19 |
| % of SDI 18-24" d.b.h. | 19 | 21 | 24 | 27 | 26 |
| % of SDI >24" d.b.h. | 8 | 8 | 10 | 13 | 11 |
| % of Max SDI | 99 | 99 | 90 | 96 | 100 |
| TPA >18" | 24 | 26 | 27 | 36 | 36 |
| Ponderosa Pine BA | 108 | 111 | 88 | 95 | 114 |
| Gambel Oak BA | 62 | 63 | 64 | 71 | 67 |
| All BA | 185 | 192 | 171 | 200 | 209 |
| % Oak BA | 33 | 33 | 37 | 36 | 32 |

**Table 122. Changes in forest structure attributes for MSO target habitat in Alternative E**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative E (Year 2020) | Alternative E (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| % of SDI 12-18" d.b.h. | 30 | 29 | 30 | 24 | 28 |
| % of SDI 18-24" d.b.h. | 12 | 14 | 17 | 23 | 19 |
| % of SDI >24" d.b.h. | 7 | 8 | 10 | 11 | 9 |
| % of Max SDI | 81 | 83 | 70 | 78 | 84 |
| TPA >18" | 14 | 16 | 17 | 26 | 24 |
| Ponderosa Pine BA | 118 | 123 | 94 | 105 | 128 |
| Gambel Oak BA | 32 | 34 | 35 | 44 | 40 |
| All BA | 156 | 165 | 138 | 169 | 184 |
| % Oak BA | 20 | 20 | 25 | 26 | 22 |

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative E (Year 2020) | Alternative E (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 3** | | | | | |
| % of SDI 12-18" d.b.h. | 26 | 26 | 26 | 23 | 24 |
| % of SDI 18-24" d.b.h. | 14 | 15 | 17 | 19 | 18 |
| % of SDI >24" d.b.h. | 8 | 8 | 9 | 12 | 11 |
| % of Max SDI | 78 | 80 | 73 | 82 | 84 |
| TPA >18" | 13 | 16 | 16 | 23 | 22 |
| Ponderosa Pine BA | 99 | 104 | 86 | 97 | 110 |
| Gambel Oak BA | 36 | 38 | 38 | 47 | 44 |
| All BA | 146 | 156 | 140 | 173 | 179 |
| % Oak BA | 25 | 24 | 27 | 27 | 25 |

**Table 123. Changes in forest structure attributes for MSO restricted “other” habitat in Alternative E**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative E (Year 2020) | Alternative E (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| % of SDI 12-18" d.b.h. | 30 | 31 | 25 | 21 | 30 |
| % of SDI 18-24" d.b.h. | 12 | 14 | 21 | 20 | 20 |
| % of SDI >24" d.b.h. | 7 | 7 | 14 | 19 | 10 |
| % of Max SDI | 68 | 71 | 35 | 46 | 75 |
| TPA >18" | 12 | 14 | 11 | 17 | 23 |
| Ponderosa Pine BA | 111 | 118 | 52 | 71 | 129 |
| Gambel Oak BA | 21 | 23 | 16 | 25 | 29 |
| All BA | 138 | 148 | 74 | 107 | 170 |
| % Oak BA | 15 | 15 | 22 | 23 | 17 |
| **Restoration Unit 3** | | | | | |
| % of SDI 12-18" d.b.h. | 29 | 30 | 25 | 20 | 27 |
| % of SDI 18-24" d.b.h. | 13 | 15 | 21 | 21 | 21 |
| % of SDI >24" d.b.h. | 7 | 7 | 12 | 17 | 10 |
| % of Max SDI | 70 | 73 | 39 | 51 | 77 |
| TPA >18" | 12 | 14 | 12 | 17 | 23 |
| Ponderosa Pine BA | 98 | 104 | 52 | 69 | 114 |
| Gambel Oak BA | 30 | 32 | 23 | 33 | 39 |
| All BA | 137 | 148 | 82 | 116 | 170 |
| % Oak BA | 21 | 21 | 26 | 27 | 23 |

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative E (Year 2020) | Alternative E (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 4** | | | | | |
| % of SDI 12-18" d.b.h. | 28 | 27 | 23 | 18 | 24 |
| % of SDI 18-24" d.b.h. | 13 | 15 | 21 | 19 | 20 |
| % of SDI >24" d.b.h. | 8 | 9 | 14 | 18 | 11 |
| % of Max SDI | 67 | 71 | 39 | 52 | 75 |
| TPA >18" | 12 | 14 | 11 | 16 | 22 |
| Ponderosa Pine BA | 86 | 92 | 47 | 63 | 101 |
| Gambel Oak BA | 33 | 35 | 24 | 37 | 45 |
| All BA | 129 | 141 | 80 | 115 | 165 |
| % Oak BA | 24 | 24 | 29 | 30 | 26 |
| **Restoration Unit 5** | | | | | |
| % of SDI 12-18" d.b.h. | 24 | 26 | 24 | 24 | 28 |
| % of SDI 18-24" d.b.h. | 10 | 10 | 15 | 16 | 15 |
| % of SDI >24" d.b.h. | 9 | 9 | 14 | 16 | 10 |
| % of Max SDI | 51 | 56 | 30 | 42 | 65 |
| TPA >18" | 8 | 9 | 8 | 13 | 16 |
| Ponderosa Pine BA | 80 | 88 | 45 | 63 | 103 |
| Gambel Oak BA | 15 | 18 | 12 | 22 | 28 |
| All BA | 102 | 116 | 64 | 98 | 147 |
| % Oak BA | 15 | 17 | 19 | 22 | 20 |

### *MSO Prey Habitat*

#### Snags, Logs, and Coarse Woody Debris

Snags greater than 18 inch d.b.h. would decrease in the short-term in threshold and target habitats (Table 124 and Table 125). The change would consistently be about a 1/10th of a snag per acre. The scale of change is suspect in that the accuracy of modeling 1/10th of a snag per acre might not be meaningful on the ground. However, the fact that it is a consistent change suggests minor decreases could happen. Snags greater than 18 inch d.b.h. would about double in restricted “other” habitat (Table 126). Snags greater than 18 inch d.b.h. would continue to increase in the long-term across restricted habitat. However, current values are and would continue to be consistently below forest plan direction. The impact of low snag densities relative to forest plan guidance is unclear because of the uncertainty regarding natural snag levels in southwest ponderosa pine forests (Ganey 1999, Waskiewicz et al. 2007, Ganey et al. 2014). However, increased drought and beetle activity could lead to levels above those modeled here (Ganey and Vojta 2012). Snag mitigation includes selecting for live residual trees with dead tops and lightning strikes. This would retain elements of snag habitat in living trees (i.e., the living dead) that are more resistant to fire (Waskiewicz et al. 2007).

Logs would decrease in threshold and target habitats (Table 124 and Table 125) and increase in restricted “other” habitat (Table 126). CWD is currently at the low end of or below the recommended range in all restricted habitats (Table 124, Table 125, and Table 126). CWD would decrease in the short-term, largely as a result of prescribed fire, but would increase in the long-term.

Snags, logs, and CWD represent elements of small mammal habitat. Snags, logs, and CWD would primarily be affected by burning. While retaining adequate amounts of these habitat components is essential, site conditions are currently highly variable. Overall, restoration treatments can improve habitat for MSO prey species (Kalies et al. 2012, Martin and Maron 2012). Treatment objectives include lowering surface fuels to lower the risk of MSO habitat loss due to high-severity fire and thereby allow fire to play a more natural role in the ecosystem.

### Understory Index

Reduced BA and intermittent openings would increase light and moisture availability for herbaceous understory species. Understory biomass is currently low in threshold and target habitats. Index values would increase in both habitats, but remain low after treatment because of the minimal changes to the forest overstory (Table 124 and Table 125). Biomass changes in restricted "other" habitat would have the strongest understory response (Table 126). These changes do not reflect the nutrient pulse associated with burning or the decrease in litter and decreased competition with active tree roots, suggesting results on the ground would be above those modeled here.

Increased biomass production represents grass and forb development during the growing season, providing food and cover for arthropods, small mammals and birds. In turn, this can increase prey availability, diversity, and biomass for MSOs. Total prey biomass may be more influential on MSO fitness than the abundance of any one prey species (Ganey et al. 2011). The recovery plan recommends managers provide diverse habitats to support a diverse prey base. However, improvements in understory production would gradually decline without future treatments as overstory canopies expand and new trees became established.

**Table 124. Changes in prey habitat attributes within MSO threshold habitat under Alternative E**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative E (Year 2020) | Alternative E (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| Snags >12" | 2.4 | 3.4 | 3.6 | 4.0 | 5.5 |
| Snags >12" and <18" | 2.0 | 2.9 | 3.1 | 2.8 | 4.3 |
| Snags >18" | 0.5 | 0.5 | 0.4 | 1.1 | 1.2 |
| CWD >3" | 7.1 | 8.8 | 3.8 | 7.0 | 12.9 |
| Logs | 6.1 | 6.7 | 4.1 | 6.2 | 9.0 |
| Understory Index | 13 | 12 | 24 | 14 | 9 |
| **Restoration Unit 3** | | | | | |
| Snags >12" | 3.7 | 4.9 | 4.4 | 4.7 | 6.5 |
| Snags >12" and <18" | 3.0 | 3.9 | 3.4 | 2.6 | 4.4 |
| Snags >18" | 0.7 | 1.0 | 0.9 | 2.2 | 2.1 |
| CWD >3" | 4.5 | 6.6 | 2.8 | 7.0 | 11.7 |
| Logs | 1.8 | 3.1 | 2.2 | 6.2 | 7.9 |
| Understory Index | 19 | 17 | 25 | 15 | 12 |

**Table 125. Changes in prey habitat attributes within MSO target habitat in Alternative E**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative E (Year 2020) | Alternative E (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| Snags >12" | 3.0 | 3.8 | 4.3 | 5.2 | 6.8 |
| Snags >12" and <18" | 2.5 | 3.3 | 3.8 | 3.8 | 5.4 |
| Snags >18" | 0.5 | 0.6 | 0.5 | 1.4 | 1.4 |
| CWD >3" | 6.0 | 7.5 | 3.3 | 6.8 | 11.8 |
| Logs | 4.6 | 5.3 | 3.3 | 6.2 | 8.1 |
| Understory Index | 33 | 28 | 45 | 26 | 20 |
| **Restoration Unit 3** | | | | | |
| Snags >12" | 2.6 | 3.2 | 3.9 | 4.6 | 5.7 |
| Snags >12" and <18" | 2.1 | 2.6 | 3.4 | 3.3 | 4.4 |
| Snags >18" | 0.5 | 0.6 | 0.5 | 1.3 | 1.4 |
| CWD >3" | 4.6 | 6.0 | 2.5 | 6.3 | 10.1 |
| Logs | 2.3 | 3.0 | 1.9 | 4.8 | 5.8 |
| Understory Index | 45 | 37 | 49 | 28 | 25 |

**Table 126. Changes in prey habitat attributes within MSO restricted “other” habitat under Alternative E**

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative E (Year 2020) | Alternative E (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| **Restoration Unit 1** | | | | | |
| Snags >12" | 2.1 | 2.8 | 4.0 | 2.1 | 5.9 |
| Snags >12" and <18" | 1.7 | 2.4 | 3.2 | 1.2 | 4.8 |
| Snags >18" | 0.4 | 0.4 | 0.8 | 0.8 | 1.1 |
| CWD >3" | 4.3 | 5.5 | 3.4 | 5.7 | 8.9 |
| Logs | 1.0 | 1.7 | 2.2 | 4.5 | 4.1 |
| Understory Index | 46 | 38 | 149 | 82 | 26 |
| **Restoration Unit 3** | | | | | |
| Snags >12" | 2.3 | 3.0 | 4.8 | 2.3 | 5.6 |
| Snags >12" and <18" | 1.8 | 2.5 | 3.8 | 1.3 | 4.4 |
| Snags >18" | 0.4 | 0.5 | 1.0 | 1.0 | 1.2 |
| CWD >3" | 3.9 | 5.1 | 3.4 | 6.3 | 8.7 |
| Logs | 1.5 | 2.1 | 2.4 | 5.0 | 4.6 |
| Understory Index | 49 | 41 | 131 | 72 | 27 |
| **Restoration Unit 4** | | | | | |
| Snags >12" | 2.2 | 2.8 | 4.6 | 2.1 | 5.2 |
| Snags >12" and <18" | 1.7 | 2.2 | 3.5 | 1.1 | 3.9 |

| Forest Attribute | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative E (Year 2020) | Alternative E (Year 2050) | Alternative A (Year 2050) |
|---|---|---|---|---|---|
| Snags >18" | 0.5 | 0.6 | 1.1 | 1.0 | 1.3 |
| CWD >3" | 3.2 | 4.3 | 2.8 | 5.7 | 7.9 |
| Logs | 1.1 | 1.7 | 2.0 | 4.7 | 4.3 |
| Understory Index | 52 | 42 | 127 | 67 | 27 |
| **Restoration Unit 5** | | | | | |
| Snags >12" | 1.4 | 1.7 | 3.0 | 1.6 | 3.6 |
| Snags >12" and <18" | 1.1 | 1.3 | 2.4 | 1.1 | 2.9 |
| Snags >18" | 0.4 | 0.4 | 0.6 | 0.6 | 0.7 |
| CWD >3" | 3.2 | 3.8 | 2.2 | 4.1 | 6.0 |
| Logs | 0.6 | 1.0 | 1.3 | 2.9 | 2.5 |
| Understory Index | 85 | 66 | 172 | 92 | 37 |

Changes in forest structure and prey habitat were designed to balance impacts to the various measures of MSO habitat, including the need to develop and maintain large trees in a landscape dominated by mid-sized trees. Groups of large trees distributed across MSO habitat should improve dispersal habitat as well. Threshold habitat would maintain nesting and roosting conditions and target habitat would move stands towards future nesting and roosting structure. These conditions would be achieved sooner in target habitat than if no action were taken.

Mechanical treatments in restricted habitats would be implemented during the nesting season. While most foraging is proximal to the nest site and would thus occur primarily in PACs, cutting in restricted habitat could disturb individual owls foraging or roosting outside PACs.

### Fire Effects

By definition, all crown fire in ponderosa pine produces high-severity effects (fire ecology report). Over 1/3 of restricted habitat acres would move from risk of crown fire to surface fire after treatment in 2020 (Table 127). Similarly, the risk of crown fire in target and threshold habitats would be reduced from 40 to 4 percent of the area. This would bring the risk levels of high-severity fire in restricted habitat to about the same level as the general ponderosa pine forest (Table 127). The dominance of surface fire (86 to 95 percent) in restricted habitat and across the landscape (93 percent) would reduce the risk of stand replacing fire in MSO habitat. Overall, mechanical thinning and prescribed fire treatments are projected to move restricted habitat towards the restoration of low-severity fire.

Prescribed fire would occur across about 71,170 acres of restricted habitat, including 7,059 acres of target and 1,892 acres of threshold habitats. This includes about 2,354 acres of burn-only treatments in restricted “other” habitat and about 300 acres in target and threshold habitats. Burning would reduce litter layers and raise canopy base height, improving prey habitat and sub-canopy flight space for owls.

**Table 127. Predicted fire behavior in restricted habitat under current conditions and after implementation of Alternative E[1]**

| MSO Habitat | Total (Acre) | Surface Fire (Acre) | Passive Crown Fire (Acre) | Active Crown Fire (Acre) | Surface Fire (%) | Passive Crown Fire (%) | Active Crown Fire (%) |
|---|---|---|---|---|---|---|---|
| **Existing Condition (Year 2010)** | | | | | | | |
| Ponderosa Pine | 507,839 | 311,313 | 48,023 | 143,186 | 61 | 9 | 28 |
| Target/ Threshold | 8,692 | 4,275 | 922 | 3,482 | 49 | 11 | 40 |
| Restricted "Other" | 66,419 | 35,019 | 6,540 | 24,756 | 53 | 10 | 37 |
| **Alternative E (Year 2020)** | | | | | | | |
| Ponderosa Pine | 507,839 | 474,404 | 17,002 | 11,140 | 93 | 3 | 2 |
| Target/ Threshold | 8,692 | 8,293 | 45 | 337 | 95 | 4 | 4 |
| Restricted "Other" | 66,419 | 57,426 | 8,359 | 541 | 86 | 13 | 1 |

1. Acres by fire behavior- do not equal total acres due to areas of nonburnable substrate such as rock, cinders, and areas with insufficient fuels that would not support fire; nonburnable substrate totals <1% of the ponderosa pine treatment area.

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. The increase in acres supporting surface fire would help maintain MSO habitat over time. In addition, areas treated outside of MSO habitat would also move closer towards the historical range of variation, thereby decreasing the threat of high-severity fire reaching MSO habitat. Treatments in restricted habitats would be implemented during the nesting season. While most foraging is proximal to the nest site and would thus occur in PACs, burning in restricted habitat could disturb individual owls foraging or roosting outside PACs. In addition, the emphasis on low severity fire would be expected to produce a patchier burn, resulting in a mosaic of habitat conditions for MSOs and their prey.

### *Other Habitat Effects*

Understory vegetation development is related to the amount of solar radiation reaching the ground. This creates a direct and inverse relationship between canopy closure and herbaceous cover. The uncharacteristic forest structure existing in the ponderosa pine forests of northern Arizona restricts herbaceous growth well below presettlement conditions (appendix 6). Ponderosa pine forests in Arizona are relatively homogeneous and the site-specific habitat variability that springs, streams, meadows, grasslands, savannas, and aspen represent are important to a wide array of wildlife, including MSO prey species. These distinct vegetation-types support understory vegetation that is typically denser, more continuous, and more diverse because of the soil types supporting them and the increased solar radiation and moisture availability compared to ground conditions in the general forest. Understory vegetation provides the food and cover that supports an array of wildlife, including many small mammals, birds, bats, and a variety of arthropods that serve as food for vertebrate species and pollinators to help maintain herbaceous diversity. These micro-habitats directly and indirectly support MSO prey species. Improvements to springs, ephemeral channels, meadows, and aspen can benefit MSOs in ways greater than simple area estimates indicate.

### Springs and Ephemeral Channels

Springs and ephemeral channel restoration numbers per acres are the same for all action alternatives and described under Actions Common to Alternatives B, C, D, and E (above).

### Grasslands, Savannas, and Meadows

Grassland and meadow treatments in PACs would be the same as alternative C and include 97 acres of prescribed fire-only treatment and 35 acres of grassland mechanical with prescribed fire treatments. All PAC treatments would occur outside the nesting season.

Mechanical thinning with prescribed fire treatments in grasslands would remove encroaching post-settlement trees. Treatment design would retain presettlement trees, if present, and retain large post-settlement trees where evidence (e.g., stumps, logs) indicates past presence of presettlement trees. The combination of mechanical thinning and prescribed fire would stimulate grass-forb vegetation in the short-term and improve conditions over the long-term by reducing conifer competition and tree seed sources. Prescribed fire-only treatment would improve grassland, savanna, and meadow habitats but would not fully restore them. Encroaching trees not killed by fire would continue to be a source of needle cast, seeds, and compete for sunlight, water, and nutrients.

Alternative E would accomplish the least restoration or improvement of grassland, savanna, or meadow acres in restricted habitat (Table 128). Mechanical and prescribed fire treatments would be designed to restore existing grassland habitat. An additional 15 acres of operational burning would also occur, creating limited tree mortality along with a reduction in pine-related litter and a short-term influx of nutrients. Residual tree cover would continue to function as sources of seeds, needle cast, and shade and continue the long-term degradation of grassland habitat. Small grasslands can blend into large meadows, hence some of the grassland acreage would likely function as MSO foraging habitat. Improvements to foraging habitat would provide food and cover for MSO prey species through time, potentially improving prey numbers within grasslands and meadows and providing source populations for dispersal into the surrounding forest. In addition, arthropod prey such as beetles and moths would also likely benefit from these treatments. Therefore, meadow and grassland treatments would be expected to improve understory conditions for MSO prey species. Meadow and grassland treatments, combined with interspace and other natural openings, could also improve populations of pollinator species, maintaining herbaceous diversity and potentially improving habitat function, indirectly improving habitat for MSO prey species.

**Table 128. Treatments in grass-dominated open habitats under Alternative E**

| Treatment Type | Acres |
|---|---|
| Grassland Restoration[1] | 0 |
| Savanna[2] | 0 |
| Grassland Operational Burn-Only[3] | 15 |
| Grassland Mechanical[4] | 3,657 |
| **Total Acres** | **3,672** |

1. Pine-dominated mollisol soils
2. Pine-dominated mollic-intergrade soils
3. Operational burn (no prescription objectives)
4. Restoration of existing grassland

Grassland, savanna, and meadow treatments would improve habitat for small mammals, bats, birds, and arthropods, thereby increasing prey biomass for owls. MSOs have not been observed in openings greater than or equal to 10 acres (Ganey et al. 2011), but these larger openings would improve potential source populations of prey species. Enhancing source populations could increase prey dispersal into MSO habitat, indirectly benefiting MSO. In addition, restoration treatments occurring on meadow-derived soils within a forested matrix would also include areas smaller in scale (meadows). Meadow treatments less than 10 acres could directly benefit affect owls by increasing small mammal reproduction in areas used for foraging owls.

### Aspen

Aspen treatments in protected habitat would consist of prescribed fire - only treatments on about 201 acres (Table 129). Burn-only treatments in aspen would average about 29 acres, ranging from 2 acres (Kendrick PAC on the Kaibab NF) to 61 acres (Red Raspberry PAC on the Coconino NF). All aspen treatments in PACs would occur outside the nesting season. Returning fire to these habitats would improve aspen health and understory cover. All aspen treatments would include fencing. The FWS suggests that new structures (such as fences) constructed in an occupied owl territory puts the owl at risk of a potentially fatal collision (USDI 2012b). No wire fencing would be used for new fences in PACs. Instead, other fence designs such as double-welded pipe rail would be used. Fencing decisions would be made in collaboration with the FWS. If non-wire fencing options are not available, aspen treatments would not occur in PACs.

**Table 129. Acres of aspen treatments in protected activity centers (PACs), Alternative E**

| PAC | Acres |
|---|---|
| Jeep | 29 |
| Mayflower Tank | 55 |
| Mint Spring | 12 |
| Pierce Tank | 32 |
| Red Raspberry 9 | 61 |
| Weatherford 2 | 10 |
| Kendrick[1] | 2 |
| **Total** | **201** |

1 Kaibab National Forest

Prescribed fire in PACs would be conducted so that burn severity would remain low. Prescribed fire would have site-specific objectives in aspen (versus operational burning). Meeting the objectives would be affected by several factors. Because aspen typically constitutes limited acreage in any burn unit, the time for burning aspen would be determined by conditions in the surrounding ponderosa pine. Burn windows for ponderosa pine are much wider than for aspen, meaning aspen would typically be burned under less than ideal conditions, i.e., when conditions could create a patchy burn, leaving untreated areas within the clone. Basing ignition decisions on the surrounding ponderosa pine could also typically reduce fire intensity in aspen. Lack of mechanical manipulation and an inherently variable pine litter layer could also contribute to patchy results. While these factors affecting fire behavior could benefit aspects of small mammal habitat in the short-term, they could also limit the percentage of conifers exposed to fire. Combined, these factors reduce potential improvements to aspen by reducing mortality of encroaching pine and maintaining the effects of shading and competition for water and nutrients by encroaching pine. In short, prescribed fire-only treatments would likely improve aspen, but not restore aspen to long-term sustainability.

Aspen treatments in restricted habitat (746 acres) are consistent across alternatives and is described the Actions Common to Alternatives B, C, D, and E section above.

### *Summary*

At the scale of 4FRI, improvements to prey habitat from meadow, aspen, spring, and ephemeral channel treatments within MSO habitat would be limited and site specific. However, these collective treatments would enhance prey habitat in key locations. This is particularly important in PACs where resident MSOs concentrate their use even if they do not nest in a given year (Ganey et al. 2011). MSO reproductive success appears tied to prey availability (Ganey et al. 2011).

Under alternative E, aspen and meadow treatments in PACs would be similar to the other action alternatives, except for alternative D which does not treat these key habitats in PACs. However, alternative E is the only alternative that would not restore grassland, savanna, or meadows on mollisol and mollic-intergrade soils in currently forested areas in restricted habitat. This alternative only restores or improves about 22 percent of the total grassland, savanna, and meadow acres in restricted habitat that the other action alternatives address. Alternative E (and B) would include more acres of meadow, grassland, and savanna habitat than the other alternatives. Alternatives E would also include nearly 3,660 acres of grassland restoration (mechanical thinning and prescribed fire in existing but encroached grasslands), similar to alternative C.

MSO primarily select for peromyscid mice and voles in the UGM (Ganey et al. 2011). The reliance on these species may reflect the historically abundant edge habitat in the UGM (USDI 1995). Alternative D should improve and increase edge habitat. Other small mammals, bats, birds, and nocturnal flying insects (primarily lepidopterons and coleopterans) are also prey for MSOs and would benefit from the proposed treatments. Overall prey abundance may be very important to nesting MSOs during years when individual prey species are be limited (Ganey et al. 2011). Providing localized patches of increased food and cover for prey species should directly benefit MSOs. While alternative E would improvement meadows, grasslands, savannas, aspen, springs, and ephemeral channels, it would accomplish the least amount of restoration of these vegetation types in MSO habitat in general, and the least in restricted habitat specifically.

## Disturbance

Activities that could create disturbance to MSOs include moving and operating harvest machinery, hauling forest materials, building fireline, managing prescribed fire, smoke, personnel in the field, and road maintenance and construction. These activities could potentially disturb nesting, roosting, and foraging owls. See appendix 2 for details on disturbance factors associated with implementing these operational aspects of the 4FRI.

#### Road-Related Disturbance

About 108,847 acres (25 percent of the total 431,049 acres) represents MSO habitat proposed for treatment, including burn-only treatments. About 34,426 acres of MSO habitat are considered occupied habitat. The risk of collisions to owls could extend beyond designated habitat and there is no way to predict where MSOs without a territory, seasonally migrating, or dispersing may occur. Therefore effects of hauling will be based on the total number of acres of proposed treatment across the entire 4FRI area. After project implementation is complete, about 153 miles of road is proposed for decommissioning within MSO habitat (16 percent of the 957 total open roads in MSO habitat). Roads proposed for decommissioning would occur in each MSO habitat type. About 14 percent of the 787 miles of road within MSO Critical Habitat (111 miles) is proposed for decommissioning.

About 44 miles of open roads in protected habitat would be decommissioned across 4 RUs and 12 different subunits (Table 130). About 29 percent of total road miles in 52 PACs would be decommissioned. Decommissioning roads in PACs would occur outside the breeding season and average 0.8 miles of road per PAC (range of work = 0.02 to 3.8 miles in individual PACs). One PAC with road decommissioning is on the Kaibab NF (Sitgreaves with 0.8 miles proposed for decommissioning) and the remaining PACs are on the Coconino NF. Road decommissioning would occur in 13 core areas, including about 5 out of about 7.6 total road miles in core areas (66 percent). An average of 0.38 miles of road would be decommissioned per core area (range = 0.02 to 0.93 miles in individual core areas). All 13 core areas are on the Coconino NF. Nearly 110 miles of open roads in restricted habitat would be decommissioned across 15 different subunits, including about 16 miles (20 percent) within target and threshold habitat (Table 131).

**Table 130. Road miles proposed for decommissioning within PAC habitat by subunit**

| Forest | Subunit | Road Miles Proposed For Decommission | Total Road Miles | Percent of Roads Decommissioned |
|---|---|---|---|---|
| Coconino NF | 1-1 | 0.1 | 1.7 | 6 |
| | 1-3 | 8.2 | 46.9 | 17 |
| | 1-4 | 1.2 | 11.7 | 10 |
| | 1-5 | 20.0 | 120.7 | 17 |
| | 3-3 | 0.7 | 2.9 | 24 |
| | 3-4 | 5.4 | 7.6 | 71 |
| | 3-5 | 2.3 | 17.7 | 13 |
| | 4-3 | 1.3 | 1.6 | 81 |
| | 4-4 | 0.2 | 0.2 | 100 |
| | 5-1 | 4.4 | 19.3 | 23 |
| | 5-2 | 0.2 | 16.1 | 1 |
| Kaibab NF | 4-4 | 0.1 | 2.2 | 5 |
| | Total | 44.0 | 251 | 18 |

**Table 131. Proposed road decommissioning in restricted habitat by subunit on the Coconino (CNF) and Kaibab (KNF) National Forests**

| | | Restricted Other Habitat | | | Target and Threshold Habitats | | |
|---|---|---|---|---|---|---|---|
| **Forest** | **Restoration Subunit** | **Road Miles Proposed for Decommissioned** | **Total Road Miles** | **Percent of Total Roads Decommissioned** | **Road Miles Proposed for Decommission** | **Total Road Miles** | **Percent of Total Roads Decommissioned** |
| CNF | 1-1 | 6.0 | 21.6 | 28 | 0.9 | 1.7 | 55 |
| | 1-2 | 0.7 | 3.4 | 21 | 0 | 0 | 0 |
| | 1-3 | 8.6 | 62.9 | 14 | 5.0 | 15.7 | 32 |
| | 1-4 | 0.3 | 3.0 | 9 | 0.1 | 0.1 | 110 |
| | 1-5 | 14.1 | 92.4 | 15 | 4.3 | 14.1 | 30 |
| | 3-3 | 2.8 | 9.7 | 29 | 0.5 | 2 | 27 |
| | 3-4 | 5.4 | 19.9 | 27 | 2.1 | 3.2 | 65 |
| | 3-5 | 28.4 | 133.1 | 21 | 1.0 | 20.8 | 5 |
| | 4-5 | 0.2 | 0.6 | 29 | 0 | 0 | 0 |
| | 5-1 | 2.9 | 8.2 | 35 | 0 | 0.7 | 0 |
| | 5-2 | 2.5 | 10.0 | 25 | 0.4 | 1.3 | 32 |
| KNF | 3-1 | 8.2 | 126.1 | 7 | 0.1 | 7 | 1 |
| | 3-2 | 7.1 | 53.9 | 13 | 1.3 | 7.7 | 17 |
| | 3-3 | 4.4 | 70.2 | 6 | 0.4 | 7.5 | 6 |
| | 4-3 | 0.1 | 0.6 | 25 | 0 | 0 | 0 |
| | 4-4 | 1.4 | 8.9 | 16 | 0 | 0.3 | 0 |
| Total | | 93.1 | 623.9 | 15 | 16.3 | 82.1 | 20 |

Noise disturbance to owls has typically been a concern with road-related activities. In response, disturbance researchers have monitored owl response to different noise sources and volumes. Experiments have been conducted at varying distances from known nest and roost sites, correlating noise levels with the biology and/or behavior of owls. A simple but consistent relationship has been identified between noise and distance to birds: as stimulus distance decreased, spotted owl response increased, regardless of stimulus type or season (Wasser et al. 1997, Delaney et al. 1999).

Transportation-related activities have timing or distance restrictions in or near PACs and core areas. The intent and expectation is to avoid all mechanized equipment in core areas and avoid working in PACs during the nesting season. Hauling would occur in 1 PAC and along the border of another PAC during the nesting season. In both cases the haul roads are greater than 0.25 miles from the core areas. An added mitigation factor would require trucks to drive less than 25 miles per hour within PAC boundaries. We expect to avoid noise disturbance to nesting and roosting owls as a result of preplanning, project design features, and mitigation. Foraging owls could be affected by noise, but based on research related to mechanical noise disturbance, we do not expect adverse effects. However, history has shown that timelines and circumstances can change in ongoing projects. It is not unreasonable to anticipate unforeseen circumstances leading to a need to conduct road work or hauling within a PAC during the breeding season. The risk of this occurring is underlined by the spatial and temporal scales of the project. While this is not the intent of the project, if exceptions were to occur they would be limited in number and scale and the FWS would be notified.

In the short-term, road work and particularly hauling materials off forest increases the risk of collisions between MSOs and vehicles involved in forest harvest activities. There are documented mortalities of MSOs from collisions with moving vehicles, including unpaved forest roads (USDI 2012b). Little information is available on how frequently collisions might occur and what conditions might relate to owls being more or less vulnerable. Birds migrating or dispersing through unfamiliar terrain may be at higher risk than resident birds (USDI 2012b). Given the total acreage proposed for mechanical treatments, on average there would be an estimated maximum of 420 truck trips per day across the 4FRI landscape during a 276 day hauling season (see appendix 2 for details). This average would be reduced if more chipping occurred rather than harvesting of merchantable materials, if shorter winters extended the hauling season, or if fewer acres were treated than the total analyzed as is common for most projects. While collisions are not typically analyzed in vegetation manipulation projects, we felt the scale of the 4FRI in terms of time, area, and intensity of road traffic warranted this consideration.

Task orders will be issued to implement work in defined portions of the 4FRI area on a yearly basis. Work will be spread across the treatment area and implementation would occur in an incremental manner as new annual task orders are issued. Vehicular activities resulting from harvest operations would increase current traffic levels well above existing conditions in portions of the treatment area on an annual basis for the duration of the project. This would typically create an increase in risk of collisions in localized areas for about 2 years before operations would shift to other areas. The level of short-term risk cannot be quantified, i.e., there is no defined relationship between open road miles or vehicle use 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 4FRI-related harvest activities, although not all harvest and related actions would overlap with MSO 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.

#### Fire-Related Disturbance

New fireline would be required to prevent fire from entering core areas where there are no roads, trails, or natural barriers to stop the spread of surface fire. Building fireline would occur outside the nesting season. Potential effects of fireline construction include effects to habitat such as erosion or loss of cover for prey species. Fireline “trails” (social trails) could increase recreation and access in PACs, increasing disturbance and potential loss of snags and logs. Building fireline would occur outside the nesting season.

Prescribed fire in PACs would occur outside the MSO breeding season (i.e., from September 1 through February 28), including core areas, eliminating the need to build firelines inside most PACs (see below). Prescribed fire could potentially disturb or effect owls due to smoke emissions. Prolonged exposure to ozone caused lung damage in Japanese quail after seven days of continuous contact. Here prolonged exposure is defined as three or more continuous days and nights of smoke contact. Smoke settling into PACs less than three continuous days and nights would not be expected to cause adverse effects.

Smoke is not expected to be a disturbance to MSOs for several reasons. Settling smoke has long been an issue that fire experts address on this landscape. This has led to knowledge of smoke patterns and developing ignition techniques to minimize undesirable smoke effects. Recognizing these issues led to the development of a strategy for prescribed fire specifically designed to minimize the risk of smoke settling into PACs (see the discussion on Exclusion and Opportunity Zones in the Methods section above and in appendix 5). Prescribed fire in PACs and exclusion zones would occur outside the breeding season. This would avoid the risk of adverse effects to eggs and nestlings and minimize the risk of adverse effects to adults and yearlings given the seasonal shift in site fidelity. In addition, smoke from prescribed fire would comply with Arizona Department of Environmental Quality requirements (ADEQ). Smoke effects are regulated and permits are required by ADEQ before burning is initiated. Air quality requirements specify management actions will meet air quality standards. ADEQ considers the cumulative effects of smoke emissions from multiple jurisdictions prior to approving daily prescribed fire activities. This mitigates the potential for severe smoke effects from multiple prescribed fire projects across the treatment area. Given the planning, design features, and ignition techniques, smoke from prescribed fire would not be expected to result in adverse effects to MSO. However, this cannot be guaranteed and adverse effects to owls could occur if smoke unexpectedly settled into PACs for three or more days and nights (see Methodology above).

### *Alternative E - Determination of Effects*

An overview of immediate post-treatment results (year 2020) and long-term changes to habitat structure (year 2050) are displayed at the Restoration Unit and subunit levels in appendices 15, 16, 17, and 18. Existing conditions and long-term changes with no management action are also presented for comparison. See Comparison of Alternatives for quantitative details comparing treatments among alternatives.

Forest structure would improve for MSO and their prey in 70 PACs and in about 9,252 acres of target and threshold habitats. Mechanical thinning in 18 selected PACs (outside of core areas) would range up to 9 inches d.b.h. The minimum BA target would be 150 square feet per acre. Average BA for PACs with mechanical thinning and prescribed fire would be 153 square feet per acre immediately after treatment and 172 square feet per acre by 2050. This alternative would move MSO habitat towards desired conditions as measured by improvements in the ratio of large trees, decreasing the percent of SDImax, releasing Gambel oak, and increasing herbaceous understory. However, the resulting values for these forest metrics would consistently be the lowest of all action alternatives. Thinning up to 9 inches d.b.h. would require removing most small trees to make a change in BA and even then it would have little effect on growth rates of large trees. The removal of the small tree cohort would lead to a future gap in recruitment into the larger size-classes. Simplifying the forest structure would yield limited results in return. Changes in numbers of large trees, understory response, and surface fuels would be more pronounced in restricted “other” habitat as a result of group selection versus intermediate thinning treatments in current and future nesting and roosting habitats. All treatments in MSO habitat would follow Recovery Plan direction. Treatments on 66,419 acres of restricted “other” habitat would provide for “groupy” tree structure and canopy gaps, resembling historical conditions and improving habitat for MSO prey species.

Changes in forest structure in MSO habitats would be less than those in non-MSO forest types because of the small scale of change proposed in owl treatments. By design, mechanical thinning and low severity prescribed fire within MSO habitats would be minimal. This is particularly true in alternative E where the use of forest plan amendments was dropped to address public comments. Nevertheless, improvements would occur in stand structure in terms of ratios of tree size-classes, density of trees, and maintenance of MSO prey species components would therefore meet the objective of moving towards increased numbers of large trees and increased forest resiliency. Unlike the other alternatives, a limited change in tree growth rates means development of mature and old trees, including Gambel oak, is little different from taking no action. This, in turn, does little to recruit large snags, logs, and CWD over the long-term.

The Old and Large Tree Implementation Plan would have limited effect in MSO 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 MSO 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.

Alternatives E would include prescribed fire in PACs, but similar to alternative B, would exclude fire from 54 core areas. Prescribed fire would include steep slope habitat (836 acres) for a total of 31,043 acres in protected habitat. Preventing fire in core areas would require construction of firelines. Fireline construction would create soil and vegetation disturbance, creating trail-like scars around designated nesting and roosting habitat within PACs. This could increase disturbance from recreation and firewood cutting. Some additional percentage of each PAC outside of core areas would also be excluded to facilitate designating fireline around core areas. Risk of high-severity fire within other MSO habitats because of prescribed fire effects reducing surface fuels, decreasing litter layers, and increasing canopy heights. Prescribed fire would not be conducted in PACs or areas where resulting smoke could settle into PACs during the nesting season.

Without forest plan amendments, more restricted habitat would be designated as target on the Kaibab NF. Because the original intent was to designate future nesting and roosting habitat in areas likely to be used by owls, rather than simply applying a formula without regard to MSO biology and ecology, these additional acres on the Kaibab are not expected to provide much additional benefit to MSOs. Prescribed fire is proposed for a total of 7,276 acres of target, 1,976 acres of threshold, and 64,576 acres of restricted “other” habitat.

About 72 percent of protected habitat would burn as surface fire in 2020, and increase of over 20 percent. Active crown fire would decrease from about 40 to 24 percent. This would result in more projected crown fire and less surface fire than alternatives B or C. Similarly, alternative E would maintain more area in a highly departed condition class (VCC3) than alternatives B or C. As a result of mechanical thinning and prescribed fire, future fires would be more likely to burn as surface fires rather than crown fires, more closely resembling the historical range of variation. However, only alternative D would provide a lower level of results in regards to moving portions of the landscape away from a highly departed state.

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. However, alternative E would move the fewest trees towards the largest size-classes while retaining higher BA levels in PACs. Fewer trees reaching larger d.b.h. size-classes would reduce the creation of future large snags. In addition, creation of firelines inside PACs to prevent core areas from burning could lead to more snags cut by firewood collectors in the short-term; subsequent road decommissioning should reduce vulnerability of snags in the long-term.

An additional indirect benefit of prescribed fire treatments is the resulting inputs of soil nutrients, benefiting both over- and understory vegetation and thereby improving the habitat of MSOs and their prey (appendix 6). Prescribed burning would also reduce litter, further improving the potential response of understory plants. In addition, reductions in total BA, increasing relative contributions of Gambel oak to soil resources, and increasing solar radiation reaching the understory would all improve the herbaceous response. These improvements would be similar across alternatives with the exception of alternative D. However, similar to alternative B, these benefits would not occur in core areas.

Road construction would only occur for new temporary roads. All temporary roads would be decommissioned after implementation is complete. This would be based on implementation of individual task orders, so decommissioning would typically be within a year. All “new” temporary roads in PAC habitat already exist on the ground but are not part of the National Forest road inventory. These too will be decommissioned after treatments are completed. Construction, upgrading, and decommissioning of temporary roads would occur outside of the nesting season in PACs. Short-term disturbance could happen to foraging owls in restricted habitat or in protected habitat if foraging occurred in PACs outside the nesting season.

Improvements and restoration of key prey habitats (i.e., spring and channel restoration and meadow, savanna, grassland and aspen treatments) interspersed within the pine-oak forest would improve habitat for prey species. All alternatives would restore 23 springs and about 4 miles of ephemeral channels in MSO habitat. Alternative E would not improve about 97 acres and restore about 35 acres of meadow vegetation in PACs. Alternatives E would treat less than 1/3 the acres of grassland, savanna, and meadow vegetation improved or restored in the other action alternatives. Grassland, savanna, and meadow vegetation are key areas of prey habitat interspersed with MSO habitat outside of PACs. All alternatives would restore about 739 acres of aspen and improve (i.e., prescribe fire-only) another 7 acres of aspen in MSO habitat outside of PACs. Alternative E would improve the same acres of aspen within PACs as alternative B.

Restoration of key prey habitats would increase the area supporting herbaceous ground cover and better connect currently fragmented openings. Increasing openings dominated by grasses, sedges, forbs, and shrubs would improve habitat for small mammals, some bat species, and arthropods. In addition, improvements to pollinator habitats would also occur which could indirectly improve herbaceous undergrowth and indirectly benefit MSO prey species in the long-term. These actions would improve vegetation heterogeneity and increase food and cover for prey species, presumably increasing total prey biomass. There is a strong link between raptors and their food and conserving and enhancing prey habitat is expected to benefit MSOs in the short- and long-term. Alternative E would improve or restore about the same number of acres of prey habitat as alternative B. This would be less than alternative C and more than alternative D.

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 MSOs 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. This would be the same for all alternatives.

Amounts of hauling and individual haul routes would be similar between alternatives. Therefore the potential for collisions between owls and vehicles implementing the 4FRI would be similar across alternatives. The level of risk is considered to be low and is unquantifiable.

The amount of burning at the treatment area scale is similar between alternatives B, C, and E and all alternatives preclude prescribed fire in PAC habitat during the nesting season. Therefore the risk of smoke settling into PACs is similar between alternatives B, C, and E but would remain lowest in alternative D. Smoke may have an adverse effect if predicted weather conditions were to change during burn operations and smoke settled into a low-lying PAC for 3 or more continuous days and nights. Fire and smoke from prescribed burning could disturb individual birds in and adjacent to treatment areas, but landscape assessments of smoke patterns and of PACs vulnerable to settling smoke, along with seasonal restrictions for burning, should minimize risk of disturbance to nesting and roosting owls. However, the amount of burning across the landscape under this alternative creates increased potential for smoke to unexpectedly settle into a PAC, potentially leading to adverse effects to individual nesting or roosting owls or nestlings. Potential disturbances to foraging owls should be limited to short-term effects. The risk of smoke to owls is considered low and is unquantifiable.

The use of prescribed fire brings inherent uncertainty. While this would be minimized through the use of ignition and control techniques, the sheer number of acres and years until implementation is complete and the number of discrete applications of fire could increase the risk of a fire burning outside of burn plan objectives. While torching of individual trees or pockets of trees could improve habitat conditions by adding diversity in dense, relatively homogeneous stands of pine-oak, torching could also create long-term adverse effects to MSO habitat. Adverse effects would only happen if fire severity exceeded burn plan objectives. This would be an unintended result and the risk of its occurrence is unknown. Based only on acres of prescribed fire, the potential risk would be lower in alternative E than in alternatives B or C.

The disturbance associated with mechanical thinning, prescribed fire, restoration activities, road maintenance, construction, decommissioning, and realignment, and hauling could result in short-term displacement of foraging owls and owls roosting outside the breeding season. Design features should ensure nesting and roosting MSOs are not disturbed during the breeding season.

Overall, alternative 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. Fewer trees in the largest size-class classes, higher BA, and the percent of SDImax would all result from using a 9 inch d.b.h. limit on thinning. The predicted values for these metrics would reduce understory response and limit future large snag development. The high percent of SDI max means achieving a codominance in 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 in order to mitigate adverse effects associated with treatments.

### Slide Fire Environmental Consequences

Proposed treatments for MSO habitat burned in the Slide Fire consist of two entries of prescribed fire-only (Table 132). In addition, about 0.3 miles of ephemeral stream restoration are proposed in restricted habitat (Table 133). 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.

**Table 132. Prescribed fire-only treatments in MSO habitat within the Slide Fire perimeter**

| MSO Habitat/Treatment Type | Acres | Number of Stands | Outside Fire Perimeter | Vegetation Severity | | | |
|---|---|---|---|---|---|---|---|
| | | | | Unchanged | Low | Moderate | High |
| **Alternative B** | | | | | | | |
| Protected | 1,019 | 35 | 0 | 28 | 302 | 456 | 233 |
| No Proposed Treatments | 7 | 1 | 0 | 0 | 0 | 7 | 0 |
| Prescribed Fire Only – Not including Core Area | 1,012 | 34 | 0 | 28 | 302 | 449 | 233 |
| Threshold | 32 | 1 | 0 | 0 | 14 | 13 | 4 |
| Threshold Treatment | 32 | 1 | 0 | 0 | 14 | 13 | 4 |
| Target | 318 | 10 | 0 | 26 | 135 | 120 | 38 |
| Target Treatment | 318 | 10 | 0 | 26 | 135 | 120 | 38 |
| Restricted | 3,793 | 58 | 1 | 255 | 1,747 | 1,463 | 327 |
| Restricted Treatment | 3,793 | 58 | 1 | 255 | 1,747 | 1,463 | 327 |
| **Alternative C** | | | | | | | |
| Protected | 1,019 | 35 | 0 | 28 | 302 | 456 | 233 |
| Prescribed Fire Only | 1,012 | 34 | 0 | 28 | 302 | 449 | 233 |
| Prescribed Fire Only – Including Core Area | 7 | 1 | 0 | 0 | 0 | 7 | 0 |
| Threshold | 32 | 1 | 0 | 0 | 14 | 13 | 4 |
| Threshold Treatment | 32 | 1 | 0 | 0 | 14 | 13 | 4 |
| Target | 318 | 10 | 0 | 26 | 135 | 120 | 38 |
| Target Treatment | 318 | 10 | 0 | 26 | 135 | 120 | 38 |
| Restricted | 3,793 | 58 | 1 | 255 | 1,747 | 1,463 | 327 |
| Restricted Treatment | 3,793 | 58 | 1 | 255 | 1,747 | 1,463 | 327 |
| **Alternative D** | | | | | | | |
| Protected | 1,019 | 35 | 0 | 28 | 302 | 456 | 233 |
| No Proposed Treatments | 1,019 | 35 | 0 | 28 | 302 | 456 | 233 |
| Threshold | 32 | 1 | 0 | 0 | 14 | 13 | 4 |
| Threshold Treatment | 32 | 1 | 0 | 0 | 14 | 13 | 4 |

| MSO Habitat/Treatment Type | Acres | Number of Stands | Outside Fire Perimeter | Vegetation Severity | | | |
|---|---|---|---|---|---|---|---|
| | | | | Unchanged | Low | Moderate | High |
| Target | 318 | 10 | 0 | 26 | 135 | 120 | 38 |
| Target Treatment | 318 | 10 | 0 | 26 | 135 | 120 | 38 |
| Restricted | 3,793 | 58 | 1 | 255 | 1,747 | 1,463 | 327 |
| Restricted Treatment | 3,793 | 58 | 1 | 255 | 1,747 | 1,463 | 327 |
| **Alternative E** | | | | | | | |
| Protected | 1,019 | 35 | 0 | 28 | 302 | 456 | 233 |
| No Proposed Treatments | 7 | 1 | 0 | 0 | 0 | 7 | 0 |
| Prescribed Fire Only – Not Including Core Area | 1,012 | 34 | 0 | 28 | 302 | 449 | 233 |
| Threshold | 32 | 1 | 0 | 0 | 14 | 13 | 4 |
| Threshold Treatment | 32 | 1 | 0 | 0 | 14 | 13 | 4 |
| Target | 318 | 10 | 0 | 26 | 135 | 120 | 38 |
| Target Treatment | 318 | 10 | 0 | 26 | 135 | 120 | 38 |
| Restricted | 3,793 | 58 | 1 | 255 | 1,747 | 1,463 | 327 |
| Restricted Treatment | 3,793 | 58 | 1 | 255 | 1,747 | 1,463 | 327 |

**Table 133. Ephemeral stream channel reaches in MSO habitat proposed for restoration within the Slide Fire perimeter overlaid with soil severity (BARC)**

| Habitat/Soil Severity | Miles |
|---|---|
| Restricted | 0.06 |
| Low | 0.06 |
| **Target/Restricted Boundary** | **0.24** |
| Low | 0.19 |
| Moderate | 0.02 |
| Unburned/Very Low | 0.02 |
| **Total** | **0.30** |

### *Slide Fire: Alternative A*

Under alternative A, no treatments would occur under the 4FRI in the area burned in the Slide Fire. Fire-killed trees in high severity fire areas would mostly fall within the next 10 years, increasing potential for high severity effects to soil and vegetation (including regeneration) in the event of a wildfire burning under undesirable conditions (Figure 27). Future tree recruitment could be delayed under these conditions because the soil seed bank could be expended and tree regeneration would depend on seeds from surviving trees capable of seed production. Although ponderosa pine trees seven years and older are potentially capable of seed production, seeds from trees aged 60 to 160 years produce the most viable seeds (Burns and Honkala 1990). Therefore, some of the 665 acres of high severity effects from the Slide Fire might not develop forest conditions for decades under these conditions.

**Figure 27. An example of tree regeneration growing in high surface fuel loading near the Mogollon Rim, Arizona**

### *Slide Fire: Alternatives B, C, D, and E*

No management actions are proposed within the footprint of the Slide Fire for at least five years after initiation of 4FRI implementation to allow vegetation recovery and to protect soil resources. If after five years it was determined that prescribed fire treatments could improve habitat conditions then treatments would be implemented. Only prescribed fire treatments are proposed in PACs within the Slide Fire perimeter (Table 134). Mechanical treatments developed to meet Recovery Plan desired conditions and ephemeral stream restoration are proposed in restricted habitat (Table 134). All alternatives would include about 0.6 miles of ephemeral stream restoration in restricted habitat under the 4FRI. Research on fire effects to spotted owls suggests that owl residency will continue post-Slide Fire and subsequent prescribed fire could improve habitat conditions.

**Table 134. Proposed treatments in MSO habitat within the Slide Fire perimeter**

| Treatments | Acres | Number of Stands | Acre of Stand Outside the Fire Perimeter | Vegetation Severity Class & Acres | | | |
|---|---|---|---|---|---|---|---|
| | | | | Unchanged | Low | Moderate | High |
| Protected | 1,019 | 35 | 0 | 28 | 302 | 456 | 233 |
| Restricted | 3,793 | 58 | 1 | 255 | 1,747 | 1,463 | 327 |
| Target | 318 | 10 | 0 | 26 | 135 | 120 | 38 |
| Threshold | 32 | 1 | 0 | 0 | 14 | 13 | 4 |

Only alternative C would include prescribed fire in core areas, although there are only seven acres of core area in the overlap of the Slide Fire and the 4FRI treatment area. No prescribed fire would occur in PACs under alternative D. Habitat conditions in core areas under alternatives B and E and within PACs in general under alternative D would be similar to alternative A. This could potentially set both vegetation and soil conditions back to current post-fire conditions in high-severity burn areas. Currently, vegetation recovery after the Slide Fire, including both overstory and understory species, would be aided by the soil seed bank. A subsequent fire with uncharacteristic surface fuel loading could delay recovery if the soil seed bank was absent as a result of fire severity.

### *Summary of Slide Fire Effects*

The Slide Fire resulted in direct impacts to MSO habitat, including PACs. Prescribed fire could assist in the ecological recovery of the area (e.g., thin tree regeneration, reduce surface fuel loading) and mitigate the potential for future high severity fire effects. Alternative A represents the greatest risk of undesirable future fire effects and behavior. Potential for crown fire would be substantially decreased under the action alternatives because horizontal and vertical continuity of canopy fuels would be broken-up. The availability of prescribed fire as a tool would provide flexibility for managers under alternatives B, C, and E as the high severity areas of the Slide Fire recover and surface fuel loading changes. Alternative D represents the greatest risk of undesirable future fire effects and behavior in PACs of all the action alternatives.

## Comparison of Alternatives – Effects to Mexican Spotted Owl

### *Changes to Vegetation*

Many of the treatments proposed are similar across the action alternatives, but each alternative varies in important ways (Table 135). The similarities stem from the intent to move MSO habitat towards the desired conditions described in the Recovery Plan and attain more sustainable conditions in a fire-adapted ecosystem undergoing climate change. The differences in specific measures reflect comments from the public on alternative B such as increasing the degree of restoration (alternative C), decreasing the amount of prescribed fire in order to reduce smoke output (alternative D), and avoiding the use of forest plan amendments (alternative E). See the FEIS for more detail on alternative development.

**Table 135. Summary or proposed treatments in MSO habitat by alternative**

| Metric | Alternative B | Alternative C | Alternative D | Alternative E |
|---|---|---|---|---|
| **Protected Activity Centers** | | | | |
| Mechanical Treatments (acre) | 18 PACs with a 16 inch d.b.h. limit | 18 PACs with an 18 inch d.b.h. limit | 18 PACs with a 16 inch d.b.h. limit | 18 PACs with a 9 inch d.b.h. limit |
| Prescribed (Rx) Fire (acre) | Portions of 70 PACs. Also 836 acres of steep slope habitat | All or portions of 70 PACs. Also 836 acres of steep slope habitat | 836 acres of steep slope habitat | Portions of 70 PACs. Also 836 acres of steep slope habitat |
| Rx Fire in Core Areas (acre) | 0 | 6,084 (54 core areas) | 0 | 0 |
| Total Mechanical/ Rx Fire (acre) | 10,284/31,043 | 10,284/35,018 | 10,284/836 | 10,284/30,043 |
| Springs (#)/ Ephemeral Channels (miles) | 5/1.66 | | | |
| **Restricted Habitat** | | | | |
| Threshold Thinned/Burned (acre) | 1,894/1,978 | 1,892/1,978 | 1,894/84 | 1,892/1,892 |
| Target Thinned/ Burned (acre) | 6,497/6,714 | 6,495/6,712 | 6,497/217 | 7,059/7,059 |
| “Other” Thinned/ Burned (acre) | 64,065/66,419 | 62,785/65,139 | 64,065/2,354 | 62,222/64,576 |
| Total Mechanical/ Rx Fire (acre) | 72,456/75,111 | 71,173/75,111 | 72,456/2,655 | 71,170/71,170 |
| Aspen Thin & Burn/Rx Fire-Only | 739/7 | | | |
| Springs (#)/ Ephemeral Channels (miles) | 18/3.3+ | | | |
| **Total MSO Habitat[1]** | | | | |
| Thinning + Rx Fire (acre) | 188,894 | 190,303 | 86,231 | 186,328 |

1. These values represent total acres by management treatment-type which sums to more than simply the total number of acres; in many instances the same acre may be thinned and burned.

While proposed treatments have similarities among alternatives, the degree of change affected in individual habitat components varies. Differences among alternatives are apparent in treated PACs, particularly when compared to existing condition and alternative A (Table 136). Several forest metrics are similar across alternatives in 2020. The fact that the action alternatives are similar to alternative A in 2020 is a reflection of the minimal actions being proposed in PACs. The percent of SDImax 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 SDImax to the bottom of this category in 2020, almost achieving a “high density” ranking (high density = percent SDImax of 55 and lower). A key result of these treatments would be increases in trees 24 inches d.b.h. and greater. Alternatives B-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. Although the modeled change would only be 2 to 3 percent, this represents 2 to 3 percent of about 10,284 PAC acres.

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. Modeling works with averages and cannot take into account which individual trees would be selected for removal. Part of the thinning design in MSO habitat is to “daylight” existing large and old trees by thinning young, competitive trees near them. Decreasing competition around presettlement trees should enhance their survival and potentially result in more large trees than displayed in the model results. In the long-term, reducing abundant quantities of mid-sized trees and increasing areas dominated by large trees should improve MSO nesting and roosting habitat (USDI 1995, May and Gutierrez 2002, May et al. 2004, Blakesley et al. 2005).

**Table 136. Changes in forest metrics for 18 PACs with mechanical thinning and prescribed fire treatments by alternative**

| Alternatives | Year | Percent Area by Tree Size-Class | | | % of Max SDI | Total BA |
|---|---|---|---|---|---|---|
| | | 12 - 17.9" d.b.h. | 18 - 23.9" d.b.h. | ≥24" d.b.h. (%) | | |
| 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 |

Thinning, not group selection, is proposed in PACs, in part to limit affects to overstory structure. The scale of these treatments can be judged in several ways: changes in the percentages of tree size-classes tend to be less than five percent after treatment compared to alternative A (Table 136); PACs would remain in the highest density category in regards to percent of SDImax after treatment. Understory index response, which is tied directly to BA and canopy cover, would be low in PACs, tending to increase by about 10 pounds per acre versus increases of 80 to over 100 pounds per acre in restricted “other” habitat. This represents a short-term benefit in PACs before canopy growth again blocks most direct solar radiation from reaching the ground. Understory increases could potentially be long-term in restricted other habitat as a result of canopy gaps and openings.

Fire modeling shows surface fuel loading tracks post-treatment canopy openness, with the highest surface fuel loading in PACs and core areas (i.e., areas with the lowest canopy openness). Short-term decreases in the threat of high-severity fire in MSO habitat would follow prescribed fire treatments. Long-term decreases in the risk of crown fire could result from treatments outside of PACs where treatments are frequently of higher intensity.

Treatments in vegetation types interspersed within the pine-oak also vary by alternative. These small scale site-specific treatments do not add up to many acres, but represent areas that, if restored, could support dense herbaceous understories. These alternate vegetation types include grasslands, savannas, and meadows (designation depends on soil and size – in the case of patches within PACs these would largely qualify as meadows), aspen, springs, and ephemeral channels. These are areas with different soils and can support different species of ground cover, different arthropod assemblages, and higher densities of small mammals and birds relative to the surrounding pine forest matrix. Prescribed fire can reduce the number of invading trees, but restoration depends on the ability to remove larger pine trees as well. Prescribed fire- only treatments would likely result in short-term benefits to prey habitats while the combination of mechanical and prescribed fire would yield long-term benefits.

Spring and ephemeral channel restoration is the same across all alternatives and will not be discussed further here. Treatments and the number of acres treated in grasslands, savannas, and meadows vary by alternative (Table 137). Alternatives B and D would treat the most acres, 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 function ecologically as forest. There is a strong link between raptors and their food and restoring and enhancing prey habitat is expected to benefit MSO and their prey in the short- and long-term (Kalies et al. 2012, Ganey et al 2011).

Acres of treated aspen also vary by alternative, but the treatment itself, prescribed fire-only, is the same (Table 137). While alternatives B, C, and E treat similar acres, alternative D does nothing to improve aspen patches within PACs and alternative C treats the most total acres.

**Table 137. Acres and treatment types by alternative for grasslands, savannas, meadows, and aspen**

| Treatment Type | Alt. B | Alt. C | Alt. D | Alt. E |
|---|---|---|---|---|
| Grassland Restoration | 2,254 | 2,254 | 2,254 | 0 |
| Grassland Mechanical | 0 | 3,657 | 0 | 3,657 |
| Savanna | 10,791 | 10,725 | 10,791 | 0 |
| Prescribed Fire Only - Operational | 3,6910 | 15 | 3,691 | 15 |
| **Total Acres** | **16,736** | **16,651** | **16,736** | **3,672** |
| Aspen (Prescribed Fire Only) | 201 | 219 | 0 | 201 |

While the changes in MSO habitat are relatively minor, they are targeted to achieve specific goals. Part of the objectives for the 4FRI is to allow fire to return to the landscape and predominantly burn with low-severity fire effects. Post-treatment, MSO habitat would still represent areas with the highest surface fuel loading (appendix 19). Treatments outside of MSO habitat would affect the risk of high-severity fire inside MSO habitat. At the scale of the treatment area, all alternatives would move acres out of VCC3 and would reduce the FRCC ranking (Table 138). Alternatives B, C, and E reduce VCC3 from over 60 percent of area to about 4-5 percent. Alternative D would result in over 1/3 the total area remaining in VCC3. By 2050, alternatives D and E would maintain 40 percent or more of the area in VCC3 while alternatives B and C would have about 35-36 percent of the area in VCC3. Only alternative D would result in FRCC returning to a class 3, but the distribution of VCC indicates that alternatives B and C would better achieve desired conditions compared to alternative E.

**Table 138. Changes in fire regime condition class and vegetation condition class over time by alternative**

| Alternative | Condition Class | Condition Class of Treatment Area 2010 | 2020 | 2050 |
|---|---|---|---|---|
| B | % VCC3 | 61 | 5 | 36 |
| | FRCC | 3 | 2 | 2 |
| C | % VCC3 | 61 | 4 | 35 |
| | FRCC | 3 | 2 | 2 |
| D | % VCC3 | 61 | 35 | 45 |
| | FRCC | 3 | 2 | 3 |
| E | % VCC3 | 61 | 5 | 40 |
| | FRCC | 3 | 2 | 2 |

Fire behavior would change under each alternative (Table 139). While each alternative would move more acres into the surface fire category and reduce the number of acres susceptible to active crown fire, alternative C would do the most in this regard, followed by alternatives B and E. Alternative D would produce the fewest surface fire acres and the most active crown fire acres of any action alternative.

**Table 139. Changes in fire behavior after treatment by alternative**

| Fire Behavior | Ponderosa Pine | Protected 2010 | Alternative B 2020 | Alternative C 2020 | Alternative D 2020 | Alternative E 2020 |
|---|---|---|---|---|---|---|
| Total (acre) | 507,839 | 35,262 | 35,262 | 35,262 | 35,262 | 35,262 |
| Surface Fire (acre) | 311,313 | 18,122 | 25,803 | 26,953 | 19,976 | 25,429 |
| Passive Crown Fire (acre) | 48,023 | 3,034 | 2,195 | 1,896 | 3,300 | 1,289 |
| Active Crown Fire | 143,186 | 14,106 | 7,103 | 6,247 | 11,820 | 8,380 |
| Surface Fire (%) | 61 | 51 | 73 | 76 | 57 | 72 |
| Passive Crown Fire (%) | 9 | 9 | 6 | 5 | 9 | 4 |
| Active Crown Fire (%) | 28 | 40 | 20 | 18 | 34 | 24 |

Overall, changes in forest structure and fire behavior are similar among alternatives and, overall, the scale of change is frequently minimal. However, alternative C consistently displays the most benefits, measured either by acres or by treatment type, in moving MSO habitat towards desired conditions, improving key habitats for prey species, and reducing the risk of high severity fire.

### Disturbance

**Direct Effects:** Patterns of habitat use vary with owl activity both seasonally and regionally. MSOs appear to be far more selective for habitats used for roosting and nesting than for habitats used for foraging. Foraging habitat has a broader array of both cover types and structural conditions. Similarly, selection for particular types of habitats appears to be relaxed during the non-breeding season, when owls wander more widely and use a wider array of habitats that also tend to have a more open structure (USDI 2012b).

Conversely, resident MSOs concentrate their use within PACs during the breeding season, even if they do not nest in a given year. Therefore, all mechanical and prescribed fire treatments within PACs would have timing restrictions prohibiting activities until after the nesting season when the owls are not tied as strongly to their nesting area. Adverse effects to MSOs from implementing the 4FRI would primarily result from disturbance, but use of timing restrictions is expected to limit potential disturbance to foraging MSOs outside of the nesting season.

Prescribed burning during the nesting season would occur in areas where smoke is unlikely to settle into PACs. Areas available to prescribed fire during the nesting season took landscape features into account both in terms of where smoke would be initiated and where smoke would be likely to settle. PACs vulnerable to settling smoke were identified and dispersion patterns of smoke were considered when identifying zones of opportunity (where burning during the breeding season could occur) and zones of exclusion (areas that could only be burned outside the breeding season). Therefore, potential direct effects from prescribed fire are only expected to disturb foraging owls or owls outside of the breeding season. Potential disturbance from smoke would be short-term.

Disturbance could occur as a result of project-related activities including moving and operating harvest machinery, hauling forest materials, managing prescribed fire, other personnel in the field, and road maintenance and construction. Noise disturbance from project activities may affect foraging MSOs, but are not expected to affect nesting or roosting owls due to design features and project planning. Noise effects from hauling would also be restricted by avoiding areas within ¼ mile of PACs during the breeding season. Effects from road decommissioning could also result in noise disturbance. This too would have a timing restriction in within a ¼ mile of PACs and so be limited to foraging owls or affecting owls outside the breeding season. Disturbance could result in short-term displacement of foraging owls and owls roosting outside the breeding season. Design features should ensure nesting and roosting MSOs are not disturbed during the breeding season.

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 effect. Similarly, truck traffic related to implementation could lead to collisions with MSOs, particularly during crepuscular hours when owls are active. Although collisions with logging trucks are not likely, given this is a species that hunts rodents by sound, vehicular collisions have been documented on forest roads. Design features restricting hauling during the nesting season near PACs should reduce, but cannot eliminate this threat. Loss of nesting or roosting habitat due to high-severity fire resulting from prescribed fire or any owl mortalities resulting from vehicle collisions would have long-term effects.

**Indirect Effects:** Mechanical and prescribed fire treatments were designed to meet or make progress towards the desired conditions for MSO habitat described in the Recovery Plan. Treatments are light and modeling indicated that change is limited. Indirect effects could include short-term decreases in logs, CWD, and small to medium-sized oak in alternatives B, C, and E. The limited use of prescribed fire in alternative D would avoid or minimize these decreases. Based on modeling, little to no change is expected in snag numbers, although part of this may include loss of existing snags that are replaced by the creation of new snags. While total number of snags might not change, longevity of individual snags could decrease as fire-created snags replace snags created by other mechanisms. The exception would again be in alternative D where little to no change in snag density would be expected. Any effects to snags would be considered short-term with repeat burns creating pulses of new snags until enough trees grow into larger size-classes and increased snag recruitment occurs.

