# 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 conditions, and effects analysis for threatened, endangered and proposed species and critical habitat listed under the Endangered Species Act of 1973, as amended, Region 3 Sensitive Species, Management Indicator Species, and Migratory Birds and their habitats within the Four-Forest Restoration Initiative (4FRI) Coconino and Kaibab National Forest (NF) project area. Regulatory requirements for effects analysis and determinations have been met using the best available science and professional judgment. Best available science and methodology used for the wildlife analysis is described in this report by species and/or species assemblage.

The objective of this analysis is to reestablish forest structure, pattern, and composition, which will lead to increased forest resiliency and function. Resiliency increases the ability of the ponderosa pine forest to survive natural disturbances such as insect and disease, fire, and climate change (FSM 2020.5). This project is expected to put the project area on a trajectory towards comprehensive, landscape-scale restoration with benefits that include improved vegetation biodiversity, wildlife habitat, soil productivity, and watershed function.

The detailed description of the alternatives as well as the analysis for each proposed restoration action is described in the Silviculture Specialist Report and Fire Ecology Specialist Report. This report incorporates these reports by reference and includes a less detailed description of the alternatives for effects analysis.

## Project Area Location and Description

The Forest Service assessed a 988,764 acre project 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 587,923 acres on the Coconino NF and Kaibab NF. About 356,115 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 231,809 acres of treatment would occur on the Williams and Tusayan Ranger Districts of the Kaibab NF (Figure 1).

Within the 988,764 acre project area, approximately 380,000 acres have been excluded from this proposal. Over 204, 957 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 project 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.

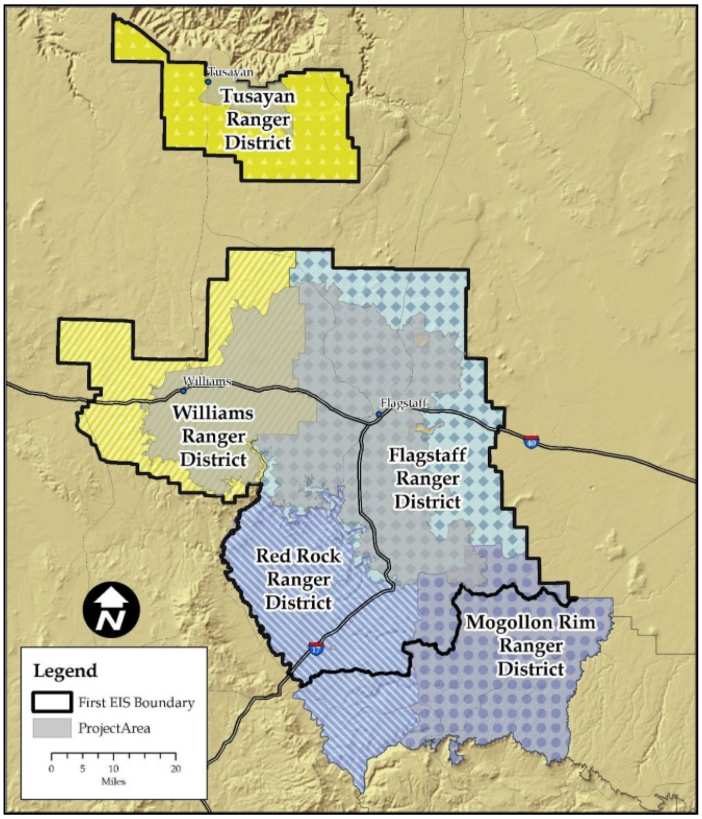



**Figure 1. Coconino NF and Kaibab NF Ranger Districts Within the Project Area**

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).

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. Additional details on vegetation within the project area, the stratification of forested and non-forested land within the project area and analysis area for each species is described on pages 34 to 42. The desired condition is to restore tree density and pattern to the natural range of variability, while meeting forest plan requirements, as amended, for Mexican spotted owl (MSO) protected and restricted habitat and goshawk nest stands. 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.

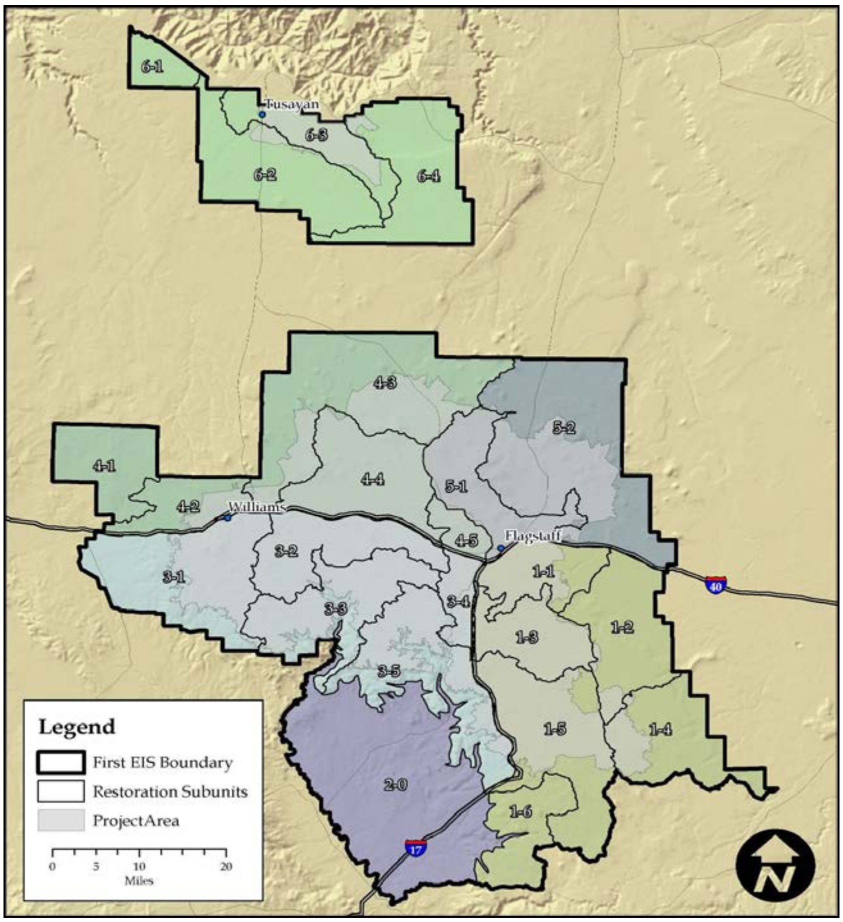



**Figure 2. Restoration Units (1st digit in number codes) sub-units (second digit in number codes) within the project area**

# 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 (Eagle Act), 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 1988, 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 Fish and Wildlife Service (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.

### 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 C.F.R. § 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).

### 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)). 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). Key policies regarding sensitive species are 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, 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 U.S. Fish and Wildlife Service and Arizona State (FSM 2670.32).

### 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). Forest-wide assessments summarize current knowledge of population and habitat trends for management indicator species on both the Coconino (USDA Forest Service 2002) and Kaibab (USDA Forest Service 2010) NFs. Additional site specific (Game Management Unit) population information was provided by Arizona Game and Fish Department with their annual survey results.

### Migratory Bird Treaty Act (MBTA)

Migratory Bird Treaty Act (as amended 1998) implements Conventions between the United States and four neighboring countries (Canada, Mexico, Japan, and Russia) for the protection of migratory birds and has specific provisions in the statute that includes: Establishment of a Federal prohibition, unless permitted by regulations, to "pursue, hunt, take, capture, kill, attempt to take, capture or kill, possess, offer for sale, sell, offer to purchase, purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported, carry, or cause to be carried by any means whatever, receive for shipment, transportation or carriage, or export, at any time, or in any manner, any migratory bird, included in the terms of this Convention . . . for the protection of migratory birds . . . or any part, nest, or egg of any such bird." (16 U.S.C. 703).

Executive Order (EO) 13186, signed January 10, 2001, imposes substantive obligations for the conservation of migratory birds and their habitats and through the Migratory Bird Treaty Act

(MBTA) lists several responsibilities of federal agencies to protect migratory birds and their resources. The EO defines ‘‘Take refers to injury or death of migratory birds and defined as meaning both ‘‘intentional’’ and ‘‘unintentional’’ take. ‘‘Intentional take’’ occurs as part of the purpose of the proposed activity in question. ‘‘Unintentional take’’ means take that results from, but is not the purpose of, the activity in question. ‘‘Migratory bird’’ means any bird listed in Title 50 of the Code of Federal Regulations § 10 sub-section 13. ‘‘Migratory bird resources’’ means migratory birds and the habitats upon which they depend. Federal actions should support the conservation intent of the migratory bird conventions by integrating bird conservation principles, measures, and practices into agency activities and by avoiding or minimizing, to the extent practicable, adverse impacts on migratory bird resources when conducting agency actions.

### Bald and Golden Eagle Protection Act (Eagle Act)

The 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);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 U.S. Fish and Wildlife Service (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 National Forest Plan (USDA 1987a, as amended 2011) and Kaibab National Forest Land Management Plan (USDA 1988, as amended 2011) determine standards and guidelines for snags and downed logs, wildlife cover, raptor nest buffers, old growth, turkey nesting and roosting habitat, and bear habitat. They also provide wildlife direction for other programs, including forest management, range management, recreation, etc. Both plans incorporate the Mexican Spotted Owl (MSO) Recovery Plan (USDI 1995) and Management Recommendations for the Northern Goshawk

(Reynolds et al. 1992). Because wildlife direction is interwoven throughout both forest plans, the large volume of text can be reviewed in Appendix 1.

# 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, forest-wide 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**, forest-wide **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 coarse woody debris (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 burning and its related disturbances have on **Threatened, Endangered and Forest Service Sensitive**, forest-wide **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**, forest-wide **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).

## 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 (see literature cited section and appendices), forest plan standards and guidelines (“Forest Plans,” page 8 above), 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).

### 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), restoration unit (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 burn 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 burn would be conducted). Long-term is 30 years post-treatment, 2050.

Details on modeling to evaluate fire risk and 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 Geographic Area (Kaibab NF) were used to help with analysis of effects to species' habitats.

## 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 1996 ROD amended forest plans in the southwest by incorporating 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, 1988).

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.

Protected areas include: protected activity centers (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.

**MSO 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 less specific 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 owl 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 in such a way as to mimic the natural landscape.

Protected Habitat consists of Protected Activity Centers (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. The primary objective for protected habitat is the protection of the best available habitat for MSOs while retaining management flexibility to address the risk of high severity fire and to improve habitat conditions for the owl and its prey. It was assumed that the best available owl habitat is currently or was recently (since 1989) occupied by MSOs.

PACs are at least 600 acres in size and should provide for nesting, roosting, and 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 most commonly found on steep slopes as a result of past management actions.

Management guidelines within restricted habitat are derived from principals of ecosystem management. The Recovery Team concluded that all lands do not require equal protection and that potential exists for owls to use unoccupied areas. The underlying objective in restricted habitat is to manage the landscape to maintain and create replacement MSO habitat where appropriate while providing a diversity of stand conditions and stand sizes across the landscape. Providing a continuous supply of nesting and roosting habitat requires maintaining stands in various stages of ecological succession. The landscape mosaic or mixture of habitat conditions resulting from such an allocation should ensure adequate nesting, roosting, and foraging habitat for the owl, and available habitat for the variety of MSO prey species. The guidelines for restricted habitat are intended to minimize threats to the MSO, retain and enhance important but difficult-to-replace habitat elements, and provide management flexibility.

Categories of restricted habitat include target and threshold habitat, which is based on certain identifiable features of nesting/roosting habitat, including high tree basal area, large trees, multi-storied canopy, high canopy cover, snags and downed logs. Values for these features are summarized in Table III.B.1 of the Recovery Plan (USDI FWS 1995:page 92) and represent targets to be achieved with time and management, but only for the portion of the landscape that can sustain those condition (e.g., south-facing slopes may be more suited to managing as foraging habitat). Treatment of a particular stand depends on its capability to attain the desired stand conditions. These habitat features also represent threshold conditions in that they define minimal levels that, once achieved, must be maintained. Management activities can occur within stands that exceed threshold conditions, but the outcome of such activities cannot lower the stands below threshold values unless a large-scale assessment indicates a surplus of such conditions across the landscape. Examples of why activities would occur in threshold stands include reducing the risk of undesirable fire effects and behavior, 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 desirable 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. Threshold values for all habitat features must be met simultaneously for a stand to meet threshold conditions. By definition (Table III.B.1), at least 10 percent of pine-oak habitat must meet threshold conditions before a surplus can exist. Target habitat should be managed to achieve threshold conditions as rapidly as possible.

**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 US Fish and Wildlife Service (“FWS”) and wildlife biologists from both National Forests, we reviewed restricted habitats in the greater 4FRI area. The area under consideration constituted the majority 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. Restricted habitat was primarily designated on the Flagstaff and Williams Ranger Districts (RDs), each of which represent the land base of two historic RDs later combined into today’s management configuration. Restricted habitat also included portions of the Mogollon Rim RD. 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.

To accomplish this effort, meetings were held among wildlife biologists from the FWS, both NFs, and members of the 4FRI team starting on March 4$^{th}$, 2011. 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 and 1996 ROD guidelines, we identified the best restricted habitat as target and threshold habitat across the 4FRI project area rather than looking at individual RDs or NFs. Although the Kaibab and Coconino NFs share a common border across much of the 4FRI project area, the pine-oak forest structure 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. Trees large enough for MSO nesting are uncommon on the Kaibab NF where Gambel 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 both NFs). PACs on the Kaibab NF either occur on the mountainous cinder cones or in canyons; While PACs on the Kaibab contain individual stands of pin-oak habitat, they principally consist of mixed-confier forest. In contract, MSO occupancy on the Coconino NF occurs in relatively large, contiguous patches of habitat. 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 associated with Bill Williams Mountain in 1994. Because of the marked difference between MSO occupancy between the NFs, we focused designation of target and threshold habitat on the Coconino NF where MSOs are common in pine-oak habitat.

To be sure to identify the best candidate stands as restricted habitat, data from the Kaibab and Coconino NFs (based on polygons) was 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). Existing or potential nesting and roosting habitat within this new layer was stratified with the following queries:

- Pine - oak 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 trees or greater than or equal to 10 BA based on oak at least five inches diameter or greater at root crown (drc)
- Percent of trees 12 to 18 inches dbh and trees greater than18 inches dbh
- At least 20 tpa 18 inches dbh or greater
- Stands with northerly aspects (assumed to be more sustainable), ranging from 292˚ to 67˚ (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 dbh and trees greater than24 inches dbh
- Oak 5-12" drc and oak greater than 12" drc.
- At least 20 percent BA for oak greater than five inches drc
- 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 generally identified stands with appropriate habitat structure. They 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: it was discovered that remotely-sensed data sometimes misidentified juniper as oak in the understory (this was a problem on the Williams RD near Sycamore Canyon); stands were adjacent to newly designated 300 foot parking areas for campers on the Coconino NF under the Travel Management Rule finalized in September, 2011; where 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 strategy in designating restricted habitat was to provide well distributed habitat that 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 forsest plans) and/or support landscape connectivity for MSOs. 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. However, small, scattered stands of isolated habitat in a matrix of non-MSO habitat would not be expected to support owls or provide connectivity and were dropped even if the above queries identified them as quality habitat, i.e., results from the above criteria was assessed in terms of ecological function in addition to meeting the query criteria.

Proximity to PAC habitat was also an evaluation criterion. We sought to augment PAC habitat by identifying nearby pine-oak stands as restricted habitat with the assumption that known or suspected owl use indicated high quality habitat. Areas ranging from the northwest to the southeast of PACs were also closely evaluated for inclusion as restricted habitat. 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, 2011as quality control.

Approximately 76,091 acres were designated as MSO restricted habitat within the project area (Table 1). 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 11.5 percent of available restricted habitat Only 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.

As described above, emphasis was placed on developing nesting and roosting habitat on the Coconino NF, which supports some of the highest numbers of owl pairs in the Region. In contrast, the Kaibab NF supports very few owl pairs. We made the assumption that this disparity in use by nesting MSO indicated better habitat conditions on the Coconino NF. This led us to the conclusion that creating more future nesting and roosting habitat on the Coconino NF would make better progress towards recovery. More importantly this process identified habitat capable of maintaining a population of MSOs and that could be sustained though time. Overall, 13 percent of the restricted layer (6,465 acres) was designated a target and threshold habitat on the Coconino NF and about 8 percent (2,247 acres) was designated as target and threshold habitat on the Kaibab NF. More importantly, this process identified habitat more likely to maintain a population of MSOs and that is more likely to be sustained through time.

**Table 1. Acres of Mexican Spotted Owl Habitat within the Treatment Area**

| | Cover Type Acres by Restoration Unit | | | | | |
|---|---|---|---|---|---|---|
| **MSO Habitat** | **RU 1** | **RU 3** | **RU 4** | **RU 5** | **RU 6** | **Total** |
| **Protected Habitat** | | | | | | |
| Protected Activity Center | 29,349 | 4,268 | 556 | 1,393 | 0 | 35,566 |
| Pine Oak >40% Slope | 648 | 239 | 3 | 0 | 0 | 889 |
| Total MSO Protected Acres: | 29,996 | 4,507 | 558 | 1,393 | 0 | 36,455 |
| **Restricted Habitat – Pine Oak** | | | | | | |
| Threshold | 873 | 1,104 | 0 | 0 | 0 | 1,977 |
| Target | 3,941 | 2,795 | 0 | 0 | 0 | 6,736 |
| Restricted Other | 26,421 | 38,748 | 1,575 | 634 | 0 | 67,378 |
| **Total MSO Restricted Acres:** | **31,234** | **42,648** | **1,575** | **634** | **0** | **76,091** |
| **Total MSO Habitat Acres** | **61,231** | **47,155** | **2,134** | **2,026** | **0** | **112,546** |

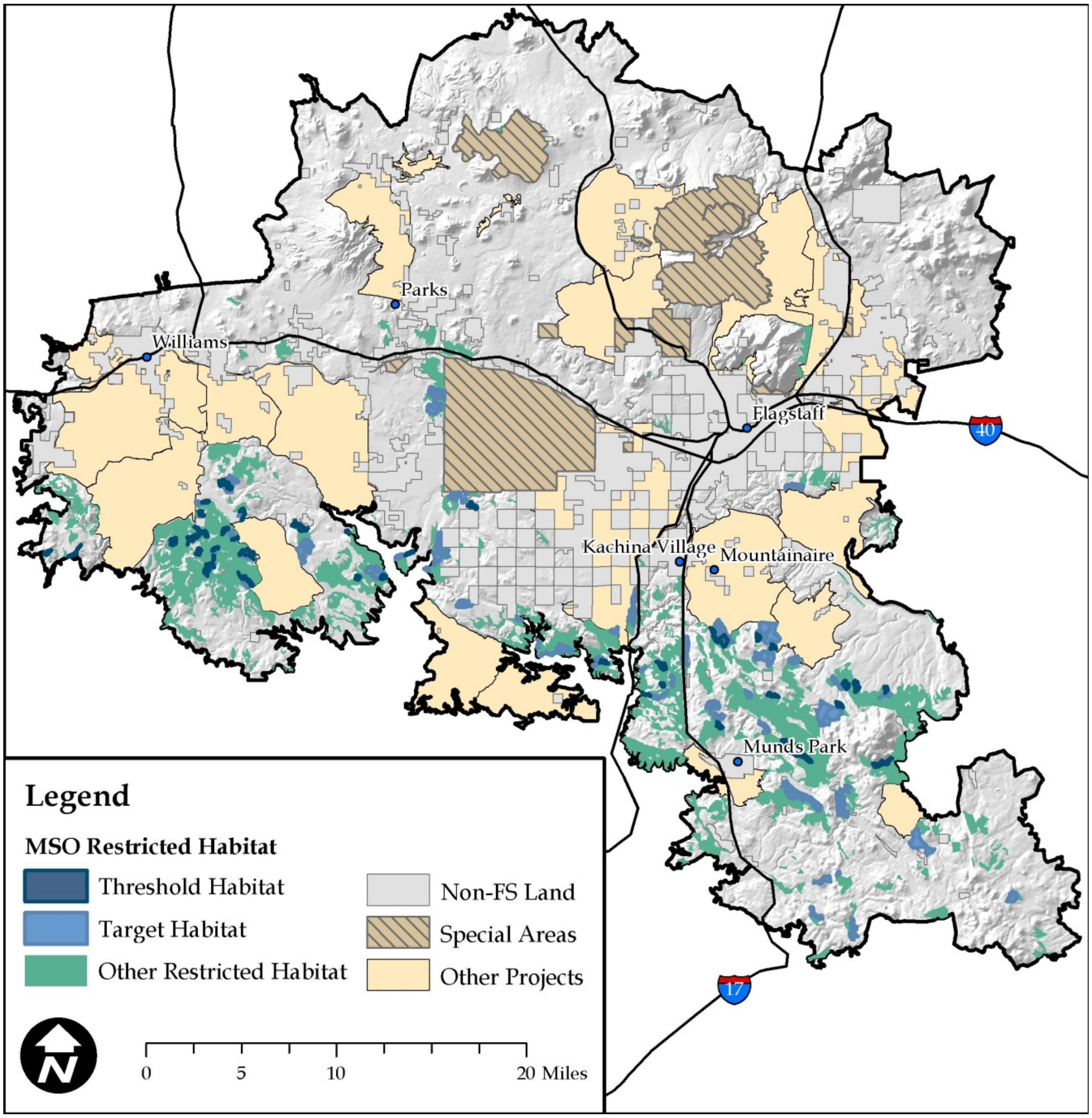



**Figure 3. Resricted Habitat for the 4FRI Treatment Area**

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 (i.e., existing nesting and roosting habitat would be maintained).

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). Eighteen of 117 PACs (15 percent) were recommended for potential mechanical treatments. Prescribed burning was recommended for all PACs that were evaluated, including core areas.

This analysis was followed by field visits to a subset of PACs proposed for treatment (Appendix 2). 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 35,566 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).

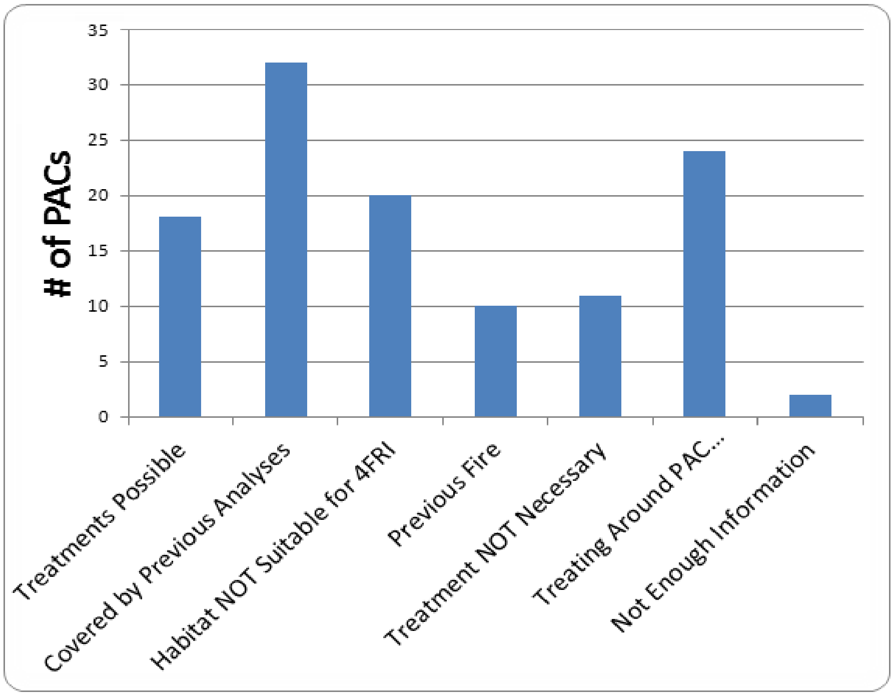



**Figure 4. 4FRI MSO PAC Evaluation (2011-2012); See Text for Legend Definitions**

### Goshawk Habitat

Coconino NF and Kaibab NF forest plans define goshawk as nest stands, post-family fledging 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 PFA’s 1.25 miles
- Blocks of habitat occurring with ≤ 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 dbh and larger; numbers of large (≥ 18 inches dbh) snags; and Crown 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 silvicultural and prescribed burning treatments 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 the 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 project area. To achieve ecological objectives and modify landscape-scale fire behavior and 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. "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. Restoration Units 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 project 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. 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 3.

Arizona Game and Fish Department (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 project 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. In addition to the corridors provided by AGFD, Hell Canyon, an east-west feature crossing much of the Williams RD, was designated 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. 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 interruption in the fire return interval, led to an 8 to 21-fold increase in tree densities in northern Arizona ponderosa pine forests relative to pre-settlement times (Fule´ 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-integrade soils as a guide.

Open corridors were designed to provide landscape connectivity for species that have been losing native habitat for the century and a half. In open corridors, treatments designed to provide 40 to 55 percent openings were typically bumped-up to savanna treatments in areas that overlapped mollic-intergrade soils. Additionally, alternative C was changed from burn-only treatments to mechanically cutting invading pines and pine plantations in true mollisol soils.

### 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 (Patton and Chambers 2002). 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 pray 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).

Both the Coconino and Kaibab forest plans 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 and1988). 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 (Fule´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 is expected to result in more resilient wildlife communities and more sustainable wildlife habitat by moving them towards the evolutionary environment. 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 2008). 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 2002). 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 2002).

This process allows comparisons of alternatives, including the no action alternative (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 NF), the approach used in this analysis is consistent with the intent of the forest plans in terms of maintaining appropriate habitats on the landscape. All data related to assessing a surrogate for HCI is located in MIS effects analysis (pages 334 to 367).

### Hiding and Thermal Cover

Providing for hiding and thermal cover is required by both forest plans. Hiding cover is intended to conceal animals from observation and this mitigate potential human disturbance. It is defined as enough vegetative cover to hide 90 percent of a standing elk from a viewer at a distance of 200 feet or less. Thermal cover intended to ameliorate weather effects and consist of coniferous trees with a high degree of crown closure. Both plans direct for at least 10 percent hiding cover and 10 percent thermal cover in assessment areas. An additional 10 (Coconino NF) to 20 percent (Kaibab NF) of cover can be either unless the needs of species listed as threatened or endangered under the ESA conflicts with this direction (USDA 1987, 1988). Wildlife cover on the Coconino NF should be assessed in 10,000 acre blocks while the Kaibab describes cover assessments in terms of project areas. Both are intended to ensure that cover is provided across the area under consideration and not concentrated in some regions and absent from others. However, neither scale meets the intent of the forest plans when applied to the 4FRI treatment area. Ten thousand acre blocks are small relative to 4FRI and the project area is too large. Therefore, wildlife cover will be evaluated at the subunit scale, allowing for an assessment of unit areas fully distributed across the treatment area.

Both plans were written before the 1996 amendment that moved management from relatively even-aged stand-based objectives to an interspersion of various-aged groups and clumps of trees. Sizes of tree groups and canopy cover developed for the 4FRI are from the scientific literature and site conditions assigned by the Terrestrial Ecosystem Survey. The resulting forest structure is designed to meet or move towards forest plan direction (e.g., even-aged stands cannot attain uneven-aged conditions in a single entry). This approach does incorporate the best science available to better meet the intent of the forest plans. 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 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 (PACs are too variable to generalize as meeting hiding cover)
3. All MSO restricted habitat (because of the oak component)
4. Pine-oak with 500 tpa or greater of oak less than five inches dbh (note: this is outside restricted habitat but can include elements of PAC habitat)
5. All pine-sage habitat
6. Ponderosa pine with pinyon pine and/or alligator, one-seed, and/or Utah junipers 500 tpa or greater and less than five inches dbh
7. Ten BA or 10 percent BA of pinyon pine and/or alligator, one-seed, and/or Utah junipers greater than five inches dbh and
8. Any stands meeting VSS 2BC, 3BC, or 4BC.

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 of the treatments and increased open space. The stands would still be dominated by dense trees or support a woody understory, 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 is developed enough to provide hiding cover. The canopy conditions are such that, in number eight, even without woody understory species, the forest would be dense enough in these smaller diameter classes that sight distances would still be broken-up by the number of tree boles.

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 the above conditions, only half the acres would count due to the higher intensity of the treatments and increased open space. Stands would still be dominated by dense large trees, 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, it will be assumed that there will 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 count towards cover. Slope by itself does not contribute to thermal cover.

The following assumptions were made for treatment intensities:

- Stands designed to have 10 to 25 percent openings are comparatively 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) due to the combination of VSS 1s & 2s along with the intended openings but they are only moderately open forests in long-term
- Stands designed to have 40 to 55 percent openings are comparatively open forests

Final assessments for cover categories included a combination of treatment intensity, VSS category, canopy cover, and woody plant species other than pine. All data and documentation related to hiding and thermal cover is located in Appendix 5.

### 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 U.S. Fish and Wildlife Service and/or the Arizona Game and Fish Department:

- Mexican spotted owl surveys utilized the survey protocol developed by the U.S. Fish and Wildlife Service. The Mexican spotted owl survey protocol was first developed in 1988 by the Southwest Region of the U.S. Forest Service and has been revised several times, most recently by the U.S. Fish and Wildlife Service in 2003
- Surveys for northern goshawks use the Southwestern Region Protocol

- Northern leopard frog surveys follow the recommendations of the U.S. Fish and Wildlife Service and the Arizona Game and Fish Department
- 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 Arizona Game and Fish Department
- 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 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 6.

### 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 Field Office of the USFWS. See Appendix 2 for details from these efforts.

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 dbh, 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. Since January of 2010 through April of 2012 he has surveyed a total of 42 natural caves on the Kaibab and Coconino National Forests. 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 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. We can avoid the risk of heavy machinery collapsing passageways and potentially risking human safety by restricting mechanical manipulation of vegetation in the area immediately 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. Understory Response to Changes in Overstory Cover (Appendix 8) summarizes literature pertinent to soils resources, plant community structure and composition, water and nutrient cycles, forage production, biodiversity, wildlife habitat, and fire effects across the Four Forest Restoration Initiative landscape. This document is the basis for comparing vegetative response to proposed treatments and corresponding wildlife response to those changes. A review of MSO biology, ecology, and habitat components is presented in Appendix 7.

## Affected Environment

A diverse assemblage of wildlife (species identified under the ESA, Forest Service sensitive, MIS, migratory birds) are known to occur or have habitat within or adjacent to the treatment area. Each species that occurs or have potential to occur within the project area are analyzed within their respective sections. In some cases, surveys for these species have confirmed their presence in or near the project 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 Mexican spotted owl are also analyzed in a separate Biological Assessment (BA) for the purpose of section 7 consultation with the U.S. Fish and Wildlife Service.

### Location and Setting

See the DEIS for descriptions of the project's location and acres that have been excluded from the project area.

### Coconino and Kaibab Forest Plan Management Areas, Geographic Areas, and Land Use Zone

The project area includes 23 management areas (MA) as described in the Coconino NF forest plan (pp. 46 to 206-113). Because the FLEA MA incorporates 10 MAs, the location-specific direction in the various MAs has been utilized (per forest plan direction). The MAs located within the project area, forest plan MA emphasis specific to wildlife, and the relationship between MA total acreage to the project are displayed in Table 2.

On the Kaibab NF, the project area includes five geographic areas (GAs) and one land use zone (LUZ). Approximately 183, 729 acres of GA 2 (Williams forestland) and 41,012 acres of GA 10, (Tusayan forestland) is proposed for treatment in the project area. About 8,353 acres of treatment are proposed within GA 1 (Western Williams Woodland), 3 (North Williams Woodland), and GA 8 (Tusayan Woodland). Treatments are proposed within about 1,049 acres of LUZ 21, existing developed recreation sites.

For additional information, see chapter 4 of the forest plans (Coconino NF Forest Plan, pp. 21 to 206-118), Kaibab NF Forest Plan (pp. 16 to 114) where detailed descriptions of forest-wide resource direction specific to the management or geographic areas can be found. A summary of management emphasis specific to wildlife is presented in the Appendix 1.

**Table 2. Project Area Management Area, Geographic Area, and Land Use Zone Emphasis and Acres**

| Forest Plan Management Areas (MA) and Geographic Areas (GA) within the project area* | Description | Forest Plan emphasis relevant to wildlife | Forest-wide MA and GA acres | MA and GA acres within project area | Acres (Percent) of forest-wide MA/GA proposed for treatment |
|---|---|---|---|---|---|
| MA 3 | Ponderosa pine and mixed conifer on less than 40% slope | Manage habitat for the following indicator species through ISM: Turkey, Goshawk, Pygmy nuthatch, Elk, Abert squirrel, Red squirrel, Hairy woodpecker, Spotted owl | 511,015 | 236,245 | 190,763 (37%) |
| MA 35 | Lake Mary Watershed | Re-introduce fire's natural role as much as possible, and ponderosa pine lands progress towards desired forest structure, including northern goshawk and Mexican spotted owl habitats. | 62,536 | 59,301 | 37,801 (60%) |
| MA 38 | West | Within the Urban/Rural Influence Zone, and along the Highway 89A corridor, reduce the risk of catastrophic wildfire, emphasize daytime recreation activities, both motorized and non-motorized, balance recreation demands with protection of the soils, water,wildlife and vegetation, and maintain public access to public lands. Maintain wildlife travelways. | 36,298 | 36,134 | 19,538 (54%) |
| MA 33 | Doney | Restore natural grasslands, and promote healthy pinyon/juniper woodland. Ponderosa pine lands progress towards desired forest structure (goshawk habitat). | 40,530 | 25,779 | 14,023 (35%) |

| Forest Plan Management Areas (MA) and Geographic Areas (GA) within the project area* | Description | Forest Plan emphasis relevant to wildlife | Forest-wide MA and GA acres | MA and GA acres within project area | Acres (Percent) of forest-wide MA/GA proposed for treatment |
|---|---|---|---|---|---|
| MA 36 | Schultz | Reduce the risk of catastrophic wildfire, especially within the Urban/Rural Influence Zone. Reintroduce fire's natural role as much as possible. Balance recreation demands with protection of the soils, water, vegetation, and sensitive species. Ponderosa pine lands progress towards desired forest structure (goshawk habitat). | 21,289 | 21,130 | 7,069 (33%) |
| MA 37 | Walnut Canyon | Reduce fire risk in urban/rural interface zone, progress towards desired forest structure including MSO and goshawk habitats | 20,566 | 18,030 | 6,420 (31%) |
| MA 13 | Cinder Hills | Management Indicator Species for this MA are mule deer, pygmy nuthatch, and hairy woodpecker | 13,711 | 13,732 | 13,670 (99%) |
| MA 6 | Unproductive timber lands | Emphasize a combination of wildlife habitat, watershed condition, and livestock grazing. Other resources are managed in harmony with the emphasized resources. Manage for the following indicator species: Elk, Abert's squirrel, Mule Deer, Hairy woodpecker | 67,146 | 12,115 | 11,628 (17%) |
| MA 4 | Ponderosa pine and MC above 40% | Emphasize wildlife habitat, watershed condition, and dispersed recreation. Management intensity is low. Manage for the following indicator species: Turkey, Goshawk, Pygmy nuthatch, Elk, Abert squirrel, Red squirrel, Hairy woodpecker, Spotted owl | 46,382 | 11,793 | 8,107 (18%) |

| Forest Plan Management Areas (MA) and Geographic Areas (GA) within the project area* | Description | Forest Plan emphasis relevant to wildlife | Forest-wide MA and GA acres | MA and GA acres within project area | Acres (Percent) of forest-wide MA/GA proposed for treatment |
|---|---|---|---|---|---|
| MA 32 | Deadman Wash | Restore and maintain grasslands and grassland adapted wildlife species, especially antelope. Provide large tracts of un-roaded landscape for disturbance sensitive species and remote recreation experiences. | 58,133 | 11,659 | 11,380<br>(20%) |
| MA 31 | Craters | Restore natural grasslands, re-establish or maintain fire in pinyon-juniper woodland | 29,940 | 8,969 | 8,969<br>(15%) |
| MA 10 | Transition Grassland/Sparse PJ above Mogollon Rim | Emphasize range management, watershed condition, and wildlife habitat. Other resources are managed to improve outputs and quality. Emphasis is on prescribed burning to achieve management objectives. Manage for antelope, indicator species. | 160,494 | 8,544 | 8,012<br>(5%) |
| MA 9 | Mountain Grasslands | Emphasize livestock grazing, visual quality, and wildlife habitat. Smaller mountain meadows in remote areas are managed mostly for wildlife habitat, especially for elk summer range. Manage for the following indicator species: antelope, elk | 9,049 | 7,102 | 5,385<br>(60%) |
| MA 20 | Highway 180 Corridor | Scenic attraction, access to year-round recreation and Grand Canyon NP. Manage local and temporary roads intersecting with Hwy 180 as needed to enhancewildlife habitat, dispersed recreation and safety . | 7,608 | 6,213 | 4,237<br>(56%) |

| Forest Plan Management Areas (MA) and Geographic Areas (GA) within the project area* | Description | Forest Plan emphasis relevant to wildlife | Forest-wide MA and GA acres | MA and GA acres within project area | Acres (Percent) of forest-wide MA/GA proposed for treatment |
|---|---|---|---|---|---|
| MA 7 | PJ Woodlands < 40% | Emphasize firewood production, watershed condition, wildlife habitat, and livestock grazing. Wildlife habitat management emphasizes forage production on 0 to 15 percent slopes, in conjunction with firewood harvest using Integrated Stand Management (ISM). Manage for the following indicator species: plain titmouse, mule deer, elk | 273,815 | 3,206 | 3,203<br>(1%) |
| MA 5 | Aspen | Emphasize a combination of wildlife habitat, visual quality, firewood production, watershed condition, and dispersed recreation with other resources and uses managed to be compatible. Manage for the following indicator species: yellow bellied sapsucker and mule deer. | 3,450 | 2,761 | 695<br>(20%) |
| MA 28 | Schnebly Rim | Schnebly Hill Road serves as a seasonal gateway for visitors entering the redrock landscape from Interstate 17. Conserve wildlife habitat, especially winter range for deer, elk and turkey. | 5,090 | 2,455 | 2,455<br>(48%) |
| MA 34 | Flagstaff | Reduce the risk of catastrophic wildfire, emphasize daytime non-motorized recreation opportunities and balance recreation demands with protection of the soils, water, wildlife and vegetation, and maintain public access to public lands. | 1,781 | 1,675 | 1,460<br>(82%) |

| Forest Plan Management Areas (MA) and Geographic Areas (GA) within the project area* | Description | Forest Plan emphasis relevant to wildlife | Forest-wide MA and GA acres | MA and GA acres within project area | Acres (Percent) of forest-wide MA/GA proposed for treatment |
|---|---|---|---|---|---|
| MA 18 | Elden Environmental Study Area | Lessen risk of catastrophic wildfire and maintain shrubs, such as Arizona cliffrose, that provide winter food source for deer. | 1,577 | 1,611 | 337<br>(21%) |
| MA 12 | Riparian and Open Water | Emphasize wildlife habitat, visual quality, fish habitat, and watershed condition on the wetlands, riparian forest, and riparian scrub. Manage for the following indicator species: cinnamon teal, Lincoln's sparrow, yellow breasted chat, Lucy's warbler, macroinvertebrates. Defer logging activities from April 15 to June 30 in known bear maternity areas. | 20,490 | 653 | 609<br>(3%) |
| MA 8 | PJ Woodlands greater than 40 % | Wildlife habitat management emphasizes forage production on 0 to 15 percent slopes, in conjunction with firewood harvest using Integrated Stand Management (ISM). | 19,077 | 248 | 248<br>(<1%) |
| MA 15 | Developed Recreation Sites | developed recreation emphasis – no relevant wildlife direction | 874 | 805 | 48<br>(6%) |
| MA 14 | Oak Creek Canyon | Wildlife habitat, healthy stream conditions and clean air and water are protected. | 5,388 | 7 | 7<br>(<1%) |

| Forest Plan Management Areas (MA) and Geographic Areas (GA) within the project area* | Description | Forest Plan emphasis relevant to wildlife | Forest-wide MA and GA acres | MA and GA acres within project area | Acres (Percent) of forest-wide MA/GA proposed for treatment |
|---|---|---|---|---|---|
| **Kaibab National Forest** | | | | | |
| GA 2 | Williams Forestland | Emphasis areas include suitable timberland, recreation, grazing, and wildlife habitat.<br>Improve habitat components and diversity through vegetative manipulations and the coordinated interaction of other planned resource practices. | 308,394 | 299,842 | 181,371<br>(59%) |
| GA 10 | Tusayan Forestland | Emphasis areas include suitable timberland, recreation, grazing, and wildlife habitat. Principal elk calving, deer and pronghorn antelope fawning, and turkey nesting habitat in the Tusayan District are located here.<br>Improve habitat components and diversity through vegetative manipulations and the coordinated interaction of other planned resource practices. | 86,250 | 43,559 | 41,012<br>(48%) |

| Forest Plan Management Areas (MA) and Geographic Areas (GA) within the project area* | Description | Forest Plan emphasis relevant to wildlife | Forest-wide MA and GA acres | MA and GA acres within project area | Acres (Percent) of forest-wide MA/GA proposed for treatment |
|---|---|---|---|---|---|
| GA 1 | Western Williams Woodland | Emphasis includes wildlife habitat (including quality winter and summer habitat for elk and deer), sandstone products, scenic routes and features, grazing, and wild burro territory.<br>Improve habitat components and diversity through vegetative manipulations and the coordinated interaction of other planned resource practices. | 169,041 | 4,807 | 3,360<br>(2%) |
| GA 3 | Northern Williams Woodland | Emphasis includes winter wildlife habitat for mule deer, elk, pronghorn, and turkey, scenic routes and features, and grazing.<br>Improve habitat components and diversity through vegetative manipulations and the coordinated interaction of other planned resource practices. | 65,533 | 3,485 | 3,475<br>(5%) |
| GA 8 | Southern Tusayan Woodland | Emphasis includes wildlife habitat, scenic routes and features, grasslands, and grazing.<br>Improve habitat components and diversity through vegetative manipulations and the coordinated interaction of other planned resource practices. | 195,118 | 1,518 | 1,518<br>(1%) |
| LUZ 21 | Existing Developed Recreation Sites | Emphasis includes existing public and private sector developed recreation sites and other smaller sites (trailheads, interpretive sites, etc.) There is no specific emphasis for wildlife. | 1,556 | 1,049 | 1,049<br>(67%) |

## Vegetation Cover Types Within Project Area

The dominant forest on the Coconino and Kaibab NFs is ponderosa pine. Similarly, the majority of the treatment area is ponderosa pine (86 percent), but other habitat types include pine/oak (8 percent), water (less than 1 percent), aspen (less than 1 percent) and grasslands, savannas, and meadows (8 percent) (Table 3). A map of the dominant cover types can be found in the silviculture report. Cover types are summarized by RU across the analysis area (593,211 acres).

**Table 3. Vegetation Cover Type Acres by Restoration Unit (RU)**

| | Cover Type Acres by RU | | | | | |
|---|---|---|---|---|---|---|
| Cover Type | RU 1 | RU 3 | RU 4 | RU 5 | RU 6 | Total |
| **Non-Vegetated** | | | | | | |
| Barren | 120 | 134 | 129 | 1,301 | 48 | 1,732 |
| **Non-Forest Communities** | | | | | | |
| Grassland | 8,230 | 12,799 | 22,665 | 4,987 | 93 | 48,774 |
| **Forest Communities** | | | | | | |
| Pinyon Juniper Woodland | 1,427 | 5,884 | 7,283 | 8,845 | 2,219 | 25,658 |
| Oak Woodland | 287 | 1,633 | 926 | 523 | 30 | 3,399 |
| Ponderosa Pine | 145,793 | 129,225 | 134,301 | 61,671 | 41,188 | 512,178 |
| Aspen | 368 | 201 | 499 | 403 | 0 | 1,471 |
| **Total Forested Acres:** | **147,875** | **136,943** | **143,009** | **71,441** | **43,437** | **542,705** |
| **Total Analysis Area Acres:** | **156,225** | **149,876** | **165,803** | **77,730** | **43,578** | **593,211** |

### 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 512,178 acres of ponderosa pine forest in the project 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 open park-like characteristic of reference conditions for ponderosa pine forests 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.

#### Ponderosa Pine – Understory Vegetation

Understory vegetation beneath ponderosa pine represents nearly all the vegetation species richness and diversity in southwest ponderosa pine forests. Herbaceous vegetation affects soil, supports the arthropod community which in turn provides other ecosystem services (e.g., pollination, pest control, soil health services, etc), and provides food and cover for most of the vertebrate wildlife. A summary of understory plant and arthropod relationships with forest cover and how these interrelationships can affect MSO and northern goshawk prey species can be found in Appendix 8 and is incorporated into this report. 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 postsettlement pine trees. The ponderosa pine analysis area supports high stand densities and closed tree canopies, locking up many nutrients that historically were available to herbaceous plants. The relative density of young to mid-aged trees is uncharacteristically high (see silviculture report, USDI 1995, and Appendix 8), 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 project area and declines are expected to continue with time (Appendix 8).

#### 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. Its presence adds diversity to forest structure and habitat, understory vegetation, and soil microflora (see Appendix 8 for details). 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). 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. Gambel oaks provide important elements of wildlife habitat. Small, brushy growth forms provide hiding cover; intermediate sizes have the highest mast production, and larger diameter trees (greater than 10 inches drc) provide a range of nesting substrates, including cavities and branching for cup and stick nesters. 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 (*Ursus americanus*), wild turkeys (*Meleagris gallopavo*), 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*); and Gambel oak is an important component of MSO habitat (reviewed in Chambers 2002). Ponderosa pine – Gambel oak habitat is managed as Restricted Habitat under the MSO Recovery Plan (USDI 1995).

#### 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 structural within the project 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 project area, quaking aspen 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 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. Aspen is 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 approximately 1,471 acres of aspen in the project area. Most aspen within the project 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 (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 (<7500 ft) 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. There are unique habitat features associated with islands of aspen within a sea of ponderosa pine that are being lost and the loss is expected to continue under current conditions.

### 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 support high densities of small mammals, making them important foraging areas for carnivorous mammals, 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. The delay in replacing this component of woodland habitat also delays future large diameter snag recruitment.

### Grasslands, Savannas, and Meadows

Grasslands within the project area typically categorized as the productive Montane/Subalpine and the more arid Colorado Plateau/Great Basin and total 48,774 acres. Grasslands vary in size from just a few acres (“meadows”) to well over 1,000 acres and support a wide variety of species 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 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. Meadows permeated the open grown ponderosa pine forests of northern Arizona and are associated with mollic-intergrade soils (Appendix 8). 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, Swainson's hawks, and ferruginous hawls (Sensitive Species) and an abundance of small mammals including Navajo Mogollon voles and Merriam's and dwarf shrews (Sensitive Species). Changes in wildlife populations within grasslands, savannas, and meadows since Euro-American settlement in northern Arizona include: one species has been 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 compete for water and nutrient. The sum of these effects reduces biomass and decreases species richness in the herbaceous layer (see Appendix 8). 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 in meadows (e.g., burrowing owls). Some of the wildlife discussions below focus on meadow habitat and meadow restoration. Acreage summaries are based on and dominated by actual grassland habitat. Sometimes acres of meadow can be identified because true grassland is limited or does not occur in a defined area, as in MSO protected habitat. Here 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. 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. While this is known to likely be negatively biased, it is expected to provide a reasonable estimate to evaluate effects to restricted habitat.

The 4FRI treatment area includes nearly 48,500 acres of grassland that would benefit from prescribed burning and mechanical treatments, nearly 45,500 acres of encroached savanna (defined by mollic-intergrade soils), and small meadows scattered across nearly 311,000 acres of ponderosa pine forest.

### Tree Density

Euro-American settlement in northern Arizona has altered wildlife populations indirectly through uncharacteristic changes in forest structure. Ponderosa pine forests within the project 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 8). The abundance of trees and lack of fire have allowed an uncharacteristic build-up of forest litter and other 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, insectivores, carnivores, and omnivores; Appendix 8) while maintaining a higher risk from high severity fire.

Stand density is relevant to wildlife because it affects both forest structure and forest health. In terms of wildlife habitat, this relates to habitat quality 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, using BA alone does differentiate between a stand with many small trees or a stand with few big trees. These 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, Stand Density Index (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 that diameter and species. SDI is a good indicator of how site resources are being used by the trees and so provides insight into habitat conditions such as open or closed growing conditions and susceptibility to 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 at a particular diameter (Table 4). 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%+ of maximum stand density (zone 4).

**Table 4. Relationships of Forest Density to Forest Stand Development and Tree Characteristics**

| % Maximum SDI* | Zone | Forest Stand Development and Tree Characteristics |
|---|---|---|
| 0 – 24% 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% 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% 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+% 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 |

*Ponderosa pine SDImax basis (450)

When existing conditions are summarized by BA, tpa, and percent of maximum SDI, most of the landscape is either approaching the onset of density-related mortality or currently in the range of active competition-induced mortality (Table 5). Table 5 includes seedlings of all tree species. Seedlings have little influence on BA, but a strong influence on TPA. The average relative density is highest in RUs 1 and 3, which are well above the zone 4 threshold. Although there is site-specific variability in terms of habitat quality, both of these are key RUs for MSO. The average relative density in RUs 4 and 6 are on the high end of zone 3, while RU 5 is in the middle of zone 3. The high percent of maximum SDI indicates severe competition among trees so that, despite the site-specific variation, the habitat is at risk from high-severity fire, insects, and disease. Conversely, forest health and resiliency is low on this landscape.

**Table 5. Existing Forest Density by Restoration Unit**

| Restoration Unit | Acres | Basal Area | | Trees Per Acre | | % of Maximum Stand Density Index | | |
|---|---|---|---|---|---|---|---|---|
| | | Range | Avg. | Range | Avg. | Range | Avg. | Zone |
| 1 | 145,793 | 31 to 270 | 136 | 73 to 8,850 | 789 | 20 to 100 | 66 | 4 |
| 3 | 129,225 | 14 to 227 | 132 | 86 to 2,050 | 711 | 8 to 100 | 63 | 4 |
| 4 | 134,301 | 13 to 197 | 115 | 59 to 1,620 | 450 | 6 to 89 | 51 | 3 |
| 5 | 61,671 | 35 to 197 | 98 | 107 to 1,442 | 472 | 20 to 92 | 45 | 3 |
| 6 | 41,188 | 53 to 144 | 98 | 297 to 1,462 | 823 | 31 to 76 | 51 | 3 |
| **Total** | **512,178** | **13 to 270** | **123** | **59 to 8,850** | **646** | **6 to 100** | **58** | **4** |

Based on these forest density relationships, a variety of stand and tree characteristics would develop by varying the timing, scale, and intensity management. For example:

- Open canopied tree groups with grassy understories and large-diameter trees with long, heavy-limbed crowns will develop by maintaining densities in zones 1 and 2.
- Groups of moderately dense canopy, intermediate-sized trees with thrifty, well-pruned crowns will develop by maintaining densities in the upper half of zone 2 and the lower half of zone 3.
- Clumpy, irregular tree groups containing groups of varying ages will develop by periodically making openings (regeneration group openings) where growing space is made available for seedling establishment. Growing space areas would fall into zone 1.
- Longevity of existing old-growth trees would be enhanced by thinning adjacent smaller trees to create zone 2 or 3 growing conditions.
- Maintaining dense tree groups while avoiding density-related mortality and maintaining forest vigor can be achieved by maintaining densities at or less than the lower half of zone 3.

The risk of insect and/or disease outbreak is also a function of increased tree density. 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, fires, and competition-induced mortality tend to disproportionately kill older trees. Large (greater than 18 inches dbh), old trees are already deficit on the landscape and take longer to replace (USDI 1995), moving the forest further from desired conditions. 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 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. The existing condition lacks diversity in forest structure, with key components such as large trees, open meadows, and pockets of aspen 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 Mexican spotted owl 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. Species that prefer dense pine forests have, in general, reduced forage availability whether they are herbivores, carnivores, insectivores, or omnivores.

### 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. Within MSO Protected and Restricted habitat, the MSO standards and guidelines take precedence over the northern goshawk standards and guidelines, 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 5). Acres of MSO and northern goshawk habitat within the project area are displayed in Table 6.

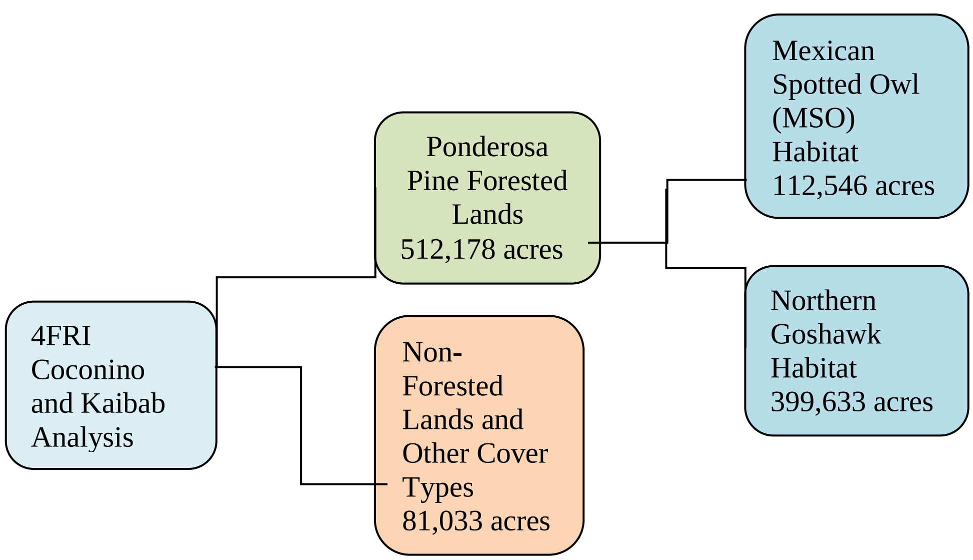



**Figure 5. Stratification of ponderosa pine forested lands, other cover types and non-forested land within the project area**

**Table 6.Goshawk and MSO habitat within the 4FRI treatment area[1]**

| Habitat Type | Acres |
| --- | --- |
| Goshawk Post-Family Fledging Area (PFA), dispersal PFA and nest stands | 30,600 |
| Goshawk non-PFA | 369,033 |
| **Goshawk habitat total acres** | **399,633** |
| MSO Protected Activity Area (PAC) | 35,566 |
| Protected >40 % slope | 889 |
| MSO Restricted | 67,378 |
| MSO Target/Threshold | 8,713 |
| **MSO habitat total** | **112,546** |
| **Total Acres of goshawk and MSO habitat** | **512,178** |

[1] See the Mexican spotted owl and northern goshawk affected environment for additional details on habitat within the project area

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 and trees typically grew in groups (see silviculture report and Appendix 8. Openings defined the groups and supported denser understories. Currently ponderosa pine is found in even-aged and uneven-aged structural conditions across the project area (Table 7). 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 project area lacks age and size class diversity and is in an even-aged structure (silviculture report). The forest is no longer dominated by older trees, 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 7. Distribution of even-aged stands in goshawk habitat outside of Post-family Fledging Areas Within the 4FRI Project Area**

| Vegetation Structural Stage (VSS) | Tree Diameter (dbh) | Even-Aged Existing % of Area | 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 8). 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 8. Forest structure in goshawk Post-Family Fledging Areas/nest stands in the project area**

| Vegetation Structural Stage (VSS) | Tree Diameter (dbh) | Existing % of Area | 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 for MSO pine-oak habitat has changed through time similar to ponderosa pine forest in general. MSO habitat includes protected and restricted habitat and, within restricted, target/threshold habitat. MSO habitat can be evaluated by comparing the percent stand density index (SDI) by size class to the desired percent of SDI by size class and TPA greater than 18 inches dbh. SDI is a metric used to rate the potential for density related tree mortality. 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 Specialist’s Report). MSO pine-oak restricted habitat has an excess of five to 18 inch dbh trees and is deficit in trees 18 inches dbh and larger, particularly trees greater than 24 inches dbh (**Error! Reference source not found.**). 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 recruitment of suitable future nesting habitat. The dominance of closed forest conditions in young to mid-aged trees limits food and cover development for potential prey habitat by shading out understory growth (Appendix 8).

**Table 9. Existing Spotted Owl Habitat Forest Structure and Habitat Components**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Desired | | >150 | NA | 15 | 15 | 15 | 20 | 10% | 5-7 tons/ac | ≥2/ac |
| Restricted Target/ Threshold | RU 1 | 164 | 85 | 29 | 14 | 7 | 16.3 | 20 | 1.6 | 0.5 |
| | RU 3 | 158 | 84 | 26 | 15 | 8 | 16.3 | 26 | 0.8 | 0.6 |
| | All | 162 | 85 | 28 | 15 | 7 | 16.3 | 23 | 1.2 | 0.5 |
| Restricted Other | RU 1 | 138 | 68 | 30 | 12 | 7 | 11.5 | 13 | 0.4 | 0.4 |
| | RU 3 | 137 | 70 | 29 | 13 | 7 | 11.6 | 20 | 0.5 | 0.4 |
| | RU 4 | 129 | 67 | 28 | 13 | 8 | 11.6 | 22 | 0.4 | 0.5 |
| | RU5 | 102 | 51 | 24 | 10 | 1 | 8.4 | 9 | 0.2 | 0.4 |
| | All | 137 | 69 | 29 | 13 | 7 | 11.5 | 17 | 0.5 | 0.4 |
| Protected | RU 1 | 155 | 78 | 31 | 13 | 8 | 14.5 | 13 | 0.7 | 0.6 |
| | RU 3 | 169 | 82 | 31 | 15 | 9 | 18.0 | 11 | 1.1 | 0.7 |
| | RU 4 | 100 | 49 | 33 | 9% | 5 | 8.6 | 7% | 0.4 | 0.4 |
| | RU 5 | 136 | 67 | 31 | 15 | 8 | 14.2 | 11 | 1.2 | 0.8 |
| | All | 155 | 78 | 31 | 14 | 8 | 14.9 | 12 | 0.8 | 0.8 |

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

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

The following list of federally Threatened, Endangered and Proposed species is adopted from the USFWS web-page (http://www.fws.gov/southwest/es/arizona), accessed on March 22, 2012). This list includes all federally Threatened, Endangered and Proposed species in Coconino County. For the purpose of this analysis, only those Federally listed threatened, endangered, candidate species and their critical habitat, along with Forest Service sensitive species, that are known or have potential to occur within the 4FRI project area are analyzed below. Species that are not present or do not have potential habitat in the project area are dismissed from further analysis as the project would have no affect to these species.

There are 48 species of special status addressed by this analysis. 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. In total, there are 3 Threatened and Endangered species, Critical Habitat for one species, 20 Forest Service Sensitive Species, 10 MIS, 19 neotropical migratory birds, one Important Bird Area, and golden eagles (protected under the Bald and Golden Eagle Protection Act) occurring in the treatment area. 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 10 lists species that are known to occur or have potential to occur within the project area and are addressed by this analysis. Species in bold font apply to both the Coconino and Kaibab Forests. Other species only apply to the Coconino National Forest.

**Table 10. Threatened, Endangered, Candidate, Sensitive, Migratory Bird and Management Indicator Species Evaluated in this Analysis**

| Scientific Name | Common Name | Status |
|---|---|---|
| **Amphibians (1)** | | |
| ***Lithobates pipiens*** | **Northern Leopard Frog** | **S** |
| **Birds (28)** | | |
| ***Strix occidentalis lucida*** | **Mexican Spotted Owl** | **T** |
| ***Haliaeetus leucocephalus*** | **Bald Eagle** | **S** |
| ***Accipiter gentilis*** | **Northern Goshawk** | **S/MIS/Mig Bird**[1] |
| ***Falco peregrinus anatum*** | **American Peregrine Falcon** | **S** |
| *Aechmophorus clarkii* | Clark's Grebe | S |
| ***Athene cunicularia hypugaea*** | **Burrowing Owl (western)** | **S/Mig Bird** |
| *Buteo regalis* | Ferruginous Hawk | S/Mig Bird |
| ***Sitia pygmaea*** | **Pygmy nuthatch** | **MIS** |
| ***Meleagris gallopavo*** | **Turkey** | **MIS** |
| ***Picoides villosus*** | **Hairy woodpecker** | **MIS** |
| ***Sphyrapicus varius*** | **Red-naped sapsucker** | **MIS** |
| ***Baeolophus ridgwayi*** | **Juniper titmouse** | **MIS** |
| ***Otus flammeolus*** | **Flammulated Owl** | **Mig Bird** |
| ***Contopus cooperi*** | **Olive-sided Flycatcher** | **Mig Bird** |
| ***Empidonax occidentalis*** | **Cordilleran Flycatcher** | **Mig Bird** |
| ***Setophaga graciae*** | **Grace's Warbler** | **Mig Bird** |
| ***Melanerpes lewis*** | **Lewis's Woodpecker** | **Mig Bird** |

| Scientific Name | Common Name | Status |
|---|---|---|
| ***Progne subis*** | **Purple Martin** | **Mig Bird** |
| ***Carpodacus cassinii*** | **Cassin’s Finch** | **Mig Bird** |
| ***Syphirapicus nuchalis*** | **Red-naped sapsucker** | **Mig Bird** |
| ***Vireo vicinior*** | **Gray Vireo** | **Mig Bird** |
| ***Gymnorhinus cyanocephalus*** | **Pinyon Jay** | **Mig Bird** |
| ***Baeolophus griseus*** | **Juniper Titmouse** | **Mig Bird** |
| ***Setophaga nigrescens*** | **Black-throated Gray Warble** | **Mig Bird** |
| ***Empidonax wrightii*** | **Gray Flycatcher** | **Mig Bird** |
| ***Buteo swainsoni*** | **Swainson’s Hawk** | **Mig Bird** |
| ***Ammodramus savannarum*** | **Grasshopper Sparrow** | **Mig Bird** |
| ***Toxostoma bendirei*** | **Bendire’s Thrasher** | **Mig Bird** |
| **Insects (3)** | | |
| ***Piruna polingii*** | **Four-spotted Skipperling** | **S** |
| *Speyeria nokomis nitocris* | Nitocris Fritillary | S |
| *Speyeria nokomis nokomis* | Nokomis Fritillary | S |
| **Mammals (14)** | | |
| ***Mustela nigripes*** | **Black-footed Ferret** | **E** |
| ***Microtus mexicanus Navaho*** | **Navajo Mexican Vole** | **S** |
| ***Microtus longicaudus*** | **Long-tailed Vole** | **S** |
| ***Sorex merriami leucogengys*** | **Merriam’s shrew** | **S** |
| ***Sorex nanus*** | **Dwarf Shrew** | **S** |
| ***Lasiurus blossevillii*** | **Western Red Bat** | **S** |
| ***Euderma maculatum*** | **Spotted Bat** | **S** |
| ***Idionycteris phyllotis*** | **Allen’s Lappet-browed Bat** | **S** |
| ***Corynorhinus townsendii pallescens*** | **Pale Townsend’s Big-Eared Bat** | **S** |
| *Eumops perotis californicus* | Greater Western Mastiff Bat | S |
| ***Sciurus aberti*** | **Abert’s squirrel** | **MIS** |
| ***Cervis elaphus*** | **Rocky Mountain elk** | **MIS** |
| ***Odocoileus hemionus*** | **Mule deer** | **MIS** |
| ***Antilocapra americana*** | **Pronghorn** | **MIS** |

| Scientific Name | Common Name | Status |
|---|---|---|
| **Reptiles (1)** | | |
| *Thamnophis rufipunctatus* | Narrow-headed Garter Snake | S |

Status: E = Federally Endangered; T = Federally Threatened; C = Federal Candidate; S = Forest Service Sensitive; MIS = Management Indicator Species; Mig Bird = Migratory Birds
[1] Analyses for Management Indicator Species and Migratory Birds can be found below
[2]Note that MSO are analyzed as a Threatened Species under the ESA

Table 11 lists species that are not present or do not have potential habitat in the project area. These were dismissed from further analysis because they do not occur in the project.

**Table 11. Threatened, Endangered, Candidate, Sensitive, and Management Indicator Species not Addressed in This Analysis**

| Scientific Name | Common Name | Rationale for Dropping | Status |
|---|---|---|---|
| **Amphibians (3)** | | | |
| Lithobates chiracahuensis | Chiricahua Leopard Frog | Neither the species nor its habitat occurs in the project area | T |
| Bufo microscaphus microscaphus | Southwestern (Arizona) Toad | Neither the species nor its habitat occurs in the project area | S |
| Lithobates yavapaiensis | Lowland Leopard Frog | Neither the species nor its habitat occurs in the project area | S |
| **Birds (5)** | | | |
| **Empidonax traillii extimus** | **Southwestern Willow Flycatcher** | **Neither the species nor its habitat occurs in the project area** | **E** |
| **Gymnogyps californianus** | **California Condor** | **Not Known to occur in project area (random occurrence may happen)** | **E/Exp-NonE** |
| Rallus longirostris yumanensis | Yuma Clapper Rail | Neither the species nor its habitat occurs in the project area | E |
| **Icteria virens** | **Yellow-breasted chat** | **Indicator habitat does not occur in project area** | **MIS** |
| **Vermivora luciae** | **Lucy’s warbler** | **Indicator habitat does not occur in project area** | **MIS** |
| **Melospia lincolnii** | **Lincon’s sparrow** | **Indicator habitat does not occur in project area** | **MIS** |
| **Anas cyanoptera** | **Cinamon teal** | **Indicator habitat does not occur in project area** | **MIS** |
| Coccyzus americanus occidentalis | Western Yellow-billed Cuckoo | Neither the species nor its habitat occurs in the project area | C |

| Scientific Name | Common Name | Rationale for Dropping | Status |
|---|---|---|---|
| Buteogallus anthracinus | Common Black Hawk | Neither the species nor its habitat occurs in the project area | S |
| Pipila aberti | Abert's Towhee | Neither the species nor its habitat occurs in the project area | S |
| **Strix occidentalis lucida** | **Mexican spotted owl** | **Indicator habitat does not occur in project area2** | **MIS** |
| | | **Mammals (3)** | |
| *Lutra canadensis sonora* | Southwestern River Otter | Neither the species nor its habitat occurs in the project area | S |
| *Perognathus amplus cineris* | Wupatki Arizona Pocket Mouse | Neither the species nor its habitat occurs in the project area | S |
| *Reithrodontomys montanus* | Plains Harvest Mouse | Neither the species nor its habitat occurs in the project area | S |
| *Tamiasciurus hudsonicus* | Red squirrel | Indicator habitat does not occur in project area | MIS |
| | | **Reptiles (2)** | |
| *Thamnophis eques megalops* | Northern Mexican Garter Snake | Neither the species nor its habitat occurs in the project area | C |
| *Heloderma suspectum suspectum* | Reticulate Gila Monster | Neither the species nor its habitat occurs in the project area | S |
| | | **Insects (3)** | |
| *Various Species* | Aquatic Insetcs[1] | Not Addressed in the Terrestrial Wildlife Species Report | MIS |

STATUS: E = Federally Endangered; T = Federally Threatened; Exp-NonE = Experimental/Non-essential; C = Federal Candidate; S = Forest Service Sensitive; MIS= Management Indicator Species; [1]Analyzed in the Fisheries Report
[2] Analyzed as a Threatened Species

### Mexican Spotted Owl Habitat

The proposed 4FRI project occupies the western portion of the Upper Gila Mountain Recovery Unit (UGM). A summary of MSO biology, and ecology, and habitat use can be found in Appendix 7 and is incorporated into this report. The MSO Recovery Plan recommends recovery actions concentrate on: Recovery Units with the highest owl populations and where significant threats exist. The UGM supports over half the known population of MSOs (Ganey et al. 2011) and is at significant risk of high-severity wildfire (USDI FWS 1995). The Recovery Plan also recommends management should emphasize alleviating the greatest threats; and should be tailored to the needs of the area under analysis. Lands managed by the USDA Forest Service account for 42 percent of the UGM. The central location of the UGM within the overall range of the MSO facilitates gene flow across their range (Figure 6). The 4FRI analysis area occupies the extreme western end of the UGM along the Mogollon Rim. More information on the status of the UGM can be found in Appendix 7.

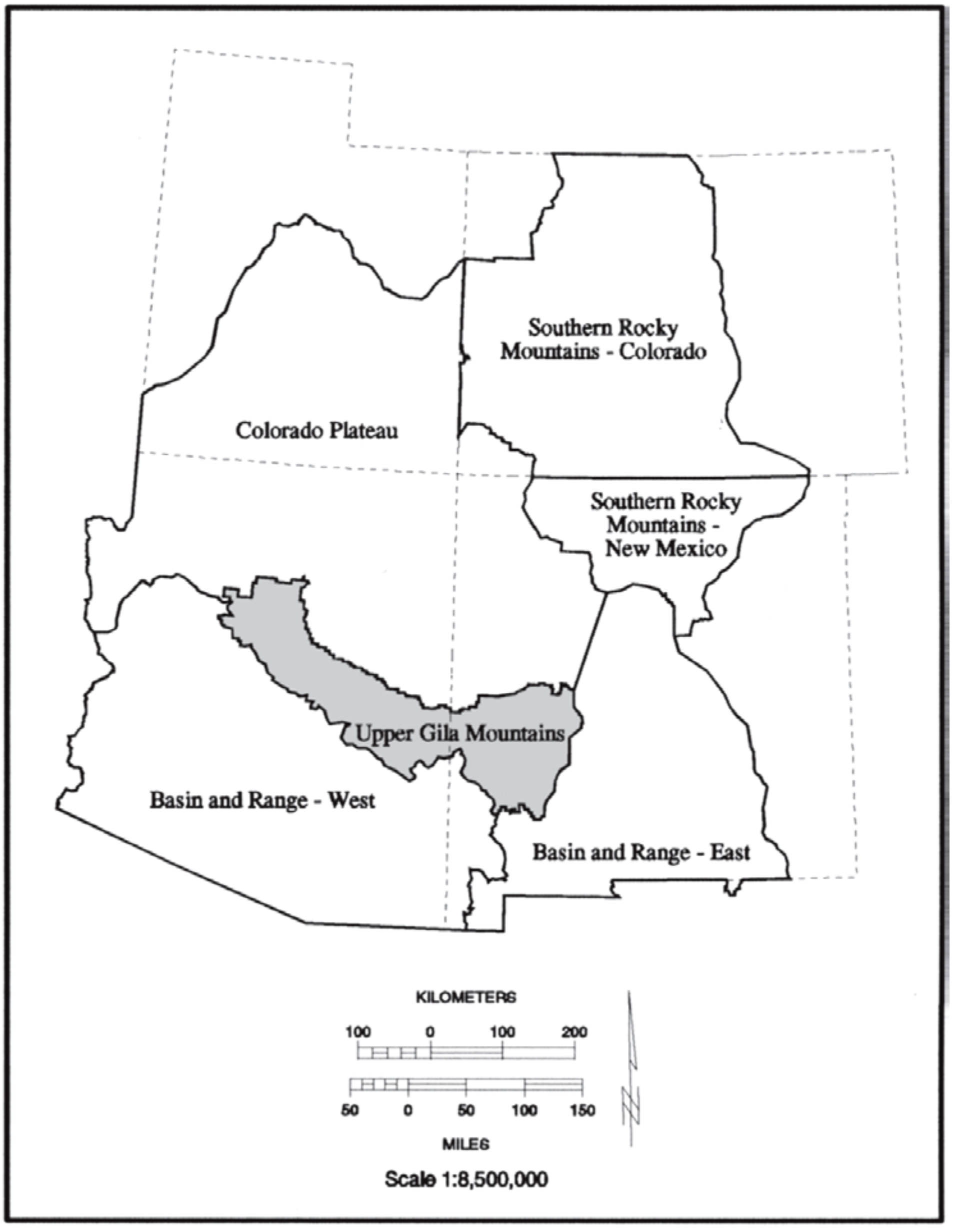



**Figure 6. Recovery Units Designated in the Mexican spotted owl Recovery Plan (USDI 1995)**

About 19 percent (112,546 acres) of the analysis area (593,211 acres) is designated as MSO habitat. 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/ Restoration Unit 6). Patterns in habitat conditions and changes that would result from the proposed alternatives are similar between sub-units and restoration units. Therefore, habitat patterns are typically summarized at the restoration unit scale in this report to facilitate the discussion of MSO habitat at the scale of the 4FRI analysis. Details at the subunit level can be found in Appendices 15, 16, 17, and 18.

There are 168 MSO PACs occurring entirely on the Coconino NF. In addition, 6 PACs on the Coconino NF overlap with the Apache-Sitgreaves NF, 4 PACs overlap with Walnut Canyon National Monument, 4 PACs overlap with State lands, 3 PACs overlap with the Kaibab NF, 1 PAC overlaps with the Navajo Army Depot, 1 PAC overlaps with the Naval Observatory and State land, 1 PAC overlaps with private property, and 2 PACs overlap with both private property and the Apache-Sitgreaves NF. The Kaibab NF has 3 PACs, not including those that overlap with the Coconino NF. In total, the Kaibab NF administers 6 PACs. Overall, there are 195 PACs occurring completely or partially on the two NFs.

The 4FRI project area is approximately 988,764 acres and includes all state, private, and all Federal lands (Table 12).There are 99 PACs within the 4FRI project area boundary. PACs within a ¼ mile of the project area boundary are included for the cumulative effects analysis. The 4FRI treatment area is approximately 512,178 acres and represents only those lands managed by the FS and proposed for mechanical and/or prescribed burning activities within the project area boundary. Areas outside the treatment area but within the project area include designated wilderness, current and recent projects on the individual ranger districts, mixed conifer vegetation, etc. There are 72 PACs in the 4FRI treatment area (Table 12).

**Table 12. Mexican spotted owl Protected Activity Centers within and/or in close proximity to the 4FRI project and treatment area**

| Location | Number of MSO PACs |
|---|---|
| Within the 4FRI Treatment Area (512,178 ac) | 72 |
| Within ¼ mile of 4FRI Treatments | 91 |
| Within the 4FRI Project Area Boundary* (988,764 ac) | 99 |
| Within ¼ mile of the Project Area Boundary | 110 |

*Total of all vegetation cover-types managed by the Forest Service within the 4FRI Treatment Area is 593,211 acres

The treatment area contains about 36,455 acres of MSO protected habitat (Figure 7), of which 35,566 acres are within designated PAC’s that are considered occupied. The remaining protected habitat (889 acres) occurs on steep slopes where timber harvest has not occurred in the previous 20 years. See Methodology section and Appendix 2 for the process used to identify PACs that could potentially be improved from vegetation treatments, the existing condition, and need for habitat improvement.

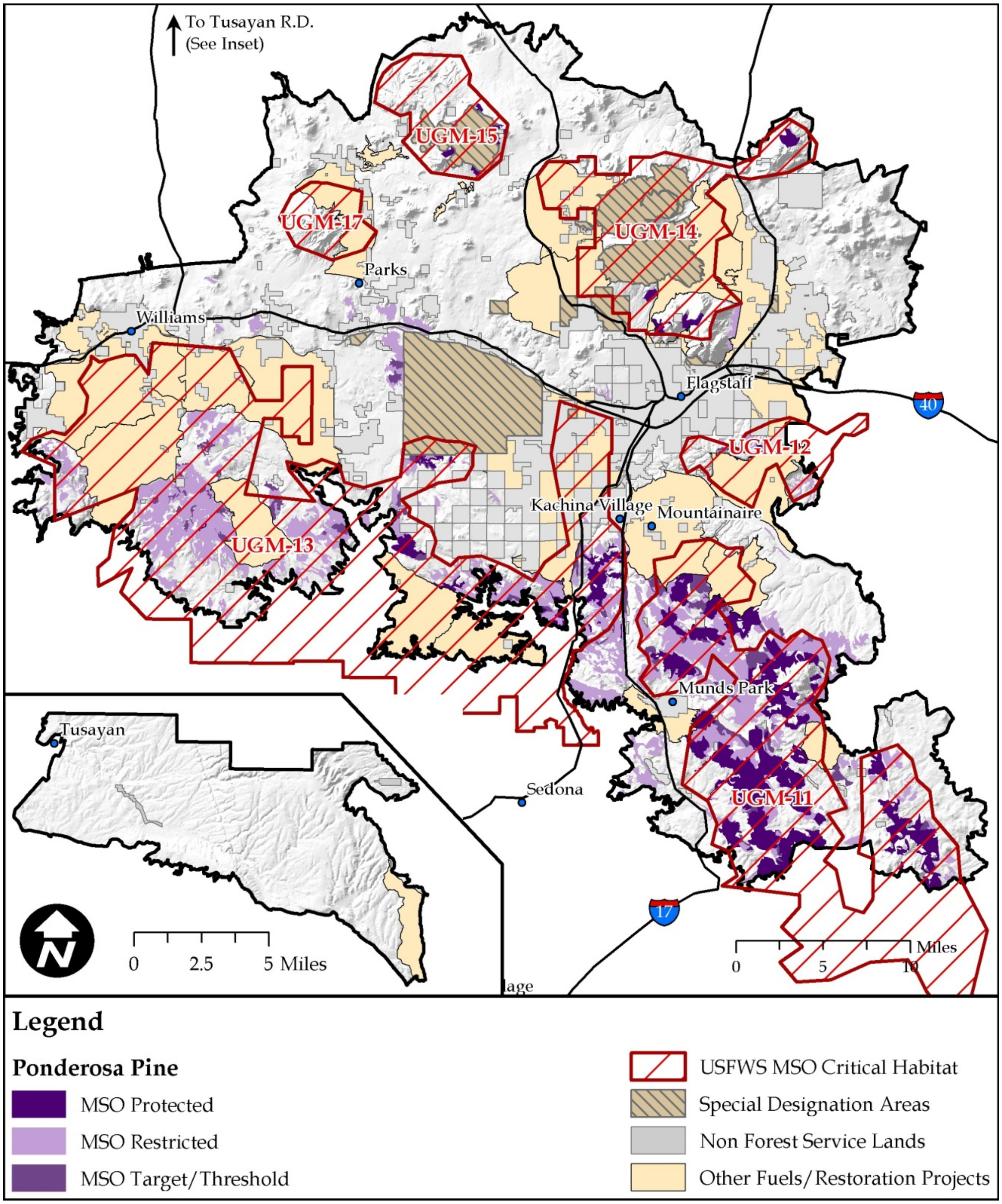


**Figure 7. Mexican Spotted Owl Habitat Within the 4FRI Treatment Area.**

By definition, restricted habitat is not considered occupied by MSOs, but is assumed to be used by MSOs. Current forest plan direction and the Recovery Plan require that at least 10 percent of MSO restricted habitat be designated as threshold habitat. The Recovery Plan also defines target habitat as areas approaching, but not currently meeting forest structure conditions described in Table III.B.1 of the Recovery Plan (USFWS 1995: page 92). Target habitat should be managed towards achieving nesting and roosting conditions. Threshold habitat represents forest structure simultaneously meeting nesting and roosting criteria. Management activities in threshold habitat should not bring any of these habitat values below the minimums described in Table III.B.1 and as identified in the forest plans unless an abundance of such habitat could be demonstrated at large scales (Table 13).

**Table 13. 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" dbh | Percent of total SDI by trees 18-24" dbh | Percent of total SDI by trees >24" dbh | Stand Basal area | Trees per acre >18" dbh | Basal area of oak > 5" drc |
|---|---|---|---|---|---|---|---|
| Pine-oak forest | 10 | 15 | 15 | 15 | 150 | 20 | 20 |

Currently, MSO habitat occurs in all RUs except for RU 6, the Tusayan RD. Approximately 76,091 acres of MSO restricted habitat exists within the treatment area, including 1,977 threshold acres and 6,736 target acres (see Table 1).

MSO critical habitat was designated by the U.S. Fish and Wildlife Service in 2004 (USDI 2004). Critical habitat is defined as protected and restricted habitats within designated areas which contain the primary constituent elements (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. Primary constituent elements 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 primary constituent elements can be found on page 184.

Six Critical Habitat Units (CHUs) occur partially or completely within the 4FRI analysis area (Table 14). 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 93,739 acres of CH occur within the 4FRI treatment area. However, not all acres within a CHU boundary equal owl habitat. As stated above, only those acres designated as protected or restricted habitat occurring within critical habitat boundaries actually function as habitat. Within the 4FRI treatment area non-MSO habitat occurs within CHUs and designated MSO habitat occurs outside of CHUs.

**Table 14. Critical Habitat Units (CHUs) occurring in the 4FRI treatment area**

| Critical Habitat Unit | Total CHU Acres | Acres of Proposed Treatments | National Forest(s) | Approximate Location Description |
|---|---|---|---|---|
| UGM 11 | 144,790 | 53,018 | 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 | 37,544 | 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 | 1,457 | 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 2011 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 2010). Owls have not been detected 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 USFWS 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 15 and Table 16. 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 15. Coconino NF Summary of PACs Monitored 1987 to 2011**

| Year | Number of PACs Monitored | Percent (%) Occupied | PACs w/ Adult Pairs | Pairs w/ Young | Total Young | 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 |

**Table 16. Kaibab NF Summary of PACs Monitored 1978 to 2011**

| Year | PACs Surveyed | PACs with MSO | Known Percent Occupied | Detections | |
|---|---|---|---|---|---|
| | | | | Adult(s) | # 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 |

| Year | PACs Surveyed | PACs with MSO | Known Percent Occupied | Detections | |
|---|---|---|---|---|---|
| | | | | Adult(s) | # of Young |
| 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 |

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

### Forest Structure in MSO Habitat

Existing habitat components in MSO protected habitat meet guidelines for trees 12 to 23.9 inches dbh, but average values fall short of the desired conditions for trees greater than or equal to 24 inches dbh, the number of TPA 18 inches dbh or greater, and the density of Gambel oak for trees greater than 5 inches drc as described in the Recovery and forest plans (Table 17). Threshold habitat serves as replacement nesting and roosting habitat, so habitat components should be an approximate match between protected and threshold habitat. Target habitat, by definition, does not meet these standards but is the next best habitat as measured by nesting and roosting guidelines. Target habitat should be managed to achieve these same guidelines. Therefore, the following discussion will focus on existing and desired conditions in nesting and roosting habitat. Other restricted habitat, i.e., those areas not identified as existing or future nesting and roosting habitat, does not have specific criteria for each of the forest metrics discussed here. It serves a variety of roles in owl ecology, including foraging and dispersal habitat.

**Table 17. Existing Ponderosa Pine-Gambel Oak Forest Structure by Recovery Unit (RU) in Mexican Spotted Owl (MSO) Protected Habitat**

| MSO Habitat | RU | Avg. Percent of Total Pine SDI by DBH Size Class | | | Avg. TPA 18”+ | Avg. Gambel Oak BA (% 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 |

| MSO Habitat | RU | Avg. Percent of Total Pine SDI by DBH Size Class | | | Avg. TPA 18"+ | Avg. Gambel Oak BA (% of Total BA) |
|---|---|---|---|---|---|---|
| | | 12.0 – 17.9" | 18.0 – 23.9" | 24.0" + | | |
| **Restoration Unit (RU) Existing Conditions** | RU 1 | 31 | 13 | 8 | 14.5 | 13 |
| | RU 3 | 31 | 15 | 9 | 18 | 11 |
| | RU 4 | 33 | 9 | 5 | 8.6. | 7 |
| | RU5 | 31 | 15 | 8 | 14.2 | 11 |
| | **Averaged Total** | 31 | 14 | 8 | 14.9 | 12 |

The relative distribution of tree size-classes can be described more than one way. Table 17 above displays the dominant size-class as assessed by stand using SDI. Forest structure can also be described by averaging the diameter of all *individual* trees and summarizing by size class. A comparison of existing conditions and desired conditions for restored ponderosa pine forest, based on trees per acre, is presented below. Desired conditions for MSO habitat would be, on average, denser than the desired conditions identified below (Table 18). Even so, this approach again shows existing forests in the project area are well below target values in the larger size classes (greater than 18 inches dbh). In addition, the low value for trees less than 5 inches dbh suggests a future bottleneck in recruitment of trees into larger sizes classes. The balance in forest structure is made up by an abundance of mid-aged trees (5 to 17.9 inches dbh).

**Table 18. Desired and Existing Conditions Based on Trees per Acre (Rather Than Stand Averages) by Size Class in the Analysis Area**

| Condition | Average Percent (%) Trees Per Acre by Size Class (dbh) | | | | |
|---|---|---|---|---|---|
| | 0-4.9" | 5-11.9" | 12-17.9" | 18-23.9" | 24"+ |
| Desired | 45% (40 to 50) | 30% (25 to 35) | 12% (10 to 14) | 8% (7 to 9) | 5% (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 RU, but average values are consistently high (Table 17). Existing conditions in indicate that much of the BA is within young to mid-aged tree size-classes. Table 4 describes the effects of different categories of maximum SDI. Table 19 shows that, on average, three of the four RUs supporting protected habitat are in zone 4 where trees are in severe competition and minimizing understory production (Long 1985). The remaining RU with protected habitat (RU 4) averages 55 percent of maximum SDI, 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 enhance dense forest conditions. 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. 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). 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 19. Existing Forest Density by Restoration Unit in MSO Protected Habitat**

| Restoration Unit | Acres | Basal Area | | TPA | | SDI % of Maximum | |
|---|---|---|---|---|---|---|---|
| | | Range | Avg. | Range | Avg. | Range (%) | Avg (%) |
| 1 | 29,996 | 31 to 270 | 155 | 73 to 8,850 | 1,064 | 20 to 100 | 78 |
| 3 | 4,507 | 14 to 216 | 169 | 135 to 1,385 | 987 | 10 to 97 | 82 |
| 4 | 558 | 13 to 177 | 100 | 59 to 1,385 | 680 | 6 to 88 | 49 |
| 5 | 1,393 | 93 to 195 | 136 | 534 to 1,385 | 967 | 46 to 92 | 67 |
| Total | 36,455 | 13 to 270 | 155 | 59 to 8,850 | 1,041 | 6 to 100 | 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 project area (Appendix 8). 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 variety occurs as a result of meadows, savannas, and forest density. The information presented above regarding BA and TPA indicates forests are dominated by trees 5 to 18 inches dbh. Key components of MSO habitat are the TPA 18 inches and larger dbh. High canopy closure in smaller diameter trees creates dense conditions with low crown base height. The dense canopy restricts development of the herbaceous biomass, limiting prey habitat, and low branching limits flight ability for foraging owls. In the field review of PACs proposed for treatment (Appendix 7), 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 maximum SDI is currently 69 in restricted "other" habitat, 85 in target and threshold habitat, and 78 in protected habitat. All three values are in the "extremely high density" category indicating severe competition among trees, competition-induced mortality, and minimal or stagnating tree growth rates. In addition, surface fuels were building and there was 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 8, 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 20$^{th}$ 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)".

An index of relative understory biomass was developed to compare understory response among the proposed alternatives. 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 8. Biomass indices comparing current trajectories and those of each action alternative were graphed by individual subunit and can be found in Appendix 8, pages 48 to 58.

Conditions in dense stands 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 dbh 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 (2003) found pine snag densities well below FS guidelines in relatively undisturbed forests in northern Arizona.

Fire promotes recruitment of large snags, but in a study 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 *pers. comm*., Mast *pers. comm.*). Similar fall rates appear to occur for beetle-killed ponderosa pine trees (Chambers *pers. comm*., Mast *pers. comm.*). 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 mre 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 20). 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. While more trees were dying in the smaller size-classes, proportions of dying trees were greatest in the largest size classes. Large snags cannot be created without large trees and 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).

**Table 20. 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 (dbh) | | |
|---|---|---|---|
| | 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 dbh or greater is well below forest plan guidelines of two snags per acre in ponderosa pine forest. In MSO Critical Habitat, snags important to owls and their prey species are defined as 12 inches dbh or greater. The combination of snag size classes above 12 inches dbh 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 dbh) 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 dbh as well as general forest dynamics, MSO habitat criteria are currently being met. The deficit in snags is primarily a forest plan issue. More information on snag recruitment and retention can be found in Appendix 7.

The range in snag values indicate that the distribution of snags is patchy and while guidelines may be met at different scales, snags could be lacking within a given stand (Table 21). 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 21. Existing Snags and Coarse Wood > 12 inches diameter in MSO Protected Habitat by Restoration Unit (RU)**

| Habitat | RU | Acres | Snags 12 to 18” Per Acre | | Snags ≥18” Per Acre | | Coarse Wood (tons per acre) | | Log Equivalent (ft) |
|---|---|---|---|---|---|---|---|---|---|
| | | | Range | Avg | Range | Avg | Range | Avg | Avg |
| MSO Protected | 1 | 29,996 | 0 to 11.4 | 2.8 | 0 to 5.3 | 0.6 | 0.2 to 20.5 | 5.5 | 16.6 |
| | 3 | 4,507 | 0 to 8.2 | 2.9 | 0 to 2.5 | 0.7 | 0.9 to 16.1 | 6.5 | 19.6 |
| | 4 | 558 | .3 to 4.5 | 1.8 | 0.1 to 1.0 | 0.4 | 2.4 to 6.6 | 5.6 | 16.9 |
| | 5 | 1,393 | .9 to 4.5 | 2.4 | 0.1 to 2.4 | 0.6 | 2.1 to 10.9 | 5.5 | 16.6 |
| | **All** | **36,455** | **0 to 11.4** | **2.8** | **0 to 5.3** | **0.6** | **0.2 to 20.5** | **5.6** | **16.9** |

| Habitat | RU | Acres | Snags 12 to 18" Per Acre | | Snags ≥18" Per Acre | | Coarse Wood (tons per acre) | | Log Equivalent (ft) |
|---|---|---|---|---|---|---|---|---|---|
| | | | Range | Avg | Range | Avg | Range | Avg | Avg |
| MSO – Restricted Target/ Threshold | 1 | 4,814 | .6 to 6.1 | 2.4 | .2 to 1.4 | 0.5 | 5.6 to 9.0 | 6.3 | 19 |
| | 3 | 3,899 | .6 to 6.1 | 2.6 | .1 to 1.4 | 0.6 | 2.1 to 9.0 | 4.9 | 14.8 |
| | **All** | **8,713** | **.6 to 6.1** | **2.5** | **.1 to 1.4** | **0.5** | **2.1 to 9.0** | **5.4** | **16.3** |
| MSO – Restricted Other | 1 | 26,421 | .4 to 3.9 | 1.8 | .2 to .8 | 0.6 | 2.1 to 7.4 | 4.5 | 13.6 |
| | 3 | 38,748 | .4 to 3.9 | 1.8 | .2 to 1.1 | 0.7 | 1.4 to 7.4 | 3.8 | 11.4 |
| | 4 | 1,575 | .5 to 3.7 | 1.6 | .2 to 1.1 | 0.4 | 1.4 to 5.9 | 3.1 | 9.3 |
| | 5 | 634 | .6 to 2.9 | 1.2 | .2 to .8 | 0.6 | 2.1 to 5.4 | 3.3 | 9.9 |
| | **All** | **67,378** | **.4 to 3.9** | **1.8** | **.2 to 1.1** | **0.6** | **1.4 to 7.4** | **4.0** | **12.0** |

Forest plan direction for woody debris is to leave three large downed logs per acre and five to seven tons of coarse woody debris (CWD) per acre. 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 ($p < 0.001$) during that same period. These changes represent initial results from a drought-mediated pulse in tree mortality (Ganey and Vojta 2011).