**Beneficial Effects:** Additional short-term effects would include an increase in understory biomass. The limited changes to overstory in protected habitat would limit the duration of any increase in herbaceous understory until existing canopy again expanded post-treatment. Understory effects would last longer in restricted “other” habitat where canopy gaps and openings would allow solar radiation to reach the ground over the long-term. Meadow, spring, and ephemeral channel restoration would create both short- and long-term effects to habitat as increased herbaceous growth would be expected to respond in the short-term and be sustained over time. Aspen treatments would create a short-term increase in understory and a long-term benefit from enhanced/sustained aspen on the landscape. Road decommissioning would have long-term effects due to reduced vehicular noise disturbance and reducing the potential loss of habitat components such as snags, logs, and oak associated with travel access. These benefits would occur in all MSO habitat types, including PACs and core areas within PACs. Proposed treatments in MSO habitat would yield a short-term decrease in the risk of high-severity fire.

Long-term changes to forest structure would be expected to include increases in the largest tree size-classes. The primary objective of the mechanical treatments was to increase large trees and tree growth rates. This was realized to varying degrees in all the action alternatives, but was greatest in alternative C and least in alternative D.

### *MSO Critical Habitat*

#### Alternative A – No Action

Affects to MSOs must be analyzed in terms of effects to the animal, effects to its habitat, and effects to designated CH (ESA, PL 93-205, USDI 2004). In addition to being a requirement, CH displays a summary of effects to MSO habitat because it combines treatments in protected and restricted habitats. It also shows variability across the landscape because each CHU is a separate, non-over-lapping polygon. Cumulative effects were assessed in terms of the project area for CH. Under alternative A, current and foreseeable projects would thin about 51,096 acres of MSO habitat and prescribed fire would occur on about 68,097 acres. As modeled for the 4FRI, most MSO habitat would continue to trend away from desired conditions.

#### Forest Structure and Prey Habitat

Changes to overstory structure and prey habitat with no 4FRI-related activities are presented below (Table 140, Table 141). Discussions and comparisons of the effects of no action can be found in the individual alternative sections below. Changes to the primary constituent elements by sub-unit can be viewed in appendix 14.

**Table 140. Modeled changes to forest structure in MSO critical habitat units (CHUs), Alternative A**

| Forest Attributes | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative A (Year 2050) |
|---|---|---|---|
| **UGM-11** | | | |
| Acres | 48,677 | | |
| % of SDI 12-18” d.b.h. | 31 | 31 | 29 |
| % of SDI 18-24” d.b.h. | 13 | 15 | 22 |
| % of SDI >24” d.b.h. | 7 | 8 | 10 |
| % of Max SDI | 75% | 77% | 80% |
| TPA >18" | 13 | 16 | 26 |
| Ponderosa Pine BA | 117 | 123 | 130 |
| Gambel Oak BA | 23 | 24 | 29 |
| All BA | 150 | 159 | 178 |
| % Oak BA | 15 | 15 | 16 |
| **UGM-12** | | | |
| Acres | 1,150 | | |
| % of SDI 12-18” d.b.h. | 24 | 25 | 25 |
| % of SDI 18-24” d.b.h. | 13 | 14 | 17 |
| % of SDI >24” d.b.h. | 12 | 13 | 15 |
| % of Max SDI | 63% | 66% | 70% |
| TPA >18" | 12 | 14 | 20 |
| Ponderosa Pine BA | 101 | 107 | 118 |
| Gambel Oak BA | 19 | 21 | 28 |
| All BA | 126 | 136 | 159 |
| % Oak BA | 14 | 15 | 17 |
| **UGM-13** | | | |
| Acres | 37,609 | | |
| % of SDI 12-18” d.b.h. | 29 | 30 | 26 |
| % of SDI 18-24” d.b.h. | 14 | 16 | 21 |
| % of SDI >24” d.b.h. | 7 | 7 | 10 |
| % of Max SDI | 72% | 75% | 78% |
| TPA >18" | 13 | 16 | 25 |
| Ponderosa Pine BA | 100 | 106 | 114 |
| Gambel Oak BA | 31 | 33 | 39 |
| All BA | 141 | 151 | 173 |
| % Oak BA | 21 | 21 | 22 |

| Forest Attributes | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative A (Year 2050) |
|---|---|---|---|
| **UGM-14** | | | |
| Acres | 908 | | |
| % of SDI 12-18” d.b.h. | 34 | 34 | 28 |
| % of SDI 18-24” d.b.h. | 14 | 16 | 23 |
| % of SDI >24” d.b.h. | 7 | 8 | 12 |
| % of Max SDI | 64% | 67% | 71% |
| TPA >18" | 13 | 16 | 27 |
| Ponderosa Pine BA | 97 | 102 | 108 |
| Gambel Oak BA | 14 | 16 | 21 |
| All BA | 132 | 143 | 165 |
| % Oak BA | 10 | 11 | 13 |
| **UGM-15** | | | |
| Acres | 570 | | |
| % of SDI 12-18” d.b.h. | 33 | 35 | 38 |
| % of SDI 18-24” d.b.h. | 10 | 14 | 24 |
| % of SDI >24” d.b.h. | 5 | 5 | 8 |
| % of Max SDI | 47% | 50% | 55% |
| TPA >18" | 9 | 11 | 20 |
| Ponderosa Pine BA | 77 | 84 | 96 |
| Gambel Oak BA | 11 | 12 | 15 |
| All BA | 98 | 107 | 129 |
| % Oak BA | 8 | 8 | 9 |

**Table 141. Modeled changes to prey habitat in MSO critical habitat units (CHUs), Alternative A**

| Forest Attributes | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative A (Year 2050) |
|---|---|---|---|
| **UGM-11** | | | |
| Acres | 48,677 | | |
| Snags >12" | 3.0 | 3.8 | 7.0 |
| Snags >12" and <18" | 2.5 | 3.2 | 5.6 |
| Snags <18" | 0.5 | 0.6 | 1.4 |
| CWD >3" | 5.1 | 6.6 | 10.8 |
| Logs | 1.9 | 2.8 | 6.1 |
| Understory | 35 | 30 | 21 |
| **UGM-12** | | | |
| Acres | 1,150 | | |
| Snags >12" | 1.7 | 2.2 | 4.6 |
| Snags >12" and <18" | 1.2 | 1.7 | 3.6 |
| Snags <18" | 0.5 | 0.5 | 1.0 |
| CWD >3" | 4.2 | 5.1 | 8.0 |
| Logs | 1.6 | 2.1 | 4.0 |

| Forest Attributes | Existing Conditions (Year 2010) | Alternative A (Year 2020) | Alternative A (Year 2050) |
|---|---|---|---|
| Understory | 182 | 160 | 123 |
| **UGM-13** | | | |
| Acres | 37,609 | | |
| Snags >12" | 2.5 | 3.3 | 6.0 |
| Snags >12" and <18" | 2.0 | 2.7 | 4.6 |
| Snags <18" | 0.5 | 0.6 | 1.4 |
| CWD >3" | 4.1 | 5.5 | 9.3 |
| Logs | 1.8 | 2.5 | 5.3 |
| Understory | 52 | 44 | 30 |
| **UGM-14** | | | |
| Acres | 908 | | |
| Snags >12" | 3.2 | 3.8 | 7.3 |
| Snags >12" and <18" | 2.6 | 3.2 | 5.6 |
| Snags <18" | 0.5 | 0.6 | 1.7 |
| CWD >3" | 5.5 | 6.9 | 11.0 |
| Logs | 3.2 | 4.1 | 8.0 |
| Understory | 42 | 35 | 23 |
| **UGM-15** | | | |
| Acres | 570 | | |
| Snags >12" | 2.4 | 3.0 | 5.6 |
| Snags >12" and <18" | 2.0 | 2.5 | 4.2 |
| Snags <18" | 0.4 | 0.4 | 1.3 |
| CWD >3" | 5.6 | 6.4 | 9.1 |
| Logs | 1.3 | 1.9 | 4.6 |
| Understory | 95 | 80 | 53 |

Alternative A would not improve or restore any aspen (over 960 acres in CH), springs (19 occurring in CHUs 11 and 13), and ephemeral channels (over 4 miles of restoration in 4 different CHUs). 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 MSO habitat and in ponderosa pine forests in general and are important to wildlife (Griffis-Kyle and Beier 2003, Finch et al. [vol2] 2004). The pine canopy is commonly interrupted in these areas, allowing greater herbaceous development than in the general pine-oak forest, benefiting arthropods, including pollinators, small mammals, seed and insect feeding birds, and foraging bats. In the absence of management activities tree encroachment would continue, compromising aspen, grasslands, savannas, meadows, and springs. This would be expected to directly reduce the quality of MSO 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.

### Alternative B – Proposed Action

Changes in habitat features are presented by CHU below. Changes at the sub-unit level are in appendix 14.

#### Forest Structure and Density

A primary goal of treatments in MSO habitat would be increasing the numbers of trees 24 inches d.b.h. and greater. The percent increase in the largest trees would be most evident in CHUs 11 – 13, accounting for about 98 percent of total CH acres (Table 142). The percent of SDImax would decrease to either the low end of Zone 4 or the mid to upper end of zone 3. This would decrease 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 BA. Loss of oak from operation activities would typically result in resprouting. Young sprouts would not account for much BA. Therefore, the lack of change or the increases in oak BA suggests an increase in the mean diameter of Gambel oak.

**Table 142. Modeled changes in forest structure attributes in CHUs under Alternative B**

| Forest Attributes | Existing Conditions 2010 | Alt A 2020 | Alt B 2020 | Alt B 2050 | Alt A 2050 |
|---|---|---|---|---|---|
| **UGM-11** | | | | | |
| Acres | 48,677 | | | | |
| % of SDI 12-18” d.b.h. | 31 | 31 | 30 | 25 | 29 |
| % of SDI 18-24” d.b.h. | 13 | 15 | 19 | 23 | 22 |
| % of SDI >24” d.b.h. | 7 | 8 | 11 | 14 | 10 |
| % of Max SDI | 75 | 77 | 59 | 65 | 80 |
| TPA >18" | 13 | 16 | 15 | 24 | 26 |
| Ponderosa Pine BA | 117 | 123 | 91 | 103 | 130 |
| Gambel Oak BA | 23 | 24 | 22 | 28 | 29 |
| All BA | 150 | 159 | 125 | 151 | 178 |
| % Oak BA | 15 | 15 | 18 | 19 | 16 |
| **UGM-12** | | | | | |
| Acres | 1,150 | | | | |
| % of SDI 12-18” d.b.h. | 24 | 25 | 21 | 20 | 25 |
| % of SDI 18-24” d.b.h. | 13 | 14 | 18 | 18 | 17 |
| % of SDI >24” d.b.h. | 12 | 13 | 19 | 22 | 15 |
| % of Max SDI | 63 | 66 | 41 | 50 | 70 |
| TPA >18" | 12 | 14 | 12 | 17 | 20 |
| Ponderosa Pine BA | 101 | 107 | 63 | 79 | 118 |
| Gambel Oak BA | 19 | 21 | 17 | 24 | 28 |
| All BA | 126 | 136 | 87 | 115 | 159 |
| % Oak BA | 14 | 15 | 19 | 21 | 17 |
| **UGM-13** | | | | | |
| Acres | 37,609 | | | | |
| % of SDI 12-18” d.b.h. | 29 | 30 | 26 | 20 | 26 |
| % of SDI 18-24” d.b.h. | 14 | 16 | 21 | 21 | 21 |
| % of SDI >24” d.b.h. | 7 | 7 | 12 | 16 | 10 |
| % of Max SDI | 72 | 75 | 47 | 57 | 78 |
| TPA >18" | 13 | 16 | 13 | 20 | 25 |
| Ponderosa Pine BA | 100 | 106 | 63 | 78 | 114 |

| Forest Attributes | Existing Conditions 2010 | Alt A 2020 | Alt B 2020 | Alt B 2050 | Alt A 2050 |
|---|---|---|---|---|---|
| Gambel Oak BA | 31 | 33 | 24 | 34 | 39 |
| All BA | 141 | 151 | 98 | 129 | 173 |
| % Oak BA | 21 | 21 | 25 | 26 | 22 |
| **UGM-14** | | | | | |
| Acres | 908 | | | | |
| % of SDI 12-18” d.b.h. | 34 | 34 | 34 | 27 | 28 |
| % of SDI 18-24” d.b.h. | 14 | 16 | 17 | 24 | 23 |
| % of SDI >24” d.b.h. | 7 | 8 | 8 | 13 | 12 |
| % of Max SDI | 64 | 67 | 62 | 69 | 71 |
| TPA >18" | 13 | 16 | 16 | 27 | 27 |
| Ponderosa Pine BA | 97 | 102 | 94 | 101 | 108 |
| Gambel Oak BA | 14 | 16 | 15 | 21 | 21 |
| All BA | 132 | 143 | 134 | 159 | 165 |
| % Oak BA | 10 | 11 | 12 | 13 | 13 |
| **UGM-15** | | | | | |
| Acres | 570 | | | | |
| % of SDI 12-18” d.b.h. | 33 | 35 | 35 | 38 | 38 |
| % of SDI 18-24” d.b.h. | 10 | 14 | 15 | 25 | 24 |
| % of SDI >24” d.b.h. | 5 | 5 | 5 | 8 | 8 |
| % of Max SDI | 47 | 50 | 48 | 54 | 55 |
| TPA >18" | 9 | 11 | 11 | 20 | 20 |
| Ponderosa Pine BA | 77 | 84 | 80 | 93 | 96 |
| Gambel Oak BA | 11 | 12 | 12 | 15 | 15 |
| All BA | 98 | 107 | 104 | 125 | 129 |
| % Oak BA | 8 | 8 | 8 | 9 | 9 |

#### MSO Prey Habitat

The FWS determined that snags greater than 12 inches d.b.h. are part of the primary constituent elements for CH (USDI 2004). Therefore, results for snags greater than 12 inches d.b.h. are displayed. However, larger snags get more use by wildlife in general and because the forest plans identified snags greater than 18 inches as important, they are displayed too. The total for snags between 12 and 18 inches d.b.h. and those greater than 18 inches d.b.h. are additive and equal the total for snags greater than 12 inches d.b.h. Snags would consistently remain above the no action levels (Table 143). 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. Decreases typically average 1/10 of a log per acre. A similar pattern occurs with CWD, 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 CWD 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 CHU. However, the CHUs with larger increases (i.e., CHUs 11-13) account for the most acres.

**Table 143. Modeled changes in prey habitat attributes in CHUs under Alternative B**

| Forest Attributes | Existing Conditions 2010 | Alternative A 2020 | Alternative B 2020 | Alternative B 2050 | Alternative A 2050 |
|---|---|---|---|---|---|
| **UGM-11** | | | | | |
| Acres | 48,677 | | | | |
| Snags >12" | 3.0 | 3.8 | 4.8 | 5.1 | 7.0 |
| Snags >12" and <18" | 2.5 | 3.2 | 4.1 | 3.8 | 5.6 |
| Snags >18" | 0.5 | 0.6 | 0.7 | 1.3 | 1.4 |
| CWD >3" | 5.1 | 6.6 | 3.6 | 7.3 | 10.8 |
| Logs | 1.9 | 2.8 | 2.3 | 5.6 | 6.1 |
| Understory Index | 35 | 30 | 56 | 35 | 21 |
| **UGM-12** | | | | | |
| Acres | 1,150 | | | | |
| Snags >12" | 1.7 | 2.2 | 3.4 | 2.7 | 4.6 |
| Snags >12" and <18" | 1.2 | 1.7 | 2.6 | 1.7 | 3.6 |
| Snags >18" | 0.5 | 0.5 | 0.8 | 1.0 | 1.0 |
| CWD >3" | 4.2 | 5.1 | 2.9 | 5.4 | 8.0 |
| Logs | 1.6 | 2.1 | 1.9 | 4.2 | 4.0 |
| Understory Index | 182 | 160 | 312 | 208 | 123 |
| **UGM-13** | | | | | |
| Acres | 37,609 | | | | |
| Snags >12" | 2.5 | 3.3 | 5.0 | 3.1 | 6.0 |
| Snags >12" and <18" | 2.0 | 2.7 | 4.0 | 1.9 | 4.6 |
| Snags >18" | 0.5 | 0.6 | 1.0 | 1.1 | 1.4 |
| CWD >3" | 4.1 | 5.5 | 3.3 | 6.6 | 9.3 |
| Logs | 1.8 | 2.5 | 2.4 | 5.4 | 5.3 |
| Understory Index | 52 | 44 | 113 | 64 | 30 |
| **UGM-14** | | | | | |
| Acres | 908 | | | | |
| Snags >12" | 3.2 | 3.8 | 5.1 | 6.7 | 7.3 |
| Snags >12" and <18" | 2.6 | 3.2 | 4.5 | 5.0 | 5.6 |
| Snags >18" | 0.5 | 0.6 | 0.6 | 1.7 | 1.7 |
| CWD >3" | 5.5 | 6.9 | 2.8 | 7.4 | 11.0 |
| Logs | 3.2 | 4.1 | 2.6 | 6.9 | 8.0 |
| Understory Index | 42 | 35 | 44 | 27 | 23 |
| **UGM-15** | | | | | |
| Acres | 570 | | | | |
| Snags >12" | 2.4 | 3.0 | 3.9 | 5.4 | 5.6 |
| Snags >12" and <18" | 2.0 | 2.5 | 3.5 | 4.0 | 4.2 |
| Snags >18" | 0.4 | 0.4 | 0.5 | 1.3 | 1.3 |
| CWD >3" | 5.6 | 6.4 | 3.4 | 6.6 | 9.1 |
| Logs | 1.3 | 1.9 | 1.5 | 4.4 | 4.6 |
| Understory Index | 95 | 80 | 85 | 57 | 53 |

## Alternative C – Preferred Action

### Forest Structure and Density

This alternative would thin to a larger size-class and a lower minimum BA 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 (Table 144). 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 TPA 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 CHUs UGM 14 and 15 (Table 144). The reason for the exceptions is unknown but likely relates to site-specific conditions given the differences in total acreage between these 2 CHUs (totaling less than 2 percent of the total CH acres) and the other CHUs. Changes at the sub-unit level are presented in appendix 14.

**Table 144. Modeled changes in forest structure attributes in CHUs under Alternative C**

| Critical Habitat Unit | Existing Condition 2010 | Alternative A 2020 | Alternative C 2020 | Alternative C 2050 | Alternative C 2050 |
|---|---|---|---|---|---|
| **UGM-11** | | | | | |
| Acres | 48,677 | | | | |
| % of SDI 12-17.9" d.b.h. | 31 | 31 | 29 | 25 | 29 |
| % of SDI 18-23.9" d.b.h. | 13 | 15 | 19 | 23 | 22 |
| % of SDI ≥24" d.b.h. | 7 | 8 | 11 | 15 | 10 |
| % of Max SDI | 75 | 77 | 58 | 65 | 80 |
| TPA >18" | 13 | 16 | 15 | 24 | 26 |
| Ponderosa Pine BA | 117 | 123 | 89 | 101 | 130 |
| Gambel Oak BA | 23 | 24 | 22 | 29 | 29 |
| All BA | 150 | 159 | 122 | 149 | 178 |
| % Oak BA | 15 | 15 | 18 | 19 | 16 |
| **UGM-12** | | | | | |
| Acres | 1,150 | | | | |
| % of SDI 12-17.9" d.b.h. | 24 | 25 | 21 | 20 | 25 |
| % of SDI 18-23.9" d.b.h. | 13 | 14 | 19 | 17 | 17 |
| % of SDI ≥24" d.b.h. | 12 | 13 | 19 | 22 | 15 |
| % of Max SDI | 63 | 66 | 40 | 50 | 70 |
| TPA >18" | 12 | 14 | 12 | 17 | 20 |
| Ponderosa Pine BA | 101 | 107 | 61 | 77 | 118 |
| Gambel Oak BA | 19 | 21 | 17 | 25 | 28 |
| All BA | 126 | 136 | 85 | 114 | 159 |
| % Oak BA | 14 | 15 | 19 | 21 | 17 |
| **UGM-13** | | | | | |
| Acres | 37,609 | | | | |
| % of SDI 12-17.9" d.b.h. | 29 | 30 | 26 | 20 | 26 |
| % of SDI 18-23.9" d.b.h. | 14 | 16 | 21 | 21 | 21 |
| % of SDI ≥24" d.b.h. | 7 | 7 | 12 | 16 | 10 |

| Critical Habitat Unit | Existing Condition 2010 | Alternative A 2020 | Alternative C 2020 | Alternative C 2050 | Alternative C 2050 |
|---|---|---|---|---|---|
| % of Max SDI | 72 | 75 | 48 | 58 | 78 |
| TPA >18" | 13 | 16 | 13 | 20 | 25 |
| Ponderosa Pine BA | 100 | 106 | 64 | 78 | 114 |
| Gambel Oak BA | 31 | 33 | 25 | 34 | 39 |
| All BA | 141 | 151 | 99 | 130 | 173 |
| % Oak BA | 21 | 21 | 25 | 26 | 22 |
| **UGM-14** | | | | | |
| Acres | 908 | | | | |
| % of SDI 12-17.9" d.b.h. | 34 | 34 | 34 | 27 | 28 |
| % of SDI 18-23.9" d.b.h. | 14 | 16 | 17 | 24 | 23 |
| % of SDI ≥24" d.b.h. | 7 | 8 | 8 | 13 | 12 |
| % of Max SDI | 64 | 67 | 62 | 69 | 71 |
| TPA >18" | 13 | 16 | 16 | 27 | 27 |
| Ponderosa Pine BA | 97 | 102 | 94 | 101 | 108 |
| Gambel Oak BA | 14 | 16 | 15 | 21 | 21 |
| All BA | 132 | 143 | 134 | 159 | 165 |
| % Oak BA | 10 | 11 | 12 | 13 | 13 |
| **UGM-15** | | | | | |
| Acres | 570 | | | | |
| % of SDI 12-17.9" d.b.h. | 33 | 35 | 36 | 37 | 38 |
| % of SDI 18-23.9" d.b.h. | 10 | 14 | 15 | 25 | 24 |
| % of SDI ≥24" d.b.h. | 5 | 5 | 5 | 9 | 8 |
| % of Max SDI | 47 | 50 | 48 | 53 | 55 |
| TPA >18" | 9 | 11 | 11 | 20 | 20 |
| Ponderosa Pine BA | 77 | 84 | 79 | 92 | 96 |
| Gambel Oak BA | 11 | 12 | 12 | 15 | 15 |
| All BA | 98 | 107 | 102 | 125 | 129 |
| % Oak BA | 8 | 8 | 8 | 9 | 9 |

Because CH values are influenced more strongly by treatments in restricted habitats, and given that alternatives B and C have the same treatments in restricted “other” habitat, they accomplish similar results based on the above forest structure metrics.

#### MSO Prey Habitat

The FWS determined that snags greater than 12 inches d.b.h. are part of the primary constituent elements for CH (USDI 2004). Therefore, results for snags greater than 12 inches d.b.h. are displayed. However, larger snags get more use by wildlife in general and because the forest plans identified snags greater than 18 inches as important, they are displayed too. The total for snags between 12 and 18 inches d.b.h. and those greater than 18 inches d.b.h. are additive and equal the total for snags greater than 12 inches d.b.h. Snags would consistently remain above the no action levels (Table 145). 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. Decreases typically average 1/10 of a log per acre. A similar pattern occurs with CWD, 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 CWD 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 BA in PACs, threshold, and target habitats. Changes at the sub-unit level are presented in appendix 14.

**Table 145. Modeled changes in prey habitat attributes in CHUs under Alternative C**

| Critical Habitat Unit | Existing Condition 2010 | Alternative A 2020 | Alternative C 2020 | Alternative C 2050 | Alternative A 2050 |
|---|---|---|---|---|---|
| **UGM-11** | | | | | |
| Acres | 48,677 | | | | |
| Snags >12" d.b.h. | 3.0 | 3.8 | 4.8 | 4.9 | 7.0 |
| Snags 12" – 17.9" d.b.h. | 2.5 | 3.2 | 4.1 | 3.6 | 5.6 |
| Snags ≥18" d.b.h. | 0.5 | 0.6 | 0.7 | 1.3 | 1.4 |
| CWD >3" (tons per acre) | 5.1 | 6.6 | 3.2 | 6.9 | 10.8 |
| Logs per Acre | 1.9 | 2.8 | 2.3 | 5.5 | 6.1 |
| Understory Index | 35 | 30 | 59 | 36 | 21 |
| **UGM-12** | | | | | |
| Acres | 1,150 | | | | |
| Snags >12" d.b.h. | 1.7 | 2.2 | 3.3 | 2.6 | 4.6 |
| Snags 12" – 17.9" d.b.h. | 1.2 | 1.7 | 2.5 | 1.6 | 3.6 |
| Snags ≥18" d.b.h. | 0.5 | 0.5 | 0.8 | 0.9 | 1.0 |
| CWD >3" (tons per acre) | 4.2 | 5.1 | 2.8 | 5.3 | 8.0 |
| Logs per Acre | 1.6 | 2.1 | 2.0 | 4.1 | 4.0 |
| Understory Index | 182 | 160 | 319 | 210 | 123 |
| **UGM-13** | | | | | |
| Acres | 37,609 | | | | |
| Snags >12" d.b.h. | 2.5 | 3.3 | 4.9 | 3.1 | 6.0 |
| Snags 12" – 17.9" d.b.h. | 2.0 | 2.7 | 4.0 | 2.0 | 4.6 |
| Snags ≥18" d.b.h. | 0.5 | 0.6 | 1.0 | 1.1 | 1.4 |
| CWD >3" (tons per acre) | 4.1 | 5.5 | 3.3 | 6.5 | 9.3 |
| Logs per Acre | 1.8 | 2.5 | 2.4 | 5.3 | 5.3 |
| Understory Index | 52 | 44 | 110 | 63 | 30 |
| **UGM-14** | | | | | |
| Acres | 908 | | | | |
| Snags >12" d.b.h. | 3.2 | 3.8 | 5.1 | 6.7 | 7.3 |
| Snags 12" – 17.9" d.b.h. | 2.6 | 3.2 | 4.5 | 5.0 | 5.6 |
| Snags ≥18" d.b.h. | 0.5 | 0.6 | 0.6 | 1.7 | 1.7 |
| CWD >3" (tons per acre) | 5.5 | 6.9 | 2.8 | 7.4 | 11.0 |
| Logs per Acre | 3.2 | 4.1 | 2.6 | 6.9 | 8.0 |
| Understory Index | 42 | 35 | 44 | 27 | 23 |

| Critical Habitat Unit | Existing Condition 2010 | Alternative A 2020 | Alternative C 2020 | Alternative C 2050 | Alternative A 2050 |
|---|---|---|---|---|---|
| **UGM-15** | | | | | |
| Acres | 570 | | | | |
| Snags >12" d.b.h. | 2.4 | 3.0 | 4.3 | 5.2 | 5.6 |
| Snags 12" – 17.9" d.b.h. | 2.0 | 2.5 | 3.8 | 3.9 | 4.2 |
| Snags ≥18" d.b.h. | 0.4 | 0.4 | 0.5 | 1.3 | 1.3 |
| CWD >3" (tons per acre) | 5.6 | 6.4 | 2.5 | 5.8 | 9.1 |
| Logs per Acre | 1.3 | 1.9 | 1.2 | 4.3 | 4.6 |
| Understory Index | 95 | 80 | 87 | 58 | 53 |

## Alternative D

### Forest Structure and Density

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 (Table 146). 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 MSO 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 MSO habitat. Changes at the sub-unit level are presented in appendix 14.

**Table 146. Modeled changes in forest structure attributes in CHUs under Alternative D**

| Forest Attributes | Existing Conditions 2010 | Alternative A 2020 | Alternative D 2020 | Alternative D 2050 | Alternative A 2050 |
|---|---|---|---|---|---|
| **UGM-11** | | | | | |
| Acres | 48,677 | | | | |
| % of SDI 12-18” d.b.h. | 31 | 31 | 29 | 25 | 29 |
| % of SDI 18-24” d.b.h. | 13 | 15 | 18 | 22 | 22 |
| % of SDI >24” d.b.h. | 7 | 8 | 10 | 13 | 10 |
| % of Max SDI | 75 | 77 | 63 | 70 | 80 |
| TPA >18" | 13 | 16 | 16 | 24 | 26 |
| Ponderosa Pine BA | 117 | 123 | 96 | 108 | 130 |
| Gambel Oak BA | 23 | 24 | 24 | 30 | 29 |
| All BA | 150 | 159 | 132 | 158 | 178 |
| % Oak BA | 15 | 15 | 18 | 20 | 16 |
| **UGM-12** | | | | | |
| Acres | 1,150 | | | | |
| % of SDI 12-18” d.b.h. | 24 | 25 | 20 | 19 | 25 |
| % of SDI 18-24” d.b.h. | 13 | 14 | 17 | 16 | 17 |
| % of SDI >24” d.b.h. | 12 | 13 | 17 | 19 | 15 |
| % of Max SDI | 63 | 66 | 47 | 58 | 70 |
| TPA >18" | 12 | 14 | 13 | 17 | 20 |

| Forest Attributes | Existing Conditions 2010 | Alternative A 2020 | Alternative D 2020 | Alternative D 2050 | Alternative A 2050 |
|---|---|---|---|---|---|
| Ponderosa Pine BA | 101 | 107 | 69 | 84 | 118 |
| Gambel Oak BA | 19 | 21 | 20 | 29 | 28 |
| All BA | 126 | 136 | 96 | 128 | 159 |
| % Oak BA | 14 | 15 | 20 | 22 | 17 |
| **UGM-13** | | | | | |
| Acres | 37,609 | | | | |
| % of SDI 12-18” d.b.h. | 29 | 30 | 24 | 20 | 26 |
| % of SDI 18-24” d.b.h. | 14 | 16 | 19 | 20 | 21 |
| % of SDI >24” d.b.h. | 7 | 7 | 10 | 14 | 10 |
| % of Max SDI | 72 | 75 | 55 | 65 | 78 |
| TPA >18" | 13 | 16 | 14 | 20 | 25 |
| Ponderosa Pine BA | 100 | 106 | 68 | 82 | 114 |
| Gambel Oak BA | 31 | 33 | 29 | 39 | 39 |
| All BA | 141 | 151 | 109 | 142 | 173 |
| % Oak BA | 21 | 21 | 27 | 28 | 22 |
| **UGM-14** | | | | | |
| Acres | 908 | | | | |
| % of SDI 12-18” d.b.h. | 34 | 34 | 33 | 27 | 28 |
| % of SDI 18-24” d.b.h. | 14 | 16 | 16 | 23 | 23 |
| % of SDI >24” d.b.h. | 7 | 8 | 8 | 13 | 12 |
| % of Max SDI | 64 | 67 | 65 | 70 | 71 |
| TPA >18" | 13 | 16 | 16 | 27 | 27 |
| Ponderosa Pine BA | 97 | 102 | 99 | 105 | 108 |
| Gambel Oak BA | 14 | 16 | 15 | 21 | 21 |
| All BA | 132 | 143 | 139 | 162 | 165 |
| % Oak BA | 10 | 11 | 11 | 13 | 13 |
| **UGM-15** | | | | | |
| Acres | 570 | | | | |
| % of SDI 12-18” d.b.h. | 33 | 35 | 35 | 38 | 38 |
| % of SDI 18-24” d.b.h. | 10 | 14 | 14 | 24 | 24 |
| % of SDI >24” d.b.h. | 5 | 5 | 5 | 8 | 8 |
| % of Max SDI | 47 | 50 | 50 | 55 | 55 |
| TPA >18" | 9 | 11 | 11 | 20 | 20 |
| Ponderosa Pine BA | 77 | 84 | 83 | 95 | 96 |
| Gambel Oak BA | 11 | 12 | 12 | 15 | 15 |
| All BA | 98 | 107 | 106 | 128 | 129 |
| % Oak BA | 8 | 8 | 8 | 9 | 9 |

#### MSO Prey Habitat

The FWS determined that snags greater than 12 inches d.b.h. are part of the primary constituent elements for CH (USDI 2004). Therefore, results for snags greater than 12 inches d.b.h. are displayed. However, larger snags get more use by wildlife in general and because the forest plans identified snags greater than 18 inches as important, they are displayed too. The total for snags between 12 and 18 inches d.b.h. and those greater than 18 inches d.b.h. are additive and equal the total for snags greater than 12 inches d.b.h. Snags would decrease or remain stable, depending on the CHU. Snags would consistently remain above the no action levels (Table 147). Logs and CWD would consistently increase after treatment, likely due to the limited use of prescribed fire. A similar pattern occurs with CWD, although immediately 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 CHU. 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.

**Table 147. Modeled changes in prey habitat attributes in CHUs under Alternative D**

| Forest Attributes | Existing Conditions 2010 | Alternative A 2020 | Alternative D 2020 | Alternative D 2050 | Alternative A 2050 |
|---|---|---|---|---|---|
| **UGM-11** | | | | | |
| Acres | 48,677 | | | | |
| Snags >12" | 3.0 | 3.8 | 3.3 | 5.4 | 7.0 |
| Snags >12" and <18" | 2.5 | 3.2 | 2.7 | 4.1 | 5.6 |
| Snags >18" | 0.5 | 0.6 | 0.6 | 1.3 | 1.4 |
| CWD >3" | 5.1 | 6.6 | 7.3 | 10.2 | 10.8 |
| Logs | 1.9 | 2.8 | 3.4 | 6.0 | 6.1 |
| Understory Index | 35 | 30 | 49 | 30 | 21 |
| **UGM-12** | | | | | |
| Acres | 1,150 | | | | |
| Snags >12" | 1.7 | 2.2 | 1.7 | 2.9 | 4.6 |
| Snags >12" and <18" | 1.2 | 1.7 | 1.2 | 2.0 | 3.6 |
| Snags >18" | 0.5 | 0.5 | 0.5 | 0.9 | 1.0 |
| CWD >3" | 4.2 | 5.1 | 6.1 | 7.6 | 8.0 |
| Logs | 1.6 | 2.1 | 2.9 | 4.3 | 4.0 |
| Understory Index | 182 | 160 | 269 | 175 | 123 |
| **UGM-13** | | | | | |
| Acres | 37,609 | | | | |
| Snags >12" | 2.5 | 3.3 | 2.9 | 3.5 | 6.0 |
| Snags >12" and <18" | 2.0 | 2.7 | 2.3 | 2.4 | 4.6 |
| Snags >18" | 0.5 | 0.6 | 0.6 | 1.1 | 1.4 |
| CWD >3" | 4.1 | 5.5 | 6.4 | 8.5 | 9.3 |
| Logs | 1.8 | 2.5 | 3.5 | 5.5 | 5.3 |
| Understory Index | 52 | 44 | 91 | 52 | 30 |
| **UGM-14** | | | | | |
| Acres | 908 | | | | |
| Snags >12" | 3.2 | 3.8 | 3.8 | 7.1 | 7.3 |
| Snags >12" and <18" | 2.6 | 3.2 | 3.2 | 5.4 | 5.6 |
| Snags >18" | 0.5 | 0.6 | 0.6 | 1.7 | 1.7 |

| Forest Attributes | Existing Conditions 2010 | Alternative A 2020 | Alternative D 2020 | Alternative D 2050 | Alternative A 2050 |
|---|---|---|---|---|---|
| CWD >3" | 5.5 | 6.9 | 7.0 | 10.9 | 11.0 |
| Logs | 3.2 | 4.1 | 4.2 | 8.0 | 8.0 |
| Understory Index | 42 | 35 | 39 | 25 | 23 |
| **UGM-15** | | | | | |
| Acres | 570 | | | | |
| Snags >12" | 2.4 | 3.0 | 3.3 | 5.5 | 5.6 |
| Snags >12" and <18" | 2.0 | 2.5 | 2.8 | 4.2 | 4.2 |
| Snags >18" | 0.4 | 0.4 | 0.5 | 1.3 | 1.3 |
| CWD >3" | 5.6 | 6.4 | 6.3 | 9.1 | 9.1 |
| Logs | 1.3 | 1.9 | 1.9 | 4.7 | 4.6 |
| Understory Index | 95 | 80 | 82 | 55 | 53 |

## Alternative E

### Forest Structure and Density

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 (Table 148). 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 CH results. Changes at the sub-unit level are presented in appendix 14.

**Table 148. Modeled changes in forest structure attributes in CHUs under Alternative E**

| Forest Attributes | Existing Conditions (Year 2010) | Alternative A 2020 | Alternative E 2020 | Alternative E 2050 | Alternative A 2050 |
|---|---|---|---|---|---|
| **UGM-11** | | | | | |
| Acres | 48,677 | | | | |
| % of SDI 12-18" d.b.h. | 31 | 31 | 30 | 26 | 29 |
| % of SDI 18-24" d.b.h. | 13 | 15 | 18 | 22 | 22 |
| % of SDI >24" d.b.h. | 7 | 8 | 10 | 14 | 10 |
| % of Max SDI | 75 | 77 | 60 | 67 | 80 |
| TPA >18" | 13 | 16 | 15 | 24 | 26 |
| Ponderosa Pine BA | 117 | 123 | 94 | 106 | 130 |
| Gambel Oak BA | 23 | 24 | 22 | 28 | 29 |
| All BA | 150 | 159 | 127 | 153 | 178 |
| % Oak BA | 15 | 15 | 18 | 19 | 16 |
| **UGM-12** | | | | | |
| Acres | 1,150 | | | | |
| % of SDI 12-18" d.b.h. | 24 | 25 | 21 | 20 | 25 |
| % of SDI 18-24" d.b.h. | 13 | 14 | 18 | 18 | 17 |
| % of SDI >24" d.b.h. | 12 | 13 | 19 | 22 | 15 |
| % of Max SDI | 63 | 66 | 41 | 50 | 70 |

| Forest Attributes | Existing Conditions (Year 2010) | Alternative A 2020 | Alternative E 2020 | Alternative E 2050 | Alternative A 2050 |
|---|---|---|---|---|---|
| TPA >18" | 12 | 14 | 12 | 17 | 20 |
| Ponderosa Pine BA | 101 | 107 | 63 | 79 | 118 |
| Gambel Oak BA | 19 | 21 | 17 | 24 | 28 |
| All BA | 126 | 136 | 87 | 115 | 159 |
| % Oak BA | 14 | 15 | 19 | 21 | 17 |
| **UGM-13** | | | | | |
| Acres | 37,609 | | | | |
| % of SDI 12-18” d.b.h. | 29 | 30 | 26 | 21 | 26 |
| % of SDI 18-24” d.b.h. | 14 | 16 | 21 | 21 | 21 |
| % of SDI >24” d.b.h. | 7 | 7 | 11 | 16 | 10 |
| % of Max SDI | 72 | 75 | 48 | 59 | 78 |
| TPA >18" | 13 | 16 | 14 | 20 | 25 |
| Ponderosa Pine BA | 100 | 106 | 65 | 80 | 114 |
| Gambel Oak BA | 31 | 33 | 25 | 34 | 39 |
| All BA | 141 | 151 | 101 | 132 | 173 |
| % Oak BA | 21 | 21 | 25 | 26 | 22 |
| **UGM-14** | | | | | |
| Acres | 908 | | | | |
| % of SDI 12-18” d.b.h. | 34 | 34 | 34 | 27 | 28 |
| % of SDI 18-24” d.b.h. | 14 | 16 | 17 | 24 | 23 |
| % of SDI >24” d.b.h. | 7 | 8 | 8 | 13 | 12 |
| % of Max SDI | 64 | 67 | 62 | 69 | 71 |
| TPA >18" | 13 | 16 | 16 | 27 | 27 |
| Ponderosa Pine BA | 97 | 102 | 94 | 101 | 108 |
| Gambel Oak BA | 14 | 16 | 15 | 21 | 21 |
| All BA | 132 | 143 | 134 | 159 | 165 |
| % Oak BA | 10 | 11 | 12 | 13 | 13 |
| **UGM-15** | | | | | |
| Acres | 570 | | | | |
| % of SDI 12-18” d.b.h. | 33 | 35 | 35 | 38 | 38 |
| % of SDI 18-24” d.b.h. | 10 | 14 | 15 | 25 | 24 |
| % of SDI >24” d.b.h. | 5 | 5 | 5 | 8 | 8 |
| % of Max SDI | 47 | 50 | 48 | 54 | 55 |
| TPA >18" | 9 | 11 | 11 | 20 | 20 |
| Ponderosa Pine BA | 77 | 84 | 80 | 93 | 96 |
| Gambel Oak BA | 11 | 12 | 12 | 15 | 15 |
| All BA | 98 | 107 | 104 | 125 | 129 |
| % Oak BA | 8 | 8 | 8 | 9 | 9 |

#### MSO Prey Habitat

The FWS determined that snags greater than 12 inches d.b.h. are part of the primary constituent elements for CH (USDI 2004). Therefore, results for snags greater than 12 inches d.b.h. are displayed. However, larger snags get more use by wildlife in general and because the forest plans identified snags greater than 18 inches as important, they are displayed too. The total for snags between 12 and 18 inches d.b.h. and those greater than 18 inches d.b.h. are additive and equal the total for snags greater than 12 inches d.b.h. Snags would consistently remain above the no action levels (Table 149). 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. Decreases typically average 1/10 of a log per acre. A similar pattern occurs with CWD, 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 CWD 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 CHUs with larger increases (i.e., CHUs 11-13) account for the most acres.

**Table 149. Modeled changes in prey habitat attributes in CHUs under Alternative E**

| Forest Attributes | Existing Conditions (Year 2010) | Alternative A 2020 | Alternative E 2020 | Alternative E 2050 | Alternative A 2050 |
|---|---|---|---|---|---|
| **UGM-11** | | | | | |
| Acres | 48,677 | | | | |
| Snags >12" | 3.0 | 3.8 | 4.6 | 5.3 | 7.0 |
| Snags >12" and <18" | 2.5 | 3.2 | 3.9 | 4.0 | 5.6 |
| Snags >18" | 0.5 | 0.6 | 0.7 | 1.3 | 1.4 |
| CWD >3" | 5.1 | 6.6 | 4.2 | 7.9 | 10.8 |
| Logs | 1.9 | 2.8 | 2.6 | 6.0 | 6.1 |
| Understory Index | 35 | 30 | 53 | 33 | 21 |
| **UGM-12** | | | | | |
| Acres | 1,150 | | | | |
| Snags >12" | 1.7 | 2.2 | 3.4 | 2.7 | 4.6 |
| Snags >12" and <18" | 1.2 | 1.7 | 2.6 | 1.7 | 3.6 |
| Snags >18" | 0.5 | 0.5 | 0.8 | 1.0 | 1.0 |
| CWD >3" | 4.2 | 5.1 | 2.9 | 5.4 | 8.0 |
| Logs | 1.6 | 2.1 | 1.9 | 4.2 | 4.0 |
| Understory Index | 182 | 160 | 312 | 208 | 123 |
| **UGM-13** | | | | | |
| Acres | 37,609 | | | | |
| Snags >12" | 2.5 | 3.3 | 4.9 | 3.3 | 6.0 |
| Snags >12" and <18" | 2.0 | 2.7 | 4.0 | 2.1 | 4.6 |
| Snags >18" | 0.5 | 0.6 | 1.0 | 1.2 | 1.4 |
| CWD >3" | 4.1 | 5.5 | 3.4 | 6.7 | 9.3 |
| Logs | 1.8 | 2.5 | 2.4 | 5.4 | 5.3 |
| Understory Index | 52 | 44 | 107 | 62 | 30 |

| Forest Attributes | Existing Conditions (Year 2010) | Alternative A 2020 | Alternative E 2020 | Alternative E 2050 | Alternative A 2050 |
|---|---|---|---|---|---|
| **UGM-14** | | | | | |
| Acres | 908 | | | | |
| Snags >12" | 3.2 | 3.8 | 5.1 | 6.7 | 7.3 |
| Snags >12" and <18" | 2.6 | 3.2 | 4.5 | 5.0 | 5.6 |
| Snags >18" | 0.5 | 0.6 | 0.6 | 1.7 | 1.7 |
| CWD >3" | 5.5 | 6.9 | 2.8 | 7.4 | 11.0 |
| Logs | 3.2 | 4.1 | 2.6 | 6.9 | 8.0 |
| Understory Index | 42 | 35 | 44 | 27 | 23 |
| **UGM-15** | | | | | |
| Acres | 570 | | | | |
| Snags >12" | 2.4 | 3.0 | 3.9 | 5.4 | 5.6 |
| Snags >12" and <18" | 2.0 | 2.5 | 3.5 | 4.0 | 4.2 |
| Snags >18" | 0.4 | 0.4 | 0.5 | 1.3 | 1.3 |
| CWD >3" | 5.6 | 6.4 | 3.4 | 6.6 | 9.1 |
| Logs | 1.3 | 1.9 | 1.5 | 4.4 | 4.6 |
| Understory Index | 95 | 80 | 85 | 57 | 53 |

## Comparison of Alternatives in Critical Habitat

### *Forest Structure in Critical Habitat*

Alternative C would consistently result in more trees in the larger size-classes and lower total BA than the other alternatives (Table 150). 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 SDImax values. Alternative D would consistently result in the fewest trees in the larger size-classes and the highest BA. Alternative E would create a similar distribution in tree size-classes, but would result in total BA values higher than alternatives B or C. Values for Gambel oak BA 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. Large trees are an important component of MSO habitat and lowering total BA would improve forest resiliency MSO habitat.

**Table 150. Comparison of alternative results for forest structure among critical habitat units**

| Forest Attributes | Existing Conditions (Year 2010) | Alt A 2020 | Alt B 2020 | Alt C 2020 | Alt D 2020 | Alt E 2020 |
|---|---|---|---|---|---|---|
| **UGM-11** | | | | | | |
| Acres | 48,677 | | | | | |
| % of SDI 12-18” d.b.h. | 31 | 31 | 30 | 29 | 29 | 30 |
| % of SDI 18-24” d.b.h. | 13 | 15 | 19 | 19 | 18 | 18 |
| % of SDI >24” d.b.h. | 7 | 8 | 11 | 11 | 10 | 10 |
| % of Max SDI | 75 | 77 | 59 | 58 | 63 | 60 |
| TPA >18" | 13 | 16 | 15 | 15 | 16 | 15 |
| Ponderosa Pine BA | 117 | 123 | 91 | 89 | 96 | 94 |

| Forest Attributes | Existing Conditions (Year 2010) | Alt A 2020 | Alt B 2020 | Alt C 2020 | Alt D 2020 | Alt E 2020 |
|---|---|---|---|---|---|---|
| Gambel Oak BA | 23 | 24 | 22 | 22 | 24 | 22 |
| All BA | 150 | 159 | 125 | 122 | 132 | 127 |
| % Oak BA | 15 | 15 | 18 | 18 | 18 | 18 |
| **UGM-12** | | | | | | |
| Acres | 1,150 | | | | | |
| % of SDI 12-18” d.b.h. | 24 | 25 | 21 | 21 | 20 | 21 |
| % of SDI 18-24” d.b.h. | 13 | 14 | 18 | 19 | 17 | 18 |
| % of SDI >24” d.b.h. | 12 | 13 | 19 | 19 | 17 | 19 |
| % of Max SDI | 63 | 66 | 41 | 40 | 47 | 41 |
| TPA >18" | 12 | 14 | 12 | 12 | 13 | 12 |
| Ponderosa Pine BA | 101 | 107 | 63 | 61 | 69 | 63 |
| Gambel Oak BA | 19 | 21 | 17 | 17 | 20 | 17 |
| All BA | 126 | 136 | 87 | 85 | 96 | 87 |
| % Oak BA | 14 | 15 | 19 | 19 | 20 | 19 |
| **UGM-13** | | | | | | |
| Acres | 37,609 | | | | | |
| % of SDI 12-18” d.b.h. | 29 | 30 | 26 | 26 | 24 | 26 |
| % of SDI 18-24” d.b.h. | 14 | 16 | 21 | 21 | 19 | 21 |
| % of SDI >24” d.b.h. | 7 | 7 | 12 | 12 | 10 | 11 |
| % of Max SDI | 72 | 75 | 47 | 48 | 55 | 48 |
| TPA >18" | 13 | 16 | 13 | 13 | 14 | 14 |
| Ponderosa Pine BA | 100 | 106 | 63 | 64 | 68 | 65 |
| Gambel Oak BA | 31 | 33 | 24 | 25 | 29 | 25 |
| All BA | 141 | 151 | 98 | 99 | 109 | 101 |
| % Oak BA | 21 | 21 | 25 | 25 | 27 | 25 |
| **UGM-14** | | | | | | |
| Acres | 908 | | | | | |
| % of SDI 12-18” d.b.h. | 34 | 34 | 34 | 34 | 33 | 34 |
| % of SDI 18-24” d.b.h. | 14 | 16 | 17 | 17 | 16 | 17 |
| % of SDI >24” d.b.h. | 7 | 8 | 8 | 8 | 8 | 8 |
| % of Max SDI | 64 | 67 | 62 | 62 | 65 | 62 |
| TPA >18" | 13 | 16 | 16 | 16 | 16 | 16 |
| Ponderosa Pine BA | 97 | 102 | 94 | 94 | 99 | 94 |
| Gambel Oak BA | 14 | 16 | 15 | 15 | 15 | 15 |
| All BA | 132 | 143 | 134 | 134 | 139 | 134 |
| % Oak BA | 10 | 11 | 12 | 12 | 11 | 12 |
| **UGM-15** | | | | | | |
| Acres | 570 | | | | | |
| % of SDI 12-18” d.b.h. | 33 | 35 | 35 | 36 | 35 | 35 |
| % of SDI 18-24” d.b.h. | 10 | 14 | 15 | 15 | 14 | 15 |
| % of SDI >24” d.b.h. | 5 | 5 | 5 | 5 | 5 | 5 |

| Forest Attributes | Existing Conditions (Year 2010) | Alt A 2020 | Alt B 2020 | Alt C 2020 | Alt D 2020 | Alt E 2020 |
|---|---|---|---|---|---|---|
| % of Max SDI | 47 | 50 | 48 | 48 | 50 | 48 |
| TPA >18" | 9 | 11 | 11 | 11 | 11 | 11 |
| Ponderosa Pine BA | 77 | 84 | 80 | 79 | 83 | 80 |
| Gambel Oak BA | 11 | 12 | 12 | 12 | 12 | 12 |
| All BA | 98 | 107 | 104 | 102 | 106 | 104 |
| % Oak BA | 8 | 8 | 8 | 8 | 8 | 8 |

### *Prey Habitat in Critical Habitat*

Alternatives B, C, and E would produce similar results in terms of snags, although alternative C would create slightly more snags across all CHUs (Table 151). 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 CWD, 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 MSO prey habitat. Overall, alternative C would do most for prey species habitat.

**Table 151. Comparison of alternative results for prey habitat variables among critical habitat units**

| Forest Attributes | Existing Conditions Year 2010 | Alt A 2020 | Alt B 2020 | Alt C 2020 | Alt D 2020 | Alt E 2020 |
|---|---|---|---|---|---|---|
| **UGM-11** | | | | | | |
| Acres | 48,677 | | | | | |
| Snags >12" | 3.0 | 3.8 | 4.8 | 4.8 | 3.3 | 4.6 |
| Snags >12" and <18" | 2.5 | 3.2 | 4.1 | 4.1 | 2.7 | 3.9 |
| Snags <18" | 0.5 | 0.6 | 0.7 | 0.7 | 0.6 | 0.7 |
| CWD >3" | 5.1 | 6.6 | 3.6 | 3.2 | 7.3 | 4.2 |
| Logs | 1.9 | 2.8 | 2.3 | 2.3 | 3.4 | 2.6 |
| Understory | 35 | 30 | 56 | 59 | 49 | 53 |
| **UGM-12** | | | | | | |
| Acres | 1,150 | | | | | |
| Snags >12" | 1.7 | 2.2 | 3.4 | 3.3 | 1.7 | 3.4 |
| Snags >12" and <18" | 1.2 | 1.7 | 2.6 | 2.5 | 1.2 | 2.6 |
| Snags <18" | 0.5 | 0.5 | 0.8 | 0.8 | 0.5 | 0.8 |
| CWD >3" | 4.2 | 5.1 | 2.9 | 2.8 | 6.1 | 2.9 |
| Logs | 1.6 | 2.1 | 1.9 | 2.0 | 2.9 | 1.9 |
| Understory | 182 | 160 | 312 | 319 | 269 | 312 |
| **UGM-13** | | | | | | |
| Acres | 37,609 | | | | | |
| Snags >12" | 2.5 | 3.3 | 5.0 | 4.9 | 2.9 | 4.9 |
| Snags >12" and <18" | 2.0 | 2.7 | 4.0 | 4.0 | 2.3 | 4.0 |

| Forest Attributes | Existing Conditions Year 2010 | Alt A 2020 | Alt B 2020 | Alt C 2020 | Alt D 2020 | Alt E 2020 |
|---|---|---|---|---|---|---|
| Snags <18" | 0.5 | 0.6 | 1.0 | 1.0 | 0.6 | 1.0 |
| CWD >3" | 4.1 | 5.5 | 3.3 | 3.3 | 6.4 | 3.4 |
| Logs | 1.8 | 2.5 | 2.4 | 2.4 | 3.5 | 2.4 |
| Understory | 52 | 44 | 113 | 110 | 91 | 107 |
| **UGM-14** | | | | | | |
| Acres | 908 | | | | | |
| Snags >12" | 3.2 | 3.8 | 5.1 | 5.1 | 3.8 | 5.1 |
| Snags >12" and <18" | 2.6 | 3.2 | 4.5 | 4.5 | 3.2 | 4.5 |
| Snags <18" | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| CWD >3" | 5.5 | 6.9 | 2.8 | 2.8 | 7.0 | 2.8 |
| Logs | 3.2 | 4.1 | 2.6 | 2.6 | 4.2 | 2.6 |
| Understory | 42 | 35 | 44 | 44 | 39 | 44 |
| **UGM-15** | | | | | | |
| Acres | 570 | | | | | |
| Snags >12" | 2.4 | 3.0 | 3.9 | 4.3 | 3.3 | 3.9 |
| Snags >12" and <18" | 2.0 | 2.5 | 3.5 | 3.8 | 2.8 | 3.5 |
| Snags <18" | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 |
| CWD >3" | 5.6 | 6.4 | 3.4 | 2.5 | 6.3 | 3.4 |
| Logs | 1.3 | 1.9 | 1.5 | 1.2 | 1.9 | 1.5 |
| Understory | 95 | 80 | 85 | 87 | 82 | 85 |

## Cumulative Effects for MSO

Because of the size of the 4FRI analysis area and the large portion of the western UGM Recovery Unit that it occupies, the analysis area itself was considered adequate for assessing habitat effects to PACs. However, due to the potential for disturbance to owls, the cumulative effects boundary was extended ½ mile beyond the analysis area periphery to account for the spatial component of this analysis. Cumulative effects includes effects of alternative A. With this additional ½ mile buffer there are 110 PACs in the cumulative effects area (Table 152). The temporal component in this analysis was defined as 10 years for short-term effects and 30 years for long-term effects.

**Table 152. Mexican Spotted owl protected activity centers within and/or in close proximity to the 4FRI project and treatment area**

| PAC Location | Number of MSO PACs |
|---|---|
| Within the 4FRI Treatment Area[1] | 70 |
| Within the 4FRI Project Area Boundary[2] | 99 |
| Within ¼ mile of the Project Area Boundary | 112 |

1. The area of treatments proposed under the 4FRI; this is a subset of the total areas with the 4FRI boundary
2. Total area including all vegetation cover-types and all projects managed by the Forest Service within the 4FRI boundary

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, personal communications 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.

Current and foreseeable projects within the 4FRI boundary have or will thin a total of 39,111 acres of MSO habitat and use prescribed fire on 37, 585 acres. This is mostly (84 percent) due to work conducted in restricted habitat (Table 153). Most work done in MSO habitat involves mechanical thinning or prescribed fire. Thinning and burning in MSO 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, and limited acres of animal damage control, erosions control, and disease tree harvest (appendix 17). Effects to MSO habitat are broken down into two broad categories: Forest structure and prey habitat. The actions discussed in these sections were elements in the descriptions for those project listed in appendix 17.

### *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 towards 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 will 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. Both categories of treatments lead to increased understory development, lasting until overstory canopies again close. Thinning treatments with restoration objectives are similar to the goshawk habitat and MSO 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 has been used in compromises to meet social agendas and in fuels reduction projects. Pre-settlement and large post-settlement trees are retained, 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 TPA larger than 18 inches. However, in the short-term using diameter caps removes habitat diversity, simplifying habitat in areas where the forest and Recovery Plans promote complex habitat structure. This can negatively affect some wildlife species. Thinning from below removes a range of tree sizes that can eventually delay tree recruitment into larger d.b.h. size-classes. This can negatively affect future forest structure. The only way to avoid these issues is to retain trees below the diameter cap limit. However, this reduces or precludes other stand objectives such as increasing tree growth rates, developing larger trees sooner, and adding resiliency to the stand. This approach does not meet ecological objectives.

**Table 153. Cumulative acres of treatment in the 4FRI project area and a ½ mile beyond the project area**

| Cumulative Effects in the 4FRI Project Area | Thin ponderosa pine habitat | Rx burn ponderosa pine habitat | Thin mixed conifer habitat | Rx burn mixed conifer habitat | Thin MSO protected habitat | Rx Burn MSO protected habitat | Thin MSO Restricted habitat | Rx 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** | **Rx burn ponderosa pine habitat** | **Thin mixed conifer habitat** | **Rx burn mixed conifer habitat** | **Thin MSO protected habitat** | **Rx Burn MSO protected habitat** | **Thin MSO Restricted habitat** | **Rx 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** |

Thinning projects in MSO habitat typically followed Recovery Plan direction. This includes only removing trees 9 inches d.b.h. and smaller in protected habitat. Removing only small trees reduces ladder fuels, thereby decreasing the risk of surface fire becoming crown fire. While this aids in retaining forest structure over time, it did little to improve the quality of MSO habitat. These projects should result in post-treatment BA and canopy cover values meeting or moving towards Recovery Plan direction.

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 towards desired stand structure conditions in restricted habitat by maintaining dense groups of trees and providing forage habitat.

Snags would be decreased in mechanical treatments due to operations and human health and safety concerns, but snags are also created from mechanical damage and fire. The cumulative effect to snags is difficult to summarize because of the lack of detail on snag structure, i.e., in addition to overall numbers, snag diameter, height, age, presence of bark, and spatial distribution all affect use by wildlife.

Removing conifer competition to release Gambel oak would contribute to maintaining and improving oak growth and vigor, directly improving MSO habitat.

Wildfires from 2001 to 2010 have burned on approximately 108,160 acres of the project area. Of these acres, 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) 30 percent mixed severity, and 50 percent low severity (silviculture report). There is wide variability among these percentages from fire to fire. 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 (potential nest and roost structure for MSO and mast for 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. This would reduce surface fuels and cause tree mortality. Seedlings, saplings, and susceptible pre-settlement trees would all be affected. Loss of seedlings and saplings benefits wildlife habitat in some areas (e.g., reducing meadow encroachment) and can limit development of wildlife habitat in other areas (forest areas lacking deficit in this cohort for future forest development). Ignition techniques and design features should limit mortality in the larger size-classes, but this size/age class is already deficit on the landscape. Individual projects would typically assess and account for these needs. In the short-term, CWD, logs, and snags would 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. Created openings in canopies tend to be a relatively short-term event as increased growth rates in residual trees reestablishes continuous canopy cover. This allows for a short-term increase in understory production, improving prey food and cover. However, thinning might not provide for long-term understory benefits unless interspace or openings are created rather than merely opening the canopy. 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.

Broadcast burning would decrease tree seedlings and saplings, reduce surface fuels, and increase understory production. 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 MSO (overstory) and their prey (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 towards 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 20). 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. About 80 percent of the total project is grazed and that includes most MSO habitat. Plant species composition and diversity is expected to be maintained in the long-term by ongoing and future grazing. Small mammal populations in pastures with early summer grazing are likely negatively affected by 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 less pressure (steeper slopes). Allotments are managed to provide 60 percent or more of the understory biomass for wildlife. However, some areas such as near water sources, meadows, areas where stock congregate, etc., commonly have more grazing pressure. Overall, forest plan guidance directs the range program to maintain adequate understory conditions.

Other projects have restored habitat heterogeneity, directly improving prey habitats. These include:

- **Grasslands** – Historic grasslands and savannas and forest openings were restored by removing ponderosa pine tree canopy shading out understory herbaceous vegetation. Thinning treatments with a restoration objective also restored historic forest openings.
- **Oak** – Removing conifer competition with mid and understory oak as part of the thinning contributed to maintaining and improving oak growth and vigor. Mixed and high severity wildfire killed large oaks that were replaced by oak sprouts thereby changing oak from old to young structure.
- **Aspen** – Aspen restoration treatments were very similar to the aspen treatments proposed under this EIS and have resulted in aspen regeneration and age class diversity.

- **Pine Sage** – Some of the fuels reduction thinning within pine sage on the Tusayan district removed overtopping young pines and improved conditions for understory sage. Some projects also targeted sage, reducing the overall cover of this important species in shrubland habitats.

### *Reasonably Foreseeable Actions*

Appendix 17 lists known future projects expected to overlap protected and restricted habitat. Some projects may have negative impacts to MSOs and their habitat (powerline ROW maintenance, Bill Williams Mountain Restoration Project, Flagstaff Watershed Protection Project, reopening rock pits). 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 impacts to MSO habitat. Most projects include habitat restoration objectives in MSO habitat (e.g., Turkey/Barney, Upper Beaver Creek, Aspen Restoration). The Elk Park project will cut trees across 390 acres in the Clark PAC. The project has a restoration design and will only cut ponderosa pine trees. This project is designed to decrease risk of high-severity fire and improve MSO habitat. Substantial long-term improvements to restricted habitat are expected in both forest structure and prey habitat in over 20,000 acres from the projects intended to improve forest health, resiliency, and create tree groups and canopy gaps within the MSO Recovery Plan guidelines (e.g., Elk Park, Marshall, McCracken, Turkey/Barney). Project activities would typically include elements of the following actions:

- Slash treatments associated with the above thinning consists of prescribed burning. In addition, there are also burn-only treatments within the ponderosa pine habitat. Many past projects have maintenance burns occurring on five to 20-year cycles and hence qualify as past and ongoing projects. There are an estimated 104,750 acres of burning in the treatment area.
- Both forests are actively trying to restore aspen stands. The majority of the aspen on the Coconino NF is variable sized stands within wilderness areas. Aspen on the south zone of the Kaibab NF usually occurs in small patches scattered within the ponderosa pine forest. Aspen restoration is planned for high priority areas outside of wilderness. Cumulatively, restoration of these areas across both forests will treat stands that are at high risk of dying in the near future. There is a total of 5,130 acres of aspen treatments planned within the project area.
- 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.
- The Kaibab NF will allow for large game retrieval during hunting season in all GMUs while the Coconino will allow for elk-only retrieval in all GMU except 5a and 5b (the Mogollon Rim District). The Coconino NF will allow people to park up to 300-feet away in designated corridors along roads for campers. Outside these designated areas campers can park up to 30-

feet away from roads. The Kaibab will allow parking up to 30 feet away from all open roads and does not have designated areas for parking further in from roads.

- Both forests have on-going maintenance of right of ways (ROW) for power, gas, and oil lines and associated infrastructure. This involves thinning and burning within the ROWs to keep the area clear of trees and shrubs. ROW maintenance prevents forest development, retaining early seral habitat in linear swaths across the landscape. ROWs include 32,344 acres with the majority of the area on the Coconino NF. Currently there are 500 acres proposed for ROW 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. 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 is no additional affects beyond existing conditions.
- There is 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.

#### *Summary of Cumulative Effects*

Overall, there are about 194,800 acres of MSO habitat within the 4FRI project boundary. Six CHUs 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.

Past, current, and reasonably foreseeable projects have or will treat about 76,700 acres (39 percent) of MSO habitat, including 12,000 acres of protected and 66,700 acres of restricted habitat. About 39,100 acres of MSO habitat has or is proposed for thinning and about 37,600 acres has or is proposed for prescribed fire. Nearly all of the treatments were designed to improve MSO habitat or were mitigated to minimize negative effects to the owls and their habitat. About 119,000 acres of MSO habitat are or have been proposed for treatment within the 1/5 buffer of the entire 4FRI project area.

### Cumulative Effects Alternative A

Alternative A would not contribute to the improvement of either forest structure or prey habitat within MSO habitat. The contributions of past, ongoing, and reasonably foreseeable actions would affect habitat for MSO and their prey, but no cumulative effect would result from 4FRI (i.e., no change would occur either spatially and temporally to alter these effects of other actions on the landscape).

Maintaining existing conditions would extend the current deficit of trees greater than 24 inches d.b.h. Current levels of TPA 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 towards 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 and roosting habitat even in locations where individual trees might benefit and eventually grow into larger size-classes.

Pine-oak habitat would remain outside the historical range of variability in terms of tree densities and age-class distribution under alternative A. Loss of large diameter oak would continue, as would the suppression of young oak by competing pine trees. Total BA in oak may decline over time and would likely remain below desired conditions. 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 MSO nesting and roosting habitat.

The lack of road closures, with continued access to the existing roads footprint, would maintain the same threat to large snag persistence. Ecosystem function would continue to decline with continued tree encroachment into spring, channel, meadow, and aspen habitats.

The ability to retain sustainable and resilient ecosystems would be further compromised by vulnerability to high-severity fires. 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. By not treating outside MSO habitat, the risk of high-severity fire remains high from ignitions starting outside of pine-oak habitats as well as fire igniting within MSO habitat.

### Cumulative Effects for Alternatives B - E

Restoration treatments would contribute towards improving MSO forest health and vegetation diversity and composition under alternatives B-E. This would aid in sustaining old forest structure over time and moving forest structure towards desired conditions.

Cumulative effects were evaluated across the 4FRI analysis area plus a ½ mile buffer beyond the 4FRI boundary (Table 154). The cumulative effects area includes 110 PACs. Most of the projects identified as part of the cumulative effects analysis occur outside of MSO habitat. Cumulative effects would likely be minimal, but include disturbance related to implementation and operations and smoke drifting and settling away from ignition areas.

**Table 154. 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 (Rx) Fire | Total cumulative and proposed Mechanical Treatments | Total cumulative and proposed Rx Fire |
|---|---|---|---|---|
| Alternative A | 166,520 | 208,268 | 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 with treatments specifically occurring in MSO habitat include prescribed fire (68,097 acres) and mechanical thinning with prescribed fire (51,196 acres) in protected habitat and restricted habitat (Table 155). 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 MSO 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.

**Table 155. 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 |

| Activities | Protected | Restricted | Total Acres |
|---|---|---|---|
| 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** |

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 MSO 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 BA of pine would decrease in the short-term, but because the focus is on small trees, BA might not substantially change. Overall BA 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 BA in the short term. However, design features should ensure retention of large diameter oak and small oak commonly sprout vigorously after fire. The total BA of Gambel oak is not expected to change substantially in the long-term. Created canopy gaps should benefit MSO prey species and the reduction in small trees should open the space between ground level and canopy base height, improving MSO 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.

Changes are expected in MSO prey habitat. Decreases would occur in CWD, 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 CWD 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 CWD 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 MSO 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 MSO 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 MSO 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 MSO habitat, including PACs and restricted habitat, in the short- and long-term. However, the risk of high-severity fire eliminating MSO 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 MSO 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 MSOs 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 MSO 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 MSO population in the long-term. Overall, treatments in MSO habitat should move forest conditions towards desired conditions and decrease the risk of habitat loss to large-scale high severity fire.

## Narrow-headed Gartersnake

### Alternative A No Action

#### *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 gartersnakes 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. Thinning and burning are used to manage vegetation and uncharacteristic fuel loads. These projects typically follow forest plan guidance with habitat objectives designed to improve MSO or goshawk habitat and include soil and riparian protection BMPs. None of these projects would be in or adjacent to narrow-headed gartersnake habitat, i.e., along or in the West Fork and mainstem of Oak Creek. See cumulative the effects discussion below for more details. 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 gartersnake 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).

#### *Determination of Effect*

Alternative A may impact narrow-headed gartersnake, but considering direct and indirect effects, BMPs, and cumulative effects, alternative A **may affect but is not likely to adversely affect** the species, nor is it likely to adversely affect the snake’s habitat.

### Alternative B Proposed Action

#### *Direct, Indirect, and Cumulative Effects*

Under alternative B, project activities would have no direct effect to narrow-headed gartersnake or its proposed critical habitat (USDA 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 28). No narrow-headed gartersnakes 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 so no direct effects would occur to the species or its habitat. Thinning and burning may affect narrow-headed gartersnakes and their habitat in the short-term because of increased sedimentation resulting from vegetation removal. These effects would be mitigated through BMPs that provide filter strips and maintain course woody debris (see BMP numbers 7, 8, 32 and 33).

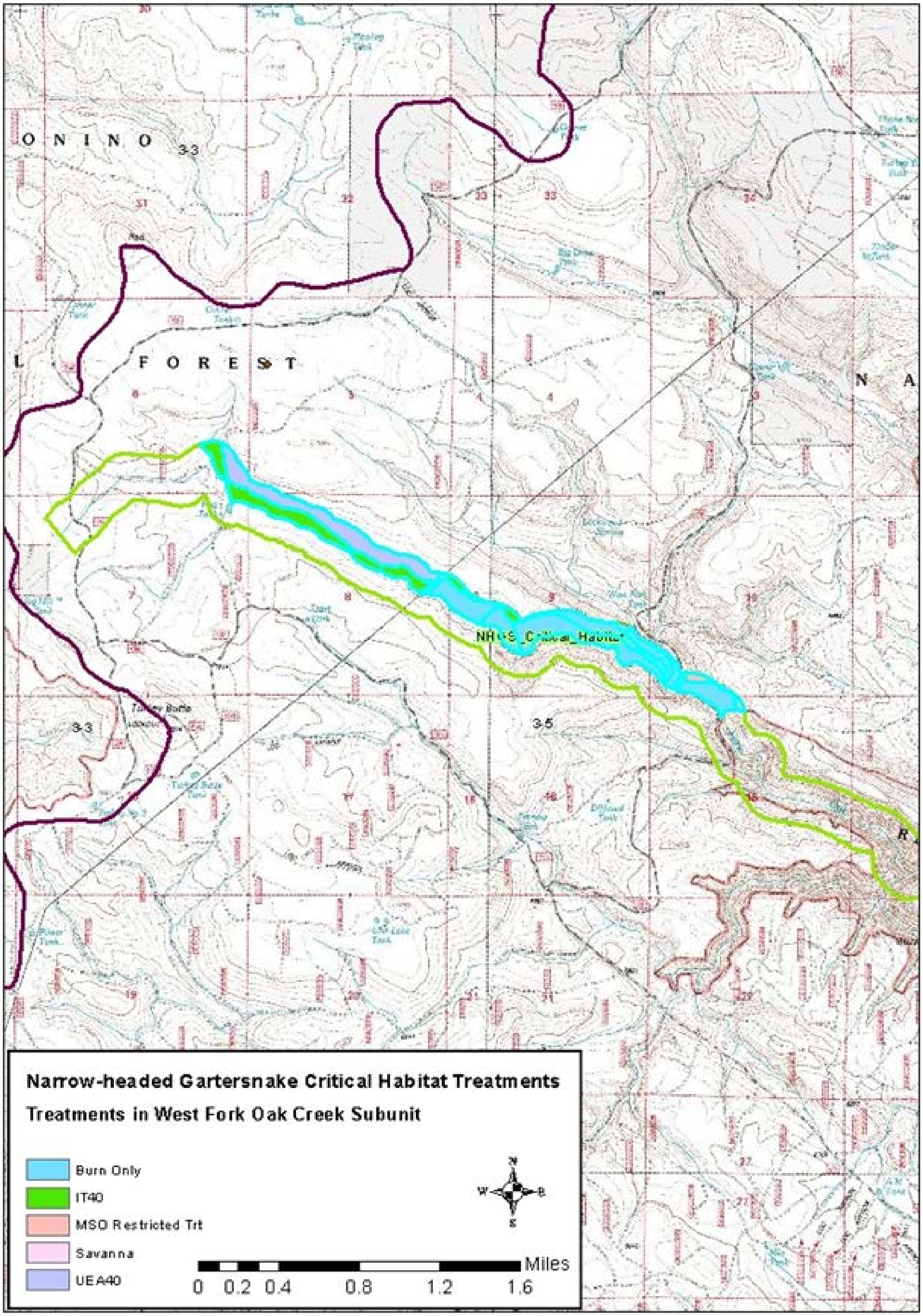


**Figure 28. Narrow-headed gartersnake treatments in proposed critical habitat for Alternatives B, C, and D**

Decreases in water quality can result in potential negative effects to macroinvertebrate and native fish populations. It is unlikely that alternative B 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 gartersnake prey habitat (Fisheries and 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 gartersnakes. Conversely, moving the forested uplands towards 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 Sterling Canyon streamcourse in alternative B to reduce the risk of sediment and ash flow into Upper Oak Creek.

Spring restoration under alternative B 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 gartersnake.

Narrow-headed gartersnake 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.

#### *Determination of Effect*

Alternative B may impact narrow-headed gartersnake, but considering direct and indirect effects, BMPs, and cumulative effects, alternative B **may affect but is not likely to adversely affect** the species, nor is it likely to adversely affect the snake’s habitat.

### Alternative C

#### *Direct, Indirect, and Cumulative Effects*

The effects for alternative C are the same as Alternative B.

#### *Determination of Effect*

Alternative C may impact narrow-headed gartersnake, but considering direct and indirect effects, BMPs, and cumulative effects, alternative C **may affect but is not likely to adversely affect** the species, nor is it likely to adversely affect the snake’s habitat.

### Alternative D

#### *Direct, Indirect, and Cumulative Effects*

The effects for alternative D are the same as those for alternatives B and C.

#### *Determination of Effect*

Alternative D may impact narrow-headed gartersnake, but considering direct and indirect effects, BMPs, and cumulative effects, alternative D **may affect but is not likely to adversely affect** the species, nor is it likely to adversely affect the snake’s habitat.

## Alternative E

### Direct, Indirect, and Cumulative Effects

The effects for alternative E would be reduced compared to alternatives B and C. Without a forest plan amendment no savanna treatments would occur.

### Determination of Effect

Alternative E may impact narrow-headed gartersnake, but considering direct and indirect effects, BMPs, and cumulative effects, alternative E **may affect but is not likely to adversely affect** the species, nor is it likely to adversely affect the snake's habitat.

## Cumulative Effects

Narrow-headed gartersnakes only occur in subunit 3-5 in the 4FRI landscape. Vegetation treatments would occur above the Mogollon Rim and narrow-headed gartersnake habitat is in the drainage bottoms below the Rim. Therefore, the cumulative effects area analyzed for narrow-headed gartersnakes is subunit 3-5 and cumulative effects includes effects of alternative A. No directs would result from 4FRI treatments; the following analysis addresses indirect effects.

The baseline includes effects from the Slide fire which now contributes to cumulative effects in the West Fork and Oak Creek mainstem watershed. There are 1,771 acres of proposed critical habitat for the narrow-headed gartersnake within the Slide Fire perimeter (USDI 2013a). Based on post-fire analyses (USDI BAER report 2014), nearly 850 acres of proposed critical habitat (48 percent) lie within moderate to high soil burn severities (Table 156).

**Table 156. Slide Fire soil burn severity in narrow-headed gartersnake proposed critical habitat**

| Proposed critical habitat units in the Verde River Sub-basin | Acres Unburned | Acres Low Soil Burn Severity | Acres Moderate Soil Burn Severity | Acres High Soil Burn Severity | Total Acres |
|---|---|---|---|---|---|
| Oak Creek | 13 | 66 | 71.3 | 71.1 | 221.3 |
| West Fork Oak Creek | 208.9 | 634.9 | 558 | 147.9 | 1,549.6 |
| Grand Total | 221.8 | 700.9 | 629.3 | 219.0 | 1,771 |

There are also 22.7 stream miles within the Slide fire perimeter, including about 6.6 miles along Oak Creek and 16.1 miles along the West Fork of Oak Creek. Flood waters could 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 storm events, making it difficult to predict effects to gartersnakes. Multiple precipitation events could occur in a day or in a week. Storms could be focused in the same or multiple drainages and each drainage could transport ash. Ash changes the pH and oxygen levels of water and can kill fish and macroinvertebrates which are the food base for gartersnakes. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, scouring drainages and modifying or removing riparian vegetation.

The BAER report (Runyon 2014) recommended and implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes less than 40 percent to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites with high potential for flooding or debris flow and which connect directly to perennial water. The goal of the mitigation is to reduce sedimentation into connected waters.

The 4FRI planners added the following protective measures:  No ground disturbing activities would occur for 5 years and then proposed treatments would be evaluated relative to soil and vegetation conditions; BMPs were developed to protect habitat within and downstream of the Slide fire area (see BMPs 41 and 42 in the Soils Specialist Report, additional detail in the Water Quality and Riparian Report, and appendix F of the EIS).

Past, current, and foreseeable actions were summarized for subunit 3-5 (Table 157 and Table 158). Note that 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. Most, if not all activities would follow forest plan direction for moving existing conditions towards either MSO or goshawk habitat. Treatments have and would continue to emphasize prescribed fire and mechanical thinning to current uncharacteristic forest structure towards presettlement conditions. Note that these are not mutually exclusive – many acres include both treatments. Both activities could potentially add sedimentation to gartersnake 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 gartersnake habitat.

**Table 157. Total acres of mechanical thinning and prescribed fire by alternative with past, current and future foreseeable projects in Restoration Units 3-5 (narrow-headed gartersnake habitat)**

| Project | Total mechanical treatment | Total Prescribed Fire | Total cumulative mechanical treatment | Total cumulative Prescribed Fire |
|---|---|---|---|---|
| Total Past, Current and Future Foreseeable Projects in restoration Unit 3-5 | 34,713 | 41,161 | | |
| Alternative B | 26,969 | 36,385 | 61,682 | 77,546 |
| Alternative C | 28,088 | 36,391 | 62,801 | 77,552 |
| Alternative D | 26,969 | 7,972 | 61,682 | 49,133 |
| Alternative E | 27,695 | 36,385 | 62,408 | 77,546 |

**Table 158. Summary of cumulative effects projects in the restoration unit 3-5 (narrow-headed gartersnake habitat)**

| Cumulative Effects Project Type | Thin Pipo LOPFA | Rx Burn Pipo LOPFA | Thin Mixed Conifer Protected MSO Habitat | Burn Mixed Conifer Protected MSO Habitat | MSO PAC Treat Thin | MSO PAC Burn | NOGO PFA/ Nest Treat-ments | Thin Mc MSO Restricted Habitat | Burn Mc MSO Restricted Habitat | Thin Pipo MSO Restricted Habitat | Burn Pipo MSO Habitat (Restricted) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| current | 4,653 | 9,558 | 0 | 0 | 71 | 71 | 228 | 0 | 0 | 4,637 | 4,637 |
| future foreseeable | 6,940 | 6,528 | 0 | 0 | 1,703 | 0 | 0 | 0 | 0 | 6,030 | 6,442 |
| past | 10,147 | 13,925 | 0 | 0 | 0 | 0 | 304 | 0 | 0 | 0 | 0 |
| **Grand Total** | **21,740** | **30,011** | **0** | **0** | **1,774** | **71** | **532** | **0** | **0** | **10,667** | **11,079** |
| **Cumulative Effects Project Type** | **Thin Grass-land** | **Rx Burn Grass-land** | **Thin Pinyon-Juniper** | **Rx Burn Pinyon-Juniper** | **Road Obliter-ation** | **Closed Road** | **Aspen Regener-ation** | **Reforesta-tion** | **Rock Pit Develop-ment** | **Water Develop-ment** | **Channel Restoration** |
| current | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| future foreseeable | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39 | 0 | 0 |
| past | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Grand Total** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **39** | **0** | **0** |

Under alternative A, the likelihood of sediment affect gartersnake 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 SDImax. 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 gartersnakes.

The action alternatives would move the landscape towards 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 gartersnake habitat. Cumulative effects would further reduce the risk of adverse indirect effects to gartersnakes.

## Narrow-Headed Gartersnake Proposed Critical Habitat

Primary constituent elements for proposed critical habitat are listed in the Federal Register (USDI 2013a) and addressed below as they relate to the proposed actions for implementing alternatives B - E: Effects of the Slide Fire on gartersnake habitat are described above.

### *Direct and Indirect Effects*

*1) Stream habitat, which includes:*

- a. *perennial or spatially intermittent streams with sand, cobble, and boulder substrate and low or moderate amounts of fine sediment and substrate embeddedness, and that possess appropriate amounts of pool, riffle, and run habitat to sustain native fish populations;*

  Prescribed fire treatments in subunits connected to the Oak Creek watershed or related 6th-code HUC watersheds upstream could potentially lead to short-term increases in sedimentation and/or ash flow into narrow-headed gartersnake critical habitat.

  The soils and water report (Steinke 2013) indicates that wildfire resulting in overstory removal could result in soil erosion in areas where slope exceeds 15 percent. Prescribed fire treatments under alternative B have a low short-term risk (1-2 years) of increasing sedimentation or ash flow. However, design features would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent and may not contribute to effects to gartersnake Critical Habitat. In addition, the Soils and Water Report (Steinke 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope. 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 this critical habitat unit.

  Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. Again, BMPs would be in place to mitigate these short-term risks in order 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.

  Finally, the proposed Coconino forest plan amendment would not have measurable effects on narrow-headed gartersnake proposed critical habitat, as discussed above.

b. *A natural, unregulated flow regime that allows for periodic flooding or if flows are modified or regulated, a low regime that allows for adequate river functions. Such as flows capable of processing sediment loads;*

The proposed action would not regulate or alter flow. The project would reduce the high risk of increased sedimentation and ash flows resulting from stand-replacing crown fires.

c. *Shoreline habitat with adequate organic and inorganic structural complexity (e.g. boulders, cobble bars, vegetation, and organic debris such as downed trees or logs, debris jams), with appropriate amounts of shrub and sapling-sized plants to allow for thermo regulation , gestation shelter, protection from predators, and foraging opportunities; and*

Subunit 3-5 of the project area borders the West Fork of Oak Creek. This portion of West Fork of Oak Creek is an ephemeral stream and rarely contains running water or pools. There are 111 acres proposed for thinning and burning and 118 acres for prescribed fire only in the western portion of this drainage which would directly modify vegetation. Resource protection measures would be put in place to minimize the potential for soil disturbance within the drainage reducing impacts to Critical Habitat (see BMP's numbers 7, 8, 32, and 33). 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.

d. *Aquatic habitat with no pollutants or, if pollutants are present as levels that do not affect survival of any age class of the narrow-headed gartersnake or the maintenance of prey populations.*

Minor, short-term changes (i.e., 1-2 years) in water quality are possible in water bodies close to or downstream from mechanical vegetation treatments, areas subjected to prescribed burning, areas of temporary road construction and decommissioning, and where stream channel restoration activities are conducted. However, 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).

Resource protection measures are put in place to minimize nonpoint source pollution as outlined in the intergovernmental agreement between the Arizona Department of Environmental Quality (ADEQ) and the Southwestern Region of the Forest Service (ADEQ 2008). Best Management Practices (BMPs) referenced within the mitigation text are BMP's outlined in the Region 3 USFS Soil and Conservation Handbook (R3) FSH 2509.22 and are listed above.

Dust abatement would have no effect on narrow-headed gartersnake critical habitat, as no dust abatement treatments are proposed near open water (Childs 2014).

*2) Adequate terrestrial space (600' lateral extent to either side of bankfull stage) adjacent to designated stream systems with sufficient structural characteristics to support life history functions such as gestation, immigration, emigration, and brumation.*

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. All three action alternatives propose prescribed burning in or near each canyon. BMPs, including a buffer strip of at least 70 feet (BMP number 8; Steinke 2013) along the Sterling Canyon streamcourse, would be used to mitigate the risk of sedimentation in these canyons.

*3) A prey base consisting of viable populations of native fish species or soft-rayed, nonnative fish species.*

The Fisheries Specialist Report (Childs 2014) determined some short-term, localized impacts to native fish may occur as a result of project implementation. Application of the defined BMPs is expected to mitigate these impacts (Childs 2014, Steinke 2013). Native fish occurring in the Verde River Subbasin Unit (i.e. longfin dace, desert sucker, Sonoran sucker, roundtail chub) are long-lived species (adults live over ten years), so the risk of short-term effects is mitigated by the fact that the species is adapted to occasional sediment pulses and can reproduce after such occurrences have dissipated. Additionally, any effects to native fish would be insignificant and discountable (Childs 2014).

*4) An absence of nonnative fish species of the families Centrarchidae and Ictaluridae, bullfrogs (Lithobates catesbeianus), and/or crayfish (orconectes virilis, Procambarus clarki, etc.), or occurrence of these nonnative species at low enough levels such that recruitment of narrow-headed gartersnakes and maintenance of viable native fish or soft-rayed, non-native fish populations (prey) in still occurring.*

The project is not expected to change the occurrences of nonnative fish, bullfrog or crayfish. Native fish species may be affected by the action alternatives are not likely to adversely affected (Fisheries and Aquatics Specialist Report).

# Forest Service 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.

## Effects Common to All Action Alternatives

### Forest Plan Amendments

Alternatives B - D include actions dependent on forest plan amendments. 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 non-significant forest plan amendments would be required on the Coconino NF. Not incorporating the proposed amendments would affect the habitat of most sensitive species addressed in this report (Table 11). The MSO amendments would allow managing for lower tree densities and basal area and creating canopy gaps. This would create and sustain MSO habitat that would include more large pine and large oak trees. In the long-term, this would provide more large snags and logs and create a greater understory response. Not incorporating these amendments would lead to:

- uncharacteristically dense forest conditions and fewer big pine and oak trees with an increased risk of high severity wildfire in forested habitats, including 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 70 PACs (related to the proposed prescribed fire treatments in alternative C only)
- fewer PACs attaining the desired post-treatments conditions due to sequencing of treatments through time (all action alternatives)
- BA values higher than those recommended in the revised Recovery Plan across all PACs, target, and threshold habitats, i.e., this project would not be using the best science available (alternative C only)
- understory conditions would continue to decline across MSO habitat, affecting prey habitat and likely decreasing the total prey biomass for raptors and carnivores.

While these amendments apply to MSO habitat, they would affect a range of wildlife species that occur within those same acres. Increasing the retention and development of large trees, snags, and logs along with providing for a stronger understory response would directly or indirectly benefit most of the sensitive species analyzed here.

- About 28,952 acres of grassland, savanna, and meadows would not be restored. Grasslands are one of the most endangered terrestrial ecosystems in the nation, without a forest plan amendment these acres would continue to function as ponderosa pine forest to the detriment of many of the sensitive species (analyzed below).

Managing for open reference conditions within ponderosa pine forest would provide the rooting space necessary to sustain dense groups of trees, providing sustainable habitat for closed canopy species. Simultaneously, forest densities would be reduced at the stand level, increasing the sustainability and resiliency of this habitat component in regards to stochastic events and the synergistic interactions between these events and climate change.

Group and gap forest structure would maintain closed canopy conditions while providing shrub and herbaceous vegetation, thereby increasing foods for herbivores, granivores, insectivores, and so for carnivores as well. It would provide connectivity for dispersing grassland/open canopy species, aiding in the maintenance of prey populations (e.g., rodents and lagomorphs).

Currently, many of the sensitive species potentially affected by the 4FRI depend on habitats or habitat elements related to canopy openings (Table 159). Existing closed canopy forests limit or eliminate many of the necessary habitat components these species rely on. The desired condition would provide closed canopy tree groups interspersed with opens, similar to the evolutionary landscape that existed in northern Arizona before Euro-settlement.

**Table 159. Effects to sensitive species habitats by not incorporating proposed amendments into the action alternatives**

| Species | Habitat Links | Long-Term Effect to Habitat Links |
|---|---|---|
| **Amphibians** | | |
| Northern Leopard Frog | Site specific/ habitat not affected | None |
| **Birds** | | |
| Bald Eagle | Roosting and Prey Habitat | Degraded |
| Northern Goshawk | Late-seral PIPO/Prey Habitat | Degraded |
| American Peregrine Falcon | Prey Habitat | Degraded |
| Burrowing Owl (western) | Open/Grassland | Degraded |
| **Mammals** | | |
| Navajo Mogollon Vole | Forest openings/ meadows/understory development | Degraded |
| Western Red Bat | Forest openings/oak/meadows/ arthropods | Degraded |
| Spotted Bat | Forest openings/meadows/ arthropods | Degraded |
| Allen’s Lappet-browed Bat | Snags/forest openings/meadows/ arthropods | Degraded |
| Pale Townsend’s Big-Eared Bat | Forest openings/meadows/ arthropods | Degraded |

## Treatment-Related Disturbance

Mechanical treatments, prescribed burning, road construction and decommissioning, hauling of timber and other restoration activities may cause visual or auditory disturbance to sensitive species. This disturbance would be localized, of short duration and low intensity, and would not be expected to substantially interfere with normal feeding or dispersal behavior regardless if the species of consideration is associated with grassland or forest. 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 Forests (within the treatment area); however, these are short-term effects and the level of the effects would be reduced by activities being spatially and temporally separated.

## Road-Related Impacts

About 520 miles of temporary roads would be constructed and decommissioned when treatments are complete (no new permanent roads would be constructed). Reconstruction of up to 40 miles of existing, open roads would be done for resource and safety concerns. About 30 miles of this reconstruction would be roads improvements for hauling harvested materials (primarily widening corners to improve turn radiuses) and about 10 miles would consist of relocating roads out of stream bottoms. Relocated roads would include rehabilitation of the abandoned road segment.

Decommissioning 860 miles of roads would improve habitat quality along and adjacent to the roadways. Road decommissioning could include one or more of the following:

- Reestablishing former drainage patterns, stabilizing slopes, and restoring vegetation;
- Blocking the entrance to a road or installing water bars;
- Removing unstable fills, pulling back road shoulders, and scattering slash on the roadbed;

- Completely eliminating the roadbed by restoring natural contours and slopes; and/or
- Other methods designed to meet specific conditions associated with unneeded roads.

Decommissioning a total of 1,380 miles of road would create disturbance to wildlife involving noise, sediments, hauling, and human presence. However, decommissioning individual road segments would be tied to task orders and accomplished by contractors. This would ensure it would be done across time, as individual task orders were completed. It would also make certain that activities would be separated spatially as well. Disturbance associated with any one decommissioning would therefore have limited effects to wildlife in the vicinity of the action.

Decommissioning would increase habitat for most wildlife in the action area. Eliminating disturbance along the roadway would be expected to improve habitat quality beyond the immediate proximity of the road. Each mile of decommissioned road would improve about three acres of habitat. In total, about 2,580 acres of wildlife habitat would be improved (not including temporary road decommissioning). Not all acres would function as viable habitat, but reducing human disturbance, human effects to habitat (e.g., cutting snags and logs), and redirecting precipitation run-off would improve habitat effectiveness at the site scale. While these actions add up to many acres of habitat improvement, it would consist of many (i.e., 860) individual actions. Therefore this would not have a discernible impact to habitat across the landscape.

Road-related operations would include dust abatement treatments. An expert panel, sponsored by the U.S. Environmental Protection Agency, conducted a literature review of dust suppressants (Batista et al. 2002) Magnesium chloride ($MgCl2$) is the most widely used salt for suppressing dust. Salts move through soil easily with water and, in areas near the application, could potentially have negative impacts on plant growth near application sites. In lab tests, lignin was found to cause weight gain and colon ulcers in rodents. It did not prevent seed germination in field trials and may be the most environmentally compatible dust suppressant (Batista et al. 2002).

Batista et al (2002) concluded that the determination of effects must be based on assessing site-specific conditions. Dust abatement treatments would be limited in the 4FRI, occurring in selected areas where private landownership concerns could arise. Eight road sediments 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. The effectiveness of $MgCl2$ is related to humidity levels (Batista et al. 2002). The higher the humidity the more effective it becomes. However, the drier the conditions, the more dust becomes an issue. Therefore, lignin would probably be used most often in the 4FRI landscape. Treatments would be temporary and only be used when hauling would occur on a particular road. None of the proposed treatment segments are near open water. No treatments would occur near northern leopard frog habitat. 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 wildlife or their habitat.

Restoring springs, ephemeral streams, riparian habitat associated with both, meadows, and aspen in the action alternatives would improve habitat for small mammals and herptofauna. There would be a short-term disturbance to vegetation during implementation of restoration projects. However, vegetation would be expected to be restored within a one to three year period (Water Quality and Riparian report). Springs would be surveyed prior to implementation and appropriate timing restrictions would apply where applicable, reducing direct impacts to wildlife.

## Northern Goshawk

### Alternative A

#### *Direct and Indirect Effects*

Direct effects are those caused by the action and occur at the same time and place. There would not be any direct effects from alternative A because there are no actions occurring.

Indirect effects are those effects caused by the action and are later in time and/or further removed in distance. The physical changes to the quantity and quality of the goshawk's habitat and that of its prey species are indirect effects and are addressed here and in the Management Indicator Species analysis. Following are site specific details regarding the effects of the no action alternative.

On the Coconino and Kaibab National Forests, 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.

**Vegetation Structural Stage**

Under the no action alternative, most of the overall landscape would move towards desired conditions slower than the other alternatives while some areas may not move towards desired conditions at all (appendix 20). PFAs/dPFAs and LOPFAs under alternative A would have less age class diversity than the other alternatives. 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).

The two forest plans have guidance to manage towards uneven-age stand conditions. In LOPFAs, alternative A would have the slowest progress of all alternatives towards having older age classes in uneven-aged (desired) condition.

LOPFA: In 2020 the LOPFA even-aged stands would still be dominated by the young and mid-aged forest structural stages with an overall combined distribution of 91 percent. Overall distribution of VSS 1 is less than 1 percent as is VSS 2. VSS 5 is deficit by 13 percent and VSS 6 is deficit by 19 percent. The distribution shifts toward the mid-aged and mature forest structural stages by 2050 and would dominate with a combined overall distribution of 81 percent. In 2050, there would be less than one percent VSS 1 and less than one percent VSS 2 stands. The overall distribution of VSS 3 would be deficit by six percent while VSS 6 would be deficit by 15 percent relative to desired conditions.

In even-aged LOPFA, the young forest stage ranges from a low of 20 percent to a high of 89 percent depending on the subunit. The mid-age forest stage ranges from less than 1 percent to a high of 59 percent. The mid-age forest stage ranges from a low of nineteen percent to a high of 77 percent. The mature forest stage ranges from zero percent to a high of 52 percent.

Uneven-aged LOPFA stands in 2020 would have changed little from existing with an overall combined distribution of 73 percent in young and mid-aged forest structural stages or about 33 percent more than desired. There would be little to no VSS 1 or VSS 2 structural stages or regeneration. VSS 5 would be deficit by eight percent and VSS 6 would be deficit by seven percent. By 2050, here would still be a low distribution of VSS 1 and VSS 2 structural stages (0 to less than one percent respectively). Relative to desired conditions, VSS 3 would be deficit by 10 percent, VSS 4 would exceed desired condition by 22 percent, VSS 5 would exceed desired condition by only seven percent, and VSS 6 would exceed desired condition only by one percent.

PFA: The PFA even-aged stands show a similar trend as the LOPFA even-aged stands. In 2020, they are dominated by the young and mid-aged forest structural stages with a combined overall distribution of 91 percent, more than twice the desired. The young forest stage ranges from a low of 0 percent to a high of 83 percent. The mid-age forest stage ranges from a low of 0 percent to a high of 100 percent. Overall distribution of VSS 1 is deficit by 10 percent, VSS 2 is deficit by 9 percent, VSS 5 is deficit by 13 percent and VSS 6 is deficit by 19 percent. As stand development continues, the distribution shifts toward the larger stages by 2050. The mid-aged and mature forest structural stages would dominate with a combined overall distribution of 88 percent. The mid-age forest stage ranges from a low of 7 percent to a high of 100 percent. The mature forest stage ranges from a low of 0 percent in several subunits to a high of 62 percent. In 2050, there would be no VSS 1 or VSS 2 stands. The overall distribution of VSS 3 would be deficit by 16 percent and VSS 6 is deficit by 14 percent.

In 2020 PFA uneven-aged stands would be dominated by the young and mid-aged forest structural stages with a combined overall distribution of 80 percent, twice the desired. The young forest stage ranges from a low of 0 percent to a high of 84 percent depending on the subunit. The mid-age forest stage ranges from a low of 6 percent to a high of 82 percent depending on the subunit. Overall, there would be no VSS 1 and less than 1 percent VSS 2 stands, VSS 5 is approaching desired at 14 percent and VSS 6 is deficit by 14 percent. As stand development continues, the dominant distribution shifts toward the mid-aged and mature larger structural stages by 2050 with a combined overall distribution of 76 percent, nearly twice the desired. The distribution of mid-aged structural stages would range from 28 percent to 84 percent and the mature structural stage would range from 0 percent to 63 percent depending on the subunits. Overall there would be no VSS 1 stands, less than 1 percent VSS 2, VSS 3 is now deficit by 14 percent, VSS 5 exceeds desired by 9 percent and VSS 6 would approach desired at 17 percent.

### Old Growth

Currently, VSS 5 and 6 (which represent large and old trees) are underrepresented in ponderosa pine and occur in predominantly closed and dense conditions. Consequently, there are threats to the sustainability of these trees due to competition, density related mortality, and the threat of uncharacteristic fire. It is desired to have large and old trees scattered across an uneven-aged condition landscape that is comprised of a balance of structural stages. Old forest structure, including presettlement trees, should be sustained over time across the landscape.

Table 160 displays the old growth structural attributes projected out to the years 2020 and 2050 under alternative A.

**Table 160. Alternative A - 2020 and 2050 ponderosa pine old growth structural attributes by restoration unit and subunit**

| Restoration Subunit /Unit | Old Growth Acres | Average TPA 18"+ Desired: 20/acre about 180 years old | | | Average BA Desired: 70-90 square feet/acre | | | Average Tons CWD ≥12" | | | Average Snags Per Acre ≥12" Desired: 1/acre | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 |
| **All** | **192,819** | **13.0** | **16.0** | **25.5** | **118** | **129** | **156** | **0.4** | **0.6** | **1.2** | **1.8** | **2.3** | **4.2** |
| **1** | **64,090** | **13.9** | **16.8** | **26.4** | **134** | **144** | **168** | **0.5** | **0.8** | **1.6** | **2.3** | **2.9** | **5.3** |
| 1-1 | 3,578 | 13.2 | 16.0 | 25.2 | 117 | 129 | 158 | 0.4 | 0.5 | 1.0 | 1.4 | 1.8 | 3.3 |
| 1-2 | 2,034 | 11.0 | 13.8 | 23.6 | 101 | 112 | 142 | 0.3 | 0.4 | 0.9 | 1.1 | 1.6 | 3.1 |
| 1-3 | 17,105 | 13.5 | 16.3 | 25.8 | 128 | 139 | 164 | 0.6 | 0.7 | 1.5 | 2.0 | 2.6 | 4.7 |
| 1-4 | 6,323 | 11.6 | 14.5 | 24.3 | 117 | 129 | 157 | 0.3 | 0.5 | 1.1 | 1.7 | 2.2 | 4.2 |
| 1-5 | 35,050 | 14.9 | 18.0 | 27.6 | 146 | 156 | 176 | 0.6 | 0.9 | 1.9 | 2.8 | 3.6 | 6.3 |
| **3** | **46,663** | **14.4** | **17.5** | **27.8** | **132** | **142** | **166** | **0.5** | **0.6** | **1.4** | **2.1** | **2.8** | **4.9** |
| 3-1 | 6,216 | 12.9 | 16.1 | 26.9 | 121 | 132 | 159 | 0.3 | 0.4 | 1.0 | 1.6 | 2.2 | 3.9 |
| 3-2 | 9,317 | 14.7 | 18.1 | 28.1 | 113 | 124 | 151 | 0.3 | 0.4 | 1.0 | 1.5 | 2.0 | 3.4 |
| 3-3 | 15,624 | 13.8 | 16.9 | 27.2 | 132 | 142 | 166 | 0.4 | 0.6 | 1.3 | 2.0 | 2.8 | 4.8 |
| 3-4 | 4,201 | 15.8 | 18.8 | 28.5 | 148 | 158 | 178 | 0.7 | 0.9 | 2.0 | 2.8 | 3.7 | 6.4 |
| 3-5 | 11,305 | 15.2 | 18.3 | 28.7 | 147 | 157 | 178 | 0.8 | 1.0 | 1.9 | 2.6 | 3.5 | 6.1 |
| **4** | **48,059** | **12.7** | **16.0** | **27.0** | **113** | **125** | **153** | **0.3** | **0.4** | **0.9** | **1.4** | **2.0** | **3.6** |
| 4-2 | 3,710 | 13.0 | 15.9 | 25.3 | 103 | 114 | 143 | 0.2 | 0.3 | 0.7 | 1.2 | 1.6 | 2.7 |
| 4-3 | 20,144 | 11.9 | 15.0 | 25.3 | 107 | 118 | 146 | 0.3 | 0.4 | 0.9 | 1.4 | 1.9 | 3.5 |
| 4-4 | 22,175 | 13.2 | 16.8 | 28.6 | 119 | 131 | 159 | 0.3 | 0.4 | 0.9 | 1.4 | 2.1 | 3.7 |
| 4-5 | 2,030 | 14.1 | 17.9 | 30.7 | 136 | 147 | 173 | 0.4 | 0.6 | 1.3 | 2.1 | 2.9 | 5.0 |
| **5** | **23,716** | **11.8** | **14.2** | **21.4** | **87** | **98** | **124** | **0.5** | **0.6** | **1.1** | **1.3** | **1.5** | **3.0** |
| 5-1 | 5,187 | 11.7 | 14.4 | 23.3 | 99 | 111 | 140 | 0.5 | 0.6 | 1.1 | 1.4 | 1.8 | 3.4 |
| 5-2 | 18,530 | 11.9 | 14.1 | 20.9 | 84 | 94 | 121 | 0.5 | 0.6 | 1.1 | 1.3 | 1.5 | 2.9 |
| **6** | **10,291** | **9.0** | **10.6** | **16.6** | **91** | **105** | **143** | **0.2** | **0.3** | **0.5** | **0.6** | **0.7** | **1.8** |
| 6-2 | 1,689 | 8.5 | 10.0 | 15.7 | 84 | 98 | 134 | 0.2 | 0.3 | 0.5 | 0.6 | 0.7 | 1.7 |
| 6-3 | 8,210 | 9.1 | 10.7 | 16.9 | 92 | 106 | 144 | 0.2 | 0.3 | 0.5 | 0.6 | 0.7 | 1.8 |
| 6-4 | 392 | 9.3 | 10.7 | 15.7 | 109 | 122 | 154 | 0.3 | 0.4 | 0.8 | 1.0 | 1.2 | 2.7 |

In 2020, the average conditions are at or above the minimum criteria with the following exceptions (from the silvicultural report):

- Trees per acre (TPA) larger than 18 inch d.b.h. and 180 years old: This condition is deficit in all subunits ranging from a low of 10 TPA in SU 6-2 to a high of 18.8 trees per acre in SU 3-4 with an overall average for all acres of 16 trees per acre. The age of these trees is estimated be in the range of 100 to 140 years old with a few relic trees meeting the 180 year old criteria.
- Coarse woody debris greater than 12 inches. This condition is estimated to be deficit with less than the equivalent of 2 pieces per acre throughout Restoration Units 4 and 6, and various subunits.
- Snags per acre: This condition is estimated to be deficit with less than 1 snag per acre in Subunits 6-2 and 6-3 and for Restoration Unit 6 overall.

Over time, old growth conditions improve in terms of meeting the minimum criteria. In 2050, all Restoration Units meet or exceed the criteria for trees per acre larger than 18 inch d.b.h. with the exception of Restoration Unit 6. The age of these trees is estimated be in the range of 130 to 170 years old. Coarse woody debris greater than 12 inch remains deficit in Restoration Unit 6. It is estimated that all the other criteria will be met throughout the old growth acres. However, 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. These risks to old growth could affect a range of species including goshawks, MSOs, and black bears.

**Tree Groups, Interspaces, and Openness**

Under alternative A, no treatments would be implemented to create a mosaic of interspaces and tree groups. Existing interspace would continue to be encroached upon by expanding tree crowns and ingrowth. However, any large scale tree mortality occurring has the potential to enhance interspace and create tree groups, although this would typically be at the cost of larger and older trees.

Alternative A has the least progress towards desired conditions and the least improvement of habitat for goshawks and goshawk prey.

Alternative A is considerably less open in PFA/dPFA and LOPFA habitat than alternatives B, C, D, and E due to lack of treatments. Table 161 displays the percentage of openness in PFA/dPFA and LOPFA habitat. Very Open represents 70-90 percent openness; Open represents 40-70 percent; Moderately Closed represents 25-40 percent openness; and Closed represents less than 25 percent. 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. The section on ‘density’ in this alternative describes impacts to forest health in more detail. These conditions do not reflect Coconino forest plan guidance to provide healthy, sustainable forest environments for post-fledging family needs. It is compliant with Kaibab 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 161. Acres of openness in goshawk habitat by alternative**

| Habitat | Openness | Existing Acres | Alt B Acres | Alt C Acres | Alt D Acres | Alt E Acres |
|---|---|---|---|---|---|---|
| **PFA/dPFA 30,015 acres** | Very Open | 499 | 499 | 499 | 499 | 499 |
| | Open | 4,271 | 16,441 | 16,103 | 16,441 | 16,103 |
| | **Subtotal Very Open & Open PFA/dPFA** | **4,770** | **16,940** | **16,602** | **16,940** | **16,602** |
| | Moderately Closed | 11,531 | 8,064 | 8,163 | 8,064 | 8,163 |
| | Closed | 13,714 | 5,010 | 5,250 | 5,010 | 5,250 |
| | **Subtotal Moderately Closed & Closed PFA/dPFA** | **25,245** | **13,074** | **13,142** | **13,074** | **13,142** |
| **LOPFA 367,452 acres** | Very Open | 14,329 | 66,601 | 66,383 | 66,601 | 14,329 |
| | Open | 100,639 | 208,903 | 204,797 | 208,903 | 251,360 |
| | **Subtotal Very Open & Open LOPFA** | **114,968** | **275,504** | **271,180** | **275,504** | **265,689** |
| | Moderately Closed | 111,840 | 66,379 | 67,045 | 66,379 | 70,069 |
| | Closed | 140,644 | 25,569 | 29,228 | 25,569 | 31,694 |
| | **Subtotal Moderately Closed & Closed LOPFA** | **252,484** | **91,948** | **96,273** | **91,948** | **101,763** |

### Density

Density was evaluated using stand density index percent of maximum (SDI percent of Max) and basal area (BA) of all trees and was considered one of the indicators of the health and sustainability of goshawk habitat. The extremely high density zone is SDI percent of Max of 56+ percent, moderate density is 25-34 percent and high density is 35-55 percent. Table 162 shows the shifts in tree density in goshawk habitat in the different restoration units and subunits. The darkest shading is extremely high density; the lightest shading is moderate density; and the intermediate shading is high density. Values by alternative are displayed in appendix 20.

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 sub-units (Table 162) in 2010, increasing by 2020, and increasing again by 2050. Alternative A increases the percent SDI which would not alleviate these dynamics in both the PFA nesting habitat as well as the prey habitat in the LOPFA. The action alternatives move the entire landscape into Zone 2 which has less than full site occupancy with both intermediate forage production and individual tree diameter growth. The reduced percent SDI makes more space and nutrients available for each tree, providing the requirements for the trees to grow to larger diameter in less time and retain more of their live crown ratios. These physical characteristics provide additional higher quality goshawk nesting substrate than alternative A.

The conditions in alternative A would eventually reduce the number of trees per acre through density induced mortality from competition for limited space and resources. Alternatives B and C would change the TPA in both the PFA and the LOPFA to slightly less than the TPA in alternative D. Having fewer trees across the landscape reduces competition among trees for limited space and resources, providing opportunities for healthier and potentially larger trees for goshawks and their prey species.

**Table 162. Density in goshawk habitat in Alternative A**

| Restoration Unit and Subunit | SDI % of Max PFA/dPFA | | | | SDI % of Max LOPFA | | |
|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | | 2010 | 2020 | 2050 |
| All | 61% | 64% | 69% | | 61% | 66% | 74% |
| **1** | 61% | 64% | 69% | | 57% | 60% | 66% |
| 1-1 | 71% | 74% | 77% | | 65% | 67% | 72% |
| 1-2 | 72% | 75% | 79% | | 56% | 60% | 67% |
| 1-3 | 50% | 54% | 62% | | 49% | 53% | 60% |
| 1-4 | 65% | 68% | 72% | | 61% | 64% | 70% |
| 1-5 | 64% | 67% | 72% | | 60% | 63% | 69% |
| **3** | 78% | 80% | 81% | | 70% | 72% | 75% |
| 3-1 | 63% | 65% | 69% | | 63% | 66% | 71% |
| 3-2 | 58% | 61% | 67% | | 59% | 63% | 69% |
| 3-3 | 55% | 58% | 63% | | 52% | 56% | 62% |
| 3-4 | 65% | 67% | 71% | | 63% | 66% | 71% |
| 3-5 | 79% | 81% | 82% | | 72% | 75% | 77% |
| **4** | 69% | 72% | 75% | | 71% | 73% | 76% |
| 4-2 | 56% | 59% | 64% | | 51% | 55% | 61% |
| 4-3 | 48% | 50% | 58% | | 44% | 48% | 56% |
| 4-4 | 54% | 57% | 63% | | 47% | 51% | 57% |
| 4-5 | 61% | 64% | 68% | | 54% | 58% | 63% |
| 5 | 56% | 59% | 63% | | 57% | 61% | 67% |
| 5-1 | 56% | 59% | 64% | | 40% | 43% | 51% |
| 5-2 | 58% | 62% | 67% | | 45% | 49% | 57% |
| **6** | 53% | 56% | 61% | | 37% | 41% | 49% |
| 6-2 | 50% | 55% | 66% | | 52% | 57% | 68% |
| 6-3 | 42% | 47% | 57% | | 45% | 50% | 62% |
| 6-4 | 50% | 55% | 67% | | 51% | 57% | 68% |

These stands would be vulnerable to insect and disease and at high risk for uncharacteristic fire due to the high density of trees. The ability of the trees to develop open crowns and increase tree diameter would be lower as stand density indices and competition increase. This would have a negative effect on the development of old growth and the quality of foraging habitat. Stagnation of stands 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.

The silvicultural report describes the methods used to evaluate bark beetle hazard, another indicator of the health of goshawk habitat. That report states that stands of ponderosa pine within the project area with a relative density below 30 percent of SDImax have a low bark beetle hazard rating, stands between 30 and 40 percent of SDImax have a moderate bark beetle hazard rating, and stands above 40 percent are high. Using these relative density thresholds, approximately 8 percent of the ponderosa pine analysis area has a low bark beetle hazard rating, while 21 percent of the area has a moderate rating and the remaining 71 percent has a high hazard of beetle attack (Table 163). All PFA and LOPFA habitats are rated high.

**Table 163. 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 (% of Total) |
|---|---|---|---|---|---|---|
| Low | 3% | 6% | 8% | 26% | 0% | 37,933 (7%) |
| Moderate | 12% | 11% | 27% | 46% | 25% | 106,132 (21%) |
| High | 85% | 83% | 65% | 28% | 75% | 363,775 (72%) |

According to the silvicultural report, the bark beetle hazard rating across the analysis area would increase in all restoration units in 2020 and even more so in 2050. This suggests that a large proportion of the ponderosa pine within the 4FRI analysis area would have low resistance to successful bark beetle attack and would be susceptible to large scale mortality.

The silvicultural report also states that dense conditions that result from alternative A are at a high risk to density related mortality and 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. High density stands would be more vulnerable and less resilient to the projected hotter climate in the southwest (Kerhoulas et al. 2013). High density stands result in less deep water storage in the soil because the canopies interfere with precipitation reaching the ground and canopies allow moisture to be exposed to evaporation longer. Deep soil water is recharged by winter precipitation and ponderosa pines, especially large trees, rely heavily on this deep water. The risk of landscape-scale wildfire, with the potential to eliminate large portions of forested habitat, would increase with the lack of treatments in alternative A.

### Oak and Aspen

The various age classes of Gambel oak and aspen provide species and structural diversity within ponderosa pine and improve the quality of prey habitat. They also provide forage for wildlife not otherwise available in the ponderosa pine forest. Ponderosa pine tree canopy would continue to increase, shading out Gambel oak and aspen mid and understory trees. 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. No fences or barriers to protect aspen clones from browsing would be constructed. Browsing of aspen would continue at current levels.

The impaired regeneration and stagnated growth and vigor due to no treatments would not be beneficial in the short or long term because the resulting imbalance of age classes would not lead to resiliency or sustainability of these habitat components. However, the eventual mortality of oak and aspen could be beneficial for prey habitat by increasing snags, logs, and coarse woody debris that serve as cover for small mammals and other goshawk prey.

### Coarse Woody Debris, Logs, and Snags

Following are discussions on additional physical features associated with habitat and cover for prey species in ponderosa pine forest (Figure 29, Figure 30, and Figure 31). Values by alternative are displayed in appendix 20.

**Coarse woody debris:** 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. Surface fuels contribute to flammability, surface fire intensity, surface fire effects, soil effects, and smoke emissions.

Figure 29 compares the estimated amounts of coarse woody debris in PFA/dPFA and LOPFA habitat. 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. The short term amount (estimated 4.56 tons per acre) in the LOPFA would be near the lower end of the guideline in the Coconino forest plan of 5-7 tons per acre in ponderosa pine and would meet the guideline of 5 tons per acre in the PFA/dPFA. This short term amount would meet the Kaibab forest plan recommendations of 3-10 tons per acre in both PFA/dPFA and LOPFA habitat. 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 20.

**Logs**: Logs provide important habitat features for prey species, including substrate for foraging, den and nest sites, and cover. In the short term (2020), alternative A would have log densities similar to alternatives B, C, and E and log densities lower than alternative D in the PFAs/dPFAs and LOPFAs (Figure 30). In the long term (2050), alternative A would have the lowest log density per acre of all the alternatives in PFAs/dPFAs and LOPFAs. Log density per acre would increase from year 2020 to year 2050 so although alternative A would not meet Coconino or Kaibab forest guideline/desired condition of at least 3 large logs per acre in the short term. The requirements from both forest plans would be exceeded in the long term. More logs would be provided in PFA/dPFA versus LOPFA habitat (Figure 30). Predicted densities of large logs per acre by restoration unit, subunit, and alternative are displayed in appendix 20.

**Snags:** Snags provide nesting and denning habitat, roosts, and foraging habitat for many bird and mammal species. Predicted snag densities by restoration unit, subunit, and alternative are displayed in appendix 20. In the short term (2020), alternative A would have the lowest density of large snags per acre in PFA/dPFAs followed by alternative D, then alternative B, C, and E. As shown in Figure 31, the differences are slight. In the long term (2050), there are no differences in the density of large snags between alternatives in PFAs/dPFAs. Although snags per acre would increase in both the PFAs/dPFAs and LOPFAs over time in alternative A, snag density would still not achieve the guideline in the Coconino Forest Plan for at least 2 large snags per acre in the short or long term. In the short term, snag density would not meet the desired conditions of 1-2 snags per acre from the Kaibab Forest Plan in PFAs/dPFAs and LOPFAs. In the long term, snag density desired conditions from the Kaibab 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. 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. Snags in alternatives B and C would initially decrease the amount of snags in the LOPFA while increasing snags within the PFAs. Snags created in alternatives B and C would predominantly result from prescribed fire.

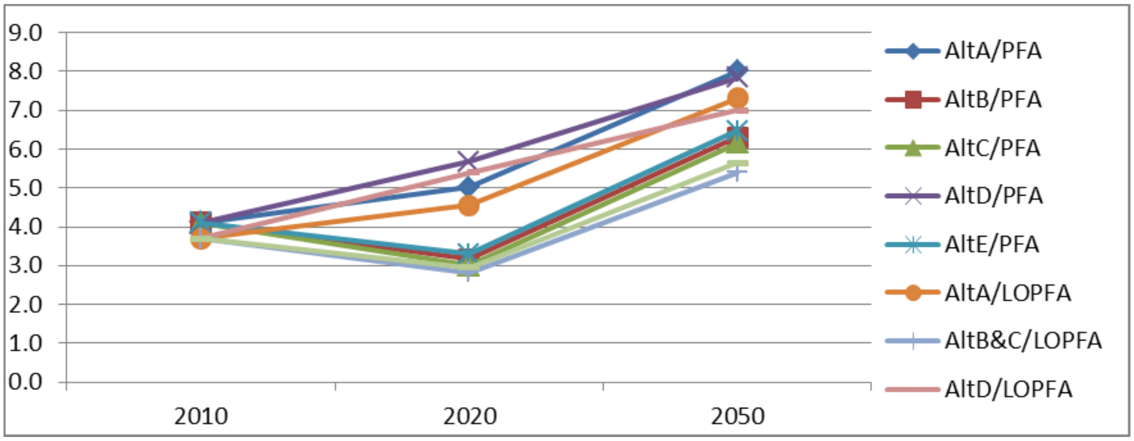


**Figure 29. Coarse woody debris (tons per acre) in goshawk habitat by alternative**

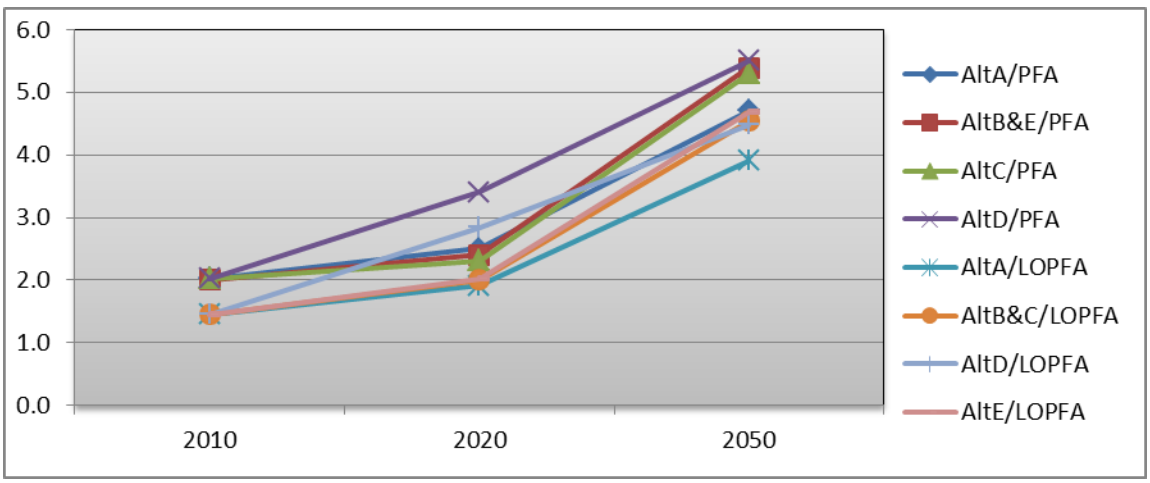


**Figure 30. Logs per acre in goshawk habitat by alternative**

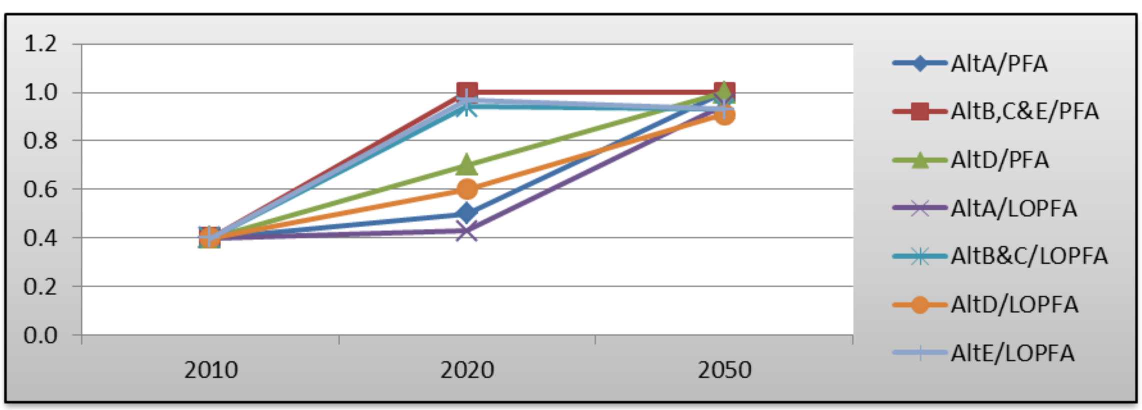


**Figure 31. Snags greater than 18 inches d.b.h. per acre in goshawk habitat by alternative**

### Understory Development

Because forests are so dense, canopy cover is also dense. Treatments in goshawk habitat would be implemented using stocking guidelines that would maintain interlocking or nearly interlocking tree crowns. Tree group density would meet and exceed canopy cover requirements (Coconino NF only) and desired conditions (Kaibab NF). Canopy cover would be measured at the stand level on about 39,860 acres of goshawk habitat where there is a preponderance of VSS 4, 5, and 6. These dense groups of trees would provide connected (interlocking or nearly interlocking) tree crowns for tassel-eared squirrels, a primary prey species for the goshawk. As the physical configuration of the features of the forested habitat are moved towards historic conditions, the quality of the habitat would be expected to increase for most native species that evolved in the evolutionary landscape characterized by pre-settlement conditions in the ponderosa pine forest type. Changes in biomass production would primarily occur as the result of openings in the forest canopy (i.e., decreasing percent SDI). Allowing light and water to reach the forest floor allows herbaceous species to grow. Reducing the number of trees (TPA or BA) on the landscape not only reduces competition for limited space and resources, but it also reduces the resulting needle cast which can further suppress understory growth.

A productive and diverse understory protects soil from erosion, creates forage and cover for wildlife, provides fuels to carry low-severity surface fires, and is the repository for much of the biodiversity in ponderosa pine ecosystems (Moore et al. 2006). In addition to these basic ecosystem services, understory vegetation defines and supports the arthropod community. Arthropods (including insects, spiders, mites, centipedes, millipedes, isopods, and mollusks (snails and slugs)) respond to changes in habitat structure (Pellmyer 1985, Buddle et al. 2006, Stephens and Wagner 2006, Moisset and Buchmann 2011) and are key drivers of ecosystem structure and function. They decompose organic material, aerate and enrich soil, release nutrients back into the ecosystem, maintain genetic diversity within plant species, and serve as key prey for birds and small mammals which, in turn, support populations of larger predators (Meyer and Sisk 2001, Waltz and Covington. 2001, Samways 2005, Black 2005, Black et al. 2007, Capinera 2010, Mooney et al. 2010). Appendix 6 provides a literature review on understory and arthropod response to overstory cover and fire and details changes by subunit.

Appendix 20 contains a table that compares understory index by restoration unit, subunit in LOPFAs and PFAs/dPFAs by alternative. 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. 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). 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. This would be the least beneficial for goshawk prey species like American robins, Band-tailed pigeons, Cottontail rabbits, Golden-mantled ground squirrels, Mourning doves, Northern flickers, Stellars jay, and Williamson's sapsucker because of declining foraging and nesting habitat and invertebrate prey.

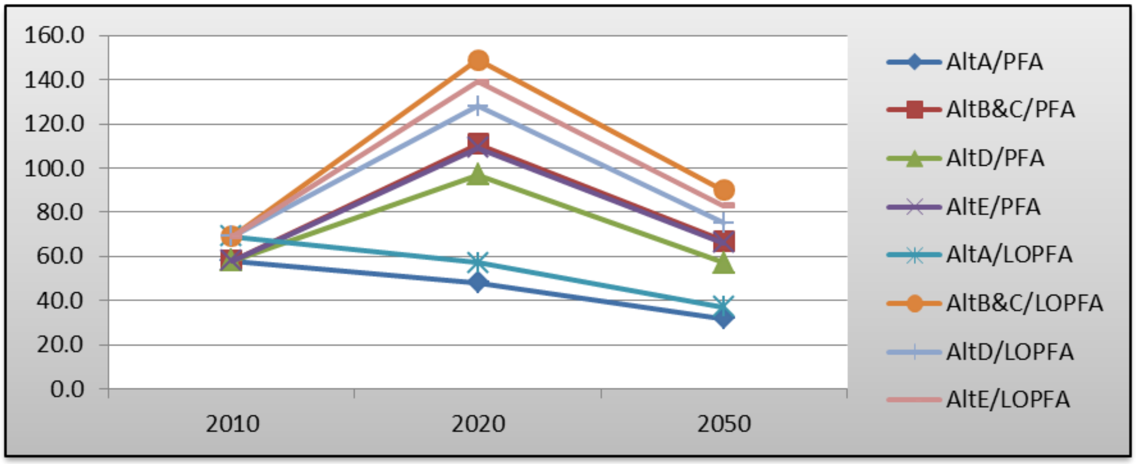


**Figure 32. Average pounds per acre of herbaceous biomass in goshawk habitat by alternative**

### Roads

Road maintenance would continue at current levels. No road decommissioning, construction of temporary roads, opening closed roads, hauling, or reconstructing roads associated with 4FRI would occur. Vegetation development (ingrowth and mortality) within current road rights of way would continue on the current trajectory.

### Stream Channel and Spring Restoration

No treatments adjacent to or within riparian habitat, ephemeral streams, seeps and springs would occur. No improvements in habitat quality for goshawk prey would occur.

## *Cumulative effects for Northern Goshawks*

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.

Overall, there are about 176,030 PFA/dPFA habitat acres on the Coconino and Kaibab forest. Cumulatively, there are between 34,037 and 34,134 PFA/dPFA acres treated by prescribed burning and/or mechanical thinning. This represents about 19 percent of the PFA/dPFA acres on the two forests.

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.

Thinning and prescribed burning are the primary past, current, and foreseeable activities within the 4FRI project area and within ½ mile of the boundary (Table 164). Although MSO direction takes priority over direction for goshawk habitat, treated MSO habitat would be overlapping PFA, dPFA, or LOPFA habitat. Thinning and burning in goshawk habitat would follow forest plan guidance except in powerline right of ways, in which most trees are removed, or in MSO habitat, which would follow forest plan guidance, Recovery Plan guidance, and/or specifics resulting from consultation with the U.S. Fish and Wildlife Service. Other activities include slash disposal, invasive weed treatments, erosion control, and disease tree harvest (appendix 17). Effects to goshawk habitat are broken down into two broad categories: Forest structure and prey habitat.

In addition to the above, there are 23,564 acres of mechanical treatments in grassland, pinyon juniper, and aspen vegetation types plus 9,976 acres of prescribed burning in grassland and pinyon juniper woodland (Table 165). These vegetation types are primarily habitat for prey species. These activities would result in more open grasslands (through removal of encroaching trees), improvement of soil condition in pinyon juniper through thinning, and more vigorous aspen. Consequently herbaceous and shrub production would improve, providing higher quality or more abundant food and cover for small mammals and birds, some of which would be expected to disperse into nearby foraging habitat for goshawks.

### 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 towards 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 MSO 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 MSO Recovery Plan promote complex habitat structure. This can negatively affect some wildlife species because thinning from below removes a range of tree sizes that grow into larger d.b.h. size-classes over time, therefore the development of larger trees is delayed. This can negatively affect future forest structure. The only way to avoid these issues is to retain trees below the diameter cap limit. However, this increases stand density which reduces or precludes other stand objectives such as increasing tree growth rates, developing larger trees sooner, and adding resiliency to the stand.

**Table 164. 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 | Rx 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 | Rx Burn mixed conifer or ponderosa pine in MSO protected and PAC habitat | Rx Burn mixed conifer or ponderosa pine in MSO Restricted habitat |
|---|---|---|---|---|---|---|---|
| current | 61,230 | 97,908 | 228 | 29,129 | 1,986 | 2,285 | 50,742 |
| future foreseeable | 39,159 | 38,255 | 2,047 | 12,807 | 7,277 | 1,851 | 13,219 |
| past | 30,197 | 50,862 | 1,218 | | | | |
| **Total** | **130,586** | **187,025** | **3,493** | **41,933** | **9,263** | **4,136** | **63,961** |

**Table 165. Cumulative treatments and activities in 4FRI project area plus ½ mile beyond the project area- other activities**

| Project Type | Thin grassland (ac) | Rx burn grassland (ac) | Thin pinyon-juniper (ac) | Rx burn pinyon-juniper (ac) | Road obliteration (miles) | Road closure (miles) | Aspen regenera-tion (ac) | Rock pit develop-ment (# of pits) | Water develop-ment (#) | 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 | |
| **Grand Total** | **11,483** | **6,552** | **6,876** | **3,426** | **54** | **18** | **5,205** | **39** | **24** | **1** |

Thinning projects in MSO habitat (which is also used by goshawks) typically followed Recovery Plan (USDI Fish and Wildlife Service 1995) direction which recommended only removing trees 9 inches d.b.h. and smaller in MSO protected habitat. Removing only small trees reduces ladder fuels, thereby decreasing the risk of surface fire becoming crown fire. While this aids in retaining forest structure needed by the MSO 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 towards MSO Recovery Plan direction but sometimes higher than desired values for goshawks and with little improvement in understory that would benefit 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 towards desired stand structure conditions in LOPFA habitat by maintaining dense groups of trees and providing foraging habitat.

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 and their density and distribution.  Snags would be decreased 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. Of these acres, 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) 30 percent mixed severity, and 50 percent low severity (silviculture report). There is wide variability among these percentages from fire to fire. 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 might not provide for long-term understory benefits unless interspace or openings are created rather than merely opening the canopy. 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 towards 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. See Cumulative Effects for all Alternatives under the Description of Alternatives for more details. 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:

**Grasslands** – Historic grasslands and savannas and forest openings were restored by removing ponderosa pine tree canopy shading out understory herbaceous vegetation. Thinning treatments with a restoration objective also restored historic forest openings.

**Oak** – Removing conifer competition with mid and understory oak as part of the thinning contributed to maintaining and improving oak growth and vigor. Mixed and high severity wildfire killed large oaks that were replaced by oak sprouts thereby changing oak from old to young structure.

**Aspen** – Aspen restoration treatments were very similar to the aspen treatments proposed under this EIS and have resulted in more vigorous aspen regeneration and growth and age class diversity.

**Pine Sage** – Some of the fuels reduction thinning within pine sage on the Tusayan district removed overtopping young pines and improved conditions for understory sage. Some projects also targeted sage, reducing the overall cover of this important species in shrubland habitats.

**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 GFFP. 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 MSO 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 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:

- Slash treatments associated with the above thinning consists of prescribed burning. In addition, there are also burn-only treatments within the ponderosa pine habitat. Many past projects have maintenance burns occurring on five to 20-year cycles and hence qualify as past and ongoing projects. There are an estimated 104,750 acres of burning in the treatment area.
- Both forests are actively trying to restore aspen stands. The majority of the aspen on the Coconino NF is distributed in variable sized stands within wilderness areas, although smaller patches occur in moister cooler locations across the forest. Aspen on the south zone of the Kaibab NF usually occurs in small patches scattered within the ponderosa pine forest. Aspen restoration is planned for high priority areas outside of wilderness. Cumulatively, restoration of these areas across both forests will treat stands that are at high risk of dying in the near future. There are a total of 5,205 cumulative acres of aspen treatments.
- Both the Coconino and Kaibab NFs have implemented travel management restrictions 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.

- The Kaibab NF will allow for large game retrieval during hunting season in all GMUs while the Coconino will allow for elk-only retrieval in all GMUs except 5A and 5B. The Coconino NF will allow people to park up to 300-feet away in designated corridors along roads for campers. Outside these designated areas campers can park up to 30-feet away from roads. The Kaibab will allow parking up to 30 feet away from all open roads and does not have designated areas for parking further in from roads.
- Both forests have on-going maintenance of right of ways (ROW) for power, gas, and oil lines and associated infrastructure. This involves thinning and burning within the ROWs to keep the area clear of trees and shrubs. ROW maintenance prevents forest development, retaining early seral habitat in linear swaths across the landscape. ROWs include 32,344 acres with the majority of the area on the Coconino NF. Currently there are 500 acres proposed for ROW 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 Alternative A**

Alternative A would contribute to the improvement of forest structure and prey habitat within goshawk habitat, but progress towards 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 TPA 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 towards 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 ability to retain sustainable and resilient ecosystems would be further compromised by vulnerability to high-severity fires due to the reduced scale 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.

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.