Data on logs and CWD for the 4FRI does not include length of the logs. Traditional stand data does not measure this attribute, but Brown et al. (2001) developed a conversion factor for this kind of data. The bole weight of a dead 12 inch ponderosa pine tree averages about.332 tons. Knowing the diameter of CWD then allows an estimate of how many logs are included in the tonnage value. The equivalent levels of logs based on CWD greater than 12 inches diameter exceeds forest plan direction (Table 21).

### 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 project 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 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 competition;
- Snags greater than 18 inches dbh are deficit across the landscape relative to forest plan direction; combined with snags 12 to 18 inches dbh 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 higher in MSO habitat. Minimum requirements for BA in protected 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.

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 dbh,
- 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.

### Fire

Abundant research exists with consistent conclusions regarding existing fuel levels and fire behavior relative to the historical range of variation for ponderosa pine forests in general and in northern Arizona specifically. Ponderosa pine and ponderosa pine-Gambel oak forests are highly departed from the historical fire regime (see Fire Specialists report)..

Current conditions in the pine-oak component of the project 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 Fule 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. The tree form rarely produces crown fire. Fire exclusion has contributed to a shift in oak densities, with increases in oak density and BA since the late 1800's (Abella 2008, Fule 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.

Pine-oak is a subset of within the general ponderosa pine forest. Nearly 200,000 acres of ponderosa pine forest is at risk of crown fire across the project area (Table 22). Some of the 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 in this landscape. 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 and the crown fire distributed spatially (Swetnam and Baison, 1996; Roccaforte et al., 2008). Pine- oak forest structure corresponds to the overall conditions of general ponderosa pine forest (see Fire Ecology Specialist's Report).

**Table 22. Current fire behavior under moderate conditions (equal to the Schultz Fire) across the treatment area by restoration unit**

| Existing Conditions | RU1 | RU 3 | RU 4 | RU 5 | RU 6 | Totals |
|---|---|---|---|---|---|---|
| **Total acres** | **146,037** | **129,225** | **134,301** | **61,730** | **41,188** | **512,481** |
| Surface fire (acres) | 81,276 | 72,734 | 83,435 | 42,304 | 33,675 | **313,424** |
| Passive crown fire (acres) | 15,967 | 12,629 | 10,614 | 7,104 | 2,219 | **48,533** |
| Active crown fire (acres) | 48,300 | 43,227 | 39,806 | 8,532 | 5,247 | **145,112** |
| Surface fire % | 56 | 56 | 62 | 70 | 82 | **61** |
| Passive crown fire % | 11 | 10 | 8 | 12 | 5 | **9** |
| Active crown fire % | 33 | 33 | 30 | 14 | 5 | **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, about half of the total MSO habitat in the treatment area would support some form of crown fire with nearly a third of MSO habitat (33,549 acres) at risk of active crown fire (Table 23).

**Table 23. Predicted Fire Behavior in Existing Mexican Spotted Owl Habitat**

| MSO Habitat | Habitat Acres | Surface Fire (Ac) | Passive Crown Fire (Ac) | Active Crown Fire (Ac) | Surface Fire (%) | Passive Crown Fire (%) | Active Crown Fire (%) |
|---|---|---|---|---|---|---|---|
| Protected | 36,757 | 18,610 | 3,141 | 14,847 | 51 | 9 | 41 |
| Target/ Threshold | 8,713 | 4,292 | 926 | 3,479 | 49 | 11 | 40 |
| Restricted | 67,378 | 35,465 | 6,608 | 25,187 | 53 | 10 | 37 |

The risk of crown fire means potential loss of the tree-sized component of Gambel oak. The larger sized tree boles often have heart rot and provide substrate for MSOs and a host of other cavity nesting birds. 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.

Before Euro-settlement, Southwestern ponderosa pine forests supported frequent, low severity surface for at least the last 1,400 years (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 feeding a surface fire affects burn severity and the risk of fire burning into the canopy. Rather than fire predominantly consuming fuels such as litter, duff, woody debris, and dried herbaceous materials, fires are now uncharacteristically prone to crown fire (Roos and Swetnam 2012).

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 has less than protected habitat (Table 24) illustrates this point using tree size-class as a surrogate for 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, MSO habitat also has higher fuel build-up at ground level. 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 8). Additionally, high litter levels increases the consumption of logs and coarse woody debris, 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 8). Although the desired condition is returning fire behavior to predominantly surface fire, current fuel loading presents threats to MSO prey habitat from both the risk of crown fire and uncharacteristically severe surface fire.

**Table 24. Surface Fuel Loading by Tree Size-Classes (dbh) Within Forested Habitats**

| Habitat by DBH Size Classes | Fuels (tons/acre) | | |
|---|---|---|---|
| | Large woody debris | Duff | Litter |
| **Ponderosa Pine** | | | |

| Habitat by DBH Size Classes | Fuels (tons/acre) | | |
|---|---|---|---|
| | Large woody debris | Duff | Litter |
| 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 core team silviculturist, GIS specialist/data manager, and wildlife biologists. Treatments in these stands were reviewed and increasing the intensity of treatments was evaluated to reduce the risk of high severity fire to 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 was assigned with the goal of better safeguarding the dense stand conditions within PAC habitat.

### Road Systems

A total of 904 miles of road within the 4FRI treatment area were recommended for decommissioning under the Travel Management Rule (see the transportation report for more detail) and will be addressed in this analysis. About 164 miles of road is proposed for decommissioning within MSO habitat (17% of the 961 total open roads in MSO habitat). Roads proposed for decommissioning by MSO habitat type and total miles of proposed road decommissioning are the same in each alternative (Table 25). About 15 percent of the 793 miles of road within MSO Critical Habitat is being proposed for decommissioning.

**Table 25. Total Road Miles and Proposed Miles for Decommissioning in MSO Habitat Within the 4FRI Treatment area**

| MSO Habitat | Miles of Roads Proposed for Decommissioning | Total Road Miles | Percent of Roads Proposed For Decommissioning |
|---|---|---|---|
| Protected | 49 | 251 | 20 |
| Core Area[1] | 5 | 20 | 20 |

| | | | |
|---|---|---|---|
| Target/Threshold | 17 | 82 | 21 |
| Restricted Other | 98 | 624 | 16 |
| **Total** | **164** | **957** | **17** |

[1]Core Area acres are a subset of protected habitat totals

Open road systems in MSO habitat increase the probability of human-caused disturbance during the nesting season. Access allows firewood cutters to cut snags and logs. While limits exist on what snags can be legally removed from the forest, a direct correlation has been identified between snag availability and road access. Snags were nearly three 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 and in flatter topography (Wisdom and Bate 2008). The same relationship between human access and decreased snag and log availability has been recognized in northern Arizona ponderosa pine and in pine-oak habitat within the treatment area (Chambers 2002, Ganey, *pers comm*.). Road decommissioning within MSO habitat should improve habitat conditions for MSOs and their prey. Road maintenance, temporary road construction and reconstruction, and road relocation would also occur in MSO habitat (Table 26).

**Table 26. Road Maintenance, Construction, and Relocation in Mexican spotted owl Habitats Within the 4FRI**

| MSO Habitat | Road Maintenance | Temporary Road Construction | Road Relocation | Total Miles of Road Work |
|---|---|---|---|---|
| Protected Total | 97.6 | 7.2 | 0.0 | 104.8 |
| Target/Threshold Total | 40.9 | 5.3 | 0.05 | 46.3 |
| Restricted | 319.1 | 63.5 | 1.0 | 383.5 |
| Total | 457.6 | 76.0 | 1.2 | 534.7 |

An identified road system for hauling harvested materials out of the forest was identified to implement restoration activities. Haul routes were evaluated across the entire project area relative to MSO PAC habitat. The objective was to assess road systems for hauling materials with the goal of avoiding or minimizing impacts to MSOs. This required assessing blocks of commercial treatment areas ranging from 100s to 1000s of acres, and connecting the sites to major transportation corridors. This broad scale effort was evaluated in a site specific manner as roads around each individual PAC were examined in terms of functional haul routes and avoiding disturbance to MSOs. This four day review involved the 4FRI assistant team lead, 4FRI biologists, and 4FRI GIS specialist.

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. 2004) Magnesium chloride ($MgCl_2$) 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. Lignin has been found to cause weight gain and colon ulcers in lab testing of rodents. It did not prevent seed germination in field trials and may be the most environmentally compatible dust suppressant (Batista et al. 2004).

Batista et al (2004) 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 $MgCl_2$ is related to humidity levels (Batista et al. 2004), 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. Because of the limited application spatially and temporally and 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.

#### Springs, Ephemeral Channels, Meadows, and Aspen

Springs and ephemeral channels typically represent areas of concentrated use by wildlife, from invertebrates to large mammals. Increased moisture availability after tree removal at these sites can potentially support more diverse vegetation, more robust plants, and more total biomass compared to sites growing in the dry forests northern Arizona. The desired condition for springs is to have the necessary soil, water, and vegetation attributes to be healthy and functioning at or near potential. Spring restoration would move water flow patterns, recharge rates, and geochemistry towards historical levels that persist over time. Water quality and quantity would maintain native aquatic and riparian habitat and water for wildlife and designated beneficial uses, consistent with water rights and site capability. The desired condition for vegetation near springs is for plant distribution and species composition resilient to natural disturbances. Microsite vegetation is important to wildlife, including MSO prey species. Spring restoration treatments proposed under 4FRI are the same in all alternatives. Spring restoration is proposed in 74 different sites across the 4FRI treatment area. Twenty three springs (29 percent) are in MSO habitat, including protected and restricted habitats.

Ephemeral streams are important for hydrological function of watersheds and provide important seasonal habitat for a variety of wildlife, including MSO prey species. Some ephemeral stream channels are heavily eroded with excessive bare ground, denuded vegetation, and head cuts, including riparian and non-riparian streams. About 39 miles of ephemeral stream channel restoration is proposed across the 4FRI treatment area. Over four miles of ephemeral stream channel restoration is proposed within MSO habitat (Table 27). Ephemeral stream channels proposed for restoration treatments under 4FRI are the same in all alternatives and would occur in all MSO habitat classifications.

Restoration of springs and ephemeral channels would be evidence-based and designed to improve species composition of the associated vegetation. Pre-settlement trees would remain where present and the largest trees available would be left where there is evidence of other pre-settlement trees. 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 first-entry and maintenance prescribed burning. 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
- Apply northern leopard frog mitigation where breeding habitat occurs

Spring and channel restoration would occur in four of the six CHUs occurring within the treatment area.

**Table 27. Number of Springs and Miles of Ephemeral Stream Channel Restoration Proposed in MSO Critical Habitat Units under the 4 Forest Restoration Initiative**

| Feature | UGM-11 | UGM-12 | UGM-13 | UGM-14 |
|---|---|---|---|---|
| Spring (Coc NF) | 8 | 0 | 9 | 0 |
| Ephemeral Stream | 1.9 | 0.48 | 0. 38 | 0.67 |

Within the silviculture database, areas of pine forest having at least 10 percent Gambel oak 5 inches or greater DRC were classified as pine-oak habitat or MSO habitat. By definition, meadows and aspen are not MSO habitat. Meadows and aspen within pine-oak habitat tend to occur as small inclusions and, because of the prey base they support, may be regularly used by foraging MSOs even if owls would not nest or seldom roost within these stands. Interspersed patches of higher quality prey habitat could support source populations for surrounding habitats degraded by uncharacteristic densities of young and mid-aged pine. Therefore, acres of meadows and aspen were summarized by PAC and CHU where individual stands could be tallied within discrete polygons of MSO habitat. Direct tallies of meadow and aspen habitat could not be made within restricted habitat. This latter category is defined on a stand by stand basis, even when stands of restricted habitat are typically clustered. Unlike PACs and Critical Habitat where "non-MSO" stands could be queried within the respective **polygons**, the database could not be queried for habitat elements within or between **stands** of MSO habitat. Therefore, results from queries of Critical Habitat will be used for approximating acres of meadow and aspen within restricted habitat, recognizing Critical Habitat includes protected habitat and restricted habitat occurs outside Critical Habitat boundaries.

Over 4,000 acres of meadow treatments are proposed in MSO habitat within the 4FRI treatment area. Up to 135 acres of meadow treatments are proposed in 12 different PACs, depending on the alternative. Meadow treatments average 11 acres per PAC, ranging from one acre (Howard Mountain) to 28 acres (Meadow Tank). Treatment types vary by alternative and all PACs with proposed meadow treatments are located on the Coconino NF. Meadow treatments would occur in five CHUs (UGM-11, UGM-12, UGM-13, UGM-14, and UGM-15) and total 3,870 acres. Treatments would occur on both the Coconino (2,411 acres) and Kaibab (1,460) NFs. Meadow treatments range from small inclusions within pine-oak forest to larger grassland treatments near or adjacent to MSO habitat. Treatment objectives vary from operational burns to prescribed fire. Operational burns are not intended to change habitat structure, but instead would simply allow fire to carry across an area to facilitate attaining prescription objectives in neighboring stands while minimizing creation of firelines in non-ponderosa pine habitats. Where firelines are necessary, they could be as simple as raking a hand-line in litter and duff or pushing material aside with a dozer blade. Meadow treatment objectives related to prescribed fire include removal/reduction in litter, raising a stand's crown base height, or deliberate tree mortality intended to restore the function of the habitat.

Approximately 1,471 acres of aspen occur in the treatment area. Aspen treatments vary by alternative. Up to 209 acres of aspen are proposed for treatment s in PAC habitat and up to 959 acres are proposed for treatment within Critical Habitat (UGM-11, UGM-13, UGM-14, UGM-15, and UGM-17). Treatment objectives vary from burn only to tree removal and prescribed burning intended to restore the function of the habitat. Treatments designed to achieve aspen restoration would occur within restricted habitat. Actual aspen restoration, intended for restricted habitat, would be comprised of the removal of all post-settlement conifers inside aspen clones and within 100 feet surrounding treated clones. Some removal of aspen, ground disturbing activities and/or prescribed fire 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. Aspen restoration would improve overall habitat diversity for MSOs.

### California Condor (Endangered/Experimental Population)

The California condor is a long-lived species with low reproductive rates, with breeding pairs laying one egg every other year. Condors nest in various types of rock formations including crevices, overhung ledges, potholes, caves. Near the Pacific coast they also nest in tree cavities. In Arizona, condors nest and roost in steep terrain with cliffs, ledges, and caves (AGFD website: http://www.AGFD.gov/w_c/california_condor.shtml). Cliffs, tall conifers, and snags are generally used as roost sites, which also provide strong updrafts required for lift into flight. Condors are opportunistic foragers, feeding only on carcasses found by sight. Most condors forage in open terrain, and can travel 100 miles or more per day.

Reintroduction of captive-bred condors in Arizona began in 1996 at the Vermilion Cliffs National Monument Release Site. Condors were reintroduced under Section 10(j) of the Endangered Species Act (USDI FWS 1996). Section 10(j) allows for the designation of a nonessential experimental population. Under this designation the protections for an endangered species are relaxed, providing greater flexibility for management of a reintroduction program. An experimental population area was designated to accommodate future movements and expansions of reintroduced condors (USDI FWS 1996). The designated nonessential experimental population area is located in Arizona, Utah, and Nevada. The nonessential experimental population status applies to condors only when they are within the geographic bounds of the designated 10(j) area of the Southwest, which is defined by: Interstate Highway 40 on the south, U.S. Highway 191 on the east (parallel to the New Mexico and Colorado state borders), Interstate Highway 70 on the north, and Interstate Highway 15 to U.S. Highway 93 near Las Vegas, Nevada on the west. When condors leave this area they receive full protection of the ESA, which may have regulatory implications. Portions of the Coconino and Kaibab NFs north of I-40 are within the designated experimental population area.

The condors have been known to fly widely, but generally remain within the Grand Canyon Ecoregion/Colorado River corridor. Early in the program, condors left the nonessential experimental area on several occasions, flying as far as Flaming Gorge, Wyoming (310 miles from the release site), and Grand Junction, Colorado (approximately 250 miles from the release site). All of the far-wandering condors returned to the release area.

Between 2002 and 2006 The Peregrine Fund obtained more than 50,000 relocation fixes from an average of 17 GPS-equipped condors (Austin et al. 2007). Condor use is focused on the North and South rims and river corridor of the Grand Canyon, the Kaibab Plateau, and the Kolob area in southern Utah (approximately 70 miles north of the release site on the Paria Plateau). 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 National Forest or the Williams or Tusayan Ranger Districts of the Kaibab National Forest (Parrish, pers. comm.). The Arizona condor population was at 74 as of March, 2011 (AGFD website accessed April 25, 2012). Four FRI would not affect nesting or roosting habitat and, because condors rarely occur within the project area, would not affect foraging habitat. Therefore, this project would not affect condors. No further analysis will be conducted.

### Black-footed Ferret (Endangered)

There are presently no known populations of black-footed ferrets on either the Coconino or Kaibab NF. There are no known records of black-footed ferrets on the Coconino Forest. There is one historic location of black-footed ferrets that was reported to come from 12 miles west of Winona, which would make it very close to Flagstaff (Cockrum 1960). There are also historic records from 7 miles NE of Williams and in Government Prairie near Parks, Arizona (Cockrum 1960). Ferrets have been reintroduced as an experimental nonessential population in the Aubrey Valley near Seligman, Arizona, since 1996 (USDI 1996). There have been no comprehensive surveys for black-footed ferrets on the Forest. The USFWS believes that undiscovered wild populations of black-footed ferrets may still exist where prairie dogs persist (USDI 2012).

Characteristics used to determine the suitability of prairie-dog colonies for black-footed ferrets include size of colonies, distance from other colonies, density of each colony, and disease dynamics. Essentially, larger colonies in close proximity of other colonies that have a high density of occupancy are more suitable for supporting black-footed ferrets. Prairie-dog colonies that are less than 7 km (4.3 mi) apart are considered a complex. Habitat for black-footed ferrets in Arizona has been described as an active prairie dog complex greater than 80 ha (200 acres) in size with a burrow density of > 20 burrows per ha (>8 burrows/ac) (Mikesic and Nysted 2001). Three Gunnison's prairie dog complexes have been mapped within the project area. Of these, two complexes are within the treatment area. Table 28 displays the acres of each complex by subunit. Because these complexes exceed the 200 acre threshold identified in (Mikesic and Nysted 2001), habitat suitable for supporting a population of black-footed ferrets could be present in the treatment area, depending on prairie-dog activity and burrow density. Plague outbreaks, eradication efforts and drought have contributed to the lack of Gunnison's prairie-dog activity on these colonies. Prairie dog surveys will be completed prior to treatments within these complexes and if colonies are active and burrow densities adequate black-footed ferret surveys will be completed prior to implementation in these areas.

**Table 28. 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** |

In addition to these complexes there are 48,774 acres of grassland within the treatment area that could provide additional habitat for Gunnison's prairie-dogs and black-footed ferrets. Conifer encroachment is occurring around the edges of and within grasslands in the project area, reducing quality and availability of habitat for prairie-dogs and potential for occupancy by black-footed ferrets. Corridors identified for prairie dogs are fragmented from pine encroachment, private development and past tree plantings within meadows reducing the ability of prairie dogs to colonize new areas.

## 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 U.S. Fish and Wildlife Service and state of Arizona (FSM 2670.32). 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 10 and Table 11 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

Elements that relate to northern goshawk forest habitat apply to the forest and woodland communities. See Appendix 1 for details.

### Project Area Affected Environment

**Ponderosa Pine -** The majority of the project area is the ponderosa pine plant association. The ponderosa pine associations include two major sub-types: Ponderosa pine-bunchgrass and ponderosa pine-Gambel oak. The ponderosa pine project area is dominated by high stand densities and closed tree canopies. Data in the silvicultural report shows that the average relative density throughout the project area is considered extremely high and 57 percent has closed canopy conditions (see silviculture report).

Approximately 54 percent of the landscape in LOPFA habitat is in an even-aged condition characterized by stands of trees dominated by a single age class. The current average stand density across the landscape for LOPFA habitat is 51 percent of the maximum SDI, which is considered high density. The desired condition is a range from 15 to 35 percent, the equivalent of low density up to the threshold of high density stand conditions. The average percent of maximum SDI in PFAs is 52 percent with a desired range of 25 to 40 percent of maximum SDI, or moderate to high stand density conditions. For a full discussion of this topic refer to the silvicultural report for this project.

**Gambel Oak Within Ponderosa Pine Forest** – Gambel oak is frequently the only deciduous tree in otherwise pure southwestern ponderosa pine forests, adding diversity to these forests. Similar to pure ponderosa pine forests, pine-Gambel oak forests have become altered since Euro-American settlement in the late 1800s resulting in an overall increase in small- and medium sized Gambel oak stems and a more simplified forest structure. Goshawk population dynamics have been shown to be strongly tied to prey abundance and the availability of alternate prey species during years when focal prey species populations are low (Salafsky 2004). The presence of Gambel oak means additional food availability for goshawk prey species in terms of mast (acorns) and increased species richness in terms of invertebrate prey species (Appendix 8).

**Understory Vegetation Within Ponderosa Pine Forest -** Grasses and forbs make up the herbaceous understory within the ponderosa pine plant associations throughout the project area.

Research across the 4FRI project area has shown substantial declines in herbaceous vegetation diversity and growth over the past century due to increased tree density, canopy covers, and forest floor depth (Appendix 8). This trend indicates a shift away from abundant food and cover for goshawk prey species as site occupancy and resource use became dominated by pine trees. See the goshawk MIS report and the silviculture report for additional information on habitat characteristics within the project area.

#### Coconino NF Goshawk Habitat Characteristics (Forest Service 2002, draft 2012)

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. The earliest record for a goshawk on the forest was in 1972. Opportunistic sightings and limited surveys were conducted in the 1980s and in 1990. Since 1991 annual surveys were initiated and have continued since then. Some surveys may have been conducted during nonbreeding or low breeding years thereby reducing survey success rates. Additionally, much of the habitat not associated with projects (i.e. wilderness) has not been surveyed. Therefore, the number of goshawk territories is likely underestimated on the Coconino NF. As of 2008, there were 70 known territories on the Coconino NF (Table 15). Goshawk territories have been established based on the results of surveys. Some goshawk nesting areas were known prior to 1991, but survey efforts increased in the early 1990's. In 1987, 11 territories were known on the Forest. Some level of monitoring has occurred since 1991 and is summarized in the MIS section for goshawk. The history of goshawk occupancy on the Coconino NF is summarized in Table 29.

On the Coconino National Forest, some northern goshawk territories have been monitored every year since 1989, with an average of 43 territories monitored from 1991 to 2001. The occupancy rate of territories has declined over the last eleven years; however, this does not signify a corresponding trend in population numbers. However, the goals of monitoring are to gain information on territory occupancy and reproduction; data collected on the forest are not designed to detect changes in population trends. See the forest-wide wildlife report for monitoring details and the history of goshawk occupancy on the forest. During the later years of this time period, precipitation amounts have been below average. Climate may very well play an important role in whether or not northern goshawks breed in a given year, and would also influence nesting success of northern goshawks.

The age class distribution of ponderosa pine is dominated by mid-seral stage stands. Loss of mature and old-growth aged trees continues to occur, primarily from fire, insects, and disease (see the silviculture report). Forest age-class distributions within goshawk habitat are displayed figures 10 through 13 (below). This decrease in older trees may have affected nesting habitat for goshawks. Some early seral-stage habitat has been created, mostly by wildfire (see fire ecology report). Because this species is dependent on the Forest's ability to provide a continuous flow of habitat structural types over time to provide nesting and foraging habitat, the habitat trend for goshawks should improve as vegetation management projects are implemented with the newer standards and guidelines and moved towards historic conditions. Goshawk surveys were conducted in 2011 and will continue in 2012 in association with 4FRI planning efforts. Previously unsurveyed areas meeting criteria for habitat and distance from occupied PFAs were designated as dispersal PFAs (dPFAs; see Modeling and Habitat methodology above).

**Table 29. Goshawk occupancy and reproduction from 1991 through 2008 on the Coconino National Forest**

| Year | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # Known Territories | 41 | 52 | 56 | 57 | 57 | 60 | 60 | 62 | 64 | 66 | 66 | 66 | 66 | 66 | 68 | 69 | 69 | 70 |
| Territories Monitored | 41 | 51 | 50 | 36 | 36 | 40 | 41 | 43 | 45 | 38 | 48 | 25 | 26 | 26 | 18 | 22 | 27 | 26 |
| Total Occupied | 36 | 36 | 35 | 19 | 22 | 13 | 12 | 17 | 21 | 19 | 12 | 18 | 16 | 16 | 6 | 8 | 10 | 6 |
| % Occupied | 88 | 71 | 70 | 53 | 61 | 33 | 29 | 40 | 47 | 50 | 25 | 72 | 62 | 62 | 33 | 36 | 37 | 23 |
| Nesting Attempts | 28 | 24 | 26 | 13 | 17 | 8 | 7 | 16 | 19 | 16 | 5 | 9 | 8 | 7 | 4 | 5 | 4 | 3 |
| Mean # of young | 1.2 | 1.7 | 1.3 | 0.5 | 1.4 | 1.0 | 0.7 | 1.5 | 1.8 | 1.2 | 0.8 | 1.0 | 0.5 | 1.7 | 1.25 | 1.4 | 1.5 | 1.0 |
| # Successful (fledged young) | 22 | 21 | 20 | 5 | 16 | 6 | 5 | 14 | 18 | 11 | 3 | 9 | 4 | 12 | 5 | 7 | 6 | 3 |
| % Nest Success | 79 | 88 | 77 | 39 | 94 | 75 | 71 | 88 | 95 | 69 | 60 | 100 | 50 | 100 | 100 | 100 | 100 | 100 |

### Kaibab NF Goshawk Habitat Characteristics (Forest Service 2010)

Forests and woodlands used for breeding by goshawks show great variation in horizontal and vertical vegetation structure. Despite the wide diversity of habitats occupied by goshawks, within a habitat type, goshawk nest areas are consistently comprised of mature and older forests. Typically, 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. In the southwest, goshawks use ponderosa pine extensively. Goshawks construct stick nests in the lower third of the largest tree available. Nest height 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. If there is ample prey available with adequate nesting structure, goshawks will nest regardless if the habitat type is forests, woodlands, or shrub lands. 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). Salafsky et al. (2005) suggest that 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.

Together 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 confounded by ongoing drought conditions.

Although most of the NKRD 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 . Data for the rest of the Forest show a similar decline in occupied territories (Figure 8). Note that trend lines do not denote statistical significance). 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. Goshawk surveys were conducted in 2011 and will continue in 2012. Previously unsurveyed areas meeting habitat and distance from occupied PFAs criteria were designated as dispersal PFAs (see Modeling and Habitat methodology above). There are currently 68 goshawk territories on the southern portion of the Kaibab NF, including 36 goshawk PFAs on the Kaibab NF portion of the project area.

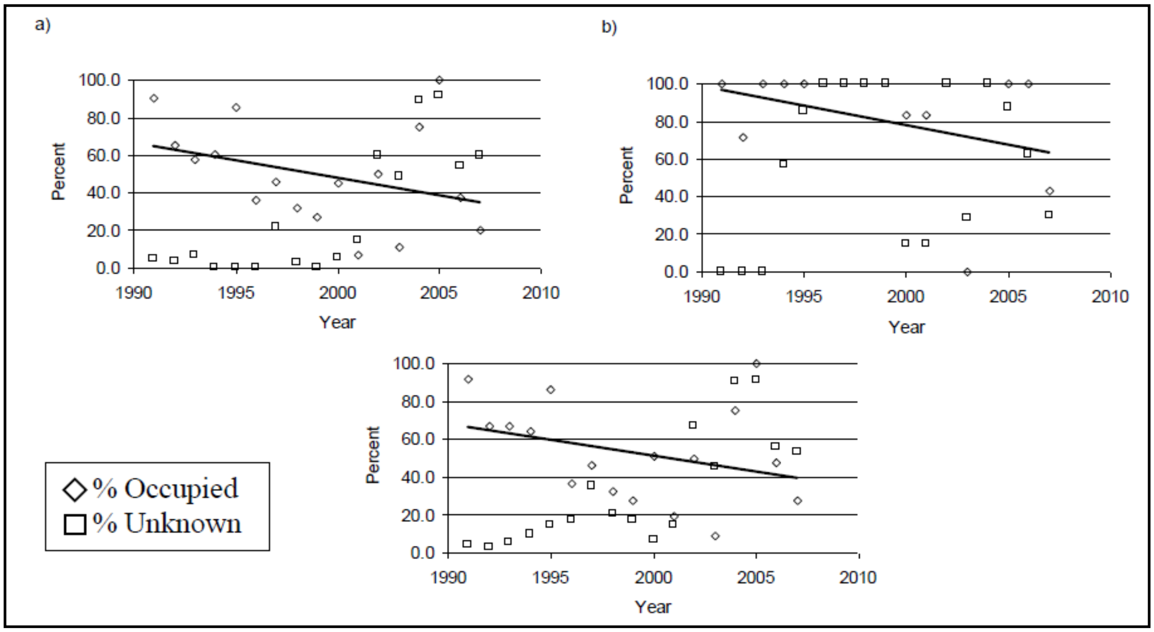



**Figure 8. Percent of surveyed and occupied goshawk territories present on the Kaibab National Forest (1990 to 2010) : a) Williams Ranger District, b) Tusayan Ranger District, and, c) South Zone (William's and Tusayan Ranger Districts combined)**

Considering the information above, northern goshawks are assumed to be declining on the Kaibab National Forest. However, if future weather patterns produce good precipitation, the population could stabilize. 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.

### Habitat Strata and Scales of Analysis

An analysis at three spatial scales is required by the Forest Plan for northern goshawk habitat. Evaluations of PFA habitat (used for nesting, breeding and primary foraging during the nesting season) and LOPFA;(used primarily for foraging) will be done at the project, subunit, and restoration unit (RU) levels. An additional fourth scale of analysis will be done at the landscape scale and will include all of the ponderosa pine within the project area. All PFA habitat and LOPFA habitat outside of MSO habitat occurring within the 4FRI treatment area is presented in Figure 9. Goshawk habitat outside of PFAs in designated MSO habitat is managed according to the MSO Recovery Plan.

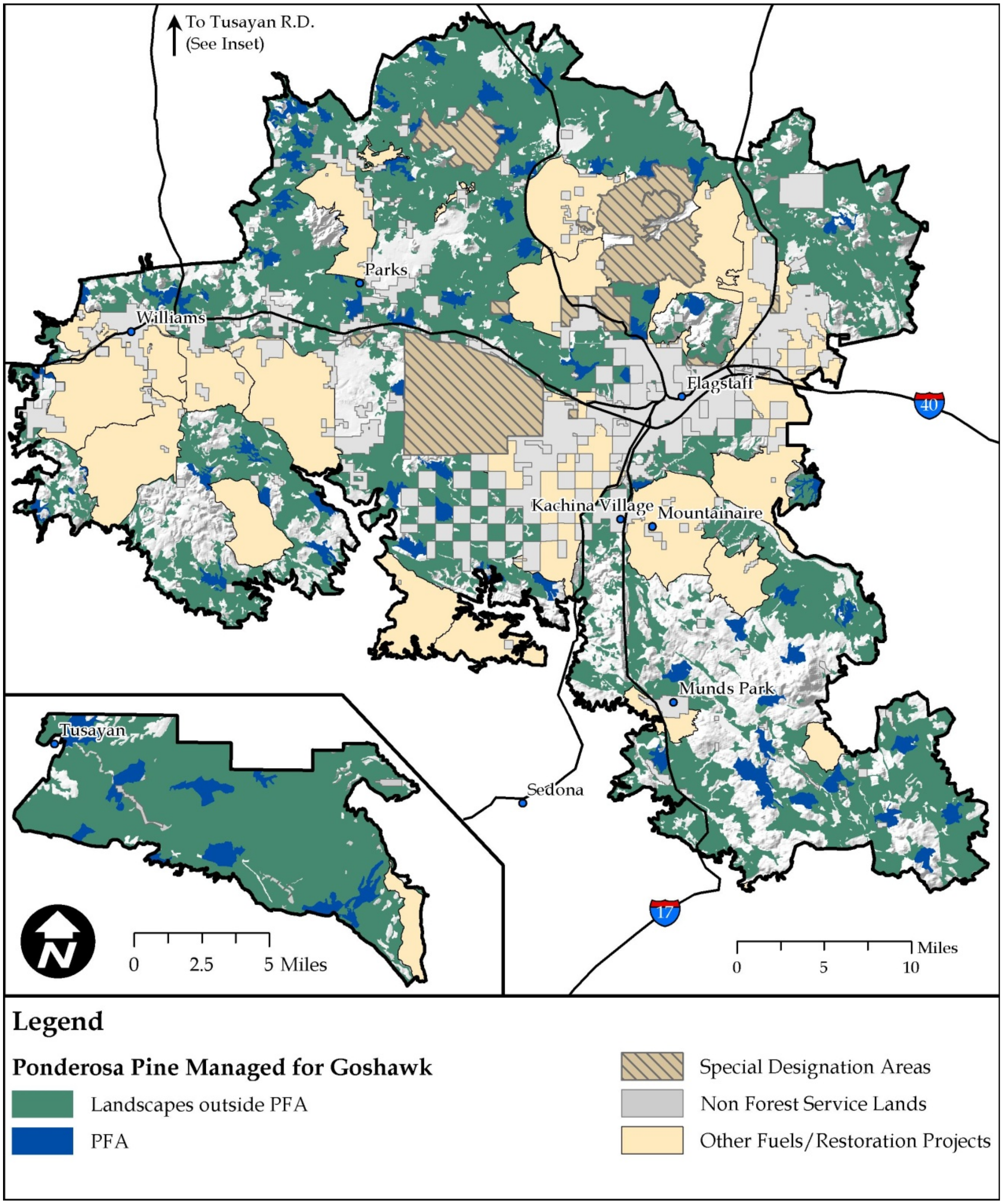



**Figure 9. All Goshawk Post Fledging Family Areas (PFAs) and Landscapes Outside PFAs Occurring Outside of MSO Habitat Within the 4FRI Treatment Area**

Large trees are defined as being 18” or greater in diameter (the low end of VSS 5 diameter range). Considering that both the MSO and the northern goshawk are associated with larger, older forested habitats, overlap in their habitats is to be expected. Management direction for those areas of overlap would follow prescriptions for the MSO because of its threatened status under the ESA. Those acres being managed for the MSO and under MSO prescriptions are not included in the total acre calculations for northern goshawk LOPFA habitat assessments. In general, the prescriptions for MSO habitat would result in dense forest structure with canopy gaps, versus the mosaic of tree groups and associated openings desired for goshawk habitat. MSO habitat treatments are designed to move the habitat towards denser and older forest conditions. For an analysis of the effects to MSO protected, restricted, and threshold habitats, see the MSO habitat analysis section of this report.

For perspective, the following graphs depict the relative percentages of the various northern goshawk habitat strata that would be under MSO prescriptions. Nest stands are the smallest unit of northern goshawk habitat and potentially the most limiting. Figure 10 displays just over one-quarter of the nest stands fall within either protected or restricted MSO habitat. The PFA area immediately surrounding the nest stands provides the closest foraging opportunities as well as alternate nesting sites. Similar to the nest stands, Figure 11 shows about the same portion of the PFA, slightly less than one quarter, is considered MSO habitat.

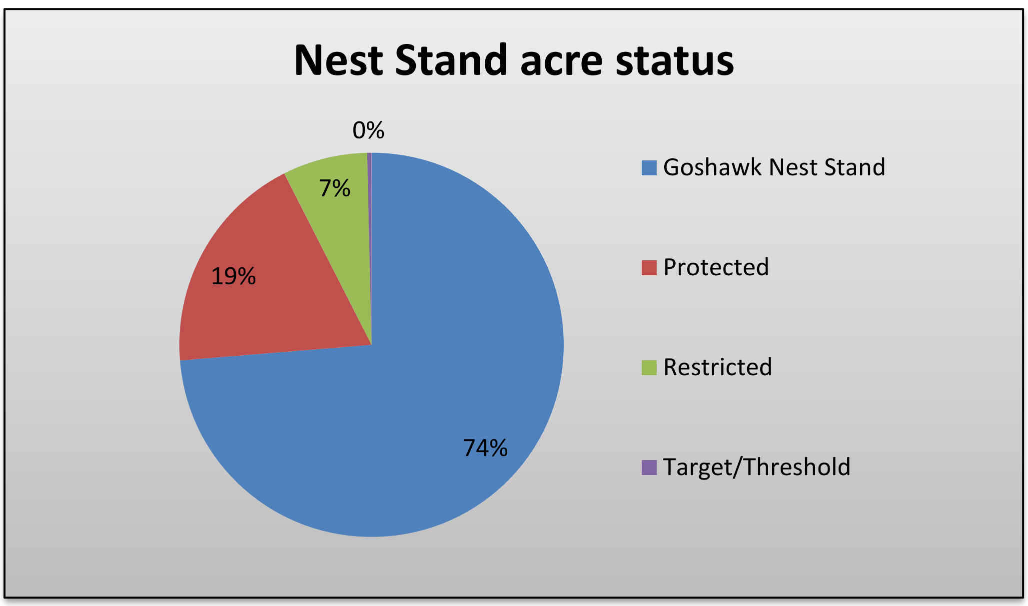



**Figure 10. Goshawk nest stand status by habitat type and percent of acres**

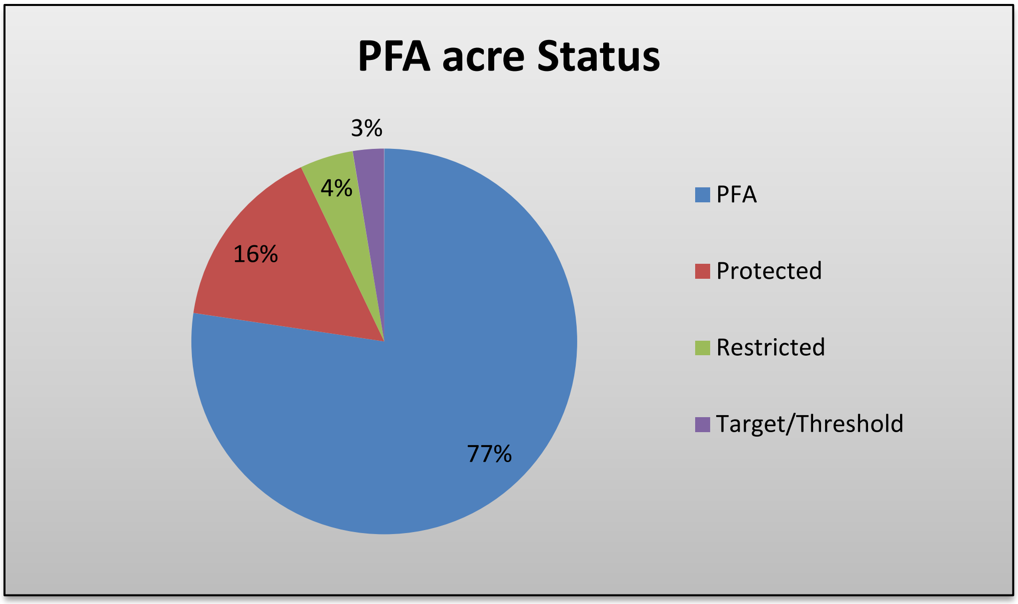



**Figure 11. Goshawk PFA status by habitat type and percent of acres**

About 30 percent of the areas designated as potential or dispersal PFAs (dPFAs), i.e., large enough areas distant enough from known PFAs that could potentially support a pair of nesting goshawks but which have not yet been surveyed, are within MSO habitat (Figure 12)

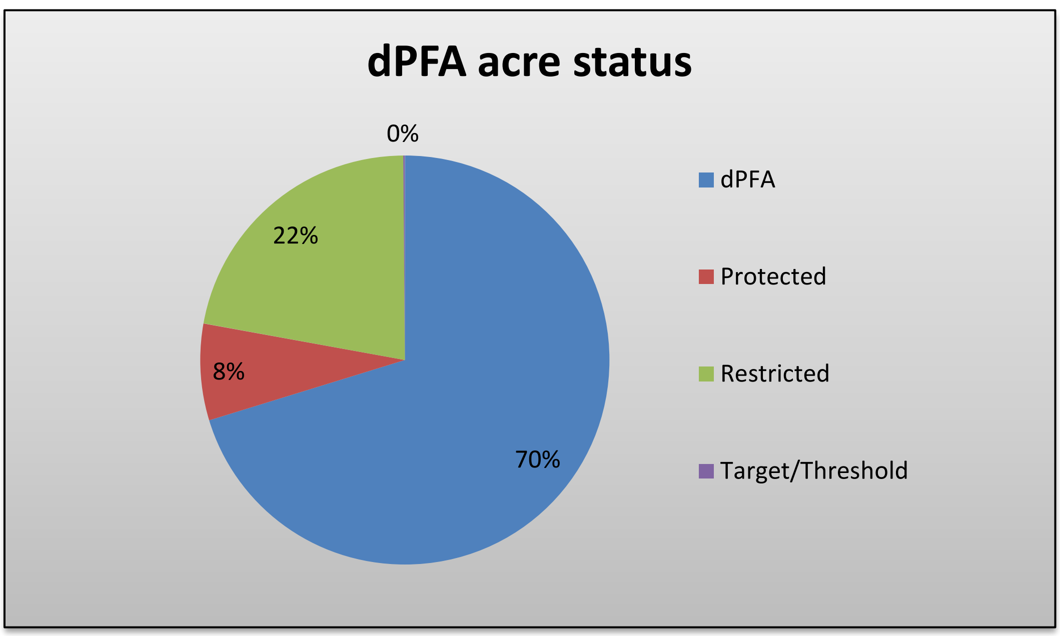



**Figure 12.Goshawk dPFA status by habitat type and percent of acres**

For the landscape outside of the PFAs (LOPFAs), where the emphasis is on prey species habitat, 22 percent is in MSO habitat (Figure 13).

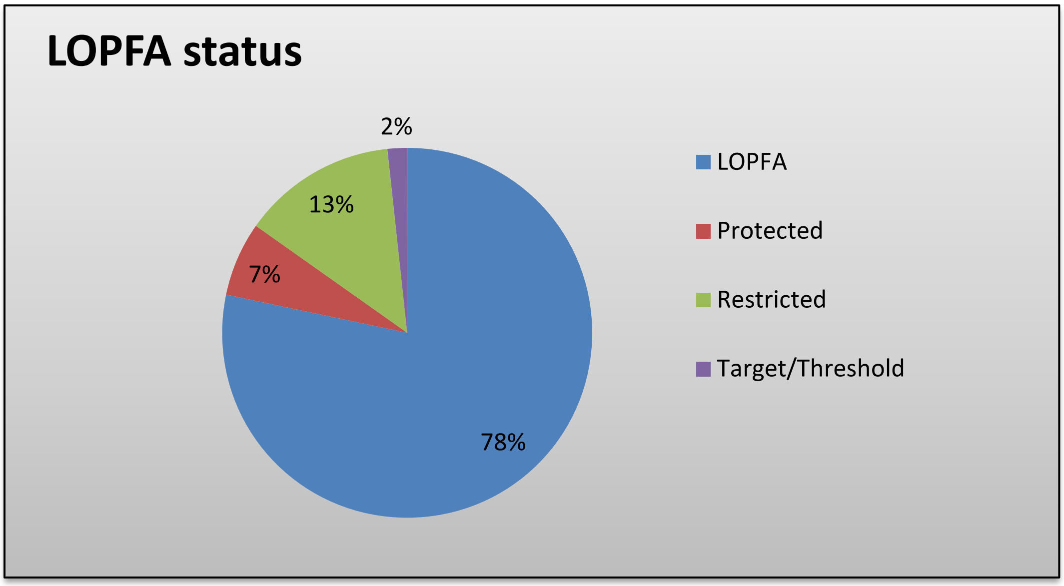



**Figure 13. Goshawk Landscape Outside PFAs (LOPFA) status by habitat type and percent of acres**

The conditions in those portions of the northern goshawk habitat that are within 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 be 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.

#### Project Level Analysis

For habitat within nest/PFA/dPFA areas, all of the acres within the respective goshawk strata were included in the calculations for VSS and changes to VSS within these areas. For the LOPFA, only those acres that were managed to northern goshawk prescriptions were included, which would be about 78 percent of the acres.

The existing ratios of VSS within nest/PFA/dPFAs at the project level are distributed with about 4/5 or 87 percent of the areas in the young to mid-seral VSS 3 and 4 (Figure 14). This is about double the acreage desired for these mid-seral structure stages in goshawk habitat (Figure 15). Additionally, seedling/sapling stage forest is about a level of magnitude below desired conditions for the distribution of VSS classes across the landscape.

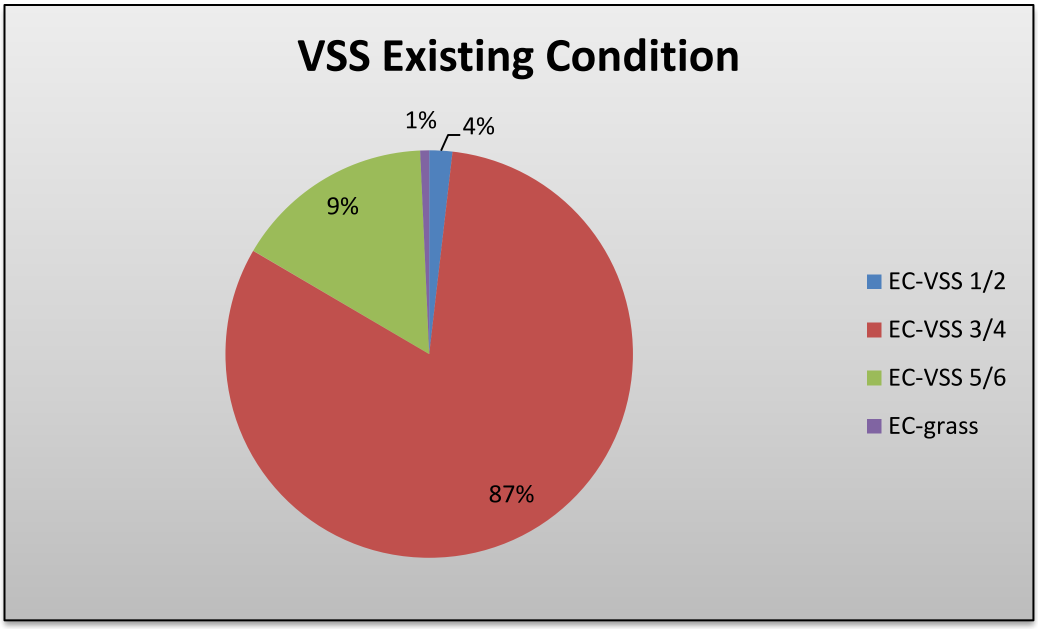



**Figure 14. Existing VSS percent within goshawk nest/PFAs**

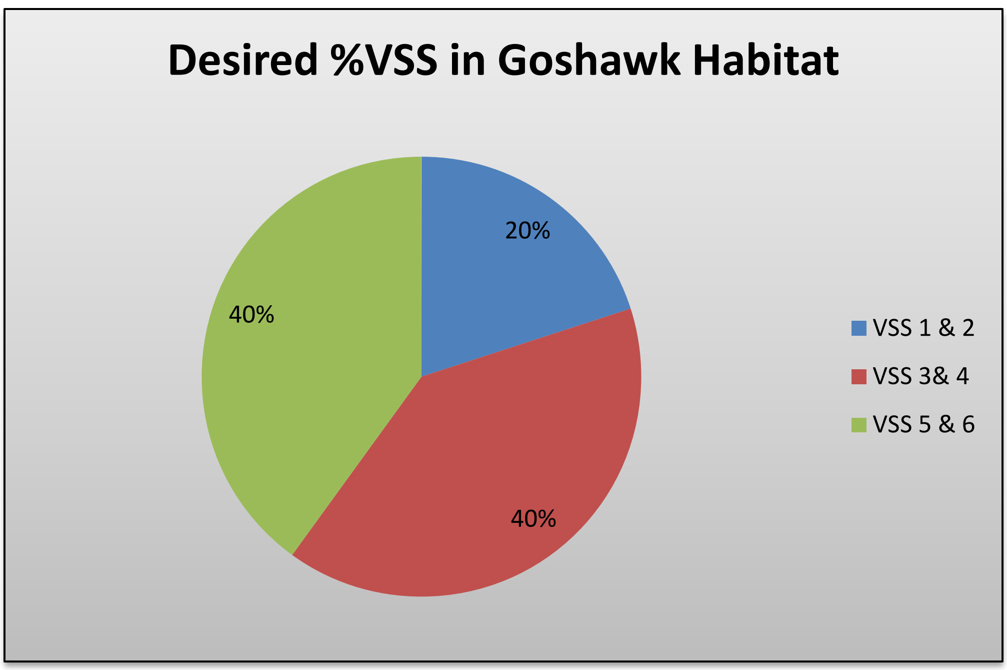



**Figure 15. Desired VSS percent in goshawk habitat across the landscape**

LOPFA acres, or those areas with an emphasis on foraging habitat, were analyzed in two parts based on stand structure of either even-aged or uneven-aged forest. About 44 percent of LOPFA areas are even-aged and 56 percent uneven-aged (Figure 16 and Figure 17). Appendix 9 displays the range in VSS classes for SU and RU for goshawk habitat in even- and uneven-aged stands.

Even-aged stands do not meet the desired condition for goshawk habitat or for forest structure in general (see Silviculture report). Even-aged structure limits habitat diversity. As described above, even-aged stands are currently dominated by mid-seral forest, restricting the area of regeneration and young-seral forest. Eventually this will limit the succession of trees into the larger size-classes (see Silviculture report).

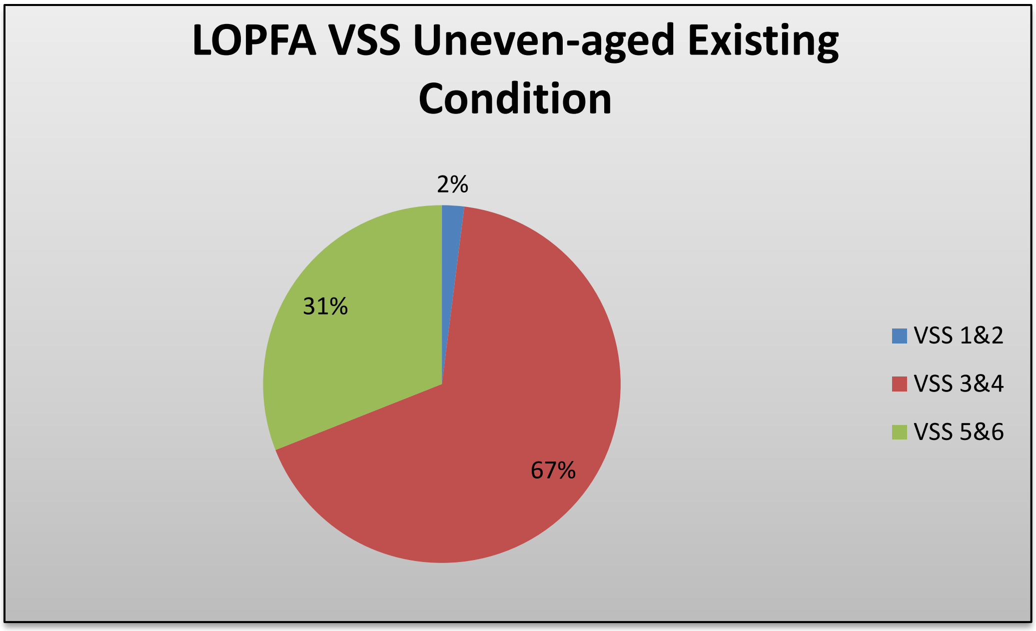



**Figure 16. Percent of Uneven-Aged VSS within landscapes outside of PFAs (LOPFA)**

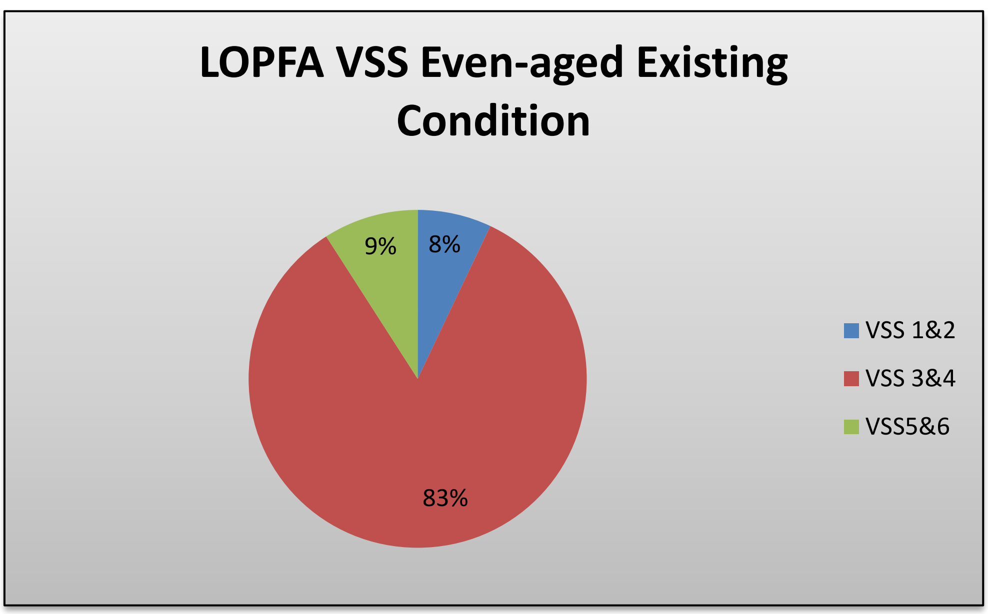



**Figure 17. Percent of Even-Aged VSS within landscapes outside of PFAs (LOPFA)**

Uneven-aged conditions partially meet forest plan direction, but the desired balance of VSS classes is lacking. The desired condition is to move even-aged stands to an uneven-aged structure and move forest conditions towards the forest plan VSS percent distribution.

### Restoration Unit (RU) Level of Analysis

A visual picture of the relative changes to goshawk nesting habitat among the SUs can be seen in Appendix 9. Appendix 10 displays pie charts of northern goshawk nest, PFA, and dPFA habitat by relative percent of VSS by RU for each alternative, including existing condition, the year 2020 (immediately post-treatment), and the year 2050 (thirty years post-treatment). The trends in changes are similar at all scales of analysis as are the reasoning for the resultant cause and effect. The VSS distribution for the RU level is thoroughly analyzed in detail in the silvicultural report. The VSS distribution is dominated by VSS 3 through VSS 6 in uneven-aged PFAs and LOPFAs. In even-aged PFA and LOPFA habitat, 80-100 percent of the stands are VSS 3 and 4. The only exception is RU-5 where 64 percent of the LOPFA are in VSS 3 and 4. Over a quarter of the LOPFA in RU-5 is VSS1 and the remainder is in VSS 5 and 6. The effects of the changes to the VSS on the northern goshawk are discussed in the analysis portion of this document.

### Restoration Subunit Level of Analysis

The existing condition and analysis of VSS changes among subunits (SU) is discussed in the silviculture report for this project. The VSS distribution among the SUs reflects those discussed for the RUs with the uneven-aged areas showing greater diversity of VSS distribution than the even-aged stands which have primarily mid-seral conditions in VSSs 3 and 4. Appendix 9 displays the range in VSS classes for SU and RU for goshawk habitat in even- and uneven-aged stands.

### Landscape Level of Analysis

For the landscape perspective, the ponderosa pine vegetation is addressed, encompassing the entire treatment area where changes would occur if 4FRI is implemented (Figure 18). The existing condition is not that different from the other goshawk strata analyzed above.

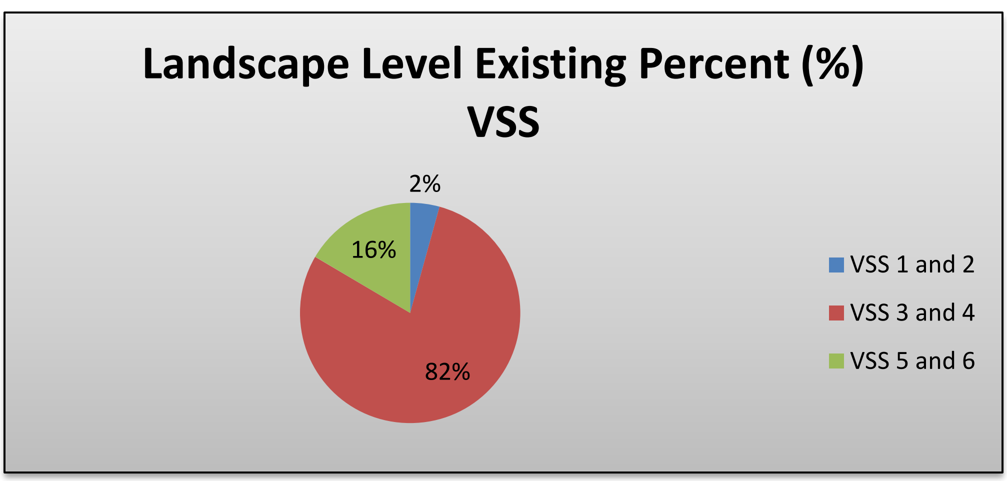



**Figure 18. VSS Percentage at the landscape level (ponderosa pine extent)**

### Stand Density and Canopy Cover Requirements

The existing condition within the PFA and LOPFA (Post-fledging Family Area and Landscape Outside PFA) is considered to be high, with stand densities typically above 40 percent of maximum SDI. This high density is classified as Zone 3 which includes: minimum forage production, severe competition among trees and active crown differentiation along with declining individual tree diameter growth at this tree density. (see silviculture report for stand density discussion). Desired conditions for goshawk habitat include 15 to 35 percent maximum SDI in LOPFA and 25 to 40 percent in PFAs. Neither BA, SDI, or TPA meet the desired conditions for goshawk habitat (Table 30and Table 31). Despite these dense conditions, tons of CWD greater than 12 inches diameter (i.e., logs) and snags greater than 18 inches dbh are both below desired conditions. Resulting stand dynamics include minimum forage production, severe competition among trees, and declining tree diameter growth. For information on projected changes in these metrics at the various spatial scales and the relationships between BA, SDI, TPA and canopy cover, see the silviculture report.

**Table 30. Forest structure values in goshawk habitat by forest by restoration unit**

| Forest by RU | Percent of Max SDI | Trees per Acre | Basal Area | Tons CWD[1] >12" | Snags >18" |
|---|---|---|---|---|---|
| **CNF** | | | | | |
| 1 | 52 | 240 | 125 | 1.09 | 0.42 |
| 3 | 52 | 249 | 125 | 0.30 | 0.37 |
| 4 | 53 | 250 | 127 | 1.87 | 0.41 |
| 5 | 45 | 231 | 107 | 0.95 | 0.46 |
| **KNF** | | | | | |
| 3 | 43 | 178 | 105 | 0.26 | 0.39 |
| 4 | 42 | 177 | 103 | 0.21 | 0.37 |
| 6 | 29 | 150 | 63 | 0.27 | 0.31 |

[1]An 8 ft long log with a 12 inch diameter = about 1/3 of a ton

**Table 31. Goshawk Habitat Desired Per Acre Forest Density and Habitat Components**

| Habitat | % Max SDI | Basal Area | Tons CWD | | Snags >18” |
|---|---|---|---|---|---|
| | | | Total | >12” | |
| PFA | 25-40% | 70-80 | 5 – 7 | ≥1 | 2 |
| LOPFA | 15-35% | 50-70 | 5 - 7 | ≥1 | 2 |

The trends in changes for these metrics are similar among the strata, with more variability at the smaller scales. The following graphs (Figure 19, Figure 20, and Figure 21) provide perspective for the expected changes to goshawk and prey habitat. Projected trends of various physical stand characteristics are based on FVS modeling (see silviculture report). The data for these graphs are compiled from individual stand data and aggregated up to the PFA/LOPFA at the landscape scale.

The existing condition within the PFA and LOPFA is considered to be high density or Zone 3 (Silviculture report). Resulting habitat dynamics include minimum forage production, severe competition among trees and declining tree diameter growth. 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 (Figure 19). 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.

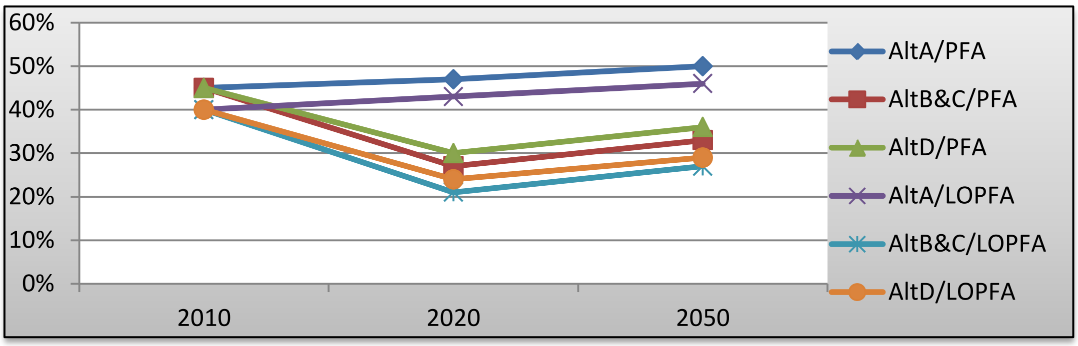



**Figure 19. Percent max Stand Density Index by PFA and LOPFA by Alternative**

The existing condition across the ponderosa pine landscape is about 200 trees per acre. The conditions in Alternative A would eventually reduce the TPA through density induced mortality from competition for limited space and resources (Figure 20). Alternatives B and C 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.

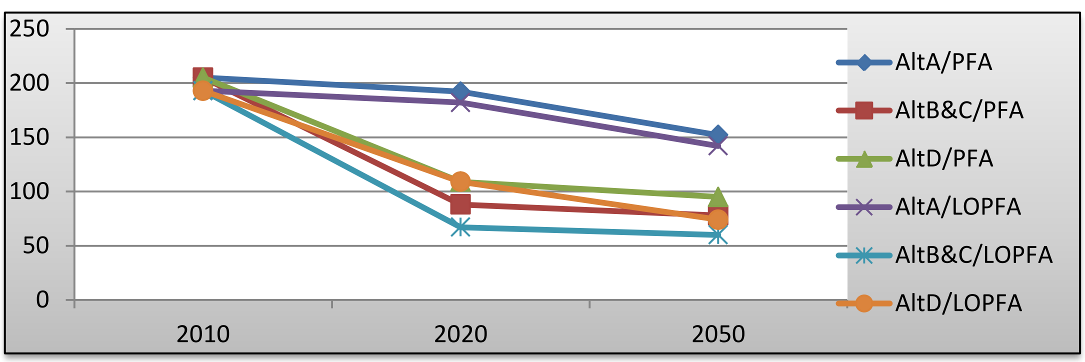



**Figure 20. Trees per Acre (TPA) PFA/LOPFA by Alternative**

Basal area is yet another way of measuring tree density. With no actions in Alternative A, the basal area would increase from the existing conditions, creating more dense forest conditions of trees competing for limited space and resources (Figure 21). In Alternative A, the basal area would be found in the number of trees on the landscape. Alternatives B and C reduce the basal area slightly more than Alternative D immediately post-treatment in 2020. The basal area increases for the next 30 years in all action alternatives as the residual groups of trees grow with the created space and more available nutrients and water. For the action alternatives, the increased basal area would be found in larger trees on the landscape. There is less increase in Alternative D as a result of less prescribed burning leaving higher tree densities on site to compete for water and nutrients.

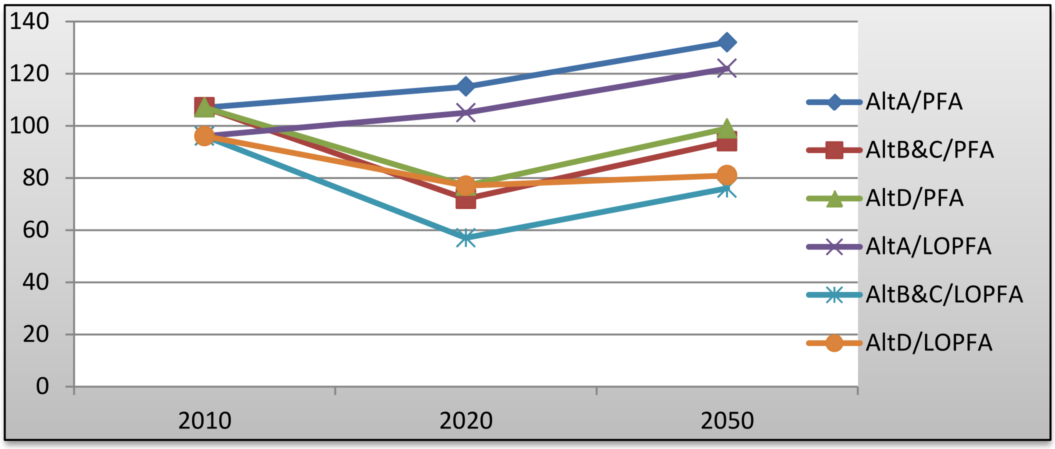



**Figure 21. Basal Area (BA) PFA/LOPFA by Alternative**

Because forests are so dense, canopy cover is also dense. The calculations in managing for canopy cover are incorporated within the tree group stocking guides for silviculture. Based on these guides, canopy cover of 40 percent or more would be met in VSS 4, 5, and 6 in LOPFAs. Similarly, canopy cover of 50 or 60 percent would be met in VSS 4, 5, and 6 in PFAs. . 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 %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. 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. A relative index was developed to compare potential understory vegetation development among alternatives (Figure 22). Alternative A represents the continuation of current conditions. See Appendix 8 for details.

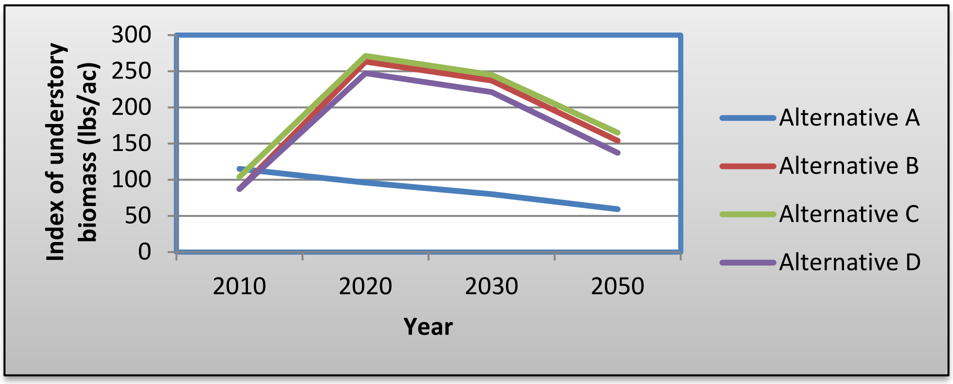



**Figure 22. Relative Index of Understory Biomass production on all habitats across the treatment area by alternative**

The index of understory biomass production is directly proportional to herbaceous understory production measured in lbs/ac (Appendix 8). Based on the projected changes to tree densities displayed above, with all other climatic factors the same, the relative index of biomass production would be drastically increased comparably for the action alternatives. This would be seen in the amount of herbaceous and shrubby material produced after the treatments. The index of biomass production would slowly decrease after treatment as the crowns on the standing trees grew and once again closed. With no treatments to open the canopy or reduce the density of trees across the landscape, the index of biomass production for Alternative A would steadily decline across the landscape. This would mean less grasses, forbs and shrubs would be produced as food and habitat for prey species. Compounding the issue is the fact that today's level of understory production is only a fraction of pre-settlement herbaceous growth (Appendix 8).

### Goshawk 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 nest by female 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.

The Management Recommendations for the Northern Goshawk 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 project 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 32). 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 twelve prey species.

**Table 32. Rating of habitat component importance[1] for twelve goshawk prey species**

| Species | Forest Type[2] | Snags | Downed Logs | Woody Debris | Openings | Large trees[3] | Herb, Shrub, Understory | Interspersion[4] 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 |

P – ponderosa pine / MS – mixed species / SF – spruce-fir / PJ – pinyon-juniper (from MRNG)

[1] Large trees = live >18 inches DBH (MRNG)

[2]PP – ponderosa pine / MS – mixed species / SF – spruce-fir / PJ – pinyon-juniper (from MRNG)

[3]Large trees = live >18 inches DBH (MRNG)

[4]Interspersion measures the degree of intermixing of vegetation structural stages (MRNG)

#### Measures of vegetative features relevant to goshawk prey species habitat

Like goshawk habitat, prey habitat has specific structural components important to the respective prey species. These habitat components are listed below with their respective forest plan guidance for management objectives. Existing conditions for each component are identified in Table 33.

- **Snags:** Move toward/Meet Forest Plan direction - 2 snags (>18"dbh)/acre in all PIPO
- **Downed logs:** Move toward/Meet Forest Plan direction - 3 downed logs (>12"diameter X 8 ft. long)/acre
- **Woody debris:** Move toward/Meet Forest Plan direction - 5-7 tons (>3"diameter)/acre
- **Openings:** Prevalence of openings inversely corresponds with %SDI – also included as design feature
- **Large trees:** Large ≥18"dbh (MRNG definition) – measured in acres of VSS 5 & 6
- **Herb, shrub, understory:** Quantity and quality directly correspond with relative biomass production in understory
- **Interspersion of VSS:** Degree of interspersion directly corresponds with extent of uneven-aged conditions

**Table 33. Existing Conditions of MRNG prey species' habitat features**

| Prey Species Habitat Component | Measure | Existing Condition |
|---|---|---|
| Snags >18"dbh | Snags/ac | 0.4/ac – pfa/lopfa |
| Downed Logs | CWD #/ac >12"diameter | 0.7/ac – pfa<br>0.4/ac - lopfa |
| Woody Debris | Tons/ac | 3.9/ac - pfa<br>3.5/ac - lopfa |
| Openings | Relevant to %SDI | 45% - pfa<br>40% - lopfa |
| Large trees | % VSS 5 & 6 | 18% VSS 5&6 |
| Herb, Shrub, Understory | lbs/ac biomass production | @ 100 lbs/ac |
| Interspersion of VSS | % age structure condition | 44% - Even-aged<br>56% - Uneven-aged |

#### Opposing Science

In 2008, Beier et al. compared goshawk reproduction at 13 nest sites located among three different management scenarios that each defined desired conditions for forest structure differently. Their study used recommendations developed by the Ecological Restoration Institute

(Northern Arizona University), an advocacy group (Greenwald et al. 2005) and the MRNG (Reynolds et al. 1992). They concluded that goshawk reproduction declined as forest structure in the breeding areas more closely resembled any of the tested desired conditions, including forest structure prescribed in the MRNG. In response to this investigation, Reynolds et al (2012) looked at Beier et al.'s analysis and found several apparent errors which, when taken together, largely discounted the conclusions. Beier et al.'s rebuttal paper (2012) was a discussion of the debate itself and offered no new scientific information.

It should be noted that Beier et al. 2008 is based on a review of the General Technical Report RM-217 - Management Recommendations for the Northern Goshawk in the Southwestern United States (Reynolds et al. 1992). The technical report and the 1996 Regional Amendment to all Region 3 Land Management Plans are not the same. The selected alternative for the 1996 Regional Amendment was the Mexican Spotted Owl Recovery Plan Integration Alternative. The standards and guidelines for northern goshawks in this alternative were developed in early May 1995, and considered all known information from the Goshawk Interagency Implementation Team recommendations, the joint Arizona and New Mexico game agency letters that responded to the DEIS, and experience gained during the implementation of the interim direction (USDA 2006). These are the directions used in developing project alternatives unless forest plans are specifically amended.

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

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

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

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

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

Greenwald et al. (2005) concluded that the MRNG may be inadequate to protect goshawks. Greenwald et al. (2005) based this conclusion on their review of 12 radio-telemetry-based studies of goshawk habitat selection and 5 nontelemetry 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.

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

### 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 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 2007). 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 project 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 4, 13 and AGFD (2011) describe this linkage.

Chytrid fungus was identified by the Chiricahua Leopard Frog Recovery Plan (USDI 2007) 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 2007). 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) on the project area (Appendix 13). Their range within the project boundary is now limited to permanent waters around Stoneman Lake. A number of water bodies within the project 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 project area boundary and they occur within subunits 1-2, 1-5 and 1-6. Best potential habitat within the project 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 Restoration Unit 1, 3, 4 and 5, the primary breeding and dispersal habitat occurs in Restoration Unit 1 where the amphibian linkage is designated. Restoration Unit 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. 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 2007) 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 Arizona Game and Fish Department 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 Arizona Game and Fish Department and confirmed active with 2 young nestlings.

### 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). Bald eagle winter night roosts typically consist of clumps of large (average dbh 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 project 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. 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 in ponderosa pine and mixed conifer habitats on less than 40 percent slopes bald eagle winter roosts are to be protected. 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 direction for GA 1 requires a 10-chain buffer (1320-feet) around existing and potential roosts. 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 512,178 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 on the project 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 project 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 48,774 acres of grassland, 39 miles of riparian habitat and ephemeral streams, 74 springs and wetlands.

### Clark's Grebe

Clark's grebe use marshes, lakes, and bays for nesting. They nest in colonies among tall emergent plants along the edge of large open waters. They feed on fish and aquatic invertebrates. Threats include unmanaged grazing, drought, and disturbance of nesting colonies. There is confirmed nesting at Mormon Lake, southeast of Flagstaff. Populations on the Coconino NF are variable because some of the nesting locations are ephemeral. Neither Clark's grebe nor their habitats have been identified on the Kaibab NF. The CNF FP guidelines are to maintain and improve nesting cover and waterfowl forage on existing waterfowl islands and shorelines. Wetlands and open water containing emergent vegetation which provide nesting habitat are protected from disturbing uses that will harass nesting birds or would damage nests or nesting habitat from May 1 to July 15. Most potential habitat is located on Anderson Mesa (Subunits 1-2 and 1-4), Marshall Lake (Subunit 1-3) and Mormon Lake (Subunit 1-5).

### 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 project 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 48,774 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.

### Ferruginous Hawk

Ferruginous hawks historically nest in open shrublands, woodlands, and grasslands in southeastern and northern Arizona. Their habitat is comprised of open country, primarily prairies, plains and badlands; sagebrush, saltbush-greasewood shrubland, periphery of pinyon-juniper and other woodland, and desert. Nesting occurs in the open areas or in trees including cottonwoods, willows,and swamp oaks along waterways.They need diverse early successional states of grasslands and herbaceous ground cover to support prey with low canopy cover. Prairie dog towns are wintering sites as they provide a concentrated prey source. The current distribution of breeding birds is restricted to Plains and Great Plains Basin grasslands in northern and northeastern Arizona. Ferruginous hawks range more widely in winter and are found throughout the state, often in agricultural areas and other open habitats (Latta et al.1999). Breeding bird atlasers found nesting ferruginous hawks occupying a fairly narrow range of elevations, from 4,700 feet to 6,400 feet (Corman and Wise-Gervais 2005) with no documented nesting on the Coconino or Kaibab National Forest. Arizona Game and Fish Department personnel document a nest close to the Kaibab (on state and private lands east and south of Valle area), approximately 10 miles from the project area boundary. Ferruginous hawks forage in montane subalpine grasslands in the Flagstaff vicinity. Prairie dogs were likely important in determining the historic breeding distribution of the ferruginous hawk in Arizona (Glinski 1998). Coupled with the loss of habitat, the widespread extirpation of these rodents has greatly reduced the hawk’s nesting distribution (Corman and Wise-Gervais 2005). There are 48,774 acres of grassland habitat within the treatment area that provide potential foraging habitat for prairie dogs and consequently, ferruginous hawks. Of this, 2,175 acres of proposed savanna and grassland treatment occurs in potential nesting habitat (below 6,400 feet elevation). There is no specific Forest Plan direction for ferruginous hawks or prairie dogs however guidelines for their habitat 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.

### Four Spotted Skipperling

This butterfly ranges throughout central and northern Arizona but has not been recorded within the project area. Four spotted skipperling habitat consists of moist meadows and streamsides in high elevation mountains. This species takes nectar in cool, deep canyons and along forested road margins. The species has also been seen congregating on moist cliffsides. Dactylis glomerata (Poaceae) is a strongly suspected food plant. Habitat fragmentation (the disruption of the herbaceous layer) can cause population isolation and therefore loss of gene flow which has been demonstrated to increase extinction risk in some butterflies (Appendix 8). The four spotted skipperling is associated with mixed broadleaf deciduous and montane willow riparian forest, wetland cienega and montane subalpine grasslands. Of these habitats only montane subalpine grassland and wetland cienega occur in the treatment area. There are 48,774 acres of montane subalpine grassland and 74 springs in the treatment area.

### Nitocris Fritillary

This butterfly is known from Apache and Coconino (Kehls Spring, Clover Spring) Counties in Arizona however no locations are documented in the project area. Their habitat includes mixed conifer, ponderosa pine, spruce fir, montane willow riparian forests and wetland cienega vegetation types. Of these, only the ponderosa pine and wetland cienega occur in the project area. It is a sensitive species for the Coconino NF. It has not been recorded on the Kaibab NF and is not considered a sensitive species for the Forest where the habitat is too dry and water too ephemeral to provide habitat. Potential habitat within the Coconino portion of the project area is found throughout the 322,771 acres of ponderosa pine and 53 springs and 57.6 miles of riparian habitat in Restoration Units 1, 3, 4 and 5 within the treatment area.

### Nokomis Fritillary

These butterflies are found near springs, seeps, wet meadows, and marshes (Opler and Wright 1999). The caterpillars are strongly associated with Viola and adults feed on nectar avidly at thistle. Within the project area they are known from drainages in the San Francisco Mountains. It is a sensitive species on the Coconino NF. It has not been recorded on the Kaibab NF and is not considered a sensitive species for the Forest where the habitat is too dry and water too ephemeral to provide habitat. Potential habitat within the project area is found in Restoration Units 1, 3, 4 and 5. Within these Restoration Units there are 53 springs and almost 58 miles riparian habitat that provide habitat in the treatment area. The main threat to the species is loss of habitat from draining or development.

### 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 512,178 acres of ponderosa pine and 48,774 acres of grassland within the treatment area.

### Long-tailed vole

Most of the species range is outside of Arizona (Bowers et al 2004). The range within Arizona includes the Coconino and Kaibab NFs (Patton 2011). Arizona is at the southern edge of the range where populations are generally restricted to higher elevations in isolated mountains (NatureServe 08/28/2012). This vole is widespread but usually uncommon in the west in areas with good cover such as forest edges, streamsides and thickets. The long-tailed vole has very localized populations in coniferous forest to rocky alpine tundra, sagebrush, semi-desert, marshes, moist meadows, and forest edges. Multiple small mammal surveys initiated by the Rocky Mountain Research Station and by Northern Arizona University have not documented long-tail voles in pine or pine-oak forests on the Coconino and Kaibab NF; however, they are expected to occur within the project area. Their habitat is montane subalpine grassland with minimal canopy cover, mixed conifer and spruce-fir with dispersion of structure and openings, including meadows with well-developed herbaceous understory and wet ground. They burrow in and use soil for cover. Long-tailed vole habitat can be found in alpine-tundra, mixed conifer, montane subalpine grassland, and spruce-fir. Potential habitat within the treatment area is 48,744 acres of grassland, 51 springs, 85 miles of riparian habitat and ephemeral streams.

### Dwarf Shrew

The dwarf shrew occurs within the 4FRI area (Patton 2011), but little is known about the population status of this insectivorous animal. It is considered critically imperiled in Arizona, but recent pit fall trapping efforts have substantially increased the number of known sites (NatureServe 08/28/2012). The species is known to occur on the San Francisco Peaks and White Mountains (Hoffmeister 1986) however shrews have not been documented in the project area. They also occur in habitats from alpine tundra to pinyon-juniper, including ponderosa pine forest. In addition, they occur in subalpine meadows, herbaceous wetlands, sedge marsh, dry brushy slopes, and arid short-grass prairie (NatureServe 08/28/2012). Rocky areas and down logs are important habitat components. Potential habitat within the treatment area is 25,658 acres of pinyon-juniper, 512,178 acres of ponderosa pine and 48,744 acres of grassland.

Their dentition and digestive tracts are adapted for crushing chitinous exoskeletons and consuming only minimal amounts of vegetative material. They are opportunistic predators and their diets tend to reflect the availability of insects. As a family, shrews primarily eat earthworms, larvae and adults of beetles, caterpillars, ants, true bugs, spiders, and grasshoppers (Martin et al. 1961, Merritt 2010).

### Merriam’s Shrew

Merriam’s shrew is distributed throughout the west and Hoffmeister (1986) shows them distributed along the Mogollon Rim. Patton (2011) identifies Merriam’s shrew occurring within the 4FRI area. They are associated with grassy areas in conifer forests, frequently near water, and grasslands interspersed or associated with water Hoffmeister (1986). Habitat components for Merriam’s shrew include grassy cover, logs and coarse woody debris, and proximity to water. The shrew is associated with dry habitat, but in proximity to water. They eat a variety of arthropods, feeding principally on insects and worms. Merriam’s shrew forage at ground level and beneath the leaf litter (Hoffmeister 1971). Herbaceous cover provides shelter for shrews and their prey and they would use runways established by meadow mice which, despite being larger than shrews, can also be a prey species. No surveys have been completed however Merriam’s shrews are expected to occur in ponderosa pine forests within the project area. There are 512,178 acres of ponderosa pine 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 project 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 lepidopterans 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 project area. One bat was radio-tracked near Kachina Village within the project area and roosted in a clump of Gambel oak in dry ponderosa pine forest (Chambers, pers. comm. 2010). 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 512,178 acres of ponderosa pine and 48,774 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 on the within the project area (Restoration Units 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 maternity roosts (Solvesky and Chambers 2009). Female roost trees were all within ponderosa pine forests Allen’s lappet-browed bats forage 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 project area in Subunits 1-5, 3-3, 5-1 and 6-3. Potential habitat within the treatment area is 512,178 acres of ponderosa pine and 25,658 acres of pinyon-juniper.

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).

### 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 Forests (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 512,178 acres of ponderosa pine and 48,774 acres of grassland within the treatment area.

There are 34 caves within 300 feet of the treatment area boundary. 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.

### Greater Western Mastiff Bat

The range for this bat includes all Arizona counties, except Yavapai, Navajo, Apache and Santa Cruz. This bat occurs within the Four Forest Restoration Initiative area (Patton 2011). A specimen was collected after death near Flagstaff in 1992. Significant cliff features are associated with their distribution and provide roosting habitat. Maternity colonies can consist of 30 to several hundred individuals (typically fewer than 100) and they roost generally under exfoliating rock slabs (e.g., granite, sandstone or columnar basalt) (Western Bat Working Group 2005c). They have been documented roosting in the Grand Canyon and foraging across the Kaibab Plateau over 25 miles from the project area, Greater western mastiff bats are habitat generalists and foraging habitat includes open ponderosa pine forests, high elevation meadows surrounded by conifers, and grasslands. Potential habitat within the project area is 512,178 acres of ponderosa pine and 48,774 acres of grassland habitat. Their diet consists primarily of moths but can also include beetles, crickets, katydids, and hymenopterans (Western Bat Working Group 2005c). Openings and open forests with diverse herbaceous ground cover aids in supporting prey species. There are no known roost locations on the Coconino NF or the South Zone of the Kaibab NF although roost habitat may occur on or near the Tusayan RD (Restoration Unit 6) (Solvesky, pers. comm. 2008).

### 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, pers. comm. 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 512,178 acres of ponderosa pine and 48, 774 acres of grassland within the treatment area.

Spotted bats have been captured in coniferous forests on the Kaibab Plateau over 25 miles from the project area and in other western states. Netting efforts did not result in captures on the Coconino NF or the Williams RD, but spotted bats were captured on the Tusayan RD, Restoration Unit 6, (Solvesky, pers. comm.2008). There are no known roost locations within the project area. Surveys of abandoned mines and natural caves on the Districts did not detect any spotted bats (Corbett 2008).

### Narrow-headed Garter Snake

The narrow-headed garter snake is the most aquatic of the garter snakes, seldom found far from quiet, rocky pools in large streams and rivers. It is primarily a Mexican species, but occurs in various areas along the Rim. On the Coconino NF, narrow-headed garter snakes are currently known from Oak Creek Canyon and a few sightings from the Verde River approximately five and eight miles respectively from the project area. Population numbers in Oak Creek Canyon have decreased significantly, particularly in the lower 1/3 of the canyon. Since the late 1980s they have been entirely absent downstream of Oak Creek Canyon. Historically, this species likely occurred throughout perennial riparian areas in the Verde Valley. Based on cottonwood/willow and mixed broadleaf riparian habitats, this species is considered a potential resident of all Coconino Ranger Districts. Neither this species nor its habitat occurs on the Kaibab NF. There are no known locations of narrow-headed garter snake within the project area; however, 39 miles of riparian habitat and ephemeral drainages could provide potential habitat. The entire area within Subunit 3-5 was considered for potential impacts to downstream habitat in Oak Creek.

## Bald and Golden Eagle Protection Act (Eagle Act)

All golden and bald eagles, regardless of status, are protected under the Bald and Golden Eagle Protection Act (Eagle 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 U.S. Fish and Wildlife Service (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 2007) 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 (Jacobson et al. 2005). 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 (esp. 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 48,774 acres of grassland.

## Forest Service Management Indicator Species

The Coconino NF and Kaibab NF forest plans identified the same 17 wildlife species as MIS to monitor ecosystem health. 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 34). The presence of species carried forward for analysis was determined by surveys conducted on the forest and the FAAWN database (Patton 2011).

**Table 34. MIS and Associated Habitats Not Analyzed in the 4-Forest Restoration Initiative Project**

| Management Indicator Species | Key MIS Habitat Component Indicator for | Comments |
|---|---|---|
| Aquatic maroinvertaebrates **Kaibab NF only** | Riparian | Only a indicator of stream quality in North Canyon Creek on the North Kaibab Ragner District, Kaibab NF. Outside of project area. |
| Mexican spotted owl (*Strix occidentalis lucida)* | 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*) | 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*) | Late-seral, low-elevation, riparian habitat (< 7,000 ft) | There are 6 miles of proposed ephemeral stream channel restoration with riparain vegeation on the Coconino NF; only a fraction of this habitat occurs below 7,000 feet elevation. Riparian vegetation within these ephemeral channels does not include woody vegetation. No stream restoration with riparian habitat will occur on the Kaibab NF. The proposed restoration will not remove woody riparian vegetation. Thinning and burning could increase water-yeild for up to 5 years. This would not affect the late-serial ripairian habitat. |
| Lucy's warbler (*Vermivora luciae*) | Late-seral, low-elevation, riparian habitat (< 7,000 ‘) | There are 6 miles of proposed ephemeral stream channel restoration with riparain vegeation on the Coconino NF; only a fraction of this habitat occurs below 7,000 feet elevation. Riparian vegetation within these ephemeral channels does not include woody vegetation. No stream restoration with riparian habitat would occur on the Kaibab NF. The proposed restoration would not remove woody riparian vegetation. Thinning and burning could increase water-yield for up to 5 years (see waterwshed report). This would not affect the late-seral ripairian habitat. |
| Lincon's sparrow (*Melospia lincolnii*) | Late-seral, high-elevation riparian habitat (> 7,000 ‘) | There are 6 miles of proposed ephemeral stream channel restoration with riparain vegeation on the Coconino NF; only a fraction of this habitat occurs below 7,000 feet elevation. Riparian vegetation within these ephemeral channels does not include woody vegetation. No stream restoration with riparian habitat would occur on the Kaibab NF. The proposed restoration would not remove woody riparian vegetation. Thinning and burning could increase water-yield for up to 5 years (see waterwshed report). This would not affect the late-seral ripairian habitat. |

| Management Indicator Species | Key MIS Habitat Component Indicator for | Comments |
|---|---|---|
| Cinamon teal<br>(*Anas cyanoptera*) | Wetlands | There is no proposed activities within wetland habitat. The 6 miles of proposed ephemeral steam restoration with riparian habitat is not teal habitat. Thinning and burning could increase water-yeild for up to 5 years. This would not affect the wetland habitat. |

Ten MIS whose distribution on the forest encompasses part or all of the treatment area were included in the terrestrial effects analysis (Table 35). The analysis is based also on the forest plan and projected changes in acreage of quality habitat under all of the alternatives.

**Table 35. MIS Analyzed for the Four-Forest Restoration Initiative project**

| Management Indicator Species | Key MIS Habitat Component Indicator for | Habitat within analysis (project) area |
|---|---|---|
| Aquatic maroinvertaebrates<br>**Coconino NF only** | Riparian | See fisheries MIS section |
| Northern Goshawk<br>(*Accipiter gentiles*) | Late-seral ponderosa pine | Ponderosa pine |
| Pygmy nuthatch<br>(*Sitia pygmaea*) | Late-seral ponderosa pine | Ponderosa pine |
| Turkey<br>(*Meleagris gallopavo*) | Late-seral ponderosa pine | Ponderosa pine |
| Abert’s squirrel<br>(*Sciurus aberti*) | Early seral ponderosa pine | Ponderosa pine |
| Rocky Mountain elk<br>(*Cervis elaphus*) | Early seral ponderosa pine, mixed conifer, and spruce-fir | Ponderosa pine |
| Hairy woodpecker<br>(*Picoides villosus*) | Snags in ponderosa pine, mixed conifer and spruce-fir | Snags in ponderosa pine |
| Red-naped sapsucker<br>(*Sphyrapicus varius*) | Late-seral aspen and snags in aspens | Aspen and snags in aspen |
| Mule deer<br>(*Odocoileus hemionus*) | Early seral aspen and pinyon-juniper | Aspen and pinyon-juniper |
| Juniper titmouse<br>(*Baeolophus ridgwayi*) | Late-seral pinyon-juniper,and snags in pinyon-juniper | Pinyon-juniper and snags in pinyon-juniper |

| Management Indicator Species | Key MIS Habitat Component Indicator for | Habitat within analysis (project) area |
|---|---|---|
| Pronghorn<br>(*Antilocapra americana*) | Early and late seral grasslands | Grassland |

MIS and the habitats they represent are listed in the most recent Kaibab NF (Forest Service 2010) and Coconino NF (Forest Service 2002) Forestwide Management Indicator Species reports. A draft update for the Coconino NF is currently being developed (Overby, pers. comm.) and was used where noted in association with discussions with the Coconino Forest Biologist. 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. Information on species, their population trends, and habitat trends presented in the MIS Forestwide reports are incorporated by reference for 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 Rocky Mountain Bird Observatory and their western states monitoring program can be found at: http://www.rmbo.org/public/monitoring. One component of the bird survey effort is a sympatric tree squirrel survey. Initial results from this effort were included in the Abert's squirrel effects analysis.

Population status and trend updates for all game species were provided by the Arizona Game and Fish Department (AGFD) for the 4FRI (see Appendix 6). 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 both the Coconino and Kaibab NFs. 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 will continue in 2012.

The Forest Vegetation Simulator (FVS) tree growth model was used to determine changes in forest stand dynamics (for more information on FVS see the silviculture report). This information was used for changes in seral stages for ponderosa pine stands. Where possible, data on forest-wide vegetation was taken from the Forest-wide reports for MIS species. If acreages were not available than potential natural vegetative type (PNVT) acreage was used. PNVT acreage for different vegetation types was developed for each forest as part of the forest plan revision process. For the total acres of early and late seral ponderosa pine for the Coconino NF this analysis used the vegetation model (VDDT) from forest plan revision to determine available acres.