### Cumulative Effects for Alternatives B - E

For alternatives B, C, D, and E, the majority of acreage identified as part of the cumulative effects analysis occur in LOPFA habitat (as seen in the row titled Total –Cumulative Effects Treatment Acres (PFA/dPFA, LOPFA that is shaded in Table 166). The majority of past, current, and foreseeable future treatment acres are prescribed fire only (as seen in the Total Acres of Prescribed Fire Only in the section titled Total Past, Current and Future Foreseeable Projects that is shaded in Table 166). However, most of the alternative treatments are mechanical thin with prescribed fire (as seen shaded in the Total Acres of Mechanical Thin and prescribed fire in the Alternative section in Table 166). Alternative C cumulatively has the most treatment acres whereas alternative D has the fewest. These numbers are also shaded in table 166 and are located in the Total Acres column and the Total-Cumulative Effects Treatment Acres (PFA/dPFA, LOPFA row under the section called Cumulative Effects (Alternative number plus Total Past, Current and Future Foreseeable Projects). 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 towards improving forest health, vegetation diversity, and vegetation composition in goshawk habitat under alternatives B-E. This would aid in sustaining old forest structure over time and moving forest structure towards desired conditions.

**Table 166. Cumulative effects in goshawk habitat by alternative**

| Treatment | PFA/dPFA | LOPFA | MSO Restricted | MSO Protected or PACs | Total Acres |
|---|---|---|---|---|---|
| **Alternative B** | | | | | |
| Prescribed fire Only | 10,013 | 86,869 | 2,655 | 20,083 | 119,620 |
| Mechanical Thin and prescribed fire | 20,002 | 280,462 | 72,456 | 10,284 | 383,204 |
| Prescribed Fire Only Prey Habitat | 494 | 72,669 | 0 | 600 | 73,763 |
| Mechanical Thin and Prescribed Fire Prey Habitat | 127 | 1,635 | 0 | 0 | 1,762 |

| Treatment | PFA/dPFA | LOPFA | MSO Restricted | MSO Protected or PACs | Total Acres |
|---|---|---|---|---|---|
| **Total Past, Current and Future Foreseeable Projects** | | | | | |
| Prescribed fire Only | 0 | 187,025 | 63,961 | 4,136 | 255,122 |
| Mechanical Thin | 0 | 130,586 | 41,936 | 9,263 | 181,785 |
| Northern goshawk nest treatments (assumed mechanical) | 3,493 | 0 | 0 | 0 | 3,493 |
| Mechanical Thin in prey habitat (grassland, PJ, aspen) | 0 | 23,564 | 0 | 0 | 23,564 |
| Prescribed Fire in prey habitat (grassland, PJ) | 0 | 9,978 | 0 | 0 | 9,978 |
| **Cumulative Effects (Alternative B plus Total Past, Current and Future Foreseeable Projects)** | | | | | |
| Prescribed fire Only | 10,013 | 273,894 | 66,616 | 24,219 | 374,742 |
| Mechanical Thin and Prescribed Fire | 23,495 | 411,048 | 114,392 | 19,547 | 568,482 |
| Prescribed Fire Only Prey Habitat | 494 | 82,647 | 0 | 600 | 83,741 |
| Mechanical Thin and Prescribed Fire Prey Habitat | 127 | 25,199 | 0 | 0 | 25,326 |
| Total-Cumulative Effects Treatment Acres (PFA/dPFA, LOPFA) | 34,129 | 792,788 | 181,008 | 44,366 | 1,052,291 |
| **Alternative C** | | | | | |
| Prescribed fire Only | 10,008 | 86,869 | 2,655 | 24,735 | 124,267 |
| Mechanical Thin and prescribed fire | 19,910 | 279,724 | 71,173 | 10,284 | 381,091 |
| Prescribed Fire Only Prey Habitat | 347 | 24,917 | 0 | 589 | 25,853 |
| Mechanical Thin and Prescribed Fire Prey Habitat | 275 | 49,648 | 0 | 35 | 49,958 |
| **Total Past, Current and Future Foreseeable Projects** | | | | | |
| Prescribed fire Only | 0 | 187,025 | 63,961 | 4,136 | 255,122 |
| Mechanical Thin | 0 | 130,586 | 41,936 | 9,263 | 181,785 |
| Northern goshawk nest treatments (assumed mechanical) | 3,493 | 0 | 0 | 0 | 3,493 |
| Mechanical Thin in prey habitat (grassland, PJ, aspen) | 0 | 23,564 | 0 | 0 | 23,564 |
| Prescribed Fire in prey habitat (grassland, PJ) | 0 | 9,978 | 0 | 0 | 9,978 |

| Treatment | PFA/dPFA | LOPFA | MSO Restricted | MSO Protected or PACs | Total Acres |
|---|---|---|---|---|---|
| **Cumulative Effects (Alternative C plus Total Past, Current and Future Foreseeable Projects)** | | | | | |
| Prescribed fire Only | 10,008 | 273,894 | 66,616 | 28,871 | 379,389 |
| Mechanical Thin and Prescribed Fire | 23,403 | 410,310 | 113,109 | 19,547 | 566,369 |
| Prescribed Fire Only Prey Habitat | 347 | 34,895 | 0 | 589 | 35,831 |
| Mechanical Thin and Prescribed Fire Prey Habitat | 275 | 73,212 | 0 | 35 | 73,522 |
| Total-Cumulative Effects Treatment Acres (PFA/dPFA, LOPFA) | 34,033 | 792,311 | 179,725 | 49,042 | 1,055,111 |
| **Alternative D** | | | | | |
| Prescribed fire Only | 10,013 | 86,869 | 2,655 | 836 | 100,373 |
| Mechanical Thin Only | 20,002 | 280,462 | 72,456 | 10,284 | 383,204 |
| Prescribed Fire Only Prey Habitat | 494 | 72,669 | 0 | 0 | 73,163 |
| Mechanical Thin Only Prey Habitat | 127 | 1,635 | 0 | 0 | 1,762 |
| **Total Past, Current and Future Foreseeable Projects** | | | | | |
| Prescribed fire Only | 0 | 187,025 | 63,961 | 4,136 | 255,122 |
| Mechanical Thin | 0 | 130,586 | 41,936 | 9,263 | 181,785 |
| Northern goshawk nest treatments (assmumed mechanical) | 3,493 | 0 | 0 | 0 | 3,493 |
| Mechanical Thin in prey habitat (grassland, PJ, aspen) | 0 | 23,564 | 0 | 0 | 23,564 |
| Prescribed Fire in prey habitat (grassland, PJ) | 0 | 9,978 | 0 | 0 | 9,978 |
| **Cumulative Effects (Alternative D plus Total Past, Current and Future Foreseeable Projects)** | | | | | |
| Prescribed fire Only | 10,013 | 273,894 | 66,616 | 4,972 | 355,495 |
| Mechanical Thin Only | 23,495 | 411,048 | 114,392 | 19,547 | 568,482 |
| Prescribed Fire Only Prey Habitat | 494 | 82,647 | 0 | 0 | 83,141 |
| Mechanical Thin Only Prey Habitat | 127 | 25,199 | 0 | 0 | 25,326 |
| Total-Cumulative Effects Treatment Acres (PFA/dPFA, LOPFA) | 34,129 | 792,788 | 181,008 | 24,519 | 1,032,444 |

| Treatment | PFA/dPFA | LOPFA | MSO Restricted | MSO Protected or PACs | Total Acres |
|---|---|---|---|---|---|
| **Alternative E** | | | | | |
| Prescribed fire Only | 10,008 | 114,298 | 2,655 | 20,083 | 147,044 |
| Mechanical Thin and prescribed fire | 19,910 | 252,175 | 71,173 | 10,284 | 353,542 |
| Prescribed Fire Only Prey Habitat | 347 | 24,916 | 0 | 565 | 25,828 |
| Mechanical Thin and Prescribed Fire Prey Habitat | 275 | 49,367 | 0 | 35 | 49,677 |
| **Total Past, Current and Future Foreseeable Projects** | | | | | |
| Prescribed fire Only | 0 | 187,025 | 63,961 | 4,136 | 255,122 |
| Mechanical Thin | 0 | 130,586 | 41,936 | 9,263 | 181,785 |
| Northern goshawk nest treatments (assmumed mechanical) | 3,493 | 0 | 0 | 0 | 3,493 |
| Mechanical Thin in prey habitat (grassland, PJ, aspen) | 0 | 23,564 | 0 | 0 | 23,564 |
| Prescribed Fire in prey habitat (grassland, PJ) | 0 | 9,978 | 0 | 0 | 9,978 |
| **Cumulative Effects (Alternative E plus Total Past, Current and Future Foreseeable Projects)** | | | | | |
| Prescribed fire Only | 10,008 | 301,323 | 66,616 | 24,219 | 402,166 |
| Mechanical Thin and Prescribed Fire | 23,403 | 382,761 | 113,109 | 19,547 | 538,820 |
| Prescribed Fire Only Prey Habitat | 347 | 34,894 | 0 | 565 | 35,806 |
| Mechanical Thin and Prescribed Fire Prey Habitat | 275 | 72,931 | 0 | 35 | 73,241 |
| Total-Cumulative Effects Treatment Acres (PFA/dPFA, LOPFA) | 34,033 | 791,909 | 179,725 | 44,366 | 1,050,033 |

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 BA of pine would decrease in the short-term, but because the focus is on small trees, BA might not substantially change. Overall BA 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 BA in the short term. However, design features should ensure retention of large diameter oak and small oak commonly sprout vigorously after fire. The total BA 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 CWD, 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 CWD 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 CWD 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 MSO habitat that are employed because MSO 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 towards desired conditions and decrease the risk of habitat loss to large-scale high severity fire.

### *Determination of Effect*

Implementation of alternative A may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.

## Effects Common to Alternatives B, C, D, and E

### *Mechanical Treatments*

Alternatives B, C, D, and E mechanically treat from about 18,165 to 18, 258 acres of occupied PFA habitat and about 8,303 acres of unoccupied dPFA habitat (Table 167). This represents about 11 percent of the occupied habitat and about 52 percent of the unoccupied dPFA habitat on the two forests.

**Table 167. Extent of mechanical and burning treatments in occupied and unoccupied goshawk habitat**

| | Alternative B | | | Alternative C | | | Alternative D | | | Alternative E | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Habitat** | **Thin and burn** | **Burn only** | **Total** | **Thin and burn** | **Burn only** | **Total** | **Thin only** | **Burn only** | **Total** | **Thin and burn** | **Burn only** | **Total** |
| PFA | 18,258 | 10,861 | 29,119 | 18,165 | 11,749 | 29,914 | 18,257 | 8,797 | 27,054 | 18,165 | 10,857 | 29,022 |
| dPFA | 8,302 | 1,566 | 9,868 | 8,303 | 1,720 | 10,023 | 8,303 | 1,299 | 9,602 | 8,302 | 1,566 | 9,868 |
| **Total** | **26,560** | **12,427** | **38,987** | **26,468** | **13,469** | **39,937** | **26,560** | **10,096** | **36,656** | **26,467** | **12,423** | **38,890** |

The range of treatments proposed in alternatives B, C, D, and E are displayed in Table 168. All mechanical treatments would be accompanied by prescribed fire except in alternative D. Treatments would have indirect long term benefits to habitat. According to the silvicultural report, all treatments would retain key prey habitat components like snags, coarse woody debris, and logs as per the forest plans. Habitat would move towards desired conditions and be more sustainable and resilient to drought and other aspects of climate change. All treatments would improve overall resiliency to density related mortality including resistance to insects and disease. The resulting forest structure would facilitate the spread of low severity fire. Age class diversity would improve and there would be a positive trend towards uneven-aged conditions, two key aspects of desired conditions. This would have long term indirect beneficial effects to habitat because of more rapid progress towards desired conditions, increased growth of large trees, better intermixing of tree structural stages, and more definition of tree groups and clumps. This would benefit prey species associated with large trees such as band-tailed pigeons, chipmunks, hairy woodpeckers, mantled ground squirrels, northern flickers, Stellar’s jay, tassel eared squirrels and Williamson’s sapsuckers. Compositional and structural diversity would be enhanced by creating opening and interspaces, allowing more sunlight to reach the ground. This would improve cover and food for goshawk prey such as robins, cottontail rabbits, and mourning doves. These treatments would also reduce the risk of high severity fire in goshawk habitat because lifted and separated tree crowns and separated tree groups would discourage the spread of crown fire and encourage ground fire.

**Table 168. Proposed treatments and associated effects in goshawk habitat**

| Proposed Treatment Type | Treatment Highlights (from silvicultural report) | Expected effects to goshawk habitat |
|---|---|---|
| Mechanical Aspen Treatment | Regenerate and/or maintain aspen by removing pine aspen competition within 100 feet of aspen clone. Aspen removal, ground disturbance, burning may also occur. Barriers such as fencing may be needed to protect regeneration. Clones may be burned. Manage for desired aspen forest structure, tree densities, snag densities and CWD levels. | Additional structural and compositional diversity by promoting vigorous aspen free of competition from overtopping ponderosa pine. Improved abundance and diversity of understory. Benefit to prey habitat for Williamson's sapsucker, robins, chipmunks, rabbits, mantled ground squirrels, and mourning doves. |
| AZGFD Treatment | Same as UEA 10 below except group size. Tree group size is dependent on experimental design and would range in size from 1-15 acres. | Improved age class diversity. Improved sustainability through regeneration openings and representation of all age classes. Smaller and fewer interspaces. Canopy cover requirements met in VSS 4, 5, and 6 tree groups. Larger tree groups with higher densities and more interlocking canopy add structural diversity. Trend toward uneven-aged condition. Prey habitat benefits via improved understory and structural diversity however less understory and higher fire effects because group densities may be higher than historical range of variability. |
| Intermediate Thin 10 | Intermediate thinning to establish interspace between individual trees and tree groups, and thin tree groups within LOPFA with moderate to high dwarf mistletoe infection. Overall average density of 70-90 BA and 25-40 percent SDI max. Percent of area occupied by trees and tree groups = 75-90 percent and 10-25 percent of area occupied by interspace. Average tree group size 0.1 to 1 acre with lower intensity treatments having larger groups. Tree group density would be managed to meet canopy cover requirement of 40 plus percent within VSS4, VSS5, and VSS6 tree groups. Stocking Guidelines are in the silvicultural report. | Improve forest health by removing dwarf mistletoe. Improved age class diversity and intermixing of vegetation structural stages. Improved sustainability through regeneration openings and representation of all age classes. Tree groups better defined. MRNG canopy cover requirements met in mid-aged through old VSS classes. Trend toward uneven-aged condition. Benefits twelve goshawk prey species mentioned in affected environment section. Prey habitat benefits via improved understory conditions and structural diversity. Focus on forest health improves sustainability. Faster growth of large trees. Improved understory enhances ability to restore low severity fire. |
| Intermediate Thin 25 | Same as Intermediate Thin 10 except Percent of area occupied by trees and tree groups = 60-75 percent and 25-40 percent of area occupied by interspace. | Same as Intermediate Thin 10 except more understory and faster tree growth due to more interspace. |
| Intermediate Thin 40 | Same as Intermediate Thin 10 except Percent of area occupied by trees and tree groups = 45-60 percent and 40-55 percent of area occupied by interspace. | Same as Intermediate Thin 10 except more understory and faster tree growth due to more interspace. This is the most open of the intermediate thin treatments. |

| Proposed Treatment Type | Treatment Highlights (from silvicultural report) | Expected effects to goshawk habitat |
|---|---|---|
| Pine Sage | Restore Pre-settlement tree density and pattern using evidences. Overall stand average density 30-50 BA and 15-25 percent of max SDI. Sustain as much old forest structure as possible. In PFA/dPFA: Replacement tree density would meet canopy cover requirements within VSS4, VSS5, and VSS 6 tree groups and to assure the VSS2 and VSS3 groups are managed to maintain stocking needed to meet desired canopy as groups mature to VSS4, VSS5, and VSS 6 groups. Maintain interlocking or nearly interlocking tree crowns. | Open conditions favor understory development, especially sage, and increased plant species diversity. Improved sustainability of habitat by managing stocking in younger structural stages. Interlocking crowns would favor squirrels. Maintenance and improvement of old forest structure would favor habitat of prey species such as hairy woodpeckers, northern flickers, stellar jays, tassel eared squirrels, and Williamson's sapsucker. |
| Stand Improvement 10 | Stand improvement thinning would create interspace between individual trees and tree groups and thin tree groups with PFA/dPFA even age sites with low dwarf mistletoe infection. In PFA/dPFA: tree group density would be managed to meet canopy cover requirements as described in Pine Sage Treatment. In PFA/dPFA: Percent of area occupied by trees and tree groups = 75-90 percent and 10-25 percent of area occupied by interspace. Mainly a thin from below treatment that leaves the best dominant and co-dominant trees. | Improved age class diversity and intermixing of vegetation structural stages. Improved sustainability through regeneration openings and representation of all age classes. Tree groups better defined. MRNG canopy cover requirements met in mid-aged through old VSS classes. Trend toward uneven-aged condition. Benefits twelve goshawk prey species mentioned in affected environment section. Prey habitat benefits via improved understory conditions and structural diversity. Faster growth of large trees. Improved understory enhances ability to restore low severity fire. |
| Stand Improvement 25 | Same as Stand Improvement 10 except in PFA/dPFA: percent of area occupied by trees and tree groups = 60 - 75 percent and 25-40 percent of area occupied by interspace. | Benefits similar to Stand Improvement 10 except more open.. |
| Stand Improvement 40 | Same as Stand Improvement 10 except in PFA/dPFA percent of area occupied by trees and tree groups = 45-60 percent and 40-55 percent of area occupied by interspace. In LOPFA: Percent of area occupied by interspace = 40-55 and percent of area occupied by individual trees and tree groups = 45-60 | Benefits similar to Stand Improvement 25 except more open. |

| Proposed Treatment Type | Treatment Highlights (from silvicultural report) | Expected effects to goshawk habitat |
|---|---|---|
| Uneven aged 10 Mechanical Thin | Uneven age thinning and group selection used to establish interspace between individual trees and tree groups, thin tree groups and create regeneration openings within LOPFA and PFA/dPFA habitats with low dwarf mistletoe infections. 75-90 percent of area occupied by individual trees and tree groups. 10-25 percent of area occupied by interspace. In LOPFA: average density 50-70 BA, 15-35 percent SDI Max. In PFA/dPFA: average density 70-80 BA and 24-40 percent SDI Max. In PFA/dPFA: tree group density would be managed to meet canopy cover requirements as described in Pine Sage Treatment. | Improved age class diversity and intermixing of vegetation structural stages. Improved sustainability through regeneration openings, representation of all age classes, and achievement of a particular SDI of max. Size of tree groups and interspaces dictated by site and existing trees. MRNG canopy cover requirements met in mid-aged through old VSS classes. Trend toward uneven-aged condition. Benefits twelve goshawk prey species mentioned in affected environment section. Prey habitat benefits via improved understory conditions and structural diversity. Faster growth of large trees. Improved understory enhances ability to restore low severity fire. |
| Uneven aged 25 Mechanical Thin | Same as Uneven 10 except 60-75 percent of area occupied by individual trees and tree groups. 25-40 percent of area occupied by interspace. | Same as Uneven aged 10 Mechanical Thin and Burn except more open. |
| Uneven aged 40 Mechanical Thin | Same as Uneven 10 except Average density 50-70 BA, 15-35 percent SDI Max. 45-60 percent of area occupied by individual trees and tree groups. 40-55 percent of area occupied by interspace. | Same as Uneven aged 25 Mechanical Thin and Burn except more open. |
| Wildland Urban Interface 55 Mechanical Thin | Average density 50-70 BA, 15-35 percent SDI Max.30- 45 percent of area occupied by individual trees and tree groups. 55-70 percent of area occupied by interspace. | Reduces fire risks, lowers crown fire potential, reduces canopy cover, raises canopy base height, and lowers canopy bulk density. Should help prevent fires that start in communities from entering into goshawk habitat. |
| Grassland - Restoration | Manage for open reference condition with 10-30 percent of area under ponderosa pine and deciduous tree crowns. 70-90 percent of area would be interspace. Reduces tree cover in transition areas between forest and grassland, savanna, meadow areas. | Occurs only in LOPFA, not PFA/dPFA habitat. Benefit to mourning doves and rabbits which are strongly associated with herbs, shrubs, and understory, which could disperse into PFA or dPFA habitat. |
| Grassland Mechanical | Manage for open reference condition with 10-30 percent of area under ponderosa pine and deciduous tree crowns. 70-90 percent of area would be interspace. | Benefits habitat for prey such as mourning doves and rabbits which are strongly associated with herbs, shrubs, and understory and which could disperse into PFA or dPFA habitat. |

| Proposed Treatment Type | Treatment Highlights (from silvicultural report) | Expected effects to goshawk habitat |
|---|---|---|
| MSO Restricted Treatment | Uneven aged thinning and groups selection used to create interspace between tree groups, thin tree groups and create regeneration openings to obtain 70-90 BA (stand average, 25-40 SDI percent Max, greater than or equal to twenty 18 inch + trees/acre. No trees larger than 24 inches would be cut. | Improved forest health and improved ability to restore low severity fire makes these areas more sustainable. Reduced susceptibility to uncharacteristic fire. Trend towards uneven-aged condition. Retention of large trees and increased tree growth favors habitat for hairy woodpecker, northern flicker, tassel-eared squirrels, and Williamson's sapsucker. |
| MSO Target Treatment | Sustain high tree density. Sustain old trees by thinning around them up to diameter limit as per Recovery Plan. Irregular spacing and intermediate thinning to improve residual tree health and vigor and reduce fire hazard. Prescribe burn to treat fuels, mitigate fuel hazards, increase tree canopy base height, reduce surface fuel loading while still maintaining and enhancing desired structure, densities, snag densities, and coarse woody debris levels. Alternatives B and D: maintain basal area greater than or equal to 150 BA in alternatives B and D and maintain 110-150 BA in alternative C. No trees larger than 24 inches d.b.h. would be cut. | Same as MSO Restricted Treatment except would have higher tree density. Habitat may be less resilient to insect and disease and more vulnerable to high severity fire. Understory response, and consequently benefits to some prey species, would be less than for MSO Restricted Treatments because of higher density, basal area, and canopy cover. Retention of trees greater than 24 inches d.b.h. would benefit Hairy woodpecker, Northern flicker, tassel-eared squirrels and Williamson's sapsucker. |
| MSO Threshold Treatment | Same as for MSO Target Treatment | Similar to MSO Target Treatment |
| PAC – Grassland Mechanical | Mechanical treatment designed to re-establish the historic meadow edge as defined by the current forest structure of young trees encroaching around the meadow edge; retain large trees with long-lived characteristics. Accompanied by Rx fire. Trees up to 17.9" d.b.h. may be cut. | Enhancing and creating small openings within Mexican spotted owl PACs will improve habitat for prey species including mice, voles, rabbits, and possibly mantled ground squirrels. |
| PAC – Mechanical Thin | Same as for MSO Threshold Treatment in addition to a 100 acre no treatment area around known nest or roost sites | Similar to MSO Target Treatment |
| Prescribed Fire Only | In LOPFA, prescribe burn to treat fuels, mitigate fuel hazards, increase tree canopy base height, reduce surface fuel loading while still maintaining and enhancing desired LOPFA structure, tree densities, snag densities, and coarse woody debris levels. In PFA/dPFA: same objectives as for LOPFA except fires are designed to maintain and enhance desired dPFA/PFA forest structure, tree densities, snag densities, and CWD levels. | Should improve abundance and nutritional quality of herbaceous understory in the short term for prey species. Key features of prey habitat should be retained as described in silvicultural report. Should reduce risk of high severity fire. |

| Proposed Treatment Type | Treatment Highlights (from silvicultural report) | Expected effects to goshawk habitat |
|---|---|---|
| Prescribed Fire Only - Operational | Prescribe burn to treat fuels, mitigate fuel hazards, increase tree canopy base height, reduce surface fuel loading while still maintaining and enhancing desired structure, tree densities, snag densities, and coarse woody debris levels depending on the vegetation type | Should improve abundance and nutritional quality of herbaceous understory in the short term for prey species. Should reduce risk of high severity fire and reduce the need for some fire lines and associated disturbance. |
| Savanna | Restore pre-settlement tree density and pattern using evidences. Manage for open reference condition with 10-30 percent of area under ponderosa pine and deciduous tree crowns. 70-90 percent of area would be interspace. | Does not occur in PFA/dPFA habitat. Occurs in LOPFA. Benefits habitat for mourning doves and rabbits which could disperse into PFA or dPFA habitat. |
| WUI PJ | Establish interspace between tree groups, thin tree groups within LOPFA PJ sites. Sustain as much old forest structure as possible. Live trees with existing cavities and dead tops favored for retention. Groups formed concentrations of large mature trees with 1-3 groups/acre and 5-30 trees in each group. Retain all pre-settlement yellow pines. Use evidences to restore old structure. Manage to sustain large oaks. Manage for 1 snag per acre in 75% of area. | An uneven-aged mosaic of overstory and understory densities, age classes, and species composition should help promote the growth of oak, cliffrose, sagebrush, other shrubs and herbaceous understory species should benefit habitat for chipmunks and rabbits, This plus emphasis on the retention of large trees would benefit habitat for northern flickers. |

Habitat features that appear to be important to a variety of goshawk prey species would be retained or improved in all action alternatives (see analysis under each alternative in this report, the silvicultural report, Appendix C and D in the FEIS). These habitat features include snags, downed logs, large trees, openings and associated herbaceous and shrubby vegetation, interspersion, and canopy cover (Reynolds et al. 1992, USDI Fish and Wildlife Service 1998, Squires and Kennedy 2006). Design criteria specific to these features include:

- Old tree implementation plan (see silvicultural report) and large tree retention as described in Alternative B through D Implementation Plan in Appendix D of the FEIS
- Created openings would not exceed 2 acres in goshawk PFAs.
- In tassel-eared squirrel nest stands, operators would avoid felling trees with active squirrel nests.
- Protect snags and logs wherever possible by placing landings in existing openings or in areas where snags and/or logs, and old trees would be minimally impacted.
- Protect/provide snags and logs wherever possible through site prep, implementation planning, green tree selection, and ignition techniques to retain > 2 snags/ac > 30’ high and > 18” dbh + > 3 logs > 8’long and > 12” mid-point diameter + 5-7 tons of coarse woody debris (>3” diameter/acre in pine and pine-oak habitat.
- Retain trees ≥18” dbh with dead tops, cavities, and lightning strikes wherever possible to provide cavity nesting/foraging habitat (i.e., the living dead) in ponderosa pine habitat.
- Within Group Density (VSS 4-6): Manage mid-aged tree groups for a range of density and structural characteristics by thinning approximately 50 percent of the mid-aged groups to the

lower range of desired stocking conditions, approximately 20 percent each to the middle and upper range of desired stocking conditions and approximately 10 percent remain un-thinned.

- Within Group Structure (VSS 4-6): Enhance and maintain mid-aged, mature or old group structure by retaining individual and clumps of vigorous ponderosa pine seedlings, sapling and poles within the larger group.
- For wildlife cover and stand heterogeneity in ponderosa pine cover type: Gambel oak, juniper and pinyon species would not be cut with the following exceptions: seedling/sapling, young and mid-aged pinyon and juniper up to 11" DRC may be cut within a 50' radius of individual or groups of old ponderosa pine (as defined in the old tree implementation strategy); and when there is no other option to facilitate logging operations (skid trail and landing locations). Gambel oak, juniper and pinyon species >5" drc (diameter root collar) may be considered as residual trees in the target group spacing and stocking.
- Manage for large oaks (10" drc or larger) by removing ponderosa pine up to 18" dbh that do not meet the "old tree" definition and do not have interlocking crown with oaks and occur within 30 feet of base of oak 10" drc or larger.

Canopy cover in tree groups would meet recommendations in the MRNG. Tree groups would provide microsites that provide denning, nesting, and foraging habitat for prey species, as well as perch and potential nest sites for goshawks. Prey habitat is expected to improve under all action alternatives in response to the retention, protection, or development of the key habitat features. This is described in more detail under each alternative.

Other indirect long term effects could include shifts in competitive interactions with other raptors or predator prey relationships. Although the results from Johnson (1992) in Squires and Kennedy (2006) and La Sorte et al (2004) suggest that habitat fragmentation can increase the potential for increased abundance of potential competitors and avian predators, like great horned owls and red-tailed hawks, empirical data that demonstrates that competition is truly affecting the viability of goshawk populations is lacking (Squires and Kennedy 2006).

For example, changes to forest habitat could result in habitat that is more accessible and attractive to competitors such as Red-tailed hawks and Great horned owls which would decrease habitat available to goshawks (USDI Fish and Wildlife Service 1998). It is not known if this is a linear relationship or if some threshold needs to be reached in order to affect predation or competition (Squires and Kennedy 2006). Great horned owls are habitat generalists most abundant in fragmented landscapes (Houston et al 1998 in Squires and Kennedy 2006). In a study by Johnson (1992) in Squires and Kennedy 2006), Great horned owl detections declined with increasing amounts of old forests.

In a study on the North Kaibab, red-tailed hawks were more variable in habitat selection than goshawks (La Sorte et al 2004). Red-tailed hawks tended to choose nest sites on steep north-facing slopes with dense understories whereas goshawks consistently chose moderate slopes, tall trees, and open understories. Apparently this is in response to how the two raptors enter their nests, red-tailed hawks enter from above and goshawks tend to enter from below. In this study, forest fragmentation tended to be greater around Red-tailed hawk nests in comparison to the patches of continuous forest and level terrain around goshawk nests.

It is unknown if predation of goshawks is increasing due to forest management or if predation rates are reducing goshawk survival, especially given that predation is a natural mortality factor in goshawk populations. Squires and Kennedy (2006) cited studies on passerines that suggest that predation rates increase in forested communities with increased fragmentation and/or reduction of canopy cover. They speculate that Great horned owls are the dominant predator of goshawks in North America due to their wide distribution, abundance, and capacity to prey on large raptors. They report that predation on goshawk nestlings may increase during periods of low goshawk food availability because female goshawks may spend more time foraging away from the nest rather than protection they young.

Analysis of vegetation structural stages and old growth, plus the implementation of design features listed above, suggests that the development of large trees, retention of old trees, and sustainability of mature and old forests will improve most in alternatives B, C, and E; improve more slowly in alternative D, and improve least of all in alternative A. This would be expected to result in beneficial long term indirect effects because large and old trees within PFAs, dPFAs, and LOPFAs would be more sustainable and more widely distributed. This may not improve habitat for predators like Great horned owls.

Proposed treatments in the action alternatives would result in continuity of forest vegetation in PFAs and dPFAs, maintaining reproductive habitat for goshawks, and not causing fragmentation of habitat. In alternatives B, C, and D, between 45,102 and 45,405 acres of savanna treatments are proposed in LOPFA but not PFA/dPFA habitat. These treatments could result in the biggest shift in canopy cover and forest structure in LOPFA habitat, compared to other treatments. The magnitude of the shift should vary in individual areas because the objective of savanna treatments is to restore pre-settlement tree density and pattern using evidences which could be different in different locations. Location of savanna treatments is guided by distribution of mollisol and mollic intergrade soils. These types of soils developed under open conditions with large percentages of organic input coming from grasses and forbs. The degree of openness would be similar to the reference conditions raptors would have evolved with on this landscape.

Mechanical treatments could cause negative short term direct effects by disrupting reproduction if they occurred during the breeding season. Most of the disturbance associated with thinning result from the presence of people and the noise associated with their presence and associated machinery. Because these activities have timing restriction, nesting goshawks would not be affected.

In all the action alternatives, several design features would result in beneficial long term indirect effects or would remove negative indirect effects by maintaining or improving habitat for goshawk prey species. Timing restrictions during the breeding season would mitigate potential direct effects to reproduction from harvest activities. Design features are located in Appendix C and Appendix D in the FEIS and are listed here:

- Harvest activities would not occur in occupied northern goshawk PFAs during the breeding season unless specific analysis has documented impacts would not result in a trend to listing or loss of viability. PFAs can be cleared for treatment if pre-treatment surveys determine the area is no longer occupied.

Additional disturbance could occur as a result of project-related activities including moving and operating harvest machinery, hauling forest materials, personnel in the field, and road related activities. The resulting noise disturbance and activities could result in negative short term direct effects. Disturbance can negatively affect reproduction during the March 1 through September 30 breeding season. Disturbance and the mitigations designed to reduce short term negative effects are discussed below.

### *Roads and Disturbance*

About 49 miles of roads would be decommissioned in 62 PFAs/dPFAs in alternatives B, C, D, and E (appendix 20). About 41 miles would be decommissioned in 50 PFAs, 7.7 miles in 12 dPFAs, and about 811 miles in LOPFA habitat. This would improve the quality of the habitat in those areas where the roads are decommissioned. The physical structure and features of the habitat for goshawks and their prey would be restored along the former road alignment, ingrowth of forest vegetation would be allowed, and roadway disturbance would largely be eliminated, thereby improving the quality of habitat beyond the immediate area of the road for the goshawk and its prey species. In alternative A, use of any open roads would continue the current level of disturbance occurring within PFAs and would not improve the quality of the adjacent habitat.

About one third mile of roads would be relocated in 7 PFAs/dPFAs. About 0.2 miles would be relocated in PFAs, less than 0.1 mile in dPFAs and about 6 miles would be relocated in LOPFA. Camp 36, Jackass North, Mars, Spring Valley, Stage Station, Dispersal PFA 08, and Dispersal PFA 13 would have less than 0.1 miles of road each relocated. The impacts from relocated roads are similar to those associated with temporary roads and would be expected to occur in small discreet areas. The new road alignments would move the disturbance associated with the road use to the adjusted location. Road relocation would occur outside the nesting season and would be done to protect natural resources currently being negatively impacted by the road or to improve public safety. This could include: reestablishment of former drainage patterns, stabilization of slopes, restoration of vegetation; blocking the entrance to a road or installing water bars; removing culverts, reestablishing drainages, removing unstable fills, pulling back road shoulders, and scattering slash on the roadbed. The roadbed could be completely eliminated by restoring natural contours and slopes. No acres would be impacted in alternative A.

About 40 miles of temporary roads would be constructed in 45 PFAs/dPFAs in alternatives B, C, D, and E. Of these, about 31 miles would be constructed in 37 PFAs, about 9 miles would be constructed in eight dPFAs, and about 481 would be constructed in LOPFA habitat. The term “temporary roads” in this instance includes a road authorized by contract, permit, lease, or other written authorization that is not a forest road and that is not included in a forest transportation atlas. The effects of temporary road construction to goshawk PFA and nest habitat would include removal of trees and understory vegetation along the road alignment. Implementing breeding season timing restrictions would eliminate disturbance impacts to nesting goshawks. No acres would be impacted in alternative A. 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.

While 60 PFAs are identified for treatments, 72 PFAs would have some sort of hauling occurring through the PFA (Table 169). 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”.

**Table 169. Miles of roads in PFAs**

| Miles of haul roads in PFA | Number of PFAs |
|---|---|
| 0-0.9 mile of haul road | 13 |
| 1 - 1.9 miles of haul roads | 19 |
| 2.0 – 2.9 miles of haul roads | 24 |
| 3.0 – 3.9 miles of haul roads | 8 |
| 4.0 – 4.9 miles of haul roads | 4 |
| 5.0 – 5.9 miles of haul roads | 4 |

The three PFAs without timing restrictions on hauling are in an area with some of the highest projected amounts of project activity and associated hauling traffic. This area has three level 3 roads suitable for hauling and each of the roads passes through one of the PFAs. The three PFAs without timing restrictions where hauling would occur include Devil Dog PFA (Forest Road 108), Barney PFA (FR 108), and Black Mesa Tank PFA (FR 122).

Hauling in these areas would transport material from about 7,600 acres of treatment. With about one truck load per acre and two truck trips per load, this would be the equivalent of about 15,200 truck trips. The timeframe for harvest of this material is expected to last 3-5 years, potentially creating 3,040 to 5,067 trips per year. Assuming hauling occurs 9 months out of the year, there could be 337 to 563 trips a month and between 15 and 26 trips a day (assuming 22 working days a month). Most of the material is expected to move through the Devil Dog PFA which is adjacent to and straddles I-40. Vehicular noise disturbance may have less impact to nesting goshawks in this PFA because of the proximity of the PFA to Interstate 40.

Some material could still be taken through either Barney PFA or the Black Mesa Tank PFAs but these routes have operational issues and neither is expected to receive much if any use. Nevertheless, both routes are considered options. While only a single nest is active in a given season, a pair of goshawks has an average of two to three different nest sites in a territory and can have up to nine different nests. Forest plan direction is to provide at least six nest stands of at least 30 acres each. Therefore, depending on active nest site selection and occupancy, timing, volume of materials hauled in a season, and other factors related to operations, logging truck traffic could potentially impact a breeding pair and their young more or less during the breeding season. Goshawk surveys would be done before hauling to evaluate occupancy and location of active nests in these three PFAs (Figure 33).

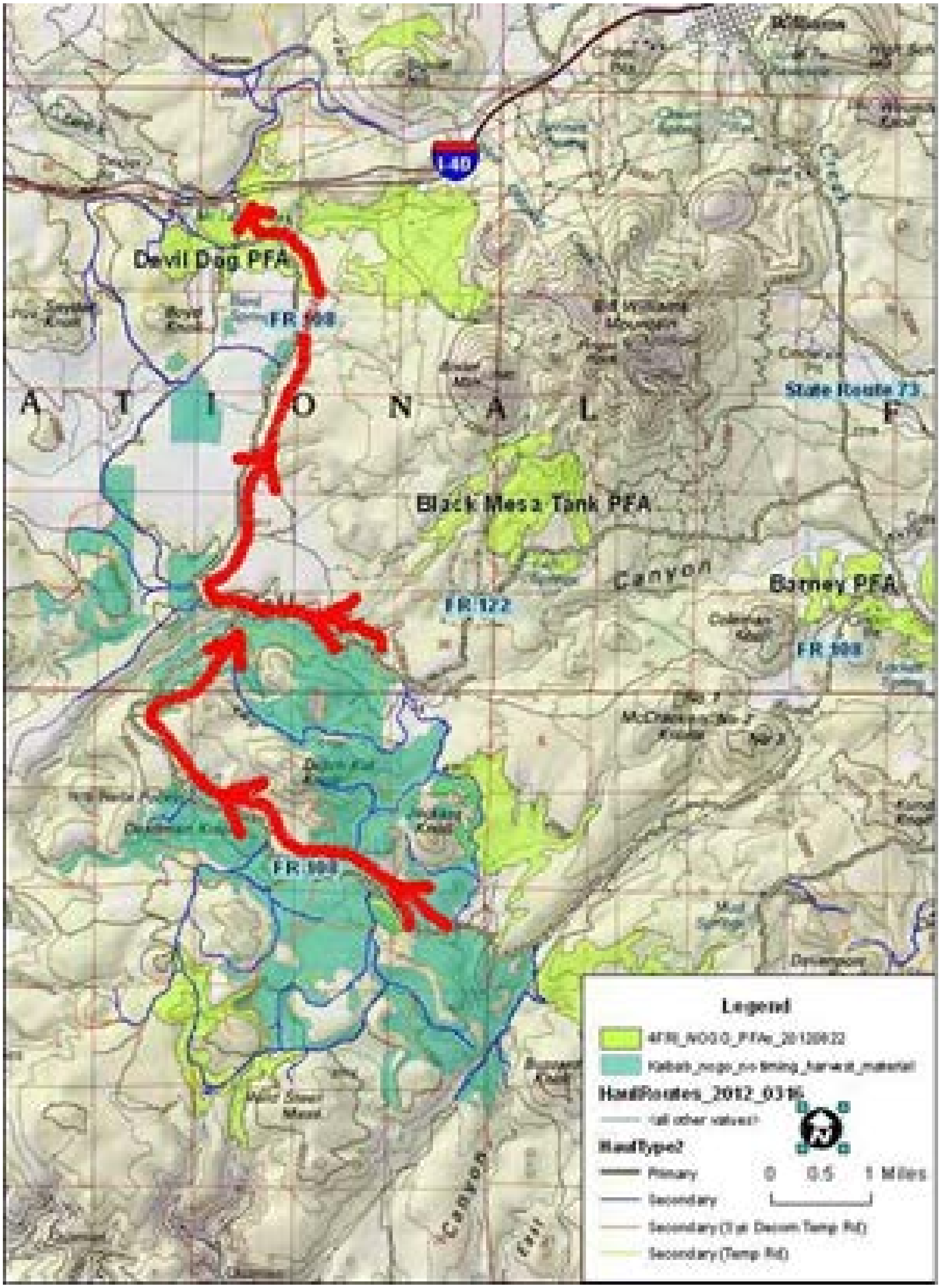


**Figure 33. Likely haul route (red line) and PFAs without timing restrictions that could potentially be affected by hauling**

Noise disturbance from logging trucks was monitored for nesting goshawks in a study on the Kaibab NF. The study was coordinated between the Kaibab NF, Rocky Mountain Research Station, U.S. Army, and a private sound consultant. Results from this field based, controlled experiment found no evidence of negative effects from truck noise. Observed goshawk response to logging truck noise was limited to, at most, looking in the direction of the hauling road (Grubb et al. 2012). However, this study measured the effects of a single truck on nesting goshawks. Thousands of truck trips may cause more pronounced behavior, depending largely on the distance to the nest and any intervening topography and vegetation.

Disturbance from hauling will vary based on which nest site is selected during the time that hauling occurs. Therefore, road disturbance, even with thousands of truck trips, may cause little or no disturbance. Conversely, an active nest in the Devil Dog PFA could occur in an area where past road noise was minimal but which could support high levels of road use that particular year.

Road work and use of haul roads could increase the potential for goshawk collision with vehicles. Little information is available on how frequently collisions might occur and what conditions might increase or lessen the vulnerability of goshawks.

A number of factors could influence the likelihood of collision. Goshawks in the three PFAs without breeding season timing restrictions would be at increased risk of a collision with a moving truck. A speed limit of 25 miles per hour will be implemented for vehicles passing through these PFAs to reduce the hazard of collisions. Given the adult goshawk's natural agility in flight and the size and noise of the log trucks, adult goshawks would be expected to avoid colliding with log trucks passing through the PFA. Newly fledged goshawks still developing their flight skills may have a slightly higher potential for colliding with a logging truck, but the reduced speed of the trucks and natural agility of goshawks should minimize this potential. Birds migrating or dispersing through unfamiliar terrain may be at higher risk than resident birds.

Vehicle activity will rotate around the 4FRI landscape in an incremental manner as different task orders are issued and will concentrate in an area while the work is being conducted. Activity would be expected to increase well above existing traffic levels for about 2 years until operations shift to other localized areas.

In summary, hauling may cause no noise disturbance to nesting goshawks and may result in no collisions, but there is potential to disrupt reproduction and rearing of young by, at most, one to two pairs of goshawks and may result in the injury or death to one or more young, although this risk would be lowered with a lower speed limit.

### *Design Features to Reduce Disturbance*

Design features, best management practices, and mitigation have been developed to reduce the magnitude of short term direct effects from disturbance in alternatives B, C, D and E. These are located in Appendix C of the FEIS and are listed below.

The following design criteria have been identified to reduce disturbance related effects to northern goshawks in alternatives B, C, D, and E.

- 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.
- Logging trucks would not exceed 25 miles per hour when traveling through PFAs during the nesting season (March 1-September 30).
- Road construction, obliteration, relocation, and maintenance would not occur inside PFAs during the breeding season (March 1-September 30) if occupied.
- In northern goshawk nest stands, mechanical treatments would not occur within nest stands, or within replacement nest stands.
- Harvest activities would not occur in occupied northern goshawk PFAs during the breeding season unless specific analysis has documented impacts would not trend to listing or loss of viability. PFAs can be cleared for treatment if pre-treatment surveys determine the area is no longer occupied.
- In northern goshawk PFAs, road construction, obliteration, relocation, and maintenance would not occur during the breeding season (March 1 to September 30) if occupied.
- Road construction, obliteration, relocation, and maintenance would not occur in occupied northern goshawk PFAs during the breeding season (March 1 to September 30).

**Prescribed Fire**

The forest plans allow for prescribed burning to occur within PFAs within and outside the breeding season although human disturbance should be limited during the breeding season so that goshawk reproductive success is not affected by human activities. Low intensity ground fires are allowed at any time but high intensity crown fires are not acceptable in PFAs or nest areas. The following design feature supports this: “Fuels in goshawk nesting areas will be evaluated and, if necessary, will be manipulated outside of the nesting period (March 1 to September 30) to ensure low severity fire effects from prescribed fire”. In addition, the Coconino forest plan says to avoid burning the entire home range of a goshawk pair in a single year. The following design feature supports this: “Burn units will not include more than 5,000 acres of a goshawk pair’s home range as per applicable forest plan guidance”.

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).

Incubating adults or young goshawks unable to fly could inhale smoke from prescribed fires. Smoke could result in an extended absence of the adults during brooding or when the chicks are very young. This could result in increased vulnerability to predators or to unfavorable weather, or reduced feeding. Smoke is likely to be worse during first-entry burning under conditions where fuels have built up to unnatural levels due to years of fire suppression. Smoke would be expected to be more within the range of natural variability after a first-entry burn and to have less intensity or duration. There would be a low likelihood of loss of nest trees or goshawks due to the heat, flames or smoke of a prescribed fire with implementation of design criteria W24 –"Prescribed burn plans would be designed and implemented to minimize smoke impacts to nesting birds and minimize loss of nest trees, including goshawk nest stands".

Other design criteria have been identified to reduce disturbance related effects to northern goshawks in alternatives B, C, D, and E.

- Fuels in goshawk nesting areas would be evaluated and, if necessary, would be manipulated outside of the breeding period (March 1 to September 30) to ensure low severity fire effects from prescribed fire.
- Burn Plans and Ignition Techniques: Apply fire prescriptions to maintain forest plan levels of coarse woody debris and to maintain the sage in the understory community in pine-sage habitat.
- Burn Plans: Ensure that the potential cumulative effects of multiple fires burning in a given area do not produce negative effects to local wildlife; coordinate burning between administrative units and between wildlife and fire management to minimize potential disturbance.
- 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.

**Old and Large Trees**

There is a design feature for silviculture that states that the stakeholder developed Old Tree Implementation Plan would be 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. A Large Tree Implementation Plan is also included in alternatives C and E, Goshawk prey species utilize large and old trees for nesting and raising young, and as food sources. There is an engineering design feature that states that no old trees would be cut during rehabilitation of temporary roads in PFAs and MSO PACs, target and threshold habitat. There is also a design feature that states that mechanical treatments will not occur within nest stands, or within replacement nest stands. A general design feature would retain trees greater than or equal to 18 inches d.b.h. with dead tops, cavities, and lightning strikes wherever possible to provide cavity nesting/foraging habitat in ponderosa pine habitat.

There is a design feature for silviculture that states that trees greater than 24 inches d.b.h. would not be harvested in restricted and protected MSO habitat. PFA/dPFA and LOPFA habitat overlaps restricted and protected habitat. This is beneficial for goshawks because large trees are used for nesting and perching and are habitat for prey species. Table 170 shows that this design feature would be applied to the most acres in alternative C and the fewest in alternative D.

**Table 170. Acres goshawk habitat within treated Mexican spotted owl habitat**

| Alternative | PFA/dPFA acres Within Treated Mexican Spotted Owl Habitat | LOPFA Acres within Treated Mexican Spotted Owl Habitat | Total Goshawk Habitat within Treated Mexican Spotted Owl Habitat |
|---|---|---|---|
| B | 9,002 | 96,504 | 105,506 |
| C | 10,049 | 98,826 | 108,875 |
| D | 6,643 | 79,588 | 86,231 |
| E | 9,002 | 95,221 | 104,223 |

### Stream Channel and Spring Restoration

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 stream channel restoration in 11 PFAs (Table 171); restoration of one spring in the Tree Spring PFA (number 030405019); and restoration of 73 springs in LOPFA habitat (Table 172). Breeding season timing restrictions would apply to reduce disturbance to nesting goshawks.

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. Up to 4 miles of protective fencing would be established around restored springs. 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 re-establishment 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. Possible management actions for springs include: Remove tree canopy to pre-settlement condition within 2-5 chains of the spring; Apply for water right if none exists; remove noxious weeds; Prescribe burn; Identify stressor and provide protection measure for the stressor (fence, jackstraw, remove/relocate road/trail etc.)

**Table 171. Miles of Stream Channel Restoration by PFA in Alternatives B, C, D, and E**

| PFA Name | PFA Number | Miles |
|---|---|---|
| Cherry Canyon | 030405020 | 0.3 |
| Coxcombs | 030702028 | 0.4 |
| Faye | 030405022 | 0.3 |
| Marshall Mesa | 030405003 | 0.4 |
| Marteen | 030702004 | 0.1 |
| Monument 36 | 030405021 | 0.2 |
| Newman | 030405016 | 1.1 |
| Pipeline III | 030402027 | < .1 |
| Pumphouse | 030405007 | 0.9 |
| Schultz Pass | 030402006 | 1.0 |
| Squaw | 030702029 | 1.5 |
| **Grand Total** | | **6.2** |

**Table 172. Number of springs restored in goshawk habitat by alternatives B, C, D, and E**

| Restoration Unit/Subunit | PFA | LOPFA | Grand Total |
|---|---|---|---|
| 1 | 1 | 31 | 32 |
| 1-2 | | 1 | 1 |
| 1-3 | | 7 | 7 |
| 1-4 | | 3 | 3 |
| 1-5 | 1 | 20 | 21 |
| 3 | | 24 | 24 |
| 3-1 | | 7 | 7 |
| 3-2 | | 6 | 6 |
| 3-3 | | 7 | 7 |
| 3-4 | | 2 | 2 |
| 3-5 | | 2 | 2 |
| 4 | | 14 | 14 |
| 4-3 | | 5 | 5 |
| 4-4 | | 9 | 9 |
| 5 | | 4 | 4 |
| 5-1 | | 2 | 2 |
| 5-2 | | 2 | 2 |
| **Grand Total** | **1** | **73** | **74** |

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 A would not improve prey species habitats at the springs or along the ephemeral channels.

## Alternative B Proposed Action

Alternative B would propose a variety of treatments to move towards 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 (Table 173). Treatment acres by individual PFAs and dPFAs are shown in appendix 20. Acres by treatment type are shown in and described in more detail in the silvicultural report. Direct effects are those caused by the action and occur at the same time and place. This typically means effects from the proposed action on the species being evaluated. Breeding season timing restrictions would reduce disturbance from mechanical treatments. Design criteria to reduce disturbance to goshawks are described in the section titled Common to Alternatives B, C, D, and E.

The more acres treated the more acres that would move towards desired conditions. Alternative B treatments are displayed in Table 173. Treatments are described in more detail in the section titled Common to Alternatives B, C, D, and E, the silviculture report, and in the implementation plan (appendix D of the FEIS).

The amount of treated MSO habitat overlapping goshawk habitat varies slightly by alternative. MSO prescriptions would impact about 2,725 acres of PFA/dPFA habitat in alternative B. Denser

MSO habitat (e.g., PACs, target, and threshold habitats) may support lower densities of some prey species or a different array of prey species than would habitat treated to meet goshawk habitat direction in the forest plans because of the higher canopy cover, larger group size, and smaller or absent interspace. However, treatments in MSO restricted "other" habitat should improve goshawk prey habitat because it includes more interspace and lower average canopy cover. MSO treatments in PAC, target, and threshold habitats would be similar to the desired conditions for goshawk nesting habitat. Because goshawks are generalist species and have broader habitat requirements than MSO, MSO-based management treatments should not be in conflict with maintaining goshawk habitat where the two species overlap.

**Table 173. Summary of Treated Acres in Goshawk Habitat by Alternative**

| Alternative | LOPFA | PFA | dPFA | Total Treated Acres | Amount of treated MSO PAC, Target, and Threshold Treatments within Total Treated Acres |
|---|---|---|---|---|---|
| B | 465,130 | 29,569 | 10,115 | 504,814 | 18,674 |
| C | 514,799 | 30,364 | 10,269 | 555,432 | 18,584 |
| D | 448,042 | 27,476 | 9,848 | 485,366 | 18,584 |
| E | 510,756 | 29,472 | 10,115 | 550,343 | 19,235 |

### *Direct and Indirect Effects*

Direct effects are those caused by the action and occur at the same time and place.

With breeding season timing restrictions on all mechanical treatments, disturbance would be reduced. Design criteria to reduce disturbance to goshawks are described in the section titled Common to Alternatives B, C, D, and E.

The more acres treated the more acres that would move towards desired conditions. Alternative B treatments are displayed in Table 174. Treatments are described in more detail in the section titled 'Common to Alternatives B, C, D, and E', the silvicultural report and in the Implementation Plan in appendix D in the FEIS.

**Table 174. Alternative B proposed treatments in goshawk habitat**

| Cover Type and Proposed Treatment | LOPFA | PFA | dPFA | Grand Total |
|---|---|---|---|---|
| **Ponderosa Pine** | | | | |
| AZGFD Treatment | 0 | 0 | 0 | 0 |
| GL - Restoration | 11,185 | 0 | 0 | 11,185 |
| IT10 | 7,124 | 268 | 173 | 7,565 |
| IT25 | 10,741 | 922 | 208 | 11,871 |
| IT40 | 35,655 | 2,416 | 641 | 38,712 |
| MSO Restricted Treatment | 60,232 | 1,627 | 2,206 | 64,065 |
| MSO Target Treatment | 5,972 | 525 | 0 | 6,497 |
| MSO Threshold Treatment | 1,806 | 75 | 12 | 1,894 |
| PAC - Mechanical | 8,171 | 1,770 | 343 | 10,284 |

| Cover Type and Proposed Treatment | LOPFA | PFA | dPFA | Grand Total |
|---|---|---|---|---|
| Pine-Sage | 4,674 | 392 | 196 | 5,261 |
| Prescribed Fire Only | 107,193 | 10,861 | 1,566 | 119,620 |
| Savanna | 45,405 | 0 | 0 | 45,405 |
| SI10 | 1,823 | 25 | 65 | 1,914 |
| SI25 | 6,408 | 198 | 11 | 6,618 |
| SI40 | 11,935 | 368 | 0 | 12,303 |
| UEA10 | 16,218 | 1,338 | 526 | 18,082 |
| UEA25 | 36,120 | 2,123 | 947 | 39,190 |
| UEA40 | 91,045 | 6,210 | 2,878 | 100,133 |
| WUI55 | 2,130 | 0 | 95 | 2,224 |
| **Ponderosa Pine Total** | **463,836** | **29,119** | **9,868** | **502,823** |
| **Grass** | | | | |
| Grassland Mechanical | 0 | 0 | 0 | 0 |
| PAC - Grassland Mechanical | 0 | 0 | 0 | 0 |
| Prescribed Fire Only | 48,149 | 121 | 152 | 48,423 |
| **Grass Total** | **48,149** | **121** | **152** | **48,423** |
| **Aspen** | | | | |
| Aspen Treatment | 1,100 | 79 | 46 | 1,225 |
| Prescribed Fire Only | 194 | 31 | 0 | 225 |
| **Aspen Total** | **1,294** | **110** | **46** | **1,450** |
| **Pinyon-Juniper** | | | | |
| Prescribed Fire Only | 24,897 | 185 | 36 | 25,117 |
| WUI PJ Treatment | 535 | 0 | 0 | 535 |
| **Pinyon-Juniper Total** | **25,431** | **185** | **36** | **25,652** |
| **Oak Woodland** | | | | |
| Prescribed Fire Only | 3,224 | 26 | 0 | 3,250 |
| **Oak Woodland Total** | **3,224** | **26** | **0** | **3,250** |
| **Non-Veg** | | | | |
| Prescribed Fire Only | 1,712 | 8 | 12 | 1,732 |
| **Non-Veg Total** | **1,712** | **8** | **12** | **1,732** |
| **Grand Total** | **543,647** | **29,568** | **10,115** | **583,330** |

The amount of treated MSO habitat that overlaps goshawk habitat varies slightly by alternative. MSO prescriptions would impact about 2,725 acres of PFA/dPFA habitat in alternative B. Denser MSO habitat (PACs, target, threshold) may support lower densities of some prey species or a different array of prey species than would habitat treated to meet goshawk habitat direction in the forest plan because these categories would be managed to provide higher canopy cover levels. However, treatments in MSO restricted habitat should improve goshawk prey habitat because it is more open. MSO treatments in PAC, target and threshold habitats would be similar to the desired conditions for goshawk nesting habitat. Because goshawks are generalist species and have broader habitat requirements than MSO, MSO-based management treatments should not be in conflict with maintaining goshawk habitat where the two species overlap.

Objectives in nest stands are the same as for PFA/dPFA and are designed to meet or exceed the minimum structural attributes described in GTR-RM-217 for southwest ponderosa pine cover types (Table 175).

**Table 175. Minimum structural attributes for goshawk nest stands**

| Structural Attribute | Minimum Metrics | |
|---|---|---|
| Site Index | <55 | ≥55 |
| Trees per Acre | 40 | 30 |
| Mean d.b.h. (inch) | 16 | 22 |
| Age (year) | 200+ | 200+ |

Alternative B proposes prescribed burning in goshawk habitat. The forest plans allow prescribed burning to occur within PFAs during the breeding season. The effects are discussed in the section titled 'Common to Alternatives B, C, D, and E".

Indirect effects are those effects caused by the action and are later in time and/or further removed in distance. The physical changes to the quantity and quality of the goshawk's habitat and that of its prey species are indirect effects and are addressed in the preceding analyses and the Management Indicator Species analysis. Following are site specific details regarding the effects of alternative B.

Of the 60 PFAs being treated within the project area in alternative B, about 68 percent of them would have their entire territories treated by mechanical or prescribed burning (more than alternative D, less than alternative C, and the same as alternative E). About 10 percent would have 50-75 percent of the PFA treated (same as alternative D and less than alternatives C and E). About 13 percent would have 25-49 percent of the PFA treated (same as alternative C and less than alternatives D and E) and 8 percent would have less than 25 percent of the PFA treated (same as alternatives C and E and less than alternative D). As the percent of the PFA that is treated increases, the relative portion of the PFA that would move towards desired conditions for goshawk habitat would also increase resulting in beneficial long term indirect effects. Alternative A would change some physical features of habitat as discussed earlier, but because of the lack of treatments would not improve the quality of the habitat.

### Slide Fire

Table 176 shows the proposed treatments under alternative B that were affected by 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.

**Table 176. Alternative B treatments affected by the Slide Fire**

| Proposed Treatments (Alt B) | Acres | Outside Fire Perimeter | Vegetation Severity | | | |
|---|---|---|---|---|---|---|
| | | | Unchanged | Low | Moderate | High |
| **PFA** | | | | | | |
| PFA - IT40 | 34 | 0 | 9 | 22 | 3 | 0 |
| PFA - UEA40 | 11 | 0 | 0 | 8 | 2 | 0 |
| PFA Nest Stand Prescribed Fire Only | 29 | 0 | 6 | 22 | 1 | 0 |
| **LOPFA** | | | | | | |
| GL - Restoration | 13 | 0 | 5 | 8 | 1 | 0 |
| IT10 | 28 | 0 | 8 | 18 | 2 | 0 |
| IT40 | 820 | 0 | 87 | 424 | 259 | 50 |
| Prescribed Fire Only | 143 | 0 | 7 | 64 | 71 | 1 |
| Prescribed Fire Only (MSO Protected Habitat) | 1,012 | 0 | 28 | 302 | 449 | 233 |
| Prescribed Fire Only - Operational | 108 | 2 | 41 | 52 | 12 | 1 |
| Savanna | 131 | 0 | 17 | 90 | 23 | 0 |
| UEA10 | 395 | 0 | 30 | 237 | 126 | 1 |
| UEA25 | 5 | 0 | 1 | 3 | 0 | 0 |
| UEA40 | 992 | 0 | 137 | 652 | 203 | 0 |
| MSO Threshold Trt | 32 | 0 | 0 | 14 | 13 | 4 |
| MSO Target Trt | 318 | 0 | 26 | 135 | 120 | 38 |
| MSO Restricted Trt | 3,793 | 1 | 255 | 1,747 | 1,463 | 327 |
| **Grand Total** | **7,864** | **3** | **657** | **3,798** | **2,748** | **655** |

### Vegetation Structural Stage

Appendix 20 displays the VSS distribution for even age and uneven age stands by goshawk habitat projected out to the years 2020 and 2050.

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.

As stand development progresses, the distribution shifts toward the later stages by 2050. The mid-aged, mature and old forest structural stages account for a combined overall distribution of 85 percent. This is very similar to the combined distribution of these stages in alternative A with the difference being alternative A results in a higher percentage of VSS 4 while alternative B results in a higher percentage of VSS 6. In 2050, there are no VSS 1 stands and the overall distribution shows VSS 2 close to desired at 13 percent, VSS 3 deficit by 17 percent, VSS 4 and VSS 5 above desired at 30 and 34 percent respectively and VSS 6 right at desired with 21 percent.

In 2020, overall distribution within the PFA even-aged stands shows VSS 1 slightly below desired at 9 percent, no VSS 2, VSS 3 close to desired with 22 percent, VSS 4 more than twice desired at 46 percent, VSS 5 below desired with 14 percent and VSS 6 deficit by 12 percent. There is a more balanced overall distribution compared to the no action alternative with improvement toward the desired representation in the grass/forb/shrub, young, mature and old forest stages.

As stand development progresses, the distribution shifts toward the later stages by 2050. The mid-aged, mature and old forest structural stages account for a combined overall distribution of 89 percent. This is very similar to the combined distribution of these stages in alternative A with the difference being alternative A results in a higher percentage of VSS 4 while alternative B results in a higher percentage of VSS 5. In 2050, there are no VSS 1 stands and the overall distribution shows VSS 2 close to desired at 9 percent, VSS 3 deficit by 18 percent, VSS 4 and VSS 5 above desired at 41 and 39 percent respectively and VSS 6 below desired with 9 percent.

In 2020, overall distribution within the PFA uneven-aged stands shows VSS 1 slightly below desired at 8 percent, no VSS 2, VSS 3 slightly below desired with 18 percent, VSS 4 21 percent above desired, VSS 5 4 percent above desired and VSS 6 below desired with 10 percent. This is a more balanced overall distribution compared to the no action alternative with improvement toward desired representation in the grass/forb/shrub, and young, mid-aged and old forest stages.

As stand development progresses, the distribution shifts toward the later stages by 2050. The mid-aged, mature and old forest structural stages account for a combined overall distribution of 92 percent. This is very similar to the combined distribution of these stages in alternative A with the difference being alternative A results in a higher percentage of VSS 4 while alternative B results in a higher percentage of VSS 5 and 6. In 2050, there are no VSS 1 stands and the overall distribution shows VSS 2 close to desired at 8 percent, no VSS 3 stands, VSS 4 and VSS 5 above desired with 29 and 39 percent respectively and VSS 6 slightly above desired with 24 percent.

Age and size class distribution: Even-aged stands would trend toward uneven-aged and uneven-aged stands would be maintained as uneven-aged.

### Old Growth

The restoration treatments proposed under alternative B are designed to manage for old age trees in order 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 Strategy in the silvicultural report. Maintaining old growth across the landscape would benefit a range of wildlife species, including goshawks, MSO, and black bears.

The goshawk habitat structural stage analysis indicates the mature and old forest structural stages to be underrepresented in the PFA habitat and LOPFA even-aged stands. Projections show a trend toward improved representation in all habitats.

Treatments within areas currently old growth would maintain existing old growth structural attributes and are managed to move towards those conditions over time. The ponderosa pine old growth analysis indicates old growth structural attributes would continue to develop and improve across the landscape. Table 177 displays old growth structural attributes for ponderosa pine identified in the Coconino forest plan projected out to the years 2020 and 2050.

**Table 177. Alternative B - 2020 and 2050 ponderosa pine old growth structural attributes by restoration unit**

| Restoration Subunit and Unit | Average TPA 18"+ | | | Average BA | | | Average Tons CWD ≥12" | | | Average Snags Per Acre ≥12" | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 |
| **All** | **13.0** | **13.6** | **20.1** | **118** | **82** | **110** | **0.4** | **0.7** | **1.5** | **1.8** | **4.4** | **2.3** |
| 1-1 | 13.2 | 13.3 | 19.0 | 117 | 76 | 105 | 0.4 | 0.6 | 1.3 | 1.4 | 3.9 | 1.6 |
| 1-2 | 11.0 | 11.1 | 16.6 | 101 | 63 | 89 | 0.3 | 0.6 | 1.2 | 1.1 | 3.7 | 1.4 |
| 1-3 | 13.5 | 14.2 | 20.7 | 128 | 88 | 116 | 0.6 | 0.8 | 1.5 | 2.0 | 3.7 | 2.5 |
| 1-4 | 11.6 | 12.7 | 19.7 | 117 | 89 | 116 | 0.3 | 0.5 | 1.3 | 1.7 | 3.7 | 2.8 |
| 1-5 | 14.9 | 16.5 | 24.3 | 146 | 118 | 143 | 0.6 | 0.8 | 1.8 | 2.8 | 4.6 | 4.4 |
| **1** | **13.9** | **15.0** | **22.1** | **134** | **101** | **128** | **0.5** | **0.7** | **1.6** | **2.3** | **4.2** | **3.4** |
| 3-1 | 12.9 | 12.9 | 18.8 | 121 | 72 | 101 | 0.3 | 0.6 | 1.3 | 1.6 | 4.0 | 1.5 |
| 3-2 | 14.7 | 14.5 | 19.4 | 113 | 70 | 97 | 0.3 | 0.6 | 1.3 | 1.5 | 3.5 | 1.5 |
| 3-3 | 13.8 | 14.0 | 19.8 | 132 | 80 | 110 | 0.4 | 0.7 | 1.5 | 2.0 | 4.3 | 2.0 |
| 3-4 | 15.8 | 16.6 | 23.6 | 148 | 112 | 138 | 0.7 | 0.9 | 1.9 | 2.8 | 4.8 | 4.0 |
| 3-5 | 15.2 | 15.6 | 22.6 | 147 | 92 | 122 | 0.8 | 1.0 | 2.1 | 2.6 | 5.7 | 2.8 |
| **3** | **14.4** | **14.5** | **20.5** | **132** | **82** | **111** | **0.5** | **0.8** | **1.6** | **2.1** | **4.5** | **2.2** |
| 4-2 | 13.0 | 12.3 | 17.0 | 103 | 62 | 87 | 0.2 | 0.5 | 1.1 | 1.2 | 3.5 | 1.2 |
| 4-3 | 11.9 | 12.4 | 19.3 | 107 | 70 | 97 | 0.3 | 0.6 | 1.4 | 1.4 | 4.8 | 1.8 |
| 4-4 | 13.2 | 13.2 | 19.4 | 119 | 66 | 95 | 0.3 | 0.6 | 1.3 | 1.4 | 3.7 | 1.2 |
| 4-5 | 14.1 | 14.4 | 22.9 | 136 | 78 | 111 | 0.4 | 0.8 | 1.6 | 2.1 | 5.0 | 1.6 |
| **4** | **12.7** | **12.8** | **19.3** | **113** | **68** | **96** | **0.3** | **0.6** | **1.3** | **1.4** | **4.2** | **1.5** |
| 5-1 | 11.7 | 12.6 | 19.8 | 99 | 75 | 102 | 0.5 | 0.6 | 1.6 | 1.4 | 5.5 | 2.1 |
| 5-2 | 11.9 | 12.9 | 19.6 | 84 | 75 | 97 | 0.5 | 0.5 | 1.6 | 1.3 | 5.8 | 2.3 |
| **5** | **11.8** | **12.8** | **19.6** | **87** | **75** | **98** | **0.5** | **0.5** | **1.6** | **1.3** | **5.8** | **2.3** |
| 6-2 | 8.5 | 8.9 | 14.2 | 84 | 63 | 94 | 0.2 | 0.3 | 0.9 | 0.6 | 3.9 | 1.0 |
| 6-3 | 9.1 | 9.4 | 15.0 | 92 | 69 | 104 | 0.2 | 0.3 | 0.9 | 0.6 | 3.6 | 0.9 |
| 6-4 | 9.3 | 9.5 | 15.4 | 109 | 78 | 108 | 0.3 | 0.4 | 1.5 | 1.0 | 6.6 | 2.0 |
| **6** | **9.0** | **9.3** | **14.9** | **91** | **69** | **102** | **0.2** | **0.3** | **0.9** | **0.6** | **3.8** | **1.0** |

In 2020, the average conditions are at or above the minimum criteria with the following exceptions:

- Trees per acre larger than 18 inch d.b.h. and 180 years old: This condition is deficit in all subunits ranging from a low of 8.9 trees per acre in Subunit 6-2 to a high of 16.6 trees per acre in Subunit 3-4 with an overall average for all acres of 13.6 trees per acre. The age of these trees is estimated be in the range of 100 to 140 years old with a few relic trees meeting the 180 year old criteria.
- Basal area greater than or equal to 90: This condition is below desired in Restoration Units 3, 4, 5 and 6. Overall average for all acres is 82.
- Coarse woody debris greater than 12 inch: This condition is estimated to be deficit with less than the equivalent of 2 pieces per acre throughout Restoration Units 5 and 6, and various subunits.