### Late-seral Ponderosa Pine Species Indicators– northern goshawk, pygmy nuthatch, and wild turkey

The northern goshawk, pygmy nuthatch and wild turkey are all indictors 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 forest-wide surveys for both forests. Wild turkeys have been seen within the analysis area during the Rocky Mountain Bird Observatory forest-wide surveys and during survey efforts coordinated by AGFD.

All presettlement ponderosa pine trees would be retained in all alternatives unless instances of human health and safety warrant removal. Similarly, large young trees could be removed to meet restoration objectives. Over time (see 2050 projected size class structure in silviculture report), all alternatives would increase VSS 5 and VSS 6 which is currently deficit in the project area. Most old and large trees are expected to be retained. Therefore, the main difference is how much acreage (by alternative) grows into late-seral habitat. The change in acreage by year and alternative is described in the silvicultural. The acreage is based on no high severity wildfire occurring within the analysis area over the next 40 years.

**Kaibab NF late-seral ponderosa pine habitat trend**: The forest-wide habitat trend for the late-seral ponderosa pine is in an upward trend due to the forest emphasis on retaining groups of large trees and maintaining large-sized reserve trees (see appendix 12 for comprehensive list of projects with management objectives). Forest-wide, there are approximately 200,000 acres of ponderosa pine forest in trees greater than 18” dbh (Forest Service 2010). Within the treatment area there are about 27,921 acres of late-seral ponderosa pine on the Kaibab NF (see silviculture report), which is approximately 14 percent of this age class across the Forest. However, the analysis occurs on 189,407 acres of ponderosa pine habitat which is approximately 37 percent of the ponderosa pine cover type acreage for the Forest.

**Coconino NF late-seral ponderosa pine habitat trend:** The forest-wide habitat trend for late-seral ponderosa pine is declining. The age class distribution of ponderosa pine has remained essentially the same, dominated by mid-seral stage, with some loss of old-growth and older trees, and some early-seral stage habitat created by wildfire (Forest Service 2002). Based on the VDDT model there are about 80,773 acres of late-seral ponderosa pine available forest-wide. Within the analysis area there is approximate 56,615 acres of late-seral ponderosa pine, which is approximately 70 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 PNVT acreage for the Forest.

#### Northern Goshawk

**Kaibab NF**

The Kaibab National Forest (KNF) lies in three disjunct parts; two portions south of the Grand Canyon and one part north of the Grand Canyon. The Tusayan and Williams Ranger Districts lie south of the Grand Canyon and are within the project area (see Figure 1). The North Kaibab Ranger District (NKRD) lies north of the Grand Canyon and is not within the project area. Of the 203 PFAs on the KNF, 135 are on the NKRD, 68 are on the southern portion of the KNF, and 36 are within the project area.

On the KNF, ponderosa pine forest covers approximately 515,148 acres (about 34 percent of the total Forest acreage) and occurs on all three Ranger Districts (Table 36). Similarly, the corresponding PNVT covers 541,000 acres, approximately 35 percent of the total land area.

**Table 36. Kaibab NF Existing Conditions of Late Seral Ponderosa Pine (PIPO)**

| Kaibab NF Existing Condition Measure | Acres | Relevance |
|---|---|---|
| **Acres PIPO forest-wide** | 515,148 | Entire indicator vegetation type |
| **Acres of late seral PIPO (1988)** | Not available at the time the Forest Plan was implemented | Reference condition* |
| **Forest-wide late seral (18”+) acres** | 200,000 | 39% of PIPO forest-wide |
| **Project Area KNF PIPO acres** | 189,407 | 37% of PIPO forest-wide |
| **Project Area KNF late seral (VSS 5&6) PIPO Acres** | 27,921 | 14% of the late seral PIPO forest-wide |

*Acres of late seral ponderosa pines are from the MIS report see p. 105 and the graph on p. 116

Figure 23 is from the Kaibab forest-wide MIS report and displays TPA for ponderosa pine by size-class across the KNF. A natural pattern of tree size classes in an uneven-aged forest would show an abundance of small trees and decreasing numbers of trees as dbh increases. Tree patterns on the North Kaibab, which is outside the 4FRI area, resembles this pattern. The South Zone of the Kaibab NF, i.e., the portion in the 4FRI project area, displays a peak in mid-sized trees and low numbers of trees greater than 24 inches dbh. The pattern of tree size-classes is even more skewed for the Williams RD alone because logging on the Tusayan RD was of shorter duration (USDA 2010).The South Kaibab pattern matches the conclusions in the 4FRI silviculture report.

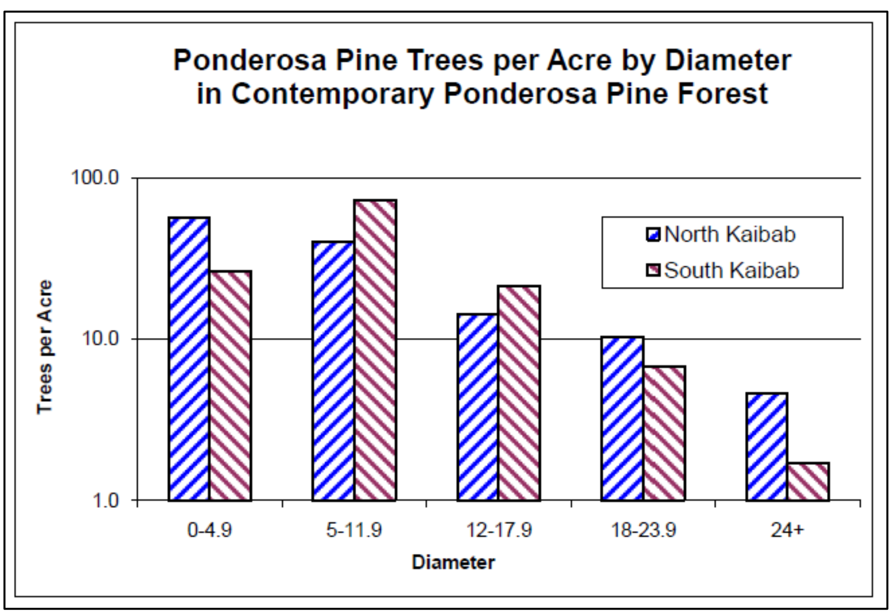



**Figure 23. Tree densities by size class across the KNF (adapted from FIA data)**

### Kaibab NF goshawk population trend:

The northern goshawk forest-wide population trend (Table 37) is considered to be declining at this time. This decline is thought to be due to drought affects to prey species abundance and the generally dense conditions of ponderosa pine forests in the being overstock with a high basal area (Forest Service 2010).

**Table 37. Existing Trends from Current Kaibab National Forest level MIS Report (2010)**

| Species | Relevance | Indicator Habitat | Habitat feature | Habitat trend | Population trend |
|---|---|---|---|---|---|
| Northern goshawk | Subject species | Ponderosa pine | Late seral | Positive | Declining |

**Coconino NF**

On the Coconino NF, there are close to 700,000 acres of the non-wilderness ponderosa pine cover type (which includes ponderosa pine-Gambel oak), and cover type acreages have remained essentially the same (Table 38). At the time the Forest Plan was developed (1987), there was not much late seral ponderosa pine. There has been some decline, particularly in the large tree component, due to both management activities and natural loss, since implementation of the Plan. See the project's appendix 12 which provides a comprehensive list of projects with management objectives. Forest-wide, the mid-seral stage continues to dominate forest structure, accounting for 70 percent or more of the acres (see silviculture report for additional detail). The remaining 30 percent would be divided between the early and late seral stages for ponderosa pine. Based on the VDDT model there are about 80,773 acres of late-seral ponderosa pine available forest-wide. Within the analysis area there is approximate 56,615 acres of late-seral ponderosa pine, which are about 70 percent of this age class across the Forest.  See Figure 1 for those portions of the CNF that lie within the project area. For the Coconino NF, there are 70 PFAs on the Forest and 38 of them are within the project area (Overby, personal communication).

**Table 38. Coconino NF Existing Conditions of late seral ponderosa pine (PIPO)**

| Coconino NF Existing Condition Measure | Acres | Relevance |
|---|---|---|
| **Acres PIPO forest-wide** | 700,000 | Entire indicator vegetation type |
| **Acres of late seral PIPO (1987)** | Not Available at the time the Forest Plan was implemented | Reference condition* |
| **Forest-wide late seral (18”+) acres** | 80,733 | -12% of the PIPO forest-wide |
| **Project Area CNF PIPO acres** | 322,772 | -46% of the PIPO forest-wide |
| **Project Area CNF late seral (VSS 5&6) PIPO Acres** | 56,615 | -8% of the PIPO forest-wide – -<br>-18% of the PIPO on CNF in project area |

*Acres of late seral ponderosa pines are from the MIS report see p. 105 and the graph on p. 116

**Coconino NF goshawk population trend:** BBS data (Sauer et al. 2011) for Arizona from 1966-2008 shows a positive population trend of 3.5 percent per year. For the ten-year period 1998-2008, trends for northern goshawk shows a 3% annual increase in observations. Sauer and Link (2011) suggest that the long-term positive trends observed over the 1966-2008 period may be a function of increase in survey effort, but trend estimates for the period 1999-2009 show a 2.2% annual increase in observations of northern goshawk within Arizona (Sauer et al. 2011). For comparison, the trend estimate for the southern Rocky Mountain/Colorado Plateau region for the same time period is estimated at 2.4 percent annual increase. The limited number of observations of this species on BBS routes makes this figure less than reliable.

The forest-wide trend is inconclusive. Although the Forest has some information on territory occupancy and reproduction, these data are not designed to detect changes in population trend. The total number of territories has increased, and statewide BBS data indicate a significant increase, but some indicators of occupancy and productivity appear to be declining on the Forest. Monitoring and surveys are ongoing on the Forest (Forest Service 2002). Table 39 displays the Coconino NF's habitat and population trend.

**Table 39. Existing Trends from Current Coconino National Forest level MIS and draft Forest level MIS Reports (2002, 2012)**

| Species | Relevance | Indicator Habitat | Habitat feature | Habitat trend | Population trend |
|---|---|---|---|---|---|
| Northern goshawk | Subject species | Ponderosa pine | Late seral | Declining | Inconclusive |

### Pygmy Nuthatch

The pygmy nuthatches use snags or trees with dead portions suitable for excavation for nesting. They are primarily insectivorous and 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 (Forest Service 2010).

**Kaibab NF pygmy nuthatch population trend:** The pygmy nuthatch is believed to be stable to declining forest-wide on the Kaibab National Forest. In areas that were treated with thinning and prescribed burns or have been thinned and burned naturally, pygmy nuthatches are likely stable to increasing (Forest Service 2010).

**Coconino NF pygmy nuthatch population trend:** The forest-wide trend is stable, although there are dramatic population fluctuations in the short term, and small, local populations, such as those in snowmelt drainages, may be temporarily extirpated (Forest Service 2002).

### Turkey

Turkeys are selected as an indicator for late-seral ponderosa pine which is used for nesting and roosting, however, many different factors of the proposed project would affect population trends for the turkey. Turkey population trends are mostly 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, and they select foraging and loafing habitats within a mix of meadows, oak, and juniper. Turkeys roost in tree groups that average 36 trees with dbh > 16", where the roost tree is often >24" dbh. 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, however unlike in their nesting habitats turkeys select for a higher canopy base height (>24') when roosting.

Clumpy-groupy forest structure is also important for turkeys in their foraging habitats, where they select for small forest opening (0.28-0.31 acres) for feeding. 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 in 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 $mi^2$. Since turkeys are a relatively wide-ranging species, they are likely to respond to changes in forest management at small and large spatial scales.

**Kaibab NF turkey population trend:** Wild turkey population trend on the Forest is considered to be variable but overall increasing (Forest Service 2010). Turkeys are found primarily in ponderosa pine forest with a mix of meadows, oak and juniper. They use larger older trees for nesting and roosting.

**Coconino NF turkey population trend:** The forest-wide population trend is increasing. 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 along survey routes. AGFD developed a better index of turkey populations in the mid-1990s. Data from 1997-2001 indicate a modestly increasing trend. For the last five years (1997-2002), GMU 7 shows a relatively stable trend, with all other GMUs showing a general increasing trend for both percent of archery elk hunters seeing turkeys and the number of turkeys seen per day (Forest Service 2002; also see Appendix 6).

## Species Indicators for Early-seral Ponderosa Pine – Elk and Abert's squirrel

Elk and Abert's squirrels are indictors for early-seral ponderosa pine habitat. Abert's squirrels have been seen in the treatment area during Forest-wide surveys on both forests. Since both of these species are part of the state permitted hunt structure, this will affect population trends both species at the state and local levels. Elk forest-wide populations are managed primarily by the state through their permitted hunt structures.

**Kaibab NF early-seral ponderosa pine habitat trend:** There is approximately 40,000 acres of early-seral ponderosa pine habitat across the forest. Current habitat trend for early-seral ponderosa pine is considered stable at this time (Forest Service 2010). Within the analysis area there are about 7,411 acres of early-seral ponderosa pine, which is approximately 18 percent of this age class across the forest. However, the analysis occurs on 189,407 acres of ponderosa pine habitat which is approximately 37 percent of the ponderosa pine cover type acreage for the forest.

**Coconino NF early-seral ponderosa pine habitat trend:** Forest-wide trend for early-seral ponderosa pine is stable. The age class distribution of ponderosa pine has remained essentially the same, dominated by mid-seral stage stands, with some loss of old growth and older trees, and some early seral stage habitat created by wildfire (Forest Service 2002). Based on the VDDT model there are approximately 152,836 acres of early-seral ponderosa pine available forest-wide. Within the analysis area there is approximate 14,525 acres of early-seral ponderosa pine, which are about 10 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 PNVT acreage for the forest.

### Elk

Elk are indictor of early-seral conifer habitat which is used for foraging, however, many different factors of the project would affect population trends for the elk. Elk are habitat generalists. In addition to occupying ponderosa pine forests, they graze grassland and woodland habitats as well as aspen and riparian areas. On both forests, elk occupy mountain meadows and forests in summer and move to lower-elevation pinyon-juniper woodland, conifer forest, and grasslands in winter.

Forage availability is important to help provide good body condition. Foraging areas are primarily openings in the forest canopy where perennial grasses and forbs are more readily 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 forest tree groups and openings tend to improve habitat conditions for elk by increasing grassland primary productivity while still providing cover nearby.

According to the AGFD, the 4FRI project area includes portions of four elk herds. One herd includes Game Management Units (GMU) 5A/5B/6A and occurs on the Coconino NF. The second herd includes 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 the fourth herd in GMU 9, which occurs primarily on the Tusayan Ranger District of the Kaibab NF. It is important to note that elk that intermix among herds do not always go back to their respective GMU after winter, which complicates interpretation of both population- and habitat-utilization data for this species.

#### Kaibab NF Elk Population trend

During the analysis for the forest-wide elk population trend in 2010, the population trend was considered to be stable at that time (Forest Service 2010.) Analysis using current data from the AGFD (Appendix 6) shows that the elk population is in a decreasing trend (see Figure 24 and Figure 25). Both forests have been working with AGFD to decrease the amount of elk on the forest for protection of forest resources. The elk numbers have primarily been affected by the hunting and the amount and type of hunting tags issued.

#### Coconino NF Elk Population trend

The Forest-wide population trend is stable based on the analysis done in 2002. Elk numbers on the Forest increased in the early to mid-1990s, with a gradual decline through 2001 to roughly the 1980’s level (Forest Service 2002). However, analysis using the most recent data from the AGFD based annual surveys shows that the elk forest wide population is in a decreasing trend

(Figure 24 and Figure 25; Appendix 6**).** Surveys include Game Management Units 5A, 5B, 6A, 6B, Camp Navajo, 7, 8, and 9. All data are available from AGFD Flagstaff Regional Office.

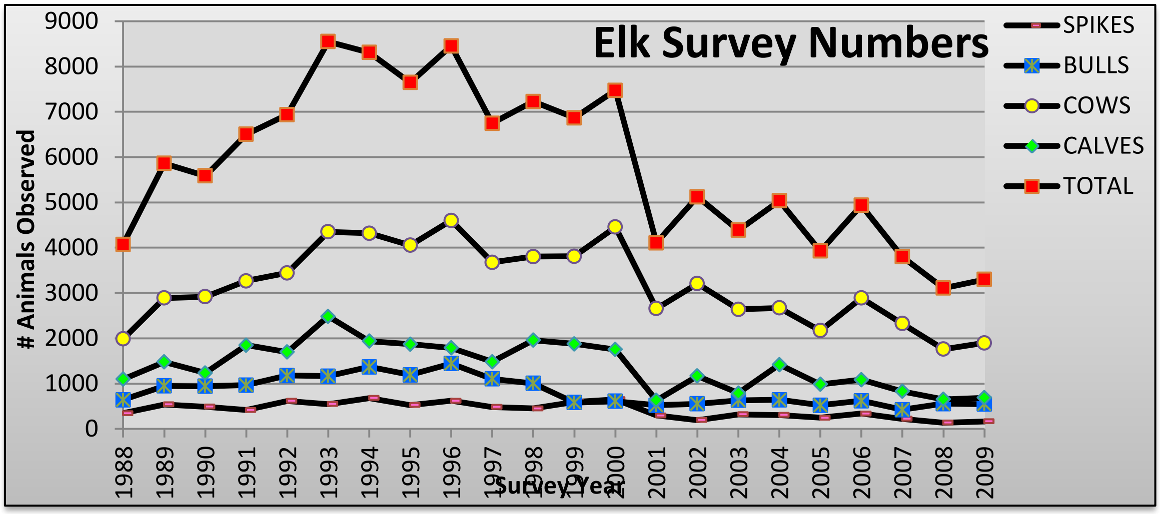



**Figure 24. Elk survey trends on the Coconino and Kaibab National Forests**

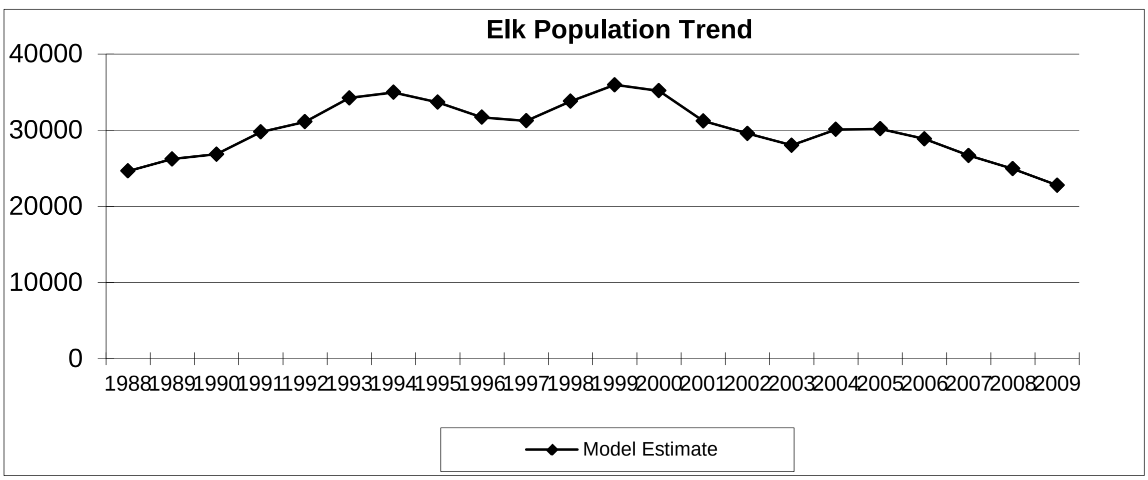



**Figure 25. Trend in Estimates Elk Populations for the Coconino and Kaibab National Forests from 1988 – 2009**

### Abert's Squirrel

While Abert's squirrels were selected for early-seral ponderosa pine, they preferred habitat structure is composed of intermediate to older aged forest (trees 9-22+ inches dbh). Forest structure and composition is probably the most important habitat attribute for tassel-eared squirrels. AGFD feeding sign survey data shows that areas with higher basal area and canopy cover as well as interlocking canopies contain the highest densities of squirrels. The squirrel's ability to access the growing pine shoots it depends on for food, as well as its ability to escape predators, is dependent 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 basal area for squirrels to be greater than 150 $ft^2$ 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 restoration unit, a continuously dense forest is not required for squirrels as long as denser patches of forest are retained for foraging, nesting, and escaping predators.

**Kaibab NF Tassel-eared Squirrel Population trend:** The tassel-eared squirrel was selected as an indicator of early-seral ponderosa pine forest (Forest Service 2010). For this project, the Abert's squirrel (*Sciurus aberti aberti*) represents the species. Tassel-eared squirrel were first selected as an indicator for mid-seral ponderosa pine which was later dropped and incorporated with early-seral ponderosa pine, which is not primary habitat for the tassel-ear squirrel. Forestwide the tassel-eared squirrel population is currently stable (Forest Service 2010.)

**Coconino NF Abert's Squirrel Population trend**: Forest-wide population trend is inconclusive since there is little Forest-specific data. Statewide information indicates a stable trend for hunter harvest of squirrels (Forest Service 2002). Additional population trend information is available for the Coconino NF, AGFD feeding sign surveys were conducted from 2005 - 2010 in association with Forest Service vegetation management projects in the Flagstaff wildland-urban interface (Appendix 6). Figure 26 displays the feeding sign survey results from 2005- 2010 in Fort Valley (FV), Kachina North (KN), Kachina South (KS), Mountainaire (MN), Woody Ridge (WD), and Airport (AP) study sites in the Flagstaff Wildland-Urban Interface. Treated refers to areas having received recent fuels reduction treatment in the form of mechanical thinning and/or prescribed fire. Untreated refers to areas not having received recent fuels reduction treatment. Given the above information, the forestwide trend is assumed to be increasing.

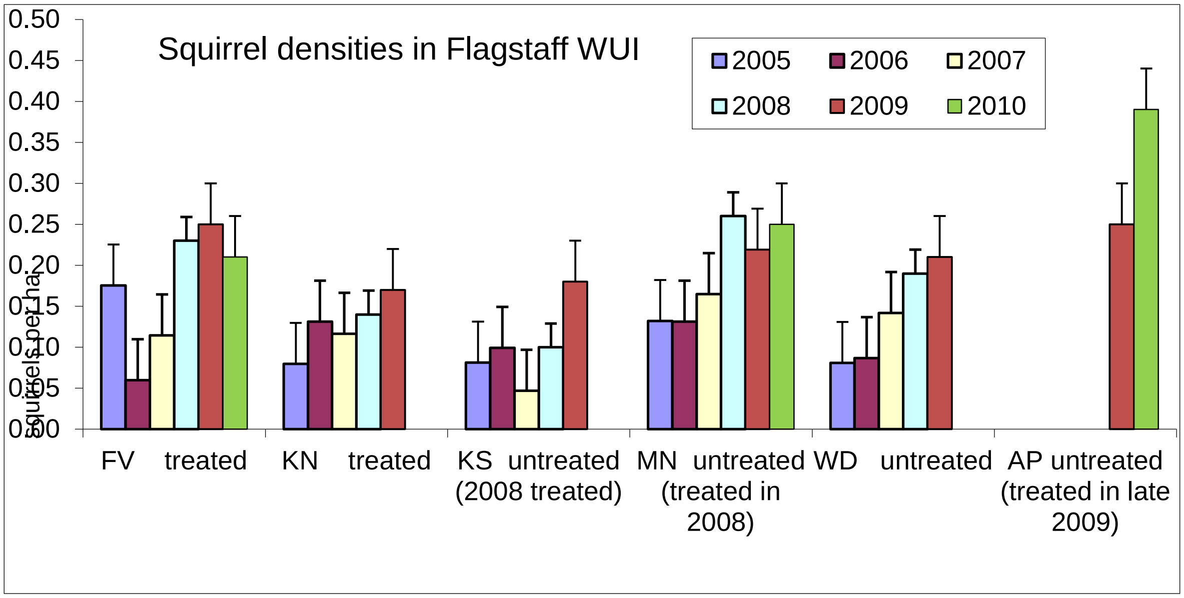



**Figure 26. Feeding sign survey results in the Flagstaff Wildland Urban Interface (2005 - 2010)**

## Species Indicators for Snags in Ponderosa Pine – Hairy woodpecker

### Hairy woodpecker

Hairy woodpecker was selected as an indicator for snags in ponderosa pine, mixed conifer, and spruce-for forest types (Forest Service 2002 and 2010). Hairy woodpeckers are common in ponderosa pine forests as well as other forest and woodland types on the both forest. The hairy woodpecker has been found 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 dead and dying portions of live trees and snags for nesting. Preferred nest tree size varies but 13.8" is typical in western conifer forests (Forest Service 2010).

**Kaibab NF Hairy Woodpecker Habitat and Population Trends:** Based on FIA data for the Kaibab National Forest, snags in all three cover types (ponderosa pine, mixed conifer & spruce-fir) types have increased between 1995 and 2007. It is believed that this habitat is in an increasing trend. There is approximately 681,158 acres of hairy woodpecker habitat currently available on the forest (Forest Service 2010). The analysis area contains 189,407 acres of ponderosa pine, which is approximately 28 percent of the PNVT for the three cover types across the forest. The hairy woodpecker forest-wide population trend is considered to be stable (Forest Service 2010.)

**Coconino NF Hairy Woodpecker Habitat and Population Trends:** In 2002 the Forest estimated that trends for snags in ponderosa pine habitats were probably declining (Forest Service 2002). However, a recent study by Ganey and Vojta (2007) conducted on the Coconino suggest that within ponderosa pine and mixed conifer habitats, model projections suggest that, at least in the short term, snag numbers will continue to increase and densities of large snags will increase.

Despite these increases, densities of large snags, > 18" dbh, 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 322,772 acres for ponderosa pine, which is approximately 36 percent of the PNVT for the three cover types across the forest.

The forest-wide population trend for the hairy woodpecker is stable, or slightly increasing. Minor population decreases occur on a short term scale of 1-3 years, but are generally followed by a recovery (Forest Service 2002).

### Species Indicators for Late-seral Aspen & Snags in Aspens–Red-naped sapsucker

#### Red-naped sapsucker

Red-naped sapsucker was selected as an indicator for late-seral aspen forest and snags (Forest Service 2002 and 2010). This species has a limited distribution on the both forests because the distribution of aspen and for the Kaibab NF many of the aspen stands are small in size. The red-naped sapsucker has been recorded during forest-wide surveys for both forests in the project area. The red-naped sapsucker will use both snags and live trees with heart rot, with minimum size of trees on average 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 being converted to conifer from lack of natural disturbance agents, mainly fire (Forest Service 2010).

**Kaibab NF Red-naped sapsucker Habitat and Population Trends:** There are approximately 28,500 acres of aspen on the forest. These stands are a mixture of early to late seral aspen and it is not possible to define late various early seral habitat stands. The forest-wide habitat trend for the red-naped sapsucker is believed to be stable at this time. Due to lack of aspen recruitment at this time there is potential for a decrease in the future (Forest Service 2010.) The condition of the aspen stands on the Williams RD is poor, with a high incidence of bole scarring on mature trees resulting from elk scraping with their lower incisors to feed on aspen cambium. Disease is prevalent in older aspen trees. There is essentially no aspen recruitment occurring in these stands because of high ungulate browse rates on suckers. Ponderosa pines are shading and competing with aspen in these stands also. There is less than four acres of aspen stands on the Tusayan RD and these stands would not be impacted with the proposed project. The population trend for the red-napped sapsuckers is believed to be stable to increasing on the forest (Forest Service 2010.)

**Coconino NF Red-naped sapsucker Habitat and Population Trends:** The forest plan (USDA Forest Service 1987) lists 10,000 acres of aspen habitat on the forest. 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 forest-wide 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 limited primarily due to grazing by animals. Management activities have not been implemented on a level, or even enough area, to prevent loss of aspen patches and provide for adequate recruitment. Aspen occurs mostly at higher elevations in the analysis area. Ungulate browsing and rubbing of aspen regeneration is present in all stands. Successful regeneration is occurring in the higher elevation stands and clumps. Aspen clumps at lower elevations have little regeneration success, and some are becoming old and decadent (Forest Service 2002). The forest-wide population trend for the red-naped sapsucker is stable. Populations on the Forest fluctuate over time, but show no indication or increasing or decreasing populations (Forest Service 2002).

## Species Indicators for Early-seral Aspen and Pinyon-juniper – Mule deer

### Mule Deer

Mule deer was selected as an indicator species for early-seral aspen and pinyon-juniper (Forest Service 2002 and 2010). Mule deer typically summer at higher elevations in aspen, mixed conifer, and ponderosa pine forests, and transition to winter in pinyon-juniper woodlands found at lower elevations. Mule deer are browsers and prefer leaves and twigs from shrubs and trees over grasses. Home range size varies, depending upon availability of forage and cover. Mule deer in the vicinity of the Tusayan and Williams Ranger Districts (Kaibab NF) have an estimated home range 141.1 mile2 (±48.3). Since mule deer are relatively wide-ranging species, they are likely to respond to changes in forest management at small and large spatial scales. Forest-wide and local population trends for mule deer are influenced more by hunting than by forest management.

While mule deer are indictors of early-seral aspen and pinyon juniper, they are effect 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 6).

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 communities which are largely outside the scope of the 4FRI project since the project includes approximately 2% of each forest pinyon-juniper habitat. However, summer range for mule deer occurs throughout the project in areas of ponderosa pine, pine-oak, pine-sage, aspen, and at springs and ephemeral channels, particularly when water is available (Appendix 6).

High levels of interspersion of forested cover 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 bed sites located 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.

**Kaibab NF Mule Deer Habitat and Population Trends:** There are approximately 28,500 acres of aspen on the forest. These stands are a mixture of early to late seral aspen. The forest-wide habitat trend for the mule deer is currently declining due to lack of aspen recruitment at this time (Forest Service 2010.) Condition of these stands on the Williams Ranger District is poor. There is essentially no aspen recruitment occurring in these stands because of especially high ungulate browse rates on aspen suckers. Ponderosa pines are shading and competing with aspen in these stands also. There are less than four acres of aspen stands on the Tusayan RD and these stands will not be impacted with the proposed project (see silviculture report). There are about 389 acres of stands mapped as aspen within the analysis area this is about 1 percent of the aspen habitat forest-wide. All action alternatives would mechanical thin and burn 372 acres and burn only 17 acres, therefore, all action alternatives would have the same effects to habitat trends.

Pinyon-juniper habitat trend for mule deer is considered to be stable. There are currently about 657,900 acres of pinyon-juniper habitat on the forest (Forest Service 2010). It is not possible to determine at this time how much is early-seral stage due to the highly variable conditions of the pinyon-juniper stands. There are approximately 12,530 acres of pinyon-juniper habitat within the analysis area, which is about 2 percent of the pinyon-juniper on the forest. Of the acreage in the analysis area approximately 5,215 acres is to be managed as early-seral stage (see silviculture report), this is approximately less than 1 percent of the forest-wide acreage of pinyon-juniper.

Mule deer populations on the Kaibab NF vary by ranger districts/GMU. The south zone of the forest appears to be following the statewide trend of decreasing numbers. Deer on the Kaibab Plateau are variable to increasing and if not for hunting, would likely be higher. Overall, mule deer forest-wide population trend are considered to be stable to increasing (Forest Service 2010).

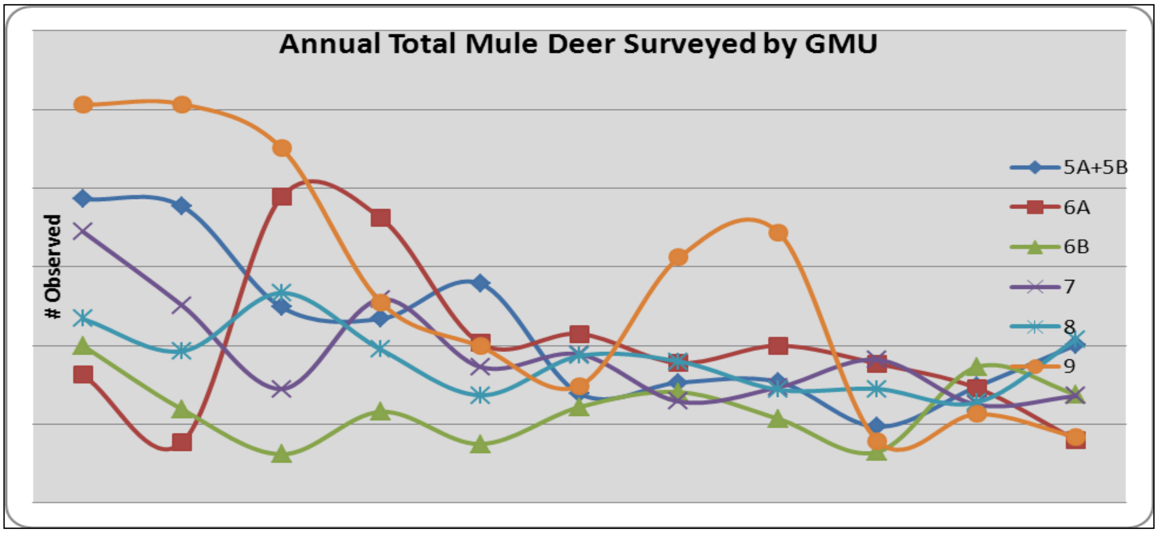
**Coconino NF Mule Deer Habitat and Population Trends:** Forest-wide trend for aspen is declining (Forest Service 2002). This decline is primarily related to fire suppression over the last century. Some early seral stage stands are being created through wildfire and management activities, but recruitment is limited primarily due to grazing by animals. Management activities have not been implemented to a level, or over enough area, to prevent loss of aspen patches and provide adequate aspen recruitment. The forest plan (USDA Forest Service 1987) lists 10,000 acres of aspen habitat on the forest. 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. Management activities have not been implemented on a level, or even enough area, to prevent loss of aspen patches and provide for adequate recruitment. See project appendix 12 for a comprehensive list of projects with management objectives.

Aspen occurs mostly at higher elevations in the analysis area. Ungulate browsing and rubbing of aspen regeneration is present in all stands. Successful regeneration is occurring in the higher elevation stands and clumps. Aspen clumps at lower elevations have little regeneration success, and some are becoming old and decadent (Forest Service 2002). Alternative B and C would treat approximately 1,063 acres and 1,082 acres respectively of aspen within the project area which is approximately 11 percent of the aspen habitat forest-wide for both alternatives. Alternative D would treat 874 acres of aspen, which is approximately 9 percent of aspen forest-wide (see silviculture report).

For pinyon-juniper the forest-wide trend is stable. The age class distribution has remained relatively stable. Less than 5 percent of pinyon-juniper on the forest has been converted to grassland through wildfire or management actions. This early-stage lasts longer in woodland habitats like pinyon-juniper compared to forest cover types due to the slow growth rates of woody vegetation in the drier habitat. Most pinyon-juniper habitat within the forest is late seral stage. Currently there are about 630,000 acres of pinyon-juniper habitat on the forest (Forest Service 2002). There is approximately 10,786 acres of pinyon-juniper habitat within the analysis area, which is approximately 2 percent of the pinyon-juniper forest-wide. Of this acreage approximately 2,475 acres is to be managed as early-seral stage (see silviculture report), this is less than 1 percent of the forest-wide acreage of pinyon-juniper.

The forest wide population trend for mule deer is declining. The number of deer seen per hour and the number of fawns per 100 does from 1985 through 2001 varies, but the trend is declining (Forest Service 2002). In good years, fawn production has been at levels minimal to sustaining populations, but in poor precipitation and forage years, fawn production has not kept up with mortality rates. Mule deer populations are starting to stabilize with a slightly increasing trend (Appendix 6). Based on the data provide above in figures 28 and 29, the forest-wide population trend appears to be stable.

Analysis including more current data from AGFD seems to show the forest-wide trend is still correct. Data are displayed by Game Management Unit (GMU; **Error! Reference source not found.**and Figure 28). For the Coconino NF, data are relevant from GMUs 5A and 5B (combined only for mule deer analysis), 6A, 6B, 7, and 8. For the Kaibab NF, data are relevant from GMUs 6B, 7, 8, and 9. All GMUs are relevant to the 4FRI project area. Overall, the declining to stable trend in mule deer surveyed over the last decade on the Coconino and Kaibab NFs is consistent with the statewide trend. The fawn to doe ratios indicates relatively stable trends in doe



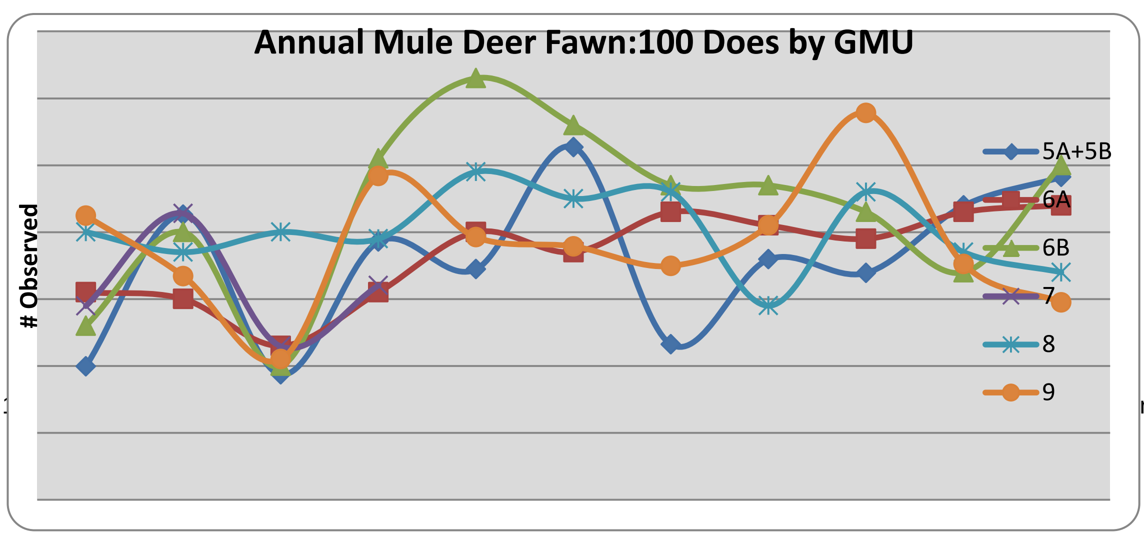

productivity over time across both Forests.

**Figure 27. Total number of mule deer surveyed by number observed and GMU, 2000 – 2010Figure 28. Ratio of mule deer fawns per 100 does by GMU, 2000 – 2010**

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

### Juniper titmouse

Juniper titmouse was selected as an indicator for late-seral pinyon-juniper woodland and snags in pinyon-juniper woodland (Forest Service 2002 and 2010). 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 with allows for developed understory. The birds tend to favor habitat that has areas of high density of dead limbs with a high level of ground cover. Fire suppression has changed pinyon-juniper woodlands from open diverse communities of trees and understory to dense woodlands. Dense forest limits the development of large mature trees and subsequent creation of snags, important breeding habitat components for this species (Forest Service 2010).

**Kaibab NF Juniper Titmouse Habitat and Population Trends:** There has been an increasing trend for juniper titmouse habitat on the forest. There is currently approximately 657,900 acres of pinyon-juniper habitat on the forest (Forest Service 2010). It is not possible to determine at this time how much is late-seral stage due to the highly variable conditions of the pinyon-juniper stands. There are about 12,530 acres of pinyon-juniper habitat within the project area, which is approximately 2 percent of the pinyon-juniper on the Forest. Of the acreage in the analysis area approximately 7,315 acres are to be managed as late-seral stage (see silviculture report), this is approximately 1percent of the forest-wide acreage of pinyon-juniper. It is believed that the juniper titmouse populations are decreasing. This trend is likely a reflection of long term habitat trends in pinyon-juniper ecosystems across their range (Forest Service 2010.)

**Coconino NF Juniper Titmouse Habitat and Population Trends:** The forest-wide habitat trend for pinyon-juniper is stable. The age class distribution of pinyon-juniper has remained relatively stable throughout the Forest Plan implementation period. A very small portion of total pinyon-juniper acres has been converted to grasslands or early seral stage pinyon-juniper through wildfire or management actions. Since the age class distribution of pinyon-juniper has not changed much, the snag component has probably remained relatively stable. Firewood cutting has probably reduced snag densities of both pinyon and juniper snags, especially close to Flagstaff. The loss of older pinyon pine trees due to drought creates new snags, but insect attacks result in rapid deterioration of snags, affecting their longevity and value to wildlife. There are currently approximately 630,000 acres of pinyon-juniper habitat on the forest (Forest Service 2002). There is approximately 10,786 acres of pinyon-juniper habitat within the analysis area, which is approximately 2 percent of the pinyon-juniper forest-wide. Of this acreage approximately 8,311 acres are to be managed as late-seral stage, about 1 percent of forest-wide pinyon-juniper.

The forest-wide population trend for the juniper titmouse is stable to slightly decreasing. BBS (breeding bird survey) trend data for Arizona indicate a slightly decreasing trend between 1996 and 2000. Christmas bird count data indicate a stable to slightly declining trend for wintering juniper titmice on the Forest (Forest Service 2002).

## Species Indicators for Early and Late-seral Grasslands

### Pronghorn

Pronghorn was selected as an indicator species for early- and late-seral grassland (Forest Service 2002 and 2010). Pronghorn have been seen in the analysis area. Pronghorn populations in Arizona have declined substantially from historic times. Forest-wide and local populations are affected through state permitted hunt structure.

Pronghorn are associated with grasslands, meadows, and savannas on the Coconino and Kaibab National Forests 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 density are important for pronghorn. Pronghorn avoid areas with high tree density and cover. Several local studies and plans 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 burning 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 0.61 m 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. 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.

**Kaibab NF Pronghorn Habitat and Population Trends:** Currently the habitat trend for grassland habitat is considered stable on the Forest. There is approximately 216,000 acres of grassland cover type on the Forest. The Forest-wide population trend for pronghorn is considered to be declining (Forest Service 2010.) However, current analysis of AGFD data indicates a stable trend for the pronghorn. **Error! Reference source not found.** and Figure 30 show the estimated population trends for the GMU on the Kaibab within the project area. In figure 8 Game Management Units 7 and 8 relate to the Williams Ranger District and Unit 9 is for the Tusayan Ranger District. Data are unpublished but available from the AGFD Flagstaff Regional Office (McCall, pers. comm. 2011).

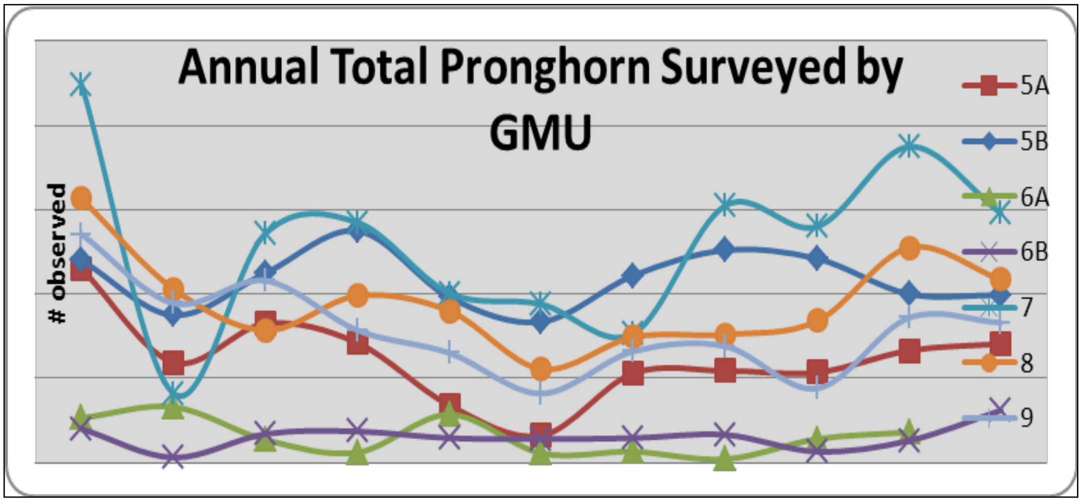
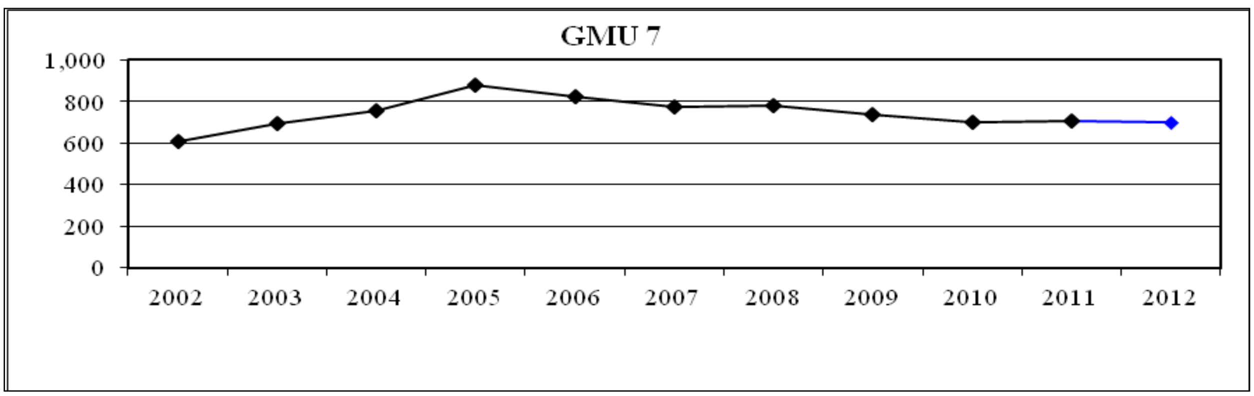
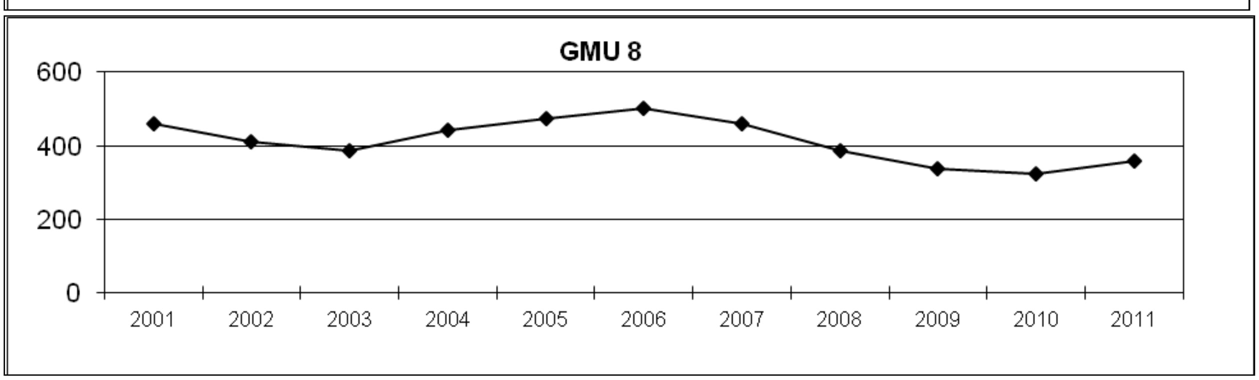



**Figure 29. Total number of pronghorn surveyed by GMU in the 4FRI project area 2001 – 2011**



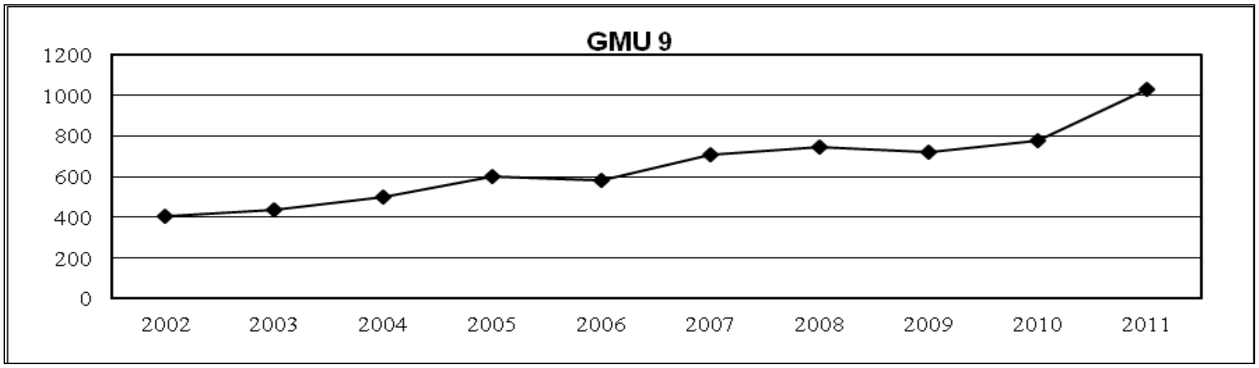



**Figure 30. Kaibab NF estimated population trends for pronghorn, 2002-2011 in GMU 7-9**

**Coconino NF Pronghorn Habitat and Population Trends:** Habitat trend is stable to declining. Although the total amount of grassland habitat has generally remained stable, habitat quality is stable to declining due to tree encroachment, fire suppression, long term climatic changes, short term drought, and ungulate grazing (Forest Service 2002). There is approximately 260,050 acres of grassland habitat on the Forest

The forest-wide population trend for pronghorn is declining. Declining numbers of animals observed and fawn to doe ratios below a breakeven of 20-35 fawns per 100 does is documented for all GMU's on the Forest except GMU 7 (Forest Service 2002). However, current analysis of AGFD data indicates a stable trend for the pronghorn. **Error! Reference source not found.** shows the estimated population trends for the GMU within the project area. Figure 32 displays estimated population trends for pronghorn, 2002-2011, on the Peaks Ranger District of the Coconino National Forest, including Game Management Units 5A, 5B, 6A, 6B, and 7. Data are unpublished but available from the AGFD Flagstaff Regional Office (McCall, pers. comm. 2011).

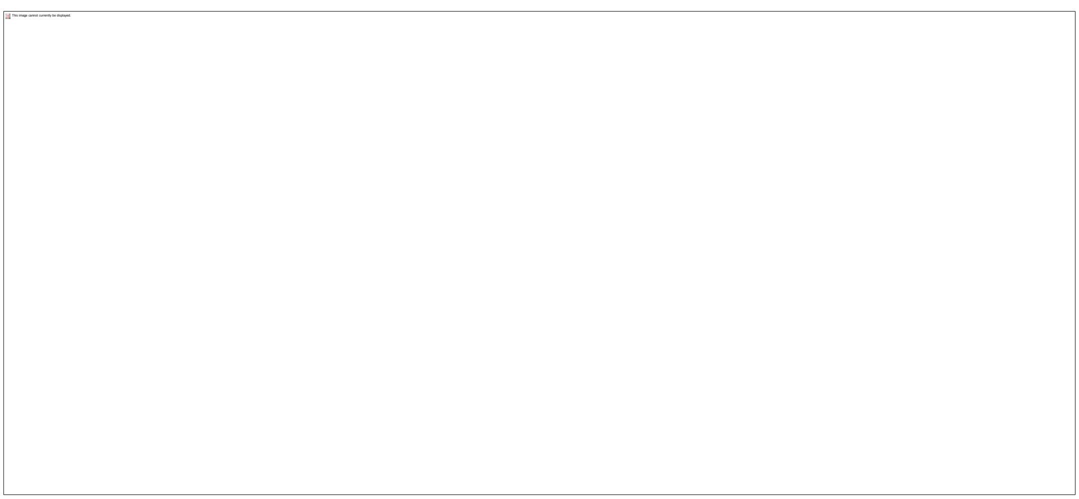


**Figure 31. Total number of pronghorn surveyed by GMU within the 4FRI project area, 2001 – 2011**

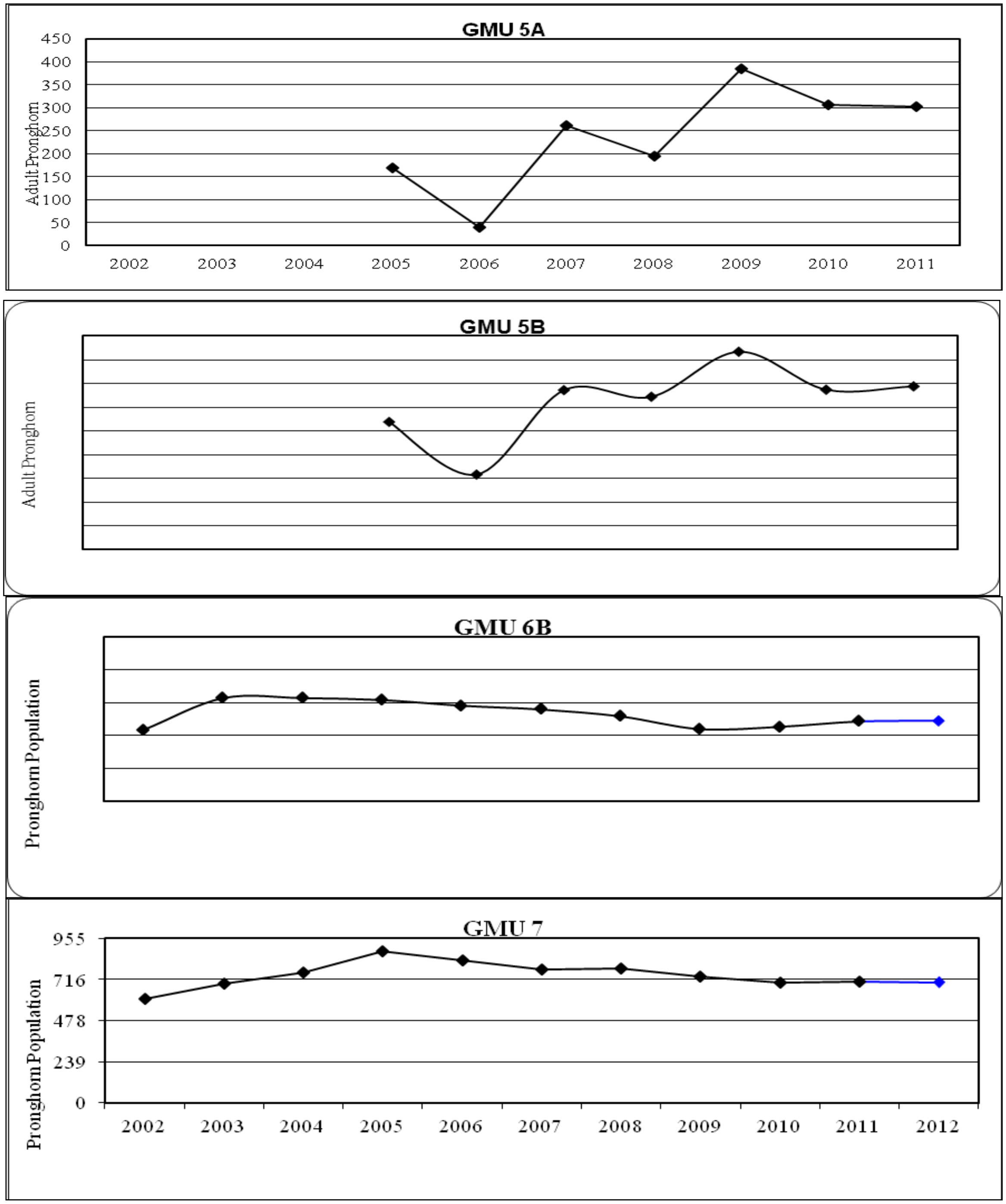



**Figure 32. Estimated population trends for pronghorn, 2002-2011, on the Peaks Ranger District of the Coconino National Forest, including Game Management Units 5A, 5B, 6A, 6B, and 7**

## Migratory Birds and Important Bird Areas

### Affected Environment

Arizona Partners in Flight (APIF) identifies physiographic areas and priority migratory bird species by broad habitat types (Latta et al. 1999). In March 2008, the U.S. Fish and Wildlife Service released its 2008 "Birds of Conservation Concern Report" (USFWS 2008). The Coconino and Kaibab NF occur within the two bird conservation regions (BCR): the Southern Rockies/Colorado Plateau (BCR #16) and Sierra Madre Occidental (BCR #34). For the Kaibab NF, the analysis area only occurs within BCR #34. This analysis considered high priority bird species from both the APIF and the USFWS birds of conservation concern (Table 40).

**Table 40. 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, "clumpiness" prefers forest edges and openings.<br>Dead branches for 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 >50% 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 and other trees, 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. |

| PIF High Priority Species and FWS BCC | Important Habitat Features and Life History Considerations |
|---|---|
| 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><br>Logged or burned pine forests are also preferred habitat for breeding.<br><br>Diet varies with seasonal abundant of food items, primarily 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><br>Open mid-story cover and open understory cover.<br><br>Prefers high snag density and tall snags adjacent to open areas. |
| Cassin's Finch | Nesting preference is for open coniferous forests.<br><br>Dry, relatively open mature ponderosa pine forest.<br><br>Nests tend to be placed >16' above ground, often out on lateral branches or near the trunk within about 3 feet of tree tops. |
| **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><br>Minimum dbh for nest tree is 10" and minimum height is usually 15'.<br><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><br>Nests low in a small tree or shrub 2 to 6' above ground.<br><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><br>Nests are typically 3 to 26' high and tend to be south-facing.<br><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><br>Tends to favor areas with a high density of dead limbs and high degree of ground cover.<br><br>An obligate secondary cavity nester.<br><br>Nest cavity height ranges from 4 to 15' above ground. Nest tree dbh range from 5 to 18". |

| PIF High Priority Species and FWS BCC | Important Habitat Features and Life History Considerations |
|---|---|
| Black-throated Gray Warble | Primarily associated with pinyon pine and juniper woodlands in northern Arizona. Canopy cover of 13 to 26% 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' 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' 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 food source is insects. They also feed on 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. |
| Grasshopper Sparrow | Prefers pure grassland habitat without trees or emergent shrubs. Requires abundant thatch and dry grass for concealment. Apparent low site-fidelity. May avoid recently burned grassland sites for ≥ 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 ft 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 512,178 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 1,471 acres of aspen habitat. The analysis area is approximately 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 etal. 1999). The analysis area contains approximately 48,774 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 43,195 to 44,751 acres of habitat will be treated within the project area, equaling about 26 to 27 percent of the IBA. 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.

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 >18” dbh.
- No vegetation treatments would occur within a ½ mile (2,500 ft), 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 burning. 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 ft 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 burning 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.

## Description of Alternatives

The Forest Service analyzed four alternatives, including no action, the proposed action and two additional alternatives in response to public comment (Table 41). The alternatives are provided in summary form. See silviculture report for additional details.

**Table 41. Summary of Action Alternatives**

| Proposed Activity | Alternative A (No Action) | Alternative B (Proposed Action) | Alternative C | Alternative D |
|---|---|---|---|---|
| Vegetation Mechanical Treatment (acres) | 0 | 388,489 | 434,001 | 388,489 |
| Prescribed Fire (acres) | 0 | 587,923 | 593,211 | 178,790 |
| Mexican spotted owl (MSO) protected activity centers (PACs) Habitat Treatments | N/A | Mechanically treat up to 16-inch dbh in 18 PACs (excluding core areas)<br>Utilize prescribed fire in 72 MSO PACs (excluding core areas) | Mechanically treat up to 18-inch dbh in 18 PACs<br>Utilize prescribed fire in 56 MSO PACs (including core areas)<br>Utilize prescribed fire in 16 MSO PACs (excluding core areas) | Mechanically treat up to 16-inch dbh in 18 PACs (excluding core areas)<br>Utilize prescribed fire in 72 MSO PACs (excluding core areas) |
| Springs Restored (number) | 0 | 74 | Same as alternative B | |
| Springs Protective Fence Construction (miles) | 0 | Up to 4 | Same as alternative B | |
| Aspen Protective Fencing (miles) | | Up to 82 | Same as alternative B | |
| Ephemeral Stream Restoration (miles) | 0 | 39 | Same as alternative B | |
| Temporary Road Construction and Decommission (miles) | 0 | 517 | Same as alternative B | |

| Proposed Activity | Alternative A (No Action) | Alternative B (Proposed Action) | Alternative C | Alternative D |
|---|---|---|---|---|
| Road Reconstruction-Improvement (miles) | N/A | Up to 30 | Same as alternative B | |
| Road Relocation (miles) | N/A | Up to 10 | Same as alternative B | |
| Existing Road Decommission (miles) | N/A | 770 | Same as alternative B | |
| Unauthorized Route Decommission (miles) | N/A | 134 | Same as alternative B | |

## Alternative A - No Action

There would be no changes in current management under the forest plans. Approximately 82,592 acres of ongoing vegetation treatments and 96,125 acres of ongoing prescribed fire projects would continue to be implemented adjacent to the treatment area. Mechanical and prescribed fire treatments will create canopy gaps, benefiting most of the species of status analyzed in this report (see species-specific cumulative effects analyses for current and ongoing project effects). Projects typically avoid treating steep slopes and are designed to retain nesting and roosting elements in goshawk and MSO habitat. Approximately 86,771 acres of vegetation treatments and 142,869 acres of prescribed fire and maintenance burning would be implemented adjacent to the treatment area by the forests in the foreseeable future (within 5 years). Alternative A is the point of reference for assessing action alternatives B–D. Wildfire would continue to be managed with protection and/or resource benefit objectives as appropriate.

## Alternative B– Proposed Action

The Coconino and Kaibab NFs propose to conduct approximately 587,923 acres of restoration activities over approximately 10 years or until objectives are met. Up to 45,000 acres of vegetation would be mechanically treated annually. Up to 40,000 acres of prescribed fire would be implemented annually across the forests. Two prescribed fires would be conducted on all acres proposed for treatment over the 10-year period. Restoration activities would:

- Mechanically cut trees and apply prescribed fire on approximately 388,489 acres. This includes: (1) mechanically treating up to 16-inch dbh within 18 MSO PACs, (2) cutting 99 acres of trees by hand on slopes greater than 40 percent, and (3) using low-severity prescribed fire within 72 MSO PACs (excluding core areas).
- Utilize prescribed fire-only on approximately 199,435 acres.

- Construct 517 miles of temporary roads for haul access and decommission when treatments are complete (no new permanent roads would be constructed).
- Reconstruct up to 40 miles of existing, open roads for resource and safety concerns (no new permanent roads would be constructed). Of these miles, approximately 30 miles would be improved to allow for haul (primarily widening corners to improve turn radiuses) and about 10 miles of road would be relocated out of stream bottoms. Relocated roads would include rehabilitation of the moved road segment.
- Decommission 770 miles of existing system and unauthorized roads on the Coconino NF.
- Decommission 134 miles of unauthorized roads on the Kaibab NF.
- Restore 74 springs and construct up to 4 miles of protective fencing.
- Restore 39 miles of ephemeral channels.
- Construct up to 82 miles of protective (aspen) fencing.
- Allocate as old growth 40 percent of ponderosa pine and 77 percent of pinyon-juniper woodland on the Coconino NF and 35 percent of ponderosa pine and 58 percent of pinyon-juniper on the Kaibab NF.

Three non-significant forest plan amendments would be required on the Coconino NF to implement the proposed action:

- Amendment 1 would add language to allow mechanical treatments up to 16-inch dbh to improve habitat structure (nesting and roosting habitat) in 18 MSO PACs. It would remove language that limits PAC treatments in the recovery unit to 10 percent increments and requires the selection of an equal number of untreated PACs as controls. Replacement language would defer to the USFWS biological opinion for the project. The amendment would also remove language referencing monitoring (pre- and post-treatment population and habitat monitoring) and replace it with language that defers MSO monitoring to the USFWS biological opinion for the project.
- In goshawk habitat (excluding nest areas) amendment 2 would add the desired percentage of interspace within uneven-aged stands to facilitate restoration, add the interspace distance between tree groups, add language clarifying where canopy cover is and is not measured, allow 29,017 acres to be managed for an open reference condition, and add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.
- Amendment 3 would remove the cultural resource standard that requires achieving a “no effect” determination and would add the words “or no adverse effect” to the remaining standard. In effect, management would strive to achieve a "no effect" or “no adverse effect” determination.

Two non-significant forest plan amendment would be required on the Kaibab NF to implement the proposed action.

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

- Amendment 2 would remove language that limits prescribed fire treatments in the Kendrick PAC to 10 percent increments and requires the selection of an equal number of untreated PACs as controls. Replacement language would defer to the USFWS biological opinion for the project. The amendment would also remove language referencing monitoring (pre- and post-treatment population and habitat monitoring) and replace it with language that defers MSO monitoring to the USFWS biological opinion for the project. Definitions for target and threshold habitat would be added and the amendment would allow managing for less than 10 percent threshold habitat within the 4FRI treatment area.

## Alternative C

The Coconino and Kaibab NFs would conduct restoration activities on approximately 593,211 acres over a period of 10 years or until objectives are met. Up to 45,000 acres of vegetation would be mechanically treated annually. Up to 40,000 acres of prescribed fire would be implemented annually across the forests. Two prescribed fires would be conducted on all acres proposed for treatment over the 10-year period. Restoration activities would:

- Mechanically cut trees on approximately 434,001 acres. This includes: (1) mechanically treating up to 18-inch dbh within 18 Mexican spotted owl protected activity centers, (2) cutting trees by hand on 99 acres on slopes greater than 40 percent, and (3) using low-severity prescribed fire within 72 Mexican spotted owl protected activity areas (including 56 core areas).
- Utilize prescribed fire-only on approximately 159,211 acres.
- Construct 517 miles of temporary roads for haul access and decommission when treatments are complete (no new permanent roads would be constructed).
- Reconstruct up to 40 miles of existing, open roads for resource and safety concerns (no new permanent roads would be constructed). Of these miles, approximately 30 miles would be improved to allow for haul (primarily widening corners to improve turn radiuses) and about 10 miles of road would be relocated out of stream bottoms. Relocated roads would include rehabilitation of the moved road segment.
- Decommission 770 miles of existing system and unauthorized roads on the Coconino NF.
- Decommission 134 miles of unauthorized roads on the Kaibab NF.
- Restore 74 springs and construct up to 4 miles of protective fencing.
- Restore 39 miles of ephemeral channels.
- Construct up to 82 miles of protective (aspen) fencing.
- Construct up to 15 weirs and 20 weather stations (up to 3 total acres of disturbance) to support watershed research.
- Allocate as old growth 40 percent of ponderosa pine and 77 percent of pinyon-juniper woodland on the Coconino NF and 35 percent of ponderosa pine and 58 percent of pinyon-juniper woodland on the Kaibab NF.

Three non-significant forest plan amendments would be required on the Coconino NF to implement alternative C:

- Amendment 1 would add language to allow mechanical treatments up to 16-inch dbh to improve habitat structure (nesting and roosting habitat) in 18 MSO PACs. It would allow low-severity prescribed fire within 56 MSO PAC core areas. It would remove language that limits PAC treatments in the recovery unit to 10 percent increments and requires the selection of an equal number of untreated PACs as controls. Replacement language would defer to the USFWS biological opinion for the project. The amendment would remove language referencing monitoring (pre- and post-treatment population and habitat monitoring) and replace it with language that defers MSO monitoring to the USFWS biological opinion for the project. In restricted pine-oak habitat, it would allow 6,321 acres of restricted target and threshold habitat to be managed for a minimum range of 110 to 150 basal area. A definition of target and threshold habitat would be included.
- In goshawk habitat (excluding nest areas), amendment 2 would add the desired percentage of interspace within uneven-aged stands to facilitate restoration, add the interspace distance between tree groups, add language clarifying where canopy cover is and is not measured, allow 29,017 acres to be managed for an open reference condition, and add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.
- Amendment 3 would remove the cultural resource standard that requires achieving a “no effect” determination and would add the words “or no adverse effect” to the remaining standard. In effect, management would strive to achieve a "no effect" or “no adverse effect” determination.

Three non-significant forest plan amendments would be required on the Kaibab NF to implement alternative C:

- In goshawk habitat (excluding nest areas), amendment 1 would add the desired percentage of interspace within uneven-aged stands to facilitate restoration, add the interspace distance between tree groups, add language clarifying where canopy cover is and is not measured, allow 27,637 acres to be managed for an open reference condition, and add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.
- Amendment 2 would allow for mechanically treating and using prescribed fire within approximately 400 acres of the proposed Garland Prairie RNA.

Amendment 3 would remove language that limits prescribed fire treatments in the Kendrick PAC to 10 percent increments and requires the selection of an equal number of untreated PACs as controls. Replacement language would defer to the USFWS biological opinion for the project. The amendment would also remove language referencing monitoring (pre- and post- treatment population and habitat monitoring) and replace it with language that defers MSO monitoring to the USFWS biological opinion for the project. Definitions for target and threshold habitat would be added and the amendment to allow managing for less than 10 percent threshold habitat within the 4FRI treatment area. In restricted pine-oak habitat, it would allow 2,090 acres of restricted target and threshold habitat to be managed for a minimum range of 110 to 150 basal area.

## Alternative D

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

The Coconino and Kaibab NFs would conduct restoration activities on approximately 567,279 acres over a period of 10 years or until objectives are met. Up to 45,000 acres of vegetation would be mechanically treated annually. Restoration activities would:

- Mechanically cut trees on approximately 388,489 acres. This includes: (1) mechanically treating up to 16-inch dbh within 18 Mexican spotted owl protected activity centers, (2) cutting 99 acres of trees by hand on slopes greater than 40 percent, and (3) disposing of slash through various methods including chipping, shredding, mastication, and removal of biomass off-site
- Utilize prescribed fire-only on approximately 178,790 acres. Up to 40,000 acres of prescribed fire would be implemented annually across the forests. Two prescribed fires would occur over the 10-year treatment period.
- Construct 517 miles of temporary roads for haul access and decommission when treatments are complete (no new permanent roads would be constructed).
- Reconstruct up to 40 miles of existing, open roads for resource and safety concerns (no new permanent roads would be constructed). Of these miles, approximately 30 miles would be improved to allow for haul (primarily widening corners to improve turn radiuses) and about 10 miles of road would be relocated out of stream bottoms. Relocated roads would include rehabilitation of the moved road segment.
- Decommission 770 miles of existing system and unauthorized roads on the Coconino NF.
- Decommission 134 miles of unauthorized roads on the Kaibab NF.
- Restore 74 springs and construct up to 4 miles of protective fencing.
- Restore 39 miles of ephemeral channels.
- Construct up to 82 miles of protective (aspen) fencing.
- Allocate as old growth 40 percent of ponderosa pine and 77 percent of pinyon-juniper woodland on the Coconino NF, and 35 percent of ponderosa pine and 58 percent of pinyon-juniper on the Kaibab NF.

Three non-significant forest plan amendments would be required on the Coconino NF to implement the proposed action:

- Amendment 1 would add language to allow mechanical treatments up to 16-inch dbh to improve habitat structure (nesting and roosting habitat) in 18 MSO PACs. It would remove language that limits PAC treatments in the recovery unit to 10 percent increments and requires the selection of an equal number of untreated PACs as controls. Replacement language would defer to the USFWS biological opinion for the project. The amendment would also remove language referencing monitoring (pre- and post-treatment population and habitat monitoring) and replace it with language that defers MSO monitoring to the USFWS biological opinion for the project.

- In goshawk habitat (excluding nest areas), amendment 2 would add the desired percentage of interspace within uneven-aged stands to facilitate restoration, add the interspace distance between tree groups, add language clarifying where canopy cover is and is not measured, allow 29,017 acres to be managed for an open reference condition, and add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.
- Amendment 3 would remove the cultural resource standard that requires achieving a “no effect” determination and would add the words “or no adverse effect” to the remaining standard. In effect, management would strive to achieve a "no effect" or “no adverse effect” determination.

Two non-significant forest plan amendment would be required on the Kaibab NF to implement the proposed action:

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

Amendment 2 would remove language that limits prescribed fire treatments in the Kendrick PAC to 10 percent increments and requires the selection of an equal number of untreated PACs as controls. Replacement language would defer to the USFWS biological opinion for the project. The amendment would also remove language referencing monitoring (pre- and post-treatment population and habitat monitoring) and replace it with language that defers MSO monitoring to the USFWS biological opinion for the project. Definitions for target and threshold habitat would be added and the amendment would allow managing for less than 10 percent threshold habitat within the 4FRI treatment area.

## Design Features, Best Management Practices and Mitigation

Applicable Forest Plan standards and guidelines, Best Management Practices, and Forest Service Manual and Handbook direction 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 DEIS for a complete list of design features and associated Best Management Practices.

Design features guiding project implementation include:

### Vegetation Design Features - Common to All Treatment Types

- Treatments are designed to move vegetation toward the desired condition as outlined in the Coconino NF and Kaibab NF forest plans.
- Treatments are designed to create tree groups and interspaces that stimulate grass, forbs and increase residual tree growth.

- Priority location for interspace is in currently non-stocked areas and in areas that lack pre-settlement evidence.
- Treatments will 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.
- Treatments are designed to manage for old age trees and maintain old forest structure across the landscape. Old trees would not be targeted for cutting. See "old tree retention strategy".
- Treatments are designed to decrease the potential for undesirable fire behavior and effects.
- 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) will be favored for retention.
- Course woody debris (CWD) would be managed for an average of 5 to 7 tons per acre after treatment.
- Prescribed burns are designed to maintain desired forest structure, tree densities, snag densities and CWD levels.
- Gambel oak, juniper and pinyon species >5" drc may be considered as residual trees in the target group spacing and stocking.

Silvicultural and prescribed burn treatments were designed to meet the objectives of the respective MSO habitat classification under consideration.

### Vegetation design features common to all treatment types within MSO habitat

The following design features have been incorporated into alternative development as have site-specific features listed in Table 42.

- Manage for 15% or more of the stand density index in ponderosa pine trees between 12 and 18" dbh, 15% or more of the stand density index in ponderosa pine trees between 18 and 24" dbh, 15% or more of the stand density index in ponderosa pine trees ≥24" dbh, and ≥20 TPA ≥18" dbh.
- No trees 24 inches dbh or larger would be removed.
- Manage for snags ≥12" dbh and down logs ≥12".
- Gambel oak, juniper and pinyon species will not be cut as part of the treatments. These species may only be cut as necessary to facilitate logging operations (skid trails and landings).

Core areas are 100-acre or greater areas that encompass known nest or roost sites or the best nesting and roosting habitat available. 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 dbh, depending on the 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
- 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 burns in PACs are to reduce surface fuels and raise crown base height. Results would include reducing surface fire intensity and flame length, thereby reducing the potential for high severity fire. Prescribed fire would reduce coarse woody debris, 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 fire hazard 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 prescribed fire treatment and to provide food and cover for prey species
- At least 20 trees or more per acre measuring 18 inches dbh 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 prescribed fire treatments
- 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 prescribed fire treatments

- 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 dbh would be cut and existing old growth attributes would be retained
- To maintain and develop large Gambel oak trees, conifers up to 18 inches dbh that do not meet the “old tree” definition would be removed within 30 feet of oak greater than or equal to10 inches drc 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 burns in PACs are to reduce surface fuels and raise crown base height, thereby reducing flame length and surface fire intensity. Prescribed fire would reduce coarse woody debris, 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 42). Environmental consequences have been evaluated with all features, practices, and mitigation considered.

**Table 42. Wildlife Design Features incorporated into 4FRI implementation planning**

| Species | Where/When | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| Mexican Spotted Owl | Restricted and protected habitat | Trees greater than 24” dbh would not be harvested. | Silviculture | Yes |

| Species | Where/When | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| Mexican Spotted Owl | Restricted and protected habitat | MSO surveys in the project area 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 | Pre- and post-treatment habitat monitoring would occur as specified in the MSO recovery plan | Silviculture and Fire | 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., 4 out of 78 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 | 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 within a 1/4 mile of nests and roosts (potentially adjusted by topography) during the breeding season (March 1 to August 31) if occupied. If nest or roosts are not known no treatments will occur within ¼ mile of nest buffer boundaries unless surveys indicate the PAC is unoccupied. | Fire and Silviculture | Yes |
| Mexican Spotted Owl | Protected Activity Centers | Hauling will not occur within PACs during the breeding season (March 1 to August 31) unless specific analysis has documented that impacts will not lead to adverse effects. | Silviculture | Yes |
| Mexican Spotted Owl | Protected Activity Centers | No new wire fencing will be constructed in PACs. 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 |

| Species | Where/When | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| Mexican Spotted Owl | Protected Activity Centers | Coordinate burning spatially and temporally to limit smoke impacts to nesting owls, particularly for PACs with nests in draws & canyons (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 |
| 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. Alt B and C. | Fire | Yes |
| Mexican Spotted Owl | Protected Activity Centers | Prescribed burn plans will be designed and implemented to minimize smoke impacts to nesting birds and minimize loss of nest trees. | Soil and Water | 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 |
| Northern Goshawk | Nest Stands | Prescribed burn plans will be designed and implemented to minimize smoke impacts to nesting birds and minimize loss of nest trees. | Fire | Yes |
| Northern Goshawk | Post-Family Fledging 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 if pre-treatment surveys determine the area is no longer occupied. | Silviculture | Yes |
| Northern Goshawk | Post-Family Fledging Areas | Loaded logging trucks will not exceed 25 mph when traveling through PFAs during the nesting season (March 1 to July 31). | Silviculture | No |

| Species | Where/When | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| Northern Goshawk | Post-Family Fledging 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-Family Fledging Areas | Road construction, obliteration, relocation, and maintenance would not occur during the breeding season (March 1 to September 30) if occupied. | Engineering | Yes |
| Turkey | Foraging and roosting cover | Retain 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. | Silviculture and Fire | Yes |
| Deer | Known fawning areas | Because of declining trends in populations, defer logging activities between May 15 and August 31. | Silviculture | Yes |
| Pronghorn | Migration routes | Avoid thinning and burning within the known travel way on the Williams RD during the 1st major snowfall of a given year to allow for seasonal migration. See Appendix 4 | Silviculture and Fire | No |
| 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 | No |
| 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 | Where/When | 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 >2 snags/ac ≥30' high and ≥18" dbh + ≥3 logs ≥8' long and ≥12" mid-point diam. + 5-7 tons of CWD (>3" diam)/ac in pine and pine-oak habitat. | Silviculture and Fire | Yes |
| General | Snags | 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. | Silviculture and Fire | No |
| General | Snags & logs within the pinyon-juniper cover type | Snags would be managed for 1/acre over 75% of the area (current direction is 1/acre over 50% 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 ≥10 inches mid-point diameter and ≥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 |
| Bald Eagles | Bald eagle winter concentration areas | Retain the tallest snags >18 "dbh | Silviculture and Fire | Yes |
| Bald Eagles | Nest sites | No mechanical treatments will occur within a 300 ft. radius of bald eagle nest trees (there are 3 bald eagle nest within 300 feet of the project analysis boundary). | Silviculture | Yes |
| Bald and Golden Eagles | Nest sites | No vegetation treatments would occur within a buffer of up to ½ mile (2,500 ft), 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 |

| Species | Where/When | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| Bald Eagles | Winter Roost sites | No mechanical treatments will occur around confirmed bald eagle roost sites (300’ 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 | 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 |
| 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 |

| Species | Where/When | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| 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 13). 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 ft buffer (or along logical topographic breaks) at all designated important water sites (i.e., 10 sites in Restoration Unit 1; Appendix 13). 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-ft protection zone (100 feet either side of the stream) will be established around designated stream courses (Appendix 13). There would be no thinning and no direct ignition of prescribed burning 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 |
| 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. | | |

| Species | Where/When | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| Bats | Caves, karst, and sink holes | A 300-ft no mechanical treatment buffer would be designated around cave entrances and 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. The intent is to avoid changing the cave/karst microclimate, (including altering vegetation near the inside and outside of the entrance/rim) and hydrology while reducing surface fuels. Ignition and other prescribed fire techniques would maintain existing vegetation patterns and forest plan guidance for snags and logs while reducing fuel loads and protecting cave and karst ecosystems from post-treatment sediment deposition. | 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 prescribed burning 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. | 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 prescribed burning. 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;<br>Other raptors: 50 ft around occupied nest. | Silviculture and Fire | Yes |

| Species | Where/When | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| Black-footed Ferrets | Prairie dog towns | Prairie dog surveys will 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 |
| Miscellaneous | 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 |
| Miscellaneous | 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 | Where/When | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| Miscellaneous | Wildlife cover and stand heterogeneity | 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<br><br>Manage for large oaks by removing ponderosa pine up to 18" dbh that do not meet the "old tree" definition and do not have interlocking crown with oaks within 30 feet of base of oak 10" drc or larger:<br><br>Manage for large oaks by removing ponderosa pine up to 18" dbh that do not meet the "old tree" definition and do not have interlocking crown with oaks within 30 feet of base of oak 10" drc or larger<br><br>All 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; when there is no other option to facilitate logging operations (skid trail and landing locations).<br><br>Areas within Savanna:<br><br>All 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; when there is no other option to facilitate logging operations (skid trail and landing locations).<br><br>and WUI PJ mechanical treatment, seedling/sapling, young and mid-aged pinyon and juniper may be cut. | Silviculture | No |
| Miscellaneous | New fences | Attach bird flight diverters (as provided by AGFD) to exclosure fencing around springs, channels, and aspen stands to avoid wildlife collisions. | Silviculture and Watershed | No |

| Species | Where/When | Description | Programs Affected | Forest Requirement |
|---|---|---|---|---|
| Miscellaneous | 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 |
| Miscellaneous | 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 |
| Miscellaneous | 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 |

## 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
- Arizona Game and Fish Department 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 large high-severity wildfires would continue to increase in light of climate change and if no action occurred
- Understory development would be maximized when BA $\leq$ 50

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 30,000 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 burn would occur in 2015 after mechanical treatments are completed and the 2nd (maintenance) prescribed burn would occur in 2019 and, on average, 40,000 acres would be prescribed burned per year; note that aspen was only burned once in 2012
- Post-treatment vegetation condition trends would be displayed in 2020, 2030, and 2050
- Old trees are assumed to be at least 18inches dbh or larger
- No trees 24 inches dbh or larger would be cut in 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 burn severity

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" 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..

# Environmental Consequences

A review of environmental consequences serves to highlight effects or unintended consequences that may occur from the proposed actions. Environmental consequences are presented below. First there is a discussion of climate change and a review of the alternatives. A description of general cumulative effects follows; aspects of cumulative effects relevant to particular species can be found in the individual species analyses. 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. A review of how treatments would affect hiding and thermal cover is at the end of the report. Much of the science supporting these analyses is identified in the literature cited and the appendices.

## Climate Change Common to All Alternatives

The following information is 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 the Kaibab National Forest forest plan revision (Leonard 2012). This document can be found at: http://www.fs.usda.gov/detail/kaibab/landmanagement/planning/?cid=STELPRDB5106605.

### Background

Climate scientists agree that the earth is undergoing a warming trend, and that human-caused elevations in atmospheric concentrations of carbon dioxide ($CO_2$) and other greenhouse gases are among the causes of global temperature increases. The observed concentrations of these greenhouse gases are projected to increase. Climate change may intensify the risk of ecosystem change for terrestrial and aquatic systems, affecting ecosystem structure, function, and productivity.

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 for Arizona between 1980 and 2006 was 123 percent. The combination of population growth and climate change would 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

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 invasive insects, plants, fungi, and vertebrates (Joyce et al 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 Forest Service 2010a). Shifts in the timing of snowmelt have already been observed which, along with increases in summer temperatures, may seriously impact survival of riparian species and challenge efforts to reintroduce species into their historic range (Joyce et al. 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 2010, 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 likely 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 2010). 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 National Forests of the southwest. Southwestern forests are particularly sensitive to drought and increasing temperatures (Williams et al. 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 mortality from fire and drought-induced die-offs (Williams et al. 2010). 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).

Currently there appears to be broad agreement among climate modelers that the Southwestern U.S. is experiencing a drying trend that will continue well into the later part of the 21st century. The Kaibab NF considering the following potential climate effects locally:

- Increased extreme weather related forest disturbances (floods, drought, wind-throw)
- Water stresses (groundwater, runoff, and timing), aquatic biota
- Wildfire risks
- 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 2010). 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 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

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 Sruvey 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 Mexican spotted owls.

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 burns
- Allow more wildland fire to burn

### Summary

By managing for resistant and resilient ecosystems, promoting landscape connectivity, and implementing concepts of adaptive management, land and resource management can respond to new information and changing conditions related to climate change that have the potential to increase ecosystem risks. Addressing potential consequences of climate change on the endangered, threatened, and candidate species in the 4FRI area is challenging. The FS Southwestern Region and the Kaibab NF have developed guidance for addressing climate change which are broad and general in scope and which rely on adaptive management as climate change science evolves. Recent work locally that focused on the 4FRI landscape supported these findings.

### Relationship of Climate Change to Alternatives

#### Alternative A

Alternative A would not prevent, delay, or ameliorate predicted effects of climate change. The dense forest conditions resulting from the no action alternative are at a high risk to density related and bark beetle 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 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.

#### Alternative B

Risks associated with dense forest conditions would be reduced and forest resiliency large scale disturbance under drier and warmer conditions would be improved by implementing the treatments proposed under alternative B. Individual tree growth would improve, resulting in larger average tree sizes. Species requiring habitat elements associated with closed canopy forest conditions or old or large tree, snag, and log structure would be more sustainable as forest resiliency improved. Open forest, savanna, and meadow and grassland habitats would remain stable in the long-term.

#### Alternative C

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. Individual tree growth would improve, resulting in larger average tree sizes. Species requiring habitat elements associated with closed canopy forest conditions or old or large tree, snag, and log structure would be more sustainable as forest resiliency improved. Open forest, savanna, and meadow and grassland habitats would remain stable in the long-term. The increased acres of mechanical and prescribed burning under this alternative would be expected to increase forest health and resiliency more than the alternatives B or D.

#### Alternative D

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. Individual tree growth would improve, resulting in larger average tree sizes. Species requiring habitat elements associated with closed canopy forest conditions or old or large tree, snag, and log structure would be more sustainable as forest resiliency improved. Open forest, savanna, and meadow and grassland habitats would remain stable in the long-term. The limited acres of prescribed burning under this alternative would be expected to maintain higher fuel loadings, resulting in the smallest increases in forest health and resiliency relative to alternatives B and C.

### All Alternatives - Cumulative Effects

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 for terrestrial wildlife resources is the project boundary. Projects listed within the 4 FRI Cumulative Effects Analysis Baseline were considered as reasonably foreseeable actions (Appendix 12).

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 burning, 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 National Forest, 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 43). 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 12.

**Table 43. 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 fire risk are quickly lost due to resulting tree growth (less than 10 yrs); 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 |

| Project Type | General Effects to Habitat | General Effects to Wildlife | Extent |
|---|---|---|---|
| Prescribed Burning | Reduces fine fuels, litter, and duff; provides a nutritional flush to trees and understory; decreases coarse woody debris (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 burns 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’; 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-raod driving associated with camping limited to within 30' 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 |

| Project Type | General Effects to Habitat | General Effects to Wildlife | Extent |
|---|---|---|---|
| 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 |
| 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% 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 |

| Project Type | General Effects to Habitat | General Effects to Wildlife | Extent |
|---|---|---|---|
| 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 burning 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 |
| 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 accounted for include various vegetation management treatments, fuels treatment and prescribed burning, and wildfires that have occurred within the project area from 2001 to 2010 (Table 44). 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 has also been 12,560 acres of tree removal to restore ponderosa pine savannas and encroached grasslands, 2,650 acres of removal of dead, damaged or dwarf mistletoe infected trees to improve forest health, 100 acres of tree removal to restore aspen inclusions and 1,935 acres of habitat improvement treatments that reduced tree density within pronghorn travel corridors. Within the project area there has been 640 acres of tree and vegetation removal associated with powerline corridor management and protection.

**Table 44. Approximate Acres of Vegetation Management Activities and Wildfire within the Project Area from 2001 to 2010**

| 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 Burn (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.

Fire treatments include prescribed burns (47,970 acres) intended to reduce natural fuels accumulations and 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 12.

### Forest Structure and Diversity - Mosaic of Interspaces and Tree Groups

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 were 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 dbh 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 the 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 burning 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 burn 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 burning 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 45). These thinning treatments vary greatly and include noncommercial thinning, group selection, sanitation thinning, and shelterwood cuts (Appendix 12). 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 burning to rejuvenate grasses and forbs. Pinyon-juniper thinning and burning is occurring on both forests.

**Table 45. 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 |

| Treatment | Treatment Type | Approximate Acres |
|---|---|---|
| | Habitat Improvement | 0 |
| | Powerline Hazard Tree Removal and Right of Way | 500 |
| Total Mechanical: | | **108,660** |
| Broadcast Burn (Total Fuels Treatments) | | **98,800** |
| Prescribed Burn (Burn Only) | | **5,950** |

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 being 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. On the Kaibab NF, the public is only allowed to drive off-road to collect fuelwood within designated 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 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.

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 20). 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 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.

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

### Mexican Spotted Owls (Threatened)

Environmental consequences are based on the application of design features, mitigation, and assumptions described in this report. Environmental consequences are provided by MSO habitat type (protected and restricted) and designated critical habitat. Proposed treatments are the same in target and threshold habitats. They are designed to be of light intensity to move forest conditions towards desired conditions as described in the forest plans and Recovery Plan. The predicted changes in habitat values are small with the objectives of increasing tree growth rates and retaining large pine and oak trees. 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 TableIII.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. Because target and threshold treatments are the same and post-treatment changes are expected to be subtle, these habitat components are combined in the remainder of this report in terms of both habitat classification and treatment results to facilitate discussion of MSO habitat at the scale of the 4FRI analysis.

#### Amendments Supporting the Action Alternatives

This analysis incorporated the proposed amendments to the forest plans, including:

- mechanical treatments in PACs (cutting trees up to 16-inches dbh in alternatives B and D and cutting trees up to 18-inches dbh in alternative C);
- prescribed fire in 56 core areas;

- designating less than 10 percent of restricted habitat as threshold habitat on the Kaibab NF;
- managing future nesting and roosting habitat according to the BA guidelines in the draft Recovery Plan rather than the BA guidelines described in the 1995 Recovery Plan;
- treating more than 10 percent of the PACs in UGM RU;
- and following a monitoring plan developed in collaboration with the US 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 of implementing the alternatives would be different from those analyzed below. By adhering to a nine inch dbh limit for cutting trees within PACs, about 2/3 of the PAC acres proposed for mechanical treatment would retain uncharacteristic BAs and ladder fuels and no fuels reduction would occur in 56 core areas. The result would be a higher risk of potential crown fire, managing for elevated rates of density-dependent tree mortality, and increasing the risk of overstory mortality from insects and disease. Post-treatment PAC habitat conditions would continue to limit the ability to retain large pine and oak trees and slow the development of future large trees and snags. Large pine and oak trees and snags are key components of nesting and roosting habitat. Restricting PAC treatments to 10 percent of the Recovery Unit would continue the risk of habitat loss for an extended period of time.

Not designating 10 percent of restricted habitat as threshold habitat on the Kaibab NF would not be expected to affect MSOs (see analysis below). Similarly, designating 10 percent of restricted habitat as threshold habitat would also not be expected to affect MSOs. Habitat use by MSOs across the Williams Ranger District is in mixed conifer forest on top of the mountainous cinder cones or in Sycamore Canyon. If MSO use of this habitat occurs, it is likely for foraging or dispersal. Managing for an extra two percent of nesting and roosting habitat would not likely affect either behavior. However, maintaining high tree densities in areas that historically did not likely have the canopy closure and stem densities associated with owl nesting and roosting habitat would negatively affect other wildlife species (see amendment analyses for sensitive, management indicator, and migratory bird species). Similarly, managing future nesting and roosting habitat with a lower minimum BA value, as described in the draft Recovery Plan, would not likely affect MSOs in the short-term. By definition, these are areas with no known resident owls. However, these minimum values represent stand or area averages, with groups of trees creating higher and lower values. Managing future nesting and roosting habitat at the higher BA values may decrease the ability to maintain these areas in the long-term due to the risk of potential crown fire, insects, and disease.