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 trees per acre larger than 18 inch d.b.h. with the exception of Restoration Unit 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 will be met throughout the old growth acres.

With the implementation of restoration treatments under alternative B, the sustainability of the large/old tree component across the landscape would be improved as presented in the following discussion about density.

**Tree Groups, Interspaces, and Openness**

Even though there is a shift from more closed to more open conditions in alternatives B, C, D, and E, 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).

The majority of the landscape currently has continuous tree canopy with generally small interspaces. The desired condition is a mosaic of interspaces and tree groups of varying sizes and shapes. Alternative B has a higher ability to attain a mosaic of interspaces and tree groups than alternative A and a similar ability to attain the desired conditions as alternatives C through E.

While all treatments with the exception of Grassland Restoration are designed to reestablish forest openings and attain a mosaic of interspaces and tree groups of varying sizes and shapes, the intensity of the treatment affects the relative tendency toward this condition. The lower intensity treatments within MSO PAC, Target/Threshold, and prescribed fire only, treatments will result in irregular tree spacing and subtle expansion of existing forest openings. The higher intensity treatments such as Pine Sage, Savanna, UEA 40, IT 40 and SI 40 will be removing more trees and extends greater flexibility in size and shape of interspaces and tree groups generated. MSO Restricted Treatments, SI10, UEA10, IT10, UEA 25, IT25, and SI25 would be expected to have a moderate contribution to the creation of interspaces and tree groups. Using Table 21, there are an estimated 266,563 acres of treatment (using the acreage of the treatments just listed) in alternative B that would contribute to the creation of interspaces and tree groups.

Alternative B would restore forest openings through restoration treatments in PFA, LOPFA and MSO restricted other habitats through the removal of ponderosa pine tree canopy that is shading out understory herbaceous vegetation and reducing forage production and species enhancing small grassland inclusions within the greater forested area. This would be followed by prescribed burning. The subsequent litter reduction and nutrient pulse would elicit a positive understory response and would provide food and cover for goshawk prey species through time, potentially improving prey numbers within grasslands and meadows and providing source populations of different prey species (e.g., mice, voles, rabbits, and gophers) for dispersal into the surrounding forest. In addition, arthropod prey such as beetles and moths would also likely benefit from these treatments. Therefore, meadow and an unknown percentage of grassland treatments would be expected to improve understory conditions for goshawk prey species.

Table 161 under alternative A compares the percentage of openness in PFA/dPFA and LOPFA habitat by alternative and the associated discussion describes the openness categories. In alternative B, over half of PFA/dPFA is estimated to be open to very open suggesting that understory needed by prey and invertebrates has improved and this proportion of open habitat is somewhat higher in LOPFA habitat. Vulnerability to uncharacteristic fire and density related mortality is less than alternative A. The increased post treatment openness would improve the sustainability of ponderosa pine in these habitats.

Alternative B has about the same proportion of open/very open acres as alternatives C and D however they have nearly 10,000 more open/very open acres in LOPFA than alternative E. The greater amount of savanna and grassland restoration treatments in this alternative (and alternative C and D) results in a higher amount of very open conditions in LOPFA than alternative E. Alternative C has less open habitat than alternative E due to fewer acres of the following treatments: Uneven-aged, Intermediate thinning, and Stand Improvement.

These conditions are more reflective of Coconino Forest Plan guidance to provide a healthy sustainable forest environment for post-fledging family needs than alternative A. It meets desired conditions in the Kaibab Forest Plan which calls for generally open conditions in ponderosa pine and appears to be compliant with Kaibab Forest Plan direction which allows for denser tree conditions in some locations and higher basal areas in some areas, such as in PFAs and could meet canopy cover guidelines listed in the Coconino Forest Plan. Forest Plan direction regarding silviculture and fire is located in the respective specialist reports. The Implementation Plan, located in appendix D of the Final Environmental Impact Statement, gives specific details on how forest plan direction for PFAs and nest areas will be met in each treatment type.

Although grassland and savanna areas are not typically considered goshawk habitat, some benefits to prey could occur with these treatments, specifically for rabbits. Increased abundance and diversity of understory should create more food and cover for cottontails. In good years, rabbits would be expected to move into adjoining habitats, more typically used for goshawk foraging. Grassland treatments would go up to an average of 10 basal area and occur on mollic soils, thus grassland and savanna areas would serve as source populations for this prey species. Savanna thin and burn treatments would average 10-30 basal area in ponderosa pine and occur on mollic intergrade soils. Some of the savanna treatments originated from overlaying open and mixed corridor pathways, identified by the Arizona Game and Fish Department, to connect similar habitats. One of these is along Interstate 40; just west of Camp Navajo to support and to help realize a future highway crossing for pronghorn and to emphasize open habitat connectivity.

If the highway crossing happens at a later date, Government Prairie and Garland Prairie would be connected and if the highway crossing does not occur, then the potential travel ways north of I-40 would be connected, again benefiting open habitat species like rabbits.

**Density**

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 (Table 178). 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.

At the Subunit level in PFA/dPFA habitat, Subunit 6-2 would have the lowest density over time while Subunit 1-5 would have the highest. In LOPFA habitat, Subunit 4-2 would have the lowest density and Subunit 3-4 would have the highest.

In general, the following characteristics would be expected to develop as density decreases.

- Grassy stands of open canopy large diameter trees with long, heavy limbed crowns.
- Stands of moderately dense canopy, intermediate size trees.
- Clumpy irregular stands with groups of varying ages. Openings for seedling establishment would be made periodically.

These would improve the quality and sustainability of nesting and fledgling 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 increases, there would be concurrent increased vulnerability to insect and disease and uncharacteristic and less understory, and slower tree growth fire by 2050. Impacts to forest health are described in more detail in the silvicultural report. Table 178 shows the shifts in tree density in goshawk habitat in the different restoration units. The darkest shading is extremely high density; the lightest shading is moderate density; and the intermediate shading is high density.

**Table 178. Density in goshawk habitat in Alternative B**

| Restoration Unit and Subunit | SDI % of Max PFA/dPFA | | | SDI % of Max LOPFA | | |
|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 |
| All | 61% | 40% | 49% | 57% | 34% | 43% |
| **1** | 71% | 52% | 58% | 65% | 40% | 49% |
| 1-1 | 72% | 35% | 48% | 56% | 32% | 42% |
| 1-2 | 50% | 34% | 43% | 49% | 27% | 35% |
| 1-3 | 65% | 39% | 47% | 61% | 36% | 46% |
| 1-4 | 64% | 44% | 53% | 60% | 37% | 46% |
| 1-5 | 78% | 62% | 67% | 70% | 45% | 53% |
| **3** | 63% | 39% | 48% | 63% | 36% | 45% |
| 3-1 | 58% | 37% | 46% | 59% | 34% | 44% |
| 3-2 | 55% | 35% | 43% | 52% | 31% | 40% |
| 3-3 | 65% | 41% | 50% | 63% | 35% | 45% |
| 3-4 | 79% | 34% | 45% | 72% | 47% | 55% |
| 3-5 | 69% | 38% | 48% | 71% | 39% | 48% |
| **4** | 56% | 35% | 44% | 51% | 28% | 37% |
| 4-2 | 48% | 31% | 40% | 44% | 24% | 32% |
| 4-3 | 54% | 35% | 43% | 47% | 28% | 36% |
| 4-4 | 61% | 36% | 45% | 54% | 28% | 37% |
| 4-5 | 56% | 38% | 46% | 57% | 32% | 42% |
| **5** | 56% | 38% | 46% | 40% | 28% | 36% |
| 5-1 | 58% | 42% | 49% | 45% | 29% | 38% |
| 5-2 | 53% | 35% | 42% | 37% | 28% | 35% |
| **6** | 50% | 34% | 45% | 52% | 34% | 46% |
| 6-2 | 42% | 28% | 37% | 45% | 29% | 40% |
| 6-3 | 50% | 34% | 46% | 51% | 35% | 47% |
| 6-4 | | | | 61% | 35% | 45% |

The silvicultural report lists the beetle hazard rating for the years 2020 and 2050 by Restoration Unit and for the ponderosa pine analysis area (Table 179). The overall hazard in 2020 is high across 22 percent of the analysis area which is considerably less than existing (over 70 percent). This increases to 52 percent in 2050. Stands with a hazard rating of low or moderate would be expected to be resistant to successful bark beetle attack and large scale mortality. Restoration Unit 5 would have the lowest proportion in the high category by 2050 and Restoration Unit 6 would have the highest proportion.

**Table 179. Alternative B Ponderosa Pine Beetle Hazard Rating (Percent of area in each RU)**

| Hazard Rating | RU 1 | RU 3 | RU 4 | RU 5 | RU 6 | % of Total | Analysis Area Acres |
|---|---|---|---|---|---|---|---|
| **2010** | | | | | | | |
| Low | 3% | 6% | 8% | 26% | 0% | 7% | 37,933 |
| Moderate | 12% | 11% | 27% | 46% | 25% | 21% | 106,132 |
| High | 85% | 83% | 65% | 28% | 75% | 72% | 363,775 |
| **2020** | | | | | | | |
| Low | 34% | 40% | 61% | 46% | 38% | 45% | 226,030 |
| Moderate | 32% | 30% | 29% | 48% | 43% | 33% | 169,152 |
| High | 34% | 30% | 10% | 6% | 19% | 22% | 112,657 |
| **2050** | | | | | | | |
| Low | 9% | 11% | 17% | 27% | 2% | 13% | 66,254 |
| Moderate | 25% | 27% | 46% | 50% | 30% | 34% | 175,058 |
| High | 66% | 62% | 37% | 24% | 68% | 52% | 266,527 |

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 B (Kerhoulas et al. 2013). Lower density stands result in more deep water storage in the soils because there would be less canopy to interfere with precipitation reaching the ground. Deep soil water is recharged by winter precipitation and ponderosa pines, especially large trees, rely heavily on this deep water. Overall, the risk of landscape-scale wildfire, with the potential to eliminate large portions of forested habitat, would decrease with the treatments in alternative B.

### Oak

Treatments proposed in alternative B are designed to conserve oak and improve conditions that favor oak growth and establishment wherever it exists by reducing pine-oak competition. This would result in improved vigor of existing oak and establishment of a variety of oak size and age classes across the landscape. These conditions would be most prevalent within goshawk habitat that overlaps the 64,065 acres of MSO restricted other habitat treatments. The silvicultural report shows that the overall post treatment oak basal area would be 5 percent higher in this habitat compared to the no action alternative. The improved balance of age classes would lead to increased resiliency and sustainability of oak.

### Aspen

Mechanical treatments in aspen would improve the quality of the aspen habitat for goshawk prey species including the red-naped sapsucker. There would be greater improvement in alternatives B, C and E, which implement prescribed burning with the mechanical treatments, than in alternative D which only uses mechanical treatments in aspen. Alternative A would not improve any acres of aspen habitat and would therefore maintain the current decline in aspen habitat. Implementing breeding season timing restrictions for any activities within PFAs would eliminate disturbance to nesting goshawks.

The treatments within 1,450 acres of aspen stands under alternative B are designed to maintain, expand, and/or regenerate aspen by reducing pine-aspen competition. These treatments would result in establishment of vigorous aspen regeneration free of competition from overtopping ponderosa pine. Mechanical treatments would increase surface fuels to better carry fire beneath aspen overstories where fuel loading can be patchy. Mechanical scarification of soils, along with prescribed fire, would better stimulate aspen suckering. Improved health and resiliency of aspen clones and a robust understory response would be expected.

Up to 82 miles of protective barriers would be established around aspen clone patches within the ponderosa pine forest to prevent ungulate grazing within aspen clones. Barriers would consist of fencing and/or felling trees (jack-strawing). Fencing would occur after mechanical and burning treatments and would have no effect to the vegetation. Jack-strawing may occur during the mechanical operation and would utilize trees that have been targeted for removal to meet treatment objectives. Short- and long-term improvements in understory vegetation and overstory aspen health and sustainability would be anticipated.

**Pine Sage**

The 5,261 acres of pine-sage thinning treatments are designed to remove post settlement pine that is currently overtopping and shading out the sage and to manage fire to enhance sage extent. These treatments would result in enhancement of the sage component and restore the historic pattern within the pine sage mosaic. This would occur in 4,674 acres of LOPFA habitat, 392 acres of PFA, and 196 acres of dPFA. Improved health and resiliency of sage and a more vigorous understory response would be expected which could improve habitat for prey species.

Snags, Logs, and Coarse Woody Debris

Refer to Figure 29, Figure 30, and Figure 31 to compare the effects of the alternatives on these components of prey habitat. Predicted snag densities by restoration unit, subunit, and alternative are displayed in appendix 20.

**Snags**: Snags provide nesting and denning habitat, roosts, and foraging habitat for invertebrates, bird and mammal species, some of which are prey for goshawks. In the short term (2020), alternatives B, C & E would have the highest density of large snags per acre in PFA/dPFAs followed by alternative D, then alternative A although the differences are slight. This general pattern holds true for the restoration unit and subunit scales. In the long term (2050), the density of large snags is similar between alternatives in PFAs/dPFAs and in LOPFAs. Snag density would increase in both the PFAs/dPFAs and LOPFAs over time in alternative B but still would not achieve the guideline in the Coconino Forest Plan for at least 2 large snags per acre. Snag density in PFA/dPFA habitat would meet the desired condition 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 low end of the Kaibab Forest Plan desired condition in the short term (average of 0.94 snags per acre) and the long term (average of 0.93 snags per acre).

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.

**Logs**: Logs provide important habitat features for prey species, including substrate for foraging, den and nest sites, and cover. In the short term (2020), alternative B would have log densities similar to alternatives A, C, and E and log densities lower than alternative D in the PFAs/dPFAs and LOPFAs. In the long term (2050), alternative B would have similar log densities per acre as alternatives C, D, and E and higher densities than alternative A in PFAs/dPFAs and LOPFAs. Log density per acre in this alternative would increase from year 2020 to year 2050 so although alternative B would not meet Forest Plan guideline/desired conditions of at least 3 large logs per acre in the short term, the requirements would be exceeded in the long term. More logs would be provided in PFA/dPFA versus LOPFA habitat. In the short term, neither PFA/dPFA or LOPFA habitat would meet guideline/desired condition of a minimum of three large logs per acre in the Coconino Forest Plan and the Kaibab Forest Plan. However it would meet these requirements 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.

**Coarse woody debris:** In the short term (2020) and long term (2050), LOPFA and PFA/dPFA habitat in alternative B would have similar amounts of coarse woody debris as alternatives C and E and lower amounts than alternatives A and D. This general pattern holds true for the restoration unit and subunit scales except in Subunit 1-5 in which alternative B would be similar only to alternative C and would have lower amounts of coarse woody debris than alternatives A, D, and E. The short term amount (estimated 4.56 tons per acre) in the LOPFA would be near the lower end of the guidelines in the Coconino forest plan of 5-7 tons per acre in ponderosa pine and would meet the guideline, at 5 tons per acre, in the PFA/dPFA. Kaibab forest plan guideline/desired condition (average of 3-10 tons per acre) would be met in PFA/dPFA habitat in the short term and in both goshawk habitat types in the long term however LOPFA habitat would not quite meet these guideline/desired conditions in the short term at an average of 2.8 tons per acre. Average 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 20.

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 requirements in the short term, it would be reached in the long term.

### Understory Development

A productive and diverse understory protects soil from erosion, creates forage and cover for wildlife, provides fuels to carry low-severity surface fires, and is the repository for much of the biodiversity in ponderosa pine ecosystems (Moore et al. 2006). Understory vegetation defines and supports the arthropod community which responds to changes in habitat and are key drivers of ecosystem structure and function. They decompose organic material, aerate and enrich soil, release nutrients back into the ecosystem, maintain genetic diversity within plant species, and serve as key prey for birds and small mammals which, in turn, support populations of larger predators. Appendix 6 provides a literature review on understory and arthropod response to overstory cover and fire. Appendix 20 contains a table that compares understory index by restoration unit and subunit in LOPFAs and PFAs/dPFAs by alternative. .

Alternative B is similar to alternative C. These two alternatives provide the greatest amount of understory (compared to the other alternatives) in the short term (2020) as openings and interspaces are created and tree density is reduced. Like the other alternatives, understory production would decline by year 2050. 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 (appendix 6). 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. This would be the most beneficial for goshawk prey species like American robins, band-tailed pigeons, cottontail rabbits, golden-mantled ground squirrels, mourning doves, northern flickers, Stellar's jay, and Williamson's sapsucker because of improving foraging and nesting habitat and invertebrate prey. This general pattern holds true for the restoration unit and subunit scales

Grassland treatments in about 48,703 acres would remove encroaching trees up to 24 inches in diameter from grassland (mollic) soils to restore grasslands to a structure that has less than 10 percent tree canopy cover. Savanna treatments on nearly 45,500 acres would remove trees up to 18 inches in diameter to achieve total ponderosa pine stand density index of 90. Both of these treatments would be followed by low intensity prescribed burning. These treatment types occur only in LOPFAs, not in PFAs/dPFAs. .

Some percentage of grassland and savanna treatments could function as cover and food for goshawk prey where the open area is relatively small. Larger areas that receive savanna and grassland restoration treatments would not function as prey habitat however could benefit goshawks indirectly. Small mammals and birds that are potential prey for goshawks could increase as the understory in the treated areas responds to treatment. They could disperse into nearby goshawk habitat and thus serve as source populations for goshawk prey in treated ponderosa pine stands.

### *Determination of Effect*

Considering direct, indirect, and cumulative effects, implementation of alternative B may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.

## Alternative C Preferred Alternative

Alternative C would implement a variety of treatments to move towards desired conditions in goshawk habitat. This alternative would treat over 555,000 acres, the most goshawk habitat in all habitat categories (Table 180). The more acres treated the more acres that would move towards desired conditions. Treatments are described in more detail in the section titled 'Common to Alternatives B, C, D, and E, the silvicultural report and in the Implementation Plan in appendix D in the FEIS.

Treatments include about 18,600 acres of treated MSO habitat. About 70 percent (42) of the 60 treated PFAs will 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 towards desired conditions for goshawk habitat would also increase. The treatment types and the acres by treatment type are shown in Table 30 and are described in more detail in the silvicultural report.

Some categories of MSO habitat (PACs, protected, target, threshold) may support lower densities of some prey species or a different array of prey species than would habitat treated to meet goshawk habitat direction in the forest plan because these categories would be managed to provide higher canopy cover levels. However, treatments in MSO restricted "other" habitat should improve goshawk prey habitat because it is more open. MSO treatments in protected and target and threshold habitats would be similar to the desired conditions for goshawk nesting habitat. Because goshawks are generalist species and have broader habitat requirements than MSO, MSO-based management treatments should not be in conflict with maintaining goshawk habitat where the two species overlap.

**Table 180. Alternative C proposed treatments in goshawk habitat**

| Cover Type and Proposed Treatment | LOPFA | PFA | dPFA | Grand Total |
|---|---|---|---|---|
| **Ponderosa Pine** | | | | |
| AZGFD Treatment | 4,563 | 274 | 0 | 4,837 |
| GL - Restoration | 11,230 | 0 | 0 | 11,230 |
| IT10 | 7,124 | 268 | 173 | 7,565 |
| IT25 | 10,741 | 922 | 208 | 11,871 |
| IT40 | 35,559 | 2,416 | 641 | 38,616 |
| MSO Restricted Treatment | 58,952 | 1,627 | 2,206 | 62,785 |
| MSO Target Treatment | 5,970 | 525 | 0 | 6,495 |
| MSO Threshold Treatment | 1,805 | 75 | 12 | 1,892 |
| PAC - Mechanical | 8,171 | 1,770 | 343 | 10,284 |
| Pine-Sage | 4,674 | 392 | 196 | 5,261 |
| Prescribed Fire Only | 110,798 | 11,749 | 1,720 | 124,267 |
| Savanna | 45,142 | 0 | 0 | 45,142 |
| SI10 | 1,823 | 25 | 65 | 1,914 |
| SI25 | 6,408 | 198 | 11 | 6,618 |
| SI40 | 11,901 | 368 | 0 | 12,269 |
| UEA10 | 16,001 | 1,338 | 526 | 17,865 |
| UEA25 | 35,425 | 2,120 | 947 | 38,492 |
| UEA40 | 87,004 | 5,847 | 2,878 | 95,730 |
| WUI55 | 2,130 | 0 | 95 | 2,224 |
| **Ponderosa Pine Total** | **465,421** | **29,914** | **10,023** | **505,358** |
| **Grass** | | | | |
| Grassland Mechanical | 48,013 | 121 | 26 | 48,161 |
| PAC - Grassland Mechanical | 35 | 0 | 0 | 35 |
| Prescribed Fire Only | 362 | 0 | 126 | 488 |
| **Grass Total** | **48,411** | **121** | **152** | **48,684** |
| **Aspen** | | | | |
| Aspen Treatment | 1,100 | 79 | 46 | 1,225 |
| Prescribed Fire Only | 213 | 31 | 0 | 243 |
| **Aspen Total** | **1,313** | **110** | **46** | **1,469** |
| **Pinyon-Juniper** | | | | |
| Prescribed Fire Only | 24,902 | 185 | 36 | 25,123 |
| WUI PJ Treatment | 535 | 0 | 0 | 535 |
| **Pinyon-Juniper Total** | **25,437** | **185** | **36** | **25,658** |
| **Oak Woodland** | | | | |
| Prescribed Fire Only | 3,184 | 26 | 0 | 3,209 |
| **Oak Woodland Total** | **3,184** | **26** | **0** | **3,209** |
| **Non-Veg** | | | | |
| Prescribed Fire Only | 1,712 | 8 | 12 | 1,732 |
| **Non-Veg Total** | **1,712** | **8** | **12** | **1,732** |
| **Grand Total** | **545,477** | **30,363** | **10,269** | **586,110** |

### *Direct and Indirect Effects*

Direct effects are those caused by the action and occur at the same time and place. With breeding season timing restrictions on all mechanical treatments, disturbance would be reduced. Design criteria to reduce disturbance to goshawks are described in the section titled Common to Alternatives B, C, D, and E.

Indirect effects are those effects caused by the action and are later in time and/or further removed in distance. The physical changes to the quantity and quality of the goshawk's habitat and that of its prey species are indirect effects and are is addressed in the preceding analyses and the Management Indicator Species analysis. Following are site specific details regarding the effects of alternative C. Mechanical thinning and prescribed burning would alter forest structure which would decrease the potential for uncharacteristic fire.

#### Slide Fire

Table 181 shows the proposed treatments under alternative C that were affected by the Slide Fire.

**Table 181. Alternative C treatments affected by the Slide Fire**

| | | | | Vegetation Severity | | | |
|---|---|---|---|---|---|---|---|
| **Proposed Treatments (Alt C)** | **Acres** | **Number of Stands** | **Outside Fire Perimeter** | **Unchanged** | **Low** | **Moderate** | **High** |
| **PFA** | | | | | | | |
| PFA - IT40 | 34 | 1 | 0 | 9 | 22 | 3 | 0 |
| PFA - UEA40 | 11 | 1 | 0 | 0 | 8 | 2 | 0 |
| PFA Nest Stand Prescribed Fire Only | 29 | 1 | 0 | 6 | 22 | 1 | 0 |
| **LOPFA** | | | | | | | |
| GL - Restoration | 13 | 1 | 0 | 5 | 8 | 1 | 0 |
| IT10 | 28 | 1 | 0 | 8 | 18 | 2 | 0 |
| IT40 | 820 | 8 | 0 | 87 | 424 | 259 | 50 |
| Prescribed Fire Only | 143 | 3 | 0 | 7 | 64 | 71 | 1 |
| Savanna | 131 | 7 | 0 | 17 | 90 | 23 | 0 |
| UEA10 | 395 | 6 | 0 | 30 | 237 | 126 | 1 |
| UEA25 | 5 | 2 | 0 | 1 | 3 | 0 | 0 |
| UEA40 | 992 | 9 | 0 | 137 | 652 | 203 | 0 |
| MSO Restricted Treatment | 3,793 | 58 | 1 | 255 | 1,747 | 1,463 | 327 |
| MSO Target Treatment | 318 | 10 | 0 | 26 | 135 | 120 | 38 |
| MSO Threshold Treatment | 32 | 1 | 0 | 0 | 14 | 13 | 4 |

| Proposed Treatments (Alt C) | Acres | Number of Stands | Outside Fire Perimeter | Vegetation Severity | | | |
|---|---|---|---|---|---|---|---|
| | | | | Unchanged | Low | Moderate | High |
| MSO Protected Habitat Prescribed Fire Only | 1,012 | 34 | 0 | 28 | 302 | 449 | 233 |
| MSO Protected Habitat Prescribed Fire Only - Core Area | 7 | 1 | 0 | 0 | 0 | 7 | 0 |
| **Grand Total** | **7763** | **144** | **1** | **616** | **3746** | **2743** | **654** |

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.

### Vegetation Structural Stage

Appendix 20 displays the VSS distribution for even age and uneven age stands by goshawk habitat projected out to the years 2020 and 2050.

In the silvicultural report, an analysis of the goshawk structure attributes for alternative C 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 C 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 C.

An analysis of the VSS distribution within goshawk habitat for alternative C showed very minor differences compared to alternative B. All percentages are the same for alternative C as alternative B for all other stages and years in each of the Restoration Units and habitats. Therefore, the narrative summaries describing post treatment and 2050 VSS distribution by habitat for alternative B are essentially the same for alternative C with the same trends.

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.

### Old Growth

Table 182 displays the old growth structural attributes of the ponderosa pine old growth acres projected out to the years 2020 and 2050 under alternative C.

In 2020, the average conditions are at or above the minimum criteria with the following exceptions:

- Trees per acre larger than 18 inch and 180 years old. This condition is deficit in all SUs ranging from a low of 8.9 TPA in SU 6-2 to a high of 16.5TPA in SU3-4 with an overall average for all acres of 13.6 TPA. The age of these trees is estimated be in the range of 100 to 140 years old with a few relic trees meeting the 180 year old criteria.
- Basal area greater than or equal to 90. This condition is below desired in RUs 3, 4, 5 and 6. Overall average for all acres is 82.
- Coarse woody debris greater than 12 inch. This condition is estimated to be deficit with less than the equivalent of 2 pieces per acre throughout RU 5 and 6, and various SUs.

Over time, old growth conditions improve in terms of meeting the minimum criteria. In 2050, all RUs are very close to or exceed the criteria for TPA larger than 18 inch 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 will be met throughout the old growth acres.

The restoration treatments proposed under alternative C are designed to manage for old age trees in order 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 Strategy in appendix A of the silvicultural report.

The goshawk habitat structural stage analysis above indicates the mature and old forest structural stages to be underrepresented in the PFA habitat and LOPFA even-aged stands. Projections show a trend toward improved representation in all habitats.

Treatments within areas currently OG will maintain existing old growth structural attributes and are managed to move towards those conditions over time. The old growth analysis above indicates old growth structural attributes will continue to develop and improve across the landscape.

With the implementation of restoration treatments under alternative C, the sustainability of the large/old tree component across the landscape will be improved as presented in the following forest health discussion. Maintaining old growth across the landscape would benefit a range of wildlife species, including goshawks, MSO, and black bears.

**Table 182. Alternative C – old growth structural attributes by restoration unit[1]**

| Restoration Subunit/Unit | OG Acres | Average TPA 18"+ | | | Average BA | | | Average Tons CWD ≥12" | | | Average Snags Per Acre ≥12" | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 |
| 1-1 | 3,578 | 13.2 | 13.2 | 18.9 | 117 | 75 | 105 | 0.4 | 0.6 | 1.3 | 1.4 | 3.9 | 1.5 |
| 1-2 | 2,034 | 11.0 | 11.1 | 16.6 | 101 | 63 | 89 | 0.3 | 0.6 | 1.2 | 1.1 | 3.7 | 1.4 |
| 1-3 | 17,105 | 13.5 | 14.2 | 20.4 | 128 | 86 | 115 | 0.6 | 0.8 | 1.5 | 2.0 | 3.6 | 2.4 |
| 1-4 | 6,323 | 11.6 | 12.7 | 19.7 | 117 | 89 | 116 | 0.3 | 0.5 | 1.3 | 1.7 | 3.7 | 2.8 |
| 1-5 | 35,050 | 14.9 | 16.4 | 24.1 | 146 | 116 | 142 | 0.6 | 0.8 | 1.8 | 2.8 | 4.6 | 4.3 |
| **1** | **64,090** | **13.9** | **14.9** | **21.9** | **134** | **99** | **127** | **0.5** | **0.7** | **1.6** | **2.3** | **4.2** | **3.3** |
| 3-1 | 6,216 | 12.9 | 12.8 | 18.7 | 121 | 71 | 101 | 0.3 | 0.6 | 1.3 | 1.6 | 4.0 | 1.5 |
| 3-2 | 9,317 | 14.7 | 14.6 | 19.4 | 113 | 71 | 98 | 0.3 | 0.6 | 1.3 | 1.5 | 3.5 | 1.5 |
| 3-3 | 15,624 | 13.8 | 14.1 | 20.0 | 132 | 81 | 111 | 0.4 | 0.7 | 1.5 | 2.0 | 4.2 | 2.0 |
| 3-4 | 4,201 | 15.8 | 16.5 | 23.4 | 148 | 111 | 138 | 0.7 | 0.9 | 1.9 | 2.8 | 4.8 | 3.9 |
| 3-5 | 11,305 | 15.2 | 15.5 | 22.7 | 147 | 93 | 123 | 0.8 | 1.0 | 2.1 | 2.6 | 5.8 | 2.8 |
| **3** | **46,663** | **14.4** | **14.5** | **20.6** | **132** | **83** | **112** | **0.5** | **0.8** | **1.6** | **2.1** | **4.5** | **2.2** |
| 4-2 | 3,710 | 13.0 | 12.3 | 17.0 | 103 | 62 | 87 | 0.2 | 0.5 | 1.1 | 1.2 | 3.5 | 1.2 |
| 4-3 | 20,144 | 11.9 | 12.4 | 19.4 | 107 | 71 | 98 | 0.3 | 0.6 | 1.4 | 1.4 | 4.8 | 1.8 |
| 4-4 | 22,175 | 13.2 | 13.3 | 19.6 | 119 | 67 | 96 | 0.3 | 0.6 | 1.3 | 1.4 | 3.7 | 1.3 |
| 4-5 | 2,030 | 14.1 | 14.4 | 22.9 | 136 | 78 | 111 | 0.4 | 0.8 | 1.6 | 2.1 | 5.0 | 1.6 |
| **4** | **48,059** | **12.7** | **12.9** | **19.4** | **113** | **68** | **97** | **0.3** | **0.6** | **1.3** | **1.4** | **4.2** | **1.5** |
| 5-1 | 5,187 | 11.7 | 12.6 | 19.8 | 99 | 75 | 102 | 0.5 | 0.6 | 1.6 | 1.4 | 5.5 | 2.1 |
| 5-2 | 18,530 | 11.9 | 12.9 | 19.6 | 84 | 75 | 97 | 0.5 | 0.5 | 1.6 | 1.3 | 5.8 | 2.3 |
| **5** | **23,716** | **11.8** | **12.8** | **19.6** | **87** | **75** | **98** | **0.5** | **0.5** | **1.6** | **1.3** | **5.8** | **2.3** |
| 6-2 | 1,689 | 8.5 | 8.9 | 14.2 | 84 | 63 | 94 | 0.2 | 0.3 | 0.9 | 0.6 | 3.9 | 1.0 |
| 6-3 | 8,210 | 9.1 | 9.4 | 15.0 | 92 | 69 | 104 | 0.2 | 0.3 | 0.9 | 0.6 | 3.6 | 0.9 |
| 6-4 | 392 | 9.3 | 9.5 | 15.4 | 109 | 78 | 108 | 0.3 | 0.4 | 1.5 | 1.0 | 6.6 | 2.0 |
| **6** | **10,291** | **9.0** | **9.3** | **14.9** | **91** | **69** | **102** | **0.2** | **0.3** | **0.9** | **0.6** | **3.8** | **1.0** |
| **All** | **192,819** | **13.0** | **13.6** | **20.1** | **118** | **82** | **110** | **0.4** | **0.6** | **1.5** | **1.8** | **4.5** | **2.3** |

1. Alternative C would also implement the large tree implementation plan which identifies where post –settlement trees greater than 16 inches d.b.h. may be cut.

### Tree Groups, Interspaces, and Openness

Even though there is a shift from more closed to more open conditions in alternatives B, C, D, and E, 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).

The majority of the landscape currently has continuous tree canopy with generally small interspaces. The desired condition is a mosaic of interspaces and tree groups of varying sizes and shapes. Alternative C has a higher ability to attain a mosaic of interspaces and tree groups than alternative A and a similar ability to attain the desired conditions as alternatives B, D, and E.

While all treatments with the exception of Grassland Restoration are designed to reestablish forest openings and attain a mosaic of interspaces and tree groups of varying sizes and shapes, the intensity of the treatment affects the relative tendency toward this condition. The lower intensity treatments within MSO PAC, Target/Threshold, and prescribed fire only, treatments will result in irregular tree spacing and subtle expansion of existing forest openings. The higher intensity Treatments such as Pine Sage, Savanna, UEA 40, IT 40 and SI 40 will be removing more trees and extends greater flexibility in size and shape of interspaces and tree groups generated. MSO Restricted Treatments, SI10, UEA10, IT10, UEA 25, IT25, and SI25 would be expected to have a moderate contribution to the creation of interspaces and tree groups. Using Table 30, there are an estimated 264,976 acres of treatment (using the acreage of the treatments just listed) in alternative C that would contribute to the creation of interspaces and tree groups.

One of the differences between alternative C and alternatives B and D is about 4,800 acres of modified UEA treatment, an experimental design developed by Arizona Game and Fish Department. This is similar to UEA10 treatments, which leaves a higher tree density than UEA40 trees, except that tree group size could increase to 15 acres. This would be beneficial for goshawk and their prey because it provides additional structural and spatial diversity.

Alternative C would restore forest openings by restoration treatments in PFA, LOPFA and MSO restricted other habitats through the removal of ponderosa pine tree canopy that is shading out understory herbaceous vegetation and reducing forage production and species enhancing small grassland inclusions within the greater forested area. This would be followed by prescribed burning. The subsequent litter reduction and nutrient pulse would elicit a positive understory response and would provide food and cover for goshawk prey species through time, potentially improving prey numbers within grasslands and meadows and providing source populations of different prey species (e.g., mice, voles, rabbits, and gophers) for dispersal into the surrounding forest. In addition, arthropod prey such as beetles and moths would also likely benefit from these treatments. Consequently, meadow and an unknown percentage of grassland treatments would be expected to improve understory conditions for goshawk prey species.

Table 173 under alternative A compares the percentage of openness in PFA/dPFA and LOPFA habitat by alternative and the associated discussion describes the openness categories. In alternative C, over half of PFA/dPFA is estimated to be open to very open suggesting that understory needed by prey and invertebrates has improved. This proportion of open habitat is higher in LOPFA habitat. Vulnerability to uncharacteristic fire and density related mortality is less than alternative A. The increased post treatment openness would improve the sustainability of ponderosa pine in these habitats.

Although grassland and savanna areas are not typically considered goshawk habitat, some benefits to prey could occur with these treatments, specifically for rabbits. Increased abundance and diversity of understory should create more food and cover for cottontails. In good years, rabbits would be expected to move into adjoining habitats, more typically used for goshawk foraging. Grassland treatments would go up to an average of 10 basal area and occur on mollic soils, thus grassland and savanna areas would serve as source populations for this prey species. Savanna thin and burn treatments would average 10-30 basal area in ponderosa pine and occur on mollic intergrade soils. Some of the savanna treatments originated from overlaying open and mixed corridor pathways, identified by the AGFD, to connect similar habitats. One of these is along Interstate 40; just west of Camp Navajo to support and to help realize a future highway crossing for pronghorn and to emphasize open habitat connectivity. If the highway crossing happens at a later date, Government Prairie and Garland Prairie would be connected and if the highway crossing does not occur, then the potential travel ways north of I-40 would be connected, again benefiting open habitat species like rabbits.

**Density**

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 (Table 6). In both the short and long term, goshawk habitat under this alternative would be healthier than if no treatment were to occur.

Table 183 shows the shifts in tree density in goshawk habitat in the different restoration units. The darkest shading is extremely high density; the lightest shading is moderate density; and the intermediate shading is high density. 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. Restoration Unit 6 is the exception because the initial density is estimated to be high and it improves in the short term to moderate density (25-34 percent). By 2050, most of the restoration units would shift to high density (except Restoration Unit 1 which rebounds to the low end of extremely high density) and none reach 2010 values. Restoration Units 4 and 6 would have the lowest densities whereas Restoration Unit 1 would have the highest densities in PFA/dPFA habitat.

Density in LOPFA habitat would improve in the short and long term compared to existing. Restoration Units 1 and 3 would improve to high density in both the short and long term, never re-attaining existing values. Restoration Units 4, 5, and 6 would improve from high density to moderate density in the short term then back to high density by 2050. Restoration Units 4 and 5 would have the lowest densities over time and Restoration Unit 1 would have the highest.

**Table 183. Density in goshawk habitat by restoration unit in Alternative C**

| Restoration Unit | SDI % of Max PFA/dPFA | | | | SDI % of Max LOPFA | | |
|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | | 2010 | 2020 | 2050 |
| All | 61% | 40% | 49% | | 57% | 34% | 43% |
| 1 | 71% | 50% | 58% | | 65% | 40% | 49% |
| 3 | 63% | 39% | 48% | | 63% | 36% | 46% |
| 4 | 56% | 35% | 44% | | 51% | 28% | 37% |
| 5 | 56% | 38% | 46% | | 40% | 28% | 36% |
| 6 | 50% | 34% | 45% | | 52% | 34% | 46% |

Table 184 shows the shifts in tree density in goshawk habitat in the different subunits. Half of the subunits in PFA/dPFA habitat 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. Four of the subunits improve but only to a lower end of the high density zone. Three subunits improve from high to moderate density in the short term (Subunits 4-2, 6-2, 6-3) then shift to high density in the long term as tree growth continues. Subunit 1-5 remains in high density in both the short and long term.

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.

In general, the following characteristics would be expected to develop as density decreases.

- Grassy stands of open canopy large diameter trees with long, heavy limbed crowns.
- Stands of moderately dense canopy, intermediate size trees.
- Clumpy irregular stands with groups of varying ages. Openings for seedling establishment would be made periodically.

These would improve the quality and sustainability of nesting and fledgling 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.

**Table 184. Density in goshawk habitat by subunit in Alternative C**

| Subunit | SDI % of Max PFA/dPFA | | | | SDI % of Max LOPFA | | |
|---|---|---|---|---|---|---|---|
| 18 | 2010 | 2020 | 2050 | | 2010 | 2020 | 2050 |
| 1-1 | 72% | 35% | 48% | | 56% | 32% | 42% |
| 1-2 | 50% | 34% | 43% | | 49% | 27% | 35% |
| 1-3 | 65% | 38% | 46% | | 61% | 36% | 46% |
| 1-4 | 64% | 44% | 53% | | 60% | 37% | 46% |
| 1-5 | 78% | 60% | 66% | | 70% | 45% | 53% |
| 3-1 | 58% | 37% | 46% | | 59% | 34% | 44% |
| 3-2 | 55% | 35% | 44% | | 52% | 32% | 40% |
| 3-3 | 65% | 41% | 50% | | 63% | 35% | 45% |
| 3-4 | 79% | 34% | 45% | | 72% | 47% | 55% |
| 3-5 | 69% | 38% | 48% | | 71% | 39% | 48% |
| 4-2 | 48% | 31% | 40% | | 44% | 24% | 32% |
| 4-3 | 54% | 35% | 43% | | 47% | 28% | 36% |
| 4-4 | 61% | 36% | 45% | | 54% | 28% | 37% |
| 4-5 | 56% | 38% | 46% | | 57% | 32% | 42% |
| 5-1 | 58% | 42% | 49% | | 45% | 29% | 38% |
| 5-2 | 53% | 35% | 42% | | 37% | 28% | 35% |
| 6-2 | 42% | 28% | 37% | | 45% | 29% | 40% |
| 6-3 | 50% | 34% | 46% | | 51% | 35% | 47% |
| 6-4 | | | | | 61% | 35% | 45% |

The silvicultural report lists the beetle hazard rating for the years 2020 and 2050 by Recovery Unit and for the ponderosa pine analysis area. The overall hazard in 2020 is high across 22% of the analysis area. This increases to 53 percent in 2050. Stands with a hazard rating of low or moderate would be expected to be resistant to successful bark beetle attack and large scale mortality.

The silvicultural report also states that dense conditions that result from alternative A are at a high risk to density related mortality and 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. High density stands would be more vulnerable and less resilient to the projected hotter climate in the southwest (Kerhoulas et al. 2013). High density stands result in less deep water storage in the soil because the canopies interfere with precipitation reaching the ground and canopies allow moisture to be exposed to evaporation longer. Deep soil water is recharged by winter precipitation and ponderosa pines, especially large trees, rely heavily on this deep water. The risk of landscape-scale wildfire, with the potential to eliminate large portions of forested habitat, would increase with the lack of treatments in alternative A.

## Oak

Treatments proposed in alternative C are designed to conserve oak and improve conditions that favor oak growth and establishment wherever it exists by reducing pine-oak competition. This would result in improved vigor of existing oak and establishment of a variety of oak size and age classes across the landscape. These conditions would be most prevalent within goshawk habitat that overlaps the 64,065 acres of MSO restricted other habitat treatments. The silvicultural report shows that the overall post treatment oak basal area would be 5 percent higher in this habitat compared to the no action alternative. The improved balance of age classes would lead to increased resiliency and sustainability of oak.

**Aspen**

The treatments within 1,469 acres of aspen stands under alternative C are designed to maintain and/or regenerate aspen by reducing pine-aspen competition. These treatments would result in establishment of vigorous aspen regeneration free of competition from overtopping ponderosa pine. Mechanical treatments would increase surface fuels to better carry fire beneath aspen overstories where fuel loading can be patchy. Mechanical scarification of soils, along with prescribed fire, would better stimulate aspen suckering. Improved health and resiliency of aspen clones and a robust understory response would be expected.

Up to 82 miles of protective barriers would be established around aspen clone patches within the ponderosa pine forest to prevent ungulate grazing within aspen clones. Barriers would consist of fencing and/or felling trees (jack-strawing). Fencing would occur after mechanical and burning treatments and would have no effect to the vegetation. Jack-strawing may occur during the mechanical operation and would utilize trees that have been targeted for removal to meet treatment objectives. Short- and long-term improvements in understory vegetation and overstory aspen health and sustainability would be anticipated.

**Pine Sage**

The 5,261 acres of pine-sage thinning treatments are designed to remove post settlement pine that currently is overtopping and shading out the sage and to manage fire to enhance sage extent. These treatments would result in enhancement of the sage component and restore the historic pattern within the pine sage mosaic.

The impacts of the research proposals in alternative C on silvicultural prescriptions are reflected in the vegetation data already analyzed. Constructing 15 weirs that impact 3 acres would not have a discernible impact to goshawk habitat at the project level. Impacts to goshawks or their prey species habitat would be limited to the immediate vicinity of the locations of the individual projects. Alternatives A, B and D do not include the research proposals and so would not impact the physical structure or quality of the goshawk habitat.

**Snags, Logs, and Coarse Woody Debris**

Refer to Figure 29, Figure 30, and Figure 31 to compare the effects of the alternatives on these components of prey habitat. Predicted snag densities by restoration unit, subunit, and alternative are displayed in appendix 20.

**Snags:** In the short term (2020), alternatives C, B, & E would have the highest density of large snags per acre in PFA/dPFAs followed by alternative D, then alternative A. As shown in Figure 38, the differences are slight. This general pattern holds true for the restoration unit and subunit scales as well. Predicted snag densities by restoration unit, subunit, and alternative are displayed in appendix 20. In the long term (2050), the density of large snags is similar between alternatives in PFAs/dPFAs and in LOPFAs. Snag density would increase in both the PFAs/dPFAs and LOPFAs over time in alternative C but still would not achieve the guideline in the Coconino Forest Plan for at least 2 large snags per acre. Snag density in PFA/dPFA habitat would meet the guideline/ desired condition 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 low end of 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).

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.

**Logs:** Logs provide important habitat features for prey species, including substrate for foraging, den and nest sites, and cover. In the short term (2020), alternative C would have log densities similar to alternatives A,B, and E and log densities lower than alternative D in the PFAs/dPFAs and LOPFAs. In the long term (2050), alternative C would have similar log densities per acre as alternatives B, D, and E and higher densities than alternative A in PFAs/dPFAs and LOPFAs. Log density per acre in this alternative would increase from year 2020 to year 2050 so although alternative C would not meet forest plan guideline of at least 3 large logs per acre in the short term, it would be exceeded in the long term. More logs would be provided in PFA/dPFA versus LOPFA habitat (figure 37). Predicted densities of large logs per acre by restoration unit, subunit, and alternative are displayed in appendix 20. In the short term, neither PFA/dPFA or LOPFA habitat would meet guideline/desired conditions of a minimum of three large logs per acre in the Coconino Forest Plan and the Kaibab Forest Plan. However it would meet these requirements in the long term in both types of goshawk habitat.

**Coarse Woody Debris:** In the short term (2020) and long term (2050), the overall values for LOPFA and PFA/dPFA habitat in alternative C would have similar amounts of coarse woody debris as alternatives B and E and lower amounts than alternatives A and D (figure 36). At the restoration unit scale, this general pattern holds true for Restoration Units 1, 3, and 4 and the associated subunits in LOPFAs.

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 20. 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 requirements in the short term, it would be reached in the long term.

LOPFA: In 2020, the Subunits range from a low of 1.79 tons per acre in Subunit 6-2 and a high of 3.95 tons per acre in Subunit 3.5. In 2050, the Subunits range from a low of 4.27 in Subunit 6-3 and a high of 7.15 tons per acre in Subunit 6-4.

PFA/dPFA: In 2020, the Subunits range from a low of 1.87 tons per acre in Subunit 6-2 and a high of 4.72 tons per acre in Subunit 1-4. In 2050, the Subunits range from a low of 4.39 in Subunit 6-3 and a high of 7.5 tons per acre in Subunit 1-4.

### Understory Development

Alternative C is similar to alternative B. These two alternatives provide the greatest amount of understory (compared to the other alternatives) 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 as tree canopies expand and fill in the gaps but not as much as the other alternatives (Figure 32).

LOPFA: In 2020, the understory index in the Subunits range from a low of 91 in Subunit 1-5 and a high of 434 in Subunit 6-2. In 2050, the Subunits range from a low of 55 in Subunit 1-5 and a high of 263 in Subunit 6-2.

PFA/dPFA: In 2020, the understory index in the Subunits range from a low of 49 in Subunit 1-5 and a high of 417 in Subunit 6-2. In 2050, the Subunits range from a low of 32 in Subunit 1-5 and a high of 273 in Subunit 6-2.

Although relative understory production varies widely, these two alternatives would be the most beneficial for grasses, sedges and forbs, and cool-season plants which all respond favorably to reductions in overstory density. These two alternatives would be the most beneficial to bird and mammal forage directly and the arthropod community indirectly. This would be the most beneficial for goshawk prey species like American robins, band-tailed pigeons, cottontail rabbits, golden-mantled ground squirrels, mourning doves, northern flickers, Stellar’s jay, and Williamson’s sapsucker because of positive impacts to foraging and nesting habitat and invertebrate prey, as described in appendix 6.

#### *Determination of Effect*

Implementation of alternative C may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative D

Thirty-six of 60 treated PFAs (about 60 percent) will have between 76 and 100 percent of the total 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 towards 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 MSO habitat. Alternative D treats about the same amount of goshawk habitat outside of MSO habitat as alternative B (30,680 acres) and a slightly higher amount than alternative C and alternative E. The treatment types and the acres by treatment type are shown in Table 185. The more acres treated the more acres that would move towards desired conditions. Treatments are described in more detail in the section titled ‘Common to Alternatives B, C, D, and E’, the silvicultural report and in the Implementation Plan in appendix D in the FEIS. Mechanical thinning and prescribed burning would alter forest structure which is discussed below.

**Table 185. Alternative D treatments in goshawk habitat**

| Cover Type and Proposed Treatment | LOPFA | PFA | dPFA | Grand Total |
|---|---|---|---|---|
| **Ponderosa Pine** | | | | |
| AZGFD Treatment | 0 | 0 | 0 | 0 |
| GL - Restoration | 11,185 | 0 | 0 | 11,185 |
| IT10 | 7,124 | 268 | 173 | 7,565 |
| IT25 | 10,741 | 922 | 208 | 11,871 |
| IT40 | 35,655 | 2,416 | 641 | 38,712 |

| Cover Type and Proposed Treatment | LOPFA | PFA | dPFA | Grand Total |
|---|---|---|---|---|
| MSO Restricted Treatment | 60,232 | 1,627 | 2,206 | 64,065 |
| MSO Target Treatment | 5,972 | 525 | 0 | 6,497 |
| MSO Threshold Treatment | 1,806 | 75 | 12 | 1,894 |
| PAC - Mechanical | 8,171 | 1,770 | 343 | 10,284 |
| Pine-Sage | 4,674 | 392 | 196 | 5,261 |
| Prescribed Fire Only | 90,277 | 8,797 | 1,299 | 100,373 |
| Savanna | 45,405 | 0 | 0 | 45,405 |
| SI10 | 1,823 | 25 | 65 | 1,914 |
| SI25 | 6,408 | 198 | 11 | 6,618 |
| SI40 | 11,935 | 368 | | 12,303 |
| UEA10 | 16,218 | 1,338 | 526 | 18,082 |
| UEA25 | 36,120 | 2,123 | 947 | 39,190 |
| UEA40 | 91,045 | 6,210 | 2,878 | 100,133 |
| WUI55 | 2,130 | 0 | 95 | 2,224 |
| **Ponderosa Pine Total** | **446,921** | **27,054** | **9,602** | **483,576** |
| **Grass** | | | | |
| Grassland Mechanical | 0 | 0 | 0 | 0 |
| PAC - Grassland Mechanical | 0 | 0 | 0 | 0 |
| Prescribed Fire Only | 48,018 | 121 | 152 | 48,291 |
| **Grass Total** | **48,018** | **121** | **152** | **48,291** |
| **Aspen** | | | | |
| Aspen Treatment | 1,100 | 79 | 46 | 1,225 |
| Prescribed Fire Only | 22 | 2 | 0 | 24 |
| **Aspen Total** | **1,122** | **81** | **46** | **1,249** |
| **Pinyon-Juniper** | | | | |
| Prescribed Fire Only | 24,629 | 185 | 36 | 24,850 |
| WUI PJ Treatment | 535 | 0 | 0 | 535 |
| **Pinyon-Juniper Total** | **25,164** | **185** | **36** | **25,384** |
| **Oak Woodland** | | | | |
| Prescribed Fire Only | 3,153 | 26 | 0 | 3,179 |
| **Oak Woodland Total** | **3,153** | **26** | **0** | **3,179** |
| **Non-Veg** | | | | |
| Prescribed Fire Only | 1,707 | 8 | 12 | 1,727 |
| **Non-Veg Total** | **1,707** | **8** | **12** | **1,727** |
| **Grand Total** | **526,084** | **27,475** | **9,848** | **563,407** |

### *Direct and Indirect Effects*

Direct effects are those caused by the action and occur at the same time and place. With breeding season timing restrictions on all mechanical treatments, disturbance would be reduced. Design criteria to reduce disturbance to goshawks are described in the section titled Common to Alternatives B, C, D, and E.

Indirect effects are those effects caused by the action and are later in time and/or further removed in distance. The physical changes to the quantity and quality of the goshawk's habitat and that of its prey species are indirect effects and are is addressed in the preceding analyses and the Management Indicator Species analysis. Following are site specific details regarding the effects of alternative D. Mechanical thinning and prescribed burning would alter forest structure which would decrease the potential for uncharacteristic fire.

Of the 60 PFAs being treated within the project area in alternative D, about 60 percent of them would have their entire territories treated by mechanical or prescribed burning (less than alternatives B, C, and E). About 10 percent would have 50-75 percent of the PFAs treated (same as alternative B and less than alternatives C and E). About 18 percent would have 25-49 percent of the PFA treated (more than alternatives B, C and E) and 12 percent would have less than 25 percent of the PFA treated (more than alternatives B, C, and E). As the percent of the PFA that is treated increases, the relative portion of the PFA that would move towards desired conditions for goshawk habitat would also increase.

#### Slide Fire

Table 186 shows the proposed treatments under alternative D that were affected by 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.

**Table 186. Alternative D treatments affected by the Slide Fire**

| Proposed Treatments (Alt D) | Acres | Number of Stands | Outside Fire Perimeter | Vegetation Severity | | | |
|---|---|---|---|---|---|---|---|
| | | | | Unchanged | Low | Moderate | High |
| **PFA** | | | | | | | |
| PFA - IT40 | 34 | 1 | 0 | 9 | 22 | 3 | 0 |
| PFA - UEA40 | 11 | 1 | 0 | 0 | 8 | 2 | 0 |
| PFA Nest Stand Prescribed Fire Only | 29 | 1 | 0 | 6 | 22 | 1 | 0 |
| GL - Restoration | 13 | 1 | 0 | 5 | 8 | 1 | 0 |
| IT10 | 28 | 1 | 0 | 8 | 18 | 2 | 0 |
| IT40 | 820 | 8 | 0 | 87 | 424 | 259 | 50 |
| Prescribed Fire Only | 143 | 3 | 0 | 7 | 64 | 71 | 1 |
| Savanna | 131 | 7 | 0 | 17 | 90 | 23 | 0 |
| UEA10 | 395 | 6 | 0 | 30 | 237 | 126 | 1 |
| UEA25 | 5 | 2 | 0 | 1 | 3 | 0 | 0 |

| Proposed Treatments (Alt D) | Acres | Number of Stands | Outside Fire Perimeter | Vegetation Severity | | | |
|---|---|---|---|---|---|---|---|
| | | | | Unchanged | Low | Moderate | High |
| UEA40 | 992 | 9 | 0 | 137 | 652 | 203 | 0 |
| Prescribed Fire Only - Operational | 108 | 8 | 2 | 41 | 52 | 12 | 1 |
| MSO Restricted Treatment | 3,793 | 58 | 1 | 255 | 1,747 | 1,463 | 327 |
| MSO Threshold Treatment | 32 | 1 | 0 | 0 | 14 | 13 | 4 |
| MSO Target Treatment | 318 | 10 | 0 | 26 | 135 | 120 | 38 |
| **Grand Total** | **6,852** | **117** | **3** | **629** | **3,496** | **2,299** | **422** |

### Vegetation Structural Stage

Appendix 20 displays the VSS distribution for even age and uneven age stands by goshawk habitat projected out to the years 2020 and 2050.

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.

Overall the VSS distribution trends under alternative D compared to alternative B indicate an increase in VSS 3, a decrease in VSS 4, a slight decrease in VSS 5 in 2020 followed by a slight increase in 2050 and an overall decrease in VSS 6. The mechanical treatments between these two alternatives is the same, so these differences can be attributed to the lack of prescribed fire mortality associated with alternative D, especially in the VSS 3 class. The denser conditions also affect the VSS distribution trend by slowing stand development and growth. This results in maintaining more of the landscape in the young forest stage and impeding development of the mature and old forest stages.

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.

### Old Growth

The silvicultural report indicates that in 2020, the average conditions are at or above the minimum criteria with the following exceptions:

- Trees per acre larger than 18 inches and 180 years old. This condition is deficit in all SUs ranging from a low of 9.2 TPA in SU 6-2 to a high of 16.9 TPA in SU 3-4 with an overall average for all acres of 13.9 TPA. The age of these trees is estimated be in the range of 100 to 140 years old with a few relic trees meeting the 180 year old criteria.

- Basal area greater than or equal to 90. This condition is below desired in RUs 4, 5 and 6. Overall average for all acres is 89.
- Coarse woody debris greater than 12 inch. This condition is estimated to be deficit with less than the equivalent of 2 pieces per acre throughout 6.

Over time, old growth conditions improve in terms of meeting the minimum criteria. In 2050, all RUs are very close to or exceed the criteria for TPA larger than 18” 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 will be met throughout the old growth acres. Details are shown in Table 187.

The restoration treatments proposed under alternative D are designed to manage for old age trees in order 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 Strategy in appendix A of the silvicultural report.

The goshawk habitat structural stage analysis above indicates the mature and old forest structural stages to be underrepresented in the PFA habitat and LOPFA even-aged stands. Projections show a trend toward improved representation in all habitats.

Treatments within areas currently OG would maintain existing old growth structural attributes and are managed to move towards those conditions over time. The old growth analysis above indicates old growth structural attributes would continue to develop and improve across the landscape.

With the implementation of restoration treatments under alternative D, the sustainability of the large/old tree component across the landscape would be improved as discussed in the following forest health discussion. Maintaining old growth across the landscape would benefit a range of wildlife species, including goshawks, MSO, and black bears.

### Tree Groups, Interspaces, and Openness

Even though there is a shift from more closed to more open conditions in alternatives B, C, D, and E, 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).

The majority of the landscape currently has continuous tree canopy with generally small interspaces. The desired condition is a mosaic of interspaces and tree groups of varying sizes and shapes. Alternative D has a similar ability to attain the desired conditions as alternatives B, C, and E and a higher ability to attain a mosaic of interspaces and tree groups than alternative A.

**Table 187. Alternative D –old growth structural attributes by restoration unit**

| Restoration Subunit/Unit | OG Acres | Average TPA 18"+ | | | Average BA | | | Average Tons CWD ≥12" | | | Average Snags Per Acre ≥12" | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 |
| 1-1 | 3,578 | 13.2 | 13.7 | 19.3 | 117 | 84 | 116 | 0.4 | 0.9 | 1.3 | 1.4 | 2.2 | 1.7 |
| 1-2 | 2,034 | 11.0 | 11.4 | 17.0 | 101 | 70 | 99 | 0.3 | 0.8 | 1.1 | 1.1 | 2.1 | 1.6 |
| 1-3 | 17,105 | 13.5 | 14.6 | 20.8 | 128 | 95 | 125 | 0.6 | 1.1 | 1.6 | 2.0 | 2.1 | 2.7 |
| 1-4 | 6,323 | 11.6 | 13.0 | 19.9 | 117 | 97 | 125 | 0.3 | 0.8 | 1.3 | 1.7 | 2.0 | 3.0 |
| 1-5 | 35,050 | 14.9 | 16.7 | 24.4 | 146 | 124 | 150 | 0.6 | 1.2 | 2.0 | 2.8 | 3.1 | 4.7 |
| **1** | **64,090** | **13.9** | **15.3** | **22.2** | **134** | **108** | **136** | **0.5** | **1.1** | **1.7** | **2.3** | **2.6** | **3.6** |
| 3-1 | 6,216 | 12.9 | 13.4 | 19.2 | 121 | 81 | 113 | 0.3 | 0.9 | 1.2 | 1.6 | 1.9 | 1.8 |
| 3-2 | 9,317 | 14.7 | 15.1 | 19.8 | 113 | 77 | 106 | 0.3 | 0.9 | 1.2 | 1.5 | 1.7 | 1.6 |
| 3-3 | 15,624 | 13.8 | 14.5 | 20.1 | 132 | 89 | 120 | 0.4 | 1.1 | 1.5 | 2.0 | 2.4 | 2.2 |
| 3-4 | 4,201 | 15.8 | 16.9 | 23.7 | 148 | 118 | 146 | 0.7 | 1.3 | 2.1 | 2.8 | 3.2 | 4.3 |
| 3-5 | 11,305 | 15.2 | 16.0 | 22.7 | 147 | 99 | 131 | 0.8 | 1.5 | 2.2 | 2.6 | 4.1 | 3.0 |
| **3** | **46,663** | **14.4** | **15.0** | **20.8** | **132** | **90** | **121** | **0.5** | **1.1** | **1.6** | **2.1** | **2.7** | **2.4** |
| 4-2 | 3,710 | 13.0 | 12.8 | 17.5 | 103 | 68 | 96 | 0.2 | 0.7 | 1.0 | 1.2 | 1.8 | 1.3 |
| 4-3 | 20,144 | 11.9 | 12.7 | 19.6 | 107 | 76 | 105 | 0.3 | 0.8 | 1.3 | 1.4 | 3.3 | 1.9 |
| 4-4 | 22,175 | 13.2 | 13.7 | 19.9 | 119 | 74 | 106 | 0.3 | 1.0 | 1.2 | 1.4 | 1.7 | 1.4 |
| 4-5 | 2,030 | 14.1 | 14.8 | 23.2 | 136 | 86 | 121 | 0.4 | 1.2 | 1.6 | 2.1 | 3.1 | 1.8 |
| **4** | **48,059** | **12.7** | **13.3** | **19.7** | **113** | **75** | **105** | **0.3** | **0.9** | **1.2** | **1.4** | **2.5** | **1.6** |
| 5-1 | 5,187 | 11.7 | 12.8 | 20.0 | 99 | 79 | 107 | 0.5 | 0.8 | 1.6 | 1.4 | 4.6 | 2.2 |
| 5-2 | 18,530 | 11.9 | 12.9 | 19.6 | 84 | 75 | 98 | 0.5 | 0.5 | 1.6 | 1.3 | 5.7 | 2.4 |
| **5** | **23,716** | **11.8** | **12.9** | **19.7** | **87** | **76** | **100** | **0.5** | **0.6** | **1.6** | **1.3** | **5.5** | **2.3** |
| 6-2 | 1,689 | 8.5 | 9.2 | 14.2 | 84 | 71 | 106 | 0.2 | 0.4 | 0.8 | 0.6 | 2.6 | 1.1 |
| 6-3 | 8,210 | 9.1 | 9.8 | 15.0 | 92 | 81 | 118 | 0.2 | 0.4 | 0.7 | 0.6 | 1.7 | 1.2 |
| 6-4 | 392 | 9.3 | 9.6 | 15.4 | 109 | 80 | 111 | 0.3 | 0.4 | 1.4 | 1.0 | 6.2 | 2.0 |
| **6** | **10,291** | **9.0** | **9.7** | **14.9** | **91** | **79** | **116** | **0.2** | **0.4** | **0.7** | **0.6** | **2.1** | **1.2** |
| **All** | **192,819** | **13.0** | **13.9** | **20.3** | **118** | **89** | **118** | **0.4** | **0.9** | **1.5** | **1.8** | **2.9** | **2.5** |

While all treatments with the exception of Grassland Restoration are designed to reestablish forest openings and attain a mosaic of interspaces and tree groups of varying sizes and shapes, the intensity of the treatment affects the relative tendency toward this condition. The lower intensity treatments within MSO PAC, Target/Threshold, and prescribed fire only, treatments will result in irregular tree spacing and subtle expansion of existing forest openings. The higher intensity Treatments such as Pine Sage, Savanna, UEA 40, IT 40 and SI 40 will be removing more trees and extends greater flexibility in size and shape of interspaces and tree groups generated. MSO Restricted Treatments, SI10, UEA10, IT10, UEA 25, IT25, and SI25 would be expected to have a moderate contribution to the creation of interspaces and tree groups. Using Table 38, there are an estimated 184,944 acres of treatment (using the acreage of the treatments just listed) in alternative D that would contribute to the creation of interspaces and tree groups.

Alternative D 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 as follows:

- 11,185 acres of grassland restoration treatments on mollisol soils;
- 45,405 acres of savanna treatments on mollic intergrade soils;
- 307,938 acres of ponderosa pine restoration treatments in PFA, LOPFA and MSO restricted other habitats enhancing small grassland inclusions within the greater forested area.

Alternative C would restore forest openings by restoration treatments in PFA, LOPFA and MSO restricted other habitats through the removal of ponderosa pine tree canopy that is shading out understory herbaceous vegetation and reducing forage production and species enhancing small grassland inclusions within the greater forested area. This would be followed by prescribed burning. The subsequent litter reduction and nutrient pulse would elicit a positive understory response and would provide food and cover for goshawk prey species through time, potentially improving prey numbers within grasslands and meadows and providing source populations of different prey species (e.g., mice, voles, rabbits, and gophers) for dispersal into the surrounding forest. In addition, arthropod prey such as beetles and moths would also likely benefit from these treatments. Consequently, meadow and an unknown percentage of grassland treatments would be expected to improve understory conditions for goshawk prey species.