The amendments proposed for managing canopy cover and open reference conditions in goshawk habitat, management in the proposed Garland Prairie RNA, and 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. Spatially in the sense of MSO habitat elements designated across the pine-oak forest. A temporal distribution includes maintaining large and old trees while setting a trajectory for future 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 dbh (at least 15% of the trees with a dbh of 12 inches or greater, 15% of the trees with a dbh of 18 inches or greater, and 15% of the trees with a dbh of 24 inches or greater) in nesting, roosting, target, and threshold habitats and 30 to 45% of the trees with a dbh 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 ( > 18" dbh)  suitable for perching or roosting (goal of at least 20 per acre)
- BA and density of pine (goal of at least 150 $ft^2$ per acre in nesting and roosting habitat) and Gambel oak (goal of at least 20 $ft^2$ per acre) in MSO pine-oak habitats
- Percent canopy cover (goal of 40% or more) and changes in canopy structure

**MSO Prey Habitat**

- Large dead trees (snags with diameters of 18 inches dbh 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 burning activities, including , preparation, implementation, smoke and fire effects (spatial and temporal duration)

**Primary Constituent Elements in Critical Habitat**

Critical habitat designations are intended to identify, to the extent known, areas that provide essential life cycle needs of the species (i.e., areas on which are found the primary constituent elements). Primary constituent elements essential to the conservation of the owl include those physical and biological features that support nesting, roosting, and foraging. Primary constituent elements 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% of the trees with a dbh of 12 inches or greater;
- Shade canopy of 40% or more;
- Snags of 12 inch or greater dbh; and

**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 the Recovery Plan.

The Silviculture Specialist Report provides a complete description for silviculture treatments for alternatives B, C, and D and conifer removal within existing ungulate exclosure in Garland Prairie (alternative C). Prescribed burning (alternatives B, C, and D) is detailed in the Fire Specialist 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 restoration unit level in an attempt to simplify reporting out of effects. More detail, e.g., effects to individual PACs or subunits, is presented in the following appendices.

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 8. 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, burning, and wildfire can affect understory vegetation and associated arthropods, along with the equations used to develop the index values, can be found in Appendix 8.

### Alternative A (No Action)

The no action alternative is required by 40 CFR 1502.14(c). It has been analyzed to contrast the impacts of the action alternatives with the current condition and expected future condition if the proposed action were not implemented. This alternative proposes no restoration treatments.

#### Forest Structure and Density in MSO Habitat

This alternative includes no new mechanical or prescribed burning in any habitat, including ponderosa pine, pine-oak, aspen, meadows, springs, ephemeral channels, or any road decommissioning within the project area. None of these different 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 dbh in both the short- and long-term. Trees 18 to 23.9 inches dbh are about at desired conditions by the year 2050. However, trees greater than 24 inches dbh remain well below the distribution described in the Recovery Plan in both the short- and long-term (Table 46). Numbers of TPA 18 inches dbh and greater are below the recommended minimum of 20 or more TPA 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. Percent Maximum SDI would increase to 80 in the protected habitat (about the upper range of the Extremely High Density category), 86 in target and threshold habitat, and 37 percent in restricted “other” habitat (about the low end of the Extremely High Density category) in the no action alternative. (See the silviculture report for details).

The percentage of Gambel oak remains low across the landscape in both the short- and long-term, particularly in protected habitat (Table 46). Canopy structure would remain dense, with low crown base height and high canopy cover. No mechanical treatments would sharply limit new regeneration and therefore decrease the number of trees available for eventual recruitment into larger size-classes.

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 46). The maximum BA for nesting and roosting habitat recommended in the current 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. Most MSO habitat acreage is not intended to be managed for the very dense forests conditions associated with nesting and roosting habitat. These dense conditions are reflected in high percentage of maximum SDI occurring in MSO habitat. A sustainable percentage of maximum SDI is 55 or less and most MSO habitat would be above 75 percent by 2050 (Table 46). The sustainability of old and large pine and oak would be compromised by density-related mortality associated with competition from younger, more vigorous trees and, in the case of large oak, overtopping by ponderosa pine. Forest health and resiliency would continue to erode and the risk from natural disturbances, including insects, disease, and high severity fire, would increase across the landscape.

Combined, these factors would limit or stagnant tree growth rates, maintaining slow recruitment into large size-classes. Within stand mortality would remain high due to tree densities. The risk of undesirable fire behavior and effects would remain high and increase as forest dynamics led to increasingly unhealthy forest conditions. Combined, this would lead to increasingly unsustainable MSO habitat.

**Table 46. Alternative A: Mexican Spotted Owl Habitat Forest Structure and Habitat Components Modeled Out for the Years 2020 and 2050**

| RU | Basal Area | | % Max SDI | | Avg. Percent of Total SDI by Size Class: 12.0 – 17.9” | | Avg. Percent of Total SDI by Size Class: 18.0 – 23.9” | | Avg. Percent of Total SDI by Size Class: 24.0” + | | Avg. TPA 18”+ | | Avg. Gambel Oak BA Percent of Total BA | | Tons CWD >12” | | Snags >18” | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 |
| RU 1 | 164 | 181 | 80 | 81 | 31 | 28 | 16 | 22 | 8 | 11 | 17.5 | 27.3 | 13 | 13 | 1 | 2.3 | 0.7 | 1.6 |
| RU 3 | 177 | 192 | 84 | 84 | 31 | 27 | 17 | 23 | 9 | 12 | 20.8 | 30.1 | 11 | 11 | 1.5 | 2.9 | 0.9 | 2 |
| RU 4 | 109 | 131 | 51 | 56 | 35 | 38 | 14 | 23 | 5 | 8 | 10.8 | 19.8 | 7 | 8 | 0.7 | 1.6 | 0.4 | 1.3 |
| RU 5 | 147 | 170 | 71 | 75 | 31 | 26 | 17 | 22 | 9 | 13 | 16.9 | 26.3 | 11 | 11 | 1.5 | 2.7 | 0.7 | 1.7 |
| All | 164 | 181 | 80 | 81 | 31 | 28 | 16 | 22 | 8 | 11 | 17.8 | 27.5 | 12 | 12 | 1.1 | 2.4 | 0.7 | 1.7 |
| RU 1 | 173 | 191 | 86 | 88 | 28 | 28 | 16 | 21 | 7 | 9 | 19.1 | 26.3 | 21 | 20 | 1.8 | 2.8 | 0.6 | 1.4 |
| RU 3 | 168 | 189 | 86 | 89 | 26 | 23 | 17 | 20 | 8 | 11 | 18.8 | 26 | 26 | 25 | 1.1 | 2.2 | 0.7 | 1.6 |
| All | 171 | 190 | 86 | 88 | 27 | 26 | 16 | 20 | 7 | 10 | 19 | 26.2 | 23 | 22 | 1.5 | 2.5 | 0.6 | 1.5 |
| RU 1 | 148 | 170 | 71 | 75 | 31 | 30 | 14 | 20 | 7 | 10 | 14 | 22.5 | 13 | 14 | 0.6 | 1.4 | 0.4 | 1.1 |
| RU 3 | 147 | 169 | 73 | 77 | 29 | 26 | 15 | 21 | 7 | 10 | 14.2 | 23 | 19 | 20 | 0.7 | 1.6 | 0.5 | 1.2 |
| RU 4 | 141 | 165 | 71 | 75 | 27 | 24 | 15 | 20 | 9 | 11 | 14.1 | 21.9 | 22 | 23 | 0.6 | 1.4 | 0.6 | 1.3 |
| RU 5 | 115 | 146 | 56 | 64 | 26 | 28 | 11 | 15 | 10 | 11 | 9.8 | 16 | 10 | 14 | 0.3 | 0.8 | 0.4 | 0.7 |
| All | 147 | 169 | 72 | 76 | 30 | 28 | 14 | 20 | 7 | 10 | 14.1 | 22.7 | 17 | 18 | 0.7 | 1.5 | 0.5 | 1.1 |

### 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 dbh (Table 46). While creation of large snags would continue, the decreasing numbers of large trees through time would maintain 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. Large snags resulting from uncharacteristic levels of stochastic events would result in large-scale decreases of big trees, which are already underrepresented across the landscape. Small mammal habitat in terms of logs and CWD would be maintained through time under this alternative.

#### *Understory*

Herbaceous forage and cover for prey species would be limited in both the short- and long-term. 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 could limit invertebrate populations. In the long-term, a potential cascading effect could occur if arthropod species richness and abundance continued to decline along with understory biomass, causing additive effects to MSO prey species (see Appendix 8). 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.

Moore et al. (2004) relocated and remeasured a subset of the Woolsey Plots, the oldest known forest inventory plots in the American Southwest. 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. Long-term research plots were established in northern Arizona ponderosa pine forest, including the 4FRI area, in the early 1900s. Moore et al. (2004) used data from this past research to develop models displaying changes in forest structure, including understory ((Figure 33)). Allometric equations developed from historic ponderosa pine tree mapping estimate production in 1870 and in 1910 after tree harvest occurred. Understory production (in kg per ha) continually declined after 1910 density and basal area have increased to levels greatly exceeding those found in 1876 (Moore et al. 2004). Understory production is predicted to have declined as basal area increased, and was lower in 2002 than at any other date. If the no action alternative were selected, the decline would be expected to continue, minimizing food and cover for wildlife in general and MSO prey species specifically (Figure 34).

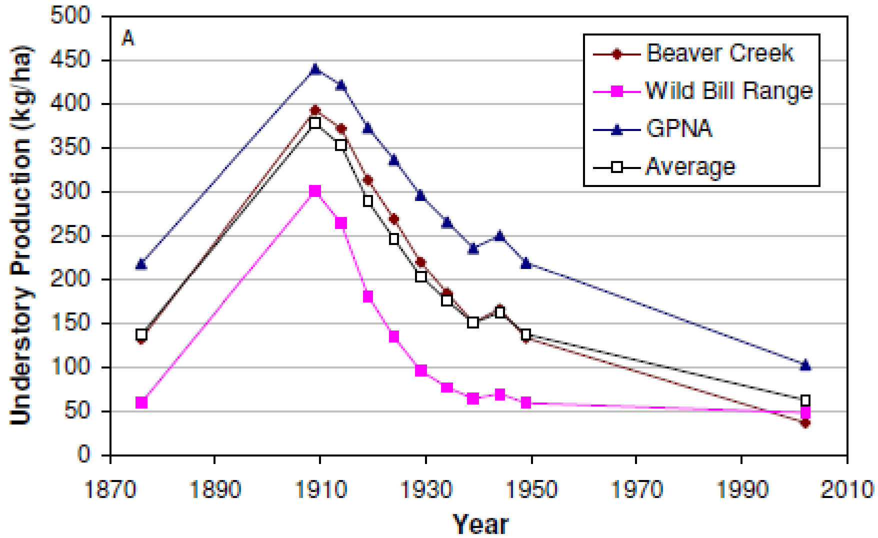



**Figure 33. Changes in Understory Production Between 1876 and 2002 (from Moore et al. 2004); All Models Were Developed Within or Adjacent to the 4FRI Project Area**

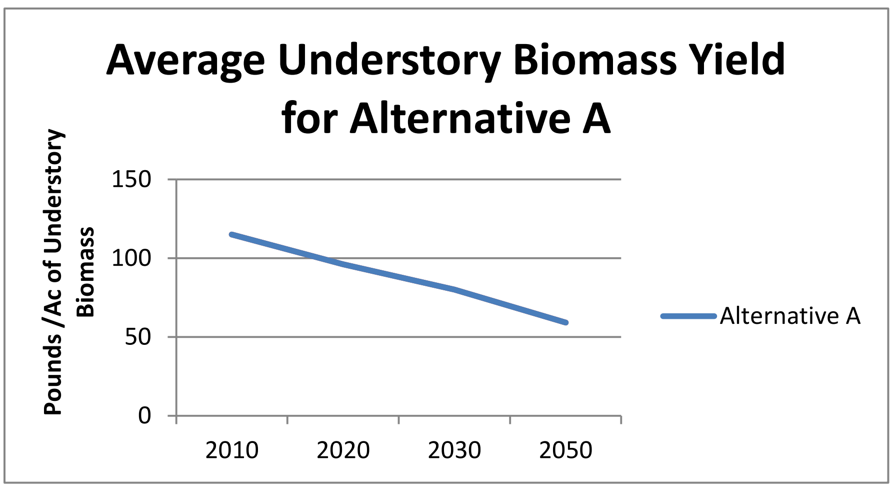



**Figure 34. Relative Changes in Biomass Indices Within the 4FRI Treatment Area Under Alternative A (see Appendix 8 for details)**

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 the owl and habitat for the variety of MSO prey species. Providing a continuous supply of nesting and roosting habitat requires maintaining stands of different stages of ecological succession. Alternative A would maintain forest conditions dominated by dense, mid-aged trees. Percent of maximum of SDI would remain in the extreme category for restricted habitat, even outside of target and threshold habitat. 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 dbh. The declining understory index values indicate prey habitat would continue to decline. 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.

**Fire Effects**

Maintaining the current trajectory for forest conditions would maintain the increasing risk of uncharacteristic fire. Departure from historic conditions can be measured using Fire Regime Condition Class (FRCC) uses three condition classes to describe low departure (FRCC 1), moderate departure (FRCC 2), and high departure (FRCC 3). Departure results from changes to one or more of the following ecological components: vegetation characteristics, including species composition, structural stage, and canopy cover, and spatial fire regime characteristics, including fire frequency and severity. In terms of modeling for the general treatment area, more of the ponderosa pine forest would continue moving into Fire Regime Condition Class 3 under alternative A (Table 47). These conditions would increase the risk of crown fire and decrease the potential for managing unplanned ignitions for resource benefits. Overall, this increases the fire risk to MSO habitat. The risk to key habitats such as nesting and roosting would remain higher in alternative A as a result of the general landscape remaining at higher risk.

**Table 47. Fire Regime Condition Class (FRCC) Ratings in Ponderosa Pine Forest Through Time Under Alternative A**

| Conditions | Year | Measure | FRCC1 | FRCC2 | FRCC3 |
|---|---|---|---|---|---|
| Existing | 2010 | Acres | 70,680 | 136,311 | 297,866 |
| | | Percent | 14 | 27 | 59 |
| Alt. A | 2020 | Acres | 55,534 | 95,923 | 353,400 |
| | | Percent | 11 | 19 | 70 |
| | 2050 | Acres | 5,049 | 136,311 | 363,497 |
| | | Percent | 1 | 27 | 72 |

Surface fuel loading (in this discussion, this includes litter, duff, and CWD>3”) in in protected habitat, particularly core areas, are well above conditions in the general ponderosa pine forest (Figure 35). 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 (see 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 burns with a higher severity and a potential to negatively impact understory resources such as seed banks, soil flora, and arthropod populations (Appendix 8). Crown fire is more likely if surface fuel build-up continues, leading to increased flame lengths. High surface fuels 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.

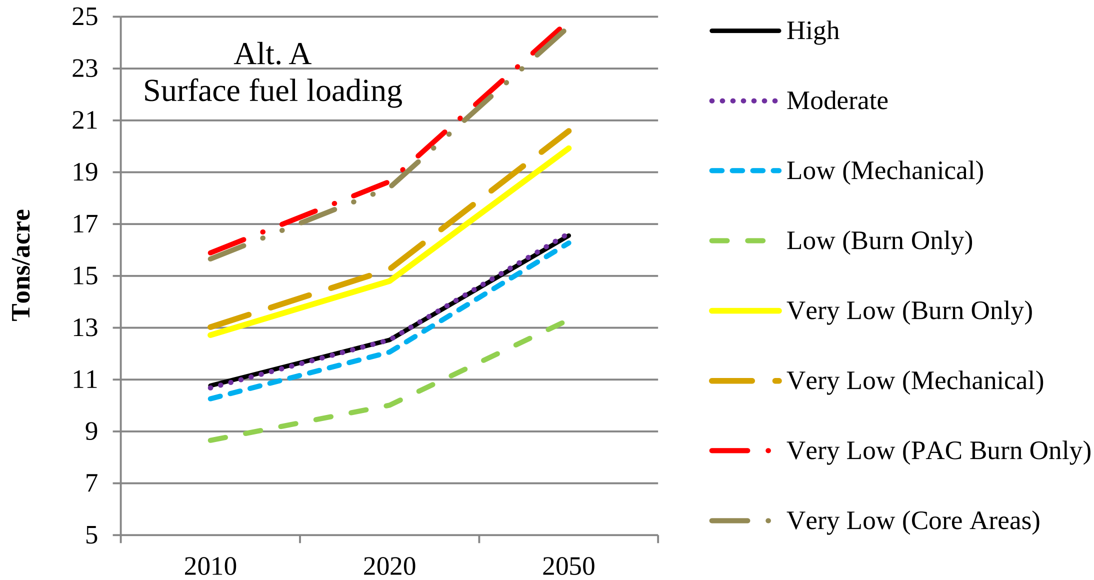



**Figure 35. Modeled changes in surface fuel loading using areas of similar management treatment intensities intended to achieve similar results in terms of forest openness (note that no treatments would occur under alternative A)**

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 in MSO habitats (Table 48). All crown fire would be expected to burn with high severity (see 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 high fire risk (USDI FWS 1995).

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 (Savage and Mast 2005, Strom and Fulé 2007).

**Table 48. Modeled Fire Behavior in MSO Habitat Under Current Conditions and in 2020 Under Alternative A**

| MSO Habitat | Total (Ac) | Surface Fire (Ac) | Passive Crown Fire (Ac) | Active Crown Fire (Ac) | Surface Fire (%) | Passive Crown Fire (%) | Active Crown Fire (%) |
|---|---|---|---|---|---|---|---|
| **Existing Condition** | | | | | | | |
| Ponderosa Pine | 507,059 | 313,423 | 48,523 | 145,113 | 61 | 10 | 29 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Protected | 36,658 | 18,610 | 3,141 | 14,847 | 50 | 9 | 41 |
| Target/ Threshold | 8,713 | 4,292 | 926 | 3,479 | 49 | 11 | 40 |
| Restricted “Other” | 67,378 | 35,465 | 6,608 | 25,187 | 53 | 10 | 37 |
| **Alternative A** | | | | | | | |
| Ponderosa Pine | 507,059 | 318,506 | 49,817 | 138,736 | 63 | 10 | 27 |
| Protected | 36,658 | 19,072 | 3,069 | 14,456 | 52 | 8 | 40 |
| Target/ Threshold | 8,713 | 4,527 | 1,228 | 2,943 | 52 | 14 | 34 |
| Restricted “Other” | 67,378 | 35,465 | 6,608 | 25,187 | 55 | 11 | 34 |

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, 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 five different PACs. Similarly, wildlife habitat associated with almost 5 miles of ephemeral stream channels would remain degraded, 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 meadow or aspen treatments would occur, allowing these important habitats to continue to decline from encroachment and competition with ponderosa pine trees. As these interspersed habitats decline within the ponderosa pine and Gambel oak forest matrix, so does overall understory biomass. 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.

### *Roads*

Current road miles would not change under this alternative. About 164 miles of roads would not be decommissioned in MSO habitat, including about 121 miles of roads (15 percent) within MSO Critical Habitat. About 75 miles of temporary road construction would not be required, including about 7 miles of temporary road that would not be constructed in MSO protected habitat. About 70 miles of roads currently on the landscape within MSO habitat would not receive maintenance.

Decommissioning would not occur for roads closed under the Travel Management Rule or on unauthorized routes. Theoretically these roads should not receive use regardless of the status of the decommissioning. Road decommissioning could take many forms, from simply adding signage, placing boulders to obstruct access, to ripping and recontouring 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.

Not knowing which technique would be used where prohibits an effects analysis other than to say that habitat recovery would be delayed and sources of ongoing resource damage would continue for the long-term.

About 70 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. An additional 1.2 miles of road currently impacting ephemeral stream channels in MSO habitat would not be relocated, thereby continuing the degradation of vegetation associated with this limited but important prey habitat.

**Direct and Indirect Effects:** With no treatments occurring, there would be no direct increase or decrease of MSO protected, restricted, or Critical Habitat in the short-term. In the long-term, MSO habitat would decrease as a result of declines in forest health and resiliency.

The lack of mechanical thinning and low severity prescribed burning would maintain forest development on its current trajectory. Dense forests would maintain closed canopy conditions and continue to exhibit reduced growth rates. The abundance of young and mid-aged forest would continue to dominate the landscape. Competition for limited water and nutrients would continue as a result of dense groups of young to mid-aged trees to the detriment of old trees and Gambel oak.

Currently, about 353,400 acres of ponderosa pine forest, including all pine-oak habitat, are in FRCC3. By 2050 FRCC3 will increase to about 363,500 acres. This alternative will not reduce the threat of high severity crown 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.

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

All action alternatives propose treatments in MSO protected habitat. None of the treatments would include mixed-conifer habitat or any MSO habitat within wilderness areas. The silviculture implementation plan includes direction to omit treatments in any area identified as a ponderosa pine cover but which, upon arrival at the actual location on the ground, is mixed-conifer vegetation .

**Protected Habitat**

#### *Springs and Ephemeral Channels*

Five springs are proposed for restoration in MSO protected habitat. All five springs are in PACs occurring in Restoration Unit 1 on the Coconino NF (Lee Spring, Mud Spring, Rock Top, Sawmill Springs, and Weimer Springs). The springs in two PACs (Mud Spring and Weimer Springs) are in meadows and the other three PACs have springs in pine-oak forest. 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). Ephemeral stream channel restoration reaches would average about 0.28 miles in length (range equals 0.02 to 0.72 miles). Only Holdup PAC has riparian vegetation within the ephemeral stream reach, but no woody vegetation is present. Recontouring of channels could also take place, depending on site conditions. Removal of encroaching trees and treating noxious weeds would be evaluated in a site-specific manner for both spring and channel restoration. 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/addressed in the individual alternative discussions.

Operational burning, where the objective is to use fire in areas not proposed for restoration treatments in order to facilitate prescribed fire treatments in adjacent areas, would occur on 100 acres of meadow habitat within 12 PACs. Aspen treatments would consist of prescribed burning on 190 acres in six PACs (five PACs on the Coconino NF and Kendrick PAC on the Kaibab) and do not include mechanical removal of trees in PACs. Prescribed burning would have site-specific objectives in aspen (versus operational burning), which would kill young encroaching conifers, though larger ones are less likely to be killed because of the need for low severity fire in PACs. Low severity fire in aspen stands would have low flame lengths, producing a patchy, low severity fire with limited mortality of overtopping pine trees. The subsequent shading of aspen and competition for water and nutrients by pine trees would continue. The expected result would be an increase in aspen suckering and a slight and very short-term improvement to understory biomass. However, because of the dense nature of nesting and roosting habitat and the value of logs and CWD for prey habitat, burn prescriptions are not expected to restore aspen nor provide for its expansion.

At the scale of 4FRI, improvements to prey habitat through spring, ephemeral channel, meadow, and aspen treatments within protected habitat are limited and site specific. However, these treatments would enhance prey habitat. MSO reproductive success appears tied to prey availability. MSOs in the UGM feed primarily on peromyscid mice and voles (Ganey et al. 2011) and restoration treatments can benefit these species (Kalies et al. 2012, Martin and Maron 2012). Other small mammals, birds, and nocturnal flying insects (primarily lepidopterans and coleopterans) are also prey for MSOs and overall prey abundance may be very important to nesting MSOs, particularly during years when a key species may be limited (Ganey et al. 2011). In general, small mammals, birds, and arthropods increase after burning and thinning in ponderosa pine forests (Appendix 8). This is particularly true for key habitat components like springs and ephemeral channels where herbaceous response would be expected to exceed that under dense forest canopies. Therefore, improvements to spring, ephemeral channel, meadow, and aspen treatments within protected habitat would improve prey habitat and potentially benefit resident MSO.

### *Roads*

About 49 miles of roads in protected habitat would be decommissioned across 12 different subunits (Table 49). About 20 percent of the total road miles in 57 PACs would be decommissioned (Appendix 14). Decommissioning roads in PACs would occur outside the breeding season and average 0.8 miles of road 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. Road decommissioning would occur in 14 core areas, including about five out of nearly 25 total road miles in core areas (20 percent). An average of 0.35 miles of road would be decommissioned per core area (range = 0.01 to 0.93 miles in individual core areas). All 14 core areas are on the Coconino NF. Timing restrictions would avoid potential noise disturbance to nesting and roosting MSOs. Recommended adaptive management actions for road-related activities were reviewed and would not result in additional effects that are not already disclosed/addressed in the individual alternative discussions.

**Table 49. Road Miles Proposed for Decommissioning Within Protected Habitat**

| Forest | Subunit | Road Miles Proposed For Decommission | Total Road Miles | Percent of Roads Decommissioned |
|---|---|---|---|---|
| CNF | 1-1 | 0.1 | 1.7 | 5 |
| | 1-3 | 8.8 | 46.9 | 19 |
| | 1-4 | 1.2 | 11.7 | 10 |
| | 1-5 | 20.0 | 120.7 | 17 |
| | 3-3 | 0.7 | 2.9 | 23 |
| | 3-4 | 5.4 | 7.6 | 72 |
| | 3-5 | 1.7 | 17.7 | 10 |
| | 4-3 | 1.3 | 1.6 | 76 |
| | 4-4 | 0.2 | 0.2 | 100 |
| | 5-1 | 6.2 | 19.3 | 32 |
| | 5-2 | 3.3 | 16.1 | 21 |
| KNF | 4-4 | 0.1 | 2.2 | 4 |
| **Total** | | **49** | **251** | **20 (Avg)** |

Road maintenance (nearly 98 miles) and temporary road construction (about 7 miles) would affect almost 105 miles of roads in protected habitat (Table 50). Road maintenance within PACs would take place outside of the breeding season. The term “temporary roads” in this instance includes non-system roads that currently function as open roads on the landscape. . These roads would also be decommissioned outside of the breeding season after 4FRI project implementation.

**Table 50. Road Maintenance and Temporary Road Construction in Mexican Spotted Owl Protected Habitat**

| MSO Habitat | Road Maintenance | New Temporary Roads | Road Relocation | Total Miles of Road Work |
|---|---|---|---|---|
| Protected Total | 97.6 | 7.2 | 0.0 | 104.8 |

**Restricted Habitat**

### *Other Habitat Effects*

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 Restoration Unit 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 1/10$^{th}$ 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/addressed in the individual alternative discussions.

About 3,870 acres of meadow treatments would occur in restricted habitat. Under alternative B, all meadow treatments are operational burn only; none of the burn treatments represent prescriptions for site-specific objectives related to meadow restoration other than allowing fire to cross non-ponderosa pine habitat, thus precluding the need for digging firelines. Large meadows can blend into small grasslands and some of the meadows treatments likely represent grassland habitat rather than true openings within forest habitat. Nevertheless, portions of grassland treatments would likely still function as MSO foraging habitat, e.g., areas where owls could forage some distance in from forest edges or from groups of trees within portions of the grassland. Meadow and an unknown percentage of grassland treatments would be expected to improve understory conditions for MSO prey species. However, operational burning is only expected to cause minimal tree mortality (e.g., seedlings but not necessarily saplings) and would not change overstory canopy and hence changes in understory response may be limited in many meadows.

Aspen treatments include about 200 acres of prescribed burning and about 740 acres of aspen restoration. Prescribed burning would decrease litter and cause moderate pine mortality. Treatments would be designed to induce aspen suckering. Aspen restoration would mechanically remove all post-settlement ponderosa pine inside clones and within 100 feet of clones. Mechanical ground disturbance may be used along with fire to stimulate suckering. Aspen restoration would be expected to improve the health and resiliency of aspen clones and move canopy conditions towards multiple canopy layers. Prescribed burning in aspen would be expected to provide more limited benefits to MSO because of the patchy nature of burning in this habitat, which limits exposure of young pine trees to fire, and moderate pine mortality within clones would reduce but still maintain shading by post-settlement pine. Reduced changes to the pine overstory would maintain shading and litter build-up within aspen clones, limiting understory response in 21 percent of the aspen with little change expected in aspen sustainability (200 acres). Aspen restoration would open the overstory, create surface fuels to 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 understory vegetation and overstory aspen health and sustainability in 79 percent of the treated aspen (740 acres).

### *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 51).

**Table 51. Proposed Road Decommissioning in Restricted Habitat by Subunit**

| Forest | Restoration Sub-unit | Restricted Other Habitat | | | Target and Threshold Habitats | | |
|---|---|---|---|---|---|---|---|
| | | Road Miles Proposed for Decom-missioned | Total Road Miles | Percent of Total Roads Decom-missioned | Road Miles Proposed for Decom-mission | Total Road Miles | Percent of Total Roads Decom-missioned |
| 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 |

About 360 miles of road maintenance would occur in restricted habitat, including about 41 miles in target and threshold habitat (Table 52). 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 52. 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*

Spring restoration would occur in two CHUs (Table 53): eight springs are proposed for restoration in UGM-11 (all on the Coconino NF) and nine in UGM-13 (two on the Coconino NF and seven on the Kaibab NF). Ephemeral stream channel restoration would occur in CHUs UGM-11, -12, -13, and -14 (Table 54). 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/addressed in the individual alternative discussions.

**Table 53. Proposed Spring Restoration by Critical Habitat Unit (CHU) Within the 4FRI Treatment Area**

| Forest | CHU | Spring |
|---|---|---|
| Coconino | UGM-11 | Howard |
| | | Lee |
| | | Mud |
| | | Rock Top |
| | | Sawmill |
| | | Sedge |
| | | Van Deren |
| | | Weimer |
| | Total | 8 |
| | UGM-13 | Lockwood |
| | | Scott |
| | Total | 2 |
| Coconino Total | 2 | 10 |
| Kaibab | UGM-13 | Andrews |
| | | Hat Tank lower unnamed spring |

| Forest | CHU | Spring |
|---|---|---|
| | | Hat Tank upper unnamed spring |
| | | Rocky Tule spring unnamed |
| | | Stewart Spring |
| | | Weed unnamed spring |
| | | Wild Horse |
| Kaibab Total | 2 | 7 |
| **Total:** | **2** | **17** |

**Table 54. 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** |

### *Roads*

Road decommissioning would occur in every CHU within the treatment area. Eight to 11 percent of the total roads will be decommissioned in the different CHUs (Table 55). Three CHUs, UGM-11, 13, and 17, would have segments of roads relocated to protect ephemeral channels. Recommended adaptive management actions for springs and ephemeral channels were reviewed and would not result in additional effects that are not already disclosed/addressed in the individual alternative discussions.

**Table 55. Roads Proposed for Decommissioning Under the 4FRI by Mexican spotted owl Critical Habitat Unit (CHU)**

| National Forest | CHU | Miles of Roads Proposed for Decommissioning | Total Road Miles by CHU | Percent of Total Roads Proposed For Decommissioning |
|---|---|---|---|---|
| CNF | UGM-11 | 51 | 308 | 17 |
| | UGM-12 | 6 | 15 | 40 |
| | UGM-13 | 31 | 174 | 18 |
| | UGM-14 | 13 | 46 | 28 |
| | UGM-15 | 1 | 2 | 50 |

| | | | | |
|---|---|---|---|---|
| KNF | UGM-13 | 19 | 245 | 8 |
| | UGM-15 | | 1 | 0 |
| | UGM-17 | 0.2 | 2 | 11 |
| **Grand Total** | | **121** | **793** | **15** |

Temporary road construction and road maintenance would occur in all CHUs within the 4FRI area, totaling about 423 miles (Table 56). Road segments totaling about one mile would be relocated in Critical Habitat to protect ephemeral stream resources.

**Table 56. Temporary Road Construction and Road Maintenance Critical Habitat**

| National Forest | Critical Habitat Unit | Road Maintenance | Temporary Road Construction | Total Miles of Road Work |
|---|---|---|---|---|
| CNF | UGM-11 | 181.2 | 26.6 | 207.7 |
| | UGM-12 | 3.6 | 4.9 | 8.5 |
| | UGM-13 | 52.0 | 6.4 | 58.4 |
| | UGM-14 | 9.4 | 1.2 | 10.6 |
| | UGM-15 | 0.7 | 0.2 | 0.9 |
| CNF Total | | 246.8 | 39.4 | 286.2 |
| KNF | UGM-13 | 108.5 | 27.5 | 136.0 |
| | UGM-15 | 0.3 | | 0.3 |
| | UGM-17 | 0.7 | < 0.1 | 0.7 |
| KNF Total | | 109.4 | 27.5 | 136.9 |
| **Grand Total** | | **356.3** | **66.9** | **423.1** |

Spring restoration would occur in two CHUs: eight springs are proposed for restoration in UGM-11 and nine in UGM-13 (Table 57). Ephemeral stream channel restoration would occur in CHUs UGM-11, -12, -13, and -14 (Table 58). 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).

**Table 57. 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 |

| Forest | CHU | Name | Total |
|---|---|---|---|
| | | 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 58. 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 described above under restricted habitat.

#### ***Disturbance***

Potential disturbance could occur from project implementation, such as noise from harvest-related machinery, transporting forest products, preparing for prescribed burning, and smoke settling during burning operations. Delaney and Grubb (2004) determined that spotted owls appear to be capable of hearing sounds from road maintenance equipment to distances of at least 400 meters (0.25 miles). However, in an experimental study with a conspecific raptor on the Kaibab NF, Grubb et al. (2012) found no evidence that the awareness of noise generated from logging trucks was correlated with actual negative effects to nesting northern goshawks. The observed response from nesting goshawks was limited to, at most, looking in the direction of the hauling road (Grubb et al. 2012).

Haul routes for transporting forest materials were evaluated to identify routes that would avoid potentially harassing nesting or roosting MSOs in the vicinity of each of the 72 PACs in the treatment area. 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 routes in and near PACs:

- Roads were selected to avoid PACs
- Where hauling in PACs could not be avoided, roads greater than a ¼ mile from core areas were selected (Woods PAC)
- Where these criteria could not be met, timing restrictions were applied to prevent disturbance to MSO during the nesting season

Therefore, while MSO may hear the sound of trucks, the design features and mitigations employed during implementation are expected to avoid adverse effects to nesting or roosting owls from road-related noises. Noise disturbance from logging trucks was monitored for nesting goshawks, a similar-sized and sympatric raptor with MSO in northern Arizona. The study was coordinated between the FS, the U.S. Army, and a private sound consultant. Results from this controlled experiment found no evidence of negative effects. Observed goshawk response to the truck noise was limited to, at most, looking in the direction of the hauling road (Grubb et al. 2012).

Most project activities would be conducted during daylight hours and most MSO activity is nocturnal. There remains some risk of disturbance to foraging owls outside of PACs during crepuscular hours. Noise associated with early morning and late evening activities related to mechanical thinning, actions related to prescribed burning, road use, maintenance operations, and etc. may disturb foraging MSOs. Disturbance would be site-specific and could cause owls to shift to areas that provide undisturbed foraging opportunities. No nesting or roosting owls inside PACs would be disturbed from noise because of implementation planning and timing restrictions.

Burning would focus on reducing surface fuels, particularly pine litter, and increasing tree crown base heights while retaining adequate levels of down logs and course woody debris through prescription and ignition techniques. This is expected to reduce surface fire intensity and flame lengths. Prescribed burning across extensive acreages is intended to move forests towards the desired condition of supporting frequent, low-severity fire. Increasing crown 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).

The presence of smoke may temporarily disturb MSO within and adjacent to the treatment area. Burning proximate to PACs during the breeding season (March 1 – August 31) would be conducted in a manner that limits smoke settling into PACs. Burning would not occur within 1/8 to ¼ mile buffers during nesting season. The distance will be decided based on site specific parameters including topography, amount of surface fuels, and wind and weather patterns. Site specific decisions will be made after discussions between biologists, fuels specialists, and in association with the USFWS. Prevailing southwest winds and the topography of the area typically act to lift smoke, carrying it away from ignition sites. Most PACs on cinder cones and other raised topographic features (e.g., Kendrick, Sitgreaves, Mormon Mountain, etc.) and most PACs in or immediately adjacent to Sycamore Canyon, Oak Creek Canyon and the Mogollon Rim are not expected to have smoke settle in them long enough to cause discernible effects to MSOs because of the air movement associated with these landscape-scaled features. Conversely, PACs with core areas occurring in small canyons (e.g., James, Kelly, Walnut, etc.) may have smoke settle in nesting and roosting habitat for one or more consecutive days. Smoke effects are regulated and permits are required before burning is initiated. Smoke from prescribed fire would comply with ADEQ requirements and we will meet air quality standards. ADEQ considers the cumulative effects of smoke emissions from multiple jurisdictions prior to approving daily prescribed burning activities. This mitigates the potential for severe smoke effects from multiple prescribed fire projects across the entire treatment area.

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 to MSO. However, first-entry burns would include fuel loads well above historical levels, causing 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. Dense smoke from first-entry burns that settled into nest areas early in the season (March through June) 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 multiple consecutive nights could also affect developing lungs of nestlings. Japanese quail continuously exposure to ozone for seven days 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 where gas exchange occurs. Japanese quail appear to lack the morphological and biochemical repair ability observed in mammals (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). Conversely, mammalian airways form a tree-like branching pattern that terminate in alveoli rather than forming a unidirectional air flow. Therefore, it is assumed that prolonged exposure to smoke would cause permanent lung damage to MSO nestlings. 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, 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. See below for a summary of actions by 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). The minimum post-treatment BA for nesting and roosting habitat would be 150 $ft^2$ per acre, in line with the current recovery plan (USDI FWS 1995). Low severity prescribed burning would be applied to all MSO habitats except for core areas (Table 59). No trees greater than 24 inches dbh would be removed and tree groups with diameters averaging 18 inches dbh or greater would not be cut for regeneration. Treatments in target habitat are designed to move forests towards threshold conditions. Treatments in threshold habitat would not lower forest structure values below the threshold levels described the forest plans and in Table III.B.1 of the Recovery Plan. A comparison of treatments in MSO PAC habitat by alternative is displayed in Appendix 15. This analysis is based on the assumption that mechanical treatments and two low-severity prescribed burns would occur within the project timelines. Alternative B would mechanically treat 84,177 acres and prescribe burn 107,696 acres in protected and restricted habitat.

**Table 59. Alternative B Summary of Treatments in MSO Pine-Oak Habitat**

| Treatment Type* | MSO Habitat Type | | | |
|---|---|---|---|---|
| | Protected | Restricted | Target/ Threshold | Total Acres |
| Burn Only | 20,864 | 2,354 | 301 | 23,519 |
| MSO Restricted – Group Selection & Intermediate Thinning + Burning | | 65,024 | | 65,024 |
| MSO Target – Intermediate Thinning + Burning | | | 6,518 | 6,518 |
| MSO Threshold – Intermediate Thinning + Burning | | | 1,894 | 1,894 |
| PAC – Intermediate Thinning ≤16” + Burning | 10,741 | | | 10,741 |
| **Total** | **31,605** | **67,378** | **8,713** | **107,696** |

An overview of immediate post-treatment results (year 2020) and long-term changes to habitat structure (year 2050) are displayed at the RU-level in Table 60. Proposed treatments for nesting and roosting habitat were designed to meet the habitat objectives described in the forest plans and in the Recovery Plan. This resulted in low intensity treatments retaining high BA and percent maximum SDI as described for protected habitat and target and threshold habitats. Increases in percent area for trees greater than 18 inches dbh, including trees greater than 24 inches dbh, would occur. Trees 12 to 18 inches dbh would decrease in all habitat classifications but remain above 20 percent in target and threshold habitat and in protected habitat and above 15 percent in restricted “other” habitat. The number of average TPA 18 inches or greater increased in both existing and future nesting and roosting habitats and decreased in restricted “other” habitat. This latter occurred as a result of creating canopy gaps, uneven-aged structure, lower total BA to accelerate growth rates for moving more trees into larger size classes, retain existing large trees, retain existing large trees, and reduce the current fire threat. This meets the direction in the Recovery Plan to manage for a landscape mosaic or mixture of habitat conditions to ensure adequate nesting, roosting, and foraging habitat for the owl and habitat for MSO prey. This alternative represents a landscape management approach to maintain and create replacement owl habitat where appropriate while providing heterogeneous forest conditions across the landscape as described in the Recovery Plan. The percent of oak BA typically remained the same or decreased by a percent in protected and target and threshold habitats and decreased by a percentage point in restricted “other” habitat. CWD increased across all RUs. Snags greater than 18 inches dbh increased in target and threshold habitat and in protected habitat and typically remained unchanged in restricted “other” habitat.

Mechanical thinning and light, prescribed underburning would take place at different times in different locations. Spotted owl habitat could be affected by mechanical treatments in one area and prescribed burning 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 8,700 acres of MSO habitat would be mechanically treated and 10,855 acres prescribed burned each year under alternative B. No mechanical treatments would occur on slopes greater than 40 percent in MSO habitat.

**Table 60. Alternative B - 2020 and 2050 Mexican Spotted Owl Habitat Forest Structure and Habitat Components Based on Weighted Stand Averages**

| RU | Basal Area | | % Max SDI | | Avg. Percent of Total SDI by Size Class | | | | | | Avg. TPA 18"+ | | Avg. Gambel Oak BA Percent of Total BA | | Tons CWD >12" | | Snags >18" | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 12.0 – 17.9" | | 18.0 – 23.9" | | 24.0" + | | | | | | | | | |
| | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 |
| Restricted Target/ Threshold | | | | | | | | | | | | | | | | | | |
| RU 1 | 144 | 175 | 73% | 81% | 29% | 24% | 20% | 25% | 9% | 11% | 19.6 | 28.4 | 25% | 24% | 1.2 | 2.1 | .5 | 1.4 |
| RU 3 | 149 | 181 | 78% | 85% | 25% | 21% | 19% | 21% | 9% | 12% | 19.0 | 26.7 | 29% | 28% | .7 | 1.8 | .7 | 1.6 |
| All | 146 | 178 | 75% | 83% | 28% | 23% | 20% | 23% | 9% | 11% | 19.3 | 27.6 | 27% | 26% | 1.0 | 1.9 | .6 | 1.5 |
| Restricted Other | | | | | | | | | | | | | | | | | | |
| RU 1 | 74 | 107 | 35% | 46% | 22% | 19% | 22% | 19% | 19% | 20% | 11.4 | 16.7 | 19% | 18% | .7 | 1.5 | .8 | .8 |
| RU 3 | 81 | 114 | 38% | 50% | 22% | 18% | 22% | 19% | 17% | 18% | 11.6 | 17.3 | 24% | 23% | .8 | 1.7 | 1.0 | .9 |
| RU 4 | 80 | 115 | 39% | 52% | 20% | 17% | 21% | 17% | 19% | 19% | 11.4 | 16.4 | 26% | 25% | .7 | 1.6 | 1.0 | 1.0 |
| RU 5 | 64 | 98 | 30% | 42% | 21% | 21% | 17% | 15% | 21% | 18% | 8.3 | 12.9 | 13% | 15% | .4 | 1.0 | .6 | .6 |
| All | 78 | 111 | 37% | 49% | 22% | 19% | 22% | 19% | 18% | 19% | 11.5 | 17.0 | 22% | 21% | .8 | 1.6 | .9 | .9 |

| RU | Basal Area | | % Max SDI | | Avg. Percent of Total SDI by Size Class | | | | | | Avg. TPA 18"+ | | Avg. Gambel Oak BA Percent of Total BA | | Tons CWD >12" | | Snags >18" | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 12.0 – 17.9" | | 18.0 – 23.9" | | 24.0" + | | | | | | | | | |
| | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 |
| **Protected** | | | | | | | | | | | | | | | | | | |
| RU 1 | 154 | 175 | 72% | 75% | 32% | 28% | 17% | 25% | 9% | 12% | 17.8 | 28.0 | 13% | 14% | .7 | 2.0 | .7 | 1.7 |
| RU 3 | 168 | 189 | 79% | 82% | 31% | 26% | 18% | 24% | 10% | 13% | 20.9 | 31.0 | 12% | 12% | 1.0 | 2.5 | .8 | 1.9 |
| RU 4 | 106 | 128 | 50% | 55% | 35% | 38% | 14% | 24% | 5% | 8% | 10.9 | 19.8 | 8% | 8% | .5 | 1.5 | .4 | 1.3 |
| RU 5 | 143 | 168 | 68% | 74% | 31% | 26% | 17% | 22% | 9% | 13% | 16.9 | 26.5 | 11% | 11% | 1.0 | 2.4 | .7 | 1.7 |
| All | 154 | 175 | 72% | 76% | 32% | 27% | 17% | 24% | 9% | 12% | 18.0 | 28.2 | 13% | 13% | .8 | 2.1 | .7 | 1.7 |

**Protected Habitat**

At a meeting of biologists from the Coconino and Kaibab NFs, the FWS, and the 4FRI, a concern was raised that forests had become so dense that mechanical treatments restricted to trees less than 9 inches dbh would not achieve desired conditions for PACs. MSO PAC field and data reviews (see Appendix 2) and vegetation simulation modeling indicated mechanical treatments that included trees greater than 9 inch dbh would better move 18 PACs towards desired conditions. Optimal size classes for trees removed would range from less than 9 inches dbh up to 16 inches dbh in this alternative (Table 61). 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. 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. Each individual PAC would have site specific evaluations with the participation of the FWS in determining how best to achieve this balance. Within the 18 PACs, approximately 3,388 acres would be improved with mechanical treatments limited to trees up to 9 inches dbh (about 32 percent of the total treated PAC acres in alternative B). 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 inch dbh 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 inch dbh on 4,151 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 inch dbh on 1,902 acres.

Modeled treatments were developed to reduce BA, but remain at or above 150 $feet^2$ 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 dbh.

**Table 61. 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 Treatment (dbh and acre) | | | |
|---|---|---|---|---|---|
| | | Treat up to 9” dbh (Acres) | Treat up to 12” dbh (Acres) | Treat up to 14” dbh (Acres) | Treat up to 16” dbh (Acres) |
| Lake No. 1/Seruchos | Dense thickets of VSS3 pine, oak is competing with pine for nutrition, sunlight and moisture, need to grow larger trees over time, enhance oaks, create small openings | 123 | 66 | 50 | 0 |
| Archies | Pine-oak with strong oak component but few large oak – many pines < 9” dbh | 444 | 41 | 11 | 0 |
| Red Hill | Scrappy habitat that has been treated with an overstory removal in the past, dense pockets of ponderosa pine with heavy mistletoe infection in areas, thin pine to grow larger trees and reduce fire threat, enhance oak where present, grow larger trees over time and reduce competition | 97 | 190 | 385 | 0 |
| Crawdad | Oak is supressed by high densities of pine, need for creating gaps around oak and releasing individual oak trees | 138 | 0 | 342 | 120 |
| Holdup | Most of PAC is pure pine, thin around any existing oak and provide areas for oak to establish | 57 | 197 | 264 | 18 |
| 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 |

| PAC Name | General Description | MSO PAC Mechanical Treatment (dbh and acre) | | | |
|---|---|---|---|---|---|
| | | Treat up to 9" dbh (Acres) | Treat up to 12" dbh (Acres) | Treat up to 14" dbh (Acres) | Treat up to 16" dbh (Acres) |
| Red Raspberry | Diverse topography, protect microclimates from fire, high percentage of VSS 3 and VSS 4, need for enhancing openings, create, retain, and enhance larger trees | 387 | 19 | 203 | 55 |
| Bear Seep | PAC is pure ponderosa or oak, high density of trees > 9 inch dbh | 453 | 0 | 0 | 144 |
| Mayflower Tank | PAC has steep slopes, heavy fuels, limited number of small trees | 257 | 0 | 139 | 217 |
| Knob | PAC has limited habitat, generally pure pine and open with some dense dog-hair thickets | 273 | 26 | 252 | 114 |
| 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 |
| Iris Tank | PAC has dense pine with pockets of doghair thickets; 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 |

| PAC Name | General Description | MSO PAC Mechanical Treatment (dbh and acre) | | | |
|---|---|---|---|---|---|
| | | Treat up to 9" dbh (Acres) | Treat up to 12" dbh (Acres) | Treat up to 14" dbh (Acres) | Treat up to 16" dbh (Acres) |
| Frank | PAC has areas of pure pine with dense pockets of VSS3 and VSS4, need to release any oaks present and encourage recruitment of oaks, reduce pine densities and increase diameters of both pine and oak | 286 | 69 | 178 | 65 |
| Rock Top | Treat in pure pine to increase the amount of oak and grow larger trees | 98 | 57 | 506 | 90 |
| Lee Butte | Treat in dense pine to increase the amount of oak, reduce tree density, and increase tree diameter on slopes to improve habitat and protect nest core | 121 | 1 | 328 | 314 |
| Foxhole | Dense thickets of pine with some oak, need for enhancing oak and thinning groups | 10 | 124 | 136 | 178 |
| Bar M | PAC is part of the mega-cluster of PACs within the Bar-M area, break up contiguous fuels in areas of pure pine, thin out dense clumps of pine and release oaks within clumps, release oaks, provide openings for forage and grow larger trees | 119 | 149 | 199 | 66 |
| Sawmill Springs | All size classes of pine and oak present, neeed for large dbh size classes to enhance and maintain habitat structure | 192 | 63 | 190 | 71 |
| **Total Mechanical Treatment Acres** | | **3,388** | **1,335** | **4,151** | **1,867** |

Mechanical treatments would take place within 18 of the 110 PACs occurring within a ¼ mile of the project area boundary (16 percent) under alternative B. This includes 10,741 acres out of 35,566 total PAC acres in the treatment area (30 percent). Only the 18 PACs receiving mechanical treatments are proposed for light prescribed underburning in alternative B. Although the implementation schedule is not yet known, an average of 1.8 PACs would be treated per year if 4FRI implementation lasted 10 years. On average, this equals less than one percent of the PACs across the two forests treated in a given year. Changes in forest structure by individual PAC are shown in Appendix 16.

The wildlife analysis for the Kaibab forest plan concluded the Kendrick PAC consisted of mixed-conifer habitat. The Kaibab assessment used a mid-scale analysis (100-1,000 acres) for evaluating effects of the proposed land management plan. The 4FRI analysis is based on a finer scale and identified individual pine-oak stands within the Kendrick PAC. About 173 acres of pine-oak habitat outside the core area were identified for burn-only treatment in the Kendrick PAC during the 4FRI analyses of potential PAC treatments. A field trip confirmed the occurrence of pine forest within the PAC in areas recovering from the Pumpkin fire, but no Gambel oak was identified (project record). The nearby Stock Tank PAC, administered by the Coconino NF, has about 15 acres of pine-oak habitat that occur on the Kaibab NF outside of the Kendrick Peak Wilderness Area that are also proposed for burn-only treatments. The 15 acres are within the PAC but outside of the core area.

### *Forest Structure and Density in MSO Habitat*

#### Large Trees

Treatments would be expected to release large, old trees from competition with unnaturally dense groups of young pine trees. Expected results would include increasing the ability to retain large trees on the landscape and increasing growth rates of existing and future large trees. Mechanical treatments would be, by design, conservative in protected habitat. Therefore treatment results would be limited in protected habitat because of the low intensity of the treatments. Only limited differences in distribution of tree size classes between mechanically treated and untreated PACs would be apparent by the year 2050 (Table 62). The percentages of trees 18 to 23.9 inches dbh would show the most improvement in mechanically treated PACs with increases would averaging five percent by 2050 at the individual PAC level compared to the no action alternative (Appendix 16). Abundance of trees greater than 24 inches dbh would also show consistent improvement in mechanically treated PACs as would trees per acre greater than 18 inches dbh (Table 62). Compared to alternative A, increases in the larger size-classes in mechanically treated PACs would result from reducing the abundant mid-aged trees in the 12 to 17.9 inch size-class, although this size class would remain above 20 percent of the area in mechanically treated PACs. More important at the site scale would be the increased ability to retain and develop large trees after treatment. Site-specific PAC visits identified density-dependent mortality of large pine and oak trees due to competition from mid-sized trees. The percent distribution of larger tree size classes would remain unchanged in the burn-only PACs. The emphasis on increasing tree growth rates and retaining large trees comes from the Recovery Plan that 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" (USFWS 1995).

#### Basal Area

Pine BA would be reduced by about 13 percent in mechanically treated PACs (Table 62**Error! Not a valid bookmark self-reference.**). Pine BA would decrease by about two percent in the burn-only PACs. Gambel oak BA would be about the same at the PAC level for all alternatives, increasing by only 2 (alternative B) to 3 percent. However, prescribed burning would contribute towards reducing overstory competition by removing small trees. The minimum BA for nesting and roosting habitat described in the Recovery Plan is 150 BA. Total BA after treatment would be about 160 in thin and burn PACs and 183 in burn-only PACs. Protected 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. Overall, this would meet the objective of retaining dense forest conditions while increasing resiliency of large trees.

**Canopy Structure**

Based on BA and percent maximum SDI, canopy cover would remain dense. Percent maximum SDI would decrease relative to no action alternative, but at 72 would remain at about the middle of the Extremely High Density Range. Canopy cover would be at least 50 percent or greater, based on BA, TPA, and tree dbh (Table 102). Canopy cover within tree groups would be higher. Only ponderosa pine would be harvested so while individual trees of other species might be affected by mechanical and burning operations, the existing variability in overstory species would remain after treatments. PACs are the most proximal and highly used foraging areas during the nesting season. Burning in PACs would improve sub-canopy flight space for foraging MSOs by lifting the crown base height. Combined, these factors should maintain or enhance the elements of canopy structure such as tree cover and density, flight space, and overstory species diversity.

Overall, changes in the above structural elements are limited under alternative B, but would move PACs towards desired conditions. While treated PACs would show limited change, the objectives behind the treatments were primarily site-specific, including the release of large oak and pine from competition, create irregular spacing, and increase growth rates in the large tree cohort. The fact that the decrease is minimal when averaged across PACs is a reflection of the "light touch" designed for treatments in PAC habitat. Changes in forest structure by individual PAC are summarized in Appendix 16.

**Table 62. Modeled Changes in Forest Structure Attributes Within MSO PACs Under Alternative B**

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative B[2] (Year 2050) |
|---|---|---|---|
| **PACs With Thinning Outside Core Areas (*n* = 18)** | | | |
| 12 – 17.9" dbh (%) | 30 | 28 | 27 |
| 18 – 23.9" dbh (%) | 14 | 23 | 28 |
| ≥ 24" dbh (%) | 8 | 12 | 14 |
| TPA ≥ 18" dbh | 15 | 27 | 29 |
| Ponderosa Pine BA | 120 | 135 | 122 |

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative B[2] (Year 2050) |
|---|---|---|---|
| Gambel Oak BA | 16 | 18 | 20 |
| All BA | 148 | 173 | 160 |
| **PACs With Prescribed Burning Outside Core Areas (n = 54)** | | | |
| 12 – 18” dbh (%) | 31 | 28 | 28 |
| 18 – 23.9” dbh (%) | 13 | 22 | 22 |
| ≥ 24” dbh (%) | 8 | 11 | 11 |
| TPA ≥ 18” dbh | 15 | 28 | 28 |
| Ponderosa Pine BA | 117 | 125 | 123 |
| Gambel Oak BA | 20 | 22 | 23 |
| All BA | 158 | 185 | 183 |

[1] = No Action Alternative
[2] = No Treatments Within Core Areas

### *MSO Prey Habitat*

#### Snags, Logs and Coarse Woody Debris

Total snags greater than 18 inches dbh would remain the same compared to untreated PACs under alternative A (Table 63). There would be about 4.2 snags per acre 12 to 18 inches dbh in PACs with mechanical treatments and about 5.9 snags per acre in the burn-only PACs. Retaining and improving growth rates of large trees would provide a more robust cohort of trees 18 inches dbh and greater and would thus better provide a source of snags beyond 2050.

Logs would decrease by less than one per acre in treated PACs (Table 63). The decrease would vary by individual PAC (Appendix 16). CWD would consistently decrease in individual PACs but remain in the upper limits of forest plan consistency (Table 63). Changes in both logs and CWD would be a result of the light mechanical and prescribed burning treatments. Both variables would remain at levels adequate for sustaining prey habitat.

#### Understory Index

Understory response would be higher under alternative B compared to the no action alternative (Table 63). The limited improvement is a reflection of the high canopy cover in protected habitat. The modeling for understory does not include the nutrient pulse or benefits of reducing the pine litter layer that burning provides (Appendix 8). Increasing the soil nutrient pool would likely benefit overstory trees that would presumably increase their nutrient translocation into the canopy, limiting understory response (Appendix 8). However, reducing the litter layer would improve understory conditions. Individual PACs receiving both mechanical and prescribed burning treatments would show more variety in understory response (Appendix 16). Localized increases in biomass production would represent increased grass and forb development during the growing season, potentially providing site specific improvements in food and cover for arthropods, small mammals and birds. In turn, this could increase localized prey availability, diversity, and total prey biomass for resident MSOs.

Overall, changes in the above structural elements would be moderate in this alternative, providing limited improvements to prey habitat. Relative to the other alternatives, alternative B would treat less than alternative C and more than alternative D. Affects to prey habitat are summarized by PAC in Appendix 16.

**Table 63. Modeled Changes in Prey Habitat Attributes Within MSO PACs Under Alternative B**

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative B[2] (Year 2050 |
|---|---|---|---|
| **PACs With Thinning Outside Core Areas (n = 18)** | | | |
| Snags/ Ac ≥ 17.9” dbh | 0.6 | 1.5 | 1.5 |
| Logs/ Ac | 1.3 | 5.7 | 5.0 |
| CWD (tons/ac) | 4.7 | 10.3 | 6.6 |
| Understory Index[3] | 47 | 40 | 53 |
| **PACs Prescribed Burning (n = 54)** | | | |
| Snags/ Ac ≥ 17.9” dbh | 0.7 | 1.8 | 1.8 |
| Logs/ Ac | 2.8 | 7.9 | 7.0 |
| CWD (tons/ac) | 6.0 | 12.5 | 9.0 |
| Understory Index[3] | 48 | 41 | 44 |

**1** = No Action Alternative
**2** = No Treatments Within Core Areas
**3**= Year 2020

### *Fire Effects*

Prescribed burning would occur in all 72 PACs in the treatment area (Appendix 16). About 86 percent of PAC acres (30,716 of 35,566 acres) would be burned, including the 18 PACs with mechanical treatments and 54 PACs receiving no other treatments. Prescribed burning 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 crown base height. Reduction of surface fuels and raising canopy base height would reduce the risk of a surface fire becoming a crown fire. Raising the crown base height would also improve sub-canopy flight space for hunting MSOs.

Post-treatment modeling indicates that the amount of ponderosa pine forest occurring in FRCC 3 across the general treatment area would decrease by almost 277,700 acres under alternative B in the year 2020 (Table 64). This would greatly decrease the risk of high-severity fire from moving into protected habitat and would increase the potential for managing unplanned ignitions for resource benefits. Combined, this would further decrease the risk of undesirable fire behavior and effects to MSO habitat. While the risk to nesting and roosting habitat would remain high, the decrease in FRCC 3 across the landscape would help mitigate the threat of losing this habitat to high-severity fire.

**Table 64. Fire Regime Condition Class (FRCC) Ratings in Ponderosa Pine Forest Through Time Under Alternative B**

| Conditions | Year | Measure | FRCC1 | FRCC2 | FRCC3 |
|---|---|---|---|---|---|
| Existing | 2010 | Acres | 70,680 | 136,311 | 297,866 |
| | | % | 14 | 27 | 59 |
| Alt. B | 2020 | Acres | 90,874 | 393,788 | 20,194 |
| | | % | 18 | 78 | 4 |
| | 2050 | Acres | 75,729 | 247,380 | 181,749 |
| | | % | 15 | 49 | 36 |

Burning in PACs would occur outside the nesting season. Burning in PACs with the associated design features would be expected to maintain most large logs and CWD (Table 63 above). In addition, future recruitment of large logs would be improved by retaining and enhancing the large tree cohort and improving large tree recruitment.

Figure X shows changes in elements of MSO prey habitat (surface fuels) by treatment intensities as tracked by canopy openness. The figure predicted relative canopy openness after treatment, e.g., “High” indicates open conditions associated with a mosaic of tree groups and interspace. Very low indicates relatively connected canopies with little discernible interspace (see fire ecology report for details). The lowest intensity treatments are associated with MSO protected habitat and would retain the highest fuel loading in all modeled years. A direct effect of prescribed fires would be the consumption of some CWD. More CWD is often produced as an indirect effect of burning (Waltz et al. 2003), but it may be of a different decay stage that does not fill the same ecological niche. CWD would increase faster after treatment than it would with no management actions, and is 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. Twenty tons per acre represents the upper end of the recommended range for fuel loading southwest ponderosa pine habitat (see fire ecology report). Adequate levels of CWD in PACs would be expected after treatment in alternative B, but litter levels may suppress understory development.

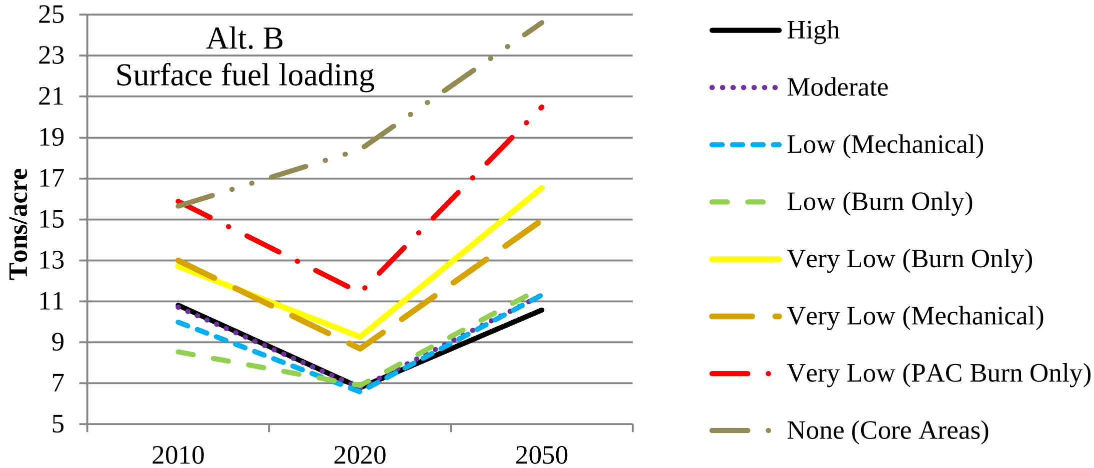



**Figure X. Modeled changes in surface fuel loading (litter, duff, and CWD combined) by desired openness for Alternative B**

Potential fire behavior would shift as a result of prescribed burning. Predicted surface fire would increase in protected habitat by over 23 percent (8,700 acres) in the year 2020 under alternative B (Table 65). The probability of active crown fire would decrease by 21 percent (about 7,796 acres) after treatments. All crown fires are predicted to burn as high-severity. 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 burning in PACs outside core areas would also lower the threat of potential fire behavior inside core areas. Appendix 16 displays MSO habitat by type of fire for each alternative.

**Table 65. Predicted Fire Behavior in Protected Habitat Under Current Conditions and After Implementation of Alternative B in 2020**

| MSO Habitat | Total (Ac) | Surface Fire (Ac) | Passive Crown Fire (Ac) | Active Crown Fire (Ac) | Surface Fire (%) | Passive Crown Fire (%) | Active Crown Fire (%) |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Existing Condition** | | | | | | | |
| **Ponderosa Pine** | 507,059 | 313,423 | 48,523 | 145,113 | 62 | 10 | 29 |
| **Protected** | 36,658 | 18,610 | 3,141 | 14,847 | 51 | 9 | 41 |
| **Alternative B** | | | | | | | |
| **Ponderosa Pine** | 507,059 | 481,209 | 16,133 | 9,717 | 94 | 3 | 2 |
| **Protected** | 36,658 | 27,319 | 2,191 | 7,087 | 75 | 6 | 19 |

**Restricted Habitat**

Mechanical treatments would occur on about 73,436 acres of restricted habitat, or 97 percent of total restricted acres in the treatment area. This includes about 97 percent of the total target and threshold acres. Although the implementation schedule is not yet known, on average 7,344 acres would be treated per year if 4FRI implementation lasted 10 years. On average, this would equal about 10 percent of the total restricted habitat treated each year. All restricted habitat (100 percent) would be treated with prescribed burning.

***Forest Structure and Density***

Treatments in restricted habitat would follow forest plan guidelines and be expected to maintain existing nesting and roosting habitat (threshold habitat) and create replacement nesting and roosting habitat (target habitat). Thinning objectives in target and threshold habitat would maintain an overall BA of 150 $ft^2$ per acre or greater, as described in the forest and Recovery Plans. In addition, treatments in restricted habitat would also provide heterogeneous forest conditions across the landscape. Treatments were designed to develop uneven-aged forest structure, irregular tree spacing, variety of tree group sizes, and reestablish interspace adjacent to tree groups. Large pine trees and Gambel oak would be released from competition with unnaturally dense groups of young pine trees.

**Large Trees**

Mechanical treatments would, by design, be conservative in target and threshold habitat and would focus on increasing both the percent area of larger tree size-classes and increasing tree growth rates, as recommended in the Recovery Plan. Treatments would be of lower intensity in these habitat classifications compared to restricted “other” habitat. Trees less than 18 inches dbh are over-abundant relative to desired conditions described in the forest plans and the Recovery Plan. Therefore, treatments would focus on trees less than 18 inches dbh to address management priorities including increasing tree growth rates to move more trees into larger size-classes and retaining existing large trees.

As a result of threshold treatments planned under alternative B, trees 12 to 17.9 inches dbh would decrease by about three percent while trees 18 to 23.9 inches dbh and trees greater than 24 inches dbh would increase by five to two percent, respectively (Table 66). All subunits would maintain greater than 15 percent cover of trees 12 to 17.9 inches dbh and trees 18 to 23.9 inches dbh after treatment except for subunit 3-2. This one subunit would decline to 13 percent by the year 2050. Simultaneously, trees 24 inches dbh and greater would increase by 2 percent in both RUs compared to the no action alternative by 2050. Treatments in 4FRI assume one mechanical entry and two entries with prescribed fire. Subunit 3-2 may require additional work to achieve densities of 15 percent or greater in each of the three dbh size-classes. Overall, each subunit displayed consistent increases in large trees by 2050 under alternative B relative to the no action alternative (Appendix 17). TPA greater than 18 inches dbh increased with most subunits increasing while some remained stable or decreased by a percent or two (Appendix 17). Average TPA 18 inches dbh and greater remained above forest plan direction with over 30 trees per acre. The intensity of the treatments are such that threshold habitat would remain in density zone 4, at risk from competition-induced mortality and lacking resiliency to large scale stochastic events. Nevertheless, treatments would maintain or improve MSO nesting and roosting habitat in terms of large tree growth rates and increasing the percentage of large trees across threshold habitat.

Changes in the distribution of large trees in target habitat were similar to those described for threshold habitat (**Error! Reference source not found.**). Trees 12 to 17.9 inches dbh were selected for cutting due to their abundance and treatments were designed to improve the ratios of large trees. Similar to threshold habitat, one subunit (subunit 1-4) decreased below 15 percent cover by 2050. Trees 18 to 23.9 inches dbh and trees greater than 24 inches dbh would increase across target habitat. TPA greater than 18 inches dbh would also consistently increase.

Trees 12 to 17.9 inches dbh would decrease in restricted “other” habitat, largely as a result of creating gaps, irregular spacing and diversifying the age-class distribution (Table 69 and Appendix 17). Decreases (10 to 13 percent) would occur in density of trees less than 18 inches dbh, compared to the no action alternative, indicating the selection of mid-sized trees in the treatment design. Trees 18 to 23.9 inches dbh would commonly decrease by 1 or 2 percent and trees greater than 24 inches dbh would increase 7 to 10 percent by 2050. Trees greater than or equal to 18 inches dbh, a simple stem count versus a density measurement, would range from 13 to 17 TPA. Removing mid-sized trees would reduce their numbers and so reduce future recruitment into larger size-classes. However, trees would grow into the largest size-classes more quickly because of improved growth rates. In time, this would reduce the total number of trees less than 24 inches dbh. This reflects the inherent trade-off in meeting Recovery Plan objectives to increase the number and growth rates of large trees on the existing landscape. However, restricted “other” habitat is not expected to provide nesting and roosting habitat (the role of target and threshold habitat) and would allow the creation and maintenance of canopy gaps, uneven-spacing, and uneven-aged forest. Increasing forest heterogeneity while increasing the large tree component would improve MSO habitat by maintaining current and future nesting and roosting structure in some areas while also increasing prey habitat and potential MSO foraging opportunities in other areas. These changes would reduce competition-induced mortality and increase resiliency to large scale stochastic events, including fire risk (see below). The emphasis on increasing tree growth rates and retaining large trees comes from the Recovery Plan that 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.”

**Basal Area**

Pine BA would decrease in all restricted habitats (Table 66). This represents a key contribution towards reducing fire threat in designated MSO habitat. Gambel oak BA would increase 2 to 4 percent in target and threshold habitats, compared to the no action alternative, and decrease by 3 to 5 percent in restricted "other" habitat (Table 67 and Table 68). No oak would be targeted for removal; the decrease in restricted "other" habitat would result from increased operations. Treatments would move forests towards uneven spacing with canopy gaps as described in the Recovery Plan. Total BA would remain at or above 200 $ft^2$ per acre in threshold habitat and be about 170 $ft^2$ per acre in target habitat where current conditions are more open than current threshold habitat. Total BA would range from 98 to 115 $ft^2$ per acre in restricted "other" habitat. These changes would increase forest health and resiliency by reducing competition-induced mortality and increasing resiliency to large scale stochastic events.

**Canopy Structure**

Based on BA and percent maximum SDI, canopy cover would remain dense. Percent Maximum SDI would decrease relative to no action alternative, but at 75 would remain at about the middle of the Extremely High Density Range for target and threshold habitats (Table 101) Restricted "other" habitat would decrease to 37, the low end of the high density category (Table 101). Canopy cover would be 50 percent or greater based on BA, TPA, and tree dbh (see silviculture report for details). Therefore, canopy cover within tree groups would be higher. Existing variability in overstory species diversity would remain by design. Prescribed burning would improve sub-canopy flight space for MSOs by lifting crown base height. Combined, these factors should improve the elements of canopy structure such as cover, density, flight space, and maintain overstory species diversity in the overstory.

**Table 66. Modeled Changes in Forest Structure for MSO Threshold Habitat in Alternative B**

| Forest Attribute | Existing Conditions (Yr 2010) | Alternative A (Yr 2050) | Alternative B (Yr 2050) |
|---|---|---|---|
| **Restoration Unit 1** | | | |
| 12 – 17.9" dbh (%) | 25 | 26 | 23 |
| 18 – 23.9" dbh (%) | 24 | 28 | 33 |
| ≥ 24" dbh (%) | 3 | 6 | 8 |
| Avg TPA ≥ 18" dbh | 28 | 35 | 39 |
| Ponderosa Pine BA | 131 | 142 | 111 |
| Gambel Oak BA | 58 | 56 | 60 |
| All BA | 204 | 226 | 202 |

| Forest Attribute | Existing Conditions (Yr 2010) | Alternative A (Yr 2050) | Alternative B (Yr 2050) |
|---|---|---|---|
| **Restoration Unit 3** | | | |
| 12 – 17.9” dbh (%) | 26 | 19 | 17 |
| 18 – 23.9” dbh (%) | 19 | 26 | 27 |
| ≥ 24” dbh (%) | 8 | 11 | 13 |
| Avg TPA ≥ 18” dbh | 24 | 36 | 36 |
| Ponderosa Pine BA | 107 | 113 | 95 |
| Gambel Oak BA | 57 | 61 | 64 |
| All BA | 185 | 209 | 200 |

**Table 67. Modeled Changes in Forest Structure for MSO Target Habitat in Alternative B**

| Forest Attribute | Existing Conditions (Yr 2010) | Alternative A (Yr 2050) | Alternative B (Yr 2050) |
|---|---|---|---|
| **Restoration Unit 1** | | | |
| 12 – 18" dbh (%) | 30 | 28 | 24 |
| 18 – 23.9" dbh (%) | 12 | 19 | 23 |
| ≥ 24" dbh (%) | 7 | 10 | 12 |
| Avg TPA ≥ 18" dbh | 14 | 24 | 26 |
| Ponderosa Pine BA | 115 | 126 | 105 |
| Gambel Oak BA | 27 | 31 | 34 |
| All BA | 156 | 184 | 169 |
| **Restoration Unit 3** | | | |
| 12 – 18" dbh (%) | 26 | 25 | 23 |
| 18 – 23.9" dbh (%) | 13 | 17 | 19 |
| ≥ 24" dbh (%) | 7 | 11 | 12 |
| Avg TPA ≥ 18" dbh | 13 | 22 | 23 |
| Ponderosa Pine BA | 100 | 112 | 98 |
| Gambel Oak BA | 31 | 35 | 37 |
| All BA | 148 | 181 | 173 |

**Table 68. Modeled Changes in Forest Structure for MSO Restricted "Other" Habitat in Alternative B**

| Forest Attribute | Existing Conditions (Yr 2010) | Alternative A (Yr 2050) | Alternative B (Yr 2050) |
|---|---|---|---|
| **Restoration Unit 1** | | | |
| 12 – 17.9" dbh (%) | 30 | 30 | 19 |
| 18 – 23.9" dbh (%) | 12 | 20 | 19 |
| ≥ 24" dbh (%) | 7 | 10 | 20 |
| TPA ≥ 18" dbh | 11 | 23 | 17 |
| Ponderosa Pine BA | 108 | 127 | 70 |
| Gambel Oak BA | 17 | 22 | 19 |
| All BA | 138 | 170 | 107 |
| **Restoration Unit 3** | | | |
| 12 – 17.9" dbh (%) | 29 | 26 | 18 |
| 18 – 23.9" dbh (%) | 13 | 21 | 19 |
| ≥ 24" dbh (%) | 7 | 10 | 18 |
| TPA ≥ 18" dbh | 12 | 23 | 17 |
| Ponderosa Pine BA | 95 | 112 | 67 |
| Gambel Oak BA | 26 | 32 | 27 |
| All BA | 137 | 169 | 114 |
| **Restoration Unit 4** | | | |
| 12 – 17.9" dbh (%) | 28 | 24 | 17 |
| 18 – 23.9" dbh (%) | 13 | 20 | 17 |

| Forest Attribute | Existing Conditions (Yr 2010) | Alternative A (Yr 2050) | Alternative B (Yr 2050) |
|---|---|---|---|
| ≥ 24” dbh (%) | 8 | 11 | 19 |
| TPA ≥ 18” dbh | 12 | 22 | 16 |
| Ponderosa Pine BA | 84 | 100 | 62 |
| Gambel Oak BA | 27 | 35 | 30 |
| All BA | 129 | 165 | 115 |
| **Restoration Unit 5** | | | |
| 12 – 17.9” dbh (%) | 24 | 28 | 21 |
| 18 – 23.9” dbh (%) | 10 | 15 | 15 |
| ≥ 24” dbh (%) | 10 | 11 | 18 |
| TPA ≥ 18” dbh | 8 | 16 | 13 |
| Ponderosa Pine BA | 77 | 101 | 62 |
| Gambel Oak BA | 9 | 17 | 14 |
| All BA | 102 | 146 | 98 |

### *MSO Prey Habitat*

#### Snags, Logs and Coarse Woody Debris

Under alternative B, snags greater than 18 inches dbh in both target and threshold habitat would be similar to the no action alternative by the year 2050 (Table 69 and Table 70). Changes in snags greater than 18 inches dbh would generally decrease by RU, although results varied by 0.1 to 0.3 snags per acre. There was no change in RU1 compared to the no action alternative (Table 60). The impact of low snag densities, relative to forest plan guidance (i.e., 2 snags per acre 18 inches dbh and larger), 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. 2003). 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 that are more resistant to fire (Waskiewicz et al. 2003).

Logs would be above forest plan guidelines (i.e., 3 logs per acre at least 12 inches at mid-diameter and 8 feet long or longer) in all restricted habitats (Table 69, Table 70, and Table 71). Threshold habitat would be more than double forest plan direction and both RUs. Target and restricted "other" habitat would exceed or be at about forest plan direction in each RU.

CWD would be at the upper end of the range (i.e., 5 to 7 tons per acre) in threshold and target habitats. In restricted "other" habitat, CWD would meet forest plan guidelines in all RUs except for RU 5 which would be about 4.1 tons per acre. Existing conditions in this RU are only at 3.1 tons per acre of CWD. Mechanical treatments would likely add to the accumulation of down wood while burning would decrease available down wood. The resulting values would be more variable by individual subunit (Appendix 17).

**Understory Index**

Reduced BA and intermittent openings would increase light, moisture, and nutrient availability for herbaceous understory species. Understory response in threshold habitat is currently low, with biomass index values averaging 14 and 20 lbs/ac in RUs 1 and 3 respectively, and would remain low after treatment (Table 69). Nevertheless, the biomass index would increase by about 85 percent in RU 1 and about 44 percent in RU 3, compared to the no action alternative. Understory response in target habitat would result in values similar to those in PAC habitat, reflecting the conservative nature of the overstory treatments in this habitat (Table 70). Changes in restricted "other" habitat are again variable with the increase in biomass yield similar to target habitat in RUs 1 and 3, but increases would nearly triple in RU 4 and would increase by almost 2 ½ times in RU 5 compared to the no action alternative (Table 71). Changes in the understory index 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 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 (USDI 1995). The recovery plan recommends managers provide diverse habitats to support a diverse prey base. However, improvements in understory production would gradually decline as overstory canopies expand and new trees became established.

**Table 69. Modeled Changes in Prey Habitat Attributes Within MSO Threshold Habitat Under Alternative B**

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative B[2] (Year 2050) |
|---|---|---|---|
| **Restoration Unit 1** | | | |
| Snags/ Ac ≥ 18" dbh | 0.5 | 1.2 | 1.1 |
| Logs/ Ac | 6.1 | 9.0 | 6.2 |
| CWD (tons/ac) | 7.1 | 12.9 | 6.9 |

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative B[2] (Year 2050) |
|---|---|---|---|
| Understory Index[3] | 14 | 13 | 24 |
| **Restoration Unit 3** | | | |
| Snags/ Ac ≥ 18" dbh | 0.7 | 2.1 | 2.2 |
| Logs/ Ac | 1.8 | 7.9 | 6.2 |
| CWD (tons/ac) | 4.4 | 11.7 | 7.0 |
| Understory Index[3] | 20 | 18 | 26 |

**Table 70. Modeled Changes in Prey Habitat Attributes Within MSO Target Habitat Under Alternative B**

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative B[2] (Year 2050) |
|---|---|---|---|
| **Restoration Unit 1** | | | |
| Snags/ Ac ≥ 18" dbh | 0.5 | 1.4 | 1.4 |
| Logs/ Ac | 4.6 | 8.1 | 6.2 |
| CWD (tons/ac) | 6.0 | 11.8 | 6.8 |
| Understory Index[3] | 37 | 31 | 48 |
| **Restoration Unit 3** | | | |
| Snags/ Ac ≥ 18" dbh | 0.5 | 1.4 | 1.3 |
| Logs/ Ac | 2.5 | 6.1 | 4.9 |
| CWD (tons/ac) | 4.8 | 10.5 | 6.4 |
| Understory Index[3] | 53 | 45 | 59 |

[1] = No Action Alternative

[2] = No Treatments Within Core Areas

[3]= Lbs of biomass/ac in Years 2010 (Existing) and 2020 (Alts A & B)

**Table 71 Modeled Changes in Prey Habitat Attributes Within MSO Restricted "Other" Habitat Under Alternative B**

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative B[2] (Year 2050) |
|---|---|---|---|
| **Restoration Unit 1** | | | |
| Snags/ Ac ≥ 18" dbh | 0.4 | 1.1 | 0.8 |
| Logs/ Ac | 1.2 | 4.3 | 4.5 |
| CWD (tons/ac) | 4.3 | 8.9 | 5.7 |
| Understory Index[3] | 61 | 50 | 180 |
| **Restoration Unit 3** | | | |
| Snags/ Ac ≥ 18" dbh | 0.4 | 1.2 | 0.9 |
| Logs/ Ac | 1.5 | 4.7 | 5.0 |
| CWD (tons/ac) | 3.9 | 8.7 | 6.2 |
| Understory Index[3] | 63 | 52 | 173 |
| **Restoration Unit 4** | | | |
| Snags/ Ac ≥ 18" dbh | 0.5 | 1.3 | 1.0 |
| Logs/ Ac | 1.1 | 4.3 | 4.7 |
| CWD (tons/ac) | 3.2 | 7.8 | 5.7 |
| Understory Index[3] | 61 | 49 | 154 |
| **Restoration Unit 5** | | | |
| Snags/ Ac ≥ 18" dbh | 0.4 | 0.7 | 0.6 |
| Logs/ Ac | 0.6 | 2.5 | 2.9 |
| CWD (tons/ac) | 3.1 | 6.0 | 4.1 |
| Understory Index[3] | 99 | 77 | 191 |

**1** = No Action Alternative

**2** = No Treatments Within Core Areas

[3]= Lbs of biomass/ac in Years 2010 (Existing) and 2020 (Alts A & B)

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 in 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 maximum SDI, with mid-range of values in the extremely high density category (zone 4 – see Table 4) and values at the low end of the high density category (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. Additionally, 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.

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 the tree densities required for nesting and roosting habitat everywhere. In addition to addressing nesting and roosting needs, restricted habitats would provide a heterogeneous forest conditions across the landscape, as described in the Recovery Plan. Using target and threshold habitat for developing and maintaining nesting and roosting habitat where appropriate 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 and ensure maintenance of other important ecological functions (Kalies and Chambers 2010). In alternative B, restricted “other” habitat can ensure adequate foraging habitat for the owl and habitats for its variety of prey, as recommended in the Recovery Plan. It therefore shows the greatest change in MSO habitat components after treatment. Combined with target, threshold, and protected habitat, treatments in restricted “other” habitat would sustain owl habitat that is well distributed spatially in such a way as to mimic the natural landscape, provide connectivity for owl dispersal, and enhance ecosystem resiliency (USDI 1995).

### *Fire Effects*

Prescribed burning, along with mechanical treatments, would occur across 76,091 acres of restricted habitat, including 8,713 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 and threshold and restricted “other” habitats, respectively (Table 72). 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 stand replacing fire in MSO habitat. Overall, thinning and burning treatments are projected to move restricted habitat towards the restoration of low-severity fire. Appendix 16 displays MSO habitat and fire behavior for each alternative.

**Table 72. Predicted Fire Behavior in Restricted Habitat Under Current Conditions and After Implementation of Alternative B in 2020**

| MSO Habitat | Total (Ac) | Surface Fire (Ac) | Passive Crown Fire (Ac) | Active Crown Fire (Ac) | Surface Fire (%) | Passive Crown Fire (%) | Active Crown Fire (%) |
|---|---|---|---|---|---|---|---|
| **Existing Condition** | | | | | | | |
| Ponderosa Pine | 507,059 | 313,423 | 48,523 | 145,113 | 61 | 10 | 29 |
| Target/ Threshold | 8,713 | 4,292 | 926 | 3,479 | 49 | 11 | 40 |
| Restricted "Other" | 67,378 | 35,465 | 6,608 | 25,187 | 53 | 10 | 37 |
| **Alternative B** | | | | | | | |
| Ponderosa Pine | 512,481 | 481,209 | 16,133 | 9,717 | 94 | 3 | 2 |
| Target/ Threshold | 8,713 | 8,236 | 109 | 353 | 95 | 1 | 4 |
| Restricted "Other" | 67,378 | 60,373 | 6,512 | 375 | 90 | 9 | 1 |

More mechanical treatments and the more open nature of foraging habitat (versus nesting and roosting habitat) would allow for fire to achieve more fuels reduction in restricted habitat outside of target and threshold habitat (67,378 acres). In addition, treated areas outside of MSO habitat would be moved closer towards the historical range of variation, thereby decreasing the threat of high-severity crown fire reaching MSO habitat.

### *Other Habitat Effects*

#### Meadows and Aspen

Meadow and aspen treatments would not include mechanical tree removal within PACs. Operational burning would occur on 135 acres of meadow habitat within 12 PACs. This would represent an average of 11 acres of meadow burned in each PAC (range = 1 to 28 acres). Operational burns would be conducted in areas where the objective is get fire into adjacent ponderosa pine without creating firelines in non-ponderosa pine habitat. This is different from prescription-based treatments that include changing elements of habitat structure to attain desired objectives. Not all encroaching trees would be removed from meadow habitats.

Aspen treatments would consist of prescribed burn-only treatments on 191 acres in six PACs (five PACs on the Coconino NF and Kendrick PAC on the Kaibab). Returning fire into these habitats would be expected to improve understory vegetation. However, because of the nature of nesting and roosting habitat, burn prescriptions would be conducted so that burn severity would remain low. Prescribed burning would have site-specific objectives in aspen (versus operational burning), but the lack of mechanical vegetation manipulation and limited pine litter layer would likely result in a patchy burn that, depending on the extent and average dbh of encroaching pines, would likely yield limited effects to competing and overtopping conifers. Therefore, limited improvements to aspen would be expected in terms of shading and competition for water and nutrients. The expected results from aspen and meadow treatments in PACs would be an increase in aspen suckering and a small and short-term increase in understory biomass. These changes would provide localized benefits to prey habitat.

At the scale of 4FRI, improvements to prey habitat through spring, ephemeral channel (common to all alternatives), meadow, and aspen treatments within protected habitat would be limited and site specific. However, these treatments would enhance prey habitat and benefit resident owls. MSO reproductive success appears tied to prey availability (Willey and Willey 2010 –add to lit. cited). MSOs in the UGM RU feed primarily on peromyscid mice and voles (Ganey et al. 2011) and restoration treatments can benefit these species (Kalies et al. 2012). Other small mammals, birds, and nocturnal flying insects (primarily lepidopterans and coleopterans) are also prey for MSOs and overall prey abundance may be very important to nesting MSOs, particularly during years when key species may be limited (Ganey et al. 2011). In general, small mammals, birds, and arthropods would increase after burning and thinning in ponderosa pine forests (Appendix 8). This is particularly true in key habitat components like meadows, springs, etc., where herbaceous response would be expected to exceed that under dense forest canopies, providing large increases in food and cover in localized patches of prey habitat.

About 6,124 acres of grassland and meadow treatments would occur in restricted habitat, including about 3,870 acres of operational burn only grassland treatments. Tree encroachment would not be fully addressed in burn-only grassland treatments, leaving potential seed sources to continue the long-term degradation of grassland habitat. Nevertheless, an unknown percentage of meadow and grassland burn-only treatments would be improved in terms of understory response in MSO prey habitat resulting from the nutrient pulse and litter reduction after burning In addition, this would preclude the need to create firelines to prevent prescribed fire from neighboring ponderosa pine forest from entering into this non-ponderosa pine habitat. Large meadows can blend into small grasslands, hence some of the grassland acreage would likely function as MSO foraging habitat. However, operational burning is only expected to cause limited tree mortality. Small changes in the overstory canopy with continued sources of pine seeds would limit the potential vegetative response in meadows. The balance of the grassland and meadow treatments, totaling about 2,254 acres, would be restored by using both mechanical removal of trees and prescribed burning. These treatments would provide additional areas where understory vegetation would be expected to respond strongly in the short-term as a result of burning and maintain improved conditions in the long-term by complete removal of encroaching conifers. This would provide food and cover for MSO 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 MSO prey species.

Aspen treatments would include about 200 acres of prescribed burn-only and about 740 acres of aspen restoration in restricted habitat. Prescribed burning alone would decrease litter build-up and cause moderate mortality to encroaching pine . Full aspen restoration would include mechanical removal of all post-settlement pine in clones and within 100 feet of clones, allowing for expansion of aspen. Mechanical treatments would increase surface fuels to better carry fire beneath aspen overstories where fuel loading can otherwise be patchy. Mechanical scarifying of soils along with prescribed fire would better stimulate aspen suckering. This difference would be expected to improve the health and resiliency of aspen clones and provide for a more robust understory response. Fencing or other barriers would be constructed after treatments to prevent ungulate grazing within aspen clones. The resulting effects to prey habitat would include both short- and long-term improvements in understory vegetation and overstory aspen health and sustainability in 79 percent of the treated aspen (740 acres).

Burn-only treatments in aspen would be expected to provide more limited benefits to MSO because of the patchy nature of burning in this habitat and moderate mortality of pine trees. . Changes to prey habitat would be more limited in terms of aspen extent and total understory biomass due to the denser overstory and continued needle fall. Burn-only aspen treatments would result in a short-term improvement in understory vegetation in 21 percent of the aspen (200 acres).

**Disturbance**

Disturbance could occur as a result of project-related activities including moving and operating harvest machinery, hauling forest materials, building fire line, managing prescribed burns, smoke, personnel in the field, and road maintenance and construction. Noise disturbance from project activities may disturb MSO. Alternative B would mechanically treat 84,177 acres.

Noise would not be expected to disturb nesting or roosting MSO because of project planning intended to minimize disturbance to nesting and roosting owls. Haul routes either avoid PACs, occur more than a ¼ mile from core areas, or employ timing restrictions to avoid disturbance during the nesting season.

Alternative B would prescribe burn 107,696 acres. Roads, natural barriers, or new fire line would be built to prevent fire from entering core areas. Building line would occur outside the nesting season. Noise and smoke related to burning could disturb owls. Design features would include timing restrictions so that habitat in and around PACs would not be prescribed burned during the breeding season (March 1 to August 31). The area excluded from burning around PACs would be determined on a PAC by PAC basis. Roads, topography, and prevailing weather patterns would be identified so that an adequate buffer would be defined around PACs. Burning within the buffer would be conducted in association with PAC burning outside the breeding season. Site-specific buffers would be designed so that noise and settling smoke from burning outside the buffer would not disturb resident owls in the PACs during the breeding season. Appropriate distances for individual PACs would be decided by biologists, fuels specialists, and the USFWS. As a result, smoke and noise are not expected to result in negative effects to MSO.

**Direct and Indirect Effects**

Treatment design, project design criteria, and mitigation would be implemented to be compliant with Recovery Plan guidelines and forest plans as amended. Management activities in PACs and protected habitat are designed to retain and improve nesting and roosting structure. Thinning treatments within PACs are designed to increase growth and retention of large pine and oak trees, benefiting PACs most threatened with loss of these habitat components. Treatments within PACs would occur outside of the breeding season. Mechanical thinning and prescribed burning activities would provide for long-term sustainability of MSO habitat components. Core areas would not be treated mechanically or with prescribed fire in alternative B. Therefore nesting and roosting habitat within PACs would continue to develop slower, relative to treated areas of similar habitat, and old trees would continue to be at risk due to forest health issues. Surface fuels would remain high in core areas, potentially creating higher severity fire effects if these areas were to burn. However, reduced threat of high severity crown fire from outside MSO habitat, combined with reductions in wildfire threat within MSO habitat, increases sustainability of these habitats. Vegetation associated with springs and ephemeral channels within PACs would be increased, providing food and cover for prey species. Meadows and aspen would be burned in protected habitat, potentially benefiting habitat for prey species. Short-term impacts may occur to individual MSO, e.g., owls foraging outside of PACs during crepuscular hours. Long-term benefits to MSO habitat and prey habitat would occur in terms of improved forest structure and reduced threats from stochastic events. Smoke from prescribed fire could potentially affect some nesting owls and developing nestlings.

Restricted habitat would be managed for sustainable long-term forest conditions by implementing combinations of group selection cuttings arranged to spatially distribute groups of trees and canopy openings, moving towards Recovery Plan and forest plan guidelines, as amended. The proposed changes to forest structure in restricted habitat are designed to retain or develop MSO nesting and roosting habitat in target and threshold habitat while moving towards habitat sustainability, thereby decreasing the risk of large scale stochastic events. In restricted “other” habitat. MSO prey habitat would benefit from the creation of openings between tree groups, meadow improvement, and conducting aspen restoration in restricted habitat, all of which would increase understory food and cover.

The combination of mechanical treatments and low severity burning would lessen potential fire behavior after treatments are implemented. Post-treatment fires would be more likely to burn as surface fires rather than crown fires which more closely resemble the historical range of variation.

Road decommissioning would reduce disturbance to MSOs, improving owl habitat quality in the long-term. Reestablishing natural drainage patterns, reducing siltation, and reestablishing hiding cover for prey species on road beds or completely eliminating road beds would increase prey habitat for foraging owls. Reducing vehicular access would likely increase snag retention, a key forest structural element in MSO habitat. Work related to road maintenance, construction, and relocation inside of PACs would occur outside the nesting season, but could create noise, potentially disturbing roosting owls in the short-term. Haul routes for removing harvested materials would avoid areas within a quarter mile of core areas or implement timing restrictions. By phasing project activities, not all MSO habitats would be treated simultaneously, thus lessening the impacts.

Activities associated with spring, ephemeral channel restoration, and meadow and aspen treatments in PAC habitat would occur outside the nesting season, but could create noise that could potentially disturb roosting MSOs. Because project implementation will be phased, not all MSO habitats would be treated simultaneously, lessening disturbance to MSOs.

Mechanical thinning and low severity prescribed burning would result in little change to overall forest structure in protected habitat. However, thinning is designed to release large oak and pine and increase growth rates of trees greater than 18 inches dbh. Treatments would increase long-term development and retention of this limited component of MSO habitat. Prescribed burning would reduce litter and increase crown base height. Combined, these changes should decrease potential fire severity. Thinning and low severity prescribed burning would bring slight improvements to prey habitat in terms of understory vegetation in protected, target, and threshold habitats in the short-term. Understory biomass would increase by 100s of pounds of forage in restricted “other” habitat relative to the other MSO habitats and would persist longer due to creation of interspaces. Increasing growth rates of mature and old growth trees and retaining existing large trees will indirectly contribute to maintaining large snags, logs, and CWD across the landscape in the long-term.

Proposed changes to forest structure in restricted habitat are designed to retain or enhance MSO nesting and roosting habitat in target and threshold habitat while moving towards the ecological capacity in restricted “other” habitat. These changes would primarily result from reductions of mid-aged trees 12 to18 inches dbh. Impacts to MSO from implementation would be reduced by phasing project activities across the treatment area.

Fire risk would decrease in PACs as a result of treatments, but the decrease would be much less than in other habitats because of the small scale of change in forest structure. Reducing the potential for crown fire increases the ability to manage unplanned ignitions and increases the potential for additional fuels reduction in future maintenance burns. Increasing the potential for future managed fire decreases the long-term risk of undesirable fire effects.

An additional indirect benefit of the fire treatments is additional inputs of soil nutrients, benefiting both over- and understory vegetation and thereby improving the habitat of MSOs and their prey. Prescribed burning across MSO habitats also reduces litter, thereby improving the potential for improvements in the understory. These improvements would include 72 PACs outside core areas. PACs are the most heavily used portion of an owl pair’s territory. Improvements in prey habitat within PACs should indirectly benefit nesting owls. Moving towards the desired condition in MSO habitat would include reductions in total BA, increasing relative contributions of Gambel oak to soil resources, and increased solar radiation reaching the understory, all of which should improve prey habitat.

Road closures, road relocations, and improvements and restoration of key habitats would also improve habitat for prey species by decreasing human disturbance and increasing habitat serving as food and cover. Large snag longevity would, on average, increase with decreased access by firewood cutters. Grasses, sedges, flowering forbs, and woody shrubs would benefit from spring and channel restoration and meadow/grassland and aspen treatments, all of which would benefit MSO prey. While small in scale and limited in scope, these actions target site-specific micro-habitats important to small mammals, birds, and arthropods and so increase total prey biomass. Improving connectivity of herbaceous undergrowth could improve arthropod populations. This in turn could indirectly benefit MSO prey species through increased food availability (i.e., arthropod availability) and improved habitat (from increased pollinator populations). Total treated acres in these prey habitats would be nearly the same between alternatives B and C, differing by about 19 acres of aspen treatment. However, meadow and grassland treatment intensity would be much lighter in alternative B, largely consisting of operational burn-only treatments. Therefore, expected benefits to herbaceous vegetation would be limited under this alternative. Understory response would be expected to be stronger in restricted habitat where, in general, greater reductions in canopy cover, and more openings would be created. Improvements in prey habitat should benefit prey species. Increases in prey populations should indirectly benefit MSOs.

#### *Alternative B - Determination of Effects for MSO*

The determination of effects for the Mexican spotted owls and their habitat is based on design criteria, mitigation, proposed forest plan amendments, the above effects discussion, and the following:

- By design, mechanical thinning and prescribed burning within MSO protected habitat would follow the intent of the MSO Recovery Plan and respective forest plan guidelines as amended; prescribed burning would not occur within or adjacent to PACs during the breeding season
- By design, mechanical thinning and low severity prescribed burning within threshold, target, and other restricted habitat would follow MSO Recovery Plan and respective forest plan guidelines as amended
- Mechanical thinning in 18 PACs and low severity prescribed burning in 72 PACs, excluding core areas, may cause short-term displacement to foraging and roosting MSOs outside the breeding season
- Improving forest structural and spatial conditions would meet short-term objectives of improving overall forest health and long-term objectives of increased forest resiliency
- Fire behavior in protected habitat would be changed in this alternative, with 75 percent of the area supporting surface fire in 2020 and 19 percent of the area at risk from active crown fire
- About 20 percent of the total road miles in 58 PACs would be decommissioned after treatment activities, lessening the amount of long-term disturbance to MSOs and their prey that is associated with access; road segments in three PACs, including core habitat in one PAC, and in restricted habitats would be relocated to provide long-term protection for ephemeral stream channels and the habitat they support
- Fire and smoke effects from prescribed burning may disturb individual birds in and adjacent to the treatment area, but timing restrictions and low severity burn prescriptions would reduce impacts and largely lead to no or only short-term effects; however, the amount of burning across the landscape under this alternative creates the potential of smoke settling into a PAC which, if this did occur, could potentially lead to adverse effects to individual owls
- Post-treatment growth rates of trees would increase, tree resiliency to drought and insects would improve, and more of the total BA would be occurring in larger size classes, improving MSO habitat components in both the short- and long-term
- Large snags (greater than 18 inches dbh) are currently below forest plan guidelines; future snag recruitment is expected through existing insect and disease activities and impacts of low severity prescribed burning. Snag development is expected to occur as more trees attain larger size-classes and meet the size-class distribution recommended in the Recovery Plan; snag retention would improve through road decommissioning; over the long-term, snag development and retention is expected to improve after project implementation
- Key sites that can support diverse and abundant understory vegetation within MSO habitats habitats (i.e., prey habitat) would be improved or restored for both the short- and long-term. About 23 springs and about 5 miles of ephemeral channels, about 3,870 acres of meadows, and about 940 acres of aspen would all be improved under this alternative.

There is a strong link between raptors and their food and conserving and enhancing prey habitat is expected to benefit MSOs (Ganey et al 2011).

- The development of 8,412 acres of restricted target and threshold habitat would be managed towards meeting 150-170 BA for long-term MSO nest and roost habitat as recommended in the existing Recovery Plan (USDI FWS 1995)
- Total treatments in MSO habitat include 84,177 acres of mechanical thinning and 107,696 acres of low severity prescribed burning and would provide for understory grass/forb/shrub release to improve habitat components for MSO prey species; improvements would be maximized in the short-term and while improvements would decline, they would be maintained above existing conditions over the long-term
- Thinning and low severity prescribed fire on 67,378 acres of restricted “other” habitat would provide for “groupy” tree structure and canopy gaps resembling historical conditions at spatial scales capable of reestablishing understory regeneration and reducing risk of active crown fire over both the long- and short-term
- Implementing both mechanical and prescribed burn treatments would reduce hazardous fuel loads, reducing the potential for high-severity fire and also protecting soil resources by reducing severity of ground fires over both the long- and short-term; however, these benefits would decrease in the long-term without maintenance burning
- Alternative B would preserve current old growth habitat and develop old growth components in 100 percent of MSO protected, target, and threshold habitats (45,168 acres) and additional acreage in restricted “other” habitat (see Silviculture report), sustaining key MSO habitat components over the long-term
- Forest conditions within the historical range of variability (FRCC 1) would be returned to 18 percent of the landscape by the year 2020, thus reducing the potential for large-scale MSO habitat loss from high-severity fire; while this benefit decreases in the long-term, the amount of area in FRCC 1 remains higher in alternatives B and C compared to existing conditions or alternative D, providing both short- and long-term benefits
- Forest conditions moderately altered from the historical range of variability (FRCC 2) would be returned to 78 percent of the landscape by the year 2020, thus reducing the potential for large-scale MSO habitat loss from high-severity fire; while this benefit decreases in the long-term, the amount of area in FRCC 2 remains higher compared to existing conditions, providing both short- and long-term benefits
- Alternative B reduces the FRCC 3 to four percent in the year 2020 and by 2050 about a third of the ponderosa pine forest (36 percent) would move into FRCC 3, providing both short- and long-term benefits relative to the historical range of variability

MSO stratified habitat will provide for a mosaic of desired forest conditions post-treatment, improving habitat heterogeneity and vegetative diversity in both short- and long-term. This mosaic would allow for a diversity of potential fire effects, thereby increasing opportunities for the maintenance of forest structure and function using planned and unplanned ignitions into the future (up to 30 years).

Alternative B would provide and sustain long-term nesting and roosting habitat while reducing potential risk of high severity wildland fire and other stochastic events. To mitigate adverse effects associated with treatments within protected habitat, no treatments would occur during the breeding season and no activities would occur within the core area. Unintended smoke from first-entry burns that settled in PACs could adversely affect egg development or nestling survival by flushing the female, or affect nestling development through lung damage.

### Alternative C

Under alternative C, mechanical treatments would occur in portions of all MSO habitats except for core areas (see protected habitat below). The minimum post-treatment BA for nesting and roosting habitat would be 110 $ft^2$ per acre, in line with the draft recovery plan (USDI FWS 2011). Low severity prescribed burning would be applied to all MSO habitats, including core areas (Table 73). No trees greater than 24 inches dbh would be removed and tree groups with diameters averaging 18 inches dbh or greater would not be cut for regeneration. Treatments in target habitat are designed to move forests towards threshold conditions. Treatments in threshold habitat would not lower forest structural values below the threshold levels described in Table C2 of the draft Recovery Plan. A comparison of treatments in MSO habitat by alternative is displayed in Appendix 15. Meadow and aspen treatments in MSO habitat would occur in this alternative. This analysis is based on the assumption that mechanical treatments and two low-severity prescribed fire treatments would occur within the project timelines. Alternative C would mechanically treat 82,344 acres and prescribe burn 112,546 acres in protected and restricted habitat. This is 1,835 fewer acres of mechanical treatment in restricted habitat and 4,850 additional acres of prescribed burning in protected habitat than alternative B. Fewer acres of mechanical treatment are a result of avoiding areas as part of the 4FRI support for research addressing fundamental aspects of the ecology of ponderosa pine systems (see description in the DEIS). Additional burn-only acres are due to 56 PAC core areas excluded from treatment in the other alternatives.

**Table 73. Alternative C Summary of Burning and Mechanical Treatments in MSO Pine-Oak Habitat**

| Treatment Type* | MSO Habitat Type | | | |
|---|---|---|---|---|
| | Protected | Restricted | Target/ Threshold | Total Acres |
| Burn Only | 25,714 | 4,187 | 301 | 30,202 |
| MSO Restricted – Group Selection & Intermediate Thinning + Burning | | 63,191 | | 63,191 |
| MSO Target – Intermediate Thinning + Burning | | | 6,518 | 6,518 |
| MSO Threshold – Intermediate Thinning + Burning | | | 1,894 | 1,894 |
| PAC – Intermediate Thinning ≤18” + Burning | 10,741 | | | 10,741 |
| **Total** | **36,455** | **67,378** | **8,713** | **112,546** |

An overview of immediate post-treatment results (year 2020) and long-term changes to habitat structure (year 2050) are displayed at the RU-level in Table 74.

Although this alternative would treat PACs using a lower minimum value in PAC habitat relative to the other action alternatives, only 18 PACs are proposed for treatment, so the effect would be limited when averaged across all the remaining PACs. Proposed treatments for nesting and roosting habitat were designed to meet the habitat objectives described in the forest plans as amended and in the Recovery Plan. This resulted in low intensity treatments retaining high BA and percent maximum SDI as described for protected habitat and target and threshold habitats. BA and percent maximum SDI values would be slightly lower in alternative C, but the differences between this and the other action alternatives are within several percentages. Increases in percent area for trees greater than 18 inches dbh, including trees greater than 24 inches dbh, would occur. Trees 12 to 18 inches dbh would decrease in all habitat classifications but remain above 20 percent in target and threshold habitat and in protected habitat and above 15 percent in restricted “other” habitat. The number of average TPA 18 inches or greater increased in both existing and future nesting and roosting habitats and decreased in restricted “other” habitat. This latter occurred as a result of creating canopy gaps, uneven-aged structure, lower total BA, and accelerated growth rates intended to move more trees into larger size classes. This meets the direction in the Recovery Plan to manage for a landscape mosaic or mixture of habitat conditions to ensure adequate nesting, roosting, and foraging habitat for the owl and habitat for MSO prey. This alternative represents a landscape management approach to maintain and create replacement owl habitat where appropriate while providing heterogeneous forest conditions across the landscape as described in the Recovery Plan. The percent of oak BA typically remained the same or decreased by a percent in protected and target and threshold habitats and decreased by a percentage point in restricted “other” habitat. CWD increased across all RUs. Snags greater than 18 inches dbh increased in target and threshold habitat and in protected habitat and typically remained unchanged in restricted “other” habitat.

Mechanical thinning and prescribed burning would take place at different times in different locations. Spotted owl habitat could be affected by mechanical treatments in one area and prescribed burning 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 8,700 acres of MSO habitat would be mechanically treated and 11,255 acres prescribed burned each year under alternative C. No mechanical treatments would occur on slopes greater than 40 percent in MSO habitat.

**Table 74. Alternative C - 2020 and 2050 Spotted Owl Habitat Forest Structure and Habitat Components**

| RU | Basal Area | | % Max SDI | | Avg. Percent of Total SDI by Size Class: 12.0 – 17.9” | | Avg. Percent of Total SDI by Size Class: 18.0 – 23.9” | | Avg. Percent of Total SDI by Size Class: 24.0” + | | Avg. TPA 18”+ | | Avg. Gambel Oak BA Percent of Total BA | | Tons CWD >12” | | Snags >18” | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 |
| **Restricted Target/ Threshold** | | | | | | | | | | | | | | | | | | |
| RU 1 | 132 | 167 | 68% | 79% | 23% | 22% | 20% | 21% | 10% | 12% | 18.4 | 24.2 | 28% | 27% | 1.3 | 2.0 | .5 | 1.2 |
| RU 3 | 142 | 176 | 75% | 84% | 22% | 20% | 19% | 19% | 10% | 13% | 18.3 | 24.2 | 31% | 30% | .8 | 1.7 | .7 | 1.4 |
| All | 136 | 171 | 71% | 81% | 23% | 21% | 20% | 20% | 10% | 12% | 18.3 | 24.2 | 29% | 28% | 1.1 | 1.9 | .6 | 1.3 |
| **Restricted Other** | | | | | | | | | | | | | | | | | | |
| RU 1 | 74 | 107 | 35% | 46% | 22% | 20% | 22% | 19% | 19% | 19% | 11.3 | 16.7 | 19% | 18% | .8 | 1.5 | .9 | .8 |
| RU 3 | 81 | 115 | 38% | 50% | 22% | 19% | 22% | 19% | 17% | 18% | 11.5 | 17.4 | 24% | 23% | .8 | 1.7 | 1.0 | 1.0 |
| RU 4 | 80 | 115 | 39% | 52% | 20% | 17% | 21% | 17% | 19% | 19% | 11.4 | 16.4 | 26% | 25% | .7 | 1.6 | 1.0 | 1.0 |
| RU 5 | 64 | 98 | 30% | 42% | 21% | 21% | 17% | 15% | 21% | 18% | 8.3 | 12.9 | 13% | 15% | .4 | 1.0 | .6 | .6 |
| All | 78 | 112 | 37% | 49% | 22% | 19% | 22% | 19% | 18% | 19% | 11.4 | 17.0 | 22% | 21% | .8 | 1.6 | 1.0 | .9 |

| RU | Basal Area | | % Max SDI | | Avg. Percent of Total SDI by Size Class 12.0 – 17.9” | | Avg. Percent of Total SDI by Size Class 18.0 – 23.9” | | Avg. Percent of Total SDI by Size Class 24.0” + | | Avg. TPA 18”+ | | Avg. Gambel Oak BA Percent of Total BA | | Tons CWD >12” | | Snags >18” | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 |
| **Protected** | | | | | | | | | | | | | | | | | | |
| RU 1 | 151 | 173 | 70% | 74% | 32% | 27% | 18% | 25% | 9% | 13% | 17.8 | 28.2 | 14% | 14% | .7 | 2.0 | .7 | 1.7 |
| RU 3 | 166 | 188 | 78% | 82% | 31% | 26% | 18% | 24% | 10% | 13% | 20.9 | 31.2 | 12% | 12% | .9 | 2.4 | .8 | 1.9 |
| RU 4 | 105 | 128 | 49% | 55% | 35% | 38% | 14% | 24% | 5% | 8% | 10.9 | 19.9 | 8% | 8% | .4 | 1.4 | .4 | 1.3 |
| RU 5 | 143 | 168 | 68% | 74% | 31% | 26% | 17% | 22% | 9% | 13% | 16.9 | 26.5 | 12% | 11% | .9 | 2.3 | .7 | 1.7 |
| All | 152 | 174 | 71% | 75% | 32% | 27% | 18% | 25% | 9% | 13% | 18.1 | 28.4 | 13% | 14% | .7 | 2.1 | .7 | 1.7 |

**Protected Habitat**

MSO PAC data and field reviews and vegetation simulation modeling indicated mechanical treatments including trees greater than 9 inch dbh would move 18 PACs towards desired conditions (Table 75). Optimal size classes for trees removed would range from less than 9 inches dbh up to 18 inches dbh under alternative C. Approximately 3,388 acres would be improved with mechanical treatments (32 percent) removing trees up to 9 inches dbh. Treating up to 18 inches dbh in this alternative would allow a greater reduction in competition between large trees (pine and oak) and uncharacteristic competition from smaller size-classes. This would result in better growth rates for large trees in ten separate PACs (634 total acres). These same ten PACs (634 acres) would have 16 inch dbh limits in alternative B. All stands identified for mechanical harvest would be marked by hand and marking would be coordinated with the FWS. Treatments were adjusted as follows to move PACs towards desired conditions for MSO habitat:

In order to move towards desired conditions for MSO habitat:

- Fifteen PACs (Lake No. 1/Seruchos, Archies, Red Hill, Holdup, Bonita Tank, Red Raspberry, Knob, T-Six Tank, Iris Tank, Frank, Rock Top, Lee Butte, Foxhole, Bar M, Sawmill Springs) would require thinning up to 12” dbh on 1,335 acres;
- Seventeen PACs (Lake No. 1/Seruchos, Archies, Red Hill, Holdup, Bonita Tank, Crawdad, Red Raspberry, Knob, T-Six Tank, Iris Tank, Frank, Rock Top, Lee Butte, Mayflower Tank, Foxhole, Bar M, Sawmill Springs) would require thinning up to 14 inch dbh on 4,151 acres,
- Thirteen PACs (Holdup, Red Raspberry, Bear Seep, Crawdad, Knob, Rocktop, Foxhole, Frank, Holdup, Iris Tank, Lee Butte, Mayflower Tank, Rock Top, Bar M, and T-Six Tank) would require 1,268 acres to be thinned up to 16” dbh, and,
- Ten PACs (Bear Seep, Bonita Tank, Crawdad, Frank, Iris Tank, Lee Butte, Mayflower Tank, Red Raspberry, Sawmill Springs, and T-Six Tank) would require thinning up to 18 inch dbh on 634 acres.

The minimum BA targeted for PAC treatments in alternative C is based on recommendations from the USFWS (Hedwall personal communication 2011) to use the value reported in the draft MSO Recovery Plan (USDI FWS 2011) of 110 feet$^2$ per acre. This revised value is based on the best available science brought forward in the new plan compared to the existing Recovery Plan published in 1995. The change is more of a clarification in analysis than an actual change in recommendations. Originally, the Recovery Team used data from plots and extrapolated that to stand values. Stand values represent a step up in spatial scale from plot data. Any given stand has dense areas (e.g., 150 BA or greater) and open areas that would result in very different plot values. The stand value is an average of multiple plots and therefore can be lower than individual plot values. By using plots selected by MSO, the original analysis inadvertently biased their estimates of stand BA. See Amendment C and the draft MSO Recovery Plan (USDI 2011) for more details.

Treatments modeled in alternative C were developed to reduce BA, but remain at or above 110 feet$^2$ per acre in areas currently supporting 110 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 the 9 inches dbh.

**Table 75. General Description and Acres of Mechanical Treatment in Alternative C by PAC (all mechanically treated PACs occur on the Coconino NF)**

| PAC Name | General Description | MSO PAC Mechanical Treatment (dbh and acres) | | | | |
|---|---|---|---|---|---|---|
| | | Treat up to 9” dbh (Acres) | Treat up to 12” dbh (Acres) | Treat up to 14” dbh (Acres) | Treat up to 16” dbh (Acres) | Treat up to 18” dbh (Acres) |
| Lake No. 1/Seruchos | Dense thickets of VSS3 pine, oak is competing with pine for nutrition, sunlight and moisture, need to grow larger trees over time, enhance oaks, create small openings | 123 | 66 | 50 | 0 | 0 |
| Archies | Pine-oak with strong oak component but few large oak – many pines < 9” dbh | 444 | 41 | 11 | 0 | 0 |
| Red Hill | Scrappy habitat that has been treated with an overstory removal in the past, dense pockets of ponderosa pine with heavy mistletoe infection in areas, thin pine to grow larger trees and reduce fire threat, enhance oak where present, grow larger trees over time and reduce competition | 97 | 190 | 385 | 0 | 0 |
| Crawdad | Oak is supressed by high densities of pine, need for creating gaps around oak and releasing individual oak trees | 138 | 0 | 342 | 99 | 21 |

| PAC Name | General Description | MSO PAC Mechanical Treatment (dbh and acres) | | | | |
|---|---|---|---|---|---|---|
| | | Treat up to 9" dbh (Acres) | Treat up to 12" dbh (Acres) | Treat up to 14" dbh (Acres) | Treat up to 16" dbh (Acres) | Treat up to 18" dbh (Acres) |
| Holdup | Most of PAC is pure pine, thin around any existing oak and provide areas for oak to establish | 57 | 197 | 264 | 18 | 0 |
| 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 | 0 | 127 |
| Red Raspberry | Diverse topography, protect microclimates from fire, high percentage of VSS 3 and VSS 4, need for enhancing openings, create, retain, and enhance larger trees | 387 | 19 | 203 | 55 | 16 |
| Bear Seep | PAC is pure ponderosa or oak, high density of trees > 9 inch dbh | 453 | 0 | 0 | 144 | 10 |
| Mayflower Tank | PAC has steep slopes, heavy fuels, limited number of small trees | 257 | 0 | 139 | 118 | 99 |
| Knob | PAC has limited habitat, generally pure pine and open with some dense dog-hair thickets | 273 | 26 | 252 | 114 | 0 |

| PAC Name | General Description | MSO PAC Mechanical Treatment (dbh and acres) | | | | |
|---|---|---|---|---|---|---|
| | | Treat up to 9” dbh (Acres) | Treat up to 12” dbh (Acres) | Treat up to 14” dbh (Acres) | Treat up to 16” dbh (Acres) | Treat up to 18” dbh (Acres) |
| 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 |
| Iris Tank | PAC has dense pine with pockets of doghair thickets; 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 | 102 |
| Frank | PAC has areas of pure pine with dense pockets of VSS3 and VSS4, need to release any oaks present and encourage recruitment of oaks, reduce pine densities and increase diameters of both pine and oak | 286 | 69 | 178 | 19 | 33 |
| Rock Top | Treat in pure pine to increase the amount of oak and grow larger trees | 98 | 57 | 506 | 90 | 0 |

| PAC Name | General Description | MSO PAC Mechanical Treatment (dbh and acres) | | | | |
|---|---|---|---|---|---|---|
| | | Treat up to 9" dbh (Acres) | Treat up to 12" dbh (Acres) | Treat up to 14" dbh (Acres) | Treat up to 16" dbh (Acres) | Treat up to 18" dbh (Acres) |
| Lee Butte | Treat in dense pine to increase the amount of oak, reduce tree density, and increase tree diameter on slopes to improve habitat and protect nest core | 121 | 1 | 328 | 247 | 67 |
| Foxhole | Dense thickets of pine with some oak, need for enhancing oak and thinning groups | 10 | 124 | 136 | 178 | 0 |
| Bar M | PAC is part of the mega-cluster of PACs within the Bar-M area, 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 | 0 |
| Sawmill Springs | All size classes of pine and oak present, but thinning would enhance and maintain large dbh size classes | 192 | 63 | 190 | 0 | 71 |
| Total Mechanical Treatment Acres | | 3,388 | 1,335 | 4,151 | 1,268 | 634 |

Mechanically treatments would take place within 18 of the 110 PACs occurring within a ¼ mile of the project area boundary (16 percent) under alternative C. This includes 10,776 acres out of 35,566 total PAC acres in the treatment area (30 percent). Low severity prescribed burning would occur in all 72 PACs within the treatment area. Eighteen PACs would be treated mechanically and 54 PACs would receive burn-only treatments. Although the implementation schedule is not yet known, on average 1.8 PACs would be mechanically treated per year if 4FRI implementation lasted 10 years. On average, this equals less than one percent of the PACs across the two forests getting treated in a given year. About 5.4 PACs (less than 3 percent) would, on average, be prescribed burned each year. Affects to forest structure within individual PACs is summarized by alternative in Appendix 16.

The wildlife analysis for the Kaibab forest plan concluded the Kendrick PAC consisted of mixed-conifer habitat. The Kaibab used a mid-scale analysis (100-1,000 acres) for evaluating effects of the proposed land management plan. The 4FRI analysis is based on a finer scale and delineated individual pine stands within the Kendrick PAC. About 173 acres of pine habitat outside the core area were identified for burn-only treatment in the Kendrick PAC during the 4FRI analyses of potential PAC treatments. The nearby Stock Tank PAC, administered by the Coconino NF, has about 26 acres of pine habitat also proposed for burn-only treatments that occur on the Kaibab NF and which are outside of the Kendrick Peak Wilderness Area. All these acres are proposed for burn-only treatment; about 11 acres are in the core area and 15 acres are in the PAC but outside the core area.

### *Forest Structure and Density in MSO Habitat*

#### Large Trees

Treatments would be expected to release large trees from competition from unnaturally dense groups of young pine trees. Expected results would include increasing the ability to retain large trees on the landscape and increasing growth rates of existing and future large trees. Mechanical treatments would be, by design, conservative in protected habitat. Therefore treatment results would be lower in protected habitat because of the low intensity of the treatments. The distribution of tree size classes greater than 18 inches dbh would increase by category and by total TPA greater than 18 inches dbh by the year 2050 (Table 76). The percentages of trees 18 to 23.9 inches dbh would show the most improvement. Abundance of trees greater than 24 inches dbh would show consistent improvement in mechanically treated PACs (Table 76 and Appendix 16). Compared to alternative A, increases in the larger size-classes would result from reducing the mid-aged trees in the 12 to 17.9 inch size-class. More important at the site scale would be the increased ability to retain existing large trees after treatment. Site-specific PAC visits identified density-dependent mortality of large pine and oak trees due to competition from mid-sized trees. Prescribed burning would contribute towards reducing competition by reducing numbers of small trees. The emphasis on increasing tree growth rates and retaining large trees comes from the Recovery Plan that 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.”

The percent distribution of larger tree size classes would remain unchanged in the burn-only PACs (Table 76). Modeling does not reflect benefits to vegetation from the subsequent nutrient pulse.

#### Basal Area

Total pine BA would be reduced more in alternative C than any other alternative as a result of adopting the draft recovery direction (USDI 2012). Overall, it would be lowered to 116 BA, compared to 135 BA in alternative A (Table 76). Pine BA would be lowered by only three percent in the burn-only PACs. Gambel oak BA would increase (Table 76). At the RU scale, three of four RUs would still have BA values of 168 or greater (Table 75 above). Protected habitat would remain in zone 4, or “extremely high density” where individual tree growth would be minimal due to within stand competition and stand mortality would increase. This would meet the objective of retaining dense stand conditions while increasing resiliency of large trees.

**Canopy Structure**
Based on BA and percent maximum SDI, canopy cover would remain dense. Percent maximum SDI would decrease relative to no action alternative, but at 71 would remain at about the middle of the Extremely High Density Range (Table 103). Canopy cover would be at least 50 percent or greater, based on BA, TPA, and tree dbh. Canopy cover within tree groups would be higher. Only ponderosa pine would be harvested so while individual trees of other species might be affected by mechanical and burning operations, the existing variability in overstory species would remain after treatments. PACs are the most proximal and highly used foraging areas during the nesting season. Burning in PACs would improve sub-canopy flight space for foraging MSOs by lifting the crown base height. Combined, these factors should maintain or enhance the elements of canopy structure such as tree cover and density, flight space, and overstory species diversity.

Overall, changes in the above structural elements would be limited, but alternative C would move PAC habitat more towards desired conditions than other action alternatives (see Comparison of Effects below). While treated PACs would show limited change, the objectives behind the treatments were primarily site-specific, including the release of large oak and pine from competition, create irregular spacing, and increase growth rates of the large tree cohort. The fact that the decrease is minimal when averaged across PACs is a reflection of the “light touch” designed for treatments in PAC habitat. Changes in forest structure by individual PAC are summarized in Appendix 16.

**Table 76. Modeled Changes in Forest Structure Attributes Within MSO PACs Under Alternative C**

| Forest Attribute | Existing Condition (Year 2010) | Alternative A1 (Year 2050) | Alternative C2 (Year 2050) |
|---|---|---|---|
| **PACs With Thinning Outside Core Areas (*n* = 18)** | | | |
| 12 – 17.9” dbh (%) | 30 | 28 | 25 |
| 18 – 23.9” dbh (%) | 14 | 23 | 30 |
| ≥ 24” dbh (%) | 8 | 12 | 16 |
| TPA ≥ 18” dbh | 15 | 27 | 29 |
| Ponderosa Pine BA | 120 | 135 | 116 |
| Gambel Oak BA | 16 | 18 | 21 |
| All BA | 148 | 173 | 155 |
| **PACs With Prescribed Burning (n = 54)** | | | |
| 12 – 18” dbh (%) | 31 | 28 | 28 |

| Forest Attribute | Existing Condition (Year 2010) | Alternative A1 (Year 2050) | Alternative C2 (Year 2050) |
|---|---|---|---|
| 18 – 23.9” dbh (%) | 13 | 22 | 22 |
| ≥ 24” dbh (%) | 8 | 11 | 11 |
| TPA ≥ 18” dbh | 15 | 28 | 28 |
| Ponderosa Pine BA | 117 | 125 | 122 |
| Gambel Oak BA | 20 | 22 | 23 |
| All BA | 158 | 185 | 183 |

[1] = No Action Alternative
[2] = Only Prescribed Burning Would Occur Within Core Areas

### *MSO Prey Habitat*

#### Snags, Logs and Coarse Woody Debris

Snags greater than 18 inches dbh would remain unchanged and would, on average, be slightly below forest plan direction (Table 77). Understory response within PACs would be similar to alternative B (Table 77). This is a reflection of the high canopy cover in protected habitat. The modeling for understory does not include the nutrient pulse or benefits of reducing the pine litter layer (Appendix 8). However, the resulting nutrient pool would likely be mostly absorbed by the overstory. The trees would presumably increase their nutrient translocation into the canopy (Appendix 8). Individual PACs receiving both mechanical and prescribed burning treatments would show more variety in understory response, but increases in biomass production would typically be limited to 2 to 5 pounds per acre, although increases would equal 10 to 20 lbs per acre in some individual PACs (Appendix 16). Localized increases in biomass production would represent increased grass and forb development during the growing season, potentially providing site specific improvements in food and cover for arthropods, small mammals and birds. In turn, this could increase localized prey availability, diversity, and total prey biomass for resident MSOs.

There would be over 3 snags per acre greater than 12 inches dbh in PACs with mechanical treatments and over 4 snags per acre in the burn-only PACs. Retaining and improving growth rates of large trees would provide a more robust cohort of trees 18 inches dbh and greater and would thus better provide a source of snags beyond 2050.

Logs would decrease by about one per acre (Table 77).

Understory response within PACs would be similar to alternative B (Table 77). This is a reflection of the high canopy cover in protected habitat. The modeling for understory does not include the nutrient pulse or benefits of reducing the pine litter layer (Appendix 8). However, the resulting nutrient pool would likely be mostly absorbed by the overstory. The trees would presumably increase their nutrient translocation into the canopy (Appendix 8). Individual PACs receiving both mechanical and prescribed burning treatments would show more variety in understory response, but increases in biomass production would typically be limited to 2 to 5 pounds per acre, although increases would equal 10 to 20 lbs per acre in some individual PACs (Appendix 16). Localized increases in biomass production would represent increased grass and forb development during the growing season, potentially providing site specific improvements in food and cover for arthropods, small mammals and birds. In turn, this could increase localized prey availability, diversity, and total prey biomass for resident MSOs.

The decrease was variable by individual PAC (Appendix 16). Similarly CWD would consistently decrease by about one to five tons per acre in individual PACs (Appendix 16). Overall, CWD would decrease, but remain within forest plan direction, indicating treatments would sustain these habitat components for MSO prey species.

**Understory Index**

Understory response within PACs would be similar to alternative B (Table 77). This is a reflection of the high canopy cover in protected habitat. The modeling for understory does not include the nutrient pulse or benefits of reducing the pine litter layer (Appendix 8). However, the resulting nutrient pool would likely be mostly absorbed by the overstory. The trees would presumably increase their nutrient translocation into the canopy (Appendix 8). Individual PACs receiving both mechanical and prescribed burning treatments would show more variety in understory response, but increases in biomass production would typically be limited to 2 to 5 pounds per acre, although increases would equal 10 to 20 lbs. per acre in some individual PACs (Appendix 16). Localized increases in biomass production would represent increased grass and forb development during the growing season, potentially providing site specific improvements in food and cover for arthropods, small mammals and birds. In turn, this could increase localized prey availability, diversity, and total prey biomass for resident MSOs.

**Table 77. Modeled Changes in Prey Habitat Attributes Within MSO PACs in Alternative C**

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative C[2] (Year 2050 |
|---|---|---|---|
| **PACs With Thinning Outside Core Areas (n = 18)** | | | |
| Snags/ Ac ≥ 18” dbh | 0.6 | 1.5 | 1.5 |
| Logs/ Ac | 1.3 | 5.7 | 4.8 |
| CWD (tons/ac) | 4.7 | 10.3 | 5.8 |
| Understory Index[3] | 47 | 40 | 59 |
| **PACs With Prescribed Burning (n = 54)** | | | |
| Snags/ Ac ≥ 18” dbh | 0.7 | 1.8 | 1.8 |

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative C[2] (Year 2050 |
|---|---|---|---|
| Logs/ Ac | 2.8 | 7.9 | 6.9 |
| CWD (tons/ac) | 6.0 | 12.5 | 8.4 |
| Understory Index[3] | 48 | 41 | 44 |

[1] = No Action Alternative

[2] = Only Prescribed Burning Would Occur Within Core Areas

### *Fire Effects*

Prescribed burning would occur in all 72 PACs in the treatment area, including 56 core areas (Appendix 14). Prescribed burning would occur on all 35,566 total PAC acres in the treatment area. Core acres in wilderness, mixed conifer forest, other project areas, or canyons would be excluded from treatment under the 4FRI, even if the treatment area contains most of the PAC acres. Expected results from these burns would include r levels of surface fuels, and increasing average canopy base height. Reduction of surface fuels and raising canopy base height would reduce the risk of a ground fire becoming a canopy fire. These changes would also reduce or eliminate accumulated pine needles, helping in the release of understory vegetation (Appendix 8) and raising the crown base height could improve sub-canopy flight space for MSOs. Combined, these changes could improve MSO prey habitat and also improve the ability of MSOs to hunt in these areas.

Post-treatment modeling indicates that the amount of ponderosa pine forest occurring in FRCC 3 across the general treatment area would decrease to zero in 2020 under alternative C, a reduction of nearly 298,000 acres (Table 78). This change would greatly decrease the risk of high-severity fire moving into protected habitat and increase the potential for managing unplanned ignitions for resource benefits. Combined, this would further decrease the fire risk to MSO habitat. While the risk within nesting and roosting habitat would remain high, the decrease in FRCC 3 across the landscape would help mitigate the threat of losing this habitat to high-severity fire.

**Table 78. Fire Regime Condition Class (FRCC) Ratings in Ponderosa Pine Forest Through Time Under Alternative C**

| Conditions | Year | Measure | FRCC1 | FRCC2 | FRCC3 |
|---|---|---|---|---|---|
| Existing | 2010 | Acres | 70,680 | 136,311 | 297,866 |
| | | Percent | 14 | 27 | 59 |
| Alt. C | 2020 | Acres | 95,923 | 408,934 | 0 |
| | | Percent | 19 | 81 | 0 |
| | 2050 | Acres | 80,777 | 257,477 | 166,603 |
| | | Percent | 16 | 51 | 33 |

Figure X shows changes in surface fuels by desired canopy openness for alternative B. The figure represents the relative degree of canopy openness predicted after treatments are completed, e.g., “High” indicates more open conditions with a mosaic of tree groups and open interspace. “Very Low” indicates relatively connected canopy with very few discernible interspace (see fire ecology report for details). General effects to surface fuels in alternative C are the same as alternative B in most treatment types. Under alternative C, Forest Plan guidelines for CWD (5 to 7 tons/acre) would be exceeded for PACs, including core areas in 2020. Modeling for this project and research in northern Arizona (Waltz et al. 2003) suggest that CWD levels increase in a year or two after treatment (Figure X). Assumptions include mechanical treatments and two prescribed fire treatments would occur between 2010 and 2020 and that no treatments of any kind would take place between 2020 and 2050. Twenty tons per acre represents the upper end of the recommended range for fuel loading in southwest ponderosa pine forest (see fire ecology report). See appendix 19 for maps comparing surface fuels across the 4FRI treatment area.

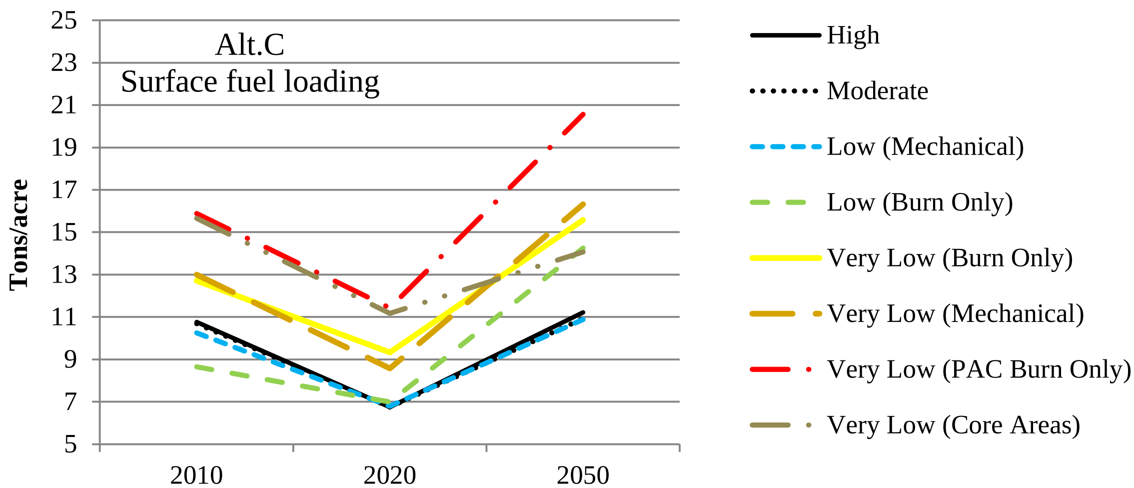



**Figure X. Modeled changes in surface fuel loading (litter, duff, CWD combined) by desired openness for Alternative C**

Burning in PACs would occur outside the nesting season. Burning in PACs 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.

Modeled fire behavior would shift as a result of prescribed burning. Predicted surface fire would increase in protected habitat by over 27 percent (9,915 acres) in the year 2020 under alternative C (). The probability of active crown fire would decrease by 23 percent (almost 8,600 acres) after treatments. All crown fires in ponderosa pine produce high-severity. 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 burning in PACs, including core areas, would lower the threat of future predicted fire behavior in core areas. Appendix 16 displays MSO habitat and fire behavior for each alternative.

**Table 79. Predicted Fire Behavior in Protected Habitat Under Current Conditions and After Implementation of Alternative C in 2020**

| MSO Habitat | Total (Ac) | Surface Fire (Ac) | Passive Crown Fire (Ac) | Active Crown Fire (Ac) | Surface Fire (%) | Passive Crown Fire (%) | Active Crown Fire (%) |
|---|---|---|---|---|---|---|---|
| **Existing Condition** | | | | | | | |
| Ponderosa Pine | 507,059 | 313,423 | 48,523 | 145,113 | 62 | 10 | 29 |
| Protected | 36,598 | 18,610 | 3,141 | 14,847 | 50 | 9 | 41 |
| **Alternative C** | | | | | | | |
| Ponderosa Pine | 507,059 | 482,879 | 15,508 | 8,672 | 95 | 4 | 1 |
| Protected | 36,596 | 28,525 | 1,908 | 6,163 | 78 | 5 | 17 |

**Restricted Habitat**

Mechanical treatments would occur on about 71,603 acres of restricted habitat, or 94 percent of total restricted acres in the treatment area. This includes about 97 percent of the total target and threshold acres. Although the implementation schedule is not yet known, on average 7,344 acres would be treated per year if 4FRI implementation lasted 10 years. On average, this would equal about 10 percent of the restricted getting treated in a given year. All restricted habitat (100%) would be prescribed burned.

### *Forest Structure and Density in MSO Habitat*

Treatments in restricted habitat would follow draft Recovery Plan guidelines (USDI 2011) and be expected to maintain (threshold habitat) and create (target habitat) replacement nesting and roosting habitat. Thinning objectives in target and threshold habitat would maintain an overall BA to between 110 and 150 $ft^2$ per acre, as recommended in the draft Recovery Plan. In addition, treatments in restricted habitat would provide a diversity of stand conditions and stand sizes across the landscape. Treatments would be designed to develop uneven-aged forest structure, irregular tree spacing and various patch sizes by thinning tree groups and reestablishing interspace adjacent to tree groups. Large trees and Gambel oak would be released from competition with unnaturally dense groups of young pine trees.

**Large Trees**

Mechanical treatments would, by design, be conservative in target and threshold habitat and would focus on increasing both the percent area of larger tree size-classes and increasing tree growth rates, as recommended in the Recovery Plan. Treatments would be of lower intensity in these habitat classifications compared to restricted “other” habitat. Trees less than 18 inches dbh are over-abundant relative to desired conditions described in the forest plans and the Recovery Plan. Therefore, treatments would focus on trees less than 18 inches dbh to address management priorities including increasing tree growth rates to move more trees into larger size-classes and retaining existing large trees.

As a result of threshold treatments planned under alternative C, trees 12 to 17.9 inches dbh would decrease by about two to five percent while trees 18 to 23.9 inches dbh and trees greater than 24 inches dbh would increase two to three percent (Table 80). The exception to this pattern is that trees 18 to 23.9 inches dbh would decrease by about two percent, but 24 percent of the SDI would be in this size-class, well above the 15 percent guideline. Individual subunits would vary from 22 to 33 percent of the SDI in trees 18 to 23.9 inches dbh in 2050. After treatment, all subunits would remain at18 percent or higher for SDI of trees 12 to 17.9 inches dbh. One subunit, subunit 2 of RU 3, would decline to 13 percent by the year 2050. Simultaneously, trees 24 inches dbh and greater would increase by 3 percent above the no action alternative by 2050 in this same subunit. Treatments in 4FRI assume one mechanical entry and two entries with prescribed fire. Subunit 3-2 may require additional work to achieve densities of 15 percent or greater in each of the three dbh size-classes. Overall, each subunit displayed consistent increases in large trees by 2050 under alternative C relative to the no action alternative (Appendix 17). The value for TPA greater than 18 inches dbh would remain high with all subunits at 31 or higher (Appendix 17). The intensity of the treatments are such that threshold habitat would remain in density zone 4, at risk from competition-induced mortality and lacking resiliency to large scale stochastic events. Nevertheless, treatments would maintain or improve MSO nesting and roosting habitat in terms of large tree growth rates and increasing the percentage of large trees across threshold habitat.

Changes in the distribution of large trees in target habitat were similar to those described for threshold habitat (Table 81). Trees 12 to 17.9 inches dbh were selected for cutting due to their abundance and treatments were designed to improve the ratios of large trees. Similar to threshold habitat, one subunit (subunit 1-4) decreased below 15 percent cover by 2050(Appendix 17). Large trees and TPA greater than 18 inches dbh would consistently increase and trees greater than 24 inches dbh would nearly double in density.

Trees 12 to 17.9 inches dbh would decrease in restricted “other” habitat, largely as a result of creating gaps and irregular spacing and diversifying the age-class distribution (Table 82 and Appendix 17). Decreases (7 to 11 percent) would occur in density of trees less than 18 inches dbh, compared to the no action alternative, reflecting the selection of mid-sized trees in the treatment design (Table 82).Trees 18 to 23.9 inches dbh would commonly decrease by about 2 percent and trees greater than 24 inches dbh increased by about 30 to 100 percent by 2050. TPA greater than 18 inches dbh, a simple stem count versus a density measurement, decreased by 3 to 6 percent as compared to the no action alternative. Large tree results were consistent across RUs in restricted “other” habitat: Removing mid-sized trees would reduce their numbers while decreasing the time required for trees to reach larger size-classes, i.e., trees would grow into the largest size-classes more quickly because of improved growth rates. This, in turn, would reduce the total number of trees less than 24 inches dbh. This reflects the inherent trade-off in meeting Recovery Plan objectives to increase the number and growth rates of large trees on the existing landscape. However, restricted “other” habitat is not expected to provide nesting and roosting habitat (the role of target and threshold habitat) and would allow the creation and maintenance of canopy gaps, uneven-spacing, and uneven-aged forest. Increasing forest heterogeneity while increasing the large tree component would improve MSO habitat by maintaining current and future nesting and roosting structure in some areas while also increasing prey habitat and potential MSO foraging opportunities in other areas. These changes would reduce competition-induced mortality and increase resiliency to large scale stochastic events, including fire risk (see below). The emphasis on increasing tree growth rates and retaining large trees comes from the Recovery Plan that 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."

**Basal Area**

Pine BA would decrease in restricted habitats (Table 80, Table 81, and Table 82). This represents a key contribution towards reducing fire threat in designated MSO habitat. Gambel oak BA would increase 3 to 5 percent in target and threshold habitat and decrease in restricted "other" habitat. No oak would be targeted for removal; the decrease in restricted "other" habitat would result from increased operations. Treatments would move towards uneven spacing with canopy gaps as described in the Recovery Plan. Total BA would be about 195 $ft^2$ per acre in threshold habitat and range from 161 to 169 $ft^2$ per acre in target habitat where current conditions are more open than current threshold conditions. Total BA would range from 98 to 115 $ft^2$ per acre in restricted "other" habitat. These changes would increase forest health and resiliency by reducing competition-induced mortality and increasing resiliency to large scale stochastic events.

**Canopy Structure**

Based on BA and percent maximum SDI, canopy cover would remain dense. Percent maximum SDI would be 71 in target and threshold habitat ("extremely high density") and 37 in restricted "other" habitat ("high density"), similar to alternative B (Table 102). Canopy cover would be 50 percent or greater at the stand level, based on BA, TPA, and tree dbh. Canopy cover within tree groups would be higher. Existing variability in overstory species diversity would remain by design. Prescribed burning would improve sub-canopy flight space for MSOs by lifting crown base height. Combined, these factors should improve the elements of canopy structure such as cover, density, flight space, and species diversity.

**Table 80. Changes in Forest Structure Attributes Within MSO Threshold Habitat Under Alternative C**

| Forest Attribute | Existing Conditions (Yr 2010) | Alternative A (Yr 2050) | Alternative C (Yr 2050) |
|---|---|---|---|
| **Restoration Unit 1** | | | |
| 12 – 17.9" dbh (%) | 25 | 26 | 21 |
| 18 – 23.9" dbh (%) | 24 | 28 | 30 |
| ≥ 24" dbh (%) | 3 | 6 | 9 |
| Avg TPA ≥ 18" dbh | 28 | 35 | 34 |
| Ponderosa Pine BA | 131 | 142 | 102 |
| Gambel Oak BA | 58 | 56 | 61 |
| All BA | 204 | 226 | 195 |

| Forest Attribute | Existing Conditions (Yr 2010) | Alternative A (Yr 2050) | Alternative C (Yr 2050) |
|---|---|---|---|
| **Restoration Unit 3** | | | |
| 12 – 17.9” dbh (%) | 26 | 19 | 17 |
| 18 – 23.9” dbh (%) | 19 | 26 | 24 |
| ≥ 24” dbh (%) | 8 | 11 | 14 |
| Avg TPA ≥ 18” dbh | 24 | 36 | 32 |
| Ponderosa Pine BA | 107 | 113 | 88 |
| Gambel Oak BA | 57 | 61 | 65 |
| All BA | 185 | 209 | 196 |

### Table 81. Changes in Forest Structure Attributes Within MSO Target Habitat Under Alternative C

| Forest Attribute | Existing Conditions (Yr 2010) | Alternative A (Yr 2050) | Alternative C (Yr 2050) |
|---|---|---|---|
| **Restoration Unit 1** | | | |
| 12 – 17.9” dbh (%) | 30 | 28 | 22 |
| 18 – 23.9” dbh (%) | 12 | 19 | 19 |
| ≥ 24” dbh (%) | 7 | 10 | 13 |
| Avg TPA ≥ 18” dbh | 14 | 24 | 22 |
| Ponderosa Pine BA | 115 | 126 | 93 |
| Gambel Oak BA | 27 | 31 | 36 |
| All BA | 156 | 184 | 161 |
| **Restoration Unit 3** | | | |

| Forest Attribute | Existing Conditions (Yr 2010) | Alternative A (Yr 2050) | Alternative C (Yr 2050) |
|---|---|---|---|
| 12 – 17.9” dbh (%) | 26 | 25 | 21 |
| 18 – 23.9” dbh (%) | 13 | 17 | 17 |
| ≥ 24” dbh (%) | 7 | 11 | 13 |
| Avg TPA ≥ 18” dbh | 13 | 22 | 21 |
| Ponderosa Pine BA | 100 | 112 | 91 |
| Gambel Oak BA | 31 | 35 | 38 |
| All BA | 148 | 181 | 169 |

**Table 82. Changes in Forest Structure Attributes Within MSO Restricted “Other” Habitat Under Alternative C**

| Forest Attribute | Existing Conditions (Yr 2010) | Alternative A (Yr 2050) | Alternative C (Yr 2050) |
|---|---|---|---|
| **Restoration Unit 1** | | | |
| 12 – 17.9” dbh (%) | 30 | 30 | 19 |
| 18 – 23.9” dbh (%) | 12 | 20 | 19 |
| ≥ 24” dbh (%) | 7 | 10 | 20 |
| TPA ≥ 18” dbh | 11 | 23 | 17 |
| Ponderosa Pine BA | 108 | 127 | 70 |
| Gambel Oak BA | 17 | 22 | 19 |
| All BA | 138 | 170 | 107 |
| **Restoration Unit 3** | | | |
| 12 – 17.9” dbh (%) | 29 | 26 | 18 |

| Forest Attribute | Existing Conditions (Yr 2010) | Alternative A (Yr 2050) | Alternative C (Yr 2050) |
|---|---|---|---|
| 18 – 23.9” dbh (%) | 13 | 21 | 19 |
| ≥ 24” dbh (%) | 7 | 10 | 18 |
| TPA ≥ 18” dbh | 12 | 23 | 17 |
| Ponderosa Pine BA | 95 | 112 | 67 |
| Gambel Oak BA | 26 | 32 | 27 |
| All BA | 137 | 169 | 114 |
| **Restoration Unit 4** | | | |
| 12 – 17.9” dbh (%) | 28 | 24 | 17 |
| 18 – 23.9” dbh (%) | 13 | 20 | 17 |
| ≥ 24” dbh (%) | 8 | 11 | 19 |
| TPA ≥ 18” dbh | 12 | 22 | 16 |
| Ponderosa Pine BA | 84 | 100 | 62 |
| Gambel Oak BA | 27 | 35 | 30 |
| All BA | 129 | 165 | 115 |
| **Restoration Unit 5** | | | |
| 12 – 17.9” dbh (%) | 24 | 28 | 21 |
| 18 – 23.9” dbh (%) | 10 | 15 | 15 |
| ≥ 24” dbh (%) | 10 | 11 | 18 |
| TPA ≥ 18” dbh | 8 | 16 | 13 |
| Ponderosa Pine BA | 77 | 101 | 62 |
| Gambel Oak BA | 9 | 17 | 14 |

| Forest Attribute | Existing Conditions (Yr 2010) | Alternative A (Yr 2050) | Alternative C (Yr 2050) |
|---|---|---|---|
| All BA | 102 | 146 | 98 |

### *MSO Prey Habitat*

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

Under alternative C, snags greater than 18 inches dbh would decrease by about 0.1 to 0.3 snags per acre in restricted habitats compared to the no action alternative (Table 46). Values would range from 0.6 to 1.8 snags per acre and forest plan direction is for an average of 2 snags per acre. 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. Large snags are currently well below forest plan guidelines in even relatively “natural” areas (Ganey 1999, Waskiewicz et al. 2003). 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 that are more resistent to fire (Waskiewicz et al. 2003).

Logs would be above forest plan guidelines (i.e., 3 logs per acre at least 12 inches at mid-diameter and 8 feet long or longer) in all restricted habitats (Table 77). Threshold habitat would be more than double forest plan direction in both RUs (Table 80). Target (Table 81) and restricted “other” habitat (Table 82) would exceed or be at about forest plan direction in each RU.

CWD would be at the upper end of the range (i.e., 5 to 7 tons per acre) in threshold and target habitats. In restricted “other” habitat, CWD would meet forest plan guidelines in all RUs except for RU 5 which would be about 4.1 tons per acre. Existing conditions in this RU are only at 3.1 tons per acre of CWD. Mechanical treatments would likely add to the accumulation of down wood while burning would decrease available down wood. The resulting values would be more variable by individual subunit (Appendix 17).

Alternative C would have the lowest values for snags, logs, and CWD of the action alternatives. Values would still exceed forest plan direction for logs and CWD in nearly all RUs. Snags would be below forest plan values, similar to most RUs in all alternatives.

**Understory Index**

**Reduced BA and intermittent openings would increase light, moisture, and nutrient availability for herbaceous understory species. Understory response in threshold habitat is currently low, with biomass index values averaging 14 and 20 lbs/ac in RUs 1 and 3 respectively, and would remain low after treatment (Table 83). Nevertheless, the biomass index would more than double in RU 1 and increase by over 60 percent in RU 3, compared to the no action alternative. Understory response in target habitat would have similar results, although index values would be nearly double that in threshold habitat at 60 and 67 pounds per acre (**

Table 85). Values in threshold and target habitat would reflect the conservative nature of the treatments in these habitats. Alternative C would have the highest understory values of any alternative, indicating the most grass and forb development associated with lower total BA values. Changes in restricted “other” habitat would be much higher, with individual RUs more than doubling or more than tripling in biomass yield relative to the no action alternative (Table 84).

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 (USDI 1995). The recovery plan recommends managers provide diverse habitats to support a diverse prey base. However, improvements in understory production would gradually decline as overstory canopies expand and new trees became established.

**Table 83. Changes in Prey Habitat Attributes Within MSO Threshold Habitat Under Alternative C**

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative C[2] (Year 2050) |
|---|---|---|---|
| **Restoration Unit 1** | | | |
| Snags/ Ac ≥ 18” dbh | 0.5 | 1.2 | 1.0 |
| Logs/ Ac | 6.1 | 9.0 | 6.1 |
| CWD (tons/ac) | 7.1 | 12.9 | 6.8 |
| Understory Index[3] | 14 | 13 | 29 |
| **Restoration Unit 3** | | | |
| Snags/ Ac ≥ 18” dbh | 0.7 | 2.1 | 1.8 |
| Logs/ Ac | 1.8 | 7.9 | 6.1 |
| CWD (tons/ac) | 4.4 | 11.7 | 6.8 |
| Understory Index[3] | 20 | 18 | 29 |

[1] = No Action Alternative

[2] = No Treatments Within Core Areas

[3]= Lbs of biomass/ac in Years 2010 (Existing) and 2020 (Alts A & C)

**Table 84. Changes in Prey Habitat Attributes Within MSO Target Habitat in Alternative C**

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative C[2] (Year 2050) |
|---|---|---|---|
| **Restoration Unit 1** | | | |

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative C[2] (Year 2050) |
|---|---|---|---|
| Snags/ Ac ≥ 18" dbh | 0.5 | 1.4 | 1.2 |
| Logs/ Ac | 4.6 | 8.1 | 6.0 |
| CWD (tons/ac) | 6.0 | 11.8 | 6.5 |
| Understory Index[3] | 37 | 31 | 60 |
| **Restoration Unit 3** | | | |
| Snags/ Ac ≥ 18" dbh | 0.5 | 1.4 | 1.2 |
| Logs/ Ac | 2.5 | 6.1 | 4.8 |
| CWD (tons/ac) | 4.8 | 10.5 | 6.3 |
| Understory Index[3] | 53 | 45 | 67 |

[1] = No Action Alternative
[2] = No Treatments Within Core Areas
[3]= Lbs of biomass/ac in Years 2010 (Existing) and 2020 (Alts A & C)

**Table 85. Changes in Prey Habitat Attributes Within MSO Restricted "Other" Habitat Under Alternative C**

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative C[2] (Year 2050) |
|---|---|---|---|
| **Restoration Unit 1** | | | |
| Snags/ Ac ≥ 18" dbh | 0.4 | 1.1 | 0.8 |
| Logs/ Ac | 1.2 | 4.3 | 4.6 |
| CWD (tons/ac) | 4.3 | 8.9 | 5.8 |
| Understory Index[3] | 61 | 50 | 179 |
| **Restoration Unit 3** | | | |
| Snags/ Ac ≥ 18" dbh | 0.4 | 1.2 | 1.0 |

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative C[2] (Year 2050) |
|---|---|---|---|
| Logs/ Ac | 1.5 | 4.7 | 5.2 |
| CWD (tons/ac) | 3.9 | 8.7 | 6.3 |
| Understory Index[3] | 63 | 52 | 169 |
| **Restoration Unit 4** | | | |
| Snags/ Ac ≥ 18” dbh | 0.5 | 1.3 | 1.0 |
| Logs/ Ac | 1.1 | 4.3 | 4.7 |
| CWD (tons/ac) | 3.2 | 7.8 | 5.7 |
| Understory Index[3] | 61 | 49 | 154 |
| **Restoration Unit 5** | | | |
| Snags/ Ac ≥ 18” dbh | 0.4 | 0.7 | 0.6 |
| Logs/ Ac | 0.6 | 2.5 | 2.9 |
| CWD (tons/ac) | 3.1 | 6.0 | 4.1 |
| Understory Index[3] | 99 | 77 | 191 |

**1** = No Action Alternative
**2** = No Treatments Within Core Areas
**3**= Lbs of biomass/ac in Years 2010 (Existing) and 2020 (Alts A & C)

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 nesting and roosting habitat, and growth rates are much slower than in young or mid-aged trees (USDI 1995). As a result, some habitat components would decrease while others increase. Changes are subtle in target and threshold habitat because of the low intensity of treatments in these habitats, but 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. Additionally, 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.

Providing a continuous supply of nesting and roosting habitat requires maintaining different forest successional stages. Much of the restricted “other” habitat is not suitable for sustaining nesting and roosting conditions and therefore treatment objectives are designed to mimic the natural landscape, resulting in more pronounced changes in some habitat components. This follows Recovery Plan direction to sustain owl nesting habitat in such a way as to maintain and create replacement owl habitat where appropriate while providing a diversity of stand conditions and stand sizes across the landscape. The percent of maximum SDI in restricted “other” habitat would decrease to the low end of the “high density” zone (Table 103). Percent of maximum SDI in target and threshold habitats would only decrease to about the middle of the “extremely high density” category. Overall, the action alternatives would create similar values for percent of maximum SDI, with mid-range of values in the extremely high density category (zone 4 – see Table 4) and values at the low end of the high density category (zone 3). but alternative C consistently had slightly lower values for target and threshold habitats and the same value in restricted “other” habitat as alternative B. The combination of owl habitats should result in a landscape mosaic that ensures adequate nesting, roosting, and foraging habitat for the owl and habitat for the variety of MSO prey species.

### *Fire Effects*

Prescribed burning, along with mechanical treatments, would occur across 71,601 acres of restricted habitat, including 8,410 acres of target and threshold habitat. An additional 4,490 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 probability of active crown fire in restricted habitat would be reduced in the year 2020 compared to existing conditions, with over a 30 percent reduction in restricted “other” habitat and nearly a 30 percent reduction in target and threshold habitats (Table 86). All crown fire in ponderosa pine produces high-severity effects (fire ecology report). The dominance of surface fire in restricted habitat (90 and 94 percent in restricted “other” and target and threshold habitats, respectively) would reduce the risk of stand replacing fire in MSO habitat. Overall, thinning and burning treatments are projected to move restricted habitat towards the restoration of low-severity fire. Appendix 16 displays MSO habitat and fire behavior for each alternative.

**Table 86. Predicted Fire Behavior in Restricted Habitat Under Current Conditions and After Implementation of Alternative C in 2020**

| MSO Habitat | Total (Ac) | Surface Fire (Ac) | Passive Crown Fire (Ac) | Active Crown Fire (Ac) | Surface Fire (%) | Passive Crown Fire (%) | Active Crown Fire (%) |
|---|---|---|---|---|---|---|---|
| **Existing Condition** | | | | | | | |
| Ponderosa Pine | 507,059 | 313,423 | 48,523 | 145,113 | 62 | 10 | 29 |
| Target/ Threshold | 8,697 | 4,292 | 926 | 3,479 | 49 | 11 | 40 |
| Restricted “Other” | 67,260 | 35,465 | 6,608 | 25,187 | 53 | 10 | 37 |

| Alternative C | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ponderosa Pine | 507,059 | 482,879 | 15,508 | 8,672 | 94 | 3 | 2 |
| Target/ Threshold | 8,697 | 8,194 | 126 | 377 | 94 | 1 | 4 |
| Restricted “Other” | 67,259 | 60,623 | 6,270 | 366 | 90 | 9 | 1 |

More mechanical treatments and the more open nature of foraging habitat (versus nesting and roosting habitat) would allow for fire to achieve more fuels reduction in restricted habitat outside of target and threshold habitat (67,378 acres). In addition, treated areas 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.

### *Other Habitat Effects*

#### Meadows and Aspen

All meadow treatments combined would total 135 acres (average = 11 acres of treatment per PAC with a range of 1 to 28 acres). Operational burning would occur on 100 acres of meadow habitat within 12 PACs. Three of these PACs would also include a total of 35 acres of mechanical thinning and burning as meadow restoration. Operational burning would improve understory production and potentially kill encroaching seedlings and saplings. The combination of mechanical treatments and prescribed burning would be focused on true meadow restoration by removing encroaching post-settlement trees in addition to burning. Only alternative C proposes meadow restoration (as compared to burn-only treatments).

Aspen treatments would consist of prescribed burn-only on 209 acres in seven PACs. Returning fire into these habitats would be expected to improve understory vegetation. However, because of the nature of nesting and roosting habitat, pine densities surrounding and potentially within clones would be expected to be high and burn prescriptions are expected to be light so that burn severity remains low. Effects to competing and overtopping pine trees would be moderate at best. Therefore, limited change would be expected in terms of shading on aspen and the competition between aspen and pine for water and nutrients. Fire would reduce litter levels within clones, benefiting understory species, but litter would be expected to continue increasing through time. Results from aspen and meadow treatments in PACs would be an increase in aspen suckering and a short-term increase in understory biomass. These changes would provide short-term benefits in localized prey habitat.

At the scale of 4FRI, improvements to prey habitat through spring, ephemeral channel (common to all alternatives), meadow, and aspen treatments within protected habitat would be limited and site specific. However, these treatments would enhance prey habitat and benefit resident owls. MSO reproductive success appears tied to prey availability. MSOs in the UGM RU feed primarily on peromyscid mice and voles (Ganey et al. 2011) and restoration treatments can benefit these species (Kalies et al. 2012). Other small mammals, birds, and nocturnal flying insects (primarily lepidopterans and coleopterans) are also prey for MSOs and overall prey abundance may be very important to nesting MSOs, particularly during years when key species may be limited (Ganey et al. 2011). In general, small mammals, birds, and arthropods increase after burning and thinning in ponderosa pine forests (Appendix 8). This is particularly true for key habitat components like meadows, springs, etc., where herbaceous response would be expected to exceed that under dense forest canopies, providing large increases in food and cover in localized patches of prey habitat.

About 6,124 acres of grassland and meadow treatments would occur in restricted habitat, including about 135 acres of operational burn only grassland/meadow treatments. Tree encroachment would not be fully addressed in burn-only grassland treatments, leaving potential seed sources to continue the long-term degradation of grassland habitat. Nevertheless, an unknown percentage of meadow and grassland burn-only treatments would be expected to be improved in terms of understory response in MSO prey habitat resulting from the nutrient pulse and litter reduction after burning In addition, this would preclude the need to create firelines to prevent prescribed fire from neighboring ponderosa pine forest from entering into this entering non-ponderosa pine habitat. The balance of the grassland and meadow treatments, totaling about 5,990 acres, would be restored by using both mechanical removal of trees and prescribed burning. These treatments would provide additional areas where understory vegetation would be expected to respond strongly in the short-term as a result of burning and maintain improved conditions in the long-term by full removal of encroaching conifers. This would provide food and cover for MSO prey species through time, potentially improving prey numbers within grasslands and meadows and allowing for individuals of different prey species (e.g., mice, voles, rabbits, and gophers), to disperse into surrounding forest. In addition, arthropod prey such as beetles and moths could also benefit from these treatments. Therefore, meadow and an unknown percentage of grassland treatments would be expected to improve understory conditions for MSO prey species.Aspen treatments in restricted habitat would include about 200 acres of prescribed burn-only and about 740 acres of aspen restoration. Prescribed burning alone would decrease , stimulate suckering, and kill some, but not all encroaching pine. Aspen restoration would include mechanical removal of encroaching pine and pine within 100 feet of clones, scarifying soils to stimulate aspen suckering, and increase surface fuels to better carry fire beneath aspen. This difference would be expected to improve the health and resiliency of aspen clones and provide for a more robust understory response. Fencing or other barriers would be constructed after all treatments to prevent ungulate grazing within aspen clones. The resulting effects to prey habitat would include both short- and long-term improvements in understory vegetation and overstory aspen health and sustainability in 79 percent of the treated aspen (740 acres). Improvements to aspen would improve prey habitat. MSOs would be expected to benefit from increases in prey abundance.

Limited change in the aspen overstories would result from burn-only treatments, allowing continued competition between pine and aspen and understory vegetation, limiting aspen and understory response. Burn-only aspen treatments would result in short-term improvement in understory vegetation in 21 percent of the aspen with little change expected in aspen sustainability (200 acres).

**Disturbance**

Disturbance could occur as a result of project-related activities including moving and operating harvest machinery, hauling forest materials, building fire line, managing prescribed burns, smoke, personnel in the field, and road maintenance and construction. Noise disturbance from project activities may disturb MSO. Alternative C would mechanically treat 82,344 acres of MSO habitat, about 1,833 acres less than alternatives B or D.

Noise would not be expected to disturb nesting or roosting MSO because of project planning intended to minimize disturbance to nesting and roosting owls. Haul routes either avoid PACs, occur more than a ¼ mile from core areas, or employ timing restrictions to avoid disturbance during the nesting season.

Alternative C would prescribe burn 112,546 acres of MSO habitat. Burning within PACs would include core areas, eliminating the need to build fire lines intended to prevent fire from entering core areas. Noise and smoke related to burning could disturb owls. Design features would include timing restrictions so that habitat in and around PACs would not be prescribed burned during the breeding season (March 1 to August 31). The area excluded from burning around PACs would be determined on a PAC by PAC basis. Roads, topography, and prevailing weather patterns would be identified so that an adequate buffer would be defined around PACs. Burning within the buffer would be conducted in association with PAC burning outside the breeding season. Site-specific buffers would be designed so that noise and settling smoke from burning outside the buffer would not disturb resident owls in the PACs during the breeding season. Appropriate distances for individual PACs would be decided by biologists, fuels specialists, and the USFWS. As a result, smoke and noise are not expected to result in negative effects to MSO.

**Direct and Indirect Effects**

Treatment design, project design criteria, and mitigation would be implemented to be compliant with Recovery Plan and forest plan guidelines as amended. Management activities in PACs and protected habitat are designed to retain and improve nesting and roosting structure. Thinning treatments within PACs are designed to increase growth and retention of large pine and oak trees, benefiting PACs most threatened with loss of these habitat components. Treatments within PACs would occur outside of the breeding season. Thinning trees in PACs from 9 to 18 inches dbh with an average BA of 110 or more would provide growth rates and retention of large trees at levels exceeding that of any other alternative. Mechanical thinning and prescribed burning activities would provide better long-term sustainability of MSO habitat components than other alternatives.

Core areas would not be treated mechanically but would be treated with prescribed fire in alternative C. Nesting and roosting habitat within PACs would continue to develop slower, relative to treated areas of similar habitat, and old trees would continue to be at risk due to forest health issues. However, development and retention of these attributes would be more pronounced under alternative C than in any other alternative due to prescribed fire treatments. Surface fuels would be reduced and crown base height raised in core areas, potentially lowering future wildfire severity. The reduced threat of high severity crown fire from outside MSO habitat, combined with reductions in wildfire threat within MSO habitat, including lower tree densities in this alternative, increases sustainability of these habitats.

Vegetation associated with springs and ephemeral channels within PACs would be increased, providing food and cover for prey species. Meadows and aspen would be burned in protected habitat, potentially benefiting habitat for prey species. Short-term impacts may occur to individual MSO, e.g., owls foraging outside of PACs during crepuscular hours. Long-term benefits to MSO habitat would occur in terms of improved forest structure and reduced threats from stochastic events. Smoke from prescribed fire could potentially affect nesting owls and developing nestlings.

Restricted habitat would be managed for sustainable long-term forest stand structure by implementing combinations of group selection cuttings arranged to spatially distribute groups of trees and canopy openings, moving towards Recovery Plan and forest plan guidelines, as amended. The proposed changes to forest structure in restricted habitat are designed to retain or develop MSO nesting and roosting habitat in target and threshold habitat while moving towards habitat sustainability, thereby decreasing the risk of large scale stochastic events. In restricted “other” habitat. MSO prey habitat would benefit from the creation of openings between tree groups, meadow improvement, and conducting aspen restoration in restricted habitat, all of which would increase understory food and cover. Overall benefits to MSO restricted habitat would be more pronounced due to lower BA objectives for thinning in alternative C than in the other alternatives.

The combination of mechanical treatments and low severity burning would lessen potential fire behavior after treatments are implemented. Post-treatment fires would be more likely to burn as surface fires rather than crown fires which more closely resemble the historical range of variation. The reduction in risk of habitat loss from potential fires is expected to be higher in alternative than other alternatives due to the greater reduction in BA and burn treatments in core areas associated with this alternative.

Road decommissioning would reduce disturbance to MSOs, improving owl habitat quality in the long-term. Reestablishing natural drainage patterns, reducing siltation, and reestablishing hiding cover for prey species on road beds or completely eliminating road beds would increase prey habitat for foraging owls. Reducing vehicular access would likely increase snag retention, a key forest structural element in MSO habitat. Work related to road maintenance, construction, and relocation inside PACs would occur outside the nesting season, but could create noise, potentially disturbing roosting owls in the short-term. Haul routes for removing harvested materials would avoid areas within a quarter mile of core areas or implement timing restrictions. By phasing project activities, not all MSO habitats would be treated simultaneously, thus lessening the impacts.

Activities associated with spring, ephemeral channel restoration, and meadow and aspen treatments in PAC habitat would occur outside the nesting season, but could create noise that could potentially disturb roosting MSOs. Because project implementation will be phased, not all MSO habitats would be treated simultaneously, lessening disturbance to MSOs.

Mechanical thinning and low severity prescribed burning would result in little change to overall forest structure in protected habitat. However, thinning is designed to release large oak and pine and increase growth rates of trees greater than 18 inches dbh. Thinning treatments in alternative C are designed to maximize these benefits in PACs most threatened with loss of these habitat components by treating some PAC stands up to 18 inches dbh and reducing BA to levels currently recommended by the Recovery Team. Prescribed burning would primarily reduce litter and increase crown base height. Combined, these changes should decrease future burn severity and the risk of crown fire in PACs, including core areas. Thinning and low severity prescribed burning would bring slight improvements to prey habitat in terms of understory vegetation in protected, target, and threshold habitats in the short-term. Understory biomass would increase by 100s of pounds of forage in restricted “other” habitat relative to the other MSO habitats and would persist longer due to creation of interspaces. Increasing growth rates of mature and old growth trees and retaining existing large trees will indirectly contribute to maintaining large snags, logs, and CWD across the landscape in the long-term.

Proposed changes to forest structure in restricted habitat are designed to retain or enhance MSO nesting and roosting conditions in target and threshold habitat while moving towards the ecological capacity in restricted “other” habitat. These changes will primarily result from reductions of mid-aged trees 12 to18 inches dbh and lower BA values post-treatment. Impacts to MSO from implementation would be reduced by phasing project activities across the treatment area.

Fire risk will decrease in PACs as a result of treatments, but the decrease will be much less than in other habitats because of the small scale of change in forest structure. Thinning in the 18 selected PACs would range from less than 9 inches dbh up to 18 inches dbh with a minimum BA of 110 $feet^2$ per acre and prescribed fire would be used in all PACs occurring in the treatment area. Reducing the potential for canopy fire increases the ability to manage unplanned ignitions and increases the potential for additional fuels reduction in future maintenance burns. Increasing the potential for future managed fire decreases the long-term risk of stand-replacing stochastic events. The ability to use future fire to better protect MSO habitat will be most effective under alternative C as a result of the minimum BA adopted in protected, target, and threshold habitats, the increased dbh limits designed to maximize benefits in PACs, and prescribed fire treatments in core area that are all part of this alternative.

An additional indirect benefit of the fire treatments is additional inputs of soil nutrients, benefiting both over- and understory vegetation and thereby improving the habitat of MSOs and their prey. Prescribed burning across MSO habitats also reduces litter, thereby improving the potential for improvements in the understory. These improvements would include 72 PACs and 56 core areas. PACs and core areas are the most heavily used portion of an owl pair’s territory. Benefits to nesting owls as a result of improvements in prey habitat within PACs are greatest in this alternative. Moving towards the desired condition in MSO habitat would include reductions in total BA, increasing relative contributions of Gambel oak to soil resources, and increased solar radiation reaching the understory, all of which should improve prey habitat and are maximized in alternative C.

Road closures, road relocations, and improvements and restoration of key habitats would also improve habitat for prey species by decreasing human disturbance and increasing habitat serving as food and cover. Large snag longevity would, on average, increase with decreased access by firewood cutters. Grasses, sedges, flowering forbs, and woody shrubs would benefit from spring and channel restoration and meadow/grassland and aspen treatments, all of which would benefit MSO prey. While small in scale and limited in scope, these actions target site-specific micro-habitats important to small mammals, birds, and arthropods and so increase total prey biomass. Improving connectivity of herbaceous undergrowth could improve arthropod populations. This in turn could indirectly benefit MSO prey species through increased food availability (i.e., arthropod availability) and improved habitat (from increased pollinator populations). Total treated acres in these prey habitats would be nearly the same in alternatives B and C, differing by about 19 fewer acres of treatments within aspen in alternative B. However, meadow and grassland treatment intensity would be higher in alternative C by combining mechanical and prescribed burning. Therefore expected benefits to herbaceous vegetation would be greater in alternative C. Understory response would be expected to be stronger in restricted habitat where, in general, greater reductions in canopy cover, and more openings would be created. Improvements in prey habitat should benefit prey species. Increases in prey populations should indirectly benefit MSOs.

### *Alternative C - Determination of Effects for MSO*

Alternative C proposes the most treatments in MSO habitat. As a result, more acres of habitat are moved towards desired conditions than under any other alternative. The determination of effects for the Mexican spotted owl habitats is based on design criteria, mitigation, proposed forest plan amendments, the above effects discussion, and the following:

- By design, mechanical thinning and low severity prescribed burning within MSO protected habitat would follow the intent of the MSO Recovery Plan and respective forest plan guidelines as amended; prescribed burning would not occur within or adjacent to PACs during the breeding season
- By design, mechanical thinning and low severity prescribed burning within threshold, target, and other restricted habitat would follow MSO Recovery Plan and respective forest plan guidelines as amended
- Mechanical thinning in 18 PACs and low severity prescribed burning in 72 PACs, including core areas, may cause short-term displacement to foraging and roosting MSOs outside the breeding season
- Improving stand structural and spatial conditions would meet short-term objectives of improving overall forest health and long-term objectives of increased forest resiliency
- Fire behavior in protected habitat would be changed in this alternative, with 83 percent of the area supporting surface fire in 2020 and only five percent of the area at risk from active crown fire
- About 20 percent of the total road miles in 58 PACs would be decommissioned after treatment activities, lessening the amount of long-term disturbance to MSOs and their prey that is associated with access; road segments in three PACs, including core habitat in one PAC, and in restricted habitats would be relocated to provide long-term protection for ephemeral stream channels and the habitat they support
- Fire and smoke effects from prescribed burning may disturb individual birds in and adjacent to the treatment area, but timing restrictions and low severity burn prescriptions would reduce impacts and largely lead to no or only short-term effects; however, the amount of burning across the landscape under this alternative creates the potential of smoke settling into a PAC, potentially leading to adverse effects to individual owls
- Post-treatment growth rates of trees would increase, tree resiliency to drought and insects would improve, and more of the total BA would be occurring in larger size classes, improving MSO habitat components in both the short- and long-term
- Large snags (greater than 18 inches dbh) are currently below forest plan guidelines; future snag recruitment is expected through existing insect and disease activities and impacts of low severity prescribed burning. Snag development is expected to occur as more trees attain larger size-classes and meet the size-class distribution recommended in the Recovery Plan; snag retention would improve through road decommissioning; over the long-term, snag development and retention is expected to improve after project implementation
- Key sites that can support diverse and abundant understory vegetation within MSO habitats would be improved or restored for both the short- and long-term, including about 23 springs, and about 5 miles of ephemeral channels, 3,870 acres of meadows, and 940 acres of aspen. There is a strong link between raptors and their food and conserving and enhancing prey habitat is expected to benefit MSOs (Ganey et al 2011).

- The development of 8,412 acres of restricted target and threshold habitats would be managed towards meeting a 110-150 BA for MSO nest and roost habitat as recommended in the draft MSO Recovery Plan (USDI FWS 2011)
- Total treatments in MSO habitat include 82,344 acres of mechanical thinning and 112,546 acres of low severity prescribed burning and would provide for understory grass/forb/shrub release to improve habitat components for MSO prey base; improvements would be maximized in the short-term and while improvements would decline, they would be maintained above existing conditions over the long-term; overall this represents the most acres of MSO habitat improved through treatment and hence the largest understory response of any action alternative
- Thinning and low severity prescribed fire on 67,378 acres of restricted "other" habitat would provide for "groupy" tree structure and canopy gaps resembling historical conditions at spatial scales capable of reestablishing understory regeneration and reducing risk of active crown fire over both the long- and short-term
- Implementing both mechanical and prescribed burn treatments would reduce hazardous fuel loads, reducing the potential for future stand replacing, high severity crown fire and also protecting soil resources by reducing severity of surface fires over both the long- and short-term; however, these benefits would decrease in the short-term without maintenance burning
- Alternative C would preserve current old growth habitat and develop old growth components in 100 percent of MSO protected, target, and threshold habitats (45,168 acres) and additional acreage in restricted "other" habitat (see Silviculture report), sustaining key MSO habitat components over the long-term
- Forest conditions within the historical range of variability (FRCC 1) would be returned to 19 percent of the landscape by the year 2020, thus reducing the potential for large-scale MSO habitat loss from high-severity fire; while this benefit decreases in the long-term, the amount of area in FRCC 1 remains higher compared to existing conditions, providing both short- and long-term benefits
- Forest conditions moderately altered from the historical range of variability (FRCC 2) would be returned to 78 percent of the landscape by the year 2020, thus reducing the potential for large-scale MSO habitat loss from high-severity fire; while this benefit decreases in the long-term, the amount of area in FRCC 2 remains high in alternative C (similar to alternative B) compared to existing conditions or alternative D, providing both short- and long-term benefits
- Alternative C is the only alternative to reduce FRCC 3 to zero in the year 2020 and by 2050 about a third of the ponderosa pine forest (33 percent) would move into FRCC 3, providing the best short- and long-term benefits relative to the historical range of variability

This is the only alternative to reduce fire severity within core areas. MSO stratified habitat will provide for a mosaic of desired stand structure conditions, improving habitat heterogeneity and vegetative diversity. This mosaic would allow for a diversity of potential fire effects, thereby increasing opportunities for the maintenance of forest structure and function using planned and unplanned ignitions in the future (up to 30 years). Canopy characteristics and surface fuel loading combine to produce combinations of surface fire intensity and physical structure (the height, density, and horizontal and vertical continuity of canopy fuels) that can produce crown fire under a given set of conditions. The closer conditions are to this threshold, the faster it will deteriorate to a point where crown fire is possible. The changes in protected, target, and threshold habitats in alternative C would maximize future opportunities to manage fire and avoid stand replacing events.

Alternative C would provide and sustain long-term nesting and roosting habitat while reducing potential risk of high severity wildland fire and other stochastic events. To mitigate adverse effects associated with treatments within protected habitat, no treatments would occur during the breeding season and no activities would occur within the core area. Unintended smoke from first-entry burns that settled in PACs could adversely affect egg development or nestling survival by flushing the female, or affect nestling development through lung damage.

### Alternative D

Under alternative D, mechanical treatments would occur in portions of all MSO habitats except for core areas (see protected habitat below). Alternative D would treat the least amount of MSO habitat with almost 20,000 fewer acres of MSO habitat than alternative B and nearly 25,000 fewer acres than alternative C. Alternative D would not prescribe burn any PAC habitat and only about four percent of total MSO habitat would be burned (Table 87). The minimum post-treatment BA for nesting and roosting habitat would be 150 $ft^2$ per acre, in line with the current recovery plan (USDI 1995). No trees greater than 24 inches dbh would be removed and tree groups with diameters averaging 18 inches dbh or greater would not be cut for regeneration. 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 the forest plans. A comparison of treatments in MSO habitat by alternative is displayed in Appendix 15. This analysis is based on the assumption that mechanical treatments and two low-severity prescribed fire treatments would occur within the project timelines. Alternative D would mechanically treat 84,178 acres and prescribe burn 3,543 acres of prescribed burning in protected and restricted habitat (Table 87).

**Table 87. Alternative D Summary of Treatments in Ponderosa Pine MSO Habitat**

| Treatment Type* | MSO Habitat Type | | | |
|---|---|---|---|---|
| | Protected | Restricted | Target/ Threshold | Total Acres |
| Burn Only | 889 | 2,354 | 301 | 3,543 |
| MSO Restricted – Group Selection/Intermediate Thinning | | 65,024 | | 65,024 |
| MSO Target – Intermediate Thinning | | | 6,518 | 6,518 |
| MSO Threshold – Intermediate Thinning | | | 1,894 | 1,894 |
| PAC – Intermediate Thinning ≤16” | 10,741 | | | 10,741 |
| Total | 11,630 | 67,378 | 8,713 | **87,721** |

An overview of immediate post-treatment results (year 2020) and long-term changes to habitat structure (year 2050) are displayed by RU (Table 88). Proposed treatments for nesting and roosting habitat were designed to meet the habitat objectives described in the forest plans and in the Recovery Plan. This resulted in low intensity treatments retaining high BA and percent maximum SDI as described for protected habitat and target and threshold habitats. Increases in percent area for trees greater than 18 inches dbh, including trees greater than 24 inches dbh would occur. Trees 12 to 18 inches dbh would decrease in most RUs, but remain above 20 percent in target and threshold habitat and in protected habitat and above 15 percent in restricted “other” habitat. The number of average TPA 18 inches or greater increased in both existing and future nesting and roosting habitats and decreased in restricted “other” habitat. This latter occurred as a result of creating canopy gaps, uneven-aged structure, and lower total BA to accelerate growth rates for moving more trees into larger size classes and retain existing large trees. This meets the direction in the Recovery Plan to manage for a landscape mosaic or mixture of habitat conditions to ensure adequate nesting, roosting, and foraging habitat for the owl and habitat for MSO prey. This alternative represents a landscape management approach to maintain and create replacement owl habitat where appropriate while providing a diversity of stand conditions and stand sizes across the landscape as described in the Recovery Plan. The percent of oak BA increased in protected habitat and typically decreased by a percentage point in restricted habitats as a result of prescribed fire. CWD increased across all RUs. Snags greater than 18 inches dbh increased in all habitats.

Mechanical thinning and prescribed burning would take place at different times in different locations. Spotted owl habitat could be affected by mechanical treatments in one area and prescribed burning 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 8,700 acres of MSO habitat would be mechanically treated and 30 acres prescribed burned each year under alternative D. No mechanical treatments would occur on slopes greater than 40 percent in MSO habitat.

**Table 88. Alternative D - 2020 and 2050 Mexican Spotted Owl Habitat Forest Structure and Habitat Components Based on Weighted Stand Averages**

| RU | Basal Area | | % Max SDI | | Avg. Percent of Total SDI by Size Class 12.0 – 17.9" | | Avg. Percent of Total SDI by Size Class 18.0 – 23.9" | | Avg. Percent of Total SDI by Size Class 24.0" + | | Avg. TPA 18"+ | | Avg. Gambel Oak BA Percent of Total BA | | Tons CWD >12" | | Snags >18" | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 |
| **Restricted Target/ Threshold** | | | | | | | | | | | | | | | | | | |
| RU 1 | 147 | 176 | 74% | 82% | 30% | 24% | 20% | 24% | 8% | 11% | 19.5 | 28.3 | 25% | 24% | 1.9 | 2.6 | .5 | 1.4 |
| RU 3 | 152 | 181 | 79% | 86% | 26% | 21% | 19% | 21% | 9% | 12% | 19.0 | 26.6 | 29% | 27% | 1.1 | 2.1 | .7 | 1.6 |
| All | 149 | 179 | 76% | 84% | 28% | 23% | 19% | 23% | 9% | 11% | 19.3 | 27.6 | 26% | 25% | 1.5 | 2.4 | .6 | 1.5 |
| **Restricted Other** | | | | | | | | | | | | | | | | | | |
| RU 1 | 86 | 123 | 43% | 56% | 20% | 18% | 20% | 16% | 17% | 17% | 11.8 | 16.7 | 20% | 19% | 1.1 | 1.5 | .4 | .8 |
| RU 3 | 94 | 130 | 48% | 60% | 20% | 18% | 20% | 17% | 16% | 16% | 12.0 | 17.4 | 25% | 24% | 1.1 | 1.6 | .5 | .9 |
| RU 4 | 96 | 130 | 50% | 61% | 18% | 16% | 19% | 16% | 18% | 17% | 11.9 | 16.4 | 27% | 26% | 1.0 | 1.5 | .5 | 1.0 |
| RU 5 | 77 | 114 | 38% | 51% | 19% | 20% | 15% | 13% | 19% | 16% | 8.6 | 12.7 | 13% | 16% | .6 | .9 | .4 | .6 |
| All | 91 | 127 | 46% | 58% | 20% | 18% | 20% | 17% | 17% | 16% | 11.9 | 17.0 | 23% | 22% | 1.1 | 1.6 | .5 | .9 |

| RU | Basal Area | | % Max SDI | | Avg. Percent of Total SDI by Size Class | | | | | | Avg. TPA 18"+ | | Avg. Gambel Oak BA Percent of Total BA | | Tons CWD >12" | | Snags >18" | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 12.0 – 17.9" | | 18.0 – 23.9" | | 24.0" + | | | | | | | | | |
| | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 | 20 | 50 |
| **Protected** | | | | | | | | | | | | | | | | | | |
| RU 1 | 158 | 177 | 74% | 76% | 32% | 28% | 17% | 24% | 9% | 12% | 17.7 | 27.8 | 13% | 13% | 1.0 | 2.2 | .7 | 1.7 |
| RU 3 | 172 | 191 | 81% | 83% | 31% | 26% | 18% | 24% | 9% | 13% | 20.9 | 30.8 | 12% | 11% | 1.5 | 2.8 | .8 | 1.9 |
| RU 4 | 109 | 131 | 51% | 56% | 35% | 38% | 14% | 23% | 5% | 8% | 10.8 | 19.8 | 7% | 8% | .7 | 1.6 | .4 | 1.3 |
| RU 5 | 147 | 170 | 71% | 75% | 31% | 26% | 17% | 22% | 9% | 13% | 16.9 | 26.3 | 11% | 11% | 1.5 | 2.7 | .7 | 1.7 |
| All | 159 | 178 | 74% | 77% | 32% | 28% | 17% | 24% | 9% | 12% | 18.0 | 28.0 | 13% | 13% | 1.1 | 2.3 | .7 | 1.7 |

**Protected Habitat**

Mechanical treatments in PACs would be the same as that described in alternative B, with trees ranging from less than 9 inches dbh up to 16 inches dbh proposed for removal. Similar to alternative B, optimal treatments were defined as those that met the BA target and produced the best growth rates; stands with incomplete data were not proposed for thinning above the 9 inch dbh category (Table 89). All stands identified for mechanical harvest would be marked by hand and marking would be coordinated with the FWS. Treatments would 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, and T6 Tank) would require thinning up to 12 inch dbh 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 inch dhb on 4,151 acres, and
- Fifteen PACs (Bar M, Bear Seep, 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 16 inch dbh on 1,867 acres

**Table 89. General Description and Acres of Mechanical Treatment in Alternative D by PAC (all mechanically treated PACs occur on the Coconino NF)**

| PAC Name | General Description | MSO PAC Mechanical Treatment (dbh and acre) | | | |
|---|---|---|---|---|---|
| | | Treat up to 9” dbh (Acres) | Treat up to 12” dbh (Acres) | Treat up to 14” dbh (Acres) | Treat up to 16” dbh (Acres) |
| Lake No. 1/Seruchos | Dense thickets of VSS3 pine, oak is competing with pine for nutrition, sunlight and moisture, need to grow larger trees over time, enhance oaks, create small openings | 123 | 66 | 50 | 0 |
| Archies | Pine-oak with strong oak component but few large oak – many pines < 9” dbh | 444 | 41 | 11 | 0 |
| Red Hill | Scrappy habitat that has been treated with an overstory removal in the past, dense pockets of ponderosa pine with heavy mistletoe infection in areas, thin pine to grow larger trees and reduce fire threat, enhance oak where present, grow larger trees over time and reduce competition | 197 | 190 | 385 | 0 |

| PAC Name | General Description | MSO PAC Mechanical Treatment (dbh and acre) | | | |
|---|---|---|---|---|---|
| | | Treat up to 9" dbh (Acres) | Treat up to 12" dbh (Acres) | Treat up to 14" dbh (Acres) | Treat up to 16" dbh (Acres) |
| Crawdad | Oak is supressed by high densities of pine, need for creating gaps around oak and releasing individual oak trees | 138 | 0 | 342 | 120 |
| Holdup | Most of PAC is pure pine, thin around any existing oak and provide areas for oak to establish | 57 | 197 | 264 | 18 |
| 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 |
| Red Raspberry | Diverse topography, protect microclimates from undesireable fire effects, high percentage of VSS 3 and VSS 4, need for enhancing openings, create, retain, and enhance larger trees | 387 | 19 | 203 | 55 |
| Bear Seep | PAC is pure ponderosa or oak, high density of trees > 9 inch dbh | 453 | 0 | 0 | 144 |
| Mayflower Tank | PAC has steep slopes, heavy fuels, limited number of small trees | 257 | 0 | 139 | 217 |
| Knob | PAC has limited habitat, generally pure pine and open with some dense dog-hair thickets | 273 | 26 | 252 | 114 |
| 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 |
| Iris Tank | PAC has dense pine with pockets of doghair thickets; 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 |

| PAC Name | General Description | MSO PAC Mechanical Treatment (dbh and acre) | | | |
|---|---|---|---|---|---|
| | | Treat up to 9" dbh (Acres) | Treat up to 12" dbh (Acres) | Treat up to 14" dbh (Acres) | Treat up to 16" dbh (Acres) |
| Frank | PAC has areas of pure pine with dense pockets of VSS3 and VSS4, need to release any oaks present and encourage recruitment of oaks, reduce pine densities and increase diameters of both pine and oak | 286 | 69 | 178 | 52 |
| Rock Top | Treat in pure pine to increase the amount of oak and grow larger trees | 118 | 57 | 506 | 90 |
| Lee Butte | Treat in dense pine to increase the amount of oak, reduce tree density, and increase tree diameter on slopes to improve habitat and protect nest core | 121 | 1 | 328 | 314 |
| Foxhole | Dense thickets of pine with some oak, need for enhancing oak and thinning groups | 41 | 124 | 136 | 178 |
| Bar M | PAC is part of the mega-cluster of PACs within the Bar-M area, break up contiguous fuels in areas of pure pine, thin out dense clumps of pine and release oaks within clumps, release oaks, provide openings for forage and grow larger trees | 119 | 149 | 199 | 66 |
| Sawmill Springs | All size classes of pine and oak present, neeed for large dbh size classes to enhance and maintain habitat structure | 192 | 63 | 190 | 71 |
| Total Mechanical Treatment Acres | | 3,388 | 1,335 | 4,151 | 1,867 |

Mechanically treatments would take place within 18 of the 110 PACs occurring within a ¼ mile of the project area boundary (16 percent) under alternative D. This includes 10,741 acres out of 35,566 total PAC acres in the treatment area (31 percent). No PACs or portions thereof are proposed for prescribed burning under alternative D. Although the implementation schedule is not yet known, an average of 1.8 PACs would be treated per year if 4FRI implementation lasted 10 years. On average, this equals less than one percent of the PACs across the two forests getting treated in a given year. Changes in forest structure by individual PAC are shown in Appendix 16.