A comparison of the openness categories by PFA/dPFA and LOPFA habitat within each alternative is located in Table 161. The variety of treatment types under alternative D would result in considerably more open habitat than alternative A. In PFA/dPFA habitat, implementation of alternative D would result in 12,171 more open acres than alternative A, the same amount of open acres as alternative B (16,441) and about 338 more open acres than alternatives B and D (16,441). Alternatives D (and B) have the least amount of moderately closed and closed acres compared to the other alternatives (13,074). In PFA/dPFA habitat, it would have 12,171 fewer acres than alternative A and 8,502 acres less than alternatives C and E.

In LOPFA habitat, alternative D would result in more open and very open habitat than alternative A and the second highest amount of open and very open habitat of the action alternatives and the same as alternative B. It would have 218 more acres in the very open category than alternative C and 52,272 more acres than alternative E mainly because of grassland and savanna treatments. It would the second most acres in the open category of any alternative and the same as alternative B. It would have 4,106 more open acres than alternatives C and 42,457 fewer open acres than alternative E.

Although grassland and savanna areas are not typically considered goshawk habitat, some benefits to prey could occur with these treatments, specifically for rabbits. Increased abundance and diversity of understory should create more food and cover for cottontails. In good years, rabbits would be expected to move into adjoining habitats, more typically used for goshawk foraging. Grassland treatments would go up to an average of 10 basal area and occur on mollic soils, thus grassland and savanna areas would serve as source populations for this prey species. Savanna thin and burn treatments would average 10-30 basal area in ponderosa pine and occur on mollic intergrade soils. Some of the savanna treatments originated from overlaying open and mixed corridor pathways, identified by the Arizona Game and Fish Department, to connect similar habitats. One of these is along Interstate 40; just west of Camp Navajo to support and to help realize a future highway crossing for pronghorn and to emphasize open habitat connectivity. If the highway crossing happens at a later date, Government Prairie and Garland Prairie would be connected and if the highway crossing does not occur, then the potential travel ways north of I-40 would be connected, again benefiting open habitat species like rabbits.

The reverse trend holds true for moderately closed and closed habitat. It has considerably less closed and moderately closed habitat than alternative A, and the lowest amount of moderately closed and closed habitat of the action alternatives, along with alternative B at 91,948 acres. It would have 4,325 fewer acres than alternative C and 9,815 fewer acres than alternative E.

It would have slightly less vulnerability to uncharacteristic fire and density related mortality and improved sustainability and resiliency to natural disturbances compared to alternatives C and E.

**Density**

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 (Table 188). In both the short and long term, goshawk habitat under this alternative would be healthier than if no treatment were to occur.

Table 188 shows the shifts in tree density in goshawk habitat in the different restoration units. The darkest shading is extremely high density; the lightest shading is moderate density; and the intermediate shading is high density. 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. Restoration Unit 6 is the exception because the initial density is estimated to be high and it improves in the short term to moderate density (25-34 percent). By 2050, most of the restoration units would shift to high density (except Restoration Unit 1 which rebounds to the low end of extremely high density) and none reach 2010 values. Restoration Units 4 and 6 would have the lowest densities whereas Restoration Unit 1 would have the highest densities in PFA/dPFA habitat.

Density in LOPFA habitat would improve in the short and long term compared to existing. Restoration Units 1 and 3 would improve to high density in both the short and long term, never re-attaining existing values. Restoration Units 4, 5, and 6 would improve from high density to moderate density in the short term then back to high density by 2050. Restoration Units 4 and 5 would have the lowest densities over time and Restoration Unit 1 would have the highest.

**Table 188. Density in goshawk habitat by restoration unit in Alternative D**

| Restoration Unit | SDI % of Max PFA/dPFA | | | | SDI % of Max LOPFA | | |
|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | | 2010 | 2020 | 2050 |
| All | 61% | 45% | 54% | | 57% | 39% | 49% |
| 1 | 71% | 56% | 63% | | 65% | 46% | 56% |
| 3 | 63% | 44% | 54% | | 63% | 42% | 52% |
| 4 | 56% | 40% | 49% | | 51% | 33% | 42% |
| 5 | 56% | 42% | 50% | | 40% | 30% | 37% |
| 6 | 50% | 41% | 53% | | 52% | 42% | 54% |

The existing forest structure in goshawk habitat (PFA/dPFA and LOPFA) is high density or extremely high density based on percent maximum stand density index (Table 189). This pattern is consistent in all restoration units and sub-units. These stands would be vulnerable to insect and disease and at high risk for uncharacteristic fire due to the high density of trees. The ability of the trees to develop open crowns and increase tree diameter would be lower as stand density indices and competition increase. This would have a negative effect on the development of old growth, and the quality of the habitat for hunting. Stagnation of stands and competition-induced mortality could negatively affect the sustainability of existing old growth, and old trees (important for nest trees, prey habitat, and perches).

**Table 189. Density in goshawk habitat by subunit in Alternative D**

| Subunit | SDI % of Max PFA/dPFA | | | | SDI % of Max LOPFA | | |
|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | | 2010 | 2020 | 2050 |
| 1-1 | 72% | 45% | 59% | | 56% | 38% | 49% |
| 1-2 | 50% | 38% | 48% | | 49% | 32% | 42% |
| 1-3 | 65% | 43% | 52% | | 61% | 42% | 52% |
| 1-4 | 64% | 48% | 57% | | 60% | 44% | 53% |
| 1-5 | 78% | 65% | 70% | | 70% | 51% | 60% |
| 3-1 | 58% | 43% | 51% | | 59% | 42% | 52% |
| 3-2 | 55% | 40% | 49% | | 52% | 37% | 46% |
| 3-3 | 65% | 46% | 56% | | 63% | 41% | 52% |
| 3-4 | 79% | 43% | 56% | | 72% | 53% | 61% |
| 3-5 | 69% | 44% | 56% | | 71% | 45% | 55% |
| 4-2 | 48% | 35% | 45% | | 44% | 28% | 38% |
| 4-3 | 54% | 39% | 48% | | 47% | 32% | 41% |
| 4-4 | 61% | 41% | 51% | | 54% | 34% | 44% |
| 4-5 | 56% | 43% | 52% | | 57% | 37% | 48% |
| 5-1 | 58% | 45% | 53% | | 45% | 32% | 41% |
| 5-2 | 53% | 38% | 47% | | 37% | 29% | 35% |
| 6-2 | 42% | 33% | 45% | | 45% | 34% | 47% |
| 6-3 | 50% | 42% | 54% | | 51% | 44% | 57% |
| 6-4 | | | | | 61% | 37% | 46% |

The condition of goshawk habitat (PFA/dPFA and LOPFA) would be reduced to high density based on percent maximum stand density index although individual subunits fall into the moderate range (table 39). 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 D.

In 2020, subunits in PFA/dPFA habitat range from 29 percent in Subunit 5-2 to 65 percent in Subunit 1-5. In 2020 subunits in LOPFA habitat range from 24 percent in Subunit 4-2 to 53 percent in 3-4. In 2050, subunits in PFA/dPFA habitat range from 45 percent in 4-2 to 70 percent in 1-5. Subunits in LOPFA habitat would range from 35 percent in Subunit 5-2 to 61 percent in Subunit 3-4 by 2050.

The ability of the trees to develop open crowns and increase tree diameter would be lower as percent max SDI values, stand density indices and competition increase. This would have a negative effect on the development of old growth, and the quality of the habitat for hunting. Stagnation of stands and competition-induced mortality at levels above 56 percent max SDI could negatively affect the sustainability of existing old growth, and old trees (important for nest trees, prey habitat, and perches). The subunits above 35 percent would be increasingly vulnerable to insect and disease and at high risk for uncharacteristic fire due to the high density of trees.

The silvicultural report describes bark beetle hazard rating for the years 2020 and 2050 by RU and for the ponderosa pine analysis area. The overall hazard in 2020 is high across 43 percent of the analysis area. This increases to 69 percent in 2050. Stands with a hazard rating of low or moderate would be expected to be resistant to successful bark beetle attack and large scale mortality.

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 D.

The silvicultural report also states that dense conditions that result from alternative A are at a high risk to density related mortality and 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. High density stands would be more vulnerable and less resilient to the projected hotter climate in the southwest (Kerhoulas et al. 2013a). High density stands result in less deep water storage in the soil because the canopies interfere with precipitation reaching the ground and canopies allow moisture to be exposed to evaporation longer. Deep soil water is recharged by winter precipitation and ponderosa pines, especially large trees, rely heavily on this deep water. The risk of landscape-scale wildfire, with the potential to eliminate large portions of forested habitat, would increase with the lack of treatments in alternative A.

### Oak

Treatments proposed in alternative D are designed to conserve oak and improve conditions that favor oak growth and establishment wherever it exists by reducing pine-oak competition. This would result in improved vigor of existing oak and establishment of a variety of oak size and age classes across the landscape. These conditions would be most prevalent within the 64,065 acres of MSO restricted other habitat treatments. The silvicultural report indicates that the overall post treatment oak basal area would be 7 percent higher in this habitat compared to the no action alternative.

### Aspen

There would be 1,227 acres of aspen treatment in alternative D. Up to 82 miles protective barriers would be established around aspen clone patches within the ponderosa pine forest. Barriers would consist of fencing and/or felling trees (jack-strawing). Fencing would occur after mechanical and burning treatments and would have no effect to the vegetation. Jack-strawing may occur during the mechanical operation and would utilize trees that have been targeted for removal to meet treatment objectives. Leaving felled material on the ground would forego the opportunity to use that material for wood products.

### Pine sage

The 5,261 acres of pine-sage thinning treatments are designed to remove post settlement pine that currently is overtopping and shading out the sage and to manage fire to enhance sage extent. These treatments would result in enhancement of the sage component and restore the historic pattern within the pine sage mosaic.

### Snags, Logs, and Coarse Woody Debris

Refer to Figure 29, Figure 30, and Figure 31 to compare the effects of the alternatives on these components of prey habitat. Predicted snag densities by restoration unit, subunit, and alternative are displayed in appendix 20.

**Snags**: In the short term (2020), alternative D would have fewer large snags per acre than alternatives B, C, & E and a higher density of snags than alternative A in both PFAs/dPFAs and LOPFAs. As shown in figure 38, the differences are slight. This general pattern holds true for the restoration unit and subunit scales as well. Predicted snag densities by restoration unit, subunit, and alternative are displayed in appendix 20. In the long term (2050), the density of large snags is similar between alternatives in PFAs/dPFAs and in LOPFAs. Snag density would increase in both the PFAs/dPFAs and LOPFAs over time in alternative D but still would not achieve the guideline in the Coconino Forest Plan for at least 2 large snags per acre. Average snag density in PFA/dPFA habitat would not meet the desired condition 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 desired condition in the short term (average of 0.6 snags per acre) or the long term (average of 0.91 snags per acre).

**Logs**: Logs provide important habitat features for prey species, including substrate for foraging, den and nest sites, and cover. In the short term (2020), alternative D would have higher log densities than alternatives A, B, Chand E in the PFAs/dPFAs and LOPFAs. In the long term (2050), alternative D would have similar log densities per acre as alternatives B, C, and E and higher densities than alternative A in PFAs/dPFAs and LOPFAs. Log density per acre in this alternative would increase from year 2020 to year 2050. More large logs would be provided in PFA/dPFA versus LOPFA habitat. In PFA/dPFA habitat, alternative D would be the only alternative to meet requirement 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 requirements in the long term as well. In LOPFA habitat, Kaibab Forest Plan and Coconino Forest Plan requirements would not be met in the short term but would be in the long term. Predicted densities of large logs per acre by restoration unit, subunit, and alternative are displayed in appendix 20.

**Coarse woody debris:** 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. 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.

The average short term amount (estimated 5.4 tons per acre in the LOPFA and 5.67 tons per acre in PFA/dPFA habitat) would be within the lower end of the requirements in the Coconino and Kaibab forest plans of 5-7 tons per acre in ponderosa pine. The average long term amount (estimated 7.00 tons per acre in LOPFA and 7.84 tons per acre in PFA/dPFA habitat) would meet requirements in the Forest Plans. Predicted tons of coarse woody debris per acre by restoration unit, subunit, and alternative are displayed in appendix 20.

**LOPFA**: In 2020, the Subunits range from a low of 2.32 tons per acre in Subunit 6-2 and a high of 7.5 tons per acre in Subunit 3.5. In the short term, ten subunits will not meet recommendations in the two forest plans: 1-2, 3-1, 3-2, 4-2, 4-3, 5-1, 5-2, 6-2, 6-3, and 6-4. 2050, the Subunits range from a low of 4.12 in Subunit 6-2 and a high of 9.65 tons per acre in Subunit 3-4. The trend is for increasing coarse woody debris over time likely due to density related mortality and prescribed fire so by 2050, only three subunits fall short of requirements in the two forest plans: 4-2, 6-2, and 6-3. PFA/dPFA: In 2020, the Subunits range from a low of 2.42 tons per acre in Subunit 6-2 and a high of 9.06 tons per acre in Subunit 3-4. In 2050, the Subunits range from a low of 4.33 in Subunit 6-2 and a high of 10.65 tons per acre in Subunit 1-5. However, in PFA/dPFA habitat, eight subunits will not meet requirements in the two forest plans in the short term: 1-2, 3-1, 3-2, 4-2, 4-3, 5-2, 6-2, and 6-3; and only two subunits will not meet requirements in the long term: 6-2 and 6-3.

**Understory Development**

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. Understory would then decline by 2050 in both PFA/dPFA and LOPFA habitat as tree canopies expand and fill in the gaps (figure 32 and appendix 20). 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 about 70 percent compared to alternative B, the proposed action.

This alternative would be an improvement for grasses, sedges and forbs, and cool-season plants (which respond favorably to reductions in overstory density) compared to alternative A but would result in the least amount of improvement of the action alternatives. This alternative would be the least beneficial to bird and mammal forage directly and the arthropod community indirectly and would be the least beneficial for goshawk prey species like American robins, band-tailed pigeons, cottontail rabbits, golden-mantled ground squirrels, mourning doves, northern flickers, Stellar’s jay, and Williamson’s sapsucker, (except for alternative A which would result in no benefits) because of fewer positive impacts to foraging and nesting habitat and invertebrate prey, as described in appendix 6.

### *Determination of Effect*

Implementation of alternative D may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.

## Alternative E

This alternative would implement a variety of treatments to move towards desired conditions in goshawk habitat (Table 190). It would treat the second highest amount of total goshawk habitat and LOPFA habitat. The more acres treated the more acres that would move towards desired conditions. Treatments are described in more detail in the section titled ‘Common to Alternatives B, C, D, and E’, the silvicultural report and in the Implementation Plan in appendix D in the FEIS.

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 towards desired conditions for goshawk habitat would also increase.

There are about 19,235 acres of treated MSO habitat in this alternative. Some categories of MSO habitat (PACs, protected, target, threshold) may support lower densities of some prey species or a different array of prey species than would habitat treated to meet goshawk habitat direction in the forest plan because these categories would be managed to provide higher canopy cover levels. However, treatments in MSO restricted “other” habitat should improve goshawk prey habitat because it is more open. MSO treatments in protected and target and threshold habitats would be similar to the desired conditions for goshawk nesting habitat. Because goshawks are generalist species and have broader habitat requirements than MSO, MSO-based management treatments should not be in conflict with maintaining goshawk habitat where the two species overlap.

### *Direct and Indirect Effects*

Direct effects are those caused by the action and occur at the same time and place. With breeding season timing restrictions on all mechanical treatments, disturbance would be reduced. Design criteria to reduce disturbance to goshawks are described in the section titled Common to Alternatives B, C, D, and E.

**Table 190. Alternative E treatments in goshawk habitat**

| Cover Type and Proposed Treatment | LOPFA | PFA | dPFA | Grand Total |
|---|---|---|---|---|
| **Ponderosa Pine** | | | | |
| AZGFD Treatment | 4,563 | 274 | 0 | 4,837 |
| GL - Restoration | 0 | 0 | 0 | 0 |
| IT10 | 7,124 | 268 | 173 | 7,565 |
| IT25 | 10,741 | 922 | 208 | 11,871 |
| IT40 | 37,215 | 2,416 | 641 | 40,272 |
| MSO Restricted Treatment | 58,496 | 1,519 | 2,206 | 62,222 |
| MSO Target Treatment | 6,426 | 633 | 0 | 7,059 |
| MSO Threshold Treatment | 1,805 | 75 | 12 | 1,892 |
| PAC - Mechanical | 8,171 | 1,770 | 343 | 10,284 |

| Cover Type and Proposed Treatment | LOPFA | PFA | dPFA | Grand Total |
|---|---|---|---|---|
| Pine-Sage | 4,674 | 392 | 196 | 5,261 |
| Prescribed Fire Only | 134,621 | 10,857 | 1,566 | 147,044 |
| Savanna | 0 | 0 | 0 | 0 |
| SI10 | 1,823 | 25 | 65 | 1,914 |
| SI25 | 6,408 | 198 | 11 | 6,618 |
| SI40 | 13,227 | 368 | | 13,595 |
| UEA10 | 16,001 | 1,338 | 526 | 17,865 |
| UEA25 | 35,425 | 2,120 | 947 | 38,492 |
| UEA40 | 112,844 | 5,847 | 2,878 | 121,570 |
| WUI55 | 2,130 | | 95 | 2,224 |
| **Ponderosa Pine Total** | **461,695** | **29,022** | **9,868** | **500,585** |
| **Grass** | | | | |
| Grassland Mechanical | 47,733 | 121 | 26 | 47,880 |
| PAC - Grassland Mechanical | 35 | 0 | 0 | 35 |
| Prescribed Fire Only | 362 | 0 | 126 | 488 |
| **Grass Total** | **48,130** | **121** | **152** | **48,403** |
| **Aspen** | | | | |
| Aspen Treatment | 1,100 | 79 | 46 | 1,225 |
| Prescribed Fire Only | 194 | 31 | 0 | 225 |
| **Aspen Total** | **1,294** | **110** | **46** | **1,450** |
| **Pinyon-Juniper** | | | | |
| Prescribed Fire Only | 24,897 | 185 | 36 | 25,117 |
| WUI PJ Treatment | 535 | 0 | 0 | 535 |
| **Pinyon-Juniper Total** | **25,431** | **185** | **36** | **25,652** |
| **Oak Woodland** | | | | |
| Prescribed Fire Only | 3,172 | 26 | 0 | 3,197 |
| **Oak Woodland Total** | **3,172** | **26** | **0** | **3,197** |
| **Non-Veg** | | | | |
| Prescribed Fire Only | 1,712 | 8 | 12 | 1,732 |
| **Non-Veg Total** | **1,712** | **8** | **12** | **1,732** |
| **Grand Total** | **541,434** | **29,471** | **10,115** | **581,020** |

### Slide Fire

Table 191 shows the proposed treatments under alternative E that were affected by 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.

**Table 191. Alternative E treatments affected by the Slide Fire**

| Proposed Treatments (Alt E) | Acres | Number of Stands | Outside Fire Perimeter | Vegetation Severity | | | |
|---|---|---|---|---|---|---|---|
| | | | | Unchanged | Low | Moderate | High |
| **PFA** | | | | | | | |
| PFA - IT40 | 34 | 1 | 0 | 9 | 22 | 3 | 0 |
| PFA - UEA40 | 11 | 1 | 0 | 0 | 8 | 2 | 0 |
| PFA Nest Stand Prescribed Fire Only | 29 | 1 | 0 | 6 | 22 | 1 | 0 |
| **LOPFA** | | | | | | | |
| IT10 | 28 | 1 | 0 | 8 | 18 | 2 | 0 |
| IT40 | 820 | 8 | 0 | 87 | 424 | 259 | 50 |
| Prescribed Fire Only | 169 | 5 | 0 | 17 | 79 | 72 | 1 |
| UEA10 | 395 | 6 | 0 | 30 | 237 | 126 | 1 |
| UEA25 | 5 | 2 | 0 | 1 | 3 | 0 | 0 |
| UEA40 | 1,110 | 15 | 0 | 149 | 735 | 226 | 0 |
| MSO Restricted Treatment | 3,793 | 58 | 1 | 255 | 1,747 | 1,463 | 327 |
| MSO Target Treatment | 318 | 10 | 0 | 26 | 135 | 120 | 38 |
| MSO Threshold Treatment | 32 | 1 | 0 | 0 | 14 | 13 | 4 |
| MSO Protected Prescribed Fire Only | 1,012 | 34 | 0 | 28 | 302 | 449 | 233 |
| **Grand Total** | **7756** | **143** | **1** | **616** | **3746** | **2736** | **654** |

### Vegetation Structural Stage

Appendix 20 displays the VSS distribution for even age and uneven age stands by goshawk habitat projected out to the years 2020 and 2050.

In the silvicultural report, 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. An analysis of the VSS distribution within goshawk habitat for alternative E showed very minor differences compared to alternative B. These differences are listed in the silvicultural report. All percentages are the same for alternative E as alternative B for all other stages and years in each of the restoration units and habitats. Therefore, the narrative summaries describing post treatment and 2050 VSS distribution by habitat for alternative B are essentially the same for alternative E with the same trends.

In the silvicultural report, the goshawk habitat structural stage analysis for alternative E 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; 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/dPFA; VSS 1 is underrepresented in the LOPFA and VSS 1, 3 and 6 are underrepresented in the PFA/dPFA; there is no representation of the VSS 2 age class in all habitats.

**Old Growth**

Table 192 displays the old growth structural attributes of the ponderosa pine old growth acres projected out to the years 2020 and 2050 under alternative E (from the silvicultural report).

In 2020, the average conditions are at or above the minimum criteria with the following exceptions:

- Trees per acre larger than 18 inch and 180 years old. This condition is deficit in all subunits ranging from a low of 8.9 TPA in Subunit 6-2 to a high of 16.6 TPA in Subunits 1-5 and 3-4 with an overall average for all acres of 13.6 TPA. The age of these trees is estimated be in the range of 100 to 140 years old with a few relic trees meeting the 180 year old criteria.
- Basal area ≥90. This condition is below desired in Restoration Units 3, 4, 5 and 6. Overall average for all acres is 82.
- Coarse woody debris greater than 12 inch. This condition is estimated to be deficit with less than the equivalent of 2 pieces per acre throughout Restoration Units 5 and 6, and various Subunits.

Over time, old growth conditions improve in terms of meeting the minimum criteria. In 2050, all RUs are very close to or exceed the criteria for TPA larger than 18 inch 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 will be met throughout the old growth acres.

The restoration treatments proposed under alternative E are designed to manage for old age trees in order 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 Strategy in appendix A of the silvicultural report.

The goshawk habitat structural stage analysis above indicates the mature and old forest structural stages to be underrepresented in the PFA/dPFA habitat and LOPFA even-aged stands. Projections show a trend toward improved representation in all habitats.

Treatments within areas currently old growth will maintain existing old growth structural attributes and are managed to move towards those conditions over time. The old growth analysis above indicates old growth structural attributes will continue to develop and improve across the landscape.

With the implementation of restoration treatments under alternative E, the sustainability of the large/old tree component across the landscape will be improved as presented in the following forest health discussion. Maintaining old growth across the landscape would benefit a range of wildlife species, including goshawks, MSO, and black bears.

**Table 192. Alternative E –old growth structural attributes by restoration unit**

| Restoration Subunit/Unit | OG Acres | Average TPA 18"+ | | | Average BA | | | Average Tons CWD ≥12" | | | Average Snags Per Acre ≥12" | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 |
| 1-1 | 3,578 | 13.2 | 13.3 | 19.1 | 117 | 76 | 106 | 0.4 | 0.6 | 1.3 | 1.4 | 3.9 | 1.6 |
| 1-2 | 2,034 | 11.0 | 12.9 | 20.4 | 101 | 76 | 104 | 0.3 | 0.6 | 1.5 | 1.1 | 5.7 | 1.8 |
| 1-3 | 17,105 | 13.5 | 14.6 | 21.5 | 128 | 93 | 121 | 0.6 | 0.8 | 1.7 | 2.0 | 4.0 | 2.8 |
| 1-4 | 6,323 | 11.6 | 13.2 | 20.8 | 117 | 94 | 122 | 0.3 | 0.6 | 1.4 | 1.7 | 4.1 | 2.9 |
| 1-5 | 35,050 | 14.9 | 16.5 | 24.3 | 146 | 120 | 146 | 0.6 | 0.9 | 1.9 | 2.8 | 4.5 | 4.6 |
| **1** | **64,090** | **13.9** | **15.2** | **22.6** | **134** | **105** | **132** | **0.5** | **0.8** | **1.7** | **2.3** | **4.3** | **3.6** |
| 3-1 | 6,216 | 12.9 | 13.2 | 19.5 | 121 | 74 | 105 | 0.3 | 0.6 | 1.4 | 1.6 | 4.3 | 1.6 |
| 3-2 | 9,317 | 14.7 | 15.4 | 21.2 | 113 | 78 | 106 | 0.3 | 0.6 | 1.4 | 1.5 | 4.2 | 1.8 |
| 3-3 | 15,624 | 13.8 | 14.3 | 20.9 | 132 | 88 | 118 | 0.4 | 0.7 | 1.6 | 2.0 | 4.8 | 2.5 |
| 3-4 | 4,201 | 15.8 | 16.6 | 23.6 | 148 | 112 | 139 | 0.7 | 0.9 | 1.9 | 2.8 | 4.8 | 4.0 |
| 3-5 | 11,305 | 15.2 | 15.8 | 23.1 | 147 | 94 | 124 | 0.8 | 1.0 | 2.1 | 2.6 | 5.8 | 2.8 |
| **3** | **46,663** | **14.4** | **14.9** | **21.5** | **132** | **87** | **117** | **0.5** | **0.8** | **1.7** | **2.1** | **4.9** | **2.4** |
| 4-2 | 3,710 | 13.0 | 13.9 | 19.6 | 103 | 70 | 97 | 0.2 | 0.5 | 1.3 | 1.2 | 4.6 | 1.6 |
| 4-3 | 20,144 | 11.9 | 12.9 | 20.4 | 107 | 74 | 102 | 0.3 | 0.6 | 1.4 | 1.4 | 5.1 | 1.9 |
| 4-4 | 22,175 | 13.2 | 13.7 | 20.6 | 119 | 70 | 100 | 0.3 | 0.7 | 1.3 | 1.4 | 4.2 | 1.4 |
| 4-5 | 2,030 | 14.1 | 14.4 | 23.0 | 136 | 79 | 112 | 0.4 | 0.9 | 1.6 | 2.1 | 5.0 | 1.6 |
| **4** | **48,059** | **12.7** | **13.4** | **20.5** | **113** | **72** | **101** | **0.3** | **0.6** | **1.4** | **1.4** | **4.7** | **1.6** |
| 5-1 | 5,187 | 11.7 | 12.8 | 20.4 | 99 | 78 | 105 | 0.5 | 0.6 | 1.6 | 1.4 | 5.8 | 2.2 |
| 5-2 | 18,530 | 11.9 | 12.9 | 19.6 | 84 | 75 | 97 | 0.5 | 0.5 | 1.6 | 1.3 | 5.8 | 2.3 |
| **5** | **23,716** | **11.8** | **12.9** | **19.8** | **87** | **75** | **99** | **0.5** | **0.5** | **1.6** | **1.3** | **5.8** | **2.3** |
| 6-2 | 1,689 | 8.5 | 8.9 | 14.2 | 84 | 63 | 94 | 0.2 | 0.3 | 0.9 | 0.6 | 3.9 | 1.0 |
| 6-3 | 8,210 | 9.1 | 9.4 | 15.0 | 92 | 69 | 104 | 0.2 | 0.3 | 0.9 | 0.6 | 3.6 | 0.9 |
| 6-4 | 392 | 9.3 | 9.5 | 15.4 | 109 | 78 | 108 | 0.3 | 0.4 | 1.5 | 1.0 | 6.6 | 2.0 |
| **6** | **10,291** | **9.0** | **9.3** | **14.9** | **91** | **69** | **102** | **0.2** | **0.3** | **0.9** | **0.6** | **3.8** | **1.0** |
| **All** | **192,819** | **13.0** | **13.9** | **20.8** | **118** | **86** | **114** | **0.4** | **0.7** | **1.6** | **1.8** | **4.7** | **2.4** |

**Tree Groups, Interspaces, and Openness**

Even though there is a shift from more closed to more open conditions in alternatives B, C, D, and E, 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).

The majority of the landscape currently has continuous tree canopy with generally small interspaces. The desired condition is a mosaic of interspaces and tree groups of varying sizes and shapes. alternative E has a higher ability to attain a mosaic of interspaces and tree groups than alternative A and a similar ability to attain the desired conditions as alternatives B, C, and D.

While all treatments with the exception of Grassland Restoration are designed to reestablish forest openings and attain a mosaic of interspaces and tree groups of varying sizes and shapes, the intensity of the treatment affects the relative tendency toward this condition. The lower intensity treatments within MSO PAC, Target/Threshold, and prescribed fire only, treatments will result in irregular tree spacing and subtle expansion of existing forest openings. The higher intensity Treatments such as Pine Sage, Savanna, UEA 40, IT 40 and SI 40 will be removing more trees and extends greater flexibility in size and shape of interspaces and tree groups generated. MSO Restricted Treatments, SI10, UEA10, IT10, UEA 25, IT25, and SI25 would be expected to have a moderate contribution to the creation of interspaces and tree groups. Using Table 30, there are an estimated 264,976 acres of treatment (using the acreage of the treatments just listed) in alternative C that would contribute to the creation of interspaces and tree groups.

One of the differences between alternatives E (and C) and alternatives B and D is about 4,800 acres of modified UEA treatment, an experimental design developed by Arizona Game and Fish Department. This is similar to UEA10 treatments, which leaves a higher tree density than UEA40 trees, except that tree group size could increase to 15 acres. This would be beneficial for goshawk and their prey because it provides additional structural and spatial diversity.

Alternative E would restore forest openings with restoration treatments in PFA, LOPFA and MSO restricted other habitats enhancing small grassland inclusions within the greater forested area through the removal of ponderosa pine tree canopy that is shading out understory herbaceous vegetation and reducing forage production and species enhancing small grassland inclusions within the greater forested area. This would be followed by prescribed burning. The subsequent litter reduction and nutrient pulse would elicit a positive understory response and would provide food and cover for goshawk prey species through time, potentially improving prey numbers within grasslands and meadows and providing source populations of different prey species (e.g., mice, voles, rabbits, and gophers) for dispersal into the surrounding forest. In addition, arthropod prey such as beetles and moths would also likely benefit from these treatments. Therefore, meadow and an unknown percentage of grassland treatments would be expected to improve understory conditions for goshawk prey species.

A comparison of the openness categories by PFA/dPFA and LOPFA habitat within each alternative is located in Table 16. The variety of treatment types under alternative E would result in considerably more open habitat than alternative A. In PFA/dPFA habitat, implementation of alternative E would result in 11,832 more open acres than alternative A, the same amount of open acres as alternative C (16,103) and about 338 fewer open acres than alternatives B and D (16,441).

In LOPFA habitat, alternative E would result in more open and very open habitat than alternative A and the least amount of open and very open habitat of the action alternatives. It would have 52,272 fewer acres in the very open category than alternatives B and D and 52,272 fewer acres than alternative C mainly because it lacks grassland and savanna treatments. It would have the same very open amount as alternative A. It would have 42,457 more open acres than alternatives B and D and 46,563 more open acres than alternative C.

The reverse trend holds true for moderately closed and closed habitat. It has considerably less closed and moderately closed habitat than alternative A, and the highest amount of moderately closed and closed habitat of the action alternatives. It would have 9,815 acres fewer acres than alternative B and alternative D and 5,491 fewer acres than alternative C, primarily because there are no savanna or grassland restoration treatments in alternative E and there are more prescribed fire only treatments.

**Density**

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 (Table 193). In both the short and long term, goshawk habitat under this alternative would be healthier than if no treatment were to occur.

Table 193 shows the shifts in tree density in goshawk habitat in the different restoration units. The darkest shading is extremely high density; the lightest shading is moderate density; and the intermediate shading is high density. 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.

All 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. Restoration Unit 6 is the exception because the initial density is estimated to be high and it improves in the short term to moderate density (25-34 percent). By 2050, most of the restoration units would remain in high density except R Restoration Unit 1 which rebounds to the low end of extremely high density and none reach 2010 values. Restoration Units 4 and 6 would have the lowest densities in 2020 whereas Restoration Unit 1 would have the highest densities in PFA/dPFA habitat.

Density in LOPFA habitat would improve in the short and long term compared to existing. Restoration Units 1 and 3 would improve to high density in both the short and long term, never re-attaining existing values. Restoration Units 4, 5, and 6 would improve from high density to moderate density in the short term then back to high density by 2050. Restoration Units 4 and 5 would have the lowest densities over time and Restoration Unit 1 would have the highest.

**Table 193. Density in goshawk habitat in Alternative E**

| Restoration Unit and Subunit | SDI % of Max PFA/dPFA | | | | SDI % of Max LOPFA | | |
|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | | 2010 | 2020 | 2050 |
| All | 61% | 41% | 49% | | 57% | 36% | 45% |
| 1 | 71% | 53% | 59% | | 65% | 42% | 51% |
| 3 | 63% | 40% | 48% | | 63% | 38% | 47% |
| 4 | 56% | 35% | 44% | | 51% | 30% | 39% |
| 5 | 56% | 38% | 46% | | 40% | 29% | 36% |
| 6 | 50% | 34% | 45% | | 52% | 34% | 46% |

Table 194 shows the shifts in tree density in goshawk habitat in the different subunits. About 61 percent of the subunits in PFA/dPFA habitat 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. One subunit 3-3 improves from high to moderate density in the short term then shifts to high density in the long term as tree growth continues. Subunit 1-5 remains in high density in both the short and long term.

**Table 194. Density in goshawk habitat by subunit in Alternative E**

| Restoration Unit and Subunit | SDI % of Max PFA/dPFA | | | | SDI % of Max LOPFA | | |
|---|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2050** | | **2010** | **2020** | **2050** |
| 1-1 | 72% | 35% | 48% | | 56% | 32% | 42% |
| 1-2 | 50% | 34% | 43% | | 49% | 32% | 41% |
| 1-3 | 65% | 39% | 47% | | 61% | 39% | 48% |
| 1-4 | 64% | 44% | 53% | | 60% | 39% | 48% |
| 1-5 | 78% | 64% | 69% | | 70% | 46% | 54% |
| 3-1 | 58% | 37% | 46% | | 59% | 35% | 45% |
| 3-2 | 55% | 35% | 44% | | 52% | 34% | 43% |
| 3-3 | 65% | 43% | 56% | | 63% | 37% | 47% |
| 3-4 | 79% | 34% | 45% | | 72% | 47% | 56% |
| 3-5 | 69% | 38% | 48% | | 71% | 39% | 49% |
| 4-2 | 48% | 31% | 40% | | 44% | 27% | 36% |
| 4-3 | 54% | 35% | 43% | | 47% | 30% | 38% |
| 4-4 | 61% | 36% | 45% | | 54% | 30% | 40% |
| 4-5 | 56% | 38% | 46% | | 57% | 32% | 42% |
| 5-1 | 58% | 42% | 49% | | 45% | 30% | 38% |
| 5-2 | 53% | 35% | 42% | | 37% | 28% | 35% |
| 6-2 | 42% | 28% | 37% | | 45% | 29% | 40% |
| 6-3 | 50% | 34% | 46% | | 51% | 35% | 47% |
| 6-4 | | | | | 61% | 35% | 45% |

Density in LOPFA habitat would also improve in the short and long term compared to alternative A. Seven 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. Eight subunits improve from high to moderate density in the short term then shift to high density in the long term as tree growth continues.

In general, the following characteristics would be expected to develop as density decreases.

- Grassy stands of open canopy large diameter trees with long, heavy limbed crowns.
- Stands of moderately dense canopy, intermediate size trees.
- Clumpy irregular stands with groups of varying ages. Openings for seedling establishment would be made periodically.

These would improve the quality and sustainability of nesting and fledgling 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 E. Impacts to forest health are described in more detail in the silvicultural report.

The silvicultural report lists the beetle hazard rating for the years 2020 and 2050 by RU and for the ponderosa pine analysis area. The overall hazard in 2020 is high across 23 percent of the analysis area. This increases to 56 percent in 2050. Stands with a hazard rating of low or moderate would be expected to be resistant to successful bark beetle attack and large scale mortality.

### Oak

Treatments proposed in alternative E are designed to conserve oak and improve conditions that favor oak growth and establishment wherever it exists by reducing pine-oak competition. This would result in improved vigor of existing oak and establishment of a variety of oak size and age classes across the landscape. These conditions would be most prevalent within the 62,222 acres of MSO restricted other habitat treatments. The silvicultural report shows the overall post treatment oak basal area would be 5 percent higher in this habitat compared to the no action alternative. The improved balance of age classes would lead to increased resiliency and sustainability of oak.

### Aspen

The treatments within 1,227 acres of aspen stands under alternative E are designed to maintain and/or regenerate aspen by reducing pine-aspen competition. These treatments would result in establishment of vigorous aspen regeneration free of competition from overtopping ponderosa pine. Mechanical treatments would increase surface fuels to better carry fire beneath aspen overstories where fuel loading can be patchy. Mechanical scarification of soils, along with prescribed fire, would better stimulate aspen suckering. Improved health and resiliency of aspen clones and a robust understory response would be expected.

Up to 82 miles of protective barriers would be established around aspen clone patches within the ponderosa pine forest to prevent ungulate grazing within aspen clones. Barriers would consist of fencing and/or felling trees (jack-strawing). Fencing would occur after mechanical and burning treatments and would have no effect to the vegetation. Jack-strawing may occur during the mechanical operation and would utilize trees that have been targeted for removal to meet treatment objectives. Short- and long-term improvements in understory vegetation and overstory aspen health and sustainability would be anticipated.

**Pine sage**

The 5,261 acres of pine-sage thinning treatments are designed to remove post settlement pine that currently is overtopping and shading out the sage and to manage fire to enhance sage extent. These treatments would result in enhancement of the sage component and restore the historic pre-settlement tree density and pattern within the pine sage mosaic. It would sustain as much old forest structure as possible and maintain canopy cover requirements in tree groups.

**Snags, Logs, and Coarse Woody Debris**

Refer to Figure 29, Figure 30, and Figure 31 to compare the effects of the alternatives on these components of prey habitat. Predicted snag densities by restoration unit, subunit, and alternative are displayed in appendix 20.

**Snags**: In the short term (2020), alternatives C, B, & E would have the highest density of large snags per acre in PFA/dPFAs followed by alternative D, then alternative A. As shown in Figure 5, the differences are slight. This general pattern holds true for the restoration unit and subunit scales as well. Predicted snag densities by restoration unit, subunit, and alternative are displayed in appendix 20. 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 requirements 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 desired condition 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 low end of 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).

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.

**Logs**: Logs provide important habitat features for prey species, including substrate for foraging, den and nest sites, and cover. In the short term (2020), alternative E would have log densities similar to alternatives A, B, and C and log densities lower than alternative D in the PFAs/dPFAs and LOPFAs. In the long term (2050), alternative E would have similar log densities per acre as alternatives B, C, and D and higher densities than alternative A in PFAs/dPFAs and LOPFAs. Log density per acre in this alternative would increase from year 2020 to year 2050 so although alternative E would not meet Forest Plan requirement of at least 3 large logs per acre in the short term, it would be exceeded in the long term. More logs would be provided in PFA/dPFA versus LOPFA habitat. Predicted densities of large logs per acre by restoration unit, subunit, and alternative are displayed in appendix 20.

**Coarse woody debris:** 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 guideline/desired condition range of 5-7 tons per acre in the Coconino Forest Plan and Kaibab Forest Plan.

In the short term (2020) and long term (2050), the average values for LOPFA habitat in alternative E would have similar amounts of coarse woody debris as alternatives B and E and lower amounts than alternatives A and D. At the restoration unit scale, this general pattern holds true for Restoration Units 1, 3, and 4 and the associated subunits in LOPFAs.

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 20. 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 requirements in the short term, it would be reached in the long term.

**Understory Development**

On the average, alternative E would result in higher amounts of understory than alternative A and D but less than alternatives B and C in LOPFA habitat. Alternative E would result in slightly lower amounts of understory as alternatives B and C in the majority of PFA/dPFA habitat but more than alternatives A and D (Figure 32).

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 like American robins, band-tailed pigeons, cottontail rabbits, golden-mantled ground squirrels, mourning doves, northern flickers, Stellar’s jay, and Williamson’s sapsucker because of positive impacts to foraging and nesting habitat and invertebrate prey, as described in appendix 6. However, alternative E does not include grassland restoration whereas alternatives B-D have about 28, 650 to 28,950 acres of additional habitat to support grasses, forbs, invertebrates, and goshawk prey species such as cottontails, ground squirrels, and pigeons.

#### *Determination of Effect*

Implementation of alternative E may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.

## Northern Leopard Frog

### Alternative A No Action

#### *Direct and Indirect Effects*

Under alternative A, habitat conditions for wildlife would largely remain in their current condition. 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 (see Affected Environment above and in the silviculture and fire ecology reports). Alternative A would have no direct effect on northern leopard frog. however there would be substantial indirect effects. Dense forest conditions would still occur and the high fire hazard potential would persist. Forty-four percent of the ponderosa pine habitat in RU 1 would remain at high risk. Large crown-wildfires could adversely affect potential habitat by destroying understory and overstory vegetation. As a result overland flow would increase, and soil erosion would increase with potentially high sediment loads. Water quality and riparian conditions would be adversely affected on a wide-scale basis (Water Quality and Riparian report), resulting in indirect adverse effects.

Under alternative A, 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 (Water Quality and Riparian report) resulting in degradation of potential habitat for frogs.

Denser forest conditions produce lower values in understory biomass (pounds per acre). Under alternative A, understory biomass would continue to decline over the next 40 years (appendix 6). Limited cover around tanks and the limited herbaceous understory across the project area would continue to reduce the likelihood that frogs would successfully disperse and feed while traveling between waters. The limited cover would also leave frogs vulnerable to predation.

### *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. Cumulative effects include effects of alternative A. This 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.

### *Determination of Effect*

Alternative A may impact northern leopard frogs, but is not likely to cause a trend to federal listing or loss of viability.

## Alternative B Proposed Action

### *Direct and Indirect Effects*

Dispersing leopard frogs could be directly impacted if they collide with mechanical equipment or if they could not find refugia during prescribed fire activities. All springs would be surveyed prior to restoration activities. Mitigations measures would reduce the likelihood of direct impacts to frogs from mechanical thinning, temporary road construction, spring and ephemeral drainage restoration, road decommissioning, and prescribed fire.

Under the Proposed Action dense forest conditions and surface fuel loading in RU 1 would be reduced. The likelihood of large crown wildfires adversely affecting potential habitat by destroying understory and overstory vegetation would be reduced by 37 percent in the ponderosa pine and five percent in grasslands within this RU. As a result overland flow would be stable, and soil erosion would not have the high sediment loading potential. Water quality would be not adversely affected on a wide-scale basis, resulting in indirect beneficial effects.

Under alternative B, 74 springs would be restored with 32 of those in RU 1, which contains all breeding and potential breeding sites and the northern leopard frog corridor. Additionally, 24 miles of ephemeral streams would be restored in this RU. There would be short term disturbance to vegetation during implementation of stream and spring restoration projects however restored vegetation would be expected to recover within a 1 to 3 year period (Soil Resources report). An important consideration for restoration of springs is to restore discharge from the spring source except where prescribed by existing water rights adjudicated. All action alternatives would allow discharge from springs to resume flow through their historic spheres of discharge as described by Springer and Stevens (2008) (Water Quality and Riparian report). Spring and seep restoration would increase riparian vegetation increasing availability of food and reproductive sites for this species over the long-term, resulting in direct beneficial effects to habitat. Restoration of ephemeral channels would improve cover and water flow that provides escape from predators and prevents water loss for migrating leopard frogs.

Reconstructing 40 miles of temporary roads along their original alignments would generally have limited impacts to the physical habitat features along the roads. About 30 miles of road reconstruction would address safety concerns for hauling. The remaining miles (about 10) would relocate roads out of drainage bottoms. Relocated roads would include rehabilitation of the abandoned road segment. Disturbance associated with road traffic is not expected to change because this represents improvements to segments of existing road, not new road construction. If each mile impacts approximately 3 acres of habitat, then about 120 acres of breeding and dispersal habitat would be impacted by road reconstruction.

Decommissioning 205 miles of roads in RU 1 would improve the quality of the habitat in those areas where the roads are decommissioned. While the physical structure and features of the habitat may not measurably change along the former road alignment, eliminating disturbance along the roadway would be expected to improve the quality of habitat and reduce the potential for frogs to be crushed by vehicles using these roads. With each mile of road impacting approximately 3 acres of habitat, about 615 acres of forested habitat may be improved within northern leopard frog breeding and dispersal habitat. Road decommissioning would include one or more of the following:

- Reestablishing former drainage patterns, stabilizing slopes, and restoring vegetation;
- Blocking the entrance to a road or installing water bars;
- Removing culverts, reestablished drainages, removing unstable fills, pulling back road shoulders, and scattering slash on the roadbed;
- Completely eliminating the roadbed by restoring natural contours and slopes; and
- Other method designed to meet the specific condition associated with the unneeded roads.

Long-term effects would habitat improvements over current conditions.

Constructing 71 miles of temporary roads would disturb vegetation and reduce habitat quality for leopard frogs. Use of these roads by machinery and equipment could crush animals moving across the road. These effects may impact individuals but are expected to be short-term occurring only during project implementation. Temporary roads would be decommissioned to eliminate use and vegetation would be restored over the long-term.

Implementation of the proposed action could increase the risk of spread of Chytrid fungus across the project area. Machinery and equipment used during implementation could transfer Chytrid fungus between water bodies, increasing the occurrence of the pathogen in leopard frog habitats across the project area. Potential impacts from chytrid fungus that is spread by machinery and equipment would be minimized by requiring decontamination procedures to be followed when activities take place within wetted areas or moist perimeter of a tank or ephemeral stream. Therefore, minimal potential for spread would exist.

Under the proposed action surface disturbance within proximity of suitable habitats would increase. Direct impacts could result from crushing and trampling of migrating and/or basking individuals. The use of heavy machinery and increased levels of human activity and traffic are likely to increase sedimentation in the earthen livestock tanks in the vicinity, especially in those located downslope from treatment areas. Effects of sedimentation on leopard frog habitats are extensive and varied. They include alterations in water quality and vegetation structure that ultimately have detrimental impacts on leopard frogs by decreasing rate of development, increasing vulnerability to predators, and reducing food availability.

Prescribed burning may result in mortality of leopard frogs. Early fall prescribed fire has the highest likelihood of impacting leopard frogs, as this is a time of year when they are migrating between suitable habitats. Leopard frogs may migrate en masse, and large numbers may therefore be susceptible to fire at one time. Prescribed burns within Subunits 1-5 and 1-6, where the majority of critical breeding sites occur, would be coordinated with a wildlife biologist to insure protections for migrating frogs. In coordination with AGFD occupied, critical breeding sites and potential breeding sites have been identified and mapped and will be included in the individual task order map with a protected water designation. Project design features have been developed to reduce the potential impact to these important breeding sites and frogs using and moving between these sites. Implementation of best management practices would curtail soil erosion and minimize potential for inflow into potential northern leopard frog habitat.

### *Determination of Effect*

Implementation of alternative B may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.

## Alternative C

### *Direct and Indirect Effects*

The direct/indirect effects are similar to alternative B. Alternative C includes construction of 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 research. The installation of structures in drainages within RUs 1and 3 could potentially act as barriers to leopard frog movement limiting their ability to occupy additional areas. Structures could force leopard frogs to move over land making them more vulnerable to predation. Structures can also alter the hydrology and potentially create pools with slow moving water creating habitat. Northern leopard frog surveys have documented frogs using pools created by these structures. The design of structures will be important to ensure ample amphibian passage. 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. Potential impacts from chytrid fungus that is spread by machinery and equipment would be minimized by requiring decontamination procedures to be followed when activities take place within wetted areas or moist perimeter of a tank or ephemeral stream. Therefore, minimal potential for spread would exist.

Alternative C treats the most acres and elicits the greatest response in understory (appendix 6). Additional meadow and grassland treatments are scattered throughout the project area and would occur in most subunits increasing the likelihood that frogs would successfully forage around and migrate between livestock tanks due to decreased risk of predation. Project design features have been developed to reduce the potential of impact to important breeding sites and the frogs using and moving between these sites.

#### *Determination of Effect*

Implementation of alternative C may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative D

#### *Direct and Indirect Effects*

This alternative has similar effects as alternative B however; alternative D produces the lowest response of understory biomass of all the action alternatives. The reduced understory biomass would result in less cover reducing the likelihood that frogs will successfully forage around and migrate between livestock tanks due to increased risk of predation. Alternative D does not include prescribed burning across the mechanical treatments as alternative B does resulting in fewer acres of prescribed burn only. The lack of burning means no nutrient pulse into the system, further limiting understory response, however, this reduction of prescribed fire could reduce direct impacts to frogs migrating overland between stock tanks. Alternative D does not include the paired watershed study reducing the need for structures within dispersal habitat.

#### *Determination of Effect*

Implementation of alternative D may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative E

#### *Direct and Indirect Effects*

This alternative has similar effects as alternative C, including construction of flumes and weather stations to support watershed research. However, alternative E produces the second lowest response of understory biomass of all of the action alternatives reducing areas where frogs could successfully forage around and migrate between livestock tanks due to increased risk of predation.

#### *Determination of Effect*

Alternative E may impact northern leopard frog, but is not likely to cause a trend to federal listing or loss of viability.

### Cumulative Effects for all Action Alternatives

The area analyzed for cumulative effects for northern leopard frog is RU1 and a ¼ mile buffer outside the project boundary along RU1 to include current and potential breeding sites. 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 are listed in appendix 17 and include fuels reduction, forest health, aspen regeneration, tornado rehabilitation and powerline development and maintenance. These activities could result in short-term direct impacts to frogs however they are not expected to result in long-term cumulative effects and are expected to be localized in nature. Mitigation measures to limit direct impacts have been developed in this project as well as ongoing and reasonably foreseeable projects (i.e. Upper Beaver Creek within ½ mile of project) within critical breeding and dispersal habitats.

Implementation of current, ongoing and reasonably foreseeable projects could occur simultaneously; however it is not anticipated to combine to cause a negative indirect effect. Best Management Practices (BMPs) are implemented for all projects and would curtail soil erosion and minimize potential for inflow into potential northern leopard frog habitat. Other activities that occur within the action area and may have impacts to leopard frogs and their habitats include livestock grazing, and recreation activities such as off road vehicle use and camping. Travel Management Rule decision reduces off road motorized travel in leopard frog habitats reducing impacts to waters and travel corridors. Range management is designed to rotate cattle to limit impacts to any one area allowing time for habitat recovery however; wild ungulates would continue to reduce vegetative understory and affect plant composition in meadows, drainages and around waters.

Alternative C and E could alter amphibian movement in drainages within RUs 1 and 3. Other projects that may combine to alter amphibian movement include the Beaver Creek Experimental Watershed, road construction, off highway vehicle use, grazing, wildfire and fire suppression activities and the lack of vegetation management to reduce tree densities and increase vegetative ground cover. These activities are not expected to result in long-term cumulative effects and are expected to be localized in nature.

## Bald Eagle

### Alternative A No Action

#### *Direct and Indirect Effects*

Alternative A includes current and foreseeable projects within the project area. Thirty-nine percent of the ponderosa pine within the 4FRI project area has potential for crown fire (Fire Ecology report). 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.

#### *Cumulative Effects*

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. 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.

## Alternative B Proposed Action

### *Direct and Indirect Effects*

Direct effects would be from activities that cause disturbances (smoke, auditory or visual) to golden eagles nesting or foraging within or adjacent to the project. Under the Proposed Action, there would be no direct adverse effects to nesting eagles as project design features would eliminate disturbance near known nesting sites. No vegetation treatments would occur within ½ mile (2,500 feet), unless mitigated by topography, of an occupied bald eagle nest between March 1 and August 31. Drift smoke from prescribed fire is expected; however, concentrations of smoke that might settle in an area for more than one or two nights when a female is on the nest could have adverse effects to individuals. Prevailing southwest winds and the topography of the area typically act to lift smoke, carrying it away from ignition sites. Nests on cinder cones and other raised topographic features and in Sycamore and Oak Creek Canyons or in canyons immediately adjacent to Sycamore and Oak Creek Canyons or the Mogollon Rim are not expected to have smoke settle in them long enough to cause measurable effects to eagles because of the air movement in these landscape-scaled features. Conversely, nests in areas occurring in small canyons or valleys may have dense smoke settle in nesting locations.

When smoke settles into low-lying areas it typically does not last more than 1 or 2 nights. Limited smoke at nest locations would be expected to expose adult eagles to negligible effects as this would repeat an aspect of their evolutionary environment (Horton and Mannan 1988, Prather et al. 2008). However, on occasion dense smoke may settle into specific nest locations. Dense smoke settling into nest areas early in the season (March through June) could disturb brooding females. If the female flushed long enough to affect incubation this could result in loss of viability of the eggs. Dense smoke settling for multiple consecutive nights could affect developing lungs of nestlings. Unlike mammals, damaged avian lungs do not repair themselves through time (Rombout et al. 1991). Causing the female to discontinue incubating eggs or affecting lung development of nestlings would cause long-term adverse effects. Outside of these examples, smoke settling in nest locations would typically be short-term and not likely to cause adverse effects.

The project area was divided into subunits that were designed using 6th code watersheds as boundaries. FWS and fire specialists determined subunits were an appropriate boundary for analyzing smoke impacts to nests and that burning within a given subunit could impact nests within that subunit if nests are located where smoke settles. Fire specialists and biologists reviewed the three bald eagle nest locations within the project area to determine if smoke would be expected to settle for more than one or two nights. Of the three nests, two at Upper Lake Mary were identified as areas where smoke would settle if conditions are not optimal and fuels loads are heavy. This is of particular concern with first-entry burns. In consultation with FWS, the Forest Service designed mitigation for those specific nest locations to include monitoring to determine if the nest is occupied/active and if so, a timing restriction would be placed on first-entry burns within the subunit with nests until the young fledge. At present, the subunit that could have a restricted burning period is 1-3. Alternative B would defer all confirmed roost sites and nest sites with a 300-foot no cut zone from mechanical thinning treatments. Additionally, timing restrictions during the winter roosting season would provide protection from disturbance to roosting eagles. Potential roost treatments would be designed to maintain and develop roost characteristics such as, large trees and snags, while reducing surface fuel loading and crown fire potential within the roost increasing roosting habitat for eagles in the project.

There is no effect to nesting or roosting eagles, however, short-term disturbance to foraging bald eagles would occur during mechanical treatments, prescribed burning, hauling of timber and other project activities may cause visual or auditory disturbance to foraging bald eagles. Approximately 40,000 acres of prescribed burning and 45,000 acres of mechanical treatment would occur annually; however, these are short-term effects and would be minimized due to activities being temporally and spatially separated. Additionally, prescribed burning effects would dissipate over time as first entry burns are usually related to consumption of accumulated surface fuels, raising crown bulk height and reducing crown bulk density (Fire and Fuels report). In ponderosa pine maintenance burns or second entry fuel loads would be significantly lower and produce low severity effects with fewer emissions (Fire and Fuels report). Disturbances would be localized and of short duration and may affect individual birds but would not affect the overall distribution or reproduction of the species.

Indirect effects to the bald eagle include effects to eagle habitat, eagle prey species, or prey species habitat. There are no anticipated adverse effects to prey species or prey species habitat. Indirect effects to habitat would occur from treatments that modify the number of trees in a group of suitable roost trees, as eagles prefer to roost in large trees within close proximity to other large trees. However, thinning would improve old tree longevity, resulting in beneficial effects. In RUs with documented bald eagle use snags would slightly increase post treatment (2020) and continue to increase in the long term. Ignition techniques and site preparation would reduce potential mortality to these components from burning activities. In addition, the Proposed Action would include developing old-growth in 36 percent of the area 10 years post treatment and 60 percent of the area 30 years later that may be used as future winter roost sites for bald eagles. Alternative B would develop more old growth in both the short-term (10 years post treatment) and in the long term (30 years post treatment) than alternatives A, D and E and the same as alternative C.

## Alternative C

### *Direct and Indirect Effects*

The effects are similar as alternative B. One documented roost is located within an AGFD Research site however these treatments are designed to provide group sizes up to 15 acres in size and will be tailored to meet Forest Plan guidelines. All alternatives are designed to eliminate disturbance to and provide habitat for nesting and roosting bald eagles. Under alternative C there would be an increase in trees greater than 18 inches d.b.h., particularly in trees greater than 24 inches d.b.h., in both the short term and the long term which will have the same benefits as described above.

### *Determination of Effect*

Alternative C may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.

## Alternative D

### *Direct and Indirect Effects*

The effects are similar as alternative B. Under alternative D there would be an increase in trees greater than 18 inches d.b.h., particularly in trees greater than 24 inches d.b.h., in both the short term and the long term which will have the same benefits as described above. Alternative D would provide 6 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 and C with slightly less than alternative E. All action alternatives are designed to eliminate disturbance and provide habitat to nesting and roosting bald eagles.

#### *Determination of Effect*

Alternative D may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative E

#### *Direct and Indirect Effects*

The effects are similar as alternative B. Under alternative E there would be an increase in trees greater than 18 inches d.b.h., particularly in trees greater than 24 inches d.b.h., in both the short term and the long term which will have the same benefits as described above. Compared to alternatives B and C, alternative E would provide 5 percent less developing old growth in the short-term (post treatment) and 3 percent less long term (30 years post treatment). Alternative E have slightly more large trees than alternative D. Alternative E would provide less foraging habitat than the other action alternatives with about 28,650 fewer acres of savanna restoration than alternative C and 28,950 fewer acres than alternatives B and D. All action alternatives are designed to eliminate disturbance and provide habitat to nesting and roosting bald eagles.

#### *Determination of Effect*

Alternative E may impact bald eagle, but is not likely to cause a trend to federal listing or loss of viability.

### Cumulative Effects for all Action Alternatives

The area analyzed for cumulative effects for bald eagle is the ponderosa pine within the project and a ½ -mile buffer outside of the project boundary. Current, ongoing and reasonably foreseeable projects are listed in appendix 17 and include fuels reduction, forest health, aspen regeneration, tornado rehabilitation and powerline development and maintenance. 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. About 2,000 acres of potential foraging habitat burned in the Slide Fire. No known nests are in the area and affects to bald eagle are considered inconsequential. All alternatives would improve and develop quality potential nesting and roosting habitat by developing groups of large trees and snags that are more fire resistant. This positive effect would be combined with similar effects from activities such as the Travel Management rule 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.

## American Peregrine Falcon

### Alternative A No Action

#### *Direct and Indirect Effects*

Under alternative A, about 6,933 acres of grassland thinning and 6,505 acres of prescribed fire in grasslands from current and foreseeable projects within the 4FRI project area would enhance peregrine foraging habitat (appendix 17). However, in other grasslands, savannas, and meadows tree encroachment would continue and litter would continue to accumulate, continuing to negatively affect some prey habitats for peregrine falcons. Stability of key ecosystem components such as, species composition, forest structure, soil characteristics and hydrologic function are at moderately to high risk of loss in the event of high severity disturbance, such as high severity wildfire on 82 percent of grasslands. This alternative would result in the most stress on meadow and grassland habitats and thus would have the greatest negative contribution to potential grassland habitat.

#### *Cumulative Effects*

The area analyzed for cumulative effects for peregrine falcon is grassland, savanna and riparian habitat within the project area and within a ½ mile outside the project boundary and cumulative effects includes effects of alternative A. This alternative would result in cumulative impacts to peregrine falcons by continuing to reduce the quality of foraging habitat by reducing meadow, grassland and savanna habitats. Additionally, the trend away from desired conditions in terms of tree numbers and densities would reduce water yield, potentially affecting marsh, pond and lake habitats that are dependent on seasonal precipitation. Increasing effects from climate change could add synergistic effects to decreasing water availability.

#### *Determination of Effect*

Alternative A may impact peregrine falcon, but is not likely to cause a trend to federal listing or loss of viability.

### Effects Common to All Action Alternatives

Constructing and reconstructing 557 miles of roads along their original alignments, including temporary and relocated roads, would not have noticeable impacts to the physical habitat features along the roads. Increased disturbance associated with the increased activity on the improved road conditions may decrease the habitat quality along the improved roads. If each mile impacts approximately 3 acres of habitat, then about 1,671 acres of habitat would be impacted by road construction and reconstruction.

Improving springs and seeps and restoring riparian habitat and ephemeral streams in the action alternatives would improve habitat. There would be short term disturbance to vegetation during implementation of restoration projects. However, restored vegetation would be expected within a one year period (i.e. Hoxworth Spring Restoration).

Decommissioning about 859 miles of roads in all of the action alternatives would improve the quality of the habitat in those areas where the roads are decommissioned. The physical structure and features of habitat for goshawks and their prey would be improved along the former road alignment and disturbance along the roadway would largely be eliminated, thereby improving the quality of habitat in the long term. With each mile of road impacting approximately 3 acres of habitat, about 2,577 acres of forested habitat may be impacted.

Constructing about 517 miles of temporary roads would disturb vegetation and reduce available habitat for peregrine prey. These effects may impact individuals but are expected to be short-term occurring only during project implementation. Temporary roads would be obliterated to eliminate use and vegetation would be restored over the long-term.

## Alternative B Proposed Action

### *Direct and Indirect Effects*

Under the proposed action, no direct effects from mechanical treatments, temporary road construction, prescribed burning or spring and riparian habitat and ephemeral streams restoration is expected. There are four peregrine eyries (nest locations) within the treatment area. All four are associated with one pair of peregrines. These eyries are located on cliff ledges in a rugged canyon. No thinning treatments are proposed in this area with a burn only treatment designated. Smoke from burning operations is expected to drain away from the nest location reducing the potential for birds to be exposed to heavy concentrations of smoke. This area is also designated as MSO PAC and protection measures developed for the owl would also protect peregrines breeding in this area as their breeding season overlaps with the owl.

Mechanical treatments prescribed burning, hauling of timber and other project activities may cause visual or auditory disturbance to foraging peregrine falcons. Approximately 40,000 acres of prescribed burning and 45,000 acres of mechanical treatment would occur annually; however, these are short-term effects and would be minimized due to activities being temporally and spatially separated. This disturbance 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.

While peregrines do not nest or forage in ponderosa pine forest, active management in portions of the pine forest could potentially affect prey base habitat, e.g., meadows, grasslands, and savannas are commonly encroached by pine trees as a result of fire exclusion; restoring these habitats towards 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.

### *Determination of Effect*

Alternative B may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.

## Alternative C

### *Direct and Indirect Effects*

Alternative C has similar effects as alternative B and D. Alternative C provides for more grassland restoration which would have a greater beneficial effect to peregrine prey.

Impacts of the silvicultural prescriptions for research proposals have been reflected in the vegetation data already analyzed. Constructing 15 weirs that would impact 3 acres would not have a discernible impact to habitat at the project level.

### *Determination of Effect*

Alternative C may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.

## Alternative D

### *Direct and Indirect Effects*

This alternative has similar effects as alternative B; however, alternative D produces the lowest response of understory biomass of all the action alternatives. Alternative D does not include prescribed burning across the mechanical treatments as alternative B does resulting in fewer acres of prescribed burn only. The lack of burning means no nutrient pulse into the system, further limiting understory response. The reduced understory biomass would result in fewer habitats for peregrine prey.

#### *Determination of Effect*

Alternative D may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative E

#### *Direct and Indirect Effects*

This alternative has similar effects as alternative B; however, 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.

#### *Determination of Effect*

Alternative E may impact peregrine falcon, but is not likely to cause a trend to federal listing or loss of viability.

### Cumulative Effects for all Alternatives

The area analyzed for cumulative effects for peregrine falcon is grassland, savanna and riparian habitat within the project area and within ½ mile of the project boundary. Under all alternatives, there would be an additive indirect effect from activities that modify vegetation. Other, present and reasonably foreseeable projects are listed in appendix 17. Those projects 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.

Two nests are known in the Slide Fire area and about 22,000 acres of foraging habitat was affected. 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. 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.

## Western Burrowing Owl

There are no documented nesting burrowing owls on the project area, however potential nesting habitat does exist.

### Alternative A No Action

#### *Direct and Indirect Effects*

Burrowing owls are closely associated with prairie dogs. Prairie dogs often occur in grassland habitats and colonies have a greater chance of being impacted under this alternative due to the continued encroachment of trees. About 13,440 acres of grassland treatment would occur due to current and future foreseeable projects (appendix 17). Most acres treated would include both thinning and burning, which are tallied separately, so the acres of actual grassland improved may be closer to 40 to 50 percent of this number. In comparison, the action alternatives under 4FRI would include nearly 48,000 to about 104,500 acres of grassland treatments. Tree encroachment and canopy development under existing trees would largely continue under alternative A. Denser forest conditions produce lower values in understory biomass (pounds per acre). Understory biomass would continue to decline over the next 40 years under alternative A (appendix 6). This in turn leads to less available habitat for prairie dogs and consequently burrowing owls. Vegetation would continue to grow and fuel would continue to accumulate, continuing to have negative effects to prairie dog habitat and consequently potential habitat for western burrowing owl. Acres of grassland in FRCC1 would decrease in the absence of any type of treatment, as woody species continue to encroach and species composition shifted in favor of less fire adapted species. Grasslands in the project area are at high risk of losing key ecosystem components such as, species composition, forest structure, soil characteristics and hydrologic function, in the event of high severity fire. High fire severity potential would persist, and a large crown wildfire event would have the potential to affect many individuals. Thirty-nine percent of the ponderosa pine and 12 percent of grassland habitat would support a crown fire. This alternative would result in the most stress on meadow and grassland habitats and thus would have the greatest negative contribution to potential western burrowing owl habitat.

#### *Cumulative Effects*

The area analyzed for cumulative effects to burrowing owls encompasses the project area, the associated prairie dog complexes, and cumulative effects includes effects of alternative A. Alternative A would maintain the current risk to burrowing owl habitat and adjacent forest lands. 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. The fire hazard would increase over time as vegetation would continue to grow and fuel would continue to accumulate, continuing to have negative effects to burrowing owl habitat.