Neither the Kendrick PAC (Kaibab NF) nor the Stock Tank PAC are proposed for treatment in alternative D.

### *Forest Structure and Density in MSO Habitat*

Mechanical treatments in MSO habitat would be identical as those in alternative B. Modeling for both alternatives used a 16 inch dbh limit and the same targeted range for BA in mechanically treated PACs. Therefore, treatment results are similar to those described in alternative B. Differences in results are highlighted in this section rather than repeating the all the detailed discussion that is presented in alternative B. Values for individual habitat components specific to alternative D are presented in Table 90and Table 91 below.

**Large Trees**

Overall results for percent of tree size classes, including TPA 18 inches dbh and larger, would be the same for as those discussed in alternative B (Table 90). Mechanical treatments are, by design, conservative in protected habitat and prescribed burning in other alternatives would be conducted to minimize loss of habitat components. Treatment results would still benefit individual large trees by increasing growth rates and potentially increasing resiliency of individual large trees to stochastic events. This would improve MSO habitat by maintaining and developing roost and nest structure in pine and Gambel oak trees and mast production in oak trees. However, only 18 of 72 PACs would realize any habitat improvements. The remaining 54 PACs would be no different from the no-action alternative.

**Basal Area**

Pine BA in alternative D would be slightly higher in all PACs, relative to the other action alternatives, and be about the same as the no action alternative. Prescribed burning in the other action alternatives would eliminate a proportion of the small trees after thinning. Omitting this source of mortality would lead to higher levels of BA in 2050 (Table 90). Gambel oak BA would be about the same at the PAC and RU levels as alternative B. No treatment would occur in 54 PACs so BA would be the same as the no action alternative. The relatively high, post-treatment BA in alternative D would make PAC habitat the most at risk of all alternatives due to the least amount of reduction in small trees/ladder fuels. While individual large trees would benefit from this alternative, overall stand conditions for most PACs would be little different from the no-action alternative.

**Canopy Structure**

Canopy cover would be highest in alternative D due to the lack of burning in PACs. Based on BA and percent maximum SDI, canopy cover would remain dense. Percent Maximum SDI would decrease relative to no action alternative, but at 74 would remain at about the middle of the Extremely High Density Range (Table 104). Canopy cover would be at least 50 percent or greater, based on BA, TPA, and tree dbh (see silviculture report for details). Therefore, canopy cover within tree groups 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 crown 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. These factors combined would maintain the elements of canopy structure such as tree cover and density, flight space, and overstory species diversity.

**Table 90. Modeled Changes in Forest Structure Attributes Within MSO PACs Under Alternative. D**

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative D[2] (Year 2050) |
|---|---|---|---|
| **PACs With Thinning Outside Core Areas (*n* = 18)** | | | |
| 12 – 17.9” dbh (%) | 30 | 28 | 28 |
| 18 – 23.9” dbh (%) | 14 | 23 | 28 |
| ≥ 24” dbh (%) | 8 | 12 | 14 |
| TPA ≥ 18” dbh | 15 | 27 | 29 |
| Ponderosa Pine BA | 120 | 135 | 126 |
| Gambel Oak BA | 16 | 18 | 20 |
| All BA | 148 | 173 | 163 |
| **PACs With Prescribed Burning Outside Core Areas (n = 54)** | | | |
| 12 – 17.9” dbh (%) | 31 | 28 | 28 |
| 18 – 23.9” dbh (%) | 13 | 22 | 22 |
| ≥ 24” dbh (%) | 8 | 11 | 11 |
| TPA ≥ 18” dbh | 15 | 28 | 28 |
| Ponderosa Pine BA | 117 | 125 | 125 |
| Gambel Oak BA | 20 | 22 | 22 |
| All BA | 158 | 185 | 185 |

[1] = No Action Alternative
[2] = No Burning Within PAC Habitat

### *MSO Prey Habitat*

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

Differences in prey habitat would be expected in alternative D compared to the other action alternatives. By not using prescribed fire in PAC habitat, snags, logs and CWD would be the same (snags greater than 18 inches dbh) or higher in this alternative than in any of the other action alternatives (Table 91). Without burning, 56 PACs would not receive any treatment, so logs and CWD would be the same as the no action alternative. The changes in attributes varied slightly by individual PAC (Appendix 16). The abundance in surface fuels could benefit prey habitat structure. However, the fire risk 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 of any action alternative post-treatment (Table 91). In addition, no nutrient pulses would occur and there would be no reduction in pine litter, limiting understory response beyond the modeled response (Appendix 8). 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 16.

**Table 91. Modeled Changes in Prey Habitat Attributes Within MSO PACs in Alternative D**

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative D[2] (Year 2050 |
|---|---|---|---|
| **PACs With Thinning Outside Core Areas (n = 18)** | | | |
| Snags/ Ac ≥ 18” dbh | 0.6 | 1.5 | 1.5 |
| Logs/ Ac | 1.3 | 5.7 | 5.2 |
| CWD (tons/ac) | 4.7 | 10.3 | 9.3 |
| Understory Index[3] | 47 | 40 | 49 |
| **PACs Prescribed Burning (n = 54)** | | | |
| Snags/ Ac ≥ 18” dbh | 0.7 | 1.8 | 1.8 |
| Logs/ Ac | 2.8 | 7.9 | 7.9 |
| CWD (tons/ac) | 6.0 | 12.5 | 12.5 |
| Understory Index[3] | 48 | 41 | 41 |

[1] = No Action Alternative

[2] = No Burning Within PAC Habitat

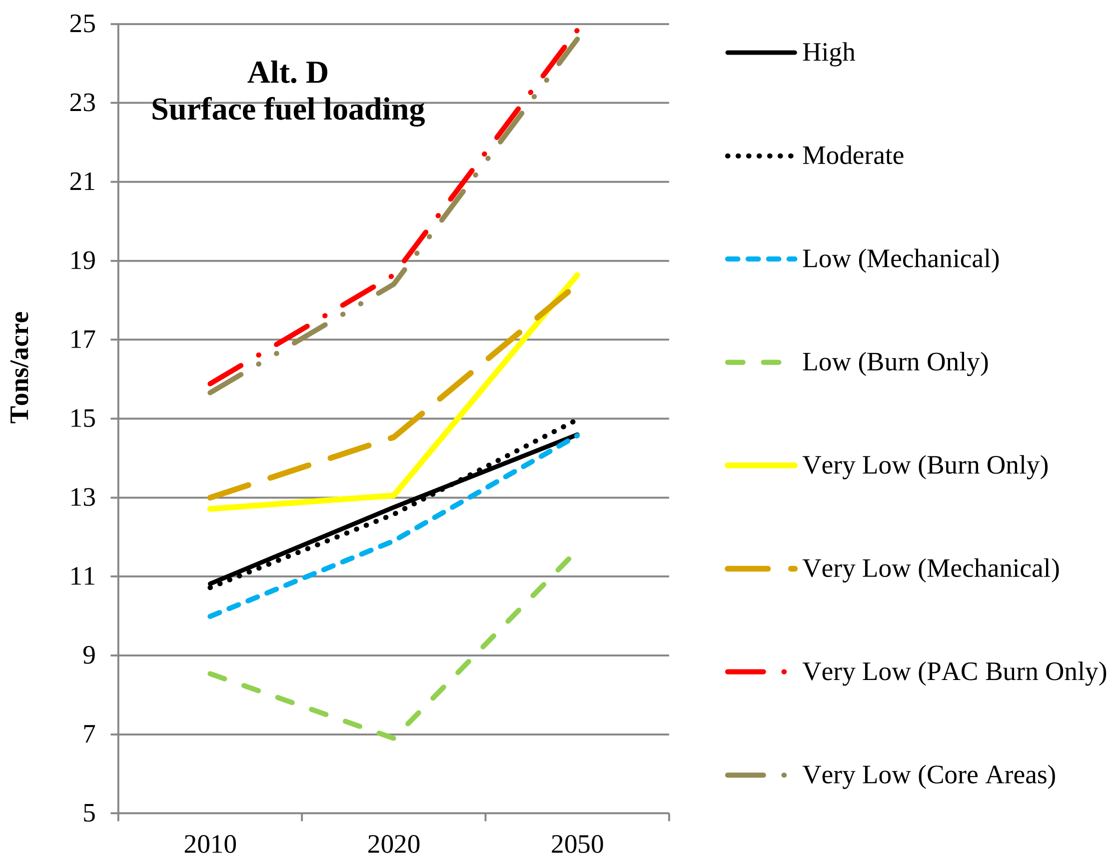
### *Fire Effects*

Alternative D is the only action alternative to have a modeled decrease in FRCC 1 across the ponderosa pine landscape by the year 2020 (Table 92). Most (82 percent) of the ponderosa pine forest would occur as FRCC 2 in 2020. By 2050, most of the total acres would be expected to move into FRCC 3. Alternative D would do little to decrease the risk of high-severity crown fire moving into protected habitat in the long-term and only makes a limited contribution towards increasing the opportunity for managing future unplanned ignitions. The risk to nesting and roosting habitat would remain high given the limited changes in fire behavior within protected habitat and outside MSO habitat.

**Table 92. Fire Regime Condition Class (FRCC) Ratings in Ponderosa Pine Forest Through Time Under Alternative D**

| Conditions | Year | Measure | FRCC1 | FRCC2 | FRCC3 |
|---|---|---|---|---|---|
| Existing | 2010 | Acres | 70,680 | 136,311 | 297,866 |
| | | % | 14 | 27 | 59 |
| Alt. D | 2020 | Acres | 40,389 | 413,983 | 50,486 |
| | | % | 8 | 82 | 10 |
| | 2050 | Acres | 25,243 | 227,186 | 252,428 |
| | | % | 5 | 45 | 50 |

Figure X shows changes in surface fuels by desired canopy openness for alternative B. The figure represents the relative degree of canopy openness predicted after treatments are completed, e.g., "High" indicates more open conditions with a mosaic of tree groups and open interspace. Very low indicates relatively connected canopy with very few discernible interspace. No prescribed fire would occur in PAC habitat under Alternative D and the high surface fuel levels reflect the



**FigureX. Modeled changes in surface fuel loading (litter, duff, CWD combined) by desired openness for Alternative D**

predicted increase (Figure X). Assumptions are that one mechanical treatment and two prescribed fire treatments would occur between 2010 and 2020, and that there were no additional mechanical treatments, wildfires, or prescribed fires between 2020 and 2050. Surface fuels in PAC habitat would be greatest under alternative D than in any other action alternative. While this represents prey habitat (i.e., CWD), these levels would not represent enhanced prey habitat because of the increased probability of surface fire becoming crown fire under uncharacteristic fuel loading (see fire ecology report) and the inhibiting effect of accumulated litter and CWD on understory vegetation. In general, surface fuel loading decreases or would have very slight increase with prescribed fire. Twenty tons per acre represents the upper end of the recommended range for fuel loading southwest ponderosa pine habitat (see fire ecology report), All areas with prescribed fire would remain below 20 tons per acre in alternative D. PAC habitats would greatly exceed this upper limit. See appendix 19 for maps comparing surface fuels across the 4FRI treatment area.

Changes in predicted surface and crown fire would be minimal between alternative D in 2020 and existing conditions. This is a result of light mechanical treatments in 18 PACs and no prescribed fire in PAC habitat. Burn-only prescriptions in protected habitat outside of PACs (889 acres) would be designed to support MSO habitat objectives. These treatments would reduce surface fuels, primarily litter, and raise crown base height across minimal acreage. Predicted surface fire would increase in protected habitat by seven percent and the probability of active crown fire would decrease by seven percent, amounting to change in about 2,800 acres (Table 93). All crown fires are projected to burn as high-severity and would account for 42 percent of protected habitat under alternative D, the most 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 93) but would also leave PACs, including core areas, vulnerable to the threat of future high-severity crown fire. Appendix 16 displays MSO habitat and fire behavior for each alternative.

**Table 93. Predicted Fire Behavior in Protected Habitat Under Current Conditions and After Implementation of Alternative D in 2020**

| MSO Habitat | Total (Ac) | Surface Fire (Ac) | Passive Crown Fire (Ac) | Active Crown Fire (Ac) | Surface Fire (%) | Passive Crown Fire (%) | Active Crown Fire (%) |
|---|---|---|---|---|---|---|---|
| **Existing Condition** | | | | | | | |
| **Ponderosa Pine** | 507,059 | 313,423 | 48,523 | 145,113 | 62 | 10 | 29 |
| **Protected** | 36,598 | 18,610 | 3,141 | 14,847 | 51 | 9 | 41 |
| **Alternative D** | | | | | | | |
| **Ponderosa Pine** | 507,059 | 481,209 | 16,133 | 9,717 | 94 | 3 | 2 |
| **Protected** | 36,596 | 18,610 | 3,141 | 14,847 | 58 | 9 | 32 |

**Restricted Habitat**

Mechanical treatments would occur on about 84,178 acres of restricted habitat, or 97 percent of total restricted acres in the treatment area (Table 87). This includes about 97 percent of the total target and threshold acres. Although the implementation schedule is not yet known, on average 8,418 acres would be mechanically treated per year if 4FRI implementation lasted 10 years. On average, this equals about 10 percent of the restricted habitat getting treated each year. About 3,543 acres of restricted habitat (about 3.5%) would be prescribed burn only treatments.

### *Forest Structure and Density in MSO Habitat*

Treatments in restricted habitat would follow forest plan guidelines and be expected to maintain existing nesting and roosting habitat (threshold habitat) and create replacement nesting and roosting habitat (target habitat). Thinning objectives in target and threshold habitat would maintain an overall BA of 150 $ft^2$ per acre or greater, as described in the forest and Recovery Plans. In addition, treatments in restricted habitat would also provide a diversity of stand conditions and stand sizes across the landscape. Treatments were designed to develop uneven-aged forest structure, irregular tree spacing, variety of tree group sizes, and reestablish interspace adjacent to tree groups. Large pine trees and Gambel oak would be released from competition with unnaturally dense groups of young pine trees. Results for many forest structure metrics are very similar to alternative B.

**Large Trees**

Mechanical treatments would, by design, be conservative in target and threshold habitat and would focus on increasing both the percent area of larger tree size-classes and increasing tree growth rates, as recommended in the Recovery Plan. Treatments would be of lower intensity in these habitat classifications compared to restricted "other" habitat. Trees less than 18 inches dbh are over-abundant relative to desired conditions described in the forest plans and the Recovery Plan. Therefore, treatments would focus on trees less than 18 inches dbh to address management priorities including increasing tree growth rates to move more trees into larger size-classes and retaining existing large trees.

As a result of threshold treatments planned under alternative D, trees 12 to 17.9 inches dbh would decrease by about three percent while trees 18 to 23.9 inches dbh and trees greater than 24 inches dbh would increase by five to two percent, respectively (Table 94). All subunits would maintain greater than 15 percent cover of trees 12 to 17.9 inches dbh and trees 18 to 23.9 inches dbh after treatment except for subunit 3-2. This one subunit would decline to 12 percent by the year 2050. Simultaneously, trees 24 inches dbh and greater would increase by 2 percent in both RUs compared to the no action alternative by 2050. Treatments in 4FRI assume one mechanical entry and two entries with prescribed fire. Subunit 3-2 may require additional work to achieve densities of 15 percent or greater in each of the three dbh size-classes. Overall, each subunit displayed consistent increases in large trees by 2050 under alternative D relative to the no action alternative (Appendix 17). TPA greater than 18 inches dbh would increase with most subunits increasing while some remained stable or decreased by a percent or two (Appendix 17). Average TPA 18 inches dbh and greater remained above forest plan direction with over 30 trees per acre. The intensity of the treatments are such that threshold habitat would remain in density zone 4, at risk from competition-induced mortality and lacking resiliency to large scale stochastic events. Nevertheless, treatments would maintain or improve MSO nesting and roosting habitat in terms of large tree growth rates and increasing the percentage of large trees across threshold habitat.

Changes in the distribution of large trees in target habitat were similar to those described for threshold habitat (Table 95). Trees 12 to 17.9 inches dbh were selected for cutting due to their abundance and treatments were designed to improve the ratios of large trees. Similar to threshold habitat, one subunit (subunit 1-4) decreased below 15 percent cover by 2050. Trees 18 to 23.9 inches dbh and trees greater than 24 inches dbh would increase across target habitat. TPA greater than 18 inches dbh would also consistently increase.

Trees 12 to 17.9 inches dbh would decrease in restricted “other” habitat, largely as a result of creating gaps, irregular spacing and diversifying the age-class distribution (Table 96and Appendix 17). Decreases (8 to 12 percent) would occur in density of trees less than 18 inches dbh, compared to the no action alternative, indicating the selection of mid-sized trees in the treatment design. Trees 18 to 23.9 inches dbh would commonly decrease by 2 or 4 percent and trees greater than 24 inches dbh would increase 5 to 7 percent by 2050. Trees greater than or equal to 18 inches dbh, a simple stem count versus a density measurement, would range from 13 to 17 TPA. Removing mid-sized trees would reduce their numbers while decreasing the time required for trees to reach larger size-classes, i.e., trees would grow into the largest size-classes more quickly because of improved growth rates. This, in turn, would reduce the total number of trees less than 24 inches dbh. This reflects the inherent trade-off in meeting Recovery Plan objectives to increase the number and growth rates of large trees on the existing landscape. However, restricted “other” habitat is not expected to provide nesting and roosting habitat (the role of target and threshold habitat) and would allow the creation and maintenance of canopy gaps, uneven-spacing, and uneven-aged forest. Increasing forest heterogeneity while increasing the large tree component would improve MSO habitat by maintaining current and future nesting and roosting structure in some areas while also increasing prey habitat and potential MSO foraging opportunities in other areas. These changes would reduce competition-induced mortality and increase resiliency to large scale stochastic events, including fire risk (see below). The emphasis on increasing tree growth rates and retaining large trees comes from the Recovery Plan that 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."

**Basal Area**

Pine BA would decrease in all restricted habitats (Table 94,Table 95, and Table 96). This represents a key contribution towards reducing fire threat in designated MSO habitat. Gambel oak BA would increase 1 to 3 percent in target and threshold habitats, compared to the no action alternative, and would generally decrease by 1 to 2 percent in restricted "other" habitat. No oak would be targeted for removal; the decrease in restricted "other" habitat would result from increased operations and relatively few acres would burn. Treatments would move forest conditions towards uneven spacing with canopy gaps as described in the Recovery Plan. Total BA would remain at or above 200 $ft^2$ per acre in threshold habitat and above 170 $ft^2$ per acre in target habitat. Total BA would range from 114 to 130 $ft^2$ per acre in restricted "other" habitat. 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**

Stand density index (SDI) is an important measure of forest density and can inform canopy structure. Percent Maximum SDI would be about 76 after t treatment, or about the middle of the "extremely high density" range for target and threshold habitats (see Table 104) Restricted "other" habitat would decrease to 46, about the middle range of the "high density" category. Both values would result in forest conditions with closed canopies. Canopy cover would be 50 percent or greater at the tree group level, based on BA, TPA, and tree dbh (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 this improvement to foraging habitat present in the other action alternatives.

**Table 94. Modeled Changes in Forest Structure Attributes Within MSO Threshold Habitat Under Alternative D**

| Forest Attribute | Existing Conditions (Yr 2010) | Alternative A (Yr 2050) | Alternative D (Yr 2050) |
|---|---|---|---|
| **Restoration Unit 1** | | | |
| 12 – 17.9" dbh (%) | 25 | 26 | 23 |
| 18 – 23.9" dbh (%) | 24 | 28 | 33 |
| ≥ 24" dbh (%) | 3 | 6 | 8 |
| Avg TPA ≥ 18" dbh | 28 | 35 | 39 |

| Forest Attribute | Existing Conditions (Yr 2010) | Alternative A (Yr 2050) | Alternative D (Yr 2050) |
|---|---|---|---|
| Ponderosa Pine BA | 131 | 142 | 113 |
| Gambel Oak BA | 58 | 56 | 59 |
| All BA | 204 | 226 | 203 |
| **Restoration Unit 3** | | | |
| 12 – 17.9” dbh (%) | 26 | 19 | 16 |
| 18 – 23.9” dbh (%) | 19 | 26 | 27 |
| ≥ 24” dbh (%) | 8 | 11 | 13 |
| Avg TPA ≥ 18” dbh | 24 | 36 | 36 |
| Ponderosa Pine BA | 107 | 113 | 96 |
| Gambel Oak BA | 57 | 61 | 63 |
| All BA | 185 | 209 | 200 |

**Table 95. Modeled Changes in Forest Structure Attributes Within MSO Target Habitat Under Alternative D**

| Forest Attribute | Existing Conditions (Yr 2010) | Alternative A (Yr 2050) | Alternative D (Yr 2050) |
|---|---|---|---|
| **Restoration Unit 1** | | | |
| 12 – 17.9” dbh (%) | 30 | 28 | 25 |
| 18 – 23.9” dbh (%) | 12 | 19 | 23 |
| ≥ 24” dbh (%) | 7 | 10 | 11 |
| Avg TPA ≥ 18” dbh | 14 | 24 | 26 |

| Forest Attribute | Existing Conditions (Yr 2010) | Alternative A (Yr 2050) | Alternative D (Yr 2050) |
|---|---|---|---|
| Ponderosa Pine BA | 115 | 126 | 108 |
| Gambel Oak BA | 27 | 31 | 33 |
| All BA | 156 | 184 | 171 |
| **Restoration Unit 3** | | | |
| 12 – 17.9” dbh (%) | 26 | 25 | 23 |
| 18 – 23.9” dbh (%) | 13 | 17 | 19 |
| ≥ 24” dbh (%) | 7 | 11 | 12 |
| Avg TPA ≥ 18” dbh | 13 | 22 | 23 |
| Ponderosa Pine BA | 100 | 112 | 100 |
| Gambel Oak BA | 31 | 35 | 36 |
| All BA | 148 | 181 | 174 |

**Table 96. Modeled Changes in Forest Structure Attributes Within MSO Restricted “Other” Habitat Under Alternative D**

| Forest Attribute | Existing Conditions (Yr 2010) | Alternative A (Yr 2050) | Alternative D (Yr 2050) |
|---|---|---|---|
| **Restoration Unit 1** | | | |
| 12 – 17.9” dbh (%) | 30 | 30 | 18 |
| 18 – 23.9” dbh (%) | 12 | 20 | 16 |
| ≥ 24” dbh (%) | 7 | 10 | 17 |
| TPA ≥ 18” dbh | 11 | 23 | 17 |
| Ponderosa Pine BA | 108 | 127 | 76 |

| Forest Attribute | Existing Conditions (Yr 2010) | Alternative A (Yr 2050) | Alternative D (Yr 2050) |
|---|---|---|---|
| Gambel Oak BA | 17 | 22 | 23 |
| All BA | 138 | 170 | 123 |
| **Restoration Unit 3** | | | |
| 12 – 17.9” dbh (%) | 29 | 26 | 18 |
| 18 – 23.9” dbh (%) | 13 | 21 | 17 |
| ≥ 24” dbh (%) | 7 | 10 | 16 |
| TPA ≥ 18” dbh | 12 | 23 | 17 |
| Ponderosa Pine BA | 95 | 112 | 71 |
| Gambel Oak BA | 26 | 32 | 30 |
| All BA | 137 | 169 | 130 |
| **Restoration Unit 4** | | | |
| 12 – 17.9” dbh (%) | 28 | 24 | 16 |
| 18 – 23.9” dbh (%) | 13 | 20 | 16 |
| ≥ 24” dbh (%) | 8 | 11 | 17 |
| TPA ≥ 18” dbh | 12 | 22 | 16 |
| Ponderosa Pine BA | 84 | 100 | 66 |
| Gambel Oak BA | 27 | 35 | 33 |
| All BA | 129 | 165 | 130 |
| **Restoration Unit 5** | | | |
| 12 – 17.9” dbh (%) | 24 | 28 | 20 |
| 18 – 23.9” dbh (%) | 10 | 15 | 13 |

| Forest Attribute | Existing Conditions (Yr 2010) | Alternative A (Yr 2050) | Alternative D (Yr 2050) |
|---|---|---|---|
| ≥ 24” dbh (%) | 10 | 11 | 16 |
| TPA ≥ 18” dbh | 8 | 16 | 13 |
| Ponderosa Pine BA | 77 | 101 | 69 |
| Gambel Oak BA | 9 | 17 | 16 |
| All BA | 102 | 146 | 114 |

### *MSO Prey Habitat*

**Snags, Logs and Coarse Woody Debris**

Snags greater than 18 inches dbh in threshold and target habitats would be maintained at about the levels in the no action alternative (Table 97 and Table 98). Snags greater than 18 inches dbh would decrease slightly compared to the no action alternative, but nearly double relative to today’s values in restricted “other” habitat (Table 99). Large snags are currently well below forest plan guidelines and would remain low. Average snags per acre 18 inches dbh and greater would be about the same as in alternative B.

Logs per acre would be about double forest plan direction in threshold and target habitats (Table 97 and Table 98). The average value for logs would be lower in restricted “other” habitat, but still exceed forest plan guidance in all RUs except for RU 5 (Table 99). RU 5 currently has about ½ or less of the existing density of logs as other RUs within restricted “other” habitat. CWD would exceed forest plan direction in most RUs across all restricted habitats.

Alternative D would have the highest values for snags, logs, and CWD of the action alternatives as a result of the reduced number of acres of prescribed fire. However, snags would be below forest plan values in most RUs.

**Understory Index**

The increase in understory response in threshold and target habitats would be limited, but still exceed the no action alternative (Table 97 and Table 98). Increases in understory response in restricted “other” habitat would range from 81 to 105 pounds per acre above the no action response (Table 99). Alternative D consistently had the smallest understory response.

The biomass index only accounts for soil and overstory BA. Implementation of alternative D would decrease competition for water, nutrients, and light, but the lack of fire would not reduce litter depth and would not result in a nutrient pulse, both of which affect understory production (Appendix 8). 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 and therefore this alternative would provide the least amount of herbaceous food and cover for MSO prey species.

**Table 97. Modeled Changes in Prey Habitat Attributes Within MSO Threshold Habitat Under Alternative D**

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative D[2] (Year 2050) |
|---|---|---|---|
| **Restoration Unit 1** | | | |
| Snags/ Ac ≥ 18" dbh | 0.5 | 1.2 | 1.1 |
| Logs/ Ac | 6.1 | 9.0 | 8.3 |
| CWD (tons/ac) | 7.1 | 12.9 | 11.8 |
| Understory Index[3] | 14 | 13 | 23 |
| **Restoration Unit 3** | | | |
| Snags/ Ac ≥ 18" dbh | 0.7 | 2.1 | 2.2 |
| Logs/ Ac | 1.8 | 7.9 | 7.2 |
| CWD (tons/ac) | 4.4 | 11.7 | 10.5 |
| Understory Index[3] | 20 | 18 | 25 |

[1] = No Action Alternative

[2] = No Treatments Within Core Areas

[3]= Lbs of biomass/ac in Years 2010 (Existing) and 2020 (Alts A & D)

**Table 98. Modeled Changes in Prey Habitat Attributes Within MSO Target Habitat Under Alternative D**

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative D[2] (Year 2050) |
|---|---|---|---|
| **Restoration Unit 1** | | | |
| Snags/ Ac ≥ 18" dbh | 0.5 | 1.4 | 1.5 |
| Logs/ Ac | 4.6 | 8.1 | 7.7 |
| CWD (tons/ac) | 6.0 | 11.8 | 10.8 |
| Understory Index[3] | 37 | 31 | 46 |
| **Restoration Unit 3** | | | |

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative D[2] (Year 2050) |
|---|---|---|---|
| Snags/ Ac ≥ 18” dbh | 0.5 | 1.4 | 1.4 |
| Logs/ Ac | 2.5 | 6.1 | 5.8 |
| CWD (tons/ac) | 4.8 | 10.5 | 9.5 |
| Understory Index[3] | 53 | 45 | 57 |

**Table 99. Modeled Changes in Prey Habitat Attributes Within MSO Restricted “Other” Habitat Under Alternative D**

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative D[2] (Year 2050) |
|---|---|---|---|
| **Restoration Unit 1** | | | |
| Snags/ Ac ≥ 18” dbh | 0.4 | 1.1 | 0.8 |
| Logs/ Ac | 1.2 | 4.3 | 4.4 |
| CWD (tons/ac) | 4.3 | 8.9 | 8.1 |
| Understory Index[3] | 61 | 50 | 155 |
| **Restoration Unit 3** | | | |
| Snags/ Ac ≥ 18” dbh | 0.4 | 1.2 | 0.9 |
| Logs/ Ac | 1.5 | 4.7 | 4.9 |
| CWD (tons/ac) | 3.9 | 8.7 | 8.0 |
| Understory Index[3] | 63 | 52 | 149 |
| **Restoration Unit 4** | | | |
| Snags/ Ac ≥ 18” dbh | 0.5 | 1.3 | 1.0 |
| Logs/ Ac | 1.1 | 4.3 | 4.4 |
| CWD (tons/ac) | 3.2 | 7.8 | 7.1 |

| Forest Attribute | Existing Condition (Year 2010) | Alternative A[1] (Year 2050) | Alternative D[2] (Year 2050) |
|---|---|---|---|
| Understory Index[3] | 61 | 49 | 130 |
| **Restoration Unit 5** | | | |
| Snags/ Ac ≥ 18" dbh | 0.4 | 0.7 | 0.6 |
| Logs/ Ac | 0.6 | 2.5 | 2.7 |
| CWD (tons/ac) | 3.1 | 6.0 | 5.6 |
| Understory Index[3] | 99 | 77 | 162 |

[1] = No Action Alternative
[2] = No Treatments Within Core Areas
[3]= Lbs of biomass/ac in Years 2010 (Existing) and 2020 (Alts A & D)

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 nesting and roosting habitat, and growth rates are much slower than in young or mid-aged trees. As a result, some habitat components decrease while others increase. Changes are subtle in target and threshold habitat but move towards future nesting and roosting conditions in less time than if no action were taken. 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.

Providing a continuous supply of nesting and roosting habitat requires maintaining different forest successional stages. Much of the restricted "other" habitat is not suitable for sustaining nesting and roosting conditions and therefore treatment objectives are designed to mimic the natural landscape, resulting in more pronounced changes in some habitat components. This follows Recovery Plan direction to sustain owl nesting habitat in such a way as to maintain and create replacement owl habitat where appropriate while providing a diversity of stand conditions and stand sizes across the landscape. Alternative D would have the highest percent of maximum SDI in restricted habitats of any action alternative, although all alternatives would result in extremely high density zone 4 for target and threshold habitats. Alternative D would also have the highest percent SDI for restricted "other" habitat, resulting in a mid-value within the high density zone 3 category. Alternatives B and C would result in values at the low end of the "high density" zone. The combination of owl habitats should result in a landscape mosaic that ensures adequate nesting, roosting, and foraging habitat for the owl and habitat for the variety of MSO prey species. However, stand health and resiliency may be lower in alternative D, based on the percent of maximum SDI, and foraging habitat may have the least amount of prey habitat.

### *Fire Risk*

Prescribed burning would occur across 2,354 acres of restricted habitat, including 301 acres of burn-only prescriptions in target and threshold habitat (Table 87 above). 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 100). 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 burning 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. In addition to decrease in risk associated with MSO treatments, treated areas 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. Appendix 16 displays MSO habitat and fire behavior for each alternative.

**Table 100. Predicted Fire Behavior in Restricted Habitat Under Current Conditions and After Implementation of Alternative D in 2020**

| MSO Habitat | Total (Ac) | Surface Fire (Ac) | Passive Crown Fire (Ac) | Active Crown Fire (Ac) | Conditional Crown Fire (Ac) | Surface Fire (%) | Passive Crown Fire (%) | Active Crown Fire (%) | Conditional Crown Fire (%) |
|---|---|---|---|---|---|---|---|---|---|
| **Existing Condition** | | | | | | | | | |
| Ponderosa Pine | 512,481 | 313,423 | 48,523 | 113,203 | 31,910 | 61 | 9 | 22 | 6 |
| Target/Threshold | 8,713 | 4,292 | 926 | 2,854 | 625 | 49 | 11 | 33 | 7 |
| Restricted | 67,378 | 35,465 | 6,608 | 20,764 | 4,423 | 53 | 10 | 31 | 7 |
| **Alternative D** | | | | | | | | | |
| Ponderosa Pine | 512,481 | 472,220 | 17,874 | 10,841 | 6,124 | 92 | 3 | 2 | 1 |
| Target/Threshold | 8,713 | 7,734 | 419 | 321 | 223 | 89 | 5 | 4 | 3 |
| Restricted | 67,378 | 63,075 | 3,778 | 283 | 124 | 94 | 6 | 0 | 0 |

### *Other Habitat Effects*

#### Meadows and Aspen

There would be no meadow and no aspen treatments in PAC habitat in Alternative D. While total acres of meadow and aspen treatments are limited in all action alternatives, none of these key prey habitats would be improved within this concentrated area of hunting for nesting MSOs.

About 3,735 acres of grassland and meadow burn treatments would occur in restricted habitat, with no mechanical removal of encroaching post-settlement trees (the same as alternative B).

Alternative D would include approximately 740 acres of mechanical removal of encroaching post-settlement pine trees in aspen habitat with no subsequent burning and about 17 acres of prescribed burn-only treatments. Removal of pine in aspen habitat would be expected to improve the health of aspen clones, providing habitat diversity that would benefit prey species within MSO habitat. Understory vegetation would also respond positively due to increased light, moisture, and nutrients. The response would not be maximized because there would be no changes to the litter layer and no nutrient pulse into the soil. Prescribed burning alone would also provide benefits to MSO because of the patchy nature of burning in aspen and the changes in overstory shading. Compared to mechanical removal of pine, the change in competition from pine would be expected to be limited. However, aspen treatments would be expected to improve understory conditions for MSO prey species.

About 5,989 acres of grassland and meadow treatments would occur in restricted habitat, including about 3,735 acres of operational burn-only grassland/meadow treatments. Tree encroachment would not be fully addressed in burn-only grassland treatments, leaving potential seed sources to continue the long-term degradation of grassland habitat. Nevertheless, an unknown percentage of meadow and grassland habitats would be expected to be improved by burn-only treatments. An improved understory response would be expected in in MSO prey habitat as a result of the nutrient pulse and litter reduction resulting from burning. In addition, this would preclude the need to create firelines to prevent prescribed fire in neighboring forest from entering non-ponderosa pine habitat. The balance of the grassland and meadow treatments, totaling about 2,254 acres, would be restored by using both mechanical removal of trees and prescribed burning. These treatments would provide additional areas where understory vegetation would be expected to respond strongly in the short-term as a result of burning and maintain improved conditions in the long-term by full removal of encroaching conifers and removing sources of future pine seeds. This would maintain food and cover for MSO prey species through time, potentially improving prey numbers within grasslands and meadows and allowing for dispersal of prey species (e.g., mice, voles, rabbits, and gophers) into surrounding forest. Arthropod prey such as beetles and moths could also benefit from these treatments, further enhancing the MSO prey base. Therefore, meadow and an unknown percentage of grassland treatments would be expected to improve understory conditions for MSO prey species and therefore improve conditions for foraging owls.

Alternative D would include 741 acres of aspen restoration in MSO restricted habitat, about 200 acres less than alternatives B and C. There would also be about 17 acres of prescribed burn-only treatment. Prescribed burning would decrease litter and produce moderate mortality of pine. This would help maintain aspen clone viability and associated prey habitat. However, pine canopy development and litter fall after treatment would limit the response of understory vegetation. Burn-only treatments would be expected to provide short-term benefits for MSO prey species. Full restoration of aspen would be expected to better improve the health of aspen clones and associated understories. Aspen restoration would be expected to result in improved understory conditions providing long-term benefits for MSO prey species.

**Disturbance**

Disturbance could occur as a result of project-related activities including moving and operating harvest machinery, hauling forest materials, building fire line, managing prescribed burns, smoke, personnel in the field, and road maintenance and construction. Noise disturbance from project activities may disturb MSO. Alternative D would mechanically treat 84,177 acres of MSO habitat, creating as much disturbance from mechanical treatments as alternative B and more than C by the amount of mechanical disturbance associated with 1,833 additional acres of treatment.

Noise would not be expected to disturb nesting and roosting MSOs because of project planning intended to minimize disturbance in and near core areas. Haul routes either avoid PACs, occur more than a ¼ mile from core areas, or employ timing restrictions to avoid disturbance during the nesting season.

Alternative D would prescribe burn 3,543 acres of MSO habitat, a fraction of the acres proposed for burning in alternative B (107,696 acres) or C (112,546 acres). Burning around PACs could include incorporating fire lines around or near PAC boundaries. Roads, natural barriers, or new fireline would be built to prevent fire from entering PACs. Building line would occur outside the nesting season. Noise and smoke related to burning could disturb owls. Design features would include timing restrictions so that habitat in and around PACs would not be prescribed burned during the breeding season (March 1 to August 31). The area excluded from burning around PACs would be determined on a PAC by PAC basis. Roads, topography, and prevailing weather patterns would be identified so that an adequate buffer would be defined around PACs. Burning within the buffer would be conducted in association with PAC burning outside the breeding season. Site-specific buffers would be designed so that noise and settling smoke from burning outside the buffer would not disturb resident owls in the PACs during the breeding season. Appropriate distances for individual PACs would be decided by biologists, fuels specialists, and the USFWS. As a result, smoke and noise are not expected to result in negative effects to MSO, particularly with the limited burning proposed under this alternative.

**Direct and Indirect Effects**

Treatment design, project design criteria, and mitigation would be implemented to be compliant with Recovery Plan guidelines and forest plans as amended. Management activities in PACs and protected habitat are designed to retain and improve nesting and roosting structure. Thinning treatments within PACs are designed to increase growth and retention of large pine and oak trees, benefiting PACs most threatened with loss of these habitat components. Treatments within PACs would occur outside of the breeding season. Mechanical thinning and prescribed burning activities would provide for long-term sustainability of MSO habitat components. Core areas would not be treated mechanically or with prescribed fire in alternative D. Therefore nesting and roosting habitat within PACs would continue to develop slower, relative to treated areas of similar habitat, and old trees would continue to be at risk due to forest health issues. Surface fuels would remain high in core areas, potentially creating higher severity fire effects if these areas were to burn. However, reduced threat of high severity fire from outside MSO habitat, combined with reductions in wildfire threat within MSO habitat, increases sustainability of these habitats. Vegetation associated with springs and ephemeral channels within PACs would be increased, providing food and cover for prey species. Meadows and aspen would be burned in protected habitat, potentially benefiting habitat for prey species. Short-term impacts may occur to individual MSO, e.g., owls foraging outside of PACs during crepuscular hours. Long-term benefits to MSO habitat and prey habitat would occur in terms of improved forest structure and reduced threats from stochastic events. Smoke from prescribed fire could potentially affect nesting owls and developing nestlings.

Restricted habitat would be managed for sustainable long-term forest conditionsby implementing combinations of group selection cuttings arranged to spatially distribute groups of trees and canopy openings, moving towards Recovery Plan and forest plan guidelines. The proposed changes to forest structure in restricted habitat are designed to retain or develop MSO nesting and roosting habitat in target and threshold areas while moving towards habitat sustainability, thereby decreasing the risk of large scale stochastic events. In restricted “other” habitat. MSO prey habitat would benefit from the creation of openings between tree groups, meadow improvement, and conducting aspen restoration in restricted habitat, all of which would increase understory food and cover.

The combination of mechanical treatments and low severity burning would lessen potential fire behavior after treatments are implemented. Post-treatment fires would be more likely to burn as surface fires rather than crown fires which more closely resemble the historical range of variation.

Road decommissioning would reduce disturbance to MSOs, improving owl habitat quality in the long-term. Reestablishing natural drainage patterns, reducing siltation, reestablishing hiding cover for prey species on road beds, or completely eliminating road beds would increase prey and owl foraging habitat. Reducing vehicular access would likely increase snag retention within MSO habitat. Work related to road maintenance, construction, and relocation inside of PACs would occur outside the nesting season, but could create noise, potentially disturbing roosting owls in the short-term. Haul routes for removing harvested materials would avoid areas within a quarter mile of core areas or implement timing restrictions. By phasing project activities, not all MSO habitats would be treated simultaneously, thus lessening the impacts.

Activities associated with spring, ephemeral channel restoration, and meadow and aspen treatments in PAC habitat would occur outside the nesting season, but could create noise that could potentially disturb roosting MSOs. Because project implementation will be phased, not all MSO habitats would be treated simultaneously, lessening disturbance to MSOs.

Mechanical thinning would result in little change to overall forest structure in protected habitat. However, thinning is designed to release large oak and pine and increase growth rates of trees greater than 18 inches dbh. Treatments would increase long-term development and retention of this limited component of MSO habitat. Combined, these changes should decrease potential fire severity. Thinning would bring slight improvements to prey habitat in terms of understory vegetation in protected, target, and threshold habitats in the short-term. Understory biomass would increase by 100s of pounds of forage in restricted “other” habitat relative to the other MSO habitats and would persist longer due to creation of interspaces. Increasing growth rates of mature and old growth trees and retaining existing large trees will indirectly contribute to maintaining large snags, logs, and CWD across the landscape in the long-term.

The limited prescribed burning in all MSO habitats would limit the benefits of reducing fire threat (i.e., litter reduction and increasing crown base height) and stimulating understory biomass development. The relative biomass index values are based only on changes to overstory. Increased biomass development from litter reduction, increasing sunlight from raising crown base height, and the associated nutrient pulse would occur on the fewest acres under alternative D. Therefore, improvements to prey habitat would be the least under alternative D relative to the other action alternatives.

Proposed changes to forest structure in restricted habitat are designed to retain or enhance MSO nesting and roosting habitat in target and threshold areas while moving towards the ecological capacity in restricted “other” habitat. These changes will primarily result from reductions of mid-aged trees 12 to18 inches dbh. Impacts to MSO from implementation would be reduced by phasing project activities across the treatment area.

Fire risk will decrease in PACs as a result of treatments, but the decrease will be much less than in other habitats because of the small scale of change in forest structure, particularly under alternative D. Thinning in the 18 selected PACs would range from less than 9 inches dbh up to 16 inches dbh with a target BA of 150 square feet per acre, similar to alternative B, and no prescribed fire would be used in PACs. Reductions in the potential for crown fire would be the least under this alternative, minimizing the ability to manage unplanned ignitions and minimizing the potential for fuels reduction in future maintenance burns.

Road closures, road relocations, and improvements and restoration of key habitats would also improve habitat for prey species by decreasing human disturbance and increasing habitat serving as food and cover. Large snag longevity would, on average, increase with decreased access by firewood cutters. Grasses, sedges, flowering forbs, and woody shrubs would benefit from spring and channel restoration and meadow/grassland and aspen treatments, all of which would benefit MSO prey. While small in scale and limited in scope, these actions target site-specific micro-habitats important to small mammals, birds, and arthropods and so increase total prey biomass. Improving connectivity of herbaceous undergrowth could improve arthropod populations. This in turn could indirectly benefit MSO prey species through increased food availability (i.e., arthropod availability) and improved habitat (from increased pollinator populations). Alternative D does the least prey habitat improvement among the action alternatives. There are about 200 fewer acres of aspen treatment and meadow and grassland treatment intensity would be light in alternative D, largely consisting of operational burns only. Limited tree mortality would be expected outside of seedlings and some saplings, so overstory shading and competition for nutrients and water would not change. Expected benefits to herbaceous vegetation would largely be limited to a short-term pulse of nutrients. Benefits to meadows and grasslands would be much less under this alternative than in alternative C. Understory response would be expected to be stronger in restricted habitat where, in general, greater reductions in canopy cover, and more openings would be created. Improvements in prey habitat should benefit prey species. Increases in prey populations should indirectly benefit MSOs.

#### *Alternative D - Determination of Effects for MSO*

Alternative D moves the 4FRI landscape towards the stated desired conditions. However, it accomplishes less than the other action alternative in terms of creating or moving towards a resilient, sustainable ecosystem. The determination of effects for Mexican spotted owls and their habitat is based on design criteria, mitigation, proposed forest plan amendments, the above effects discussion, and the following:

- By design, mechanical thinning and prescribed burning within MSO protected habitat would follow the intent of the MSO Recovery Plan and respective forest plan guidelines as amended
- By design, mechanical thinning and low severity prescribed burning within threshold, target, and other restricted habitat would follow MSO Recovery Plan and respective forest plan guidelines as amended
- Mechanical treatment activities in 18 PACs may cause short-term displacement to foraging and roosting MSOs outside the breeding season
- Improving stand structural and spatial conditions would meet short-term objectives of improving overall forest health and long-term objectives of increased forest resiliency
- Fire behavior in protected habitat would be changed in this alternative, with 58 percent of the area supporting surface fire in 2020 and 32 percent of the area at risk from active crown fire; alternative D provides the least protection from high-severity fire in protected habitat
- About 20 percent of the total road miles in 58 PACs would be decommissioned after treatment activities, lessening the amount of long-term disturbance to MSOs and their prey that is associated with access; road segments in three PACs, including core habitat in one PAC, and in restricted habitats would be relocated to provide long-term protection for ephemeral stream channels and the habitat they support
- Fire and smoke effects from prescribed burning may disturb individual birds in and adjacent to the treatment area, but timing restrictions and low severity burn prescriptions would reduce impacts and largely lead to no or only short-term effects; the amount of

burning across the landscape under this alternative minimizes the potential of smoke settling into PACs relative to the other action alternatives

- Post-treatment growth rates of trees would increase, tree resiliency to drought and insects would improve, and more of the total BA would be occurring in larger size classes, improving MSO habitat components in both the long and short-term, however, the lack of prescribed burning in acres treated mechanically would minimize these benefits relative to the other action alternatives
- Large snags (greater than 18 inches dbh) are currently below forest plan guidelines; future snag recruitment is expected through existing insect and disease activities and impacts of low severity prescribed burning. Snag development is expected to occur as more trees attain larger size-classes and meet the size-class distribution recommended in the Recovery Plan; snag retention would improve through road decommissioning; because of the limited use of prescribed burning, snag development would be minimal and snag retention is expected to be maximized in alternative D, relative to the other action alternatives
- Key sites that can support diverse and abundant understory vegetation within MSO habitats would be improved or restored for both the short- and long-term , including around 23 springs, and long 5 miles of ephemeral channels, about 3,735 acres of meadows, and about 757 acres of aspen. There is a strong link between raptors and their food and conserving and enhancing prey habitat is expected to benefit MSOs (Ganey et al 2011)
- The development of 8,412 acres of restricted target and threshold habitats would be managed towards meeting a 150-170 BA for long-term MSO nest and roost habitat as recommended in the existing Recovery Plan (USDI FWS 1995)
- Total treatments in MSO habitat include 84,178 acres of mechanical thinning and 3,543 acres of low severity prescribed burning and would provide for understory grass/forb/shrub release to improve habitat components for MSO prey species; improvements would be maximized in the short-term and while improvements would decline, they would be maintained above existing conditions over the long-term; combined, this represents the least amount of acres of MSO habitat improved relative to the other action alternatives, hence the least of amount of understory response
- Thinning on 67,378 acres of restricted “other” habitat would provide for “groupy” tree structure and canopy gaps resembling historical conditions at spatial scales capable of reestablishing understory regeneration and reducing risk of active crown fire over both the long- and short-term
- Implementing both mechanical and prescribed burn treatments would reduce hazardous fuel loads, reducing the potential for future high-severity fire and also protecting soil resources by reducing severity of ground fires over both the long- and short-term; these benefits would decrease in the short-term without maintenance burning; alternative D leaves the lowest crown base height, largest crown bulk density, and highest surface fuel loading, resulting in the highest residual threat of high-severity fire in the future
- Alternative D would preserve current old growth habitat and develop old growth components in 100 percent of MSO protected, target, and threshold habitats (45,168 acres) and additional acreage in restricted “other” areas meeting specific criteria (see Silviculture report), sustaining key MSO habitat components over the long-term

- Forest conditions within the historical range of variability (FRCC 1) would be returned to eight percent of the landscape by the year 2020. This is the smallest percentage of the landscape within the historical range of variability compared to the other action alternatives and would make limited contributions to reducing the potential for large-scale MSO habitat loss from high-severity fire;
- Forest conditions moderately altered from the historical range of variability (FRCC 2) would be returned to 82 percent of the landscape by the year 2020, thus reducing the potential for large-scale MSO habitat loss from high-severity fire in the short-term
- Alternative D reduces the FRCC 3 to 10 percent in the year 2020 and by 2050 about half of the ponderosa pine forest (50 percent) would move into FRCC 3, providing the least short- and long-term benefits relative to the historical range of variability of any of the action alternatives

MSO stratified habitat will provide for a mosaic of desired stand structure conditions, allowing for wildlife habitat and vegetative diversity. This mosaic would allow for a diversity of fire effects thereby increasing opportunities for the maintenance of forest structure and function using planned and unplanned fire in the future (up to 30 years). Canopy characteristics and surface fuel loading combine to produce combinations of surface fire intensity and physical structure (the height, density, and horizontal and vertical continuity of canopy fuels) that can produce crown fire under a given set of conditions. The closer conditions are to this threshold, the faster it will deteriorate to a point where crown fire is possible. The limited changes in protected, target, and threshold habitats in alternative D would limit future opportunities to manage fire and avoid stand replacing events.

Alternative D would provide and sustain long-term nesting and roosting habitat while reducing potential risk of high severity wildland fire and other stochastic events. To mitigate adverse effects associated with treatments within protected habitat, no treatments would occur during the breeding season and no activities would occur within the core area. Unintended smoke from first-entry burns that settled in PACs could adversely affect egg development or nestling survival by flushing the female, or affect nestling development through lung damage.

### Comparison of Alternatives

#### Mechanical Treatments

The following tables show the differences among alternatives for the MSO evaluation criteria. Table 101 and Table 102 display values for forest structure and prey habitat in protected habitat.

**Table 101. Modeled Changes by Alternative for Forest Structure Attributes in the Year 2050 Within MSO PACs**

| Forest Attribute | Alternative A | Alternative B | Alternative C | Alternative D |
|---|---|---|---|---|
| **PAC Treatments (*n* = 18)** | **No Action** | **Thinning Only Outside Core Areas** | **Thinning and Burning Outside Core Areas** | **Thinning Only Outside Core Areas** |
| 12 – 17.9” dbh (%) | 28 | 27 | 25 | 28 |
| 18 – 23.9” dbh (%) | 23 | 28 | 30 | 28 |
| ≥ 24” dbh (%) | 12 | 14 | 16 | 14 |

| Forest Attribute | Alternative A | Alternative B | Alternative C | Alternative D |
|---|---|---|---|---|
| **PAC Treatments (*n* = 18)** | **No Action** | **Thinning Only Outside Core Areas** | **Thinning and Burning Outside Core Areas** | **Thinning Only Outside Core Areas** |
| TPA ≥ 18" dbh | 27 | 29 | 29 | 29 |
| Ponderosa Pine BA | 135 | 122 | 116 | 126 |
| Gambel Oak BA | 18 | 20 | 21 | 20 |
| All BA | 173 | 160 | 155 | 163 |
| **PAC Treatments (*n* = 54)** | **No Action** | **Prescribe Burn Only** | | **No Treatments** |
| 12 – 17.9" dbh (%) | 28 | 28 | 28 | 28 |
| 18 – 23.9" dbh (%) | 22 | 22 | 22 | 22 |
| ≥ 24" dbh (%) | 11 | 11 | 11 | 11 |
| TPA ≥ 18" dbh | 28 | 28 | 28 | 28 |
| Ponderosa Pine BA | 125 | 123 | 122 | 125 |
| Gambel Oak BA | 22 | 23 | 23 | 22 |
| All BA | 185 | 183 | 183 | 185 |

**Table 102. Modeled Changes by Alternative for Prey Habitat Attributes in the Year 2050 Within MSO PACs**

| Forest Attribute | Alternative A | Alternative B | Alternative C | Alternative D |
|---|---|---|---|---|
| **PAC Treatments (*n* = 18)** | **No Action** | **Thinning Only Outside Core Areas** | **Thinning and Burning Outside Core Areas** | **Thinning Only Outside Core Areas** |
| Snags/ Ac ≥ 18" dbh | 1.5 | 1.5 | 1.5 | 1.5 |
| Logs/ Ac | 5.7 | 5.0 | 4.8 | 5.2 |
| CWD (tons/ac) | 10.3 | 6.6 | 5.8 | 9.3 |
| Understory Index[1] | 40 | 53 | 59 | 49 |
| **PAC Treatments (*n* = 54)** | **No Action** | **Prescribe Burn Only** | | **No Treatments** |
| Snags/ Ac ≥ 18" dbh | 1.8 | 1.8 | 1.8 | 1.8 |
| Logs/ Ac | 7.9 | 7.0 | 6.9 | 7.9 |
| CWD (tons/ac) | 12.5 | 9.0 | 8.4 | 12.5 |
| Understory Index[1] | 41 | 44 | 44 | 41 |

[1]Values represent pounds per acre of biomass in the year 2020

Overall, changes in forest structure within PACs would be small and reflect the careful design of treatments to move forest structure towards desired conditions while retaining dense areas with closed canopies. Trees 12 to 17.9 inches dbh decrease across all alternatives. These mid-aged trees are currently in abundance and would be targeted for removal. Post-treatment results are similar between alternatives, although alternative C would have slightly more trees removed from this size class due to the lower minimum BA associated with the draft recovery plan. All alternatives would increase tress greater than 18 inches dbh. Results would again be similar among alternatives with alternative C yielding a larger increase in big trees. Ponderosa pine BA would decrease in alternatives, which is a treatment objective, with alternative C showing the largest decrease and alternative D the smallest decrease due to the lack of prescribed burning. Maximum SDI (Density-Related Mortality is Prevalent at and Above 56 Percent Maximum SDI). Forest conditions would remain dense under all alternatives (Table 103).

**Table 103. Estimated Percent Maximum SDI[1] in 2020**

| MSO Habitat | Existing | Alternative A | Alternative B | Alternative C | Alternative D |
|---|---|---|---|---|---|
| Protected Activity Center | 78 | 80 | 72 | 71 | 74 |
| Target/Threshold | 85 | 86 | 75 | 71 | 76 |
| Restricted: Other | 69 | 72 | 37 | 37 | 46 |

[1] Forest Density Classes: Low = 0 - 24%; Moderate = 25 - 34%; High = 35 - 55%; Extremely High = > 56%

Changes in restricted habitat are shown for forest structure and prey habitat in threshold, target, (Table 104 and Table 105) and restricted “other” habitats (Table 106). Because of the deficit in the amount of existing threshold habitat across the landscape, no areas simultaneously meeting threshold conditions would be brought below minimum threshold values.

**Table 104. Modeled Changes By Alternative for Forest Structure Attributes in the Year 2050 Within MSO Threshold Habitat**

| Forest Attribute | Alternative A | Alternative B | Alternative C | Alternative D |
|---|---|---|---|---|
| **Restoration Unit 1** | | | | |
| 12 – 17.9” dbh (%) | 26 | 23 | 21 | 23 |
| 18 – 23.9” dbh (%) | 28 | 33 | 30 | 33 |
| ≥ 24” dbh (%) | 6 | 8 | 9 | 8 |
| TPA ≥ 18” dbh | 35 | 39 | 34 | 39 |
| Ponderosa Pine BA | 142 | 111 | 102 | 113 |
| Gambel Oak BA | 56 | 60 | 61 | 59 |
| All BA | 226 | 202 | 195 | 203 |
| **Restoration Unit 3** | | | | |
| 12 – 17.9” dbh (%) | 19 | 17 | 17 | 16 |

| | | | | |
|---|---|---|---|---|
| 18 – 23.9” dbh (%) | 26 | 27 | 24 | 27 |
| ≥ 24” dbh (%) | 11 | 13 | 14 | 13 |
| TPA ≥ 18” dbh | 36 | 36 | 32 | 36 |
| Ponderosa Pine BA | 113 | 95 | 88 | 96 |
| Gambel Oak BA | 61 | 64 | 65 | 63 |
| All BA | 209 | 200 | 196 | 200 |

**Table 105. Modeled Changes By Alternative for Forest Structure Attributes for the Year 2050 Within MSO Target Habitat**

| Forest Attribute | Alternative A | Alternative B | Alternative C | Alternative D |
|---|---|---|---|---|
| **Restoration Unit 1** | | | | |
| 12 – 17.9” dbh (%) | 28 | 24 | 22 | 25 |
| 18 – 23.9” dbh (%) | 19 | 23 | 19 | 23 |
| ≥ 24” dbh (%) | 10 | 12 | 13 | 11 |
| TPA ≥ 18” dbh | 24 | 26 | 22 | 26 |
| Ponderosa Pine BA | 126 | 105 | 93 | 108 |
| Gambel Oak BA | 31 | 34 | 36 | 33 |
| All BA | 184 | 169 | 161 | 171 |
| **Restoration Unit 3** | | | | |
| 12 – 17.9” dbh (%) | 25 | 23 | 21 | 23 |
| 18 – 23.9” dbh (%) | 17 | 19 | 17 | 19 |
| ≥ 24” dbh (%) | 11 | 12 | 13 | 12 |
| TPA ≥ 18” dbh | 22 | 23 | 21 | 23 |
| Ponderosa Pine BA | 112 | 98 | 91 | 100 |
| Gambel Oak BA | 35 | 37 | 38 | 36 |
| All BA | 181 | 173 | 169 | 174 |

**Table 106. Modeled Changes By Alternative for Forest Structure Attributes for the Year 2050 Within MSO Restricted “Other” Habitat**

| Forest Attribute | Alternative A | Alternative B | Alternative C | Alternative D |
|---|---|---|---|---|
| **Restoration Unit 1** | | | | |

| Forest Attribute | Alternative A | Alternative B | Alternative C | Alternative D |
|---|---|---|---|---|
| 12 – 17.9” dbh (%) | 30 | 19 | 20 | 18 |
| 18 – 23.9” dbh (%) | 20 | 19 | 19 | 16 |
| ≥ 24” dbh (%) | 10 | 20 | 19 | 17 |
| TPA ≥ 18” dbh | 23 | 17 | 17 | 17 |
| Ponderosa Pine BA | 127 | 70 | 71 | 76 |
| Gambel Oak BA | 22 | 19 | 19 | 23 |
| All BA | 170 | 107 | 107 | 123 |
| **Restoration Unit 3** | | | | |
| 12 – 17.9” dbh (%) | 26 | 18 | 19 | 18 |
| 18 – 23.9” dbh (%) | 21 | 19 | 19 | 17 |
| ≥ 24” dbh (%) | 10 | 18 | 18 | 16 |
| TPA ≥ 18” dbh | 23 | 17 | 17 | 17 |
| Ponderosa Pine BA | 112 | 67 | 67 | 71 |
| Gambel Oak BA | 32 | 27 | 27 | 30 |
| All BA | 169 | 114 | 115 | 130 |
| **Restoration Unit 4** | | | | |
| 12 – 17.9” dbh (%) | 24 | 17 | 17 | 16 |
| 18 – 23.9” dbh (%) | 20 | 17 | 17 | 16 |
| ≥ 24” dbh (%) | 11 | 19 | 19 | 17 |
| TPA ≥ 18” dbh | 22 | 16 | 16 | 16 |
| Ponderosa Pine BA | 100 | 62 | 62 | 66 |
| Gambel Oak BA | 35 | 30 | 30 | 33 |
| All BA | 165 | 115 | 115 | 130 |
| **Restoration Unit 5** | | | | |
| 12 – 17.9” dbh (%) | 28 | 21 | 21 | 20 |
| 18 – 23.9” dbh (%) | 15 | 15 | 15 | 13 |
| ≥ 24” dbh (%) | 11 | 18 | 18 | 16 |
| TPA ≥ 18” dbh | 16 | 13 | 13 | 13 |
| Ponderosa Pine BA | 101 | 62 | 62 | 69 |
| Gambel Oak BA | 17 | 14 | 14 | 16 |

| Forest Attribute | Alternative A | Alternative B | Alternative C | Alternative D |
|---|---|---|---|---|
| All BA | 146 | 98 | 98 | 114 |

Treatments would decrease the percentage of trees less than 24 inches dbh and increase trees greater than 24 inches dbh in all action alternatives. Differences among action alternatives are minor in the larger tree size-classes but apparent in BA values. The lack of burning in alternative D would leave higher tree densities and lower resiliency to insects and tree density mortality. Gambel oak densities would be higher in alternative D and potentially lead to higher densities of medium-sized oak as a result of not creating high densities of re-sprouting oak.

Results for predicted changes in prey habitat in restricted habitat are shown in Table 107 (threshold habitat), Table 108(target habitat), and Table 109 (restricted "other" habitat).

**Table 107. Modeled Changes by Alternative for Prey Habitat Attributes Within MSO Restricted Threshold Habitat for the Year 2050**

| Forest Attribute | Alternative A | Alternative B | Alternative C | Alternative D |
|---|---|---|---|---|
| **Restoration Unit 1** | | | | |
| Snags/ Ac ≥ 18" dbh | 1.2 | 1.1 | 1.0 | 1.1 |
| Logs/ Ac | 9.0 | 6.2 | 6.1 | 8.3 |
| CWD (tons/ac) | 12.9 | 6.9 | 6.8 | 11.8 |
| Understory Index[1] | 13 | 24 | 29 | 23 |
| **Restoration Unit 3** | | | | |
| Snags/ Ac ≥ 18" dbh | 2.1 | 2.2 | 1.8 | 2.2 |
| Logs/ Ac | 7.9 | 6.2 | 6.1 | 7.2 |
| CWD (tons/ac) | 11.7 | 7.0 | 6.8 | 10.5 |
| Understory Index[1] | 18 | 26 | 29 | 25 |

[1]Values represent pounds of biomass per acre for the year 2020

**Table 108. Modeled Changes By Alternative for Forest Structure Attributes for the Year 2050 Within MSO Restricted Target Habitat**

| Forest Attribute | Alternative A | Alternative B | Alternative C | Alternative D |
|---|---|---|---|---|
| **Restoration Unit 1** | | | | |
| Snags/ Ac ≥ 18" dbh | 1.4 | 1.4 | 1.2 | 1.5 |
| Logs/ Ac | 8.1 | 6.2 | 6.0 | 7.7 |
| CWD (tons/ac) | 11.8 | 6.8 | 6.5 | 10.8 |
| Understory Index[1] | 31 | 48 | 60 | 46 |

| | | | | |
|---|---|---|---|---|
| **Restoration Unit 3** | | | | |
| Snags/ Ac ≥ 18" dbh | 1.4 | 1.3 | 1.2 | 1.4 |
| Logs/ Ac | 6.1 | 4.9 | 4.8 | 5.8 |
| CWD (tons/ac) | 10.5 | 6.4 | 6.3 | 9.5 |
| Understory Index[1] | 45 | 59 | 67 | 57 |

[1]Values represent pounds of biomass per acre for the year 2020

**Table 109. Changes by Alternative for Prey Habitat Attributes in the Year 2050 in MSO Restricted "Other" Habitat**

| Forest Attribute | Alternative A | Alternative B | Alternative C | Alternative D |
|---|---|---|---|---|
| **Restoration Unit 1** | | | | |
| Snags/ Ac ≥ 18" dbh | 1.1 | 0.8 | 0.8 | 0.8 |
| Logs/ Ac | 4.3 | 4.5 | 4.6 | 4.4 |
| CWD (tons/ac) | 8.9 | 5.7 | 5.8 | 8.1 |
| Understory Index[1] | 50 | 180 | 179 | 155 |
| **Restoration Unit 3** | | | | |
| Snags/ Ac ≥ 18" dbh | 1.2 | 0.9 | 1.0 | 0.9 |
| Logs/ Ac | 4.7 | 5.0 | 5.2 | 4.9 |
| CWD (tons/ac) | 8.7 | 6.2 | 6.3 | 8.0 |
| Understory Index[1] | 52 | 173 | 169 | 149 |
| **Restoration Unit 4** | | | | |
| Snags/ Ac ≥ 18" dbh | 1.3 | 1.0 | 1.0 | 1.0 |
| Logs/ Ac | 4.3 | 4.7 | 4.7 | 4.4 |
| CWD (tons/ac) | 7.8 | 5.7 | 5.7 | 7.1 |
| Understory Index[1] | 49 | 154 | 154 | 130 |
| **Restoration Unit 5** | | | | |
| Snags/ Ac ≥ 18" dbh | 4.1 | 1.2 | 1.2 | 1.3 |
| Logs/ Ac | 2.9 | 3.5 | 3.5 | 3.7 |
| CWD (tons/ac) | 6.5 | 3.9 | 3.9 | 6.3 |
| Understory Index[1] | 65 | 283 | 283 | 267 |

[1]Values represent pounds of biomass per acre for the year 2020

Decreases would occur in all action alternatives for snags greater than 18 inches dbh and for CWD for alternatives B and C in restricted habitats. Alternative D would consistently have the highest values for snags and CWD as a result of the lack of fire. Understory response would be lowest in alternative D about similar between alternatives B and C in restricted "other" habitat. However, alternative C would be expected to produce the most food and cover for prey species in target and threshold habitats as a result of understory development. The relative index used to compare understory response does not include the effects of low severity surface fire. Prescribed burning in alternatives B and C would reduce surface fuel loading, including needle litter, and provide a nutrient flush in to the system, both of which would further increase the understory biomass approach (Appendix 8).

#### Fire Effects

All three action alternatives would move large acreages of ponderosa pine forest out of FRCC 3 immediately after treatments are completed (Table 110). Alternative C moves all treated acres out of FRCC. Alternative B has the next fewest acres in FRCC 3 after treatment and alternative D has the most acres of the action alternatives. In comparison, nearly 60 percent of total acres would be in FRCC3 under alternative A. Simultaneously, alternatives B and C would move nearly a fifth of total treated acres into FRCC 1. In 2020, alternative D would have fewer acres in FRCC 1 than the existing conditions (Table 110).

**Table 110. Fire Regime Condition Class (FRCC) Ratings in Ponderosa Pine Forest by Alternative**

| Conditions | Year | Measure | FRCC1 | FRCC2 | FRCC3 |
|---|---|---|---|---|---|
| Existing | 2010 | Acres | 70,680 | 136,311 | 297,866 |
| | | Percent | 14 | 27 | 59 |
| Alt. B | 2020 | Acres | 90,874 | 393,788 | 20,194 |
| | | Percent | 18 | 78 | 4 |
| | 2050 | Acres | 75,729 | 247,380 | 181,749 |
| | | Percent | 15 | 49 | 36 |
| Alt. C | 2020 | Acres | 95,923 | 408,934 | 0 |
| | | Percent | 19 | 81 | 0 |
| | 2050 | Acres | 80,777 | 257,477 | 166,603 |
| | | Percent | 16 | 51 | 33 |
| Alt. D | 2020 | Acres | 40,389 | 413,983 | 50,486 |
| | | Percent | 8 | 82 | 10 |
| | 2050 | Acres | 25,243 | 227,186 | 252,428 |
| | | Percent | 5 | 45 | 50 |

Fire behavior modeling resulted in similar patterns, in terms of meeting desired conditions, as that shown for FRCC (Table 111). Patterns for changes in fire behavior in protected habitat are similar to those for ponderosa pine forest in general: Action alternatives would move most of the habitat into surface fire conditions in 2020. Alternatives B and C would move most of the ponderosa pine and about ¾ of MSO protected habitat into conditions likely to support surface fire. Alternative D would move most of the ponderosa pine but less than 60 percent of MSO protected habitat towards surface fires. The remaining acres would remain vulnerable to crown fire (Table 111).

**Table 111. Predicted Fire Behavior in Protected Habitat Under Current Conditions and After Implementation of Action Alternatives in 2020**

| MSO Habitat | Total (Ac) | Surface Fire (Ac) | Passive Crown Fire (Ac) | Active Crown Fire (Ac) | Surface Fire (%) | Passive Crown Fire (%) | Active Crown Fire (%) |
|---|---|---|---|---|---|---|---|
| **Existing Condition** | | | | | | | |
| Ponderosa Pine | 507,059 | 313,423 | 48,523 | 145,113 | 62 | 10 | 29 |
| Protected | 36,658 | 18,610 | 3,141 | 14,847 | 51 | 9 | 41 |
| Target/ Threshold | 8,713 | 4,292 | 926 | 3,479 | 49 | 11 | 40 |
| Restricted "Other" | 67,378 | 35,465 | 6,608 | 25,187 | 53 | 10 | 37 |
| **Alternative B** | | | | | | | |
| Ponderosa Pine | 507,059 | 481,209 | 16,133 | 9,717 | 95 | 3 | 2 |
| Protected | 36,658 | 27,319 | 2,191 | 7,087 | 75 | 6 | 19 |
| Target/ Threshold | 8,713 | 8,236 | 109 | 353 | 95 | 1 | 4 |
| Restricted "Other" | 67,378 | 60,373 | 6,512 | 375 | 90 | 9 | 1 |
| **Alternative C** | | | | | | | |
| Ponderosa Pine | 507,059 | 482,879 | 15,508 | 3,710 | 95 | 4 | 1 |
| Protected | 36,598 | 18,610 | 3,141 | 14,847 | 78 | 5 | 17 |
| Target/ Threshold | 8,697 | 8,194 | 126 | 377 | 94 | 1 | 4 |
| Restricted "Other" | 67,259 | 60,623 | 6,270 | 366 | 90 | 9 | 1 |
| **Alternative D** | | | | | | | |
| Ponderosa Pine | 507,059 | 481,209 | 16,133 | 9,717 | 94 | 4 | 2 |
| Protected | 36,596 | 18,610 | 3,141 | 14,847 | 58 | 9 | 32 |
| Target/ Threshold | 8,698 | 7,734 | 419 | 545 | 89 | 5 | 6 |
| Restricted "Other" | 67,260 | 63,075 | 3,778 | 407 | 94 | 5 | 1 |

### Critical Habitat (All Action Alternatives)

Critical habitat is defined as protected and restricted habitats occurring within defined boundaries specific to each critical habitat unit. As such, values for the PCEs are averages of nesting and roosting habitat, future nesting and roosting habitat, and other owl habitats. By definition, there are many more acres of restricted habitat than there are in PAC habitat. The values discussed below provide relative comparisons of alternatives, but provide little insight into actual habitat conditions. Details on changes in habitat can found in the above discussions on protected and restricted habitat by individual alternative. PCEs are habitat features necessary for conservation of the species within the designated critical habitat units and were defined in the Final Rule published in the Federal Register (USDI 2004). In pine-oak forest these include one or more of the habitat needs for nesting, roosting, foraging and include:

**Forest Structure:**

- A range of tree species of different sizes and ages;
- Thirty to 45% of the trees with a dbh of 12 inches or greater;
- Shade canopy of 40% or more;
- Snags of 12 inch or greater dbh; and

**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.

Six CHUs occur within or overlap the 4FRI analysis area, encompassing about 488,974 total acres. Protected and restricted habitat within the 4FRI treatment area occurs both within designated CHUs and outside CH boundaries. Approximately 91,047 acres of protected and restricted habitat in the 4FRI treatment area are within designated CHUs boundaries. Effects to Critical Habitat are averaged for all MSO habitats (see discussion of effects to protected and restricted habitats by alternative above). Many of the differences between alternatives are limited when assessed at the scale of Critical Habitat. Overall, proposed mechanical treatment acres are similar between alternatives, but vary in terms of acres proposed for prescribed burning (Table 112).

**Table 112. Treatments in Critical Habitat by Alternative**

| Alternative | Acres Thinned | % Thin | Acres Burned | % Burn |
|---|---|---|---|---|
| B | 63,725 | 68 | 86,419 | 92 |
| C | 62,210 | 69 | 91,047 | 100 |
| D | 63,725 | 68 | 3,063 | 3 |

Comparisons of most attributes are done for the year 2050 to allow for changes in forest development to become more readily apparent. The exception to this is relative index value for understory development which is compared for the year 2020 when herbaceous response to treatments is maximized. After that, tree growth would increase and the canopy would continue developing, causing a persistent decrease in understory response through 2050. Individual values for the primary constituent elements are presented by CHU by alternative in Appendix 18.

**Forest Structure**

### *Distribution of Large Trees*

The distribution of tree size classes would be similar among alternatives, with B and C nearly identical and D frequently one or two percentages below them for trees greater than 18 inches dbh. All action alternatives had the same values for TPA 18 inches dbh and greater. Forest densities would remain high, limiting the benefits of MSO treatments in terms of forest health and resiliency, but treatments would focus on releasing large trees from competition, increasing growth rates of large trees, and retaining or creating nesting and roosting habitat.

### *Basal Area*

Pine BA would be reduced by all the action alternatives. Total BA post-treatment would be about the same in alternatives B and C. Gambel oak BA and total BA would consistently be higher in alternative DThe higher BA values in alternative D would result from the limited acres of prescribed burning in this alternative.

### *Canopy Structure*

The BA, TPA, and SDI values post-treatment would provide for canopy cover (see discussions by alternative above). No species other than ponderosa pine would be targeted for selection, unless small trees of other species are within a crown diameter of old ponderosa pine trees or large Gambel oak (see design features), ensuring species diversity and structural heterogeneity would remain in the canopy. Some oak would be lost to fire; particularly in alternatives B and C as compared to D. Design features would be in place to minimize loss of larger oak. Fire would also be expected to stimulate oak sprouting. Canopy continuity would be maintained in protected and target and threshold habitats, but some defined tree groups and canopy openings would be created in restricted "other" habitat. Combined, this would retain nesting and roosting habitat in protected and target and threshold habitats and move restricted "other" habitat towards a blend of denser forest with an interspersion of increased foraging opportunities.

**Table 113. Modeled Changes By Alternative for Forest Structure Attributes for the Year 2050 Within MSO Critical Habitat**

| Critical Habitat Unit | Existing Condition Year 2010 | Alternative A Year 2050 | Alternative B Year 2050 | Alternative C Year 2050 | Alternative D Year 2050 |
|---|---|---|---|---|---|
| **UGM-11** | | | | | |
| 12 – 17.9" dbh (%) | 31 | 29 | 24 | 24 | 24 |
| 18 – 23.9" dbh (%) | 13 | 21 | 23 | 23 | 21 |
| ≥ 24" dbh (%) | 7 | 10 | 15 | 15 | 13 |

| Critical Habitat Unit | Existing Condition Year 2010 | Alternative A Year 2050 | Alternative B Year 2050 | Alternative C Year 2050 | Alternative D Year 2050 |
|---|---|---|---|---|---|
| TPA ≥ 18" dbh | 13 | 26 | 24 | 24 | 24 |
| Ponderosa Pine BA | 114 | 128 | 102 | 100 | 106 |
| Gambel Oak BA | 19 | 23 | 23 | 23 | 24 |
| All BA | 150 | 178 | 151 | 149 | 158 |
| **UGM-12** | | | | | |
| 12 – 17.9" dbh (%) | 24 | 25 | 19 | 18 | 18 |
| 18 – 23.9" dbh (%) | 13 | 17 | 17 | 16 | 15 |
| ≥ 24" dbh (%) | 12 | 15 | 23 | 23 | 20 |
| TPA ≥ 18" dbh | 12 | 20 | 17 | 17 | 17 |
| Ponderosa Pine BA | 97 | 116 | 77 | 75 | 83 |
| Gambel Oak BA | 15 | 21 | 18 | 19 | 21 |
| All BA | 126 | 159 | 115 | 114 | 128 |
| **UGM-13** | | | | | |
| 12 – 17.9" dbh (%) | 29 | 26 | 19 | 19 | 19 |
| 18 – 23.9" dbh (%) | 14 | 21 | 20 | 20 | 18 |
| ≥ 24" dbh (%) | 7 | 10 | 17 | 17 | 15 |
| TPA ≥ 18" dbh | 13 | 24 | 20 | 20 | 20 |
| Ponderosa Pine BA | 97 | 112 | 76 | 76 | 80 |
| Gambel Oak BA | 27 | 32 | 28 | 28 | 31 |
| All BA | 141 | 172 | 129 | 129 | 141 |
| **UGM-14** | | | | | |
| 12 – 17.9" dbh (%) | 30 | 26 | 26 | 26 | 26 |
| 18 – 23.9" dbh (%) | 15 | 22 | 22 | 22 | 22 |
| ≥ 24" dbh (%) | 8 | 13 | 14 | 14 | 13 |
| TPA ≥ 18" dbh | 14 | 26 | 26 | 26 | 26 |
| Ponderosa Pine BA | 98 | 110 | 105 | 105 | 108 |
| Gambel Oak BA | 15 | 17 | 18 | 18 | 17 |
| All BA | 136 | 170 | 165 | 164 | 167 |
| **UGM-15** | | | | | |

| Critical Habitat Unit | Existing Condition Year 2010 | Alternative A Year 2050 | Alternative B Year 2050 | Alternative C Year 2050 | Alternative D Year 2050 |
|---|---|---|---|---|---|
| 12 – 17.9” dbh (%) | 33 | 38 | 38 | 37 | 38 |
| 18 – 23.9” dbh (%) | 10 | 24 | 25 | 25 | 24 |
| ≥ 24” dbh (%) | 5 | 8 | 8 | 9 | 8 |
| TPA ≥ 18” dbh | 9 | 20 | 20 | 20 | 20 |
| Ponderosa Pine BA | 76 | 94 | 91 | 91 | 94 |
| Gambel Oak BA | 10 | 12 | 12 | 12 | 12 |
| All BA | 98 | 129 | 125 | 125 | 128 |

**MSO Prey Habitat**

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

Snags 12 inches dbh and greater are considered an important element of MSO habitat when defined as a primary constituent element of Critical Habitat. Numbers of snags would be similar between alternatives B & C and consistently higher in D (Table 1134). While snags greater than 18 inches dbh (forest plan direction) are low in all CHUs, adding snags 12 to 18 inches dbh more than doubles the average number of snags per acre in all CHUs. Future snag habitat would be expected to be improved under all action alternatives because more large trees and improved growth rates for large trees would help ensure future snag recruitment, as described in the Recovery Plan.

Logs per acre would be maintained across Critical Habitat (Table 114). Values for logs per acre would be similar among alternatives, although values for alternative D would be consistently higher. This is directly correlated with the reduced acres of prescribed burning in alterative D. It is expected that low severity prescribed burning would leave a patchy mosaic in alternatives B and C, including unburned areas. Levels of CWD would exceed forest plan guidance in all alternatives (Table 114). Small mammals, including key MSO prey species, tend to respond positively to restoration-based treatments (Appendix 7).

### *Species Richness and Abundance in the Herbaceous Layer*

Understory response would show large increases under the action alternatives compared to the no action alternative (Table 114). Alternative C would, on average, have the largest increase and alternative D the smallest increase. Increases in the relative index for understory response relate to biomass quantity. An assumption can be made that large increases in understory yield, combined with low severity burning, would also increase understory species richness. Similarly, increases in arthropod abundance and richness could be assumed as well (Appendix 8). In addition to the overstory/understory relationship, prescribed burning, which would be highest in alternative C, would contribute to the understory response. Therefore, prey species response would be expected to be greatest in alternative C and least in alternative D.

**Table 114. Modeled Changes by Alternative for Prey Habitat Attributes in MSO Critical Habitat for the Year 2050**

| Critical Habitat Unit | Existing Condition Year 2010 | Alternative A Year 2050 | Alternative B Year 2050 | Alternative C Year 2050 | Alternative D Year 2050 |
|---|---|---|---|---|---|
| **UGM-11** | | | | | |
| Snags 12-18" DBH | 2.5 | 5.6 | 3.7 | 3.6 | 4.1 |
| Snags >12" DBH | 3.0 | 7.0 | 5.1 | 4.9 | 5.4 |
| Snags >18" DBH | 0.5 | 1.4 | 1.3 | 1.3 | 1.3 |
| CWD | 5.1 | 10.8 | 7.2 | 6.8 | 10.2 |
| Logs per Acre | 2.0 | 6.1 | 5.6 | 5.5 | 6.0 |
| Understory Index | 43 | 36 | 86 | 87 | 75 |
| **UGM-12** | | | | | |
| Snags 12-18" DBH | 1.2 | 3.6 | 1.7 | 1.6 | 2.0 |
| Snags >12" DBH | 1.7 | 4.6 | 2.7 | 2.5 | 2.9 |
| Snags >18" DBH | 0.5 | 1.0 | 1.0 | 0.9 | 0.9 |
| CWD | 4.1 | 8.0 | 5.4 | 5.3 | 7.6 |
| Logs per Acre | 1.6 | 4.0 | 4.2 | 4.1 | 4.3 |
| Understory Index | 199 | 172 | 376 | 380 | 333 |
| **UGM-13** | | | | | |
| Snags 12-18" DBH | 2.0 | 4.5 | 1.9 | 1.9 | 2.3 |
| Snags >12" DBH | 2.5 | 5.9 | 3.0 | 3.0 | 3.4 |
| Snags >18" DBH | 0.5 | 1.3 | 1.1 | 1.1 | 1.1 |
| CWD | 4.1 | 9.2 | 6.5 | 6.6 | 8.5 |
| Logs per Acre | 1.8 | 5.4 | 5.4 | 5.5 | 5.4 |
| Understory Index | 67 | 57 | 155 | 152 | 135 |
| **UGM-14** | | | | | |
| Snags 12-18" DBH | 2.3 | 5.2 | 4.8 | 4.8 | 5.1 |
| Snags >12" DBH | 2.9 | 6.9 | 6.5 | 6.4 | 6.8 |
| Snags >18" DBH | 0.6 | 1.7 | 1.7 | 1.7 | 1.7 |
| CWD | 5.6 | 10.9 | 7.8 | 7.4 | 10.9 |
| Logs per Acre | 3.5 | 7.9 | 7.0 | 6.7 | 8.0 |

| | | | | | |
|---|---|---|---|---|---|
| Understory Index | 53 | 41 | 53 | 53 | 48 |
| **UGM-15** | | | | | |
| Snags 12-18" DBH | 2.0 | 4.2 | 4.0 | 3.9 | 4.2 |
| Snags >12" DBH | 2.4 | 5.6 | 5.3 | 5.2 | 5.5 |
| Snags >18" DBH | 0.4 | 1.3 | 1.3 | 1.3 | 1.3 |
| CWD | 5.6 | 9.1 | 6.6 | 5.8 | 9.1 |
| Logs per Acre | 1.3 | 4.6 | 4.4 | 4.3 | 4.7 |
| Understory Index | 181 | 156 | 164 | 165 | 159 |

### Cumulative Effects

Past projects (since 1996) and current projects identified in MSO habitat within the 4FRI area have or will treat a total of 9,765 acres. This equates to 3,190 acres of protected habitat and 6,575 acres of restricted habitat. Most acres treated from these projects involve mechanical harvest or burning treatments, but also include slash disposal, invasive weed treatments, and limited acres of animal damage control, erosions control, and disease tree harvest (details can be found in Appendix 12). Effects to MSO habitat are broken down into two broad categories: Forest structure and prey habitat.

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 (Bruce Higgins, *pers comm.*). 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.

#### Forest Structure

Past and ongoing precommercial thinning, commercial thinning, thinning to reduce hazard fuels, and disease control harvest (4,204 acres) all decrease tree competition and improve tree growth rates. These projects were not likely to move towards desired forest structure conditions in terms of uneven-aged forests with canopy gaps, but did improve forest health by decreasing tree densities. Overly dense forests (zones 3 and 4) are vulnerable to stochastic events such insects, disease, and high-severity fire. Thinning treatments resulted in forest density within the low to moderate density zones and improved forest health by decreasing competition between trees and reducing the risk of habitat loss from stochastic events, even if they narrow the range of age-classes and do not create openings. These benefits will also help general forest health under drier and warmer conditions.

Precommercial thinning, commercial thinning, and thinning to reduce hazard fuels (4,181 acres) all have diameter limits for which trees are removed. The focus is on removing small to medium-sized trees. 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 trees per acre larger than 18 inches in the long-term. However, eventually recruitment will be limited in areas where multiple size-classes were removed by thinning treatments, i.e., when all trees below a certain diameter are removed, there will be a gap in time after residual trees attain larger diameters and before trees that are recruited post-treatment eventually grow into large size-classes.

Thinning projects (including precommercial thinning, commercial thinning, and thinning to reduce hazard fuels) completed in protected habitat (1,681 acres) followed Recovery Plan direction. This includes only removing trees 9 inches dbh and smaller. Removing only small trees reduces ladder fuels, thereby decreasing the risk of surface fire becoming crown fire. However, this does 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 (67 acres of restricted only) 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.

Snags would be decreased from many activities due to human health and safety concerns during operations, 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, diameter, height, age, presence of bark, and spatial distribution all affect the wildlife value of snags.

Removing conifer competition with mid and understory oak as part of the thinning contributed to maintaining and improving oak growth and vigor.

Prescribed burning (1972 acres) and managed wildfire (11 acres) produced low severity burns that reduced surface fuels and caused periodic tree mortality of susceptible pre-settlement trees, typically improving forest structure.

Mixed and high severity wildfire 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).

**Prey Habitat**

Thinning treatments open the overstory canopy and remove subcanopy structure, allowing more light to reach the forest floor and increasing moisture availability. The open spacing in canopies tends to be a 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 resources. However, the relatively regular spacing of post-thinning residual trees does not allow for support of long-term understory benefits.

Piling of fuels (1,593 acres) provides nesting and hiding cover for prey species, but typically piles are eventually burned. Pile burning (1,104 acres) can cause mortality to individual animals. Invasive weed treatments (711 acres) improves prey habitat by releasing native species. Invasive weeds may provide cover, but typically do not produce forage. Some invasive weeds can increase fire risk and some less flammable seasonally, reducing the effectiveness of prescribed fire. Erosion control (33 acres) would move prey habitat towards desired conditions. Animal damage control (18 acres of restricted habitat) would consist of direct removal of prey species, causing a short-term, localized decrease in prey numbers.

Group selection harvest (67 acres of restricted only) with a restoration emphasis was designed to reestablish forest openings and attain a mosaic of interspaces and tree groups. This treatment created patches of openings where understory development could persist in the long-term.

Broadcast burning would increase understory production. The scale of this increase would largely depend on site-specific forest structure, but in general would increase food and cover for prey species.

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 12). 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 located within the project area. Main pastures are the large pastures that are used more than 30 days per year by livestock. 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. 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. Allotments are managed to provide 60 percent or more of the understory biomass for wildlife. 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). Overall, forest plan guidance directs the range program to maintain adequate understory conditions.

**Reasonably Foreseeable Actions**

Appendix 12 lists known future projects expected to overlap protected (Table 205) and restricted habitat (Table 206). Most projects include habitat restoration objectives in MSO habitat (e.g., McCracken, Marshall, Elk Park, Turkey/Barney, Upper Beaver Creek, Aspen Restoration). Some projects will likely have negative impacts to MSOs and their habitat (powerline ROW maintenance, reopening rock pits). With limited detail on most of the foreseeable actions, including a lack of specific boundaries on where the actions will take place, it is difficult to assess impacts to MSO habitat. Most, but not all projects are expected to move habitat towards desired conditions. 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 fire risk and improve MSO habitat. Substantial improvements to restricted habitat is expected from what may result in over 20,000 acres of long-term improvements to both forest structure and prey habitat from 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).

**Summary of Cumulative Effects**

Overall, there are 194,855 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 112,546 acres of pine-oak Critical Habitat occur within the 4FRI treatment area. Past and ongoing projects have or will treat 9,765 acres of MSO habitat, including 3,190 acres of protected and 6,575 acres of restricted habitat. Tree harvest and prescribed burning treatments (6,996 acres) improved forest health, but only 2,783 of these acres actually improved forest structure and prey habitat in terms of MSO habitat. Pile burning and site preparation (1,156 acres) had negligible effects to either forest structure or prey habitat. Piling of slash fuels (1,593 acres) benefited prey habitat and animal damage control had negative effects to prey species. Reasonably foreseeable actions should largely benefit both forest structure and prey habitat in MSO habitat.

**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 both spatially and temporally are not expected to alter these effects.

Maintaining existing conditions would extend the current deficit of trees greater than 24 inches dbh. Current levels of TPA greater than or equal to 18 inches dbh, 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 prolongs 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 or limiting long-term attainment of desired conditions for mature and old-growth forest. In the long-term, consistently high canopy cover would delay or prevent development of multi-storied and uneven-aged forest structure. Growth could be further suppressed and mortality rates increased if long-term climate patterns continue towards hotter and drier growing conditions. Within-stand mortality resulting from competition for rooting space, water, and nutrient availability could lead to patches of more open conditions. This could reduce potential nesting and roosting habitat even in locations where individual trees might 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 also increases the risk of insect and disease outbreaks occurring at scales outside the historical range of variability. Large-scale stochastic events 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 will 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 fire risk 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 - D**

Alternative B, C, and D restoration treatments would contribute towards improving MSO forest health and vegetation diversity and composition, sustaining old forest structure over time, and moving forest structure toward the desired conditions.

Cumulative effects were evaluated across the 4FRI analysis area plus a ½ mile buffer beyond the 4FRI boundary. The cumulative effects area includes 110 PACs. Most of the projects identified as part of the cumulative effects analysis occur outside of MSO habitat. Projects with treatments specifically occurring in MSO habitat include nearly 3,000 acres of protected habitat (Table 203) and about 3,500 acres of restricted habitat (Table 204) in current and ongoing projects. The projects commonly use nine inch dbh limits in protected habitat and some used 12 to 14 inch dbh limits in restricted habitat. Total acres of treatment in MSO habitat within reasonably foreseeable projects are not yet known because projects are still in the planning stages. However, the best estimate at this time includes about 10,155 acres of protected habitat (Table 205) and approximately 23,800 acres of restricted habitat (Table 206) is under consideration for vegetation treatments.

Changes to MSO habitat structure as a result of these combined actions are expected to be minimal. For many projects, treatments are expected to decrease the number of trees greater than 12 inches dbh. The degree of treatment intensity is highly variable, with some projects not cutting trees greater than 12 inches dbh and others looking to lower the threat of high-severity fire in MSO habitat. The overall ratio of trees greater than 12 inches dbh is likely to increase as a result of most projects removing trees less than 12 inches dbh. Trees 18 inches dbh or greater would be little affected by fuel reduction/restoration treatments. Total BA of pine would decrease, but a focus on small trees in most projects may not substantially alter total BA. Gambel oak is not targeted for removal, but small diameter oak will likely burn, decreasing oak BA in the short term. However, design features should ensure retention of large diameter oak and shrubby 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 crown base height, improving MSO flight paths for foraging. However, dbh limits that retain mid-aged trees commonly result in loss of forest structure and decrease inherent heterogeneity in tree spacing. 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 across the board diameter caps set for retaining mid-sized trees.

Changes are expected in MSO prey habitat. Decreases would occur in coarse woody debris, logs, and snags. Burn prescriptions and ignition techniques should limit overall losses of logs and snags. Burned snags will fall and provide logs and trees killed by fire will become snags. 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 as a result of prescribed burning. Thinning and burning should increase tree growth rates and self-pruning of the lower tree branches through time should gradually replenish CWD. Improving growing conditions should decrease density-related mortality of larger and older trees. Improving recruitment into the larger size classes will 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.

These projects represent polygons omitted from the 4FRI planning effort because planning was already in progress. 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 projects and burning habitat outside the polygons. Given the dbh limits employed and the generally low intensity of the treatments, decreases in the risk of high severity fire and improvements to understory vegetation/prey habitat are expected to be short term only.

Cumulative effects will include local disturbance from noise and potentially additional disturbance from smoke. Individual projects include one on the Williams Ranger District (Bill Williams Mountain) and projects distributed across the Flagstaff District from the San Francisco Peaks to the edge of the Mogollon Rim. Given the various stages of planning or implementation, project effects would be dispersed both spatially and temporally. Given the scale of the 4FRI analysis area (593,211 acres), the amount of MSO habitat within the project area (194,855 acres), and the period of time over which treatments will be implemented (10 or more years), the cumulative effects are expected to be negligible relative to the scale of both time and space within which potential effects would occur.

## Black-footed Ferret

### Amendments Supporting the Action Alternatives

Not incorporating the proposed amendments would affect black-footed ferret habitat. The MSO amendments would allow managing for lower tree densities and basal area, creating canopy gaps, and increasing understory response. Not including amendments for MSO habitat would not affect ferret habitat.

Not including the amendment related to management of canopy cover and open reference conditions within ponderosa pine forest would prevent the ability to include open rooting space between tree groups and prevent the restoration of grasslands and savanna. This would prevent the restoration of forested areas that used to support grasslands and decrease the ability to maintain existing grasslands, savannas, and meadows. Decreased dispersal would reduce the ability of prairie dogs to naturally establish new prairie dog towns and limit the “rescue effect” of genetic exchange between fragmented populations. If some prairie dogs are genetically resistent to plague, dispersal of these animals may be key to eventually establishing black-footed ferret habitat. Forest thinning, the creation of interspace, and reestablishing grasslands, savannas, and meadows would assist in enhancing the probability of successful dispersal. Not managing the proposed Garland Prairie RNA for the grassland characteristics it was intended to support would result in similar though more localized dynamics. Not including actions related to openness and grassland restoration would omit or limit herbaceous response, decreasing prairie dog food and cover.

### Alternative A No Action

#### Direct/Indirect Effects

Habitat conditions for black-footed ferrets would remain in their current condition, notwithstanding natural processes. Because there are no known black-footed ferrets on the project area, the probability of direct effects to black-footed ferrets from the current condition are low.

Because prairie dogs often occur in open areas such as grasslands and meadows their habitat and colonies have a greater chance of being impacted by increased tree densities and encroachment of these habitats. Denser forest conditions produce lower values in understory biomass (lbs/acre). Under the No Action understory biomass would continue to decline over the next 40 years (Appendix 8). This in turn leads to less available habitat for species such as the ferret that rely on prairie dogs for food.

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 prairie dog habitat and consequently potential habitat for black-footed ferret. Nine percent of the grassland habitat has the potential for crown fire. Stability of key ecosystem components such as, species composition, forest structure, soil characteristics and hydrologic function are at moderate to high risk of loss in the event of high severity disturbance, such as high severity wildfire on 76 percent of grasslands (Fire Ecology report). This alternative would result in the most stress on meadow and grassland habitats and thus would have the greatest negative contribution to potential black- footed ferret habitat.

#### Cumulative Effects

The area analyzed for cumulative effects to black-footed ferret encompasses the grasslands within the project area and the associated prairie dog complexes. Direct and indirect effects are unlikely to occur since there are no known locations of black-footed ferrets on the project area and potential habitat will be surveyed prior to implementation. There are no effects to black-footed ferret therefore, no cumulative effects.

### Amendments Supporting the Action Alternatives

This analysis incorporated the proposed amendments for management of canopy cover and open reference conditions within northern goshawk habitat and management within the proposed Garland Prairie Research Natural Area (RNA). The amendments related to the MSO and cultural resource determinations would not affect black-footed ferrets or their habitat.

The amendments related to northern goshawk habitat and management within the proposed Garland Prairie RNA would open forests and move their structure towards pre-settlement conditions. Dense stands of mid-aged trees that are a result of fire suppression and exclusion have removed or fragmented prairie dog habitat. Managing for open reference conditions on soils that indicate historic grasslands and savannas would restore habitat that has converted to forest and better connect existing prairie dog habitat. Not including these amendments would allow the continued tree encroachment and loss of habitat prairie dogs and black-footed ferrets depend on. Not allowing for interspace within the forest matrix would reduce the likelihood of successful dispersal of prairie dogs, eventually isolating fragmented populations and reducing the ability to attain adequate habitat for ferrets. Not maintaining or restoring the ecological characteristics of the proposed RNA (alternative C only) would preclude the ability to expand available habitat in Garland Prairie where resident prairie dogs occur.

### Alternative B Proposed Action

#### Direct/Indirect Effects

Direct effects are unlikely to occur since there are no known locations of black-footed ferrets on the project area and potential habitat will be surveyed prior to implementation. Short-term and localized effects from mechanical thinning and prescribed burning would result in the potential collapsing of burrows and displacement of prairie dogs in active prairie dog towns. No temporary road construction would occur within grasslands. Alternative B would restore 11,185 acres of grassland habitat in potential habitat for black-footed ferrets and their prey. The potential for crown fire within grasslands would be slightly (1%) reduced (Fire Ecology report). Prescribed fire treatments would improve the stability of key ecosystem elements such as species composition, soils and hydrologic function within grasslands by shifting 4,500 acres from Fire Regime Condition Class (FRCC) 3 to FRCC 2, and increasing FRCC 1 by 1,683 acres (Fire Ecology report). Treatments within the open linkages are designed to provide more contiguous open conditions, improving connectivity between grasslands and allow more opportunities for prairie dogs to colonize new areas and adapt to disturbances over time. The overall increase in grassland treatments and restored connectivity of grasslands would have a beneficial impact on prairie dog populations contributing to potential black-footed ferret habitat.

## Alternative C

### Direct/Indirect Effects

This alternative has similar effects as Alternative B; however, Alternative C adds 48,206 acres of grassland restoration treatments. These treatments would occur within open linkages providing additional opportunities for prairie dogs to colonize new areas and re-colonize areas where trees have encroached previously occupied habitat in Government and Garland Prairie, Kendrick Park and other grasslands. Alternative C treats the most acres and elicits the greatest response in understory (Appendix 8). Potential for crown fire in grasslands would be eliminated and prescribed fire and mechanical treatments in grasslands would improve the stability of the key ecosystem elements by almost doubling acres in FRCC1 and reducing FRCC3 by half (Fire Ecology report). Alternative C would provide the greatest improvement to meadow and grassland habitats thereby improving habitat for prairie dogs and potential habitat for ferrets.

### Determination of Effect

Implementation of Alternative C would have no effect to the black-footed ferret.

## Alternative D

### Direct/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 (Appendix 8). Alternative D does not include prescribed burning across the mechanical treatments as Alternative B does and there are about 20,645 fewer acres of prescribed burn only. There would be little change in crown fire potential  and the lack of prescribed fire in grasslands reduces the acres in FRCC1 by 3 percent and increases the acres in FRCC3 reducing the stability of key ecosystem elements (Fire Ecology report). The lack of burning means no nutrient pulse into the system, further limiting understory response. This alternative provides the least amount and lowest quality of habitat for prairie dogs hence less habitat for black-footed ferrets.

## Cumulative Effects for all Action Alternatives

The area analyzed for cumulative effects to black-footed ferret encompasses the grasslands within the project area and the associated prairie dog complexes. Direct and indirect effects are unlikely to occur since there are no known locations of black-footed ferrets on the project area and potential habitat will be surveyed prior to implementation. There are no effects to black-footed ferret therefore, no cumulative effects.

## Forest Service Sensitive Species

The most recent Regional Forester's Sensitive Species list was transmitted to Forest Supervisor's on October 1, 2007 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

#### Amendments Supporting the Action Alternatives

Not incorporating the proposed amendments would affect the habitat of most sensitive species addressed in this report (Table X). 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, more large snags through time, and increasing understory response. Not incorporating these amendments would allow:

- uncharacteristically dense forest conditions and fewer big pine and oak trees and increased fire risk for wildlife using forested habitats in 18 PACs (related to the proposed mechanical treatments in all action alternatives)
- uncharacteristically dense forest conditions, lower crown base height, and increased fire risk in 56 PACs (related to the proposed prescribed fire treatments in alternative C only)
- fewer PACs attaining the desired post-treatments conditions due to sequencing of treatments through time (all action alternatives)
- uncharacteristically dense forest conditions, fewer canopy openings, and fewer large pine and oak trees in restricted habitat that would be managed as threshold habitat where no resident MSOs exist on the Kaibab NF (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 and carnivores

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 maximum SDI), and prevent the restoration of grasslands and savanna. This would decrease the ability to maintain dense groups of trees along with shrub and herbaceous vegetation, decreasing foods for herbivores, granivores, insectivores, and so for carnivores as well. Grassland species and dispersing individuals of prey species (primarily rodents and lagomorphs) that aid in maintaining 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.

Not managing the proposed Garland Prairie RNA for the grassland characteristics it was intended to support would result in similar dynamics, i.e., the development of forest structural characteristics used by some species while reducing habitat effectiveness for open habitat species.

Currently, many of the sensitive species depend on habitats or habitat elements related to canopy openings. Existing closed canopy forests limit or eliminate many of the necessary habitat components needed by these species. The desired condition of closed canopy tree groups interspersed with open rooting space that supports herbaceous vegetation would provide key habitat components for these species of status as well as species adapted to closed-canopy forests. Achieving this situation is the reason for the amendments and this interspersion of habitats which is a fundamental part of the desired condition would not be attained without incorporating the amendments into the action alternatives.

**Table X. Affects 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 | Prey Habitat | Degraded |
| Northern Goshawk | Late-seral PIPO[1]/Prey Habitat | Degraded |
| American Peregrine Falcon | Prey Habitat | Degraded |
| Clark's Grebe | Site specific/ habitat not affected | None |
| Burrowing Owl (western) | Open/Grassland | Degraded |
| Ferruginous Hawk | Open/Grassland | Degraded |
| Insects | | |
| Four-spotted Skipperling | Openings/springs/shrubs/herbaceous | Degraded |
| Nitocris Fritillary | Openings/springs/shrubs/herbaceous | Degraded |
| Nokomis Fritillary | Openings/springs/shrubs/herbaceous | Degraded |
| Mammals | | |
| Navajo Mexican Vole | Forest openings/ meadows/understory development | Degraded |
| Long-tailed Vole | Forest openings/ meadows/understory development | Degraded |
| Merriam's shrew | Forest openings/meadows/ arthropods | Degraded |

| Species | Habitat Links | Long-Term Effect to Habitat Links |
|---|---|---|
| Dwarf Shrew | Forest openings/meadows/ arthropods | 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 |
| Greater Western Mastiff Bat | Forest openings/meadows/ arthropods | Degraded |
| Reptiles | | |
| Narrow-headed Garter Snake | Site specific/ habitat not affected | None |

[1]PIPO = ponderosa pine forest

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. Up to 40,000 acres of prescribed burning and up to 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.

About 517 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 to improve roads 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 moved road segment.

Decommissioning 904 miles of roads would improve the quality of the habitat along and adjacent to those roadways. Road decommissioning could include 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, reestablishing drainage patterns, 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/or

5) Other method designed to meet the specific condition associated with the unneeded roads.

The combination of the above actions would increase habitat for an array of wildlife species. Eliminating disturbance along the roadway would be expected to improve habitat quality beyond the immediate proximity of the road. With each mile of road impacting approximately 3 acres of habitat, about 2,712 acres of forested habitat may be improved. 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. 2004) Magnesium chloride ($MgCl_2$) 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. 2004).

Batista et al (2004) 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 $MgCl_2$ is related to humidity levels (Batista et al. 2004), 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.

The impacts of research proposals to silvicultural prescriptions are reflected in the vegetation data in Alternative C. Therefore, the proposed experiment to monitor effects of forest patch size on wildlife has been incorporated into this analysis. Constructing 15 weirs for watershed research, impacting about 3 acres, would not have a discernible impact to habitat to sensitive species.

Improving springs and restoring riparian habitat and ephemeral streams 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

Individual forest projects would continue to move some acreage towards desired conditions, but the overall landscape would change slowly. The no action alternative would shift the VSS distribution within nest PFAs and dispersal PFAs (PFAs), with habitat developing slowly relative to the action alternatives, moving towards more VSS 5 and 6 as trees develop and mature. and minimally meeting forest plan direction (Figure 36). There would be no groups of VSS 1 or 2 by 2050, limiting regeneration to individual trees scattered under existing canopies. With few openings and a relatively continuous canopy, “volunteer” regeneration would not be likely to support a continuous flow of trees into larger size-classes. This would not promote a sustainable distribution of age-classes, would not provide the variety of habitats used by key goshawk prey species, and so overall would not meet the desired conditions by 2050.

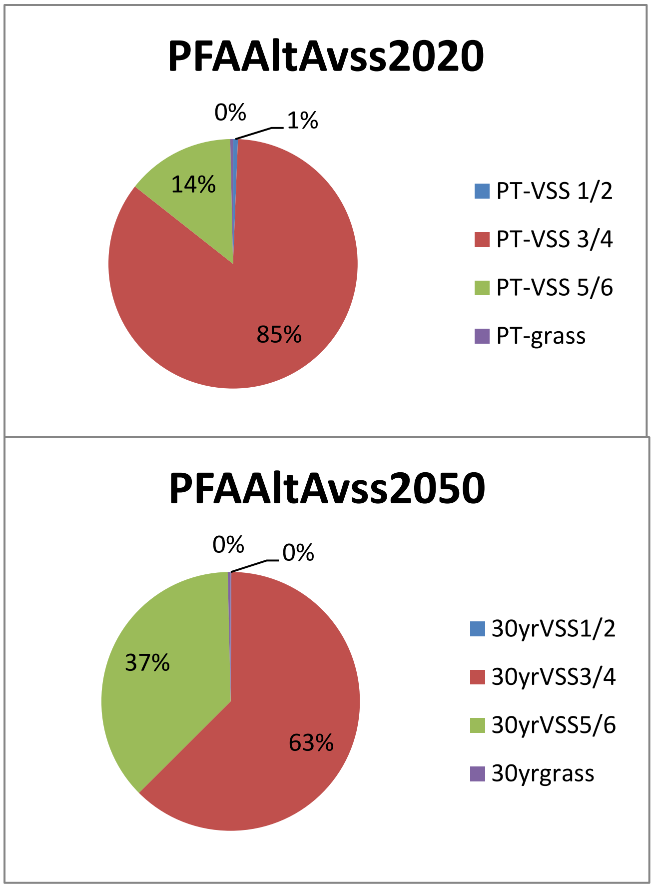



**Figure 36. Projected changes to PFA habitat post-treatment (2020) and 30 years post-treatment (2050) in Alternative A**

In uneven-aged LOPFA stands, alternative A, would change the VSS distribution through forest succession modified by the mortality associated with extremely high tree densities as trees compete for limited space and nutrients and water as well as the increased potential for insect and disease outbreaks and mortality (Figure 37).

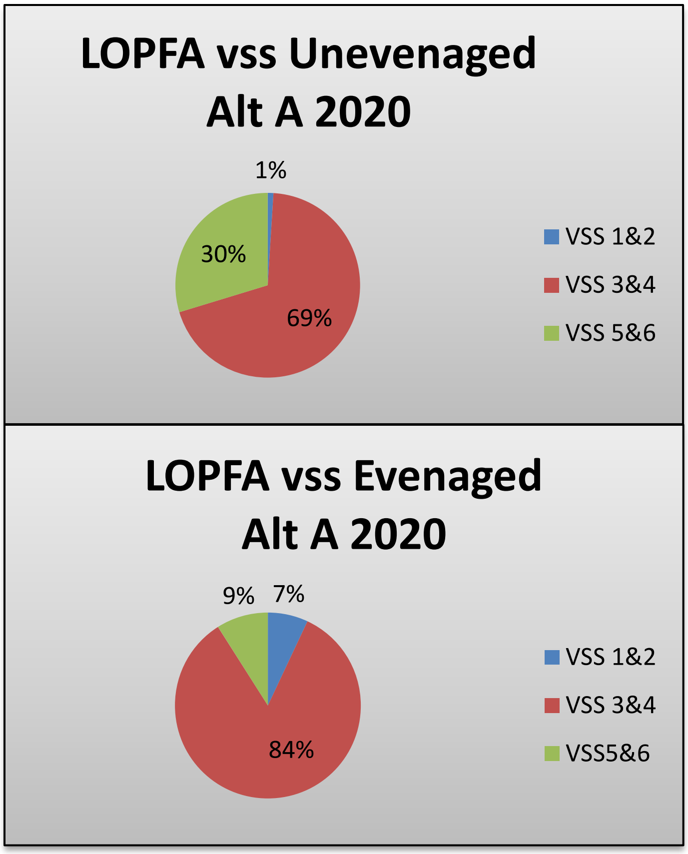



**Figure 37. Projected changes to LOPFA habitat post-treatment (2020) in Alternative A**

By 2050, overall VSS ratios would approach forest plan direction in even-aged LOPFA, but uneven-aged areas would not regenerate VSS 1 and 2 and VSS 3 and 4 would remain high, occupying about 50 percent of the LOPFA (Figure 38).

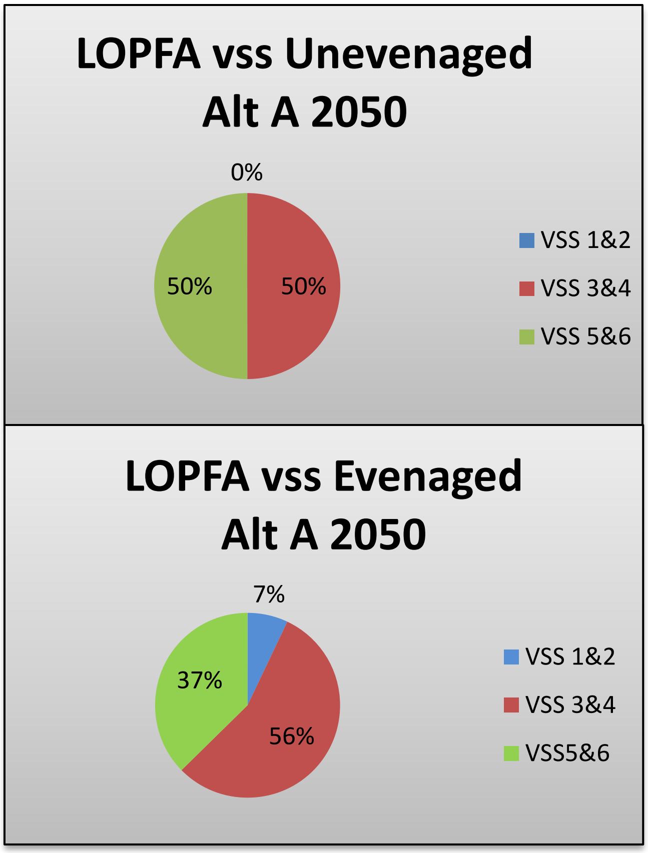



**Figure 38. Projected changes to LOPFA habitat 30 years post-treatment in Alternative A.**

#### Action Alternatives

Alternatives B and C would move the VSS balance in PFA habitat toward desired conditions through treatments designed to create goshawk habitat. By 2050 all action alternatives would create more VSS 5s and 6s than is described in the forest plans, but compared to the no action alternative, the treatments would move goshawk habitat in a trajectory towards desired conditions. Alternatives B and C would create more late successional habitat compared to alternative D. (Figure 39).

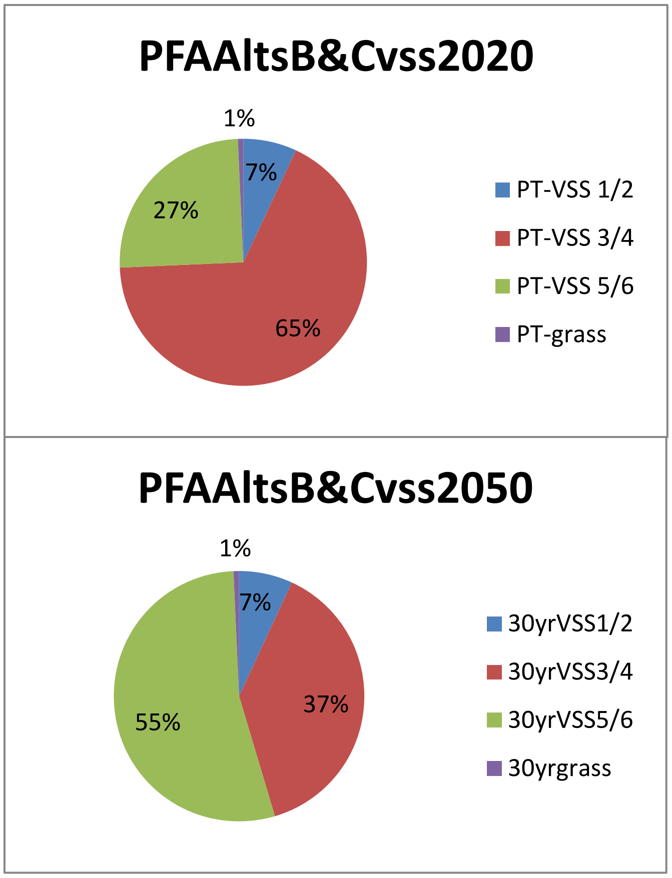
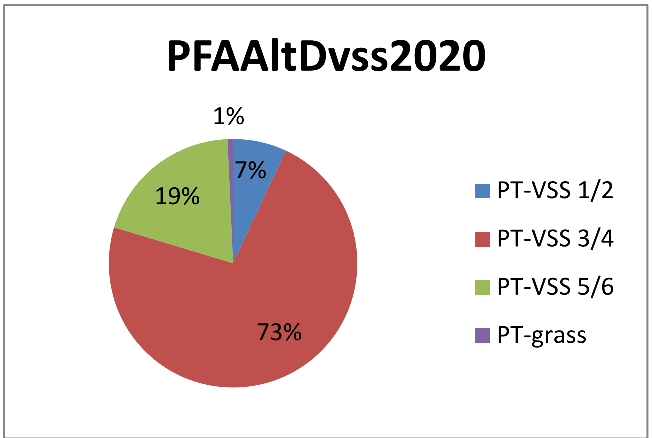



**Figure 39. Projected changes to PFA habitat post-treatment (2020) and 30 years post-treatment (2050) in Alternatives B and C**

Alternative D does not include as many acres of prescribed fire as the other action alternatives and would result in fewer acres of VSS 5 and 6 in PFA habitat (Figure 40).



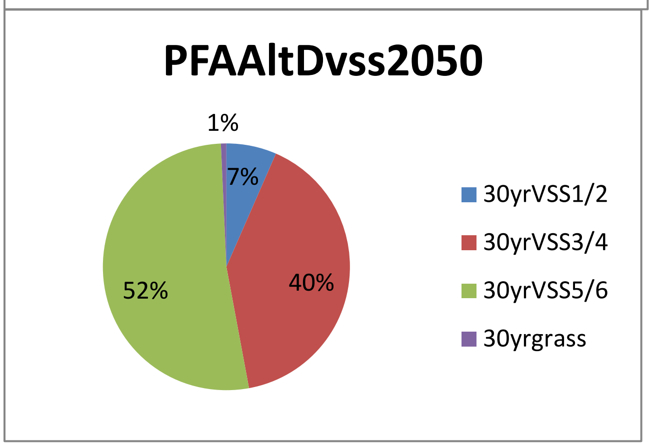




**Figure 40. Projected changes to PFA habitat post-treatment (2020) and 30 years post-treatment (2050) in Alternative D**

All action alternatives would move the VSS balance in PFA habitat toward desired conditions through treatments designed to enhance goshawk habitat. Alternatives B, C, and D would have similar results in moving the LOPFA toward balancing VSS ratios immediately post treatment (2020) by increasing the amounts of VSS 5 and 6 by primarily treating the abundant VSS 3 and 4 size-classes (Figure 41).

By 2050, all action alternatives would create more VSS 5 and 6s than is described in the forest plans, but compared to the no action alternative, the treatments would move goshawk habitat in a trajectory towards desired conditions. Prescribed burning in VSS 3 and 4 under alternatives B and C would move more acres into VSS 5 and 6 than would occur in alternative D (Figure 42). Post-treatment conditions would change the VSS distribution and promote an interspersion of regeneration groups and interspace, leading to future uneven-aged development within the existing forest. Under all scenarios, VSS 5 and 6 would exceed 50 percent of the landscape by the year 2050.

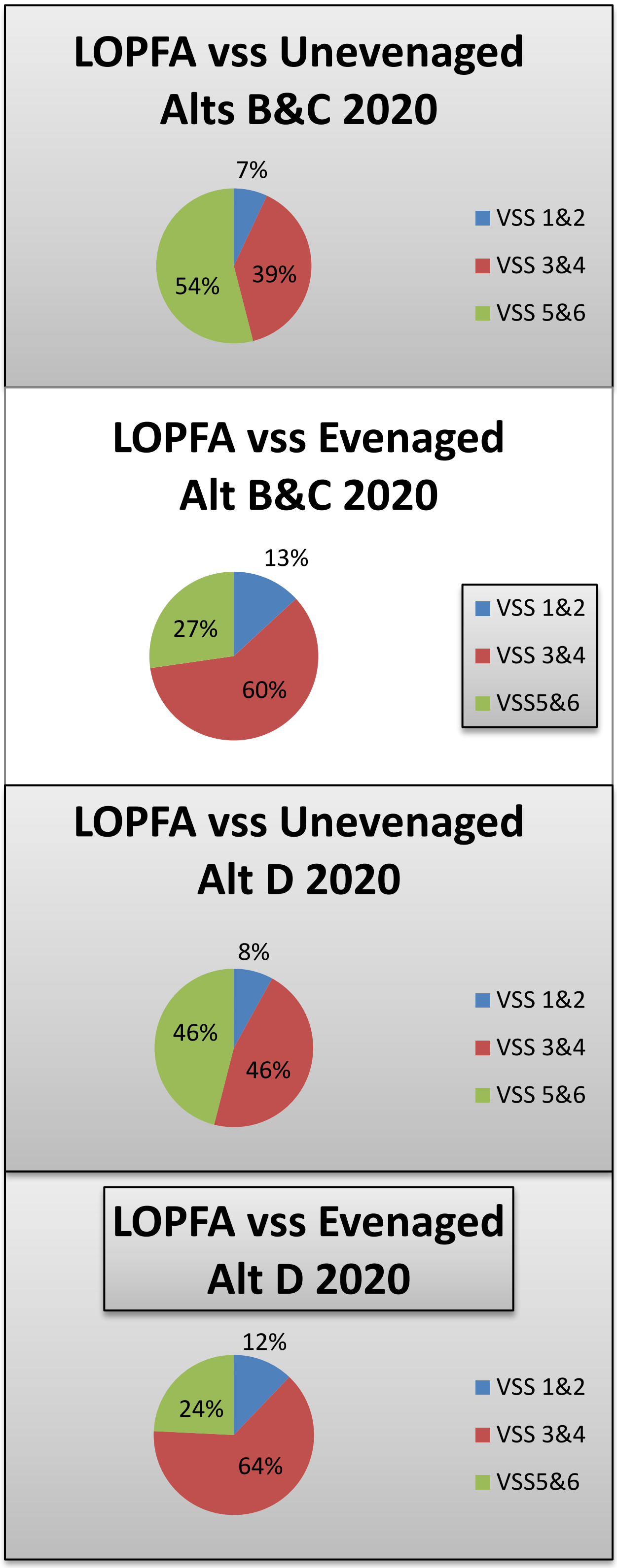



**Figure 41. Projected changes to LOPFA habitat post-treatment (2020) in Alternatives B, C, and D**

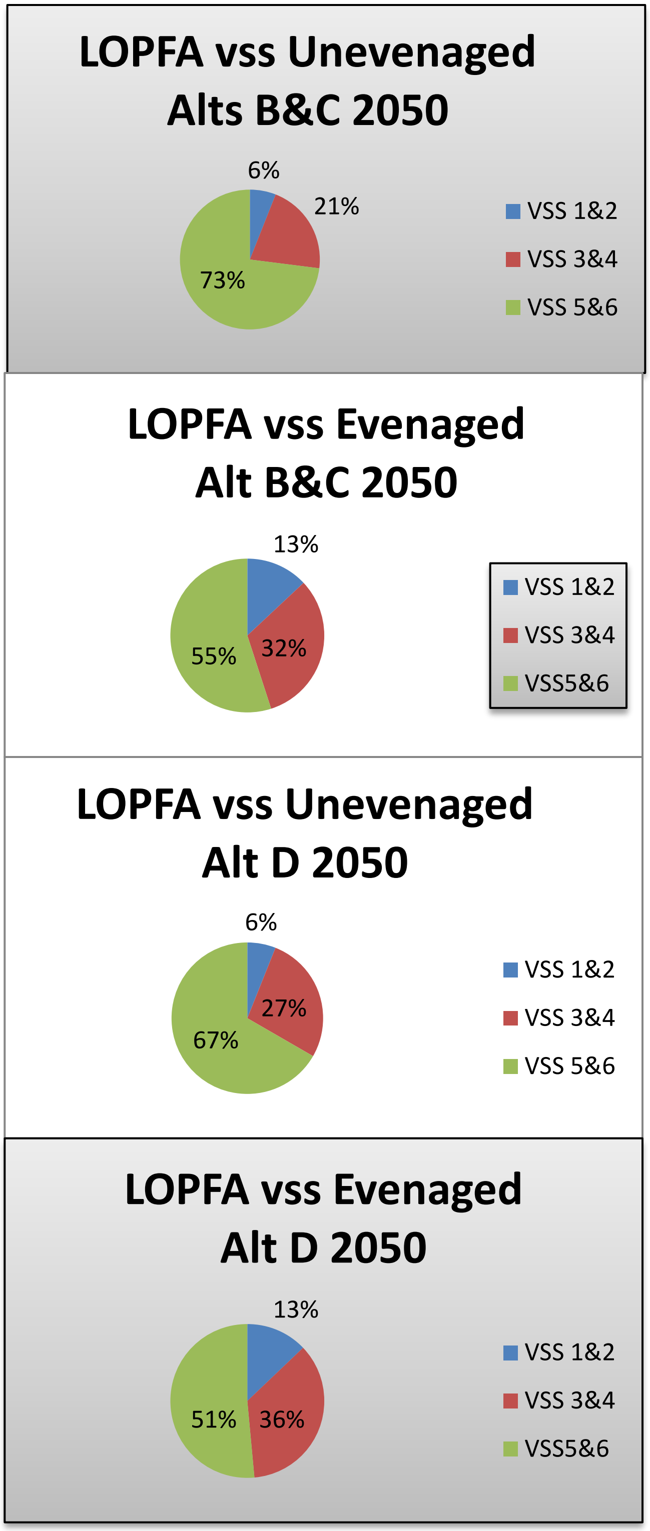



**Figure 42. Projected changes to LOPFA habitat 30 years post-treatment in Alternatives B, C, and D**

### *Analysis at the Subunit, Restoration Unit, and Landscape Scale*

When analyzed at the subunit scale, the changes in scale did not change the patterns of habitat response to proposed treatments. The analysis of VSS changes among the SUs is discussed in the silviculture specialist report for this project on pages 84 to pages 94. The existing conditions of VSS are listed in tables by SU and RU in appendix 9 of the wildlife report.

At the restoration unit scale, the trends in changes are similar as are the reasoning for the resultant cause and effect discussed above. The VSS distribution for the RU level is thoroughly analyzed in detail in the silvicultural specialist report (page 84 to page 89). See Appendix 10 of the wildlife report for pie charts displaying the relative percent of VSS by RU by alternative over time. These provide a visual picture of the relative changes to goshawk nesting habitat among the RUs.

At the landscape scale, the existing condition is again similar to the other goshawk strata analyzed above. The changes to the VSS distribution for the ponderosa pine vegetation in the treatment areas without consideration of special species status are similar to those seen at the various scales discussed above. Increases in VSS 5 and 6 for Alternative A would be caused by density induced mortality among the VSS 3 and 4 size trees.

Alternatives B and C show essentially identical changes at this scale. The changes in percent VSS are attributed to removing the VSS 3 and 4 size trees through mechanical harvest and prescribed burning and leaving the large trees that comprise VSS 5 and 6 Alternative D shows slightly less increase in VSS 5 and 6, or acres of large trees, due to the lack of prescribed burning in the dense VSS 3 and 4 size classes occupying the majority of the area (Figure 43).

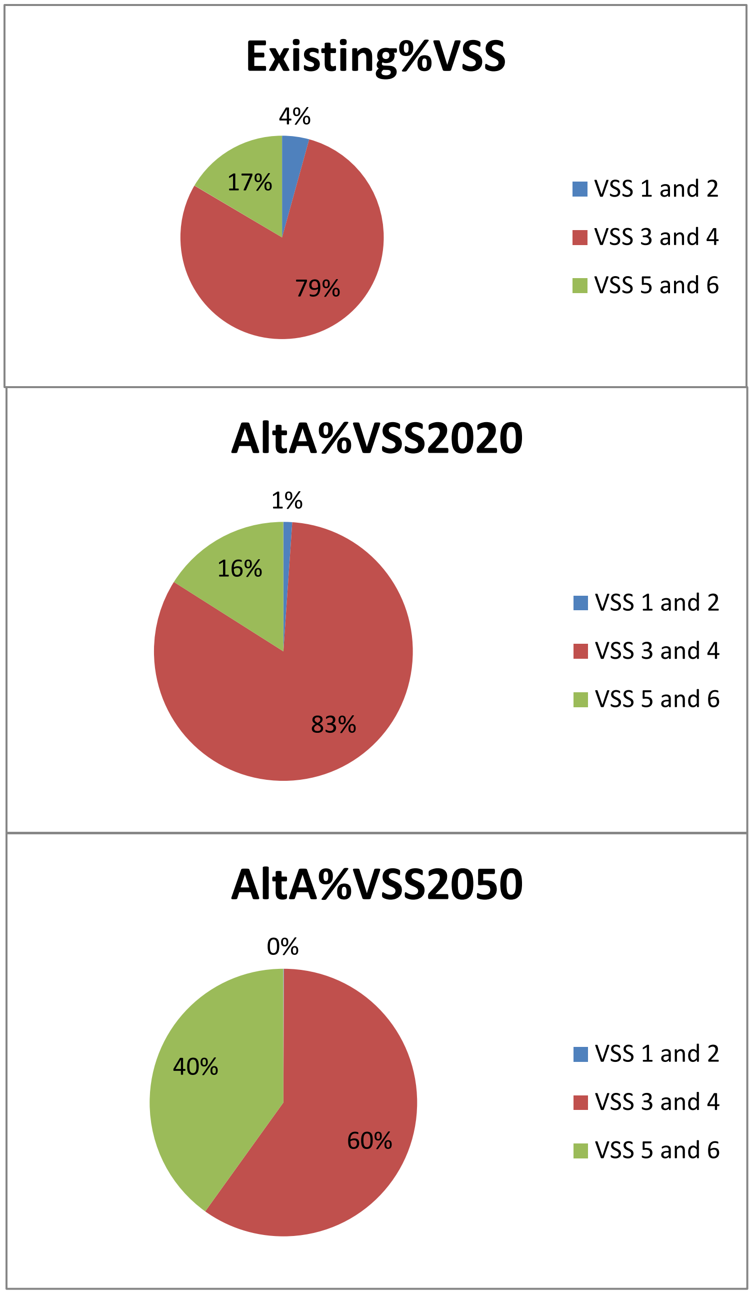



**Figure 43. Projected changes to VSS at the landscape for Alternative A post-treatment (2020) and 30 years post-treatment (2050)**

Alternatives B and C show essentially identical changes at this scale. The changes in percent VSS are attributed to removing the VSS 3 and 4 size trees through mechanical harvest and prescribed burning and leaving the large trees that comprise VSS 5 and 6 (Figure 44).

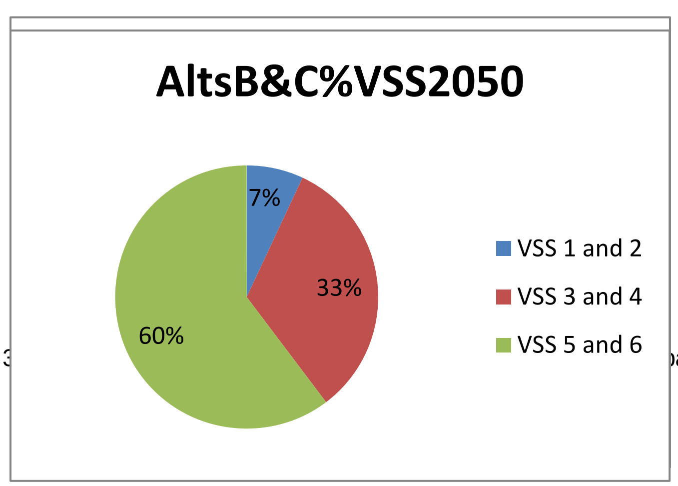
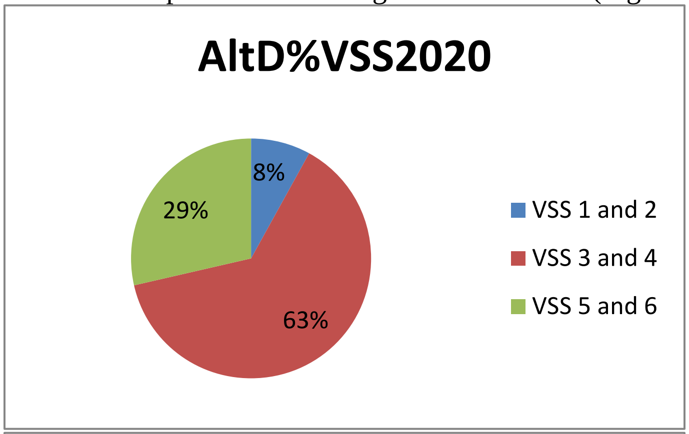


**Figure 44. Projected changes to VSS at the landscape scale for Alternatives B and C post-treatment (2020) and 30 years post-treatment (2050)**

Again, 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 (Figure 45).



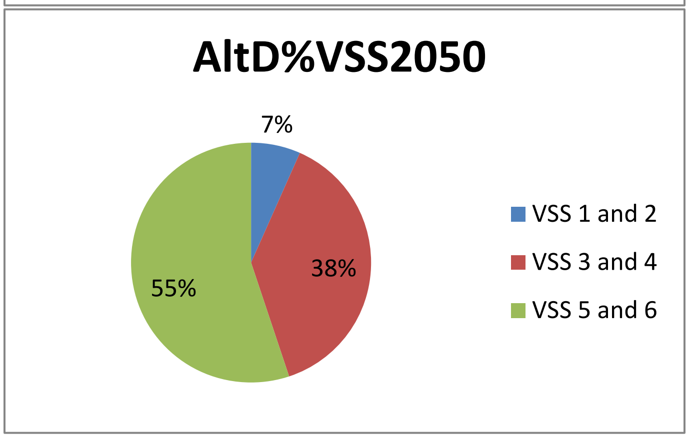




**Figure 45. Projected changes to VSS at the landscape scale for Alternative D post-treatment (2020) and 30 years post-treatment (2050)**

**Prey Habitat**

Following are discussions on additional physical features associated with habitat for prey species in ponderosa pine forest (Figure 46, Figure 47, and Figure 48). All of the alternatives ultimately increase the amount of CWD, which provides foraging habitat and cover for prey species. Although Alternatives B and C would result in an initial decrease in CWD posttreatment; all alternatives are within the range of 5-7 tons/ac of the desired condition for this habitat parameter by the year 2050 (Figure 46).

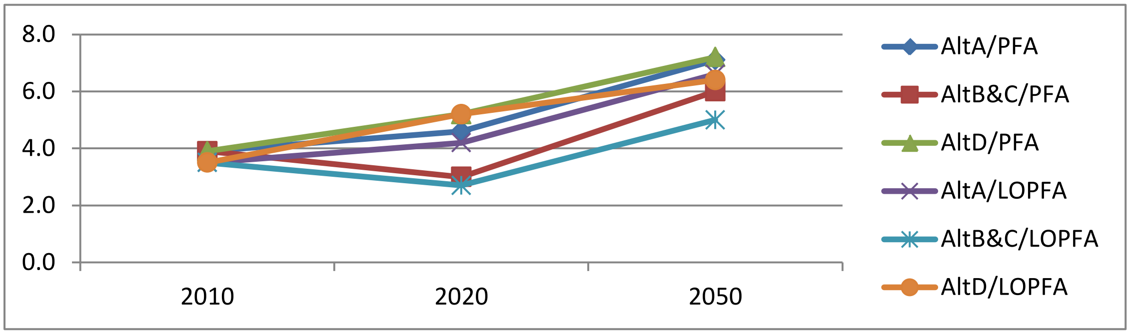



**Figure 46. Coarse woody debris (tons/ac) in PFA/LOPFA Habitats by Alternative**

Logs provide important habitat features for prey species, including substrate for foraging, den and nest sites, and cover. All of the action alternatives would provide as many or more logs than the no action alternative. More logs would be provided in PFA versus LOPFA habitat (Figure 47).

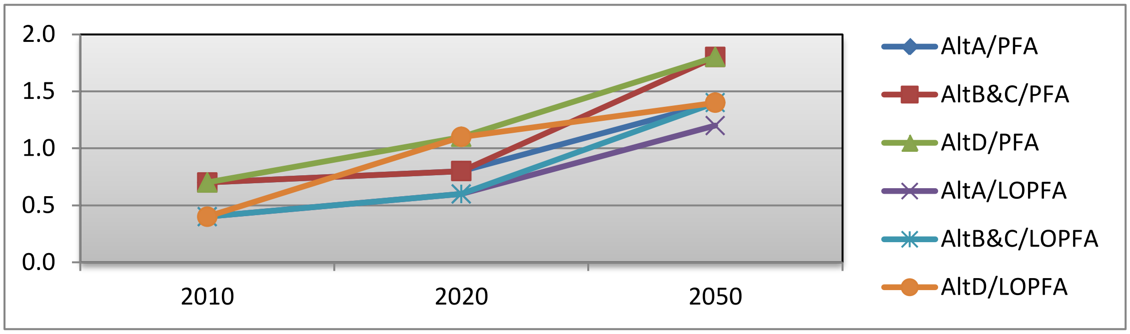



**Figure 47. Logs per acre in PFAand LOPFA habitats by Alternative**

Snags provide nesting and denning habitat, roosts, and foraging habitat for many bird and mammal species. Snag availability would be driven by treatment rather than by habitat. Alternatives B and C would create the most snags, alternative A the least, and alternative D would have snag levels between the former and latter treatments (Figure 48). Alternative A would increase in the amount of snags both in the PFA as well as in the LOPFA. Snags would be created by density induced mortality among the existing trees on the landscape, primarily from competition resulting from the VSS 3 and 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. All of the alternatives ultimately increase the amount of snags in PFAs and LOPFAs similarly by 2050.

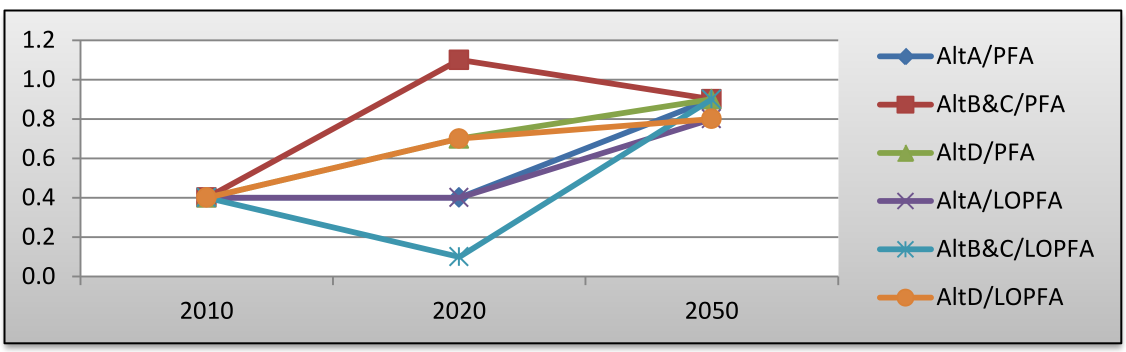



**Figure 48. Snags >18"dbh/ac in PFAand LOPFA habitats by Alternative**

Overall summaries of effects to late seral pine habitat, and changes to prey species habitat by alternative is presented in Table 115 and Table 116.

**Table 115. Summary of changes to northern goshawk prey species' habitat features by Alternative in 2050[1]**

| Prey Species Habitat Component | Measure | Existing Condition | Alternative A | Alternative B | Alternative C | Alternative D |
|---|---|---|---|---|---|---|
| Snags >18"dbh | Snags/ac | 0.4/ac – pfa/lopfa | 0.9/ac – pfa<br>0.8/ac - lopfa | 0.9/ac – pfa/ lopfa | | 0.9/ac – pfa<br>0.8/ac - lopfa |
| Downed Logs | CWD tons/ac >12"diameter | 0.7/ac – pfa<br>0.4/ac - lopfa | 1.4/ac – pfa<br>1.2/ac - lopfa | 1.8/ac pfa<br>1.4/ac - lopfa | | |
| Woody Debris | Tons/ac | 3.9/ac – pfa<br>3.5/ac - lopfa | 7.1/ac – pfa<br>6.6/ac lopfa | 6.0/ac – pfa<br>5.0/ac - lopfa | | 7.2/ac – pfa<br>6.4/ac - lopfa |
| Openings | Relevant to %SDI | 45% - pfa<br>40% - lopfa | 50% - pfa<br>46% - lopfa | 33% - pfa<br>27% - lopfa | | 36% - pfa<br>29% - lopfa |
| Large trees | % VSS 5 & 6 | 17% VSS 5&6 | 40% VSS 5 & 6 | 60% VSS 5 & 6 | | 55% VSS 5 & 6 |
| Herb, Shrub, Understory | lbs/ac biomass production | @ 100 lbs/ac | Decrease to @ 50 lbs/ac | Over 250 lbs/ac then back to 150 lbs/ac | | @ 250 lbs/ac then <150 lbs/ac |
| Interspersion of VSS | % age structure condition | 56% - Even-aged<br>44% - Uneven-aged | No change in ratio | For even-aged treatments, the general conditions will continue, with possibly one additional VSS. | | |

[1]Green indicates movement toward desired condition and red indicates movement away from desired condition. Brighter green indicates more of a move toward desired conditions.

**Table 116. Summary of Alternative Effects Relative to Reynolds et al (1992) Prey Species' Habitat Features**

| Proposed Activity | Alternative A – No Action | Alternative B – Proposed Action | Alternative C | Alternative D |
|---|---|---|---|---|
| Silviculture Treatments (UEA, IT, SI, savanna) | Overall decline in habitat quality as forest conditions deteriorate with continued dense conditions across the landscape<br><br>Net increase of acres of large trees, snags, logs, woody debris<br><br>Net decrease in herb, understory production and openings | Overall increase in habitat quantity and quality as forest conditions improve with less dense conditions across the landscape<br><br>Net increase in snags/ac, downed logs, and woody debris<br><br>Net increase in large tree component with increased acres of VSS 5&6<br><br>Net increase in herb/shrub/understory component with reduced tree density (TPA) and SDI (%SDI) as measured by biomass production<br><br>Net increase of openings with reduced SDI (%SDI) | | |

| Proposed Activity | Alternative A – No Action | Alternative B – Proposed Action | Alternative C | Alternative D |
|---|---|---|---|---|
| Prescribed Burning | No change in habitat quantity<br>Decreased biomass production due to continued dense conditions | Increased acres of large tree component from expected fire-associated mortality of competing younger trees<br>Rx fire would increase biomass production on those acres where it reduces tree densities allowing increased herb, shrub and understory quantity and thus improving prey species' habitat quality | | Less acres of Rx fire has effect of changing fewer acres to large tree than Alts B&C<br>Less acres of Rx fire would have effect of slightly less biomass production than Alts B&C due to tree densities |
| Research | NA | NA | No discernible impact to prey species' habitat at the subunit scale and larger | NA |
| MSO PACs | No change in quantity or quality of habitat | Net improved habitat with silvicultural treatments and Rx fire | Net improved habitat with silvicultural treatments and Rx fire | Less improved habitat with less Rx fire. |
| Spring, seep, channel restoration | No change in quantity or quality of habitat | Localized improvement to prey species' habitat by improving available water within habitat | | |
| Road Decommission | No change in quantity or quality of habitat | Localized improvements in quality and quality of habitat due to eliminated disturbance associated with road useand reduced resource damage and areas of reclaimed habitat<br>Long-term improvements to habitat features | | |
| Temporary Road Construction | No change in quantity or quality of habitat | Localized decrease in habitat quantity and quality in immediate vicinity of road alignments with creation of linear vegetative disturbance and subsequent road use. | | |
| Road Reconstruction | No change in quantity or quality of habitat | Potential improvement to prey species' habitat structure by moving roads out of drainages | | |
| Mechanically treat and burn Aspen | No change in quantity or quality of habitat | Improved habitat quality for red-naped sapsucker | Improved habitat quality for red-naped sapsucker | Less improvement of habitat with less Rx fire |

**Direct and Indirect Effects**

Direct effects are those caused by the action and occur at the same time and place.. For Alternative A, with no actions occurring, there would not be any direct effects from that alternative. For the Action Alternatives, implementing a breeding season timing restriction (BSTR) for activities occurring within the goshawk PFAs would eliminate most of the potential for direct effects to goshawks from all of the proposed activities. The breeding season timing restriction is taken directly from the forest plans and limits human activity within the PFA from March 1 through September 30 each year. If territories are monitored and found to be unoccupied, the breeding season timing restriction may be suspended for that particular season.

The forest plans allow for **prescribed burning** to occur within PFAs during the breeding season. The direct effect of this would be smoke inhalation by incubating adults or nestlings or extended absence of the adults from the nest during brooding or when the chicks are very young. This threat is larger during first-entry burning but maintenance burning is not considered a risk because this species evolved with a fire adapted ecosystem.

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 has been addressed in the preceding analyses and is also addressed in the MIS analysis.

Following are site specific details regarding the effects of the various proposed activities. The total acres treated within PFAs are listed by alternative in Table 117. The amount of acres proposed for treatment in alternative B is comparable to alternative C; alternative D has the least amount of acres treated within PFAs due to the reduced number of acres proposed for prescribed burning. With BSTR on all mechanical treatments, the main difference among the action alternatives for this particular action will be the reduced effects from smoke in alternative D. Alternative A would not have any impacts from prescribed burning. However, 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.

Forest-wide acres of occupied goshawk habitat were estimated by summing total acres of PFA with their associated nest stands by individual forest. In total, the Coconino NF has 45,415 acres of occupied goshawk habitat and activities under alternative B would treat about 38 percent of the forest-wide occupied habitat. On the Kaibab NF there are 124,938 acres of occupied goshawk habitat forest-wide (the substantial difference in forest-wide occupied habitat between forests is largely due to the Kaibab NF hosting over 20 years of goshawk research on the North Kaibab Ranger District). Alternative B would treat about 11 percent of the forest-wide occupied goshawk habitat on the Kaibab NF.

**Table 117. Percent of Acres treated within individual PFAs under Alternative B**

| PFA | Acres Treated | PFA Acres | % Treated |
|---|---|---|---|
| PFA_Alto_030402009 | 494 | 588 | 84 |
| PFA_Ashurst_030405018 | 682 | 682 | 100 |
| PFA_Badger_030402016 | 630 | 630 | 100 |
| PFA_Beale_030702009 | 635 | 635 | 100 |
| PFA_Bear_030405012 | 642 | 642 | 100 |
| PFA_Big_Spring_030702022 | 604 | 604 | 100 |
| PFA_Blackjack_030405004 | 526 | 617 | 85 |
| PFA_Boulin_Tank_030702014 | 596 | 596 | 100 |
| PFA_Camp_36_030704001 | 649 | 649 | 100 |
| PFA_Casner_Cabin_030402003 | 335 | 652 | 51 |
| PFA_Cherry_Canyon_030405020 | 588 | 632 | 93 |
| PFA_Corner_030402017 | 637 | 726 | 88 |

| PFA | Acres Treated | PFA Acres | % Treated |
|---|---|---|---|
| PFA_Cowhill_030407002 | 632 | 632 | 100 |
| PFA_Coxcombs_030702028 | 624 | 624 | 100 |
| PFA_Coyote_Basin_030405014 | 516 | 612 | 84 |
| PFA_Crater_030402014 | 566 | 691 | 82 |
| PFA_Devil_Dog_030701015 | 410 | 602 | 68 |
| PFA_El_Paso_030702002 | 596 | 596 | 100 |
| PFA_Fort_Valley_030402012 | 602 | 903 | 67 |
| PFA_Grandview_030704007 | 157 | 157 | 100 |
| PFA_Hammer_030704002 | 393 | 862 | 46 |
| PFA_Horseshoe_030402023 | 745 | 745 | 100 |
| PFA_Jackass_North_030701009 | 145 | 652 | 22 |
| PFA_Juniper_Ridge_030702005 | 591 | 591 | 100 |
| PFA_Kaibab_Lake_East_030702016 | 620 | 620 | 100 |
| PFA_Kaibab_Lake_West_030701001 | 655 | 655 | 100 |
| PFA_Kaufman_030702017 | 106 | 617 | 17 |
| PFA_Kennedy_Dam_030701008 | 642 | 649 | 99 |
| PFA_Long_Jim_030704010 | 753 | 753 | 100 |
| PFA_Lost_Spring_Tank_030702007 | 648 | 648 | 100 |
| PFA_Mars_030402022 | 227 | 558 | 41 |
| PFA_Marteen_030702004 | 751 | 751 | 100 |
| PFA_Mason_030405011 | 626 | 626 | 100 |
| PFA_Mud_030405010 | 661 | 775 | 85 |
| PFA_Newman_030405016 | 642 | 642 | 100 |
| PFA_Orion_030402025 | 386 | 777 | 50 |
| PFA_Path_030402026 | 610 | 610 | 100 |
| PFA_Phillips_110_030701004 | 354 | 637 | 56 |
| PFA_Porkchops_030402024 | 718 | 718 | 100 |
| PFA_Pumphouse_030405007 | 239 | 643 | 37 |
| PFA_Pumpkin_030702030 | 227 | 671 | 34 |
| PFA_Racetrack_030405013 | 493 | 679 | 73 |
| PFA_Reese_030402008 | 437 | 573 | 76 |
| PFA_Roadside_030405009 | 762 | 762 | 100 |
| PFA_Schultz_Pass_030402006 | 394 | 641 | 62 |
| PFA_Sheep_Spring_030405024 | 470 | 604 | 78 |
| PFA_Sitgreaves_030702006 | 667 | 667 | 100 |
| PFA_Squaw_030702029 | 612 | 612 | 100 |
| PFA_Stage_Station_030701010 | 501 | 530 | 95 |
| PFA_T_Six_030405001 | 526 | 631 | 83 |
| PFA_Thicket_030405006 | 536 | 650 | 83 |
| PFA_Three_Sisters_030701014 | 314 | 733 | 43 |
| PFA_Trail_030704005 | 135 | 677 | 20 |
| PFA_Tree_Spring_030405019 | 565 | 642 | 88 |

| PFA | Acres Treated | PFA Acres | % Treated |
|---|---|---|---|
| PFA_Tule_Tank_Wash_030701012 | 635 | 635 | 100 |
| PFA_Volunteer_030702025 | 360 | 360 | 100 |
| PFA_Walker_Hill_030402002 | 612 | 612 | 100 |
| PFA_White_Horse_030402007 | 462 | 804 | 58 |
| PFA_Wing_West_###### | 201 | 623 | 32 |
| PFA-D_Dispersal01 | 624 | 624 | 100 |
| PFA-D_Dispersal03 | 608 | 608 | 100 |
| PFA-D_Dispersal04 | 558 | 601 | 93 |
| PFA-D_Dispersal06 | 529 | 630 | 84 |
| PFA-D_Dispersal07 | 613 | 613 | 100 |
| PFA-D_Dispersal08 | 627 | 627 | 100 |
| PFA-D_Dispersal09 | 625 | 625 | 100 |
| PFA-D_Dispersal10 | 612 | 612 | 100 |
| PFA-D_Dispersal11 | 573 | 630 | 91 |
| PFA-D_Dispersal13 | 627 | 629 | 100 |
| PFA-D_Dispersal17 | 600 | 600 | 100 |
| PFA-D_Dispersal18 | 631 | 631 | 100 |
| PFA-D_Dispersal19 | 621 | 621 | 100 |
| PFA-D_Dispersal20 | 180 | 627 | 29 |
| PFA-D_Dispersal21 | 610 | 610 | 100 |
| PFA-D_Dispersal23 | 616 | 616 | 100 |
| PFA-D_Dispersal26 | 267 | 594 | 45 |
| PFA-D_Dispersal27 | 602 | 602 | 100 |
| TOTAL | 40,665 | 49,205 | 83 |

Alternative C would treat about 39 percent of the forest-wide occupied habitat on the Coconino NF (Table 118). Alternative C would treat about 11 percent of the forest-wide occupied goshawk habitat on the Kaibab NF (treated acres of PFA habitat on the Kaibab is the same for all alternatives).

**Table 118. Percent of Acres treated within individual PFAs under Alternative C**

| PFA | Acres Treated | PFA Acres | % Treated |
|---|---|---|---|
| PFA_Alto_030402009 | 494 | 588 | 84 |
| PFA_Ashurst_030405018 | 682 | 682 | 100 |
| PFA_Badger_030402016 | 630 | 630 | 100 |
| PFA_Beale_030702009 | 635 | 635 | 100 |
| PFA_Bear_030405012 | 642 | 642 | 100 |
| PFA_Big_Spring_030702022 | 604 | 604 | 100 |
| PFA_Blackjack_030405004 | 617 | 617 | 100 |
| PFA_Boulin_Tank_030702014 | 596 | 596 | 100 |
| PFA_Camp_36_030704001 | 649 | 649 | 100 |

| PFA | Acres Treated | PFA Acres | % Treated |
|---|---|---|---|
| PFA_Casner_Cabin_030402003 | 335 | 652 | 51 |
| PFA_Cherry_Canyon_030405020 | 588 | 632 | 93 |
| PFA_Corner_030402017 | 726 | 726 | 100 |
| PFA_Cowhill_030407002 | 632 | 632 | 100 |
| PFA_Coxcombs_030702028 | 624 | 624 | 100 |
| PFA_Coyote_Basin_030405014 | 612 | 612 | 100 |
| PFA_Crater_030402014 | 566 | 691 | 82 |
| PFA_Devil_Dog_030701015 | 410 | 602 | 68 |
| PFA_El_Paso_030702002 | 596 | 596 | 100 |
| PFA_Fort_Valley_030402012 | 602 | 903 | 67 |
| PFA_Grandview_030704007 | 157 | 157 | 100 |
| PFA_Hammer_030704002 | 393 | 862 | 46 |
| PFA_Horseshoe_030402023 | 745 | 745 | 100 |
| PFA_Jackass_North_030701009 | 145 | 652 | 22 |
| PFA_Juniper_Ridge_030702005 | 591 | 591 | 100 |
| PFA_Kaibab_Lake_East_030702016 | 620 | 620 | 100 |
| PFA_Kaibab_Lake_West_030701001 | 655 | 655 | 100 |
| PFA_Kaufman_030702017 | 106 | 617 | 17 |
| PFA_Kennedy_Dam_030701008 | 642 | 649 | 99 |
| PFA_Long_Jim_030704010 | 753 | 753 | 100 |
| PFA_Lost_Spring_Tank_030702007 | 648 | 648 | 100 |
| PFA_Mars_030402022 | 227 | 558 | 41 |
| PFA_Marteen_030702004 | 751 | 751 | 100 |
| PFA_Mason_030405011 | 626 | 626 | 100 |
| PFA_Mud_030405010 | 775 | 775 | 100 |
| PFA_Newman_030405016 | 642 | 642 | 100 |
| PFA_Orion_030402025 | 386 | 777 | 50 |
| PFA_Path_030402026 | 610 | 610 | 100 |
| PFA_Phillips_110_030701004 | 354 | 637 | 56 |
| PFA_Porkchops_030402024 | 718 | 718 | 100 |
| PFA_Pumphouse_030405007 | 239 | 643 | 37 |
| PFA_Pumpkin_030702030 | 227 | 671 | 34 |
| PFA_Racetrack_030405013 | 679 | 679 | 100 |

| PFA | Acres Treated | PFA Acres | % Treated |
|---|---|---|---|
| PFA_Reese_030402008 | 437 | 573 | 76 |
| PFA_Roadside_030405009 | 762 | 762 | 100 |
| PFA_Schultz_Pass_030402006 | 394 | 641 | 62 |
| PFA_Sheep_Spring_030405024 | 604 | 604 | 100 |
| PFA_Sitgreaves_030702006 | 667 | 667 | 100 |
| PFA_Squaw_030702029 | 612 | 612 | 100 |
| PFA_Stage_Station_030701010 | 501 | 530 | 95 |
| PFA_T_Six_030405001 | 631 | 631 | 100 |
| PFA_Thicket_030405006 | 569 | 650 | 88 |
| PFA_Three_Sisters_030701014 | 314 | 733 | 43 |
| PFA_Trail_030704005 | 135 | 677 | 20 |
| PFA_Tree_Spring_030405019 | 642 | 642 | 100 |
| PFA_Tule_Tank_Wash_030701012 | 635 | 635 | 100 |
| PFA_Volunteer_030702025 | 360 | 360 | 100 |
| PFA_Walker_Hill_030402002 | 612 | 612 | 100 |
| PFA_White_Horse_030402007 | 462 | 804 | 58 |
| PFA_Wing_West_###### | 201 | 623 | 32 |
| PFA-D_Dispersal01 | 624 | 624 | 100 |
| PFA-D_Dispersal03 | 608 | 608 | 100 |
| PFA-D_Dispersal04 | 558 | 601 | 93 |
| PFA-D_Dispersal06 | 630 | 630 | 100 |
| PFA-D_Dispersal07 | 613 | 613 | 100 |
| PFA-D_Dispersal08 | 627 | 627 | 100 |
| PFA-D_Dispersal09 | 625 | 625 | 100 |
| PFA-D_Dispersal10 | 612 | 612 | 100 |
| PFA-D_Dispersal11 | 573 | 630 | 91 |
| PFA-D_Dispersal13 | 627 | 629 | 100 |
| PFA-D_Dispersal17 | 600 | 600 | 100 |
| PFA-D_Dispersal18 | 631 | 631 | 100 |
| PFA-D_Dispersal19 | 621 | 621 | 100 |
| PFA-D_Dispersal20 | 180 | 627 | 29 |
| PFA-D_Dispersal21 | 610 | 610 | 100 |
| PFA-D_Dispersal23 | 616 | 616 | 100 |

| PFA | Acres Treated | PFA Acres | % Treated |
|---|---|---|---|
| PFA-D_Dispersal26 | 319 | 594 | 54 |
| PFA-D_Dispersal27 | 602 | 602 | 100 |
| TOTAL | 41,745 | 49,205 | 85 |

Alternative D would treat about 33 percent of the forest-wide occupied habitat on the Coconino NF (Table 119). Alternative D would treat about 11 percent of the forest-wide occupied goshawk habitat on the Kaibab NF (treated acres of PFA habitat on the Kaibab is the same for all alternatives).

**Table 119. Percent of Acres treated within individual PFAs under Alternative D (Least acres treated for any alternative)**

| PFA | Acres Treated | PFA Acres | % Treated |
|---|---|---|---|
| PFA_Alto_030402009 | 494 | 588 | 84 |
| PFA_Ashurst_030405018 | 682 | 682 | 100 |
| PFA_Badger_030402016 | 630 | 630 | 100 |
| PFA_Beale_030702009 | 635 | 635 | 100 |
| PFA_Bear_030405012 | 551 | 642 | 86 |
| PFA_Big_Spring_030702022 | 604 | 604 | 100 |
| PFA_Blackjack_030405004 | 336 | 617 | 55 |
| PFA_Boulin_Tank_030702014 | 596 | 596 | 100 |
| PFA_Camp_36_030704001 | 649 | 649 | 100 |
| PFA_Casner_Cabin_030402003 | 238 | 652 | 36 |
| PFA_Cherry_Canyon_030405020 | 588 | 632 | 93 |
| PFA_Corner_030402017 | 637 | 726 | 88 |
| PFA_Cowhill_030407002 | 632 | 632 | 100 |
| PFA_Coxcombs_030702028 | 624 | 624 | 100 |
| PFA_Coyote_Basin_030405014 | 370 | 612 | 61 |
| PFA_Crater_030402014 | 351 | 691 | 51 |
| PFA_Devil_Dog_030701015 | 410 | 602 | 68 |
| PFA_El_Paso_030702002 | 596 | 596 | 100 |
| PFA_Fort_Valley_030402012 | 602 | 903 | 67 |
| PFA_Grandview_030704007 | 157 | 157 | 100 |
| PFA_Hammer_030704002 | 393 | 862 | 46 |
| PFA_Horseshoe_030402023 | 745 | 745 | 100 |
| PFA_Jackass_North_030701009 | 145 | 652 | 22 |

| PFA | Acres Treated | PFA Acres | % Treated |
|---|---|---|---|
| PFA_Juniper_Ridge_030702005 | 591 | 591 | 100 |
| PFA_Kaibab_Lake_East_030702016 | 620 | 620 | 100 |
| PFA_Kaibab_Lake_West_030701001 | 655 | 655 | 100 |
| PFA_Kaufman_030702017 | 106 | 617 | 17 |
| PFA_Kennedy_Dam_030701008 | 642 | 649 | 99 |
| PFA_Long_Jim_030704010 | 753 | 753 | 100 |
| PFA_Lost_Spring_Tank_030702007 | 648 | 648 | 100 |
| PFA_Mars_030402022 | 227 | 558 | 41 |
| PFA_Marteen_030702004 | 751 | 751 | 100 |
| PFA_Mason_030405011 | 626 | 626 | 100 |
| PFA_Mud_030405010 | 262 | 775 | 34 |
| PFA_Newman_030405016 | 642 | 642 | 100 |
| PFA_Orion_030402025 | 136 | 777 | 17 |
| PFA_Path_030402026 | 487 | 610 | 80 |
| PFA_Phillips_110_030701004 | 354 | 637 | 56 |
| PFA_Porkchops_030402024 | 718 | 718 | 100 |
| PFA_Pumphouse_030405007 | 239 | 643 | 37 |
| PFA_Pumpkin_030702030 | 227 | 671 | 34 |
| PFA_Racetrack_030405013 | 130 | 679 | 19 |
| PFA_Reese_030402008 | 437 | 573 | 76 |
| PFA_Roadside_030405009 | 762 | 762 | 100 |
| PFA_Schultz_Pass_030402006 | 394 | 641 | 62 |
| PFA_Sheep_Spring_030405024 | 250 | 604 | 41 |
| PFA_Sitgreaves_030702006 | 667 | 667 | 100 |
| PFA_Squaw_030702029 | 612 | 612 | 100 |
| PFA_Stage_Station_030701010 | 501 | 530 | 95 |
| PFA_T_Six_030405001 | 526 | 631 | 83 |
| PFA_Thicket_030405006 | 275 | 650 | 42 |
| PFA_Three_Sisters_030701014 | 314 | 733 | 43 |
| PFA_Trail_030704005 | 135 | 677 | 20 |
| PFA_Tree_Spring_030405019 | 565 | 642 | 88 |
| PFA_Tule_Tank_Wash_030701012 | 635 | 635 | 100 |
| PFA_Volunteer_030702025 | 360 | 360 | 100 |

| PFA | Acres Treated | PFA Acres | % Treated |
|---|---|---|---|
| PFA_Walker_Hill_030402002 | 612 | 612 | 100 |
| PFA_White_Horse_030402007 | 462 | 804 | 58 |
| PFA_Wing_West_###### | 201 | 623 | 32 |
| PFA-D_Dispersal01 | 624 | 624 | 100 |
| PFA-D_Dispersal03 | 608 | 608 | 100 |
| PFA-D_Dispersal04 | 558 | 601 | 93 |
| PFA-D_Dispersal06 | 529 | 630 | 84 |
| PFA-D_Dispersal07 | 613 | 613 | 100 |
| PFA-D_Dispersal08 | 627 | 627 | 100 |
| PFA-D_Dispersal09 | 625 | 625 | 100 |
| PFA-D_Dispersal10 | 612 | 612 | 100 |
| PFA-D_Dispersal11 | 573 | 630 | 91 |
| PFA-D_Dispersal13 | 627 | 629 | 100 |
| PFA-D_Dispersal17 | 600 | 600 | 100 |
| PFA-D_Dispersal18 | 631 | 631 | 100 |
| PFA-D_Dispersal19 | 621 | 621 | 100 |
| PFA-D_Dispersal20 | 180 | 627 | 29 |
| PFA-D_Dispersal21 | 610 | 610 | 100 |
| PFA-D_Dispersal23 | 616 | 616 | 100 |
| PFA-D_Dispersal26 | 0 | 594 | 0 |
| PFA-D_Dispersal27 | 602 | 602 | 100 |
| TOTAL | 38,045 | 49,205 | 77 |

Of the 59 PFAs being treated within the project area, half of them will have their entire territories treated by mechanical or prescribed burning in Alternatives B and C. Nine PFAs would have less than half of their territories treated. Seventeen PFAs would have less than three quarters of their territories treated. 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. Alternatives B and C would move the most acres of PFA habitat towards desired conditions with the combination of mechanical and prescribed fire treatments. Alternative D would move slightly fewer acres towards desired conditions. Alternative A would change some physical features of habitat as discussed earlier, but would not improve the quality of the habitat.

**Temporary road** mileage would be the same under all action alternatives. About 32 miles of temporary roads would be constructed within 25 known occupied PFAs and 8.7 miles would be used within 8 dispersal PFAs:  19 PFAs (26 percent) would have less than 1 mile of temporary road construction; 11 PFAs (15 percent) would have 1 to 2 miles of temporary road construction; and 3 PFAs (4 percent) would have more than 2 miles of temporary road construction. Forty (55 percent) PFAs in the project area would have no temporary road construction (Table 120). About eight miles of temporary road would be constructed within nest stands. Two PFAs would have more than 1 mile of temporary road construction within nest stands. 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 BSTR would eliminate disturbance impacts to nesting goshawks.

**Table 120. Temporary road construction in PFAs**

| Miles of temporary Road Construction | Number of PFAs impacted |
|---|---|
| 0 miles of temporary road construction | 40 |
| <1 miles of temporary road construction | 19 |
| 1-2 miles of temporary road construction | 11 |
| >2 miles of temporary road construction | 3 |

**Relocating road segments** accounts for about 0.7 miles of road within 9 PFAs. Four nest stands would be impacted by about 0.2 miles of relocated road. The impacts from relocated roads are similar to those associated with temporary roads. The new road alignments would move the disturbance associated with the road use to the adjusted location. With each mile of road impacting approximately 3 acres, about 2 acres of habitat would be impacted per PFA with road relocations. No acres would be impacted in Alternative A. Road relocation would occur outside the nest season and would be done to protect natural resources currently being negatively impacted by the road or in cases of improving public safety.

**Decommissioning** 904 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 the 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 beyond the immediate area of the road for the goshawk and its prey species. With each miles of road impacting approximately 3 acres of habitat or about 2,712 total acres, may be impacted. This would not have a discernible impact to goshawk habitat across the landscape. Implementing these activities under the BSTR would eliminate disturbance to nesting goshawks. 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.

While 59 PFAs are identified for treatments, 73 PFAs would have some sort of **hauling** occurring through the PFA (). About 21 percent of the PFAs (15) 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 the BSTR on the haul routes through all but three of the PFAs, the impact from hauling through the PFAs would be limited to occurring outside of the breeding season when most goshawks are not in their territories. For the majority of the PFAs, a BSTR would alleviate both disturbance impacts to nesting and breeding behavior as well as the potential for goshawk collision with equipment implementing commercial mechanical treatments.

**Table 121. Miles of roads in PFAs**

| Miles of haul roads in PFA | Number of PFAs |
|---|---|
| 0-0.9 mile of haul road | 15 |
| 1 - 1.9 miles of haul roads | 15 |

| Miles of haul roads in PFA | Number of PFAs |
|---|---|
| 2.0 – 2.9 miles of haul roads | 25 |
| 3.0 – 3.9 miles of haul roads | 10 |
| 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 this area 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. Most of the material is expected to move through the Devil Dog PFA which is adjacent to and straddles I-40. Vehicular noise disturbance is not likely to interfere with reproduction or rearing of young with this pair of goshawks because of the proximity of I-40 ().

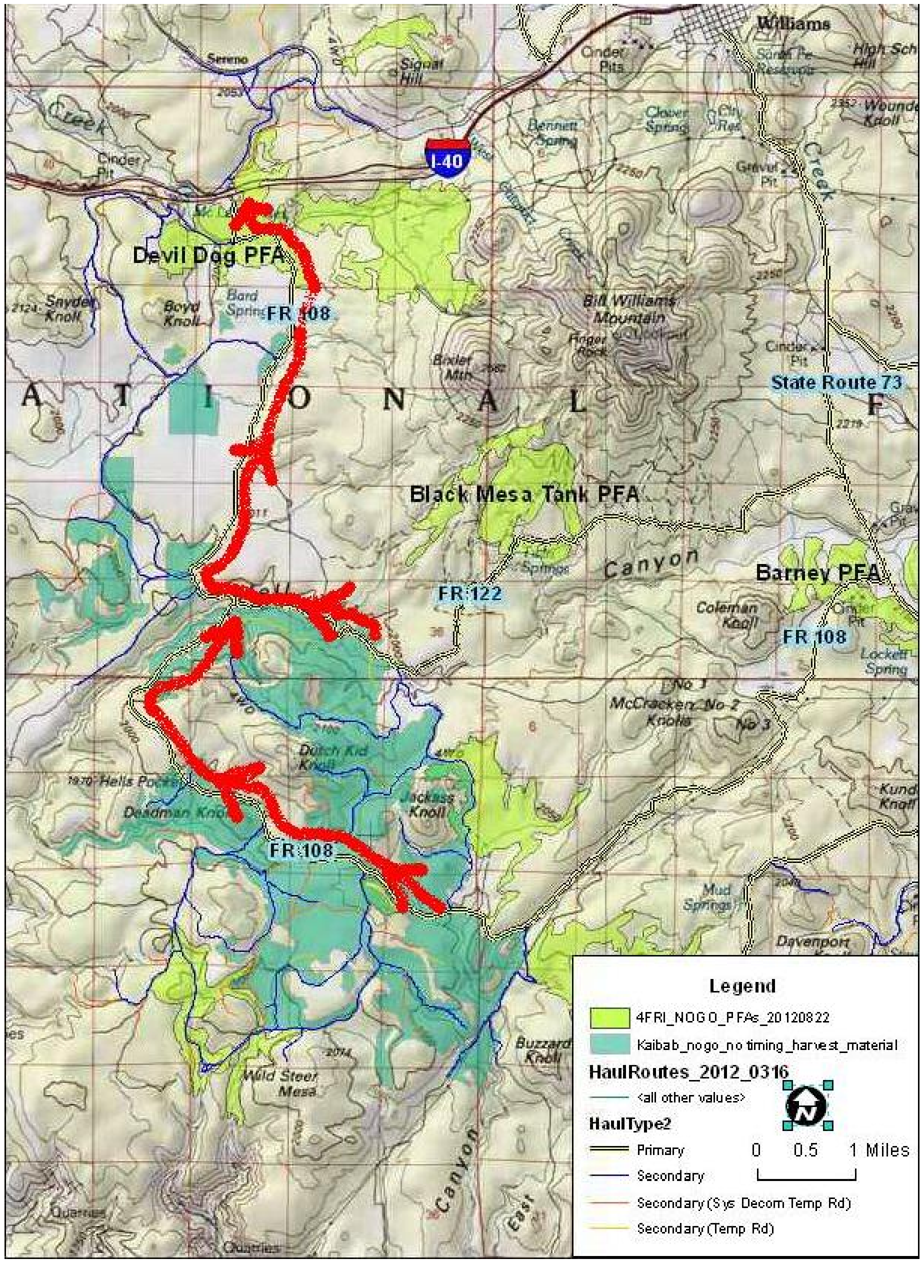



**Figure 49. Likely haul route (red line) and PFAs Without Timing Restrictions That Could Potentially be Affected by Hauling**

Most, if not all the truck trips would pass through the Devil Dog PFA which is adjacent to Interstate 40. Some material could still be taken through either Barney 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 (Reynolds pers. comm.). 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 pass through up to two of the above three PFAs during the nesting season. Goshawk surveys would be done before hauling to evaluate occupancy and location of avtive nests in these three PFAs.

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. In summary, hauling may cause no noise disturbance to goshawks, but there is potential to disrupt reproduction and rearing of young by, at most, one to two pairs of goshawks. Reducing potential disturbance from between zero to two PFAs out of 73 total PFAs meets forest plan direction “to minimize disturbance in the nest area.”

Heavy road traffic also increases the potential for goshawk collision with vehicles. Goshawks in the three PFAs without BSTR may be at increased risk of a collision with a moving truck. A speed limit of 25 mph will be implemented for vehicles passing through these PFAs to reduce the hazard of collisions. Given the adult goshawk’s natural agility in flight, the diurnal habits of the goshawk, 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, diurnal habits of the species, and natural agility of goshawks should minimize this potential.

For the **Research** proposals in Alternative C, the impacts of the silvicultural prescriptions have been reflected in the vegetation data already analyzed. Constructing 15 weirs that would 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 would not have any impacts to changing the physical structure or quality of the goshawk habitat from this facet of the project as it is not included in these alternatives.

The effects of the **MSO prescriptions** on goshawk habitat in the action alternatives are reflected in the vegetation data already analyzed. MSO prescriptions would impact approximately 22% of the goshawk habitat across the landscape. MSO habitat likely supports lower densities of many prey species than would habitat treated to meet goshawk habitat direction in the forest plan (see appendix 8 in the wildlife report). However, treatments in MSO restricted “other” habitat should improve prey habitat. 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, MSO-based management treatments would not be in conflict with maintaining goshawk territories in MSO habitat.

Improving **springs and restoring ephemeral channels** in the action alternatives would improve prey species habitat in those areas where the treatments occur. Implementing the BSTR 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.

**Decommissioning** 904 miles of **roads** in all of the action alternatives would improve the quality of the habitat in those areas where the roads are decommissioned. While the physical structure and features of the habitat for goshawks and their prey may not measurably change along the former road alignment, eliminating disturbance along the roadway would be expected to improve the quality of habitat beyond the immediate area of the road for the goshawk and its prey species. With each miles of road impacting approximately 3 acres of habitat, about 2,712 acres of forested habitat may be impacted. This would not have a discernible impact to goshawk habitat cross the landscape. Implementing these activities under the BSTR would eliminate disturbance to nesting goshawks. 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.

**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 and C, 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 the BSTR for any activities within PFAs would eliminate disturbance to nesting goshawks.

#### Cumulative Effects:

Most past vegetation treatment projects after 1996 have been designed to move the landscape towards the desired conditions for northern goshawks. Those same projects have also included BSTR for activities within goshawk PFAs. This project would contribute to the cumulative effects of moving the landscape towards desired conditions for the northern goshawk.

Alternatives B and C contribute most to moving the landscape towards desired conditions. Alternative D does slightly less to move towards desired conditions. While some desired physical features may be achieved in Alternative A, it does not contribute to the cumulative effects of moving the landscape towards desired conditions. See appendix 12 for the projects and their size, location, objectives, and wildfires addressed as part of cumulative effects.

### Northern Leopard Frog

#### Alternative A No Action

#### *Direct/Indirect Effects*

Under the No Action Alternative, habitat conditions for wildlife would remain in their current condition, notwithstanding natural processes. The No Action Alternative would have no direct effect on northern leopard frog. However, dense forest conditions would still occur and the high fire hazard potential would persist. Thirty percent of the ponderosa pine habitat in Restoration Unit 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 the No Action Alternative, 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 frogs.

Denser forest conditions produce lower values in understory biomass (lbs/acre). Under the No Action alternative understory biomass would continue to decline over the next 40 years (Appendix 8). Limited cover around tanks and the limited herbaceous understory across the project area would continue to reduce the likelihood that frogs would successfully forage around and migrate between livestock tanks due to increased risk of predation.

#### *Cumulative Effects*

The area analyzed for cumulative effects for northern leopard frog is the project area and the adjoining critical and potential breeding sites. This alternative would continue to result in indirect impacts to northern leopard frogs, which may combine with ongoing activities that have similar effects. Degradation of habitat facilitated by this alternative would cumulatively combine with other Forest activities, high-impact recreational use, livestock grazing, habitat loss and degradation on private lands and climate change and would continue to fragment key aquatic and dispersal habitat.

#### *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/Indirect Effects*

Dispersing leopard frogs could be directly impacted if they collide with mechanical equipment or are overtaken by fire 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 Restoration Unit 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 Restoration Unit. 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 Restoration Unit 1, which contains all critical and potential breeding sites and the northern leopard frog corridor. Additionally, 24 miles of ephemeral streams would be restored in this Restoration unit. 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 Restoration Unit 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:

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.

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/Indirect Effects***

The direct/indirect effects are similar to Alternative B. Alternative C includes six watershed research areas with construction of fifteen stream flow-watershed structures (weirs). The installation of 15 weirs in drainages within restoration units 1, 3, and 5 could potentially act as barriers to leopard frog movement limiting their ability to occupy additional areas. Weirs could force leopard frogs to move over land making them more vulnerable to predation. Weirs 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 weirs. The design of weirs 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 8). 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/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.

### *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.

**Cumulative Effects for all Action Alternatives**

The area analyzed for cumulative effects for northern leopard frog is the project area and the adjoining critical and potential breeding sites within ¼ mile. 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 12 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 could alter amphibian movement in drainages within Restoration Units 1, 3 and 4. 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/Indirect Effects*

No direct effect is expected because there are no activities or disturbance associated with project implementation. Thirty-nine percent of the ponderosa pine has the potential for crown fire (Fire Ecology report). 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 bald eagle nesting, roosting and foraging habitat at risk with respect to stand-replacing fire.

Tree densities would continue to be high slowing their growth into larger diameter classes and thereby limiting the development of larger diameter (≥ 18-inch) trees, and consequently larger diameter snags, important for roosting and perching. However, smaller diameter trees (VSS 3 and 4) would be lost to mortality, due to high tree densities, and in 30 years post treatment the percentage of larger trees would increase.

#### *Cumulative Effects*

The area analyzed for cumulative effects for bald eagle is the ponderosa pine within the project and ½ -mile of the project boundary. 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 roost areas. Other activities including utility line and road construction and maintenance, high-impact recreation, and climate change would combine to result in degradation of nesting and roosting habitat.

### Alternative B Proposed Action

#### *Direct/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; 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. 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 3 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 3 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 10,000 acres of prescribed burning and 30,000 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 restoration units 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 34% of the area post treatment and 60% 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 (post treatment) and in the long term (30 years post treatment) than Alternative A or D and the same as Alternative C.

**Alternative C**

***Direct/Indirect Effects***

The effects are similar as Alternative B. One documented roost is located within an Arizona Game and Fish 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.

#### *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/Indirect Effects*

The effects are similar as Alternative B. Alternative D would provide 5% less developing old growth in the short-term (post treatment) and 5% less long term (30 years post treatment) compared to alternative B and C. All 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.

**Cumulative Effects for all Action Alternatives**

The area analyzed for cumulative effects for bald eagle is the ponderosa pine within the project and ½ -mile of the project boundary. Current, ongoing and reasonably foreseeable projects are listed in Appendix 12 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. 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/Indirect Effects*

Under the No Action Alternative, there would be no direct effects to peregrines. Vegetation would continue to grow and fuel would continue to accumulate, continuing to have negative effects to meadow habitat and consequently potential habitat for peregrine prey. 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 ½ mile of the project boundary. This alternative would result in cumulative impacts to peregrine falcons by continuing to reduce the quality of foraging habitat by reducing meadow, grassland and savannas and reducing water yield in marsh, pond or lake habitats.

### *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 904 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 2,715 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/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 Mexican spotted owl protected activity center 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 10,000 acres of prescribed burning and 30,000 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/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/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.

### 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 12. 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.

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.

### Clark's Grebe

#### Alternative A No Action

##### *Direct/Indirect Effects*

Under the No Action Alternative, habitat conditions for wildlife would remain in their current condition, notwithstanding natural processes. The No Action Alternative would have no direct effect on Clark's Grebe. However, dense forest conditions would still occur and the high fire hazard potential would persist. Large, uncharacteristically severe 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.

##### *Cumulative Effects*

The area analyzed for cumulative effects for Clark's grebe is the marshes and lakes within the CNF in the project area. This alternative would result in continued high crown fire potential putting grebe habitat at risk of overland flow, increased soil erosion with potentially high sediment loads reducing water quality. This could combine with impacts from livestock grazing, recreational uses within wetlands and increased drought from climate change.

##### *Determination of Effect*

Alternative A would have no impact to the Clark's grebe.

#### Alternative B Proposed Action

##### *Direct/Indirect Effects*

Under the Proposed Action, there would be no direct effects to Clark's Grebe eggs, young, or adults from mechanical treatment and/or prescribed burning. The project would not treat in Clark's grebe habitat. Under the Proposed Action management in adjacent ponderosa pine, grasslands and ephemeral drainages could indirectly affect their habitat by increasing water yield and improving marsh, pond, and lake habitats increasing availability of food and reproductive sites for these species over the long-term, resulting in direct beneficial effects to habitat.

##### *Determination of Effect*

Alternative B would have no impact to the Clark's grebe.

#### Alternative C

##### *Direct/Indirect Effects*

The effects are similar as Alternative B and D. The research areas are not located within subunits where grebe habitat exists. The majority of the additional grassland treatments will occur on the Kaibab NF where grebes are not present.

##### *Determination of Effect*

Alternative C would have no impact to the Clark's grebe.

#### Alternative D

##### *Direct/Indirect Effects*

The effects are the same as Alternative B and C.

##### *Determination of Effect*

Alternative D would have no impact to the Clark's grebe.

#### Cumulative Effects for all Action Alternatives

The area analyzed for cumulative effects for Clark's grebe is the marshes and lakes within the CNF in the project area. Past, present and reasonably foreseeable projects are listed in Appendix 12. Activities within Clarks Grebe habitat were designed to improve habitat conditions for the grebe and include Antelope Tank, Post Lake, and Long Lake habitat restoration projects. Thinning and prescribed fire have occurred in both the ponderosa pine and juniper with projects such as; Anderson Mesa Prescribed Burn, Lake Mary, Elk Park and Mormon Lake Basin Fuels Reduction and Forest Health projects and Picket Agra Ax reducing tree densities potentially increasing water yield into grebe's habitat. Implementation of BMPs would curtail soil erosion and minimize potential for inflow into potential Clark's grebe habitat. Impacts from livestock grazing and increased drought from climate change are expected to be somewhat decreased by a reduction of tree densities increasing water yield into grebe's habitat.

### Western Burrowing Owl

#### Alternative A No Action

##### *Direct/Indirect Effects*

There are no documented nesting burrowing owls on the project area, however potential nesting habitat does exist. 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. Denser forest conditions produce lower values in understory biomass (lbs./acre). Under the No Action understory biomass would continue to decline over the next 40 years (Appendix 8). 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. Eight percent of the grassland habitat has the potential for crown fire. 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 (Fire Ecology report). 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.

##### *Determination of Effect*

Alternative A would have no impact to burrowing owls.

##### *Cumulative Effects*

The area analyzed for cumulative effects to burrowing owls encompasses the project area and the associated prairie dog complexes. The No Action Alternative would maintain the current risk to burrowing owl habitat and adjacent forest lands. The No Action Alternative 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.