#### *Determination of Effect*

Implementation of alternative A would not impact individuals and provide limited improvement to burrowing owl habitat due to current and foreseeable projects. It is not likely to cause a trend to federal listing or loss of viability.

### Alternative B Proposed Action

#### *Direct and Indirect Effects*

Alternative B would restore about 11,185 acres of historic grassland and about 45,400 acres of ponderosa pine forest would have an open reference condition, aiding in dispersal and recolonization of prairie dog towns.. 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 towards historic conditions can increase potential nesting and foraging habitat for western burrowing owls. Meadow restoration treatments would improve and increase available habitat for prairie dogs, which would subsequently provide nesting habitat for burrowing owls. The Proposed Action would increase available habitat for prairie dogs with 56,590 acres of grassland and savanna restoration treatments. Grassland treatments would not lead to a change in the percent of area with the potential for crown fire. Prescribed burning 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 for insects and small mammals increasing food sources and resulting in an indirect beneficial effect for burrowing owls.

#### *Determination of Effect*

Alternative B would have no impact to burrowing owls but would improve potential future habitat for the species. It is not likely to cause a trend to federal listing or loss of viability.

### Alternative C

#### *Direct and Indirect Effects*

Alternative C would have a more pronounced impact on decreasing pine tree encroachment in grasslands by treating about 59,400 acres of grassland, thus doing more to improve prairie dog habitat than any other alternative. About 45,140 additional acres of ponderosa pine forest would have an open reference condition, aiding in dispersal and recolonization of prairie dog towns. Treatments would reduce the acres of potential crown fire in grasslands by eight percent. These treatments would occur within open linkages providing additional opportunities for Gunnison’s 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 (appendix 6). 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 burrowing owl habitat.

#### *Determination of Effect*

Alternative C would have no impact to burrowing owls but would improve potential future habitat for the species. It is not likely to cause a trend to federal listing or loss of viability.

### Alternative D

#### *Direct and Indirect Effects*

Alternative D would improve 11,185 acres of historic grassland and about 45,400 acres of ponderosa pine forest would have an open reference condition, aiding in dispersal and recolonization of prairie dog towns. This alternative has effects similar in nature as alternative B however; alternative D produces the lowest response of understory biomass of all the action alternatives. Alternative D increases the acres of potential for crown fire for four percent of grassland habitat. Additionally, this alternative does not include prescribed burning across the mechanical treatments as alternative B does and there are about 19,923 fewer acres of prescribed burn only. 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 it would do the least in terms of providing future potential habitat for burrowing owls.

#### *Determination of Effect*

Alternative D would have no impact to burrowing owls but would improve potential future habitat for the species. It is not likely to cause a trend to federal listing or loss of viability.

### Alternative E

#### *Direct and Indirect Effects*

Alternative E would have a more pronounced impact on decreasing pine tree encroachment in grasslands by treating about 47,910 acres of grassland and improving prairie dog habitat. No additional acres of ponderosa pine forest would be treated to the open reference condition. Current forest conditions fragment many grasslands across the project area and likely work to limit dispersal and recolonization of prairie dog towns. Similar to alternative C, alternative E reduces the acres of potential crown fire by eight percent however; alternative E result in the second lowest response of understory biomass of all the action alternatives, limiting prey and resulting minimizing benefits to potential future burrowing owl haibtat.

#### *Determination of Effect*

Alternative E would have no impact to burrowing owls but would improve potential future habitat for the species. It is not likely to cause a trend to federal listing or loss of viability.

### Cumulative Effects for all Action Alternatives

The area analyzed for cumulative effects to burrowing owls encompasses the project area and the associated prairie dog complexes. Cumulative activities such as the Travel Management Rule are likely to decrease motorized use in grasslands, thus decreasing impacts to prairie dog populations. This, combined with forest thinning and prescribed burning activities, could open up more habitat and increase grassland habitat connectivity. Past, present and reasonably foreseeable projects are listed in appendix 17. Past projects have implemented thinning on 2,304 acres and prescribed burning on 8,951 acres of grasslands. Short-term and localized effects from mechanical thinning and prescribed burning would result in disturbance and potential collapse 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 potentially burrowing owls) in limited areas.

Thinning 2,340 acres and prescribed burning about 8,950 grassland acres will add to treatment acres from this project to reduce tree densities in grasslands and connect open corridors across the analysis area providing, additional potential future habitat for burrowing owls.

## Navajo Mogollon Vole

### Alternative A No Action

#### *Direct and Indirect Effects*

Most of the forested area within the project is currently in moderately-closed to closed conditions (Silviculture report), providing low quality habitat for Mogollon voles. Under alternative A, meadows would not be rehabilitated under the 4FRI. About 13,440 acres of grassland thinning and burning would occur due to current and future foreseeable projects (appendix 17). At the landscape scale there would be limited benefits to the vole habitat. Favorable habitat would decrease over time as conifers encroach into meadows and canopy closure increases, resulting in an indirect adverse effect. Acres of grassland in FRCC1 would decrease in the absence of any type of treatment, as woody species continue to encroach and species composition shifted in favor of less fire adapted species. Acres of ponderosa pine in FRCC 2 and 3 would continue to increase, leaving just 2 percent in FRCC1. Ponderosa pine in the project area would be at a high risk of losing key ecosystem components, should there be a disturbance event, such as fire or extended drought (Fire Specialist report). Ponderosa pine in the project area is at high risk of losing key ecosystem components such as, species composition, forest structure, soil characteristics and hydrologic function, in the event of high severity fire. High fire severity potential would persist, and a large crown wildfire event would have the potential to affect many individuals. Thirty-nine percent of the ponderosa pine and 12 percent of grassland habitat would support a crown fire. Vegetation would continue to grow and fuel would continue to accumulate, continuing to have negative effects to vole habitat.

#### *Cumulative Effects*

The area analyzed for cumulative effects for Navajo Mogollon vole is the project area and cumulative effects includes effects of alternative A. This alternative would continue to result in indirect impacts to Navajo Mogollon vole habitat. Cumulative effects from indirect impacts to voles would be limited to increased tree densities resulting in limited herbaceous understory, impacting the ability of voles to successfully forage around and migrate between habitats. At the landscape scale, overstory development would continue to shift understory composition towards less digestible species (appendix 6). Encroachment into openings and species composition changes would also favor less fire adapted species. Degradation and fragmentation of habitat facilitated by this alternative 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. Grazing may result in short-term impacts to habitat, is not expected to result in long-term cumulative impacts and is 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 Mogollon vole habitat.

#### *Determination of Effect*

Alternative A may impact Navajo Mogollon vole, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative B Proposed Action

#### *Direct and Indirect Effects*

Under the Proposed Action, thinning and prescribed burning activities may disturb individual voles, resulting in direct adverse effects. Up to 40,000 acres of prescribed burning and 45,000 acres of mechanical treatment could occur annually. Prescribed burning 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. In addition, the effect would be short-term and would have no impact to the population viability of voles. However, fire exclusion has resulted in uncharacteristically dense forests and meadow and grassland encroachment. Forest treatments can indirectly affect potential vole habitat by restoring meadows and reducing uncharacteristic tree densities and patterns in ponderosa pine forest. Restoring meadows and creating openings in the forest would increase potential understory development, including bunch grasses and other C-3 plants providing preferred food sources. In addition to grassland restoration treatments, Alternative B calls for a diverse range of mechanical treatments that would vary from 10-90 percent open depending on localized site conditions providing both habitat connectivity and habitat stepping stones facilitating landscape movement. Reduction in stand density could potentially reverse the declining trend in C3 plants increasing habitat quality for Mogollon vole. Prescribed fire and mechanical treatments would improve the stability of key ecosystem elements such as species composition, forest structure, soils and hydrologic function by shifting the treatment area from Fire Regime Condition Class (FRCC) 3 to FRCC 2. Acres of grasslands in FRCC1 would decrease in the absence of any type of treatment, as woody species continued to encroach and species composition shifted in favor of less fire adapted species. Although treatments in grasslands under alternative B would only occur as Operational Burning, where it is implemented, prescribed fire would improve the stability of key ecosystem elements (Fire Ecology report). The potential for crown fire within grasslands would be slightly (one percent) reduced with a greater reduction in ponderosa (six percent reduction) (Fire Ecology report). Moving these habitats towards historic conditions could increase potential habitat quality and quantity and reduce the risk of uncharacteristic, high-severity wildfire. The reduction of ponderosa pine basal area, increased growth in the understory vegetation on the forest floor and increases in snags would result in indirect beneficial impacts to the vole.

Under alternative B there are over 859 miles of closed roads that would be decommissioned. Roads often encourage removal of snags as hazard trees and provide easy access for fuelwood cutting potentially reducing snags along roadways. Ganey (personal communications 2012) found an inverse relationship between snags and roads, so the proposed decommissioning of roads means more snags will be available in the future within vole habitat.

Under alternative B, spring restoration would have short-term disturbance to vegetation limiting habitat for the vole however vegetation would be expected to recovery within a year and would improve riparian vegetation, increasing availability of food for small mammals over the long-term, resulting in indirect beneficial impacts. Fence design would allow access to small mammals. In addition, about 10 miles of road segments would be moved out of drainage bottoms, further enhancing vole habitat.

#### *Determination of Effect*

Alternative B may impact the Navajo Mogollon vole, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative C

#### *Direct and Indirect Effects*

This alternative has similar effects as alternative B. This alternative would improve the most habitats for the Navajo Mogollon vole than the other two alternatives. Alternative C adds 48,206 acres of grassland restoration treatments and restores larger grasslands such as Garland and Government Prairie where Mogollon voles are known to occur. Grassland treatments in alternative C include both mechanical treatments and thinning treatments, which should move the majority of grassland acres out of FRCC3 (Fire Ecology report). This alternative may increase vole mortality from collisions with machinery and crushing of burrows. However, the overall increase in grassland treatments would have a beneficial impact on this vole’s habitat resulting in indirect beneficial effects. Research is proposed within vole habitat however the research treatments would provide additional heterogeneity across the landscape improving opportunities for voles.

### *Determination of Effect*

Alternative C may impact the Navajo Mogollon vole, but is not likely to cause a trend to federal listing or loss of viability.

## Alternative D

### *Direct and Indirect Effects*

This alternative has the same effects as alternative B however; there is a reduction in crown fire potential on seven percent of the grassland, one percent more than alternative C and the lack of prescribed burning after thinning treatments would alter surface vegetation patterns 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. The lack of burning means no nutrient pulse into the system, further limiting understory response and therefore limiting Navajo Mogollon vole habitat.

### *Determination of Effect*

Alternative D may impact the Navajo Mogollon vole, but is not likely to cause a trend to federal listing or loss of viability.

## Alternative E

### *Direct and Indirect Effects*

This alternative has similar effects as alternative B; however, the lack of savanna and grassland restoration treatments limits understory response and therefore limit Navajo Mogollon vole habitat. 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 Navajo Mogollon vole.

### *Determination of Effect*

Alternative E may impact Navajo Mogollon vole, but is not likely to cause a trend to federal listing or loss of viability.

## Cumulative Effects for all Action Alternatives

The area analyzed for cumulative effects for Navajo Mogollon vole is the project area. Current, ongoing and reasonably foreseeable projects are listed in appendix 17 and 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 burning 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 move these habitats towards historic conditions 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 Travel Management rule 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.

Short term and localized effects from mechanical thinning, temporary road construction and prescribed burning would result in the 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. Cumulative activities such as the Travel Management Rule are likely to decrease motorized use in grasslands and meadows thus decreasing impacts to vole habitat. This combined with forest restoration activities could open up more habitats or provide more contiguous swaths of grassland habitat key to supporting thriving vole populations.

## Western Red Bat

### Alternative A No Action

#### *Direct and Indirect Effects*

Habitat quality would deteriorate for this species as overtopping ponderosa pine would lead to a decline in Gambel oak roosting habitat. 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 (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. Acres of ponderosa pine in FRCC 2 and 3 would continue to increase, leaving just 2 percent in FRCC1. Ponderosa pine in the project area would be at a high risk of losing key ecosystem components, should there be a large-scale disturbance event (Fire Specialist report). In the event of high-severity fire, key ecosystem components include species composition, forest structure, soil characteristics, and hydrologic function. High fire severity potential would persist, and a large crown wildfire event would have the potential to affect many individuals. Thirty-nine percent of the ponderosa pine and 12 percent of grassland habitat would support a crown fire. Although habitat would be provided for this species, most of the forested area within the project area is in a moderately closed or closed canopy condition (Silviculture report). Favorable habitat would decrease over time as conifers encroach into meadows and canopy closure increases, resulting in indirect adverse effects. Under alternative A, limited acres of grasslands and forest opening would be restored, thus reducing foraging habitat for red bats. Gambel oak would continue to be overtopped by pine. Loss of mid- to large diameter classes of oak from competition and from crown fire could reduce day roosts for red bats.

Water quality and riparian conditions would be adversely affected on a wide-scale basis (Water Quality and Riparian report), resulting in indirect adverse effects. Under alternative A, there would 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 (Water Quality and Riparian report) resulting in degradation of potential habitat for western red bat.

#### *Cumulative Effects*

The area analyzed for cumulative effects for western red bat is the project area and cumulative effects includes effects of alternative A. This alternative would continue to result in indirect impacts to spotted bats, which may combine with ongoing activities that have similar effects. Cumulative effects from indirect impacts to western red bat would include increased ponderosa pine densities resulting in fewer mid- to large-sized oak survival (i.e., decrease in roosting habitat), herbaceous understory limiting the availability of insects and consequently reducing prey for bats and reduced tree growth resulting in limited large trees and consequently recruitment snags impacting the ability of bats to successfully forage and locate roost sites. Degradation of habitat facilitated by this alternative 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.

### *Determination of Effect*

Alternative A may impact western red bat, but is not likely to cause a trend to federal listing or loss of viability.

## Alternative B Proposed Action

### *Direct and Indirect Effects*

Under the Proposed Action, 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 western red bats if they are roosting in caves. Under the Proposed Action, thinning and prescribed burning activities could potentially disturb red bats if they are roosting in trees and caves or hibernating among leaf litter 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 would be designed to limit smoke at critical times (April –July and mid-winter).

Prescribed burning may also result in the loss of snags and Gambel oak which could affect roosting bats; however mitigation including managing for retention of all snags 18 inch diameter and ignition techniques would reduce the losses of these forest components. Recruitment snags will be provided by retaining trees 18 inches in diameter and greater with dead tops and lightning damage. Selective thinning designed to release oak from competition would help create and retain mid- to large-sized oak. The Proposed Action is expected to result in a slight short-term decrease in snags followed by an increase over the long-term. This short term loss of snags is not expected to affect the overall distribution of western red bats on the forest.

Alternative B calls for a diverse range of mechanical treatments that would vary from 10 to 90 percent open depending on site conditions. Prescribed burning after mechanical treatments 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 on the forest floor would result in indirect beneficial impacts to bats. Forest conditions after treatment would improve bat habitat within the project area by increasing diversity and density of understory vegetation provides habitat for prey populations as many invertebrates are tied to specific understory plant species. Indirect benefits could potentially result from restoring meadows encroached by pine trees and reducing uncharacteristic tree densities and patterns in the ponderosa pine forest resulting from fire exclusion. These efforts would aid in restoring openings and edge habitat within the forest and improving understory vegetation that would benefit western red bats and their prey. Moving these habitats towards historic conditions would also increase resilience of these habitats and decrease the risk of uncharacteristic, high-severity wildfire.

Under the Proposed Action, spring, seep and ephemeral channel restoration would improve riparian vegetation, increasing availability of food for bats over the long-term, resulting in indirect beneficial effects.

#### *Determination of Effect*

Alternative B may impact the western red bat, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative C

#### *Direct and Indirect Effects*

This alternative would improve the most habitats for this bat than the other two alternatives. It treats the most ponderosa pine acreage, thereby protecting and promoting the most Gambel oak. Alternative C adds 48,206 acres of grassland treatments. The overall increase in grassland treatments would have a beneficial impact on spotted bat prey resulting in indirect beneficial effects.

#### *Determination of Effect*

Alternative C may impact the western red bat, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative D

#### *Direct and Indirect Effects*

This alternative has similar effects as alternative B except for the lack of prescribed burning after thinning treatments. Minimizing prescribed fire would retain the most mid- to large-sized oak for roosting, relative to the other action alternatives. Minimizing fire would also alter surface vegetation patterns 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. The lack of prescribed burning in alternative D would reduce the incidental loss of large snags from prescribed burning and would retain the most snags in the short-term. The lack of burning means no nutrient pulse into the system, further limiting understory response and therefore limiting western red bat habitat. Alternative D produces the lowest response of understory biomass of all the action alternatives limiting prey and resulting in indirect adverse effects to western red bat.

#### *Determination of Effect*

Alternative D may impact the Western red bat, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative E

#### *Direct and Indirect Effects*

This alternative has similar effects as alternative B; however, the lack of savanna and grassland restoration treatments limit understory response and therefore limit the quality of western red bat habitat. 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 western red bat.

#### *Determination of Effect*

Alternative E may impact Western red bat, but is not likely to cause a trend to federal listing or loss of viability.

### Cumulative Effects from all Action Alternatives

The area analyzed for cumulative effects for western red bat is the project area. There may be potential 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 burning 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 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. The Slide Fire did not affect potential roosting habitat along Oak Creek. The fire likely improved prey habitat within the fire perimeter in the adjacent dry forest. 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.

## Allen’s Lappet-browed Bat

### Alternative A No Action

#### *Direct and Indirect Effects*

Under alternative A, only current and foreseeable projects would continue with combined treatment acres totaling about ½ or less of the 4FRI action alternatives (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 and long-term suitability of habitat. 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 recruitment of large snags would not meet forest objectives in the long-term. Large diameter trees would not maintain the numbers and distribution that would support large diameter snags distributed across forested areas. There would be reduced foraging habitat for Allen’s lappet-browed bats as conifers encroach into meadows and canopy closure increases resulting in indirect adverse effects. High BA and TPA counts would decrease or stagnated growth of large trees. Active competition-induced mortality would increase, decreasing future recruitment of large snags and decreasing future maternity roost sites.

### *Cumulative Effects*

The area analyzed for cumulative effects for Allen's lappet-browed bat is the project area and includes the effects of alternative A. This alternative would continue to result in indirect impacts to Allen's lappet-browed, which may combine with ongoing activities that have similar effects. Cumulative effects from indirect impacts to Allen's lappet-browed bat would be limited to increased tree densities and decreased tree growth rates. This would result in limited herbaceous understory, thereby limiting the availability of arthropod prey for bats. In addition, reduced tree growth would reduce large tree availability and consequently future recruitment of large snags. Combined, this would reduce foraging habitat and potential roost sites. Degradation of habitat facilitated by this alternative 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. 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 Allen's lappet-browed bat habitat.

### *Determination of Effect*

Alternative A may impact Allen's lappet-browed bat, but is not likely to cause a trend to federal listing or loss of viability.

## Alternative B Proposed Action

### *Direct and Indirect Effects*

Under the Proposed Action, approximately 42 percent of the Coconino and Kaibab forestwide habitat for Allen's lappet-browed bat will be treated. Thinning and prescribed burning activities could potentially disturb Allen's lappet-browed bats if they are roosting in trees within the ponderosa pine and pinyon juniper treatment areas. 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 unsurveyed 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 would reduce the impact. Recruitment snags would be provided by retaining and creating more trees 18 inches in diameter and greater. Selection for trees with dead tops and lightning damage may contribute to potential habitat. The Proposed Action is expected to result in a slight short-term increase in snags followed by a continuing increase over the long-term with incidental loss of snags greater than 18 inch diameter.

Prescribed burning 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 on the forest floor would result in indirect beneficial impacts to bats. Forest conditions after treatment would improve bat habitat within the project area. Increasing diversity and density of understory vegetation provides habitat for prey populations. Many invertebrates are tied to specific understory plant species (Capinera 2010). Indirect benefits could potentially result from restoring meadows encroached by pine trees and reducing uncharacteristic tree densities and patterns in the ponderosa pine forest resulting from fire exclusion. These efforts would aid in restoring openings and edge habitat within the forest and improving understory vegetation that would benefit Allen's lappet-browed bats and their prey. Moving these habitats towards historic conditions would also increase resilience of these habitats and decrease the risk of uncharacteristic, high-severity wildfire.

Under alternative B there are over 859 miles of closed roads that would be decommissioned. Roads often encourage removal of snags as hazard trees and provide easy access for fuelwood cutting potentially reducing snags along roadways. Ganey (personal communications, 2012) found an inverse relationship between snags and roads, so the proposed decommissioning of roads means more snags will be available in the future within Allen's lappet-browed bat habitat providing more roosting structures.

Under the Proposed Action, spring seep and channel restoration would improve riparian vegetation, increasing availability of food for bats over the long-term, resulting in indirect beneficial effects.

#### *Determination of Effect*

Alternative B may impact Allen's lappet-browed bat, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative C

#### *Direct and Indirect Effects*

This alternative has similar effects as alternatives B and D however; this alternative would improve the most habitats for this bat. Alternative C includes the most acres of mechanical treatment. This would do the most to improve tree growth rates and forest resilience, thereby creating and maintaining large diameter trees over time. The total acres treated would ensure work is distributed across the treatment area. Combined with the large and old tree implementation plans, this would do the most to make sure appropriate snags are available for maternity roosts across the ponderosa pine forest. This alternative would also do the most grassland restoration treatments, adding 48,206 acres. This would elicit the greatest response in terms of understory biomass relative to the other action alternatives. The overall increase in understory biomass would have a beneficial impact on Allen's lappet-browed bat prey resulting in indirect beneficial effects.

#### *Determination of Effect*

Alternative C may impact Allen's lappet-browed bat, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative D

#### *Direct and Indirect Effects*

This alternative has similar effects as alternative B however the lack of prescribed burning after thinning treatments would alter surface vegetation patterns 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. The lack of prescribed burning in alternative D would reduce the incidental loss of large snags from prescribed burning and would retain the most large diameter snags in the short-term. The lack of burning means no nutrient pulse into the system, further limiting understory response and therefore limiting Allen's lappet-browed bat habitat. Alternative D produces the lowest response of understory biomass of all the action alternatives limiting prey and resulting in indirect adverse effects to Allen's lappet-browed bat.

#### *Determination of Effect*

Alternative D may impact Allen's lappet-browed bat, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative E

#### *Direct and Indirect Effects*

This alternative has similar effects as alternative B; however, the lack of savanna and grassland restoration treatments limit understory response and therefore limit the quality Allen's lappet-browed bat habitat. 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 Allen's lappet-browed bat.

#### *Determination of Effect*

Alternative E may impact Allen's lappet-browed bat, but is not likely to cause a trend to federal listing or loss of viability.

### Cumulative Effects for all Action Alternatives

The area analyzed for cumulative effects for Allen's lappet-browed bat is the project area and includes the effects of alternative A. Current, ongoing and reasonably foreseeable projects are listed in appendix 17 and include fuels reduction, forest health, aspen regeneration, tornado rehabilitation, grazing and powerline development and maintenance. There may be potential 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 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. The action alternatives are expected to result in 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). These short-term impacts added to similar impacts from other past, present and reasonably foreseeable projects were considered.

The Coconino forest plans call for an average of two large snags per acre in ponderosa pine forests, with large snags defined as 18 inches or larger d.b.h. and 30 feet tall or higher. However, research completed well after the forest plan was signed suggests this specification may be unrealistic. Ganey (1999) found only 30 percent of ponderosa pine plots in un-logged sites met or exceeded FS snag guidelines and Waskiewicz et al. (2007) found pine snag densities well below FS guidelines in relatively undisturbed forests in northern Arizona. Fire promotes and beetles increase recruitment of large snags, but neither form of snag creation remains standing long compared to other snags (Chambers and Mast 2005, Chambers and Mast 2014). In 2011, Ganey and Vojta reported a 74 percent increase in ponderosa pine mortality from 2002 to 2007 compared to mortality between 1997 and 2002. This was likely the result of a drought-mediated pulse in tree mortality (Ganey and Vojta 2011), meaning fewer large trees were survived the drought period. These stochastic events are likely to continue (see the section on climate change) and combined may elevate snag numbers over time, benefiting Allen's lappet-browed bats. However, these pulses in snag creation reduce the availability of large trees and reduce future large snag recruitment.

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, decreasing the potential for large scale wildfires and designing projects to increase tree growth resulting in larger trees and consequently more recruitment snags, would improve the ability of tree roosting bats to locate roost sites across the landscape.

Prescribed burning and managed wildfire produce low severity burns that reduce surface fuels and cause periodic loss of snags. Other activities such as high severity wildfire, construction and maintenance of utility corridors, management of snags along forest roads, and private land development will also reduce the number of snags available for roosting Allen's lappet-browed bats in the long-term. Large snags are preserved whenever possible and mitigation measures to maintain, and where possible develop, snags on the landscape are incorporated into all projects. Although individual trees may be lost, large snags will be maintained and developed across the landscape to provide roosting habitat for Allen's lappet-browed bats.

The Slide Fire likely improved habitat for Allen's lappet-browed bat. 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. In addition, 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. 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.

## Pale Townsend's Big-eared Bat

### Alternative A No Action

#### *Direct and Indirect Effects*

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. Seeps and springs would not be restored continuing to reduce availability of riparian associated host plants for noctuid moths on which they prey. High fire severity potential would persist, and a large, uncharacteristically severe wildfire event would have the potential to affect many individuals. Thirty-nine percent of the ponderosa pine and 12 percent of grassland habitat would support a crown fire. Fire intensity would continue to increase overtime as vegetation would continue to grow and fuel would continue to accumulate, continuing to have negative effects to bat habitat. Acres of grassland in FRCC1 would decrease in the absence of any type of treatment, as woody species continue to encroach and species composition shifted in favor of less fire adapted species. Acres of ponderosa pine in FRCC 2 and 3 would continue to increase, leaving just 2 percent in FRCC1. Ponderosa pine in the project area would be at a high risk of losing key ecosystem components, should there be a disturbance event, such as fire or extended drought (Fire Specialist report). Ponderosa pine in the project area is at high risk of losing key ecosystem components such as, species composition, forest structure, soil characteristics and hydrologic function, in the event of high severity fire. High fire severity potential would persist, and a large crown wildfire event would have the potential to affect many individuals. Thirty-nine percent of the ponderosa pine and 12 percent of grassland habitat would support a crown fire. 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.

#### *Cumulative Effects*

The area analyzed for cumulative effects for pale Townsend's big-eared bat is the project area and includes the effects of alternative A. This alternative would continue to result in indirect impacts to Townsend's big-eared bat, which may combine with ongoing activities that have similar effects. Cumulative effects from indirect impacts to Townsend's big-eared bat would be limited to increased tree densities resulting in limited herbaceous understory limiting the availability of insects and consequently reducing prey for bats and reduced tree growth resulting in limited large trees and consequently recruitment snags impacting the ability of bats to successfully forage and locate roost sites. Degradation of habitat facilitated by this alternative 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 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. 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 Townsend's big-eared bat habitat.

#### *Determination of Effect*

Alternative A may impact pale Townsend's big-eared bat, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative B Proposed Action

#### *Direct and Indirect Effects*

Under the Proposed Action, 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 unsurveyed 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 Action is expected to result in a slight short-term increase in snags followed by a continued increase over the long-term.

Prescribed burning 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. Indirect effects would result from vegetation modification activities such as thinning and prescribed burning. These activities would disturb or remove understory vegetation, subsequently reducing availability to insects. These effects would be short-term and would be minimized due to activities being temporally and spatially separated. In contrast, reducing canopy closure, removing trees in and at edges of meadows, restoring meadows and prescribed burning would encourage the development of understory vegetation, and increase the amount of edge increasing availability of food for the bat over the long-term. Increasing diversity and density of understory vegetation provides habitat for prey populations. Many invertebrates are tied to specific understory plant species (Capinera 2010). Indirect benefits could potentially result from restoring meadows encroached by pine trees and reducing uncharacteristic tree densities and patterns in the ponderosa pine forest resulting from fire exclusion. These efforts would aid in restoring openings and edge habitat within the forest and improving understory vegetation that would benefit pale Townsend's big-eared bats and their prey. Moving these habitats towards historic conditions would also increase resilience of these habitats and decrease the risk of uncharacteristic, high-severity wildfire.

Under alternative B there are over 859 miles of closed roads that would be decommissioned. Roads often encourage removal of snags as hazard trees and provide easy access for fuelwood cutting potentially reducing snags along roadways. Ganey (personal communications, 2012) found an inverse relationship between snags and roads, so the proposed decommissioning of roads means more snags will be available in the future within Townsend's big-eared bat habitat providing more roosting structures.

Under the Proposed Action, spring, seep 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.

#### *Determination of Effect*

Alternative B may impact pale Townsend's big-eared bat, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative C

#### *Direct and Indirect Effects*

The effects are the same as alternative B. One documented cave roost is located within an AGFD Research site however these treatments are designed to provide group sizes up to 15 acres in size and can be designed to buffer cave locations as needed. All alternatives are designed to buffer cave locations to eliminate potential sedimentation into the cave or damage from heavy machinery working over shallow passages. This alternative would improve the most habitats for this bat than the other two alternatives. Alternative C adds 48,206 acres of grassland restoration treatments. The overall increase in grassland treatments would have a beneficial impact on Townsend's big-eared bat prey resulting in indirect beneficial effects.

#### *Determination of Effect*

Alternative C may impact pale Townsend's big-eared bat, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative D

#### *Direct and Indirect Effects*

This alternative has similar effects as alternative B however the lack of prescribed burning after thinning treatments would alter surface vegetation patterns 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. The lack of burning in 68 percent of the treatment area means no nutrient pulse into the system, further limiting understory response and therefore limiting Townsend's big-eared bat habitat. 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.

#### *Determination of Effect*

Alternative D may impact pale Townsend's big-eared bat, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative E

#### *Direct and Indirect Effects*

This alternative has similar effects as alternative B; however, the lack of savanna and grassland restoration treatments limit understory response and therefore limits pale Townsend's big-eared bat habitat. 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 pale Townsend's big-eared bat.

#### *Determination of Effect*

Alternative E may impact pale Townsend's big-eared bat, but is not likely to cause a trend to federal listing or loss of viability.

### Cumulative Effects for all Action Alternatives

The area analyzed for cumulative effects for pale Townsend's big-eared bat is the project area. Current, ongoing and reasonably foreseeable projects are listed in appendix 17 and 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 burning and 2,034 acres of mechanical treatments. There may be potential 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 burning 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 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 affect plant composition in meadows and around waters. The Travel Management Rule has reduced the number of roads near Townsend's big-eared bat roost locations.

## Spotted Bat

### Alternative A No Action

#### *Direct and Indirect Effects*

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). 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 any type of treatment, as woody species continue to encroach and species composition shifted in favor of less fire adapted species. Acres of ponderosa pine in FRCC 2 and 3 would continue to increase, leaving just 2 percent in FRCC1. Ponderosa pine in the project area would be at a high risk of losing key ecosystem components, should there be a disturbance event, such as fire or extended drought (Fire Specialist report). Ponderosa pine in the project area is at high risk of losing key ecosystem components such as, species composition, forest structure, soil characteristics and hydrologic function, in the event of high severity fire. High fire severity potential would persist, and a large crown wildfire event would have the potential to affect many individuals. Thirty-nine percent of the ponderosa pine and 12 percent of grassland habitat would support a crown fire. Although habitat would be provided for this species, 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 no benefits to bats. Favorable habitat would decrease over time as conifers encroach into meadows and canopy closure increases, resulting in indirect adverse effects.

### *Cumulative Effects*

The area analyzed for cumulative effects for spotted bat is the project area and includes the effects of alternative A. The cumulative effects alternative A are similar to the indirect effects discussed above. Alternative A would not create disturbance to roosting habitat nor would it improve foraging habitat within the project area. Therefore, there would be no direct cumulative effect from this alternative.

### *Determination of Effect*

Alternative A may impact spotted bat, but is not likely to cause a trend to federal listing or loss of viability.

## Alternative B Proposed Action

### *Direct and Indirect Effects*

Under the Proposed Action, thinning and prescribed burning activities could potentially disturb spotted bats if they are roosting in rock crevices 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 caves, mines or cliff habitats would be designed to limit smoke at critical times (April –May and mid-winter).

Prescribed burning 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. Indirect effects would result from vegetation modification activities such as thinning and prescribed burning. These activities would disturb or remove understory vegetation, subsequently reducing availability to insects. These effects would be short-term and would be minimized due to activities being temporally and spatially separated. In contrast, reducing canopy closure, removing trees in meadows, restoring meadows and prescribed burning would encourage the development of understory vegetation, increasing availability of food for the bat over the long-term. Increasing diversity and density of understory vegetation provides habitat for prey populations. Many lepidopterans are tied to specific understory plant species (Waltz and Covington 2004). Indirect benefits could potentially result from restoring meadows encroached by pine trees and reducing uncharacteristic tree densities and patterns in the ponderosa pine forest resulting from fire exclusion. These efforts would aid in restoring openings and edge habitat within the forest and improving understory vegetation that would benefit spotted bats and their prey. Moving these habitats towards historic conditions would also increase resilience of these habitats and decrease the risk of uncharacteristic, high-severity wildfire. Under the Proposed Action, spring, seep and channel restoration would improve riparian vegetation, increasing availability of food for bats over the long-term, resulting in indirect beneficial impacts.

#### *Determination of Effect*

Alternative B may impact spotted bats, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative C

#### *Direct and Indirect Effects*

The effects for alternative C are similar to alternatives B, D, and E; however, alternative C treats the most acres and elicits the greatest response in understory and the greatest availability of food for bats.

#### *Determination of Effect*

Alternative C may impact spotted bats, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative D

#### *Direct and Indirect Effects*

This alternative has similar effects as alternative B; however, the lack of prescribed burning after thinning treatments would alter surface vegetation patterns 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. The lack of burning means no nutrient pulse into the system, further limiting understory response and therefore limiting spotted bat habitat. 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.

#### *Determination of Effect*

Alternative D may impact spotted bats, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative E

#### *Direct and Indirect Effects*

This alternative has similar effects as alternative B; however, the lack of savanna and grassland restoration treatments limit understory response and therefore limit spotted bat habitat. 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.

#### *Determination of Effect*

Alternative E may impact spotted, but is not likely to cause a trend to federal listing or loss of viability.

### Cumulative Effects for all Action Alternatives

The area analyzed for cumulative effects for greater spotted bat is the project area. Current, ongoing and reasonably foreseeable projects are listed in appendix 17 and 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 burning and 2,034 acres of mechanical treatments. There may be potential 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 burning 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 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.

## Bald and Golden Eagle Protection Act

For all alternatives refer to the sensitive species section for the effects analysis done for the bald eagle.

### Alternative A No Action

#### *Direct and Indirect Effects*

There are no direct effects to golden eagles as no habitat altering activities or disturbance associated with project implementation would occur. Alternative A would not treat meadows within the project area and trees would continue to encroach, reducing potential habitat for small mammal and consequently golden eagles. Tree densities would continue to be high, slowing growth into larger diameter classes and thereby limiting the development of larger diameter (≥ 18-inch) trees important for nesting, roosting, and perching. Habitat conditions would remain in their current condition, notwithstanding natural processes. Dense forest conditions would still occur and the high fire hazard potential would continue to place potential golden eagle breeding, nesting and foraging habitat at risk with respect to stand-replacing fire.

#### *Cumulative Effects*

The area analyzed for cumulative effects for the golden eagle is the project area and within ½ mile of the project boundary. Continued pine tree encroachment into grasslands and private development in grasslands 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. This alternative would result in the most stress on meadow and grassland habitats and thus would have the greatest negative contribution to potential golden eagle habitat.

## Alternative B Proposed Action

### *Direct and Indirect Effects*

Direct effects would be from activities that cause disturbances (smoke, auditory or visual) to golden eagles nesting or foraging within or adjacent to the project. Under the Proposed Action, there would be no direct adverse effects to nesting eagles as project design features would eliminate disturbance near known nesting sites. No vegetation treatments would occur within ½ mile (2,500 feet), unless mitigated by topography, of an occupied golden eagle nest between March 1 and August 31. Drift smoke from prescribed fire is expected in most places; however, concentrations of smoke that might settle in an area for more than one or two nights when a female is on the nest could have adverse effects to individuals. Prevailing southwest winds and the topography of the area typically act to lift smoke, carrying it away from ignition sites. Nests on cinder cones and other raised topographic features and in Sycamore and Oak Creek Canyons or in canyons immediately adjacent to Sycamore and Oak Creek Canyons or the Mogollon Rim are not expected to have smoke settle in them long enough to cause measurable effects to eagles because of the air movement in these landscape-scaled features. Conversely, nests in areas occurring in small canyons or valleys may have dense smoke settle in nesting locations.

When smoke settles into low-lying areas it typically does not last more than 1 or 2 nights. Limited smoke at nest locations would be expected to expose adult eagles to negligible effects as this would repeat an aspect of their evolutionary environment (Horton and Mannan 1988, Prather et al. 2008). However, on occasion dense smoke may settle into specific nest locations. Dense smoke settling into nest areas early in the season (March through June) could disturb brooding females. If the female flushed long enough to affect incubation this could result in loss of viability of the eggs. Dense smoke settling for multiple consecutive nights could affect developing lungs of nestlings. Unlike mammals, damaged avian lungs do not repair themselves through time (Rombout et al. 1991). Causing the female to discontinue incubating eggs or affecting lung development of nestlings would cause long-term adverse effects. Outside of these examples, smoke settling in nest locations would typically be short-term and not likely to cause adverse effects.

Within the project area, subunits were designed using 6th code watersheds as boundaries; FWS and fire specialists identified subunits as an appropriate boundary for determining smoke impacts. Fire specialists and biologists reviewed all current and historic golden eagle nests potentially affected by the project to determine if smoke would be expected to settle for greater than 24 hours at nest locations (Table 195). Of the 29 nests, 6 are in areas where smoke would settle if conditions are not optimal and fuels loads are heavy, particularly during first-entry burns. In consultation with FWS, the Forest Service designed mitigation for those specific nest locations to include monitoring to determine if the nest is occupied/active and if so, a timing restriction would be placed on first-entry entry burning within the subunit where the nest was located until young had fledged. Table 195 lists confirmed and potential golden eagle nests by Forest and subunit and identifies whether there is potential for smoke to settle for extended periods at a nest location. Subunits that could be restricted are 1-1, 1-3, 3-5 and 5-2.

Under the Proposed Action, mechanical treatments, prescribed, burning, road construction and decommissioning, hauling of timber and other restoration activities may cause visual or auditory disturbance to foraging golden eagles. This disturbance would be localized, of short duration and low intensity and would not be expected to substantially interfere with normal feeding behavior. Up to 40,000 acres of prescribed burning and 45,000 acres of mechanical treatment would occur annually; however, these are short-term effects and would be minimized due to activities being spatially and temporally separated. Additionally, prescribed burning effects would dissipate over time as first entry burns are usually related to consumption of accumulated surface fuels, raising crown bulk height and reducing crown bulk density (Fire Ecology report). In ponderosa pine maintenance burns or second entry fuel loads would be significantly lower and produce low severity effects with fewer emissions (Fire Ecology report).

Indirect effects to the golden eagle include affects to eagle habitat, eagle prey species, or prey species habitat. There are no anticipated adverse effects to prey species or their habitats. Opening the canopy will provide improved visbility of and access to prey by golden eagles Grassland and savanna treatments would maintain and improve foraging habitat on 59,391 acres of grassland and 45,142 acres of savanna habitat improving prey species habitat by increasing availability of food for small mammals resulting in an indirect beneficial effect.

**Table 195. Confirmed and potential golden eagle nests potentially affected by the 4FRI Project**

| Status | Name | Subunit | Forest | Potential for Smoke to Settle | Comments |
|---|---|---|---|---|---|
| Confirmed | Colton Crater | 4-3 (border) | CNF | No | 0.3 miles from Forest boundary. |
| Confirmed | Mount Elden Sandy Seep | 5-2 | CNF | No | Nest located in cliff with no eagles seen. In treatment area. |
| Confirmed | Red Mountain | 4-3 | CNF | No | Cliff nest. Not in treatment area. |
| Confirmed | Red Mountain | 4-3 | CNF | No | Alternate nest site at Red Mountain. Not in treatment area. |
| Confirmed | Secret Mountain (aka north of Lost Mountain and Boynton Canyon). | 3-5 | CNF | No | Outside treatment area. At the edge of Munds Mountain- Secret Mountain Wilderness |
| Confirmed | Upper Lake Mary South | 1-3 | CNF | Yes | Tree nest. In treatment area. |
| Confirmed | Walnut Canyon | 1-1 | CNF | Yes | Outside treatment area. Within Walnut Canyon National Monument. |
| Confirmed | Johnson Canyon | 4-2 | KNF | No | Outside treatment area. |
| Confirmed | Eagle Rock | 4-4 | KNF | No | Outside treatment area. |
| Confirmed | Cedar Mountain | 4-3 | KNF | No | Outside treatment area. |
| Confirmed | Wild Horse Canyon | 4-3 | KNF | No | In treatment area. |
| Confirmed | Eagle Nest Mountain | 4-1 | KNF | No | Outside treatment area. |
| Confirmed | Double A Knoll | 4-1 | KNF | No | Outside treatment area. |

| Status | Name | Subunit | Forest | Potential for Smoke to Settle | Comments |
|---|---|---|---|---|---|
| Confirmed | Steiger Tank | 4-1 | KNF | No | Outside treatment area. |
| Confirmed | Rabbit Bill (aka Flat Mesa) | 3-1 | KNF | No | Outside treatment area. |
| Confirmed | MC Canyon | 3-1 | KNF | No | In treatment area. |
| Confirmed | Muleshoe | 4-2 | KNF | No | Outside treatment area. |
| Confirmed | Grand Canyon Trading (aka Prairie Dog Tank) | 4-2 | KNF | No | Outside treatment area. |
| Potential | O'Leary | 5-2 | CNF | No | Outside treatment area. Golden eagles often seen in area. |
| Potential | Dry Lake | 3-5 | CNF | No | Could be a roost site. |
| Potential | Bear Sign Canyon | 3-5 | CNF | No | No data on this sight. Eagles seen in area during surveys in 2009 and 2010. |
| Potential | San Francisco Wash | 5-2 | CNF | Yes | No data or information on this site. Digitized point appears to be in bottom of wash, road on top. In treatment area. Within 0.1 mile of powerline. |
| Potential | Upper Lake Mary North | 1-3 | CNF | Yes | Tree nest. Record isn't clear if this is a confirmed nest or not. In treatment area. |
| Potential | Deadwood Draw (aka Walker Creek) | 2-0 | CNF | No | Reported to FS, not confirmed. Non-FS. Not in project area. |
| Potential | Woody Ridge | 3-5 | CNF | Yes | Outside treatment area. No data or information on this site. |
| Potential | Cedar Flat | 1-6 | CNF | No | Outside treatment area. |
| Potential | Lee Mountain | 2-0 | CNF | No | Not in treatment area. |
| Potential | Bill Williams Mountain | 3-1 | KNF | No | Outside treatment area. Nest sight not yet located but nest building expected. |
| Potential | Red Butte Mountain | 6-2 | KNF | No | Location not confirmed. In pinyon-juniper on Tusayan RD. Outside treatment area. |

## Alternative C

### *Direct and Indirect Effects*

The effects of alternative C are similar to those of the other action alternatives. Under this alternative, there would be 104,533 acres of grassland and savanna restoration treatments within golden eagle foraging habitat. These actions will benefit golden eagles by opening the tree canopy improving understory vegetation and habitat for prey species and improving access to prey for foraging eagles. Alternative C would have 47,943 acres more grassland and savanna restoration than alternative B or D and 56,653 more than alternative E restoring the most acres of foraging habitat for golden eagles. There are no nests or roosts within the additional grassland treatments or research areas and no additional effects from disturbance.

## Alternative D

### *Direct and Indirect Effects*

This alternative has the same effects as alternative B, however the lack of prescribed burning after thinning treatments would alter surface vegetation patterns 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. The lack of burning means no nutrient pulse into the system, further limiting understory response and therefore limiting golden eagle habitat. The lack of burning means no nutrient pulse into the system, further limiting understory response.

## Alternative E

### *Direct and Indirect Effects*

For golden eagle the effects of alternative E are similar to those of alternative C. Alternative E would have the least amount of foraging habitat restored of all of the action alternatives with 47,880 acres of grassland treatments. Alternative E would not include the 28,650 to nearly 30,000 acres of grassland restoration included in the other action alternatives. This would decrease potential foraging habitat included in alternatives B-D.

## Cumulative Effects for all Action Alternatives

The area analyzed for cumulative effects for the golden eagle is the project area and ½ mile of the project boundary. Past, present and reasonably foreseeable projects are listed in appendix 17 and past projects have implemented thinning on 2,304 acres and prescribed burning on 8,951 acres in grasslands. There is 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 and permanent road construction and prescribed burning 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 to 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. For bald eagles, the Forest Service Sensitive species analysis showed that effects from implementation of the Proposed Acton may impact bald eagles, but is not likely to result in a loss of viability or trend toward federal listing.

For golden eagles, all nests will be protected from disturbance during project implementation. Project design features will mitigate potential for disturbance from noise or smoke to nesting golden eagles. Project activities will not substantially interfere with foraging behavior.

Restoration treatments will improve foraging habitat and reduced potential of high severity fire impacting nest locations.

# Forest Service Management Indicator Species

In between the draft and final EIS, a new forestwide Coconino NF MIS report was produced. The Kaibab NF published their revised forest plan on March 2014 and developed a new list of MIS for analysis.

## Amendments Supporting the Action Alternatives (Coconino NF)

Not incorporating the proposed amendments would affect the habitat of most of the MIS addressed in this report (Table 196). The MSO amendments 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 all action alternatives)
- uncharacteristically dense forest conditions, lower canopy base height, and increased risk of high-severity fire in 70 PACs, including 52 PACs with prescribed fire-only and associated core areas in the treatment area (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 (all action alternatives)
- tree densities maintained well above the minimum BA 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 MSO 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 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 SDImax), 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.

**Table 196. Effects to management indicator species habitats by not incorporating proposed amendments into the action alternatives**

| Species | Habitat Links | Long-Term Effect to Habitat Links |
|---|---|---|
| **Birds** | | |
| Northern Goshawk | Late-seral PIPO[1]/Prey Habitat | Degraded |
| Pygmy nuthatch | Late-seral PIPO/insects/openings | Degraded |
| Turkey | Late-seral PIPO/insects/ oak/openings | Degraded |
| Hairy woodpecker | PIPO snags | Degraded |
| Red-naped sapsucker | Site specific/ habitat not affected | None |
| Juniper titmouse | Habitat not affected | None |
| **Mammals** | | |
| Abert's squirrel | Large trees/canopy connectivity/ mast and fungi development | Mixed |
| Rocky Mountain elk | Early seral PIPO/openings/meadows | Degraded |
| Mule deer | Forest openings/meadows/ | Degraded |
| Pronghorn | Open/Grassland | Degraded |

1. PIPO = ponderosa pine forest

# Management Indicator Species for the Coconino NF

## Management Indicators Species for Late-seral Ponderosa Pine

The northern goshawk, pygmy nuthatch and wild turkey are all indictors for late-seral ponderosa pine habitat.

Most trees in the mature and older structural stages (VSS 5 and 6) would be retained across all alternatives (Old Tree Implementation Plan; FEIS appendix D, Section C). Most old and large trees are expected to be retained. Alternatives C and E would both include the modified Large Tree Implementation Plan (FEIS appendix D, section D) which defines conditions in which large trees can be removed. The main different between the alternatives would be in the number of acres that would grow into late-seral habitat under each alternative. The change in acreage by year and alternative is based on the modeling described in the silvicultural report and is summarized in Table 197 below. A modeling assumption was that no high severity wildfire would occur within the analysis area over the next 40 years.

### *Coconino NF Late-seral Ponderosa Pine Habitat Trend*

The forestwide habitat trend for late-seral ponderosa pine is increasing slightly (USDA 2013). Within the analysis area there is approximate 55,956 acres of late-seral ponderosa pine, which is approximately 22 percent of this age class across the forest. About 1,261 acres of ponderosa pine forest burned with high-severity in the Slide Fire. The area is dominated by mid-aged forest and only a portion of these acres would have been in late-seral condition. Therefore it was concluded that the Slide Fire did not affect the habitat trends described below.

Alternative A would not have active management of the ponderosa pine within the analysis area (Table 197). In the short term, alternative A would not change the forestwide trend from increasing since there is only a small change in the amount of acres that would increase. The long term modeling indicates an increasing trend in late successional habitat. Given the size of 4FRI relative to the forestwide coverage of ponderosa pine, this indicates the forestwide trend would also increase. This modeling does not account for the likelihood of large high-severity fires which is high in the long term (Fire Ecology report). If no treatments occur in the analysis area, it is very likely that the forestwide trend would show a stable to increasing trend in the long term unless fire altered forest structure at large scales.

The action alternatives would continue the current increase. Forestwide habitat trend to for both the short and long term (Table 197). Alternatives B and C are very similar in the amount of increase in acreage with B being slightly higher in the amount of acreage. Alternatives D and E would have the least amount of increase in acreage over time.

**Table 197. Change in late-seral ponderosa pine habitat on Coconino NF by alternative**

| Alternative | Current acreage | Acreage at 2020 | Different from current | Acreage at 2050 | Different from current |
|---|---|---|---|---|---|
| A | 55,956 | 56,203 | 247 | 136,256 | 80,300 |
| B | 55,956 | 116,444 | 60,488 | 202,891 | 146,935 |
| C | 55,956 | 114,946 | 58,990 | 203,034 | 147,078 |
| D | 55,956 | 99,876 | 43,920 | 183,923 | 127,967 |
| E | 55,956 | 104,116 | 48,160 | 190,855 | 134,899 |

### *Late seral Habitat Trends for the Coconino NF*

**Alternative A:** Short-term: increasing; long-term = stable to increasing.

**Alternatives B, C, and E:** Increasing for both the short- and long-term.

**Alternative D:** Increase for both the short- and long-term, but the amount of increase would be the least of the action alternatives.

### *Northern Goshawk*

In alternative A, the quality of the habitat would deteriorate as canopies closed and tree densities increased and understory production decreased. Closed canopies associated with higher tree densities would not allow sunlight and water to reach the forest floor for understory vegetation to grow and provide habitat for prey species including vegetative cover, nesting substrates, seeds and fruits, and grasses, forbs, and shrubs as evidenced by the declining index of biomass production. In the long-term, understory species richness would decline, reducing food and cover for prey species. Increased tree densities would increase competition among trees. Tree growth would decrease or stagnate and tree health decline due to competition for limited resources and space. Meanwhile, the lack of fire disturbance has led to increased tree density and fuel loads that increase the risk of uncharacteristically intense wildfire and drought-related mortality. When fires occur under current conditions, they tend to cause high tree mortality rates, including the large and old trees. These trees take longer to replace, moving the forest further from desired conditions, and increasing the time it would take to return to desired conditions. Another function of increased tree density is increased risk of insect and/or disease outbreak. Mortality created by these outbreaks also contributes to increased fuel loads and the associated increase in the risk of uncharacteristically intense wildfire.

In all the action alternatives, the large tree habitat structure required for goshawk nesting (e.g., large, tall trees with large branches and adequate flight paths) would be more available across the landscape as the numbers of large trees increased, improving habitat for existing and future resident goshawks and potentially increasing recruitment into the population. Creating interspace between groups of trees would help support prey species. Trees used for nesting would be able to grow to larger size, retain more of their crowns, and live longer with less competition, thus providing higher quality habitat for nesting and foraging. All action alternatives would increase the long-term amount of late seral stage forest post-treatment by more than doubling the amount of existing old trees.

The quality of the late seral stage ponderosa pine habitat would be expected to improve as stand conditions move closer towards historic conditions with more open understories, less competition among trees, and healthier forest conditions. Increasing the understory response would improve the quality of goshawk foraging habitat by providing more food and cover for prey species. The improved development of understory could also increase the diversity and amount of prey species available to goshawks (appendix 6).

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.

#### Coconino NF Northern goshawk Population Trend

The northern goshawk appears to be stable to declining on the forest (USDA 2013).

Alternative A would likely continue the current stable to declining forestwide population trend for the goshawk in both the short term and long term. The potential increase in late serial habitat over the long term would be slow due to competition of dense stands of trees. It would eventually lead to development of future nest trees, although within-stand mortality would affect large tree survival. Stand density would limit understory development, limiting prey populations. The increased risk of large-scale high-severity fire in the future could also remove nest stand structure.

The action alternatives 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 action alternatives would likely change the forestwide population trend 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 used by pygmy nuthatch on either Forest. Alternative A would continue to provide large patches of trees with higher basal area, canopy density, and snags. However, overstory shading of tree boles will continue to limit habitat for insects that bark-gleaning nuthatches feed on. Late-seral ponderosa pine will continue to be threatened by unnatural stand densities, creating risk for uncharacteristic, high-severity fire.

The USGS study of climate effects on birds and reptiles (van Riper et al. 2014) projected that the pygmy nuthatch's breeding range would decrease by 75–81 percent between 2010 and 2099 when an 83 percent agreement threshold was applied. The model accuracy was shown to be 78 percent accurate. The action alternatives should help prevent such a large-scale decrease in the breeding range. The action alternatives would increase resiliency of ponderosa pine habitat to climate change.

The proposed treatments in the action alternatives would protect nesting habitat. The proposed thinning and burning activities would also create canopy openings, allowing sunlight to reach more tree boles and increasing the prey base for nuthatches. Thinning and burning treatments are designed to return forest structure and composition to within the range of natural variability, which should benefit native wildlife species (Kalies et al. 2010), particularly bark gleaning birds (George et al. 2005). The vegetation design features for all action alternatives requires that snags would be managed to meet or move toward forest plan requirement and move toward desired conditions. Snags or hazard trees within a distance of twice their height from private land boundaries or along key roads may be felled. In all other areas conifer snags greater than 12 inch d.b.h. would be maintain, with an emphasis on snags greater than 18 inches d.b.h., except in cases of human health and safety. Live conifer trees with potential to provide nesting habitat cavities, such as dead-top trees and lightning struck trees, will be favored for retention. Prescribed burns are designed to maintain desired forest structure, tree densities, snag densities and CWD levels (Silviculture report). Alternative D would be the most limited in providing these benefits of the four actions alternatives. Alternative E would not include the 28,650 to nearly 30,000 acres of grassland restoration. While pygmy nuthatches are not grassland species, groups of large and old trees would be retained where they occur on mollic-intergrade soils. The results of these treatments would be savanna conditions. This would add resilience to groups of large, old trees and potentially increase invertebrates within these stands, benefiting pygmy nuthatches.

**Coconino NF Pygmy Nuthatch Population Trend**

The current forestwide trend is stable to slightly declining (USDA 2013).

Alternative A would likely continue the current forestwide population trend for the pygmy nuthatch of stable to slightly declining in the short term. With the likelihood of large scale stand replacing wildfires in the future it is possible that in the long term that the forestwide population trend could change to decreasing.

The action alternatives 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. While pygmy nuthatches appear to have a localized populations increase in areas where thinning and prescribed burns have occurred, the short term effects might not be enough to move the species to an increasing trend. 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 used by turkey on either Forest. Alternative A would continue to provide large patches of trees with higher basal area, canopy density, and interlocking crowns thereby providing thermal and hiding cover for turkey. However, overstory suppression of oak, grass, and forb diversity and productivity will continue to limit foraging habitat for turkey in alternative A. Tree encroachment into openings and meadows will also limit turkey foraging habitat. Late-seral ponderosa pine will continue to be threatened by unnatural stand densities, creating risk for uncharacteristic, high-severity fire.

The proposed treatments in the action alternatives would protect nesting and roosting habitat. The proposed thinning and burning activities would create tree groups that are favored by turkeys and would also increase the understory production. By increasing the understory this will also increase the plant and invertebrate richness (appendix 6). The vegetation design features would protect most Gambel oaks within the analysis area and would remove ponderosa pines that are over-topping the oak. Design features also includes retention of medium to high canopy cover in pine stringers in the pinyon-juniper transition zone and target low severity burns to retain yellow pine and roosting cover and would retain clumps of older-aged trees along ridges and on slopes above drainages above the transition zone between pinyon juniper and ponderosa pine vegetation. Of the four action alternatives, alternative D would be the most limited in providing these benefits because forest canopy and its understory development would be limited by the reduce amount of prescribed burning in this alternative. Alternative E would not include the 28,650 to nearly 30,000 acres of grassland restoration. While turkeys are not grassland species, groups of large and old trees would be retained where they occur on mollic-intergrade soils. The results of these treatments would be savanna conditions.  This would add resilience to groups of large, old trees, potentially increasing turkey roost habitat. In addition, the open habitat conditions resulting from the grassland and savanna treatments would increase foraging habitat for adults and poults.

#### Coconino NF Turkey Population Trend

The forestwide population trend is variable but appears to be fairly stable (USDA 2013).

Alternative A would likely continue the current forestwide population trend for the turkey as stable in the short term. With the likelihood of large scale stand replacing wildfires in the future, loss of Gambel oak to shading from pines, and lack of understory development, it is possible that in the long term that the forestwide population trend could change to decreasing.

The action alternatives 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 (appendix 10). Alternatives B and C would have similar impacts on the species and alternatives D and E would not be as beneficial.

## Management Indicators Species for Early-seral Ponderosa Pine

### *Coconino NF Early-seral Ponderosa Pine Habitat Trend*

Forestwide trend for early-seral ponderosa pine is slightly increasing. Within the analysis area there is approximate 14,525 acres of early-seral ponderosa pine, which is approximately 10 percent of this age class across the forest.

Alternative A would not have active management of the ponderosa pine within the analysis area. In the short and long term (Table 198), alternative A would change the forestwide habitat trend from stable to decreasing due to the small amount of habitat that is current available forestwide in early-seral stages. While the long term modeling predicts a total loss of early-seral acres, there is high likelihood of large, high-severity fire (Fire Ecology report). While this could create a large amount of early-seral habitat, it could damage soils, remove seed sources, and create sustained open habitat that does not move into early seral forest. Where forest habitat does return, it could require long time periods for ponderosa pine to reestablish and develop into the early-seral stages. Depending on fire-initiated patches of habitat could also lead to the creation of large blocks of habitats rather than the interspersion of patchy habitat and thus reduce habitat effectiveness for wildlife.

The action alternatives would move the current stable forestwide habitat trend toward increasing for in the short term due to the amount of habitat currently available forestwide (Table 198). For the long term the habitat would move back to a stable level since there is not much different between 10 years and 40 years in the models. All three action alternatives would have similar effects to the habitat trend.

**Table 198. Change in early-seral ponderosa pine habitat on Coconino NF by alternative**

| Alternative | Current acreage | Acreage at 2020 | Different from current | Acreage at 2050 | Different from current |
|---|---|---|---|---|---|
| A | 13,331 | 3,056 | -10,275 | 371 | -12,960 |
| B | 13,331 | 19,937 | 6,606 | 19,316 | 5,985 |
| C | 13,331 | 20,210 | 6,879 | 19,309 | 5,975 |
| D | 13,331 | 22,013 | 8,682 | 19,417 | 6,086 |
| E | 13,331 | 22,684 | 9,353 | 21,770 | 8,439 |

### *Early seral Habitat Trends for the Coconino NF*

**Alternative A:** Short-term = decreasing; long-term = decreasing.

**Action Alternatives:** Short-term = increasing; long-term = stable

## Elk

Alternative A would not result in an immediate change to the quantity or quality of habitat used by elk on either Forest. Alternative A would continue to provide large patches of trees with higher basal area, canopy density, and interlocking crowns thereby providing thermal and hiding cover for elk. However, forage production would be limited under the forest canopies and pine encroachment into grassy openings and meadows would continue to limit foraging habitat for elk in alternative A. Under alternative A, the current unnatural stand densities will threaten sustainability of elk habitat over time by limiting understory production and creating risk for uncharacteristic, high-severity fire.

The action alternatives would promote thinning small-diameter trees and prescribed burning in ponderosa pine that would open the canopy and decrease fine fuels on the forest floor. The result would be increased growth of herbaceous and shrub-level vegetation, which would provide increased forage in the long term. Reducing tree densities and ladder fuels will reduce available thermal and hiding cover for elk. However, thermal protection for elk will continue to be available in areas maintained for higher BA and canopy density, including MSO protected and restricted habitat, NOGO nest stands, other raptor nest sites, bald eagle roosts, buffers around caves and sinkholes, a portion of the VSS 4, 5, and 6 groups intended to support higher tree densities of mixed-age trees, and areas excluded from mechanical treatment such as wilderness or areas with slope greater than 40 percent. Due the lower amount of prescribed burning in alternative D, this alternative will improve a lesser amount of foraging habitat while retaining more hiding and thermal cover over the long term. The former is likely more important than the latter in terms of affecting elk populations. Alternative E would not include the 28,650 to nearly 30,000 acres of grassland restoration. Groups of large and old trees would be retained where they occur on mollic-intergrade soils. The results of these treatments would be savanna conditions. This would increase foraging habitat while retaining patches of hiding and thermal cover.

### *Coconino NF Elk Population Trend*

The Coconino NF Management Indicator Species Report suggests that the forestwide population trend for elk is stable to increasing (USDA 2013). However, analysis using Arizona Game and Fish Department survey and hunt data shows a stable to decreasing trend in elk populations (appendix 10). This estimate of trend was supported by annual surveys and modeling that considers cow:calf ratios, bull:cow ratios, harvest, and background mortality.

Alternative A would likely promote at least a stable forestwide elk population trend in the short term Habitat factors that could influence this trend long term include an increased risk for uncharacteristic, high-severity fire which could remove hiding and thermal cover and increased canopy cover and tree establishment on the edges of grasslands which could limit understory production.

The action alternative will 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.

## Abert's Squirrel

Alternative A would continue to provide large patches of trees with higher basal area, canopy density, and interlocking crowns, thereby providing wintering habitat for squirrels on both forests. However, Alternative A will threaten the long-term viability of squirrels. Under alternative A, the current unnatural stand densities would threaten sustainability of squirrel habitat over time by reducing vigor and health, limiting pine cone production, and creating risk for uncharacteristic, high-severity fire. Vigor and health of trees in the VSS 4, 5, and 6 categories is important for sustaining squirrel nesting habitat over time. Pine cone production is important for squirrel foraging and nutritional demands. Large-scale losses of squirrel habitat from uncharacteristically large, stand-replacing fire will affect squirrel populations across both forests.

With rare exception, the action alternatives will not remove old growth trees, and there will be an emphasis on retention of large-diameter trees (Silviculture report) which should benefit Abert's squirrels for nesting, winter cover, and cone production. Project design criteria include tree thinning under the goshawk guidelines. This should result in a mosaic of vegetative structural stages, interrupt canopy closure, and allow more sunlight to reach the forest floor. In the moderate- to high-severity treatments, the reduction in canopy connectedness will reduce safe travel routes for Abert's squirrels and expose them to higher rates of predation. These higher-severity treatments will also expose more of the forest floor to direct sunlight which could remove the microsite habitat for mycorrhizal fungi production, thereby reducing an important food source for squirrels. However, Dodd et al. (2006) postulated that up to 75 percent of a forested landscape could be treated and still provide suitable squirrel habitat if treatments were applied as a mosaic of patches and areas of optimal habitat were retained. The alternatives are also designed to provide closed-canopy corridors to provide connectivity for squirrels and other species (appendix 8).

The proposed action calls for a diverse range of mechanical treatments for maintaining forest habitat. Forests would vary from 10-55 percent open, outside of grassland and savanna habitat, with variable basal area, trees per acre, and stand density index depending on site-specific conditions (silviculture report). Areas that will likely maintain a basal area and canopy cover high enough to support Abert's squirrels include MSO protected and restricted habitat, NOGO nest stands, other raptor nest sites, bald eagle roosts, buffers around caves and sinkholes, a portion of the VSS 4, 5, and 6 groups intended to support higher tree densities of mixed-age trees, and areas excluded from mechanical treatment such as wilderness or areas with slope greater than 40 percent. As such, the patches of forest within the mosaic proposed by the action alternatives would vary in terms of Abert's squirrel habitat quality. A ratio of optimal to sub-optimal patches that is skewed toward a more open condition will be less desirable to the squirrel and could lead to a short term reduction in current squirrel populations. However, long term, post-treatment conditions will include tree growth and increased canopy connectedness which should have a positive impact to squirrel populations when viewed over longer time horizons.

Alternative E would not include the 28,650 to nearly 30,000 acres of grassland restoration. While groups of large and old trees would be retained where they occur on mollic-intergrade soils, the results of these treatments would be savanna conditions. While this would increase large tree resiliency, it would also interrupt canopy connectivity and reduce fungi production by removing a relatively large percentage of canopy.

Despite the proposed overall reduction in dense forest conditions, the proposed action will also provide for sustainable forests that include large, cone-bearing trees either as individual legacy trees or in groups and clumps of mature and old-growth trees interspersed with patches suitable for fungi production. Canopy connectivity will be retained, but would no longer occur across so much of the landscape. In the long term, this should provide for more sustainable squirrel habitat over time because the risk of high-severity fire and therefore long-term degradation or loss of squirrel habitat will be significantly reduced (USDA 2010a). Landscape connectivity would be retained for canopy-dependent species (Figure 34).

### *Coconino NF Abert's Squirrel Population Trend*

The forestwide population trend is assumed to be stable because of the relatively stable statewide trend in tree squirrel harvest however there are no reliable population trend data for the Forest and no data for Abert's squirrel harvest rates (USDA 2013).

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.

The action alternatives 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, all action 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.

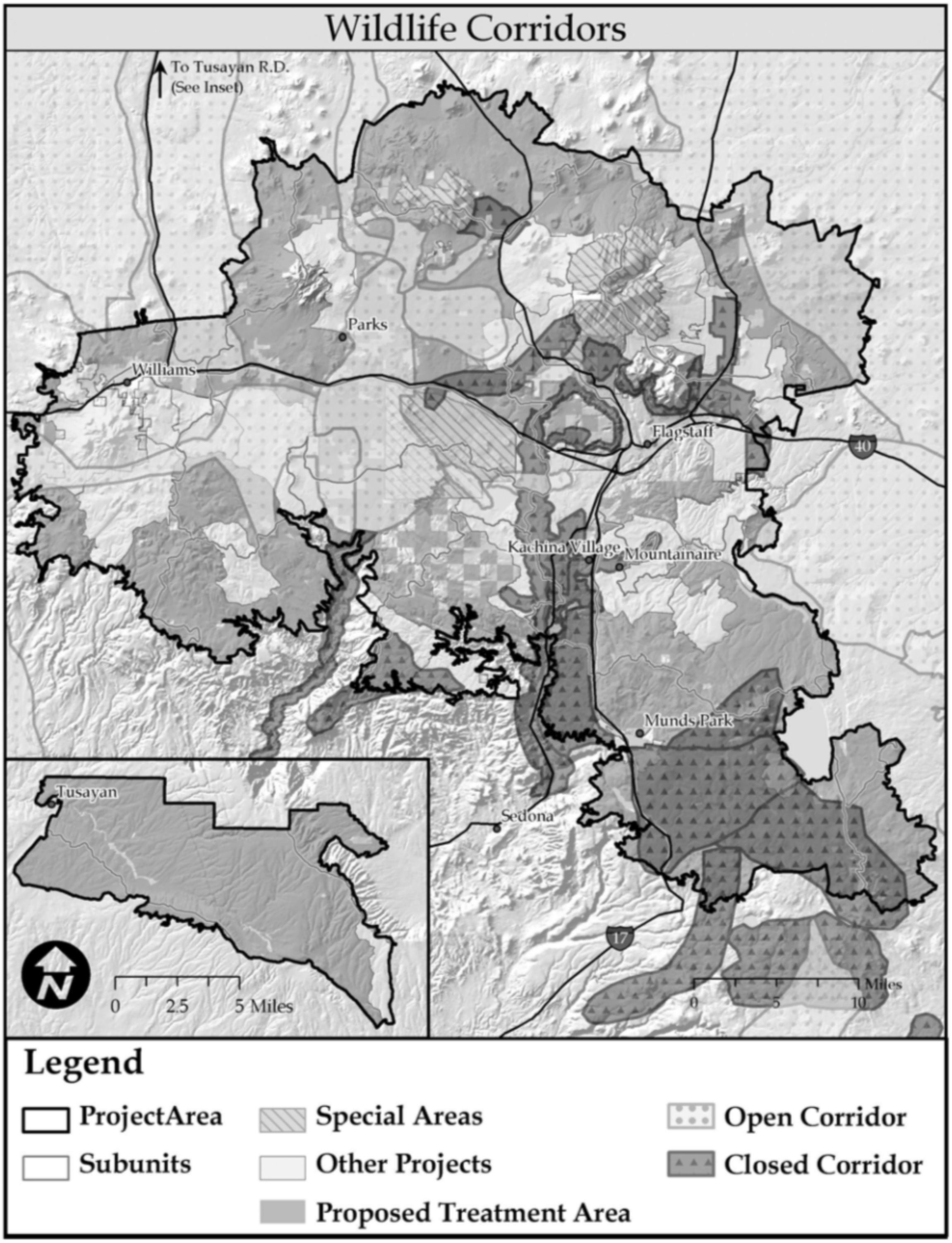


**Figure 34. Wildlife movement corridors developed by the Arizona Game and Fish Department and incorporated into the proposed 4FRI treatments under Alternatives C and E**

## Management Indicators Species for Snags Ponderosa Pine

### *Hairy Woodpecker*

Alternative A would increase the amount of late-seral forests in the long term. The risk of a large-scale wildfire is high. While fires promote recruitment of large snags, a study conducted locally, documented 40 percent of fire-killed snags falling within 7 years (Chambers and Mast 2005). Over 80 percent of ponderosa pine snags created by high-severity fire fell within 10-years post-fire (Chambers personal communications 2008, Mast personal communications 2008). In addition, patches that burn with high-severity in today's stand-replacing fires can reach several hundred hectares in size. Hairy woodpeckers do not use interior portions of larger burned areas, restricting much of their foraging to the edge habitat. The uncharacteristically large fires of recent years are less valuable than the smaller overstory-removing fires that occurred historically (USDA 2010a).

The four action alternatives are designed to restore ponderosa pine forests closer to historical range of variation. The vegetation design features for all action alternatives has the following requirements for snags: Snags would be managed to meet forest plan requirement and move toward desired conditions; snags or hazard trees within a distance of twice their height from private land boundaries or along key roads may be felled; in all other areas conifer snags greater than 12 inches d.b.h. would be maintained; selection of snags to be retained after project operations would have a preference for snags greater than 18 inches d.b.h. except in cases of human health and safety. Live conifer trees with potential to provide nesting habitat cavities such as dead-top trees and lightning struck trees will also be favored for retention. Prescribed fires are designed to maintain desired forest structure, tree densities, snag densities and CWD levels (silviculture report). Using the goshawk guidelines to direct management practices should have a positive effect to the species, as this prescription results in forest structure that more closely resembles historic forests than those present today, including large trees and an abundance of snags (USDA 2010a). Alternative D would have the least amount of positive effects with its reduce amount of prescribed fire, since returning fire to the ponderosa pine system would also produce habitat component for the hairy woodpecker (USDA 2010a). Alternative E would not include the 28,650 to nearly 30,000 acres of grassland restoration. While hairy woodpeckers are not grassland species, groups of large and old trees would be retained where they occur on mollic-intergrade soils. The results of these treatments would be savanna conditions. This would add resilience to groups of large, old trees and retain long-term recruitment of large snags by adding resiliency to the remaining stands and increasing invertebrate production.

#### **Coconino NF Hairy Woodpecker Habitat and Population Trends**

Densities of snags greater than 18 inches d.b.h. have remained stable and below forest plan guidelines (USDA 2013). The PNVT data for acreage in ponderosa pine, mixed-conifer and spruce-fir for the forest is approximately 900,426 acres. The project area contains 322,772 acres for ponderosa pine, which is approximately 36 percent of the PNVT for the three cover types across the forest. The forestwide population trend for the hairy woodpecker is slightly increasing (USDA 2013).

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 hard to predict how the woodpecker would use a post-fire area because it depends on the amount and configuration of high-severity burn patches. Therefore it is unknown how this would also affect forestwide population and habitat trends. We do know large amounts of snags are created from wildfires and that they are not long-lasting on the landscape.

The action alternatives would likely continue the stable forestwide population trends in the short term, but treatment activities are likely to decrease snag habitat in the short-term. An analysis by the FWS determined that maintaining at least 15 percent of each of the largest tree size classes (equivalent to VSS 4, 5 and 6) and managing for snag retention would provide an adequate supply of snags across the landscape (USDI 1995). In the long term, the four alternatives would change the forestwide habitat and population trend to increasing.

## Management Indicators Species for Late-seral Aspen and Snags in Aspens

### *Red-naped sapsucker*

Alternative A would continue the decline of aspen across the analysis area. Declines would continue as a result of conifer encroachment causing competition-induced mortality and ungulate grazing removing regenerating sprouts. Exceptions are in past treatments that removed conifers and erected elk-resistant fencing.

All four action alternatives propose to mechanically thin 1,227 acres of aspen habitat, but only alternatives B, C and E include prescribed fire on all these acres. Alternative D includes 22 acres of prescribed fire only treatment. Alternatives B and E would treat 223 acres and 242 acres, respectively, with prescribed fire only treatments. Up to 82 miles of barriers (fences or other obstructions) around most treated aspen would be included to prevent ungulate grazing. The mechanical thinning of ponderosa pine trees would help prevent the loss of older aspen to conifer encroachment and make the trees more resilient to weather extremes. Alternative D would burn only approximately 200 acres less habitat on the Coconino NF than the other alternatives. Fencing or other barriers around treated aspen would allow recruitment of young aspen suckers to provide future late seral aspen. Without some form of barrier, it is unlikely aspen sprouts would survive and be recruited into larger d.b.h. size-classes.

#### Coconino NF Red-naped sapsucker Habitat and Population Trends

The current forestwide population and habitat trends for red-naped sapsucker are declining (USDA 2013). Alternative B and E would treat approximately 1,063 acres and alternative C would treat 1,082 acres of aspen within the analysis area which is approximately 11 percent of the aspen habitat forestwide for these alternatives. Alternative D would treat 874 acres of aspen, which is approximately 9 percent of aspen forestwide (silviculture report).

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.

The four action alternatives 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.

## Management Indicators Species for Early-seral Aspen and Pinyon-juniper

### *Mule Deer*

Alternative A would continue to provide large patches of trees with higher basal area, canopy density, and interlocking crowns thereby providing thermal and hiding cover for mule deer. However, overstory suppression of browse would continue to limit understory diversity and productivity. Tree encroachment into openings and meadows would also limit mule deer foraging habitat. Early-seral aspen habitat is essentially absent unless clones were previously fenced. This situation would continue unless natural disturbances such as fire occur and management intervention provides barriers to ungulate access. 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.

The proposed action calls for thinning under the goshawk guidelines, which would result in a mosaic of interspersed vegetative structural stages, providing both bedding sites and foraging areas for mule deer. Thinning and burning in the pine-sage, pine-oak, and pure pine will also provide opportunities for browse to increase which should positively influence mule deer populations over time.

The action alternatives would reduce tree densities and ladder fuels, thereby reducing available thermal and hiding cover for mule deer. However, thermal protection will continue to be available in areas maintained for higher BA and canopy density including MSO protected and restricted habitat, NOGO nest stands, other raptor nest sites, bald eagle roosts, buffers around caves and sinkholes, a portion of the VSS 4, 5, and 6 groups intended to support higher tree densities of mixed-age trees, and areas excluded from mechanical treatment such as wilderness or areas with slope greater than 40 percent. Thinning small-diameter trees and burning in Gambel oak thickets could also reduce hiding and thermal cover for mule deer in the short term. These same actions would decrease the likelihood of stand replacing fire events and large-scale habitat loss over larger areas (fire ecology report).

All four action alternatives propose to mechanically thin and burn 1,227 acres of aspen habitat and would construct up to 82 miles of barriers (fences or jackstrawing) around most treated aspen to prevent ungulate grazing. The mechanical thinning of ponderosa pine trees would help prevent the loss of older aspen to conifer encroachment and make the trees more resilient to weather extremes. Alternative D would burn approximately 200 acres less habitat on the Coconino NF than alternatives B, C and E. Fencing or other barriers around treated aspen would allow recruitment of young aspen suckers to provide future late seral aspen. Without some form of barrier, it is unlikely aspen sprouts would survive and be recruited into larger d.b.h. size-classes.

All four action alternatives would include operational burning (24,850 to 25,123 acres) within pinyon-juniper to facilitate treatments in ponderosa pine habitat. The alternatives would also mechanical thin and burn 535 acres of pinyon-juniper on the Tusayan RD. All four alternatives 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 which would increase the forage potential for mule deer in these areas (appendix 6).

Alternative E would not include the 28,650 to nearly 30,000 acres of grassland restoration. Groups of large and old trees would be retained where they occur on mollic-intergrade soils. The results of these treatments would be savanna conditions. This would increase foraging habitat while retaining patches of hiding and thermal cover.

**Coconino NF Mule Deer Habitat and Population Trends**

The forestwide aspen habitat trend for the mule deer is currently declining due to lack of aspen recruitment (USDA 2013). At this time and pinyon-juniper is habitat trend is increasing. The mule deer population trend forestwide is considered to be declining (USDA 2013).

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 with elk and livestock, and increasing tree densities and canopy closure which reduce ground cover and shrub layer used by mule deer (appendix 10). In addition, there is potential for a decreasing trend in the long term due to the potential of large scale stand replacing wildfires.

The action alternatives would promote the development and recruit of early-seral aspen habitat and could move the forestwide habitat trend toward stable in the short- and long-term due to the fact that the alternatives would improve 9 to 11 percent of the aspen forestwide. The alternatives would not change the current increasing forestwide habitat trend for pinyon-juniper habitat since it would be creating early-seral habitat. 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, forestwide population trends are affected by hunting as well as forest management.

## Management Indicators Species for Late-seral Pinyon-Juniper and Snags in Pinyon-Juniper Habitat

### *Juniper Titmouse*

Alternative A would continue to maintain or increase the tree density on both forests. As tree density and canopy cover increases, juniper titmouse breeding density decreases. Increased tree density and canopy cover increases the likelihood of high-severity stand-replacing fires rather than the low-severity understory fires that historically were common in many pinyon-juniper woodlands (USDA 2010a).

All four action alternatives would include operational burning (24,850 to 25,123 acres) within pinyon-juniper to facilitate treatments in ponderosa pine habitat. The alternatives would also mechanically thin and burn 535 acres of pinyon-juniper on the Tusayan RD. All four alternatives would leave approximately 67 percent (15,626 acres) of the acreage in old growth pinyon-juniper (silviculture report). However, thinning and burning in pinyon-juniper would open the canopy and allow development of understory plants which would improve habitat conditions for the juniper titmouse in these areas (appendix 6). Alternative D would treat the least amount of acres. Prescribed burns are designed to maintain desired forest structure, tree densities, snag densities and CWD levels (silviculture report).A vegetation design feature in all action alternatives includes leaving pinyon and juniper trees where they are growing within ponderosa pine. Some of these areas, particularly near the true pinyon-juniper cover type, would increase juniper titmouse habitat. Another design features related to pinyon-juniper habitat includes managing for 1 snag per acre over 75 percent of the area (current forest plan direction is 1 snag per acre over 50 percent of the area).

**Coconino NF Juniper Titmouse Habitat and Population Trends**

The current forestwide habitat trend is stable for late-serial pinyon juniper to increasing for snags and the population trend stable (USDA 2013).

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 2 percent of the habitat on the forest.

While the action alternatives would manage 8,311 acres as late-seral habitat and develop understory components in the pinyon-juniper habitat, it would not change the short- or long-term forestwide habitat or population trends due to the fact that 2 percent of the pinyon-juniper habitat forestwide will be affected.

## Management Indicators Species for Early and Late-seral Grasslands

### *Pronghorn*

Availability of grasslands, meadows and savannas would continue to be limited for pronghorn use under alternative A. Tree density and canopy cover within historic meadows and grasslands would continue to limit sighting distances and suppress productivity of grasses and forbs for foraging and fawn hiding cover. Connectivity of pronghorn habitat would continue to decline under this alternative due to expansion of dense tree cover. Grassland and meadow habitats would continue to decline in the absence of natural disturbances such as fire and without management intervention.

Alternatives B and D would burn 48,423 to 48,493 acres of grasslands respectively on both forests. The burning would restore disturbances that work to maintain grasslands, meadows, and savannas. Low-severity fire would be expected to increase growth and diversity of herbaceous vegetation, which would provide increased forage in the long term, with expected benefits as soon as 1 to 2 years following prescribed fire. Burning from April 15 – June 15 would be avoided in known fawning areas to prevent impacts to young, less-mobile fawns.

Alternatives C and E would mechanically remove encroaching conifers and burn about 48,160 and 47,915 acres of grassland, respectively, and about 488 additional acres would be burn-only across the two forests. This would benefit pronghorn habitat connectivity and invigorate productivity of grasses and forbs. Sight distances would be improved. Herbaceous productivity, including grass, forb, and shrub species diversity, is expected to increase within 1 to 2 years post-treatment (appendix 6), which would improve pronghorn foraging and fawning habitats. These treatments would occur in Garland Prairie and Anderson Mesa which are important fawning areas for pronghorn. Thinning and burning from April 15 – June 15 would be avoided in known fawning areas to prevent impacts to young, less-mobile fawns.

Beside grassland treatments, all the alternatives B, C and D would restore about 11,200 acres of historic grasslands and meadows which are currently shown as ponderosa pine forest in the silviculture database and about 45,400 acres of savanna by thinning out encroaching pines. This would increase and improve pronghorn habitat as well as benefit pronghorn habitat connectivity. Treatments on 912 acres north of I-40 were changed to a more open intensity (UEA 40-55) or modified to maximize connected interspace among tree groups to facilitate a potential future highway crossing. 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. The long-term intent is of these treatments is to facilitate a future highway crossing over I-40. However, these treatments would incorporate connected openings/interspaces to facilitate east-west movements around private lands as well. This would improve pronghorn connectivity north of I-40 immediately after treatment. See cumulative effects for MIS below for additional detail.

Removing encroaching trees followed by prescribed burning would invigorate productivity of grasses and forbs. Sight distances would be improved by these alternatives. Grass-forb species diversity is expected to increase within 1 to 2 years post-treatment, which should improve pronghorn foraging and fawning habitats. Approximately 18 percent of treated areas would be restored to an open condition preferred by pronghorn (less than 30 tree cover in forested cover). This would significantly increase pronghorn habitat (appendix 10). Alternative E would not include these treatments.

Tree and shrub cover are occasionally used by pronghorn, indicating some selection for savanna conditions as well as grasslands. Isolated, large trees will receive some use by pronghorn for shade during hot summer months. Low shrubs can play a key role as hiding cover for fawns. Appendix 8 displays how the alternatives would provide for open corridor connectivity for pronghorn. AGFD connectivity data has been used to inform spatial arrangement of mechanical thinning treatments that favor grassland wildlife such as pronghorn. This treatment design, used in combination with soils information and historic evidences, will enhance connectivity for pronghorn populations (appendix 10).

Alternatives C and E include about 38,256 acres of treatments identified in comments to the DEIS with 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). Treatments would remain as proposed, but implementation would emphasize the low intensity end of the proposed treatment range and so would maximize tree density and BA. Few of the 1,069 stands are contiguous and they span most of the 4FRI treatment area. In general, they make little difference to the post-treatment landscape. However, two areas developed in cooperation with AZGFD would be negatively affected:

1. The potential I-40 crossing corridor (about 5,000+ acres on the Kaibab NF) and
2. Open habitat connectivity corridors (about 5,000 acres on the Coconino and Kaibab NFs).

The potential I-40 pronghorn crossing represents stands treated to support a potential crossing structure over the interstate recommended by AGFD to the Arizona Department of Transportation. An area north of I-40 was delineated by the AGFD to facilitate connectivity with key areas of pronghorn use to the north (Government Prairie) and east-west movements. Treatments were adjusted within this corridor to meet this future desired condition. Similarly, landscape-scale linkage corridors developed by AZGFD were incorporated into final treatment design, including connecting habitat for “open habitat” species. Treatments for stands within the linkage corridors were adjusted to meet the intent of open habitat connectivity. Adopting the change in treatment intent for the 38,256 means closed-canopy forest conditions would be emphasized (see the silviculture report for details), instead of open habitat, including key areas near Spring Valley Knolls, Government Hills, Government Prairie, and east of Kendrick Mountain that serve as travel routes and winter range for pronghorn.

### Coconino NF Pronghorn Habitat and Population Trends

Pronghorn population trends on the Coconino NF are relatively stable and habitat trend is stable to declining (USDA 2013). There is approximately 22,622 acres of burning grassland within the analysis area (9 percent of total grassland acres) in alternatives B and D. Alternatives C and E has approximately 22,620 acres of grassland treatments (mechanical and burning) within the analysis area.

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.

While alternatives B and D would help increase diversity and productivity of herbaceous plants, it would not likely remove large conifer trees in the grasslands. However an additional 1,562 acres of grassland would be created in the long-term. These alternatives 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. These alternatives would also do approximately 27,000 acres of savanna treatments on the forest within the analysis area. 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 E would help increase diversity and productivity of herbaceous plants due to the remove of large trees in areas currently designated at grasslands. However, no grassland restoration or savanna treatments would occur. So while the grassland habitat would be improved, habitat connectivity for the pronghorn would not improve. While the treatment 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 only 9 percent of the forestwide habitat would be treated.

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, 1562 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.

However, for all the action alternatives, the forestwide population trends for pronghorn are largely influenced by hunting, drought, and loss of connectivity due to human development.

## Management Indicators Species for the Kaibab NF

### Ponderosa Pine Indicators – Grace’s Warblers and Western Bluebirds

The current forestwide habitat and population trends for the Grace’s warbler and the western bluebird are stable. On the Kaibab NF there is approximately the 541,000 acres of ponderosa pine PNVT (Keckler and Foster 2013). There is 189,407 acres of ponderosa pine within the analysis area on the Kaibab NF. This is approximately 37 percent of the ponderosa pine PNVT on the forest. Since the PNVTs are based on historical locations of ponderosa pine in the past, there would not change the amount of acreage within the ponderosa pine PNVT for any of the alternatives. The analysis will focus on if there would be improvement in the quality of the habitat.

Most trees in the mature and older structural stages (VSS 5 and 6) will be retained across all alternatives (Old Tree Implementation Plan; FEIS appendix D). Most old and large trees are expected to be retained. Alternatives C and E both have the Modified large Tree Implementation Plan (FEIS appendix D, section D) provides the conditions in which large trees can be removed. The vegetation design features for all action alternatives has the following requirements for snags: Snags would be managed to meet forest plan requirement and move toward desired conditions; snags or hazard trees within a distance of twice their height from private land boundaries or along key roads may be felled; in all other areas conifer snags greater than 12 inches d.b.h. would be maintained; selection of snags to be retained after project operations would have a preference for snags greater than 18 inches d.b.h. except in cases of human health and safety. Live conifer trees with potential to provide nesting habitat cavities such as dead-top trees and lightning struck trees will also be favored for retention. Prescribed fires are designed to maintain desired forest structure, tree densities, snag densities and CWD levels (silviculture report).

Alternative A would not improve the quality of habitat available for either the Grace's warbler or the western blue bird. Under alternative A, no treatments would be implemented to create a mosaic of interspaces and tree groups. 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.

Treatments in Grace's warbler habitat would include mechanical, mechanical and prescribed fire, or prescribed fire only (Table 199). The level of each of the different treatments will affect the quality of the habitat.

**Table 199. Proposed treatment within ponderosa pine on the Kaibab NF by alternative**

| | Acres on Kaibab NF | | | |
|---|---|---|---|---|
| **Proposed Treatments** | **Alt B** | **Alt C** | **Alt D** | **Alt E** |
| Mechanical Treatment with Prescribed Fire | 159,239 | 157,624 | 0 | 141,474 |
| Mechanical Treatment Only | 0 | 0 | 159,239 | 0 |
| Prescribed Fire Only | 30,036 | 30,043 | 29,850 | 46,061 |
| **Grand Total** | **189,275** | **187,667** | **189,090** | **187,535** |

While all treatments within each alternative, with the exception of grassland restoration, are designed to reestablish forest openings and attain a mosaic of interspaces and tree groups of varying sizes and shapes, the intensity of the treatment affects the degree to which this condition would be met. The lower intensity treatments within MSO protected, target, and threshold and goshawk nest habitats will result in irregular tree spacing and subtle expansion of existing forest openings. The higher intensity treatments such as UEA 40, IT 40 and SI 40 would remove more trees and extend greater flexibility in the size and shape of resulting tree groups and intervening interspaces (silviculture report). All the action alternatives will increase the amount of large trees across the analysis area over time.

Differences in treatment intensity between alternatives B, C, and E would result in differences in how well the alternatives would achieve a mosaic of interspaces and tree groups. Under alternative C would include modified UEA treatments (AGFD design), providing more heterogeneity within the treatment area (silviculture report). Alternative E would treat fewer acres mechanically, but treat more acres with prescribed fire. This would potentially result in fewer acres developing the mosaic of interspaces and tree groups, depending of the effectiveness of the burning to create this structure.

Mechanical treatments between alternatives B and D are the same; therefore, differences in post-treatment stand structure can be attributed to the limited prescribed fire associated with alternative D, especially in the VSS 3 size-class. Retaining denser growing conditions would affect the VSS distribution trend by slowing stand development and recruitment of large trees. This would result more of the landscape supporting young forest age-classes and impeding development of the mature and old forest stages (silviculture report).

All the action alternatives 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.

All action alternatives would change the habitat trend for western bluebirds from stable to increasing in both the short- and long-term. The interspaces and openings created by treatments would likely increase understory development in the short-time. Western bluebirds depend on understory development for food, including arthropods and seeds. Understory development would likely be the short-term limiting factor on bluebird populations. The western bluebird 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.

### Grassland Indicator – Pronghorn

Within the grassland PNVTs on the forest, there are approximately 112,250 acres of pronghorn habitat. Not all these acres provide habitat for the pronghorn at this time. Currently, forestwide pronghorn habitat appears to be stable (Keckler and Foster 2013). There is approximately 25,871 to 26,152 acres of grassland treatments (mechanical and burning) proposed within the different alternatives. This is approximately 23 percent of the forestwide pronghorn grassland acreage.

Beside grassland treatments, alternatives B, C and D would restore about 9,620 acres of historic grasslands and meadows which are currently shown as ponderosa pine forest in the silviculture database. The restoration of grasslands that have been converted to ponderosa pine forest has already been accounted for in the designation of the PNVTs and will not increase the amount of grassland within the forestwide acreage. However, the grassland treatments and restoration would improve the function and effectiveness of pronghorn habitat in alternatives B, C and D.

Alternatives B, C, and D would treat approximately 18,000 acres of savanna habitat by thinning encroaching pines. This would increase and improve pronghorn habitat as well as benefit pronghorn habitat connectivity. Removing encroaching trees combined with prescribed fire would invigorate productivity of grasses and forbs. Sight distances would also be improved by these alternatives. Grass-forb species diversity is expected to increase within 1 to 2 years post-treatment, which should improve pronghorn foraging and fawning habitats.

About 18 percent of treated areas would be restored to an open condition preferred by pronghorn (less than 30 BA in forested cover). This would significantly increase pronghorn habitat (appendix 10). Isolated, large trees would receive some use by pronghorn for shade during hot summer months and low shrubs can provide hiding cover for fawns. Open corridors, part of the AGFD landscape connectivity strategy incorporated into alternatives C and E, would create habitat and improve habitat effectiveness by providing connectivity for pronghorn (Figure 34 above).

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.

While alternatives B and D would help increase diversity and productivity of herbaceous plants it would likely not remove large conifer trees in the grasslands. These alternatives 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 E would help increase diversity and productivity of herbaceous plants due to the remove of large trees in areas currently designated at grasslands. However, 9,620 acres grassland PNVT would not be restoration nor would savanna treatments would occur. So while the current grassland habitat would be improved, habitat connectivity for the pronghorn would not improve. 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.

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.

However, for all the action alternatives, the forestwide population trends for pronghorn are largely influenced by hunting, drought, and loss of connectivity due to human development.

## Cumulative Effects for Management Indicator Species

Some MIS are much more mobile than others. Therefore, it is important to recognize habitat outside the analysis area as the affected environment for some animals. The affected environment for cumulative effects varies by species (Table 200). The analysis includes the combined impacts of all activities within the area as evaluated by each alternative. For example, the Abert's squirrel typically does not travel far: They stay in ponderosa pine forest year-round instead of migrating to lower elevations for the winter. Therefore, its affected environment is the ponderosa pine habitat type within the project area. On the other hand, elk use much larger areas to mate, calve, graze and overwinter. Therefore, the affected environment for elk includes habitat outside the analysis area.

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. Cumulative effects can be an integral part of the effects analysis for wildlife and will be discussed for each species. Cumulative effects discussed 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 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 has occurred.

**Table 200. 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; GMUs are designed to encompass herd movements. |

## Alternative A

### *Coconino and Kaibab NFs*

The cumulative effects of the treatments occurring under alternative A are listed in appendix 17. These projects 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.

In summary, the following cumulative effects apply to the MIS for 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.

The following cumulative effects apply to the MIS for 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.

## Action Alternatives

### *Kaibab NF*

The planned thinning and burning of 39,166 to 60,934 acres of ponderosa pine habitat will help reduce small tree densities and help move habitat towards historical stand structures. These treatments would have the same benefits discussed in alternative A, but 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. Because of site conditions, sight distance would be maintained as animals approached and crossed the interstate if a structure spanning the highway were constructed here. Maintaining line of sight is particularly important to pronghorn and a crossing structure here could potentially reconnect populations that have been fragmented potentially since development of Route 66 (Ockenfels personal communications 2008). The location was included in a report submitted by the AGFD to the Arizona Department of Transportation that recommended wildlife crossing locations for Interstate 40 (Gagnon et al. 2012). Treatments in the 4FRI were changed to a more open intensity (UEA 40-55) or modified to maximize connected interspace among tree groups. These changes were incorporated into all action alternatives on 912 acres north of I-40. 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. This effort would assist in linking pronghorn herds currently fragmented by I-40 if the crossing structure was constructed. 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. Since travel off road is only allowed in fuelwood areas, this would limit how far the public can travel to collect fuelwood. This will likely leave more dead and down woody material in areas further from roads. There would likely be less dead woody material available within fuelwood areas closer to roads. This could prevent achieving forest plan requirements for snags, logs, and dead and down woody material near some 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.

The cumulative effects along with proposed activities in the action alternatives for MIS are as follows: For all the species, the cumulative effects of the above projects will not change the predicted forestwide habitat and population trends.

### *Coconino NF*

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 towards 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.

The proposed aspen restoration is planned for areas that contain the majority of the aspen outside of the wilderness areas. This 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. Off road travel is only allowed for loading cut fuelwood. This will decrease miles driven off road by people scouting for firewood. This will limit how much fuelwood is removed away from roads and increase fuelwood removal along roads. 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 above for alternative A.

The cumulative effects along with proposed activities in the action alternatives for MIS are as follows: For all species, the cumulative effects of the above projects will not change the predicted forestwide habitat and population trends.

# Migratory Birds and Important Bird Areas

The proposed project would affect ponderosa pine, aspen, pinyon-juniper, grasslands and savannas, ephemeral streams, and spring habitats.

## Amendments Supporting the Action Alternatives

Not incorporating the proposed amendments would affect the habitat of most of the migratory birds addressed in this report (Table 201). However, not including the amendments would not be expected to affect the Anderson Mesa IBA. The MSO amendments 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 affect the following on the Coconino NF:

- 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 all action alternatives)
- uncharacteristically dense forest conditions, lower canopy base height, and increased risk of high-severity fire in 70 PACs (related to the proposed prescribed fire treatments in alternative C only)
- fewer PACs attaining the desired post-treatments conditions due to sequencing of treatments through time (all action alternatives)
- tree densities maintained above the minimum BA 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 MSO habitat, affecting prey habitat and likely decreasing the total prey biomass for raptors
- About 28,650 acres (alternative C) to 28,950 acres (alternatives B and D) would be managed for open reference conditions while retaining all presettlement trees, thereby enhancing understory conditions (and seed and arthropod production), and grassland connectivity

Not including the amendment 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 issues (measured by the percent SDImax), 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 in 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. 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.

Short-term unintentional take would likely occur as result of loss of eggs, nestlings, and rarely, the loss of adult birds. This would be the result of harvesting trees containing active nests or crushing or burning ground nests during thinning and burning. Some additional degree of take could occur from collisions with project vehicles (see appendix 2 for a discussion of trucking levels and risk of collision).

## Effects of the Actions

Currently, many migratory birds depend on habitats or habitat elements related to canopy openings, snags, and early seral conditions. Existing closed canopy forests limit or eliminate many of the necessary habitat components needed by these species such as understory development sufficient to support abundant seeds, arthropods, and cover. 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. The ability to grow and maintain large trees would provide consistent development of future snags.

**Table 201. Long-term effects to migratory bird habitats by implementing the action alternatives**

| Species | Habitat Links | Long-Term Effect to Habitat |
|---|---|---|
| Northern Goshawk | Late-seral PIPO[1]/Prey Habitat | Improved |
| Flammulated Owl | PIPO/openings/insects/snags | Improved |
| Olive-sided Flycatcher | PIPO/openings/insects/snags | Improved |
| Cordilleran Flycatcher | PIPO/insects/ oak/dense forest | Mixed |
| Grace's Warbler | PIPO/openings/insects/snags | Improved |
| Lewis's Woodpecker | PIPO/openings/insects/snags | Improved |
| Purple Martin | PIPO/openings/insects/snags | Improved |
| Cassin's Finch | PIPO/openings/seeds | Improved |
| Red-naped sapsucker | Aspen | Improved |
| Gray Vireo | Pinyon-juniper | Improved |
| Pinyon Jay | Pinyon-juniper | Improved |
| Juniper titmouse | Pinyon-juniper | Mixed |
| Black-throated Gray Warble | Pinyon-juniper | Improved |
| Gray Flycatcher | Pinyon-juniper | Improved |
| Swainson's Hawk | Open/Grassland | Improved |
| Ferruginous Hawk | Open/Grassland | Improved |
| Burrowing Owl (western) | Open/Grassland | Improved |
| Grasshopper Sparrow | Open/Grassland | Improved |
| Bendire's Thrasher | Open/Grassland | Improved |

1. PIPO = ponderosa pine forest

## Ponderosa Pine Forest

APIF and the FWS designated eight different species of bird to represent ponderosa pine habitat. Table 202 displays by alternative how much treatment will occur within the ponderosa pine habitat. Treatment data is from silvicultural report for the 4FRI project (Silviculture report).

**Table 202. Ponderosa pine treatment acres by alternative**

| Alternative | Mechanical Thinning & Burning | Burning Only | No Treatment |
|---|---|---|---|
| B | 383204 | 119,620 | 5,016 |
| C | 381,091 | 124,267 | 2,482 |
| D | 383,204 | 100,373 | 24,263 |
| E | 353,542 | 147,044 | 7,254 |

All of the alternatives are designed to maintain or enhance late-seral ponderosa pine trees and protect all MSO PACs and goshawk nesting areas and PFAs. The vegetation design features for all action alternatives have the following requirements for snags:

- Snags would be managed to meet forest plan requirement and move toward desired conditions
- Snags or hazard trees within a distance of twice their height from private land boundaries or along key roads may be felled
- In all other areas conifer snags greater than 12 d.b.h. would be retained, with a preference for snags greater than 18 inches d.b.h., except in cases of human health and safety
- Live conifer trees with potential to provide nesting habitat cavities will be favored for retention (e.g., live trees with dead top trees or lightning strikes)
- Prescribed burns are designed to maintain desired forest structure, tree densities, snag densities and course woody debris levels (Silviculture report)

Wildlife design features (this report) also include the following mitigations that would reduce impacts to bird species are as follow:

- No treatments would occur in PACs during the breeding season (March 1 to August 31) if occupied
- If nest or roosts are not known, treatments will not occur within ¼ mile buffer of core areas unless surveys indicate the PAC is unoccupied
- Within goshawk PFAs, no treatments will occur from March 1 to September 30
- Manage for forest plan levels of CWD when applying fire prescriptions
- Ensure that the potential cumulative effects of multiple fires in a given area do not produce negative effects to local wildlife; coordinate burning between administrative units and between wildlife and fire management to minimize potential disturbance

Unintentional take is expected to be minimized through the application of breeding season timing restrictions in PACs and goshawk nest stands, deferral areas, and other design features described above. Long-term benefits to migratory birds would be the creation of openings/habitat heterogeneity where forests are currently dominated by homogenous conditions. Openings would support increased biomass development, including increased seed production, arthropods, and small mammals. Design features would protect existing snags and increase large tree growth. The risk of habitat loss from large-scale, high-severity fire would decrease after treatment.

## Aspen Habitat

Table 203 displays by alternative how much treatment will occur within the aspen habitat. Treatment data is from silvicultural analysis for the project (Silviculture report).

**Table 203. Aspen treatment acres by alternative**

| Alternative | Mechanical thinning & burning | Burning Only | No Treatment |
|---|---|---|---|
| B | 1227 | 223 | 71 |
| C | 1227 | 242 | 53 |
| D | 1227 | 22 | 272 |
| E | 1227 | 223 | 71 |

All action alternatives propose to mechanically thin and burn 1,227 acres of aspen habitat and protect treated aspen to prevent ungulate grazing of the new sprouts. Alternative D would burn approximately 210 acres fewer habitats on the Coconino NF than the other action alternatives (Table 203). Snag and burning requirements that are described in the ponderosa pine section would also apply to aspen treatments. APIF designated one species to represent aspen habitat. Currently there is very little aspen regeneration and the overstory is dying or compromised by a variety of factors, including competition with conifers. All action alternatives would stimulate aspen growth and protect ramets from browsing, creating multi-storied conditions over time. The risk of habitat loss from large-scale, high-severity fire would decrease after treatment. Unintentional take is expected to be minimized through the application of breeding season timing restrictions in PACs and PFAs, deferral areas, and other design features described above.

## Pinyon-Juniper Habitat

Table 204 displays by alternative how much treatment will occur within the pinyon-juniper habitat. Treatment data is from silvicultural analysis for the project (Silviculture report).

**Table 204. Pinyon-juniper treatment acres by alternative**

| Alternative | Mechanical thinning & burning | Burning Only | No Treatment |
|---|---|---|---|
| B | 535 | 25,117 | 6 |
| C | 535 | 25,123 | 0 |
| D | 535 | 24,850 | 273 |
| E | 535 | 25,117 | 6 |

The all four action alternatives would include various levels of prescribed burning within pinyon-juniper that are within the burn units for ponderosa pine. The burn objective in pinyon-juniper is simply to facilitate meeting burn prescriptions in ponderosa pine. These operational burns would allow the fire to pass through the pinyon-juniper to reach ponderosa pine that would otherwise require building firelines or not be available for burning. The alternatives would also mechanically thin and burn 535 acres of pinyon-juniper in the wildlife-urban interface on the Tusayan Ranger District (RU 6). All alternatives would leave approximately 67 percent (15,626 acres) of the acreage in old growth pinyon-juniper (silviculture report). However, the thinning and burning in the pinyon-juniper would open up the canopy and provide potential for understory plant development (appendix 6). Alternative D would treat the least amount of acres. Burning requirements described in the ponderosa pine section would also apply for pinyon-juniper treatments. Management objectives include retaining one snag per acre across 75 percent of the area (forest plan direction calls for one snag per acre over 50 percent of the area). APIF and/or the FWS designated five different species of bird to represent pinyon juniper habitat. Long-term benefits would include increasing understory development, managing for snag retention, and increasing habitat heterogeneity. Habitat in the wildlife-urban interface would have decreased effectiveness. Areas with currently dense conditions would be more open, leading to mixed long-term results for juniper titmice. Unintentional take is expected to be minimized through the application of breeding season timing restrictions in PFAs, deferral areas, and other design features described above.

## High Elevation Grassland Habitat

Table 205 displays how much treatment will occur within the grassland habitat by alternative. Treatment data is from the project silvicultural analysis (Silviculture report).

**Table 205. High elevation grassland treatment acres by alternative**

| Alternative | Mechanical thinning & burning | Burning Only | No Treatment |
|---|---|---|---|
| B | 0 | 48,423 | 281 |
| C | 48,195 | 488 | 20 |
| D | 0 | 48,219 | 412 |
| E | 47,915 | 488 | 301 |

Alternatives B and D would burn approximately 48,400 acres of grasslands on both forests. The burning would restore disturbances that work to maintain grasslands, meadows, and savannas. Low-severity prescribed fire is expected to increase growth and diversity of herbaceous vegetation, which would provide increased forage in the long term. Expected benefits could occur as soon as one to two years following prescribed fire. However, most post-settlement trees would likely remain after grassland burn prescriptions. Burning from April 15 – June 15 will be avoided in known pronghorn fawning areas to prevent impacts to young, less-mobile fawns.

Alternative C would mechanically remove encroaching conifers and burn 48,196 acres and treat 579 acres with burn-only prescriptions across both forests. This would invigorate productivity of grasses and forbs. Herbaceous productivity, including grass, forb, and shrub species diversity is expected to increase within 1-2 years post-treatment. Thinning and burning from April 15 – June 15 will be avoided in known pronghorn fawning areas to prevent impacts to young, less-mobile fawns.

Alternatives C and E would mechanically remove encroaching conifers and burn approximately 48,000 acres and treat 488 acres with prescribed fire-only prescriptions across both forests. This would invigorate productivity of grasses and forbs. Herbaceous productivity, including grass, forb, and shrub species diversity is expected to increase within 1-2 years post-treatment. Thinning and burning from April 15 – June 15 would be avoided in known pronghorn fawning areas to prevent impacts to young, less-mobile fawns.

Habitat loss and fragmentation for grassland species has been an on-going issue both nationally and locally (see Affected Environment  Vegetation Cover Types  Grasslands, Savannas, and Meadows above). Encroachment of this habitat has been a direct result of fire suppression in the 4FRI treatment area. Implementing the action alternatives, especially alternative C, would not only improve habitat effectiveness, but also increase overall acres of habitat. Unintentional take is expected to be minimized through the application of deferral areas, and other design features described above.

## Species-Specific Effects

Effects of these actions on priority species of migratory birds are presented in Table 206

**Table 206. Migratory bird species and their associated habitats likely to be affected by the action alternatives**

| PIF High Priority Species and FWS BCC | Projected Changes Likely to Affect Species |
|---|---|
| **Ponderosa Pine Forest** | |
| Northern Goshawk | Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings. Long-term effects would include improvements to goshawk habitat and decrease risk of habitat loss to high-severity fire (sensitive species write-up). |
| Flammulated Owl | Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings.<br>The four action alternatives would, for the most part, retain snags greater than 12 inch. Snags within a distance twice their height from private land boundaries or along key road or snags that may causes problems with human health and safety may be removed.<br>If snag removal occurs during thinning or burning operations in the nesting season, there is a potential for unintentional take of young of the year.<br>Only a small percentage of snags would be removed and, of the snags removed, only a small percentage would likely have active nest sites. The removal of any eggs or fledglings would not result in a measurable negative effect to the flammulated owl population from any of the four action alternatives. |
| Olive-sided Flycatcher | Presettlement trees would rarely be removed during treatments. The Old Tree Implementation Plans would ensure mature trees are generally retained. Alternative D would burn approximately 20,000 less acres which would reduce smoke and so presumably the risk of unintentional take from fire. However, this would reduce the benefits to foraging and singing habitat.<br>Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability to or injury or death to nestlings. Unintentional take of eggs or nestlings is possible from the loss of mature pine trees removed during the nesting season. Because of the desired conditions post-treatment, not many mature trees are expected to be cut and only a small fraction of mature trees actually support olive-sided flycatcher nests. The loss of any eggs or fledglings would not result in a measurable negative effect to the olive-sided flycatcher population from any of the four action alternatives. |

| PIF High Priority Species and FWS BCC | Projected Changes Likely to Affect Species |
|---|---|
| Cordilleran Flycatcher | Thinning, snag removal, and burning during the breeding season could potentially kill nestlings. Alternative D would have approximately 20,000 acres of less burning and could have less of impact than the other action alternatives.<br>The four action alternatives would, for the most part, retain all snags greater than 12 inch. Snags within a distance twice their height from private land boundaries or along key road or snags that may causes problems with human health and safety may be removed.<br>Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings, but no measurable negative effect to the Cordilleran flycatcher population would be expected from any of the four action alternatives. It would be rare for snags to be removed. All four action alternatives will maintain late-successional forest habitat and all would move forests toward mature conditions. Live mature trees would not be targeted for removal during treatments except in rare circumstances. |
| Grace's Warbler | Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings.<br>Presettlement trees would rarely be removed during treatments and mature trees will generally be retained. Alternative D would burn approximately 20,000 less acres which would reduce smoke, the risk of unintentional take from fire. However, this would reduce the benefits to foraging and singing habitat structure.<br>Unintentional take of eggs or nestlings is possible from the loss of mature pine trees removed during the nesting season. Because of the desired conditions post-treatment, not many mature trees are expected to be cut and only a small fraction of mature trees actually support olive-sided flycatcher nests. The loss of any eggs or fledgling would not result in a measurable negative effect to the olive-sided flycatcher population from any of the four action alternatives. |
| Lewis's Woodpecker | Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings.<br>This species is primary associated with pine savanna habitat. Alternatives B, C and D would restore acres of former and current pine savanna. The alternatives would retain pre-settlement trees and largest post settlement trees that most closely resemble old trees in size and form as replacement trees adjacent to pre-settlement tree evidences. If a nest tree is removed during the breeding season, there is the potential for unintentional take of eggs or nestlings. However, none of these alternatives would be expected to result in a measurable negative effect to the Lewis' woodpecker population. Alternative E does not have savanna treatments and so would accomplish less habitat improvement. |
| Purple Martin | Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings.<br>This species is primary associated with pine savanna habitat. Alternatives B, C and D would restore approximately 45,500 acres of former and current pine savanna habitat. Pre-settlement trees would be retained and the largest post settlement trees that most closely resemble old trees in size and form would be left as replacement trees near pre-settlement evidences. If a nest tree is removed during the breeding season, there is the potential for loss of eggs or nestlings. Snags will be maintained according to the vegetation design features.<br>Unintentional take of eggs or nestlings would not result in a measurable negative effect to the purple martin population in any of theses alternatives. Alternative E does not have savanna treatments and so would accomplish less habitat improvement. |

| PIF High Priority Species and FWS BCC | Projected Changes Likely to Affect Species |
|---|---|
| Cassin's Finch | Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings.<br>All four alternatives would help improve Cassin's finch habitat by reestablishing the groupy and open coniferous forests. Live mature trees would not be targeted for removal except in very specific circumstances. However, if a nest tree were removed during the nesting season, there would be potential for killing young of year.<br>There would be no measurable negative effect to the Cassin's finch population from any of the four action alternatives. Most of the project area is considered to be wintering habitat only for the species. It would be rare for a large mature pine tree to be removed and even rarer for trees with active nests to be impacted. Unintentional take of eggs or nestlings would not result in a measurable negative effect to the Cassin's finch population with any of the four action alternatives. |
| **Aspen** | |
| Red-naped sapsucker | Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings.<br>The mechanical removal of ponderosa pine trees from aspen clones, scarification, and prescribed fire would help maintain older aspen being lost to conifer encroachment and stimulate regeneration. Barriers would allow growth of ramets. Overall, clones would be more resilient to weather extremes.<br>The project occurs within four percent of the aspen occurring on both forests. There could be loss of large aspen and snags during the thinning of ponderosa pine trees and burning within aspen clones. If nest trees were removed during the nesting season, there is potential for destroying eggs or killing nestlings. Unintentional take of eggs or nestlings would not result in a measurable negative effect to the Cassin's finch population with any of the four action alternatives because of the limited amount of habitat affected and likelihood of removal of a nest tree. |
| Pinyon-Juniper Woodland | |
| Gray Vireo | The project only occurs within less than 1 percent of the pinyon-juniper that occurs across both forests. All action alternatives would open up the canopy and allow development of understory plants, improving prey habitat and nesting habitat. However, mechanical treatment and burning could destroy nests if these act ivies occurred during breeding season and short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings. Not all treatments would occur during the breeding season. Unintentional take of eggs or nestlings would not result in a measurable negative effect to the gray vireo population from any of the four action alternatives. |
| Pinyon Jay | The project occurs within less than 1 percent of the pinyon-juniper that occurs across both forests. Most large trees would not be removed and 67 percent of the area would be managed for late seral habitat, benefiting nesting and prey habitat. However, mechanical treatment and burning could destroy nests if these act ivies occurred during breeding season and short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings. Not all treatments would occur during the breeding season. Unintentional take of eggs or nestlings would not result in a measurable negative effect to the pinyon jay population from any of the four action alternatives. |

| PIF High Priority Species and FWS BCC | Projected Changes Likely to Affect Species |
|---|---|
| Juniper Titmouse | The project occurs within less than 1 percent of the pinyon-juniper that occurs over both forests. Most large trees would not be removed and 67 percent of the area would be managed for late seral habitat, benefiting foraging and nesting habitat. However, mechanical treatment and burning could destroy nests if these act ivies occurred during breeding season and short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings. Not all treatments would occur during the breeding season. Unintentional take of eggs or nestlings would not result in a measurable negative effect to the juniper titmouse population from any of the four action alternatives. |
| Black-throated Gray Warbler | The project occurs within less than 1 percent of the pinyon-juniper that occurs over both forests. All four action alternatives would open up the canopy and allow development of understory plants. Most large trees would not be removed and 67 percent of the area would be managed for late seral habitat, improving nesting and foraging habitat. However, mechanical treatment and burning could destroy nests if these act ivies occurred during breeding season and short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings. Not all treatments would occur during the breeding season. Unintentional take of eggs or nestlings would not result in a measurable negative effect to the black-throated gray warbler population from any of the four action alternatives. |
| Gray Flycatcher | The project occurs within less than 1 percent of the pinyon-juniper that occurs over both forests. All four action alternatives would open up the canopy and allow the development of understory plants. Most large trees would not be removed and 67 percent of the area would be managed for late seral habitat. This combination would benefit foraging and nesting habitat. However, mechanical treatment and burning could destroy nests if these act ivies occurred during breeding season and short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings. Not all treatments would occur during the breeding season. Unintentional take of eggs or nestlings would not result in a measurable negative effect to the gray flycatcher population from any of the four action alternatives. |
| **High Elevation Grasslands** | |
| Swainson’s Hawk | Alternatives B, C and D would burn in most of the grasslands and savanna treatments within the treatment area, while alternative E would not have the savanna treatments and so would accomplish less habitat improvement. Treatments would improve foraging habitat for the Swainson’s hawk. Alternatives C and E would mechanically remove post-settlement trees from grasslands, potentially improving nesting habitat. Known nest trees would be protected. All alternatives would protect nests form disturbance during the breeding season. Unintentional take of eggs or nestlings would only occur if nests were not detected during harvest operations and short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings. Overall, project activities would not result in a measurable negative effect to the Swainson’s hawk population from any of the action alternatives. |

| PIF High Priority Species and FWS BCC | Projected Changes Likely to Affect Species |
|---|---|
| Ferruginous Hawk | Alternatives B, C and D would burn in most of the grasslands and savanna treatments within the treatment area. Alternative E would not have the savanna treatments and so would accomplish less habitat improvement. Treatments would improve foraging habitat for the ferruginous hawk. Alternatives C and E would mechanically remove post-settlement trees from grasslands, potentially improving nesting habitat, and nest trees would be protected. All alternatives would protect known nests form disturbance during the breeding season. Ferruginous hawks can nest on the ground, in low vegetation, and in trees. Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings. However, ferruginous hawks nest in a fairly narrow range of elevations in northern Arizona and have not been detected above 6,400 feet elevation (Corman and Wise-Gervais 2005). Over 99 percent of all treatments would occur at 6,500 feet elevation or higher, hence unintentional take of ferruginous hawks could occur but is unlikely under all of the action alternatives. |
| Burrowing Owl | Because burrowing owls nest below ground, there would be no measureable short-term effects from noise or smoke disturbance. Long-term effects to the burrowing owl population would be positive as a result of habitat improvement. Alternative E would not have the savanna treatments and so would accomplish less habitat improvement. |
| Grasshopper Sparrow | Alternatives B, C and D would burn in most of the grasslands and savanna treatments within the treatment area. Alternative E would not have the savanna treatments and so would accomplish less habitat improvement. Burning would improve nesting and foraging habitat in the long-term. Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings.<br>The mechanical treatments in grasslands under alternatives C and E could result in unintentional take of eggs and nestlings through trampling of nests. Unintentional take of eggs and nestlings could also occur from prescribed fire. The project occurs on a small percentage of the sparrows range and not all treatments would occur during the breeding season. The removal of any eggs or fledgling would not result in a measurable negative effect to the grasshopper sparrow population from any of the four action alternatives. |
| Bendire's Thrasher | Alternatives B, C and D would burn in most of the grasslands and savanna treatments within the treatment area. Alternative E would not have the savanna treatments and so would accomplish less habitat improvement. Burning would improve nesting and foraging habitat in the long-term. Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings.<br>The mechanical treatments in grasslands under alternatives C and D could result in unintentional take of eggs and nestlings through trampling of nests. Unintentional take of eggs and nestlings could also occur from prescribed fire. The project occurs on a small percentage of the sparrows range and not all treatments would occur during the breeding season. The removal of any eggs or fledgling would not result in a measurable negative effect to the Bendire's thrasher population from any of the four action alternatives. |

## Important Bird Area

Most of the major vegetation cover types within the Anderson Mesa IBA would be affected by action alternatives (Table 207). However, only alternative C addresses conifer encroachment in grassland habitat. While most of the acres treated are within ponderosa pine habitat, treatments will 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 alternatives.

**Table 207. Treatments by acreage and habitat type**

| Treatments | Alternative B | Alternative C | Alternative D | Alternative E |
|---|---|---|---|---|
| Ponderosa pine mechanical/burning | 26,908 | 26,909 | 26,909 | 30,097 |
| Ponderosa pine Burn only | 2,656 | 2,878 | 1,521 | 8,414 |
| Ponderosa pine Grassland restoration | 954 | 954 | 954 | 0 |
| Ponderosa Pine Savanna | 7,770 | 7,770 | 7,770 | 0 |
| Aspen Burn only | 10 | 7 | 10 | 7 |
| Pinyon-juniper Operational burn | 476 | 476 | 455 | 476 |
| Grassland Burn Only | 4,694 | 0 | 4,694 | 0 |
| Grassland Conifer removal/ burning | 0 | 4,696 | 0 | 4,696 |
| Oak woodland Operational burn | 173 | 173 | 173 | 173 |
| **Total acres** | **43,641** | **43,863** | **42,486** | **43,641** |

Wildlife design features will help mitigate impacts from treatments and hauling harvested materials from other treatment areas and include:

- Bald eagle winter concentration areas, retain the tallest snags greater than 18 inch d.b.h.
- No vegetation treatments would occur within a ½ mile (2,500 feet), unless mitigated by topography, of an occupied bald or golden eagle nest between March 1 and August 31. Other project activities will be assessed by the district biologist and limited activities may be acceptable.
- No mechanical treatments will occur around confirmed bald eagle roost sites (300’ radius around roosts on the Coconino NF).
- No project activities will occur within 500 feet of confirmed bald eagle communal roosts from October 15 – April 15.
- Raptor nests located during project surveys will be monitored prior to project activities. Known nest trees for any raptor species would be prepped prior to prescribed fire. Buffers will be provided if nests are active:
    - ♦ Sharp-shinned hawk = no mechanical treatment buffer of 10 acres around occupied nests;
    - ♦ Cooper’s hawk = no mechanical treatment buffer of 15 acres around occupied nests;
    - ♦ Osprey = no mechanical treatment buffer of 20 acres around nest sites (occupied or unoccupied) and all logging activities will be restricted within ¼ mile of active nests from March 1 to August 15;
    - ♦ Other raptors = 50 feet around occupied nest.
- Great blue herons: No dominant or co-dominant trees will be cut in rookeries. Known sites will be prepped prior to prescribed fire and fire ignition mitigations will apply. Timing will

avoid mechanical tree harvest while birds are in the nest. Activities will be coordinated with the local biologist.

Overall, treatment objectives are to help restore forests to their historical range of variation. Grassland restoration will move areas dominated by ponderosa pine back to a grassland state. The objectives are similar for savannas, although more tree cover would be retained in these treatments. Pinyon-juniper and oak woodland surrounded by ponderosa pine would be allowed to burn so that fire carries into the associated ponderosa pine forest and avoid constructing additional firelines. Burn prescriptions are for low to moderate severity fire. Alternatives B and D include burn-only treatments in grasslands. Alternatives C and E would mechanically remove encroaching conifers as well as prescribe burn grasslands.

Overall, project treatments including road decommissioning and spring and stream channel restoration will help restore the area to more natural conditions. This should improve habitat conditions for all bird species that use the project area. There could be some limited impacts to species due to activities that might occur during the breeding season. Since only a small amount of pinyon juniper is being treated it not likely to have much effect on species associated with this habitat and would not affect local populations. Most wetland birds would be unaffected because wetland habitat is not proposed for treatment. It is expected that the habitats for which the IBA was established will benefit from the proposed treatments.

## 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. 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. Cumulative effects discussed 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 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 has occurred. Past, present and reasonably foreseeable activities are listed appendix 17. 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 right of ways (ROW) 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, 30-40 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.

### *Alternative A*

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).

Aspen restoration is proposed for areas that are a high priority for restoration on both forests. These treatments would yield limited improvements for the red-naped sapsucker in the short term, but should improve about 5,200 acres of habitat 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 proposed for treatment 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 an effect to any species because of the limited space and spatial configuration of this habitat. It would benefit some grassland species

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 more individuals of resident species may move out the 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 ongoing. Ranchers and conservation organizations are actively engaged through the Diablo Trust 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

PFAs and MSO PACs, which would reduce potential of loss for birds 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.

### *Action Alternatives*

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). Cumulatively there would be approximately 700,000 acres of ponderosa pine habitat treated within the cumutive effects analysis area.

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 effects would be similar as described above for alternative A.  However, cumulatively there would be approximately 800 miles of roads that are decommission that will reduce the opportunities for woodcutting along these roads at least on the Coconino NF where woodcutters are allowed to collect fuelwood on closed roads.

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 both cumulatively and within the proposed project.

ROW maintenance and development on private land would have the same impacts as described above in alternative A.

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. as described in alternative A. The proposed project would treat between 42,486 to 43,863 acres of habitat within the IBA.  This would cumulatively improve habitat condition within a broader area of the IBA.

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 MSO 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.

# Forest Plan Compliance:
# Rare and Narrow Endemic Species

The Kaibab forest plan directs the protection of rare and narrow endemic species. For the 4FRI project this includes the California condor and Arizona black rattlesnakes. The California condor is discussed in the Affected Environment section.

Project design features were developed for the Arizona black rattlesnake that would protect and key habitat and provide protection for the species if it occurs in the treatment area (see Design Features. Best Management Practices and Mitigation). District biologists will review task orders to determine if existing den sites or potential habitat for den sites occur within the task order area and determine which mitigations should be implemented. The project could affect individual animals. Snakes could be hit by vehicles associated with the project implementation. Activities related to implementation could disturb individuals or interfere with hunting. However, overall there would not be a measurable negative effect to the population. Long-term habitat improvements would include improved prey habitat and a decrease in potential disturbance resulting from road decommissioning.

Disturbance of individual bears could occur, but little short-term effects are expected. Long-term effects would include improved habitat by creating openings and increased habitat effectiveness related to decommissioning 860 miles of roads. Forest habitat would have a decreased risk of large-scale, high-severity fire.

## Forest Plan Compliance - Hiding and Thermal Cover

Coconino forest plan direct 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 for details) indicate the existing landscape is dominated by cover. RU summaries are presented below to facilitate discussion (Table 208, Table 209, Table 210, and Table 211); subunit summaries are included in appendix 5. The column Hiding/Thermal cover indicates areas that meet the definitions for both cover types. RUs commonly support 30 to 45 percent hiding cover and 35 to 55 percent combined hiding and thermal cover. Exceptions include: RU 3 (pine-oak is high in thermal cover); and RU 5 (pure pine is low in both hiding and thermal cover – while there is enough cover currently to meet forest plan standards 63 percent of the area does not meeting either), and Restoration Unit 6 (high in hiding cover due to presence of sagebrush). Cover continues to increase through time and the percent of the area that provides no cover approaches zero by the year 2050 under alternative A.

**Table 208. Only hiding (HC), only thermal cover (TC), both hiding and thermal cover (Both), and neither form of cover (No) across the 4FRI treatment area by restoration unit (RU) in Alternative A**

| | | 2010 Percent Hiding/Thermal | | | | 2020 Percent Hiding/Thermal | | | | 2050 Percent Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RU | Acres | HC | Both | TC | No | HC | Both | TC | No | HC | Both | TC | No |
| Pine-oak | 85,482 | 44 | 55 | 0 | 1 | 40 | 57 | 3 | 0 | 4 | 81 | 15 | 0 |
| 1 | 61,231 | 45 | 55 | 0 | 0 | 39 | 57 | 3 | 0 | 4 | 79 | 17 | 0 |
| 3 | 21,678 | 41 | 58 | 0 | 0 | 40 | 56 | 4 | 0 | 1 | 90 | 9 | 0 |
| 4 | 547 | 47 | 53 | 0 | 0 | 27 | 67 | 6 | 0 | 0 | 80 | 20 | 0 |
| 5 | 2,026 | 47 | 46 | 0 | 7 | 49 | 43 | 7 | 0 | 14 | 52 | 33 | 0 |
| Pine | 237,289 | 30 | 33 | 7 | 30 | 36 | 43 | 18 | 3 | 10 | 43 | 47 | 0 |
| 1 | 84,562 | 38 | 36 | 7 | 19 | 41 | 45 | 9 | 5 | 10 | 51 | 39 | 0 |
| 3 | 36,649 | 32 | 53 | 5 | 10 | 34 | 54 | 8 | 3 | 8 | 61 | 32 | 0 |
| 4 | 56,434 | 31 | 37 | 9 | 23 | 35 | 48 | 13 | 4 | 10 | 41 | 49 | 0 |
| 5 | 59,644 | 17 | 13 | 7 | 63 | 30 | 29 | 40 | 1 | 14 | 21 | 65 | 0 |
| **Total** | **322,771** | **39** | **37** | **5** | **19** | **39** | **47** | **11** | **4** | **11** | **56** | **32** | **0** |

**Table 209. Only hiding (HC), only thermal cover (TC), both hiding and thermal cover (Both), and neither form of cover (No) across the 4FRI treatment area by restoration unit (RU) in Alternative B**

| | | 2010 Percent Hiding/Thermal | | | | 2020 Percent Hiding/Thermal | | | | 2050 Percent Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RU | Acres | HC | Both | TC | No | HC | Both | TC | No | HC | Both | TC | No |
| Pine-oak | 85,482 | 44 | 55 | 0 | 1 | 33 | 54 | 5 | 8 | 7 | 67 | 18 | 8 |
| 1 | 61,231 | 45 | 55 | 0 | 0 | 34 | 54 | 5 | 7 | 8 | 65 | 20 | 7 |
| 3 | 21,678 | 41 | 58 | 0 | 0 | 32 | 54 | 4 | 10 | 6 | 75 | 9 | 10 |
| 4 | 547 | 47 | 53 | 0 | 0 | 34 | 55 | 6 | 5 | 0 | 75 | 20 | 5 |
| 5 | 2,026 | 47 | 46 | 0 | 7 | 38 | 50 | 7 | 5 | 13 | 49 | 33 | 5 |
| Pine | 237,289 | 30 | 33 | 7 | 30 | 16 | 20 | 16 | 48 | 1 | 21 | 36 | 42 |
| 1 | 84,562 | 38 | 36 | 7 | 19 | 10 | 16 | 16 | 58 | 1 | 15 | 34 | 49 |
| 3 | 36,649 | 32 | 53 | 5 | 10 | 14 | 24 | 14 | 48 | 0 | 22 | 37 | 41 |
| 4 | 56,434 | 31 | 37 | 9 | 23 | 14 | 21 | 14 | 51 | 1 | 20 | 36 | 44 |
| 5 | 59,644 | 17 | 13 | 7 | 63 | 27 | 24 | 17 | 32 | 0 | 29 | 40 | 31 |
| **Total** | **322,771** | **39** | **37** | **5** | **19** | **25** | **26** | **9** | **40** | **6** | **35** | **26** | **33** |

**Table 210. Only hiding (HC), only thermal cover (TC), both hiding and thermal cover (Both), and neither form of cover (No) across the 4FRI treatment area by restoration unit (RU) in Alternative C**

| RU | Acres | 2010 Percent Hiding/Thermal | | | | 2020 Percent Hiding/Thermal | | | | 2050 Percent Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HC | Both | TC | No | HC | Both | TC | No | HC | Both | TC | No |
| Pine-Oak | 85,482 | 44 | 55 | 0 | 1 | 36 | 51 | 5 | 7 | 9 | 65 | 19 | 7 |
| 1 | 61,231 | 45 | 55 | 0 | 0 | 36 | 51 | 6 | 7 | 10 | 62 | 21 | 7 |
| 3 | 21,678 | 41 | 58 | 0 | 0 | 34 | 52 | 4 | 10 | 7 | 73 | 10 | 10 |
| 4 | 547 | 47 | 53 | 0 | 0 | 34 | 55 | 6 | 5 | 0 | 75 | 20 | 5 |
| 5 | 2,026 | 47 | 46 | 0 | 7 | 38 | 50 | 7 | 5 | 13 | 49 | 33 | 5 |
| Pine | 237,289 | 30 | 33 | 7 | 30 | 15 | 21 | 16 | 48 | 0 | 22 | 37 | 42 |
| 1 | 84,562 | 38 | 36 | 7 | 19 | 9 | 16 | 16 | 59 | 0 | 15 | 34 | 51 |
| 3 | 36,649 | 32 | 53 | 5 | 10 | 13 | 27 | 14 | 45 | 0 | 24 | 38 | 39 |
| 4 | 56,434 | 31 | 37 | 9 | 23 | 14 | 23 | 14 | 49 | 0 | 21 | 36 | 42 |
| 5 | 59,644 | 17 | 13 | 7 | 63 | 27 | 24 | 17 | 32 | 0 | 29 | 40 | 31 |
| **Total** | **322,178** | **39** | **37** | **5** | **19** | **23** | **26** | **9** | **42** | **5** | **35** | **26** | **34** |

**Table 211. Only hiding (HC), only thermal cover (TC), both hiding and thermal cover (Both), and neither form of cover (No) across the 4FRI treatment area by restoration unit (RU) in Alternative D**

| RU | Acres | 2010 Percent Hiding/Thermal | | | | 2020 Percent Hiding/Thermal | | | | 2050 Percent Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HC | Both | TC | No | HC | Both | TC | No | HC | Both | TC | No |
| Pine-Oak | 85,482 | 44 | 55 | 0 | 1 | 32 | 56 | 5 | 8 | 9 | 66 | 18 | 8 |
| 1 | 61,231 | 45 | 55 | 0 | 0 | 33 | 56 | 5 | 7 | 9 | 64 | 20 | 7 |
| 3 | 21,678 | 41 | 58 | 0 | 0 | 29 | 57 | 4 | 10 | 7 | 73 | 9 | 10 |
| 4 | 547 | 47 | 53 | 0 | 0 | 24 | 66 | 6 | 5 | 3 | 72 | 20 | 5 |
| 5 | 2,026 | 47 | 46 | 0 | 7 | 42 | 46 | 7 | 5 | 17 | 45 | 33 | 5 |
| Pine | 237,289 | 30 | 33 | 7 | 30 | 22 | 22 | 14 | 41 | 7 | 20 | 34 | 39 |
| 1 | 84,562 | 38 | 36 | 7 | 19 | 21 | 19 | 13 | 47 | 12 | 15 | 30 | 43 |
| 3 | 36,649 | 32 | 53 | 5 | 10 | 18 | 25 | 16 | 41 | 5 | 22 | 34 | 39 |
| 4 | 56,434 | 31 | 37 | 9 | 23 | 19 | 23 | 13 | 44 | 6 | 18 | 35 | 41 |
| 5 | 59,644 | 17 | 13 | 7 | 63 | 28 | 26 | 16 | 31 | 1 | 28 | 40 | 30 |
| **Total** | **322,178** | **39** | **37** | **5** | **19** | **29** | **28** | **8** | **34** | **11** | **34** | **24** | **31** |

The action alternatives reduce hiding cover through the thinning and opening of current forest conditions. Results are similar between alternatives overall. RUs 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 towards 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.

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