#### Alternative B Proposed Action

##### *Direct/Indirect Effects*

Direct effects could occur if motorized equipment runs over above ground nests or burrows. There are no documented nesting burrowing owls on the project area, however potential nesting habitat does exist. While 10-15% 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 11,185 acres of grassland restoration treatments. 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.

#### Alternative C

##### *Direct/Indirect Effects*

Alternative C would have a more pronounced impact on decreasing pine tree encroachment in grasslands by treating 48,206 more acres of grassland, thus decreasing impacts to the larger prairie dog population. 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 8). 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.

#### Alternative D

##### *Direct/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 and there are about 20,645 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 less habitat for burrowing owls.

#### *Determination of Effect*

Alternative D would have no impact to burrowing owls.

#### *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 restoration activities could open up more habitats or provide more contiguous swaths of grassland habitat key to supporting thriving prairie dog colonies. Past, present and reasonably foreseeable projects are listed in Appendix 12 and past projects have implemented thinning on 2,304 acres and prescribed burning on 8,951 acres in grasslands. Short term and localized effects from mechanical thinning and prescribed burning would result in the potential collapsing of burrows and displacement of prairie dogs. This impact may combine with short-term cumulative impacts from localized dispersed camping, wildfire and wildfire suppression activities to temporarily displace prairie dog populations (and thus burrowing owls) in a limited area.

The thinning of 2,340 acres and prescribed fire on 8,951 acres in grasslands will add to the acres of treatments in this project to reduce tree densities in grasslands and connect open corridors across the analysis area providing additional potential habitat for burrowing owls.

## Ferruginous Hawk

### Alternative A No Action

#### *Direct/Indirect Effects*

Because ferruginous hawks are not known to nest in the project area the probability of direct effects from the current condition are low. The No Action Alternative would not treat meadows and grassland within the project area and trees would continue to encroach on these habitats. Denser forest conditions produce lower values in understory biomass (lbs/acre). Under the No Action understory biomass would continue to decline over the next 40 years (Appendix 8). This in turn leads to less available habitat for prairie dogs and consequently ferruginous hawks. 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 prairie dog habitat and consequently potential habitat for ferruginous hawk. Eight percent of the grassland habitat has the potential for crown fire (Fire Ecology report). 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 (Fire Ecology report). This alternative would result in the most stress on meadow and grassland habitats and thus would have the greatest negative contribution to potential ferruginous hawk habitat.

#### *Cumulative Effects*

The area analyzed for cumulative effects to ferruginous hawks encompasses the project area and the associated prairie dog complexes. The No Action Alternative would maintain the current risk to ferruginous hawk habitat and adjacent forest lands. The No Action Alternative has a cumulative effect of reducing the number of grassland acres within the project area, as dense forest conditions would continue to place ferruginous hawk 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 ferruginous hawks. This alternative would result in the most stress on grassland habitats and thus would have the greatest negative contribution to potential ferruginous hawk habitat.

#### *Determination of Effect*

Alternative A would have no impact to ferruginous hawks.

### Alternative B Proposed Action

#### *Direct/Indirect Effects*

Because ferruginous hawks are not known to nest in the project area and most treatments would occur above 6,400 feet, ferruginous hawks are known to nest in Arizona, it is unlikely that ferruginous hawks would be directly impacted by project activities. Indirect effects to the ferruginous hawk include effects to ferruginous hawk prey species or prey species habitat. Forest treatments can indirectly beneficially affect potential habitat by restoring meadows, grasslands, and savannas encroached by pine trees resulting from fire exclusion. Moving these habitats towards historic conditions could increase potential nesting and foraging habitat for ferruginous hawks.

There are no anticipated adverse effects to prey species or prey species habitat. Meadow and savanna restoration treatments may have a short-term impact of disturbing prey during implementation however over the long-term habitat would improve and increase available habitat for prairie dogs, a primary prey species. While 10-15% of the immediate area in grasslands and 10-20% in savanna may be disturbed in the short term, grasslands are 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) while soil disturbance in savanna restoration would not pose a risk to long term soil productivity (Soil Resources report). The Proposed Action would increase available habitat for prairie dogs with 11,185 acres of meadow enhancement treatments and 45,469 acres of savanna treatments, resulting in an indirect beneficial effect.

Mechanical treatments prescribed and pile burning and hauling of timber and other project activities may cause visual or auditory disturbance to foraging ferruginous hawks. Approximately 10,000 acres of prescribed burning and 30,000 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.

#### *Determination of Effect*

Alternative B would have no impact to ferruginous hawks.

### Alternative C

#### *Direct/Indirect Effects*

Alternative C would have a more pronounced impact of decreasing pine tree encroachment in grasslands by 48,196 acres thus decreasing impacts to the larger prairie dog population. 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. All three action alternatives would improve the same amount of potential nesting habitat (2,175 acres). Alternative C treats the most acres and elicits the greatest response in understory. 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 ferruginous hawk foraging habitat.

#### ***Determination of Effect***

Alternative C would have no impact to ferruginous hawks.

### Alternative D

#### ***Direct/Indirect Effects***

This alternative would have 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 and there are about 20,645 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 less habitat for ferruginous hawks.

### Cumulative Effects for all Action Alternatives

The area analyzed for cumulative effects to ferruginous hawks 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 restoration activities could open up more habitats or provide more contiguous swaths of grassland habitat key to supporting thriving prairie dog colonies. Past, present and reasonably foreseeable projects are listed in Appendix 12 and past project have implemented thinning on 2,304 acres and prescribed burning 8,951 acres in grasslands. Short term and localized effects from mechanical thinning and prescribed burning would result in the potential collapsing of burrows and displacement of prairie dogs. This impact may combine with short-term cumulative impacts from localized dispersed camping, wildfire and wildfire suppression activities to temporarily displace prairie dog populations (and thus ferruginous hawks) in a limited area.

The thinning of 2,340 acres and prescribed fire on 8,951 acres in grasslands will add to the acres of treatments in this project to reduce tree densities in grasslands and connect open corridors across the analysis area providing additional potential habitat for ferruginous hawks.

#### ***Determination of Effect***

Alternative D would have no impact to ferruginous hawks.

## Four Spotted Skipperling

### Alternative A No Action

#### ***Direct/Indirect Effects***

Under the No Action Alternative, there would be no direct effect to this species. Meadows would not be rehabilitated, thus there would no benefits to these species. Favorable habitat would decrease over the next 40 years as conifers encroach into meadows and canopy closure increases and understory productivity and diversity decreases, resulting in reduced availability of food and reproductive sites for this species. Uncharacteristic tree densities and patterns in ponderosa pine forest would potentially decrease water yield in canyons and riparian habitat and decrease resilience of the habitat by increasing the threat of high severity fire. Vegetation would continue to grow and fuel would continue to accumulate, continuing to have negative effects to grasslands. Eight percent of the grassland habitat has the potential for crown fire. Stability of key ecosystem components such as, species composition, forest structure, soil characteristics and hydrologic function are at moderate to high risk of loss in the event of high severity disturbance, such as high severity wildfire, on 82 percent of grasslands (Fire Ecology report).

Under the No Action Alternative, there would no restoration of springs. 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 habitat.

Not moving these grassland and spring habitats towards historic conditions could result in reduced food and reproductive sites and reduced habitat connectivity for four-spotted skipperling.

***Cumulative Effects***

The area analyzed for cumulative effects for the four-spotted skipperling is the project area. 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, grassland, and seep and spring habitat. This alternative would result in the most stress on meadow, grassland, and seep and spring habitats and thus would have the greatest negative contribution to potential four-spotted skipperling habitat.

***Determination of Effect***

Alternative A may impact four-spotted skipperling, but is not likely to cause a trend to federal listing or loss of viability.

**Alternative B Proposed Action**

***Direct/Indirect Effects***

Under the Proposed Action, spring and seep restoration would occur within or near wet meadows.

Under Alternative B, 74springs and 39 miles of ephemeral streams would be restored on potential habitat for four-spotted skipperling. 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.

Individuals may be impacted by mechanical activities, such as contact with machinery and tools. These activities would be minimal and short term. Spring and seep restoration would increase riparian vegetation increasing availability of food and reproductive sites for four-spotted skipperling over the long-term.

Indirect effects would result from vegetation modification activities such as mechanical treatments, temporary road construction and prescribed burning. These activities would disturb or remove understory vegetation, in effect reducing availability to adult butterflies and/or caterpillars. However, these would be short-term effects and would be minimized due to activities being temporally and spatially separated. In contrast, reducing canopy closure, removing trees in meadows, restoring openings throughout the ponderosa pine and prescribed burning would encourage the development of understory vegetation, increasing availability of food and reproductive sites and providing habitat connectivity for these species over the long-term, resulting in indirect beneficial effects. Meadow restoration treatments may have a short-term impact of disturbing four-spotted skipperling during implementation however over the long-term habitat would improve and increase available habitat for butterflies. While 10-15% of the immediate area in grasslands and 10-20% in savanna may be disturbed in the short term, grasslands are 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). Reducing uncharacteristic tree densities and patterns in ponderosa pine forest could potentially increase water yield in canyons and riparian habitat and increase resilience of the habitat by reducing the threat of high severity fire. Moving these habitats towards historic conditions could increase heterogeneity providing both direct habitat connectivity and habitat stepping stones facilitating landscape movement.

#### *Determination of Effect*

Alternative B may impact the four-spotted skipperling, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative C

#### *Direct/Indirect Effects*

Alternative C would have similar effects as Alternative B. This alternative would improve the most habitats for butterflies than the other two alternatives. Alternative C would add 48,196 additional acres of grassland restoration treatments. These treatments would occur within open linkages providing additional opportunities for butterflies to disperse and access adequate reproductive sites. Areas where trees have encroached grassland habitat in Government and Garland Prairie and Kendrick Park would provide larger patches of higher quality habitat while additional grassland treatments in other areas would provide habitat stepping stones facilitating landscape movement. The overall increase in grassland treatments would have a greater beneficial impact on the development of understory vegetation, increasing availability of food and reproductive sites and improving habitat connectivity resulting in indirect beneficial effects.

#### *Determination of Effect*

Alternative C may impact the four-spotted skipperling, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative D

#### *Direct/Indirect Effects*

Alternative D would have similar effects as Alternative B however the understory response is not anticipated to be as robust due to the lack of prescribed burning after mechanical treatments. The lack of burning means no nutrient pulse into the system, further limiting understory response. Based on a literature review of studies within the project area, litter depth appears to exert a strong negative influence on understory productions in several, but not all studies (Appendix 8).

#### *Determination of Effect*

Alternative D may impact the four-spotted skipperling, 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 four-spotted skipperling is the project area. Cumulative activities such as the Travel Management Rule are likely to decrease motorized use in grasslands and meadows thus decreasing impacts to butterfly habitat. This combined with forest restoration activities could open up more habitats or provide more contiguous swaths of grassland habitat key to supporting thriving butterfly populations. Short-term and localized effects from mechanical thinning, temporary road construction and prescribed burning would result in the reduction of understory vegetation reducing plant availability to adult insects, a primary food source. 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 temporarily displace butterflies in a limited area.

Those projects where thinning and burning occurs in grassland and spring habitats could add to direct impacts from project activities by harm from fire and mechanical activities. However, projects would be implemented at different times and/or different locations, thus disturbances to individuals would be minimized.

Other past, present and ongoing projects have implemented thinning (2,304 acres) and prescribed burning (8,951 acres) in grasslands and prescribed burning (11 springs) and mechanical treatment (6 springs) improving habitats for four-spotted skipperling in the long-term.

### Nitocris Fritillary

**Alternative A No Action**

#### *Direct/Indirect Effects*

Under the No Action Alternative, there would be no direct effect to these species. Meadows, seeps and springs would not be rehabilitated, thus there would no benefits to these species. Favorable habitat would decrease over time as conifers encroach into meadows and canopy closure increases and understory productivity and diversity decreases, resulting in an indirect adverse effect. Uncharacteristic tree densities and patterns in ponderosa pine forest would potentially decrease water yield in canyons and riparian habitat and decrease resilience of the habitat by increasing the threat of high severity fire. High fire hazard potential in the project area would persist.

Under the No Action Alternative, 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 habitat. Not moving these habitats towards historic conditions could result in reduced food and reproductive sites and reduced habitat connectivity for nitocris fritillary.

#### *Cumulative Effects*

The area analyzed for cumulative effects for nitocris fritillary is the Coconino Forest within the project area. This alternative would continue to result in indirect impacts to nitocris fritillary, which may combine with ongoing activities that have similar effects. Cumulative effects from indirect impacts to nitocris fritillary would be limited to increased tree densities resulting in limited herbaceous understory impacting the ability of butterflies to successfully forage around and migrate between habitats. 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 reproductive and foraging habitat. This alternative would result in the most stress on meadow, grassland, ponderosa pine and seep and spring habitats and thus would have the greatest negative contribution to potential nitocris fritillary habitat.

#### *Determination of Effect*

Alternative A may impact nitocris fritillary, but is not likely to cause a trend to federal listing or loss of viability.

**Alternative B Proposed Action**

#### *Direct/Indirect Effects*

Under the Proposed Action, spring and seep restoration would occur within or near wet meadows.

Under Alternative B, 47springs and 32miles of ephemeral streams would be restored on the Coconino NF, creating potential habitat for nitocris frilliary. 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. Individuals may be impacted by mechanical activities, such as contact with machinery and tools. These activities would be minimal and short term. Spring and seep restoration would increase riparian vegetation increasing availability of food and reproductive sites for nitocris fritillary over the long-term.

Indirect effects would result from vegetation modification activities such as mechanical thinning, temporary road construction and prescribed burning. These activities would disturb or remove understory vegetation, in effect reducing availability to adult butterflies and/or caterpillars. However, these would be short-term effects 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 and reproductive sites and providing habitat connectivity for these species over the long-term, resulting in indirect beneficial effects. Reducing uncharacteristic tree densities and patterns in ponderosa pine forest could potentially increase water yield in canyons and riparian habitat and increase resilience of the habitat by reducing the threat of high severity fire. Moving these habitats towards historic conditions could increase heterogeneity providing both direct habitat connectivity and habitat stepping stones facilitating landscape movement.

#### *Determination of Effect*

Alternative B may impact the nitocris fritillary, but is not likely to cause a trend to federal listing or loss of viability.

**Alternative C**

#### *Direct/Indirect Effects*

This alternative would improve the most habitats for butterflies than the other two alternatives. Alternative C adds 48,206 additional acres of grassland restoration. These treatments would occur within open linkages providing additional opportunities for butterflies to disperse and access adequate nesting sites. Areas where trees have encroached grassland habitat would provide larger patches of higher quality habitat while additional grassland treatments in other areas would provide habitat stepping stones facilitating landscape movement. The overall increase in grassland treatments would have a greater beneficial impact on the development of understory vegetation, increasing availability of food and reproductive sites and habitat connectivity resulting in indirect beneficial effects.

#### *Determination of Effect*

Alternative C may impact the nitocris fritillary, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative D

#### *Direct/Indirect Effects*

Alternative D would have similar effects as Alternative B however the understory response is not anticipated to be as robust due to the lack of prescribed burning after mechanical treatments. The lack of burning means no nutrient pulse into the system, further limiting understory response. Based on a literature review of studies within the project area, litter depth appears to exert a strong negative influence on understory productions in several, but not all studies (Appendix 8).

#### *Determination of Effect*

Alternative D may impact the nitocris fritillary, 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 nitocris fritillary is the Coconino Forest within the project area. Past, present and reasonably foreseeable projects are listed in Appendix 12 and include projects within wet areas within the ponderosa pine, springs and wet meadows. Past activities within springs and wet meadows and riparian streams have been limited with mechanical treatments implemented on 3 springs and 1.3 miles of riparian and prescribed burning on 8 springs and 2.8 miles of riparian habitats. There are 44 springs within ½ mile of the project boundary that may be improved through current and reasonably foreseeable projects that reduced tree densities and increased understory vegetation improving functional condition. These projects will combine with this forest restoration project to improve habitat for nitocris fritillary.

Cumulative activities such as the Travel Management Rule are likely to decrease motorized use in grasslands and meadows thus decreasing impacts to butterfly habitat. This combined with forest restoration activities could open up more habitats or provide more contiguous swaths of grassland habitat key to supporting thriving butterfly populations. Short term and localized effects from mechanical thinning, temporary road construction and prescribed burning would result in the reduction of understory vegetation. 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 temporarily displace butterflies in a limited area.

## Nokomis Fritillary

### Alternative A No Action

#### *Direct/Indirect Effects*

Under the No Action Alternative, there would be no direct effect to these species. Meadows, seeps and springs would not be rehabilitated, thus there would no benefits to this species. Favorable habitat would decrease over time as conifers encroach into meadows and canopy closure and litter depth increases and understory productivity and diversity decreases, resulting in an indirect adverse effect. Uncharacteristic tree densities and patterns in ponderosa pine forest would potentially decrease water yield in canyons and riparian habitat and decrease resilience of the habitat by increasing the threat of high severity fire. High fire hazard potential in the project area would persist.

Under the No Action Alternative, 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. Not moving these habitats towards historic conditions could result in reduced food and reproductive sites and reduced habitat connectivity for nokomis fritillary.

### *Cumulative Effects*

The area analyzed for cumulative effects for nokomis fritillary is the Coconino Forest within the project area. 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, grassland and seep and spring habitats. This alternative would result in the most stress on meadow, grassland, seep and spring habitats and thus would have the greatest negative contribution to potential nokomis fritillary habitat.

### *Determination of Effect*

Alternative A may impact nokomis fritillary, but is not likely to cause a trend to federal listing or loss of viability.

#### Alternative B Proposed Action

### *Direct/Indirect Effects*

Under the Proposed Action, spring and seep restoration would occur within or near wet meadows.

Under Alternative B, 47 springs and 32 miles of ephemeral streams would be restored on the Coconino NF, creating potential habitat for nokomis frilliary. 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 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. Individuals may be impacted by mechanical activities, such as contact with machinery and tools. These activities would be minimal and short term. Spring restoration would increase riparian vegetation increasing availability of food and reproductive sites for nokomis fritillary over the long-term.

Indirect effects would result from vegetation modification activities such as mechanical thinning, temporary road construction and prescribed burning. These activities would disturb or remove understory vegetation, in effect reducing availability to adult butterflies and/or caterpillars. However, these would be short-term effects 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 and reproductive sites for these species over the long-term, resulting in indirect beneficial effects. Reducing uncharacteristic tree densities and patterns in ponderosa pine forest could potentially increase water yield in canyons and riparian habitat and increase resilience of the habitat by reducing the threat of high severity fire. Moving these habitats towards historic conditions could increase heterogeneity providing both direct habitat connectivity and habitat stepping stones facilitating landscape movement and improving reproductive and feeding sites for nokomis fritillary.

#### *Determination of Effect*

Alternative B may impact the nokomis fritillary, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative C

#### *Direct/Indirect Effects*

Alternative C would have similar effects as Alternative B and D. This alternative would improve the most habitats for this butterfly than the other two alternatives. Alternative C adds 48,206 additional acres of grassland restoration. The overall increase in grassland treatments would have a greater beneficial impact on nitocris fritillary resulting in indirect beneficial effects.

#### *Determination of Effect*

Alternative C may impact the nokomis fritillary, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative D

#### *Direct/Indirect Effects*

Alternative D would have similar effects as Alternative B however the understory response is not anticipated to be as robust and litter depth is expected to remain at current levels due to the lack of prescribed burning after mechanical treatments. The lack of burning means no nutrient pulse into the system, further limiting understory response. Work with the nokomis fritillary determined probability of occupancy increased with increasing larval host-plant abundance and percent cover of adult nectar sources, but decreased as litter reached heavy levels, perhaps as a result of impeded oviposition (Appendix 8). Spring enhancement would encourage larval host-plant abundance but continued high litter depth may limit occupancy.

#### *Determination of Effect*

Alternative D may impact the nokomis fritillary, 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 nokomis fritillary is the Coconino Forest within the project area. Past, present and reasonably foreseeable projects considered are listed in Appendix 12 and include projects within springs, seeps, and riparian areas and streams. Past activities within springs and riparian areas and streams have been limited with mechanical treatments implemented on 3 springs and 1.3 miles riparian streams and prescribed burning on 8 springs and 2.8 miles riparian streams. There are 44 springs within ½ mile of the project boundary that may be improved through current and reasonably foreseeable projects that reduced tree densities and increased understory vegetation improving functional condition. These projects will combine with this forest restoration project to improve habitat for nokomis fritillary.

Cumulative activities such as the Travel Management Rule are likely to decrease motorized use in grasslands and meadows thus decreasing impacts to butterfly habitat. This combined with forest restoration activities could open up more habitats or provide more contiguous swaths of grassland habitat key to supporting thriving butterfly populations. Short term and localized effects from mechanical thinning, temporary road construction and prescribed burning would result in the reduction of understory vegetation. 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 temporarily displace butterflies in a limited area.

## Navajo Mogollon Vole

### Alternative A No Action

#### *Direct/Indirect Effects*

Under the No Action Alternative, there would be no disturbance and no direct effects. Although habitat would be provided for this species, most of the forested area within the project is currently is moderately closed to closed condition (Silviculture report), which provides low quality habitat for the Mogollon vole. Under the No Action Alternative, meadows would not be rehabilitated, thus there would no benefits to the vole. Favorable habitat would decrease over time as conifers encroach into meadows and canopy closure increases, resulting in an indirect adverse effect. Seventy percent of the ponderosa pine and 12 percent of grassland habitat 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-seven percent of the ponderosa pine and 9 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. This alternative would continue to result in indirect impacts to Navajo Mogollon vole habitat, which may combine with ongoing activities that have similar effects. 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. 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/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% 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 66 percent of the ponderosa pine from Fire Regime Condition Class (FRCC) 3 to FRCC 2 and increase FRCC1 by 7 percent. About 4,500 acres of grassland would shift from Fire Regime Condition Class (FRCC) 3 to FRCC 2 and increase FRCC 1 by 1,683 acres (Fire Ecology report). The potential for crown fire within grasslands would be slightly (1 percent) reduced with a greater reduction in ponderosa (34 percent) (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 904 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 found an inverse relationship between snags and roads (pers. comm, 2012), 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 in 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/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. 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 voles 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/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 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.

**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 12 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.

### Long-tailed vole

#### Alternative A No Action

##### *Direct/Indirect Effects*

Under the No Action Alternative, there would be no disturbance and no direct effects. Although habitat would be provided for this species, most of the forested area within the project is currently is moderately closed to closed condition, which provides low quality habitat for the long-tailed vole. Under the No Action Alternative, meadows would not be rehabilitated, thus there would no benefits to the vole. Favorable habitat would decrease over time as conifers encroach into meadows and canopy closure increases, resulting in an indirect adverse effect. In addition, high fire hazard potential would persist, and a large high-severity wildfire event would have the potential to affect many individuals. Vegetation would continue to grow and fuel would continue to accumulate, continuing to have negative effects to long-tailed vole habitat. Nine percent of the grassland habitat has the potential for crown fire (Fire Ecology report). Stability of key ecosystem components such as, species composition, 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 (Fire Ecology report).

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 the No Action Alternative, 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 long-tailed vole.

##### *Cumulative Effects*

The area analyzed for cumulative effects for long-tailed vole is the project area. 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, grassland, and seep and spring habitats. 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, seep and spring habitats and thus would have the greatest negative contribution to potential long-tailed vole habitat.

##### *Determination of Effect*

Alternative A may impact long-tailed vole, but is not likely to cause a trend to federal listing or loss of viability.

#### Alternative B Proposed Action

##### *Direct/Indirect Effects*

Under the Proposed Action, approximately 4 percent of the long-tailed vole forest-wide habitat (Coconino and Kaibab) would be treated. Thinning and prescribed burning activities may disturb individual voles, resulting in direct adverse effects. Approximately 10,000 acres of prescribed burning and 30,000 acres of mechanical treatment would 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. While 10-15% 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). Such activities would occur across the project area at different times in a small portion (4 percent) of their forest-wide habitat, thereby reducing impacts to this species. In addition, the effect would be short-term. There would be no effects to 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% open depending on localized site conditions providing both habitat connectivity and habitat stepping stones facilitating landscape movement. Moving these habitats towards historic conditions could increase potential habitat and reduce the risk of uncharacteristic, high-severity wildfire. The reduction of ponderosa pine basal area, and increased growth in the understory vegetation on the forest floor would result in indirect beneficial impacts to the vole.

Under the Proposed Action, spring and seep restoration would occur within or near wet meadows.

Under Alternative B, 74 springs and 39 miles of ephemeral streams would be restored on potential vole habitat. Spring, seep and channel restoration 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.

There would be short-term effects from riparian habitat and ephemeral stream restoration and spring restoration activities. Project implementation would disturb vegetation over the short-term. Past spring restoration projects have shown recovery of vegetation within one to three years after implementation (i.e. Hoxworth Spring). There will be no temporary roads, road construction or reconstruction within riparian habitat, ephemeral streams, or springs, although 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 long-tailed vole, but is not likely to cause a trend to federal listing or loss of viability.

**Alternative C**

### *Direct/Indirect Effects*

This alternative has similar effects as alternative B; however, this alternative treats approximately 19 percent of the forest-wide habitat (Coconino and Kaibab) for long-tailed voles and would improve the most habitats for the long-tailed vole than the other action alternatives. Alternative C adds 48,206 acres of grassland restoration treatments and restores larger grasslands such as Garland and Government Prairie where other species of voles are known to occur. The additional acres of treatment may slightly increase vole mortality from increased risk of contact with machinery. 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 long-tailed vole, but is not likely to cause a trend to federal listing or loss of viability.

**Alternative D**

#### *Direct/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 long-tailed vole habitat.

#### *Determination of Effect*

Alternative D may impact the long-tailed 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 long-tailed vole is the project area. Past, present and reasonably foreseeable projects considered are listed in Appendix 12 and include projects within springs, seeps, and riparian areas and streams. Past activities within springs and riparian areas and streams have been limited with mechanical treatments implemented on 11 springs, 50 acres of riparian areas and 1.3 miles riparian streams and prescribed burning on 6 springs, 17 acres riparian areas and 2.8 miles riparian streams. There are 44 springs within ½ mile of the project boundary that may be improved through current and reasonably foreseeable projects that reduced tree densities and increased understory vegetation improving functional condition. These projects will combine with this forest restoration project to improve habitat for long-tailed vole. Other past, present and ongoing projects have implemented thinning on 2,304 acre and prescribed burning on 8,951 acres in grasslands improving habitats for long-tailed vole in the long-term.

The action alternatives results in impacts that may combine cumulatively with other Forest and non-Forest activities including wildfire and wildfire suppression activities, livestock grazing, recreation and increased temperatures and predicted vegetation shifts at higher elevations from climate change. All these activities result in impacts by affecting vole habitat and potentially directly affecting vole burrows. The action alternatives would have a much larger beneficial cumulative effect from meadow, grassland and ponderosa pine restoration treatments. This change combined with reduced motorized use within these areas would result in less disturbance and fragmentation to vole habitat.

### Dwarf Shrew

**Alternative A No Action**

#### *Direct/Indirect Effects*

Under the No Action Alternative, there would be no disturbance and no direct effects. Although habitat would be provided for this species, most of the forested area within the project is currently is moderately closed to closed condition, which provides low quality habitat for the shrew. Under the No Action Alternative, meadows would not be rehabilitated, thus there would no benefits to the shrew. Favorable habitat would decrease over time as conifers encroach into meadows and canopy closure increases, resulting in an indirect adverse effect. In addition, high fire hazard potential would persist, and a large, uncharacteristically severe wildfire event would have the potential to affect many individuals.

#### *Cumulative Effects*

The area analyzed for cumulative effects for dwarf shrew is the project area. This alternative would continue to result in indirect impacts to dwarf shrew, which may combine with ongoing activities that have similar effects. Cumulative effects from indirect impacts to dwarf shrew would be limited to increased tree densities resulting in limited herbaceous understory impacting the ability of shrews to successfully forage around and migrate between habitats. 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. 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 dwarf shrew habitat.

#### *Determination of Effect*

Alternative A may impact dwarf shrew, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative B Proposed Action

#### *Direct/Indirect Effects*

Under the Proposed Action, thinning and prescribed burning activities may disturb individual shrews, resulting in direct adverse effects. Up to 40,000 acres of prescribed burning and 45,000 acres of mechanical treatment could occur annually. This alternative would improve dwarf shrew habitat by including 11,185 acres of grassland treatments (restoration treatments in mollisol soils) and 45,469 acres of savanna treatments on mollic intergrade soils. This could slightly increase mortality from increased risk of contact with machinery. However, alternative B would have a greater impact on dwarf shrew habitat, resulting in indirect beneficial effects.

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. There would be no effects to population viability of shrews. Increasing understory vegetation and associated litter provides cover and can enhance prey populations. Many invertebrates, such as beetles, bugs, spiders, etc., 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 understory vegetation that would benefit dwarf shrews and their prey. Coarse woody debris would increase slightly in the short term and would continue to increase over the long term. Moving these habitats towards historic conditions would also improve the resilience of these habitats and decrease the risk of uncharacteristic, high-severity wildfire. The reduction of dense forest canopy and increased growth in the herbaceous vegetation on the forest floor would result in indirect beneficial impacts to the vole. Forest conditions after treatment would improve shrew habitat within the project area.

Under the Proposed Action, spring and channel restoration would improve riparian vegetation, increasing availability of food for small mammals over the long-term, resulting in indirect beneficial impacts. Fence design for exclosures would allow access to small mammals. In addition, about 10 miles of road segments would be moved out of drainage bottoms, further enhancing shrew habitat.

#### *Determination of Effect*

Alternative B may impact the dwarf shrew, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative C

#### *Direct/Indirect Effects*

This alternative would improve the most habitats for the dwarf shrew than the other two alternatives. Alternative C adds 59,426 acres of grassland treatments (including treatments within existing grasslands and restoration treatments in mollisol soils) and 45,469 acres of savanna treatments on mollic intergrade soils. Effects to dwarf shrew food and cover would be similar to those described for alternative B, but with greater overall benefits due to the additional acres of grassland treated. The increase in grassland, savanna and forest area treatments may slightly increase mortality from increased risk of contact with machinery. However, alternative C would have a greater impact on dwarf shrew habitat, resulting in the most indirect beneficial effects.

#### *Determination of Effect*

Alternative C may impact the dwarf shrew, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative D

#### *Direct/Indirect Effects*

This alternative has the same acres treated and 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 dwarf shrew habitat. . Alternative D would improve dwarf shrew habitat, but provide the least amount of improvements to food and cover of the action alternatives.

#### *Determination of Effect*

Alternative D may impact the dwarf shrew, 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 dwarf shrew is the project area. Cumulative activities such as the Travel Management Rule are likely to decrease motorized use in grasslands and meadows thus decreasing impacts to shrew habitat. This combined with forest restoration activities could open up more habitats or provide more contiguous swaths of grassland habitat key to supporting thriving small mammal populations. Short-term and localized effects from mechanical thinning, temporary road construction and prescribed burning would result in the reduction of understory vegetation. 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 temporarily displace shrews in a limited area. Climate change is also expected to result in a higher frequency of high-severity wildfires (Marlon et al. 2009) and prolonged periods of drought (Furniss et al. 2010), which would also cumulatively contribute to decreases in vegetative ground cover.

## Merriam's Shrew

### Alternative A No Action

#### *Direct/Indirect Effects*

Under the No Action Alternative, there would be no disturbance and no direct effects. Although habitat would to be provided for this species, most of the forested area within the project is currently is moderately closed to closed condition, which provides low quality habitat for the shrew. Under the No Action Alternative, meadows would not be rehabilitated, thus there would no benefits to the shrew. Favorable habitat would decrease over time as conifers encroach into meadows and canopy closure increases, resulting in an indirect adverse effect. In addition, high fire hazard potential would persist, and a large crown wildfire event would have the potential to affect many individuals.

#### *Cumulative Effects*

The area analyzed for cumulative effects for Merriam's shrew is the project area. This alternative would continue to result in indirect impacts to Merriam's shrew, which may combine with ongoing activities that have similar effects. Cumulative effects from indirect impacts to Merriam's shrew would be limited to increased tree densities resulting in limited herbaceous understory impacting the ability of shrews to successfully forage around and migrate between habitats. 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. 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 Merriam's shrew habitat.

#### *Determination of Effect*

Alternative A may impact Merriam's shrew, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative B Proposed Action

#### *Direct/Indirect Effects*

Under the Proposed Action, thinning and prescribed burning activities may disturb individual shrews, resulting in direct adverse effects. Up to 40,000 acres of prescribed burning and 45,000 acres of mechanical treatment could occur annually. This alternative would improve Merriam's shrew habitat by including 11,185 acres of grassland treatments (restoration treatments in mollisol soils) and 45,469 acres of savanna treatments on mollic intergrade soils. This could slightly increase mortality from increased risk of contact with machinery. However, alternative B would have a greater impact on Merriam's shrew habitat, resulting in indirect beneficial effects.

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 ponderosa pine treatment area at different times; thereby reducing impacts to this species. In addition, the effect would be short-term. There would be no effects to population viability of shrews. Increasing diversity and density of understory vegetation provides habitat for prey populations. 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 Merriam's shrew and their prey. Coarse woody debris would increase slightly in the short term and would continue to increase over the long term. Moving these habitats towards historic conditions would also increase resilience of these habitats and decrease the risk of uncharacteristic, high-severity wildfire. The reduction of dense forest canopy and increased growth in the herbaceous vegetation on the forest floor would result in indirect beneficial impacts to the vole. Forest conditions after treatment would improve shrew habitat within the ponderosa pine treatment area.

Under the Proposed Action, spring and seep exclosures 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 Merriam's shrew, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative C

#### *Direct/Indirect Effects*

This alternative would improve the most habitats for Merriam's shrew than the other two alternatives. Alternative C adds 59,426 acres of grassland treatments (including treatments within existing grasslands and restoration treatments in mollisol soils) and 45,469 acres of savanna treatments on mollic intergrade soils. Effects to Merriam's shrew food and cover would be similar to those described for alternative B, but with greater overall benefits due to the additional acres of grassland treated. The increase in grassland, savanna and forest area treatments may slightly increase mortality from increased risk of contact with machinery. However, alternative C would have a greater impact on Merriam's shrew habitat, resulting in the most indirect beneficial effects.

#### *Determination of Effect*

Alternative C may impact the Merriam's shrew, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative D

#### *Direct/Indirect Effects*

This alternative has the same acres treated and 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 Merriam's shrew habitat. Alternative D would improve dwarf Merriam's shrew, but provide the least amount of improvements to food and cover of the action alternatives.

#### *Determination of Effect*

Alternative D may impact the Merriam's shrew, 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 Merriam's shrew is the project area. Current, ongoing and reasonably foreseeable projects are listed in Appendix 12 and include fuels reduction, forest health, aspen regeneration, tornado rehabilitation and powerline development and maintenance. Cumulative activities such as the Travel Management Rule are likely to decrease motorized use in grasslands and meadows thus decreasing impacts to shrew habitat. This combined with forest restoration activities could open up more habitats or provide more contiguous swaths of grassland habitat key to supporting thriving small mammal populations. Short-term and localized effects from mechanical thinning, temporary road construction and prescribed burning would result in the reduction of understory vegetation. 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 temporarily displace shrews in a limited area. Development of private and state land has the greatest potential impact to shrew habitat.

## Western Red Bat

### Alternative A No Action

#### *Direct/Indirect Effects*

Under the No Action Alternative, there would be no disturbance and no direct effects to western red bats. 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. Seventy percent of the ponderosa pine and 12 percent of grassland habitat 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. Thirty-seven percent of the ponderosa pine and 9 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. 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). Under the No Action alternative 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.

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 the No Action Alternative, 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. 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 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 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 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 dwarf shrew 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/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 which could affect roosting bats; however mitigation including managing for retention of all snags 18” diameter and greater would reduce the impact. Recruitment snags will be provided by retaining trees 18 inches in diameter and greater with dead tops and lightning damage. 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% 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/Indirect Effects*

This alternative would improve the most habitats for this bat than the other two alternatives. 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/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 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.

### 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. 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/Indirect Effects*

Under the No Action Alternative, there would be no disturbance and no direct effects to Allen's lappet-browed bats. 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. 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 the No Action alternative 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 Allen's lappet-browed bat is the project area. 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 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 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 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/Indirect Effects*

Under the Proposed Action, approximately 42 percent of the Coconino and Kaibab forest-wide 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" diameter and greater would reduce the impact.

Recruitment snags will be provided by retaining trees 18 inches in diameter and greater with dead tops and lightning damage. The Proposed Action is expected to result in a slight short-term increase in snags followed by a continuing 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. 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 904 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 found an inverse relationship between snags and roads (*pers. comm*., 2012), 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/Indirect Effects*

This alternative has similar effects as Alternative B and D however; this alternative would improve the most habitats for this bat. Alternative C treats the most acres, adding 48,206 acres of grassland restoration treatments, and elicits the greatest response of understory biomass of all action alternatives. The overall increase in understory biomass would have a beneficial impact on Townsend's big-eared 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/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 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 affects 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.

#### ***Cumulative Effects for all Action Alternatives***

The area analyzed for cumulative effects for Allen's lappet-browed bat is the project area. Current, ongoing and reasonably foreseeable projects are listed in Appendix 12 and include fuels reduction, forest health, aspen regeneration, tornado rehabilitation 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. 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 Allen's lappet-browed bat roost locations.

### Pale Townsend's Big-eared Bat

**Alternative A No Action**

#### ***Direct/Indirect Effects***

Under the No Action Alternative, there would be no disturbance and no direct effects. 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-seven percent of the ponderosa pine and 9 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. Seventy percent of the ponderosa pine and 12 percent of grassland habitat 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. 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. 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 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/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” 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 904 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 found an inverse relationship between snags and roads (*pers. comm*., 2012), 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/Indirect Effects*

The effects are the same as Alternative B. One documented cave roost is located within an Arizona Game and Fish 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/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 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.

#### *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 12 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.

### Greater Western Mastiff Bat

#### Alternative A No Action

##### *Direct/Indirect Effects*

Under the No Action Alternative, there would be no disturbance and no direct effects to greater western mastiff bats. 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. Although foraging 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 the No Action alternative grasslands and forest openings would not be restored, thus there would be no benefits to foraging 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 greater western mastiff bat is the project area. This alternative would continue to result in indirect impacts to greater Western mastiff bat, which may combine with ongoing activities that have similar effects. Cumulative effects from indirect impacts to greater Western mastiff bat would be limited to increased tree densities resulting in limited herbaceous understory limiting the availability of insects and consequently reducing prey for bats. 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 greater western mastiff bat habitat.

##### *Determination of Effect*

Alternative A may impact greater Western mastiff bat, but is not likely to cause a trend to federal listing or loss of viability.

**Alternative B Proposed Action**

### *Direct/Indirect Effects*

Under the Proposed Action, disturbance from thinning and prescribed burning activities is highly unlikely. In addition, direct effects to roosting greater western mastiff bat from project implementation are not anticipated.

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 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 greater western mastiff 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 and seep exclosures 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 greater Western mastiff bat, but is not likely to cause a trend to federal listing or loss of viability.

**Alternative C**

### *Direct/Indirect Effects*

The effects for Alternative C are similar to Alternative B and D 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 greater Western mastiff bat, but is not likely to cause a trend to federal listing or loss of viability.

**Alternative D**

### *Direct/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 greater western mastiff 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 greater western mastiff bat.

#### *Determination of Effect*

Alternative D may impact greater Western mastiff 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 greater Western mastiff bat is the project area. Current, ongoing and reasonably foreseeable projects are listed in Appendix 12 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.

## Spotted Bat

### Alternative A No Action

#### *Direct/Indirect Effects*

Under the No Action Alternative, there would be no disturbance and no direct effects to spotted bats. 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. Seventy percent of the ponderosa pine and 12 percent of grassland habitat 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. 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 the No Action alternative 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. The cumulative effects for the No Action Alternative are similar to the indirect effects discussed above. The No Action Alternative would not add any additional disturbance to wildlife species or modify habitat components 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/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/Indirect Effects*

The effects for Alternative C are similar to Alternative B and D; 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/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.

### *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 12 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.

## Narrow-headed Garter Snake

**Alternative A No Action**

### *Direct/Indirect Effects*

Under the No Action Alternative, habitat conditions for wildlife would remain in their current condition, notwithstanding natural processes. Because there are no known narrow-headed garter snakes on the project area, the probability of direct effects to narrow-headed garter snake from the current condition are low. However, dense forest conditions would still occur and the high fire hazard potential would persist. Large, uncharacteristically severe -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.

#### ***Determination of Effect***

Alternative A may impact narrow-headed garter snake, but is not likely to cause a trend to federal listing or loss of viability.

#### ***Cumulative Effects***

The area analyzed for cumulative effects for narrow-headed garter snake is Subunit 3-5. The cumulative effects for the No Action Alternative are similar to the indirect effects discussed above. The No Action Alternative would not add any additional disturbance to wildlife species or modify habitat components within subunit 3-5. Therefore, there would be no direct cumulative effect from this alternative.

### Alternative B Proposed Action

#### ***Direct/Indirect Effects***

Narrow-headed garter snakes are currently known from Oak Creek Canyon and the Verde River. There would be no direct effects to narrow-headed garter snakes from mechanical treatment and/or prescribed burning. The project would not be directly treating narrow-headed garter snake habitat.

It is unlikely that any of the Action Alternatives would contribute enough sediment or other pollutants to ephemeral or intermittent drainages within the project area to result in impairment of any downstream waterbodies (Water Quality and Riparian report). Treatments in subunits connected to these watersheds could potentially lead to increased sedimentation and/or ash flow into narrow-headed garter snake habitat (Fisheries and Aquatics report). However, this increase in sediment or ash over background levels would not have negative impacts on habitat for this species. 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 for both Alternatives B and C to reduce the risk of sediment and ash flow into the Upper Oak Creek.

Under the Proposed Action spring restoration would increase riparian vegetation increasing availability of food and reproductive sites for these species over the long-term, resulting in direct beneficial effects to habitat.

#### ***Determination of Effect***

Implementation of Alternative B may impact narrow-headed garter snake, but is not likely to cause a trend to federal listing or loss of viability.

### Alternative C

#### ***Direct/Indirect Effects***

The effects for Alternative C are the same as Alternative B.

#### ***Determination of Effect***

Implementation of Alternative C may impact narrow-headed garter snake, but is not likely to cause a trend to federal listing or loss of viability.

**Alternative D**

### *Direct/Indirect Effects*

The effects for Alternative D are the same effects as Alternative B and C however there would be no prescribed burning on slopes greater than 15% along the upstream portion of Oak Creek within Subunit 3-5 eliminating the need for a protective stream course buffer along the entire length of Sterling Canyon.

### *Determination of Effect*

Implementation of Alternative D may impact narrow-headed garter snake, 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 narrow-headed garter snake is Subunit 3-5. No cumulative effects to narrow-headed garter snake would occur from implementation of any of the alternatives, when added to past, present and reasonably foreseeable future activities. Ongoing and foreseeable future projects include tornado rehabilitation and Turkey Barney Fuels Reduction and Forest Health project. Implementation of other these projects could occur simultaneously; however it is not anticipated to combine to cause a negative effect. BMPs are implemented for all projects and would curtail soil erosion and minimize potential for inflow into potential narrow-headed garter snake habitat.

## Golden and Bald Eagle Protection Act

**Alternative A No Action**

### *Direct/Indirect Effects*

Refer to the section in this document where the effects analysis was done for the bald eagle as a Forest Service Sensitive species.

There are no direct effects to golden eagles as no habitat altering activities or disturbance associated with project implementation would occur. The No Action Alternative 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/Indirect Effects*

Refer to the section in this document where the effects analysis was done for the bald eagle as a Forest Service Sensitive species.

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. 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 (Hedwall, personal communication 2012). 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 122). 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 122 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. Grassland and savanna treatments would maintain and improve foraging habitat on 11,185 acres of grassland and 45,469 acres of savanna habitat improving prey species habitat resulting in an indirect beneficial effect.

**Table 122. Confirmed and potential golden eagle nests potentially affected by the 4FRI.**

| 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. |

| Status | Name | Subunit | Forest | Potential for Smoke to Settle | Comments |
|---|---|---|---|---|---|
| Confirmed | Eagle Nest Mountain | 4-1 | KNF | No | Outside treatment area. |
| Confirmed | Double A Knoll | 4-1 | KNF | No | Outside treatment area. |
| 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. |

| Status | Name | Subunit | Forest | Potential for Smoke to Settle | Comments |
|---|---|---|---|---|---|
| Potential | Lee Mountain | 2-0 | CNF | No | No 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/Indirect Effects*

Refer to the section in this document where the effects analysis was done for the bald eagle as a Forest Service Sensitive species.

The effects of Alternative C are similar to those of Alternative B and D. Alternative C would have 48,206 acres more grassland restoration than Alternative B or D restoring more acres of potential foraging habitat for golden eagles. The added mechanical treatments within grasslands would maintain and improve more 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/Indirect Effects*

Refer to the section in this document where the effects analysis was done for the bald eagle as a Forest Service Sensitive species.

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.

### *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 12 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

### Amendments Supporting the Action Alternatives

Not incorporating the proposed amendments would affect the habitat of most of the MIS addressed in this report (Table XX). 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, more large snags through time, and increasing understory response. Not incorporating these amendments would allow:

- uncharacteristically dense forest conditions, fewer big pine and oak trees, and increased fire risk for wildlife using forested habitats in 18 PACs (related to the proposed mechanical treatments in all action alternatives)
- uncharacteristically dense forest conditions, lower crown base height, and increased fire risk in 56 PACs (related to the proposed prescribed fire treatments in alternative C only)
- fewer PACs attaining the desired post-treatment conditions due to sequencing of treatments through time (all action alternatives)
- uncharacteristically dense forest conditions, fewer canopy openings, and fewer large pine and oak trees in restricted habitat that would be managed as threshold habitat where no resident MSOs exist on the Kaibab NF (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 maximum SDI), and prevent the restoration of grasslands and savanna. This would decrease the ability to maintain dense groups of trees along with shrub and herbaceous vegetation, decreasing foods for herbivores, granivores, insectivores, and so for carnivores as well. Grassland species and dispersing individuals of prey species (primarily rodents and lagomorphs) that aid in maintaining prey populations in forested habitat would be reduced as trees continue to encroach upon open habitats. Simultaneously, habitat for species that depend on closed canopy would gradually increase.

Not managing the proposed Garland Prairie RNA for the grassland characteristics it was intended to support would result in similar dynamics, i.e., the development of forest structural characteristics used by some species while reducing habitat effectiveness for open habitat species.

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 XX. Affects 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 Indicators Species for Late-seral Ponderosa Pine

The northern goshawk, pygmy nuthatch and wild turkey are all indictors for late-seral ponderosa pine habitat. Goshawks are consistently detected during surveys and there are documented goshawk nesting territories within the analysis area. Pygmy nuthatches are recorded each year in the analysis area during Forestwide surveys for both forests. Wild turkeys have been documented within the analysis area by both forestwide and AGFD surveys (Appendix 6).

Most trees in the mature and older structural stages (VSS 5 and 6) will be retained across all alternatives. The main different between the alternatives will be how many acres 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 95 below. A modeling assumption was that no high severity wildfire would occur within the analysis area over the next 40 years.

### Kaibab NF Late-seral Ponderosa Pine Habitat Trend

The forestwide habitat trend for the late-seral ponderosa pine is in an upward trend due to the forest emphasis on retaining groups of large trees and maintaining large-sized reserve trees. Forestwide, there are approximately 200,000 acres of ponderosa pine forest in trees greater than 18" dbh (Forest Service 2010). Within the analysis area there is approximate 27,921 acres of late-seral ponderosa pine on the Kaibab NF, which is approximately 14% of this age class across the forest. However, treatments would occur on 189,407 acres of ponderosa pine habitat which is approximately 37% of the ponderosa pine cover type acreage for the forest.

Alternative A would not have active management of the ponderosa pine within the analysis area (Table 123). In the short term, Alternative A would not change the forestwide trend from increasing due to the small amount of habitat lost from insects, disease, and within stand competition within that timeframe. While the long term predicted acres seem to show a continuation of the increasing trend forestwide, the likelihood of high-severity wildfire is high (Fire Ecology report). If no treatments occur in the analysis area, it is very likely that wildfires could cause decreases in habitat trends because the analysis area comprises 37% of the forestwide ponderosa pine cover type.

Alternatives B, C, & D would continue the current increasing forestwide habitat trend for both the short and long term (Table 123). Alternatives B and C are very similar in the amount of increase in acreage with B being slightly higher in the amount of acreage. Alternative D would have the least amount of increase in acreage over time.

**Table 123. Change in Late-seral Ponderosa Pine Habitat on Kaibab NF by Alternative**

| Alternative | Current acreage | Acreage at 2020 | Different from current | Acreage at 2050 | Different from current |
|---|---|---|---|---|---|
| A | 27,921 | 25,288 | -2,633 | 68,277 | 40,356 |
| B | 27,921 | 59,883 | 31,962 | 104,803 | 76,882 |
| C | 27,921 | 59,531 | 31,610 | 104,726 | 76,805 |
| D | 27,921 | 48,453 | 20,532 | 96,530 | 68,609 |

**Late seral Habitat Trends for the Kaibab NF**

**Alternative A**: Short-term = stable to increasing; long-term = decreasing.

**Alternatives B and C**: 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.

### Coconino NF Late-seral Ponderosa Pine Habitat Trend

The forestwide habitat trend for late-seral ponderosa pine is declining for both the short and long term. The age class distribution of ponderosa pine has remained essentially the same, dominated by mid-seral stage, with some loss of old-growth and older trees, and some early-seral stage habitat created by wildfire (Forest Service 2002). Based in the VDDT model there are approximately 80,773 acres of late-seral ponderosa pine available forestwide. Within the analysis area there is approximate 56,615 acres of late-seral ponderosa pine, which is approximately 70% of this age class across the forest. However, treatments would occur on 322,772 acres of ponderosa pine habitat which is approximately 41% of the ponderosa pine PNVT acreage for the forest.

Alternative A would not have active management of the ponderosa pine within the analysis area (Table 124). In the short term, Alternative A would not change the forestwide trend from decreasing since there is only a small change in amount of acres increased. The long term modeling indicates an increasing trend in late successional habitat. Before 4FRI there was no database for modeling stand development at this or similar scales. 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.

Alternatives B, C & D would change the current decreasing Forestwide habitat trend to increasing for both the short and long term (Table 124). Alternatives B and C are very similar in the amount of increase in acreage with B being slightly higher in the amount of acreage. Alternative D would have the least amount of increase in acreage over time.

**Table 124. 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 | 56,615 | 56,698 | 83 | 137,051 | 80,436 |
| B | 56,615 | 115,596 | 58,981 | 203,949 | 147,334 |
| C | 56,615 | 114,063 | 57,448 | 203,606 | 146,991 |
| D | 56,615 | 98,053 | 41,438 | 185,805 | 129,190 |

**Late seral Habitat Trends for the Coconino NF**

**Alternative A**: Short-term = stable to decreasing; long-term = stable to increasing.

**Alternatives B and C**: 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

**Project Level MIS Assessment – Alternative A:**

### *Northern goshawk Habitat quantity*

In Alternative A, not implementing any actions to modify the vegetation would **increase** the relative percent of VSS 5 and 6 beyond the desired percentage of 40% across the treatment area.

### *Northern goshawk Habitat quality:*

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.

### *Northern goshawk MRNG prey species habitat quality:*

- **Snags:** Alternative A would increase the snags per acre both in the PFA and in the LOPFA, similarly to the action alternatives.
- **Downed logs:** Alternative A would increase the downed logs both in the PFA and the LOPFA slightly less than the action alternatives.
- **Woody debris:** Alternative A would increase the tons/ac of woody debris similarly to Alternative D and more than Alternatives B and C.
- **Openings:** The amount or prevalence of openings across the landscape would be inversely proportional to the %SDI, as the %SDI increases; openings across the landscape would decrease. Alternative A would lead to an increased %SDI in both the PFA and LOPFA habitat areas and therefore, fewer openings across the landscape. Increasing the current tree density as measured by % SDI would reduce the conditions that provide openings in the forest across the landscape for prey species habitat.
- **Large trees:** Increasing the total acres of VSS 5 and 6 where large trees would occur would increase the total amount of habitat for the 10 prey species for which this habitat feature is of medium/high importance for maintaining viable populations.
- **Herb, shrub, understory:** Using an index of biomass production in lbs/ac as a relative measure for the quantity and quality of herbaceous vegetation, there would be a decrease in the index of biomass production with this alternative from about 100 lbs/ac to less than 50 lbs/ac in 2050. Decreased index of biomass production across the landscape would indicate a potential decrease in both the amount of herbaceous vegetation produced per acre as well as the number of acres producing vegetation suitable for prey species habitat needs. This habitat feature is of high/medium importance for nine of the twelve prey species in the ponderosa pine type.

Potential effects to goshawk and prey habitat features within late seral habitat by alternative are presented in Table 125.

**Table 125. Summary of Alternative effects to Late Seral Ponderosa Pine Relative to Goshawks and Their Prey**

| Proposed Activity | Alternative A – No Action | Alternative B – Proposed Action | Alternative C | Alternative D |
|---|---|---|---|---|
| Silviculture Treatments (UEA, IT, SI, savanna) | Net increase in quantity of late seral stage ponderosa pine<br>Net increase in habitat quality in late seral stage ponderosa pine due to dense conditions | Net increase in quantity of late seral stage ponderosa pine<br>Habitat quality improves in late seral stage ponderosa pine due to less dense stand conditions | | |
| Prescribed Burning (“Rx fire”) | No change in quantity<br>Habitat quality deteriorates w/ lack of Rx fire due to continued dense conditions | Increased acres of late seral ponderosa pine from expected fire-associated mortality of competing younger trees<br>Rx fire would increase habitat quality on those acres where it occurs by opening stand structure which favors goshawk foraging methods | | Less acres of Rx fire has effect of changing fewer acres to late seral than Alts B&C<br>Less acres of Rx fire would have effect of lower habitat quality than Alts B&C |
| Research | NA | NA | No affect to late seral ponderosa pine habitat at the subunit scale and above | NA |
| MSO PACs | No change in quantity or quality of habitat | Net increase in late seral ponderosa pine | Net increase in late seral ponderosa pine | Less increase in late seral ponderosa pine than Alts B&C due to less effects from Rx fire |
| Spring and channel restoration | No change in habitat quantity or quality | No change in late seral stage ponderosa pine quantity – Localized improvement to goshawk foraging (prey species) habitat | | |
| Road Decommission | No change in habitat quantity or quality | No change in late seral stage ponderosa pine quantity – Localized improvement in quantity and quality of habitat due to reduced disturbance and habitat improvement at the site scale | | |
| Temporary Road Construction | No change in habitat quantity or quality | No change in late seral stage ponderosa pine quantity – Localized decrease in habitat quantity and quality and increased disturbance from road use | | |
| Road Reconstruction | No change in habitat quantity or quality | No change in late seral stage ponderosa pine quantity – No discernible changes to goshawk or prey species’ habitat structure – Localized decrease in habitat quantity and quality as road use changes and increases potential for disturbance from use | | |

| Proposed Activity | Alternative A – No Action | Alternative B – Proposed Action | Alternative C | Alternative D |
|---|---|---|---|---|
| Mechanically treat and burn Aspen | No change in quantity or quality of habitat | No change in late seral stage ponderosa pine quantity or quality; Improved habitat quality for birds associated with aspen, including goshawk prey species | | No change in late seral stage ponderosa pine quantity or quality; limited improvement in aspen habitat quality due to less Rx fire |

### *Alternative A summary:*

Alternative A increases the total amount of late seral stage ponderosa pine thus increasing the amount of indicator habitat for the northern goshawk. The changes in habitat components for prey species are mixed. Four components that might be considered primarily structural and secondarily associated with food are expected to increase toward desired conditions: snags, large trees, logs and down woody material. Then, two components that might be more primarily food and secondarily structure are expected to decline away from desired conditions: openings and index of biomass production. If prey species have the structural components without the sources of food, some aspects of habitat quantity may increase while other aspects of habitat quality decrease.

**Project Level MIS Assessment - Alternatives B and C:**

### *Northern goshawk Habitat quantity:*

The large tree habitat structure required for goshawk nesting (e.g., large, tall trees with large branches and adequate flight paths) will be more available across the landscape as the number of acres of large trees increases with appropriate interspace between groups of trees. Within the project area, the existing amount of late seral stage ponderosa pine in VSSs 5 and 6 is 17%. Alternatives B and C would increase the amount of late seral stage post-treatment to almost double the existing amount. Thirty years after treatments are completed the amount of late seral stage ponderosa pine in the project area would have increased by threefold, exceeding the desired amount for that habitat feature. Increasing the total acres of VSS 5 and 6 where large trees would occur would **increase** the total amount of habitat for which the northern goshawk is an indicator.

### *Northern goshawk Habitat quality:*

The quality of the late seral stage ponderosa pine habitat would be expected to improve as stand conditions are moved closer to historic conditions with more open understories, less competition among trees, and healthier forest conditions. Opening the understories would **improve** the quality of this habitat for goshawk foraging by providing more open structure for detecting and pursuing prey. Also, 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.

### *Northern goshawk MRNG prey species habitat quality:*

- **Snags:** Alternatives B and C would increase the snags per acre both in the PFA and in the LOPFA.
- **Downed logs:** Alternatives B and C would increase the downed logs both in the PFA and the LOPFA.

- **Woody debris:** Alternatives B and C would increase the tons/ac of woody debris from the existing conditions in both the PFA and LOPFA.
- **Openings:** Coupled with the design feature to create openings across the landscape, Alternatives B and C would lead to the greatest decrease in % SDI in both the PFA and LOPFA habitat areas and thus, the most openings across the landscape.
- **Large trees:** Alternatives B and C would produce the most increase in the total acres of VSS 5 and 6 where large trees would occur thus increasing the total amount of habitat for the 10 prey species for which this habitat feature is of medium/high importance for maintaining viable populations.
- **Herb, shrub, understory:** Using index of biomass production in lbs/ac as a relative measure for the quantity and quality of herbaceous vegetation, Alternatives B and C would produce the most increase in the index of biomass production from the existing 100 lbs/ac to over 250 lbs/ac in 2020 then dropping down to 150 lbs/ac in 2050 as the canopies begin to close after treatments. Increased index of biomass production across the landscape would indicate a potential increase in both the amount of herbaceous vegetation produced per acre as well as the number of acres producing vegetation suitable for prey species habitat needs. This habitat feature is of high/medium importance for nine of the twelve prey species in the ponderosa pine type.

#### *Alternatives B and C summary:*

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 Alternative D.

### Project Level MIS Assessment - Alternative D

#### *Northern goshawk Habitat quantity:*

The large tree habitat components required by the goshawk for nesting will be more available across the landscape as the number of acres of large trees increases. Within the project area, the existing amount of late seral stage ponderosa pine is 17%. Alternative D would **increase** the amount of late seral stage post-treatment to almost double the existing amount. Thirty years after treatments are completed the amount of late seral stage ponderosa pine in the project area would have increased by almost threefold, exceeding the desired amount for that habitat feature.

#### *Northern goshawk Habitat quality:*

The quality of the late seral stage ponderosa pine habitat would be expected to improve as stand conditions are moved closer to historic conditions with more open understories, less competition among trees, and healthier forest conditions.

Opening the understories would **improve** the quality of this habitat for goshawk foraging by providing more open structure for detecting and pursuing prey. Also, large trees used for nesting would be able to grow to larger size, retain more of their crowns, and live longer with less understory competition thus providing higher quality habitat for nesting and foraging. With less prescribed burning, the quality would be slightly less than Alternatives B and C as the conditions are moved as close to desired conditions as the other alternatives.

### *Northern goshawk MRNG prey species habitat quality:*

- **Snags:** Alternative D would increase the snags per acre both in the PFA and in the LOPFA.
- **Downed logs:** Alternative D would increase the downed logs both in the PFA and the LOPFA.
- **Woody debris:** Alternative D would increase the tons/ac of woody debris from the existing conditions in both the PFA and LOPFA.
- **Openings:** Coupled with the design feature to create openings across the landscape, Alternative D would decrease the % SDI in both the PFA and LOPFA habitat areas slightly less than Alternatives B and C and thus, produce slightly fewer openings across the landscape.
- **Large trees:** Alternative D would increase the total acres of VSS 5 and 6 where large trees would occur slightly less than Alternatives B and C. This would increase the total amount of habitat for the 10 prey species for which this habitat feature is of medium/high importance for maintaining viable populations.
- **Herb, shrub, understory:** Using an index of biomass production in lbs/ac as a relative measure for the quantity and quality of herbaceous vegetation, Alternative D would produce an increase in the index of biomass production from the existing 100 lbs/ac to about 250 lbs/ac in 2020 then dropping just below 150 lbs/ac in 2050 as the canopies begin to close after treatments. Increased index of biomass production across the landscape would indicate a potential increase in both the amount of herbaceous vegetation produced per acre as well as the number of acres producing vegetation suitable for prey species habitat needs. This habitat feature is of high/medium importance for nine of the twelve prey species in the ponderosa pine type. These changes are only slightly less than the changes projected for Alternatives B and C.

### *Alternative D summary:*

Increasing the total acres of VSS 5 and 6 where large trees would occur would increase the total amount of habitat for which the northern goshawk is an indicator. Alternative D improves habitat less than Alternatives B and C in openings, large trees, and biomass production. Alternative D improves habitat more than Alternatives B and C in down woody material and is comparable to Alternatives B and C in snags and down logs. Overall, Alternative D increase habitat quantity and improves habitat quality for northern goshawk and its prey species less than Alternatives B and C.

#### Kaibab National Forest level Northern goshawk MIS assessment

Goshawk indicator habitat and trends for the Kaibab NF are presented in Table 126.

**Table 126. Existing Trends from Current Kaibab National Forest level MIS Report (2010)**

| Species | Relevance | Indicator Habitat | Habitat feature | Habitat trend | Population trend |
|---|---|---|---|---|---|
| Northern goshawk | Subject species | Ponderosa pine | Late seral | Positive | Declining |

On the KNF, ponderosa pine forest covers approximately 515,148 acres (about 34% of the total Forest acreage) and occurs on all three Ranger Districts. Similarly, the corresponding PNVT covers 541,000 acres, approximately 35% of the total land area.

The Kaibab National Forest lies in three disjunct parts; two portions south of the Grand Canyon and one part north of the Grand Canyon. The Tusayan and Williams Ranger Districts lie south of the Grand Canyon and are within the Project area (Figure 1). The NKRD (North Kaibab Ranger District) lies north of the Grand Canyon and is not within the project area. Of the 203 PFAs on the KNF, 135 are on the NKRD, 68 are on the southern portion of the KNF, and 36 are within the project area. Status of goshawk habitat on the Kaibab NF is displayed in Table 127.

**Table 127. Kaibab NF Existing Conditions of late seral ponderosa pine**

| Existing Condition Measure - KNF | Acres | Relevance |
|---|---|---|
| Acres PIPO KNF Forestwide | 515,148<br>(MIS report page 105) | Entire indicator vegetation type |
| Acres of late seral PIPO at the time of the Forest Plan. | Not available | "Reference condition" |
| Acres Late Seral (18"+ dbh) PIPO KNF Forestwide currently | 200,000<br>(MIS Report graph page 116) | 39% of the PIPO Forestwide |
| Acres of PIPO on KNF in Project Area | 189,407 | 37% of the PIPO Forestwide |
| Acres of Late Seral (VSS 5&6) PIPO on KNF in Project Area | 27,921 | 14% of the Late Seral PIPO Forestwide |

Using 27,921 as the existing number of acres of late seral stage ponderosa pine in the KNF portion of the project area, Table 128 lists the projected net changes in acres of late seral stage ponderosa pine as a result of the various alternatives and the relevant percent that represents for the entire Kaibab National Forest. It is important to note that the changes to late seral stage ponderosa pine are only occurring on the two districts that lie south of the Grand Canyon. Status of prey habitat and prey population trends is presented in Table 129 and [1]Green indicates movement towards desired condition, darker green indicates more movement towards desired conditions, and red indicates movement away from desired condition.

Table 130.

**Table 128. KNF Forestwide change (ac/%) in Late seral Ponderosa Pine**

| Alternative | 2020 | 2050 |
|---|---|---|
| Alternative A | -2,633 ac / -0.5% | +40,356 ac / +8% |
| Alternative B | +31,962 ac / +6% | +76,882 ac / +15% |
| Alternative C | +31,610 ac / +6% | +76,805 ac / +15% |
| Alternative D | +20,532 ac / +4% | +68,609 ac / +13% |

**Table 129. KNF Summary of changes to MRNG prey species' habitat features by Alternative 2050[1]**

| Prey Species Habitat Component | Measure | Existing Condition | Alt. A | Alt. B | Alt. C | Alt. D |
|---|---|---|---|---|---|---|
| Snags >18"dbh | Snags/ac | 0.4/ac – pfa<br>0.3/ac - outpfa | 0.7/ac – pfa/outpfa | | | |

| Prey Species Habitat Component | Measure | Existing Condition | Alt. A | Alt. B | Alt. C | Alt. D |
|---|---|---|---|---|---|---|
| Downed Logs | CWD #/ac >12"diameter | 0.24/ac – pfa<br>0.25/ac - outpfa | 0.85/ac – pfa<br>0.81/ac - outpfa | 1.3/ac pfa<br>1.1/ac - outpfa | 1.3/ac pfa<br>1.1/ac - outpfa | 1.2/ac pfa<br>1.0/ac - outpfa |
| Woody Debris | Tons/ac | Not calculated at the Forest Level. Results would be similar to those for the entire project area. | | | | |
| Openings | Relevant to %SDI | 39% - pfa<br>38% -outpfa | 46% - pfa<br>45% - outpfa | 32% - pfa<br>26% - outpfa | | 35% - pfa<br>29% - outpfa |
| Large trees Forestwide | % VSS 5 & 6 | 18% | +8% | +15% | | +13% |
| Herb, Shrub, Understory | lbs/ac biomass production | Not calculated at the Forest Level. Results would be similar to those for the entire project area. | | | | |

[1]Green indicates movement towards desired condition, darker green indicates more movement towards desired conditions, and red indicates movement away from desired condition.

**Table 130. Goshawk prey species long-term summaries by alternative on the Kaibab NF**

| Prey Species | Indicator habitat | Habitat Quantity Trend Across Alternatives | | | | Population Trend Across Alternatives | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | A | B | C | D |
| Hairy woodpecker | Snags in PP/MC/SF | Unknown | Increase | Increase | Increase | Unknown | Increase | Increase | Increase |
| Red-naped sapsucker | Aspen – late seral & snags | Decrease | Stable | Stable | Stable | Decrease | Stable | Stable | Stable |
| Abert's squirrel | Early Seral ponderosa pine | Decrease | Increase | Increase | Increase | Decrease | Increase | Increase | Increase |

### *Alternative A*

- **Habitat trend – Quantity:** Alternative A would have an 8% increase in % VSS 5 and 6 as measure of late seral PIPO on the Kaibab NF.
- **Habitat trend – Quality:** The quality of the habitat would **deteriorate** as canopies closed and tree densities increased and potential understory production decreased. Closed canopies would not allow sunlight and water to reach the forest floor for understory vegetation to grow and provide habitat for prey species including hiding cover, nesting substrates, seeds and fruits, and grasses forbs and shrubs. Increased tree densities would increase competition among trees with trees not being able to grow to larger sizes due to limited available 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 kill a lot of trees, 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 a moderate 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.

- **Population Trend:** Net increase in quantity of habitat with a decrease in quality of habitat coupled with some decreases in amounts of prey species' habitat and unknown to decreasing population trends for MIS prey species would be expected to have **static** impact on the population trend for the northern goshawk.

### *Alternatives B and C*

- **Habitat trend – Quantity:** Alternatives B and C would eventually have a 15% **increase** in VSS 5 and 6 as the measure for the amount of late seral ponderosa pine on the Kaibab NF.
- **Habitat trend – Quality:** The quality of the habitat would **improve** as canopies were opened up and tree densities decreased and potential understory production increased. Canopies with openings would allow sunlight and water to reach the forest floor for understory vegetation to grow and provide habitat for prey species including cover, nesting substrates, seeds and fruits, and grasses forbs and shrubs. Decreased tree densities would decrease competition among trees with trees being able to grow to larger sizes due to available resources and space.
- **Population Trend:** Net increase in quantity of habitat coupled with an increase in quality of habitat combined with increased habitat components for MRNG prey species and positive changes to MIS prey species' habitat and increasing population trends would be expected to have **positive** impact on the population trend for the northern goshawk in Alternatives B and C.

### *Alternative D*

- **Habitat trend – Quantity:** Alternative D would eventually have a 13% **increase** in VSS 5 and 6 as the measure for the amount of late seral ponderosa pine on the Kaibab NF (Table 131).
- **Habitat trend – Quality:** The quality of the habitat would **improve** as canopies were opened up and tree densities decreased and potential understory production increased. Canopies with openings would allow sunlight and water to reach the forest floor for understory vegetation to grow and provide habitat for prey species including cover, nesting substrates, seeds and fruits, and grasses forbs and shrubs. Decreased tree densities would decrease competition among trees with trees being able to grow to larger sizes due to available resources and space (Table 131).
- **Population Trend:** Net increase in quantity of habitat coupled with an increase in quality of habitat combined with increased habitat components for MRNG prey species and positive changes to MIS prey species' habitat and increasing population trends would be expected to have **positive** impact on the population trend for the northern goshawk in Alternative D (Table 131).

### *Summary*

**Table 131. KNF Summary of Project and Forest level trends for the Northern Goshawk**

| Measure | Alternative A | Alternative B | Alternative C | Alternative D |
|---|---|---|---|---|
| Project level | Increase | Increase | Increase | Increase |

| | | | | |
|---|---|---|---|---|
| habitat quantity | | | | |
| Project level<br>habitat quality | Deteriorate | Most improvement | Most improvement | Some improvement |
| KNF Forest level habitat trend | Increase 8% | Increase 15% | Increase 15% | Increase 13% |
| KNF Forest level population trend | Static | Upward/Increasing | Upward/Increasing | Upward/Increasing |

**Coconino National Forest level Northern goshawk MIS assessment**

**Table 132. Existing Trends from Current Coconino National Forest level MIS Reports (2002, draft 2012)**

| Species | Relevance | Indicator Habitat | Habitat feature | Habitat trend | Population trend |
|---|---|---|---|---|---|
| Northern goshawk | Subject species | Ponderosa pine | Late seral | Declining | Inconclusive |

There are close to 700,000 acres of the non-Wilderness ponderosa pine cover type (which includes ponderosa pine-Gambel oak), and cover type acreages have remained essentially the same (Table 133). At the time the Forest Plan was developed, there was not much late seral ponderosa pine. There has been some decline, particularly in the large tree component, due to both management activities and natural loss, since implementation of the Plan. Forest-wide, the mid-seral stage continues to dominate forest structure (70% or more of the acres). The remaining 30% would be divided between the early and late seral stages for ponderosa pine. No estimates of acres or percent are given for the late seral stage ponderosa pine in the current CNF MIS Report for reference conditions at the time of the Forest Plan. See Figure 1 of those portions of the CNF that lie within the project area. For the Coconino NF, there are 70 PFAs on the forest (Overby, *pers. comm.*) and 38 of them are within the project area.

**Table 133. Coconino NF Existing condition of late seral ponderosa pine**

| Existing Condition Measure - CNF | Acres | Relevance |
|---|---|---|
| Acres PIPO CNF Forestwide | 700,000 (MIS Report page 9) | Entire indicator vegetation type |
| Acres of late seral PIPO at the time of the Forest Plan | Not available | “Reference condition” |
| Acres Late Seral (18”+ dbh) PIPO CNF Forestwide currently | Unable to discern from MIS Report | |
| Acres of PIPO on CNF in Project Area | 322,772 | -46% of the PIPO Forestwide |
| Acres of Late Seral (VSS 5&6) PIPO on CNF in Project Area | 56,615 | -8% of the PIPO Forestwide – -18% of the PIPO on CNF in Project area |

There are 56,615 acres of existing late seral stage ponderosa pine on the CNF portion of the project area. Table 134 lists the forest-wide change in late-seral ponderosa pine, expressed as net changes in acres of late seral stage ponderosa pine that would result from the proposed alternatives compared to the entire Coconino NF.

**Table 134. CNF Forest-wide change (ac/%) in Late seral Ponderosa Pine**

| Alternative | 2020 | 2050 |
|---|---|---|
| Alternative A | +83 ac ac / 0% | +80,436 ac / +11.5% |
| Alternative B | +58,981 ac / +8% | +147,334 ac / +21% |
| Alternative C | +57,448 ac / +8% | +146,991 ac / +21% |
| Alternative D | +41,438 ac / +6% | +129,190 ac / +18.5% |

Project effects to goshawk prey species are displayed in Table 135 and [1]Green indicates movement towards desired condition, darker green indicates more movement towards desired conditions, and red indicates movement away from desired condition.
Table 136

**Table 135. Summary of changes to MRNG prey species' habitat features by Alternative 2050[1]**

| Prey Species Habitat Component | Measure | Existing Condition | Alt A | Alt B | Alt C | Alt D |
|---|---|---|---|---|---|---|
| Snags >18"dbh | Snags/ac | 0.42/ac – pfa<br>0.40/ac -outpfa | 1.14/ac – pfa<br>0.96/ac -outpfa | 1.2/ac – pfa<br>0.97/ac - outpfa | 1.2/ac – pfa<br>0.97/ac - outpfa | 1.2/ac – pfa<br>0.97/ac - outpfa |
| Downed Logs | CWD #/ac >12"diameter | 1.22/ac – pfa<br>0.58/ac -outpfa | 2.04/ac – pfa<br>1.38/ac -outpfa | 2.26/ac – pfa<br>1.63/ac - outpfa | 2.26/ac – pfa<br>1.63/ac - outpfa | 2.42/ac – pfa<br>1.63/ac - outpfa |
| Woody Debris | Tons/ac | Not calculated at the Forest Level. Results would be similar to those for the entire project area. | | | | |
| Openings | Relevant to %SDI | 51% - pfa<br>42% - outpfa | 54% - pfa<br>47% -outpfa | 34% - pfa<br>27% - outpfa | 38% - pfa<br>30% - outpfa | 38% - pfa<br>30% - outpfa |
| Large trees | % VSS 5 & 6 | 8% | +11.5% | +21% | +18.5% | +18.5% |
| Herb, Shrub, Understory | lbs/ac biomass production | Not calculated at the Forest Level. Results would be similar to those for the entire project area. | | | | |

[1]Green indicates movement towards desired condition, darker green indicates more movement towards desired conditions, and red indicates movement away from desired condition.

**Table 136. Goshawk prey species long-term summaries by alternative on the Coconino NF**

| Prey Species | Indicator habitat | Habitat Quantity Trend Across Alternatives | | | | Population Trend Across Alternatives | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | A | B | C | D |
| Hairy | Snags in | Unknown | Increase | Increase | Increase | Unknown | Increase | Increase | Increase |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| woodpecker | PP/MC/SF | | | | | | | | |
| Red-naped sapsucker | Aspen – late seral & snags | Decrease | Stable | Stable | Stable | Decrease | Stable to Increase | Stable to Increase | Stable to Increase |
| Abert's squirrel | Early Seral ponderosa pine | Decrease | Increase | Increase | Increase | Decrease | Increase | Increase | Increase |

### *Alternative A*

- **Habitat trend – Quantity:** In thirty years, Alternative A would result in an 11.5% **increase** in % VSS 5&6 as measure of late seral PIPO on the Coconino NF.
- **Habitat trend – Quality:** The quality of the habitat would **deteriorate** as canopies closed and tree densities increased and potential understory production decreased. Closed canopies would not allow sunlight and water to reach the forest floor for understory vegetation to grow and provide habitat for prey species including hiding cover, nesting substrates, seeds and fruits, and grasses forbs and shrubs. Increased tree densities would increase competition among trees with trees not being able to grow to larger sizes due to limited available 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 kill a lot of trees, 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 a moderate 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.
- **Population Trend:** Net increase in quantity of habitat with a decrease in quality of habitat coupled with some decreases in amounts of prey species' habitat and unknown to decreasing population trends for MIS prey species would be expected to have **static** impact on the population trend for the northern goshawk.

### *Alternatives B and C*

- **Habitat trend – Quantity:** Alternatives B and C would eventually have a 21% **increase** in VSS 5 and 6 as the measure for the amount of late seral ponderosa pine on the Coconino NF.
- **Habitat trend – Quality:** The quality of the habitat would **improve** as canopies were opened up and tree densities decreased and potential understory production increased. Canopies with openings would allow sunlight and water to reach the forest floor for understory vegetation to grow and provide habitat for prey species including hiding cover, nesting substrates, seeds and fruits, and grasses forbs and shrubs. Decreased tree densities would decrease competition among trees with trees being able to grow to larger sizes due to available resources and space.
- **Population trend:** Net increase in quantity of habitat coupled with an increase in quality of habitat combined with increased habitat components for MRNG prey species and positive changes to MIS prey species' habitat and increasing population trends would be expected to have **positive** impact on the population trend for the northern goshawk in Alternatives B and C.

### *Alternative D*

- **Habitat trend – Quantity:** Alternative D would eventually have an 18.5% **increase** in VSS 5 and 6 as the measure for the amount of late seral ponderosa pine on the Coconino NF.
- **Habitat trend – Quality:** The quality of the habitat would **improve** as canopies were opened up and tree densities decreased and potential understory production increased. Canopies with openings would allow sunlight and water to reach the forest floor for understory vegetation to grow and provide habitat for prey species including hiding cover, nesting substrates, seeds and fruits, and grasses forbs and shrubs. Decreased tree densities would decrease competition among trees with trees being able to grow to larger sizes due to available resources and space.
- **Population trend:** Net increase in quantity of habitat coupled with an increase in quality of habitat combined with increased habitat components for MRNG prey species and positive changes to MIS prey species' habitat and increasing population trends would be expected to have positive impact on the population trend for the northern goshawk in Alternative D (Table 137).

**Table 137. Trends for goshawks and their habitat on the Coconino NF**

| Measure | Alternative A | Alternative B | Alternative C | Alternative D |
|---|---|---|---|---|
| Project level habitat quantity | Increase | Increase | Increase | Increase |
| Project level habitat quality | Deteriorate | Most improvement | Most improvement | Some improvement |
| CNF Forest level habitat trend | Increase 8% | Increase 21% | Increase 21% | Increase 18.5% |
| CNF Forest level population trend | Static | Increasing/Upward | Increasing/Upward | Increasing/Upward |

#### 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 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 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" dbh would be maintain, with an emphasis on snags greater than 18 inches dbh, except in cases of human health and safety. Live conifer trees with potential to provide nesting habitat cavities, such as deadtop trees and lightning struck trees, will be favored for retention. Prescribed burns are designed to maintain desired forest structure, tree densities, snag densities and coarse woody debris levels (Silviculture report). Alternative D would be the most limited in providing these benefits of the three actions.

#### Kaibab NF Pygmy Nuthatch Population Trend

The pygmy nuthatch is believed to be stable to declining forestwide on the Kaibab National Forest. In areas that were treated with thinning and prescribed burns or have been thinned and burned naturally, pygmy nuthatches are likely stable to increasing (Forest Service 2010).

Alternative A would likely continue the current population trend for the pygmy nuthatch of stable to 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.

Alternatives B, C, & D would likely change the forestwide population trend to increasing in the long term due to increase 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 Alternative D would not be as beneficial.

#### Coconino NF Pygmy Nuthatch Population Trend

The Forestwide trend is stable, although there are dramatic population fluctuations in the short term, and small, local populations, such as those in snowmelt drainages, may be temporarily extirpated (Forest Service 2002).

Alternative A would likely continue the current forestwide population trend for the pygmy nuthatch of stable 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.

Alternatives B, C, & D 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 Alternative D 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 the groupy habitat favored by turkeys and would also increase the understory production. By increasing the understory this will also increase the plant and invertebrate richness (Appendix 8). The vegetation design features would protect most Gambel oaks within the analysis area and would remove ponderosa pines that are over-topping the oak. Of the three action alternatives, Alternative D would be the most limited in providing these benefits of the three action alternatives because forest canopy and its understory development would be limited by the reduce amount of prescribed burning in this alternative.

**Kaibab NF Turkey Population Trend**

Wild turkey population trend on the forest is considered to be variable but overall increasing (Forest Service 2010). Turkeys are found primarily in ponderosa pine forest with a mix of meadows, oak and juniper. They use larger older trees for nesting and roosting.

Alternative A would likely continue the current forestwide population trend for the turkey as increasing 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 population trend could change to decreasing.

Alternatives B, C, & D would likely continue the forestwide population trend as increasing in both the short and long term. The population trend is influenced by other habitat factors than the development of late-seral ponderosa pine, with the main factor being the state hunt structure. Alternatives B and C would have similar impacts on the species and Alternative D would not be as beneficial.

**Coconino NF Turkey Population Trend**

The Forestwide population trend is increasing. The trend was variable in the early part of the Plan implementation period (late 80's and early 90's), although AGFD standard survey procedures did not provide good data due to low number of observations along survey routes. AGFD developed a better index of turkey populations in the mid 1990's. Data from 1997-2001 indicate a modestly increasing trend. For the last five years (1997-2002), GMU 7 shows a relatively stable trend, with all other GMUs showing a general increasing trend for both percent of archery elk hunters seeing turkeys and the number of turkeys seen per day (Forest Service 2002; also see Appendix 6).

Alternative A would likely continue the current forestwide population trend for the turkey as increasing 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.

Alternatives B, C, & D would likely continue the forestwide population trend as increasing in both the short and long term. The population trend is influence by other habitat factors than the development of late-seral ponderosa pine, with the main factor being the state hunt structure. Alternatives B and C would have similar impacts on the species and Alternative D would not be as beneficial.

## Mangaement Species Indicators for Early-seral Ponderosa Pine

Elk and Abert's squirrels are indictors for early-seral ponderosa pine habitat. Elk are common on both forests and Abert's squirrels have been documented in the analysis area during Forestwide surveys on both forests. Since both of these species are part of the state permitted hunt structure, this will affect population trends both species at the state and local levels. Elk forestwide populations are managed primarily by the state through their permitted hunt structure.

According to the Arizona Game and Fish Department (AGFD), the 4FRI project area includes portions of four elk herds. One herd includes Game Management Units (GMU) 5A/5B/6A and occurs on the Coconino NF. The second herd includes 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 the fourth herd in GMU 9, which occurs primarily on the Tusayan Ranger District of the Kaibab NF. Elk that intermix on lower elevation winter range do not always return to the same herd during summer, which complicates interpretation of both population and habitat-utilization data for this species (see Appendix 6).

### Kaibab NF Early-seral Ponderosa Pine Habitat trend

There is approximately 40,000 acres of early-seral ponderosa pine habitat across the forest (Table 129). Current habitat trend for early-seral ponderosa pine is considered stable at this time (Forest Service 2010). Within the analysis area there is approximate 7,411 acres of early-seral ponderosa pine (Silviculture report), which is approximately 18% of this age class across the forest. However, the analysis occurs on 189,407 acres of ponderosa pine habitat which is approximately 37% of the ponderosa pine cover type acreage for the forest.

Alternative A would not have active management of the ponderosa pine within the analysis area. In the short and long term, Alternative A would change the forestwide habitat trend from stable to decreasing due to the small amount of early-seral habitat that is current available (Table 129). 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 habita 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.

Alternatives B, C and D would change the current stable forestwide habitat trend to increasing for the short term. 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 (Table 138). All three action alternatives would have similar effects to the habitat trend.

#### Early seral Habitat Trends for the Kaibab NF

**Alternative A**: Short-term = decreasing; long-term = decreasing.

**Alternatives B, C, and D**: Short-term = increasing; long-term = stable.

**Table 138. Change in Early-seral Ponderosa Pine Habitat on Kaibab NF by Alternative**

| Alternative | Current acreage | Acreage at 2020 | Different from current | Acreage at 2050 | Different from current |
|---|---|---|---|---|---|
| A | 7,411 | 1,926 | -5,485 | 0 | -7,411 |
| B | 7,411 | 17,862 | 10,451 | 16,188 | 8,777 |
| C | 7,411 | 17,658 | 10,247 | 15,984 | 8,573 |
| D | 7,411 | 18,113 | 10,702 | 14,494 | 7,083 |

### Coconino NF Early-seral Ponderosa Pine Habitat Trend

Forestwide trend for early-seral ponderosa pine is stable. The age class distribution of ponderosa pine has remained essentially the same, dominated by mid-seral stage trees, with some loss of old growth and older trees, and some early seral stage habitat created by wildfire (Forest Service 2002). Based in the VDDT model there is approximately 152,836 acres of late-seral ponderosa pine available forestwide. Within the analysis area there is approximate 14,525 acres of early-seral ponderosa pine, which is approximately 10% of this age class across the forest. However, the analysis occurs on 322,772 acres of ponderosa pine habitat which is approximately 41% of the ponderosa pine PNVT acreage for the forest.

Alternative A would not have active management of the ponderosa pine within the analysis area. In the short and long term (Table 139), 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. 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.

Alternatives B, C & D 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 139). 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.

**Early seral Habitat Trends for the Coconino NF**

**Alternative A**: Short-term = decreasing; long-term = decreasing.

**Alternatives B, C, and D**: Short-term = increasing; long-term = stable.

**Table 139. 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 | 14,525 | 3,687 | -10,838 | 274 | -14,251 |
| B | 14,525 | 20,388 | 5,863 | 19,528 | 5,003 |
| C | 14,525 | 20,218 | 5,693 | 19,372 | 4,847 |
| D | 14,525 | 22,953 | 8,428 | 19,629 | 5,104 |

### 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%. 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. The former is likely more important than the latter in terms of affecting elk populations.

**Kaibab NF Elk Population Trend**

During the analysis for the forestwide elk population trend in 2010, the trend was considered to be stable (Forest Service 2010.) Analysis using current data from the AGFD shows that the elk population is in a decreasing trend (Figure 24, Figure 25, and Appendix 6). Both forests have been working with AGFD to decrease elk numbers for protection of forest resources. Elk numbers have primarily been affected by the amount and type of hunting tags issued.

While alternative A would likely continue the decrease in forestwide elk population trend, this is due to the removal of habitat components for the elk in both short and long term and the current trend of the AGFD efforts to decrease the local herd size on the forest.

Alternatives B, C, and D will improve other forest habitat in addition to the increase of early-seral habitat for elk and would change the current decreasing forestwide population trend to increasing. However, population trends for elk are influenced more by hunting than by forest management and will remain decreasing until the AGFD, along with the input from the forest, determine the population level desirable for these elk herds.

**Coconino NF Elk Population Trend**

The forestwide population trend is stable based on the analysis done in 2002. Elk numbers on the Forest increased in the early to mid-1990’s, with a gradual decline through 2001 to roughly the 1980’s level (Forest Service 2002). However, analysis using current data from the AGFD shows that the elk forestwide population is in a decreasing trend (Figure 24, Figure 25, and Appendix 6).

While alternative A would likely continue the decrease in forestwide elk population trend, this is due to the removal of habitat components for the elk in both short and long term and the current trend of the AGFD efforts to decrease the local herd size on the forest.

Alternatives B, C, and D will improve other forest habitat in addition to the increase of early-seral habitat for elk and would change the current decreasing population trend to increasing. However, population trends for elk are influenced more by hunting than by forest management and will remain as decreasing 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% 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 4).

The proposed action calls for a diverse range of mechanical treatments for maintaining forest habitat. Forests would vary from 10-55% open, outside of grassland and savanna habitat, with variable basal area, trees per acre TPA, 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%. 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.

Despite the proposed 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 in individual groups rather than across whole landscapes. In the long term, this should provide for more sustainable squirrel habitat over time because the risk of stand-replacing fire and therefore long-term degradation or loss of squirrel habitat will be significantly reduced (Forest Service 2010).

**Kaibab NF Tassel-eared Squirrel Population Trend**

The tassel-eared squirrel was selected as an indicator of early-seral ponderosa pine forest (Forest Service 2010.) For this project, the Abert's squirrel represents the specific sub-species of tassel-eared squirrel. Tassel-eared squirrels were first selected as indicators for mid-seral ponderosa pine, which was later dropped and incorporated into early-seral ponderosa pine. Unfortunately, this is not primary habitat for tassel-ear squirrels. Forestwide, the tassel-eared squirrel population is currently stable (Forest Service 2010.)

Alternative A would not change the current stable forestwide Abert's squirrel population trend in the short term but in the long term could shift the trend to decreasing. This is due to the threat of large scale, high-severity fire in the overly dense, continuous forest canopies.

Alternatives B, C, and D could have short term negative disturbance impacts but is not known if that would change the forestwide population trend to decreasing in the short term since the project includes approximately 37% of the ponderosa pine habitat on the forest. However, for the long term, all alternatives would likely change the forestwide stable population trend to an increasing trend. These population trends are based on other habitat components rather than early-seral ponderosa pine habitat.

#### Coconino NF Abert's Squirrel Population Trend

Forestwide population trend is inconclusive since there is little Forest-specific data. Statewide information indicates a stable trend for hunter harvest of squirrels (Forest Service 2002). AGFD feeding sign surveys were conducted from 2005 - 2010 in association with Forest Service vegetation management projects in the Flagstaff wildland-urban interface on the Coconino NF (Appendix 6). Feeding sign survey results indicate a stable trend in Abert's squirrel abundance on the Forest (Figure 26, page 109).

Alternative A would not change the current increasing forestwide Abert's squirrel population trend in the short term but in the long term would change the trend to decreasing.

Alternatives B, C, and D could have short term disturbance impacts that could change the forestwide population trend to decreasing because the treatment area includes approximately 41% 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.

## Management Species Indicators 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% of fire-killed snags falling within 7 years (Chambers and Mast 2005). Over 80% of ponderosa pine snags created by high severity fire fell within 10-years post-fire (Chambers and Mast pers. comm.). 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 (Forest Service 2010).

The three 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 dbh would be maintained; selection of snags to be retained after project operations would have a preference for snags greater than 18 inches dbh except in cases of human health and safety. Live conifer trees with potential to provide nesting habitat cavities such as deadtop trees and lightning struck trees will also be favored for retention. Prescribed burns 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 (Forest Service 2010). 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 (Forest Service 2010).

**Kaibab NF Hairy Woodpecker Habitat and Population Trends**

Based on FIA data for the Kaibab National Forest, snags in all three cover types (ponderosa pine, mixed conifer & spruce-fir) have increased between 1995 and 2007. It is believed this habitat is on an increasing trend. There are approximately 681,158 acres of hairy woodpecker habitat currently available on the forest (Forest Service 2010). The analysis area contains 189,407 acres of ponderosa pine, which is approximately 28% of the PNVT for the three cover types across the forest. The hairy woodpecker forestwide population trend is considered to be stable (Forest Service 2010.)

Alternative A would not change the short term forestwide habitat or population trend for the hairy woodpecker since it continues the current level of activities on the forest. In the long term, it is likely the forestwide habitat and population trends would be stable to decreasing for the species due to the threat of large stand replacing wildfires. It is hard to predict the change in forestwide trends since woodpecker use depends on the amount of area and configuration of high-severity burn patches. It is unknown how wildfire would change the forestwide population and habitat trends. We do know although large amounts of snags are created from wildfires, and that they are not long-lasting on the landscape.

Alternatives B, C, & D would likely continue the stable forestwide population trend in the short term, but treatment activities are likely to decrease snag habitat in the short-term. An analysis by the USFWS 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 USFWS 1995). In the long term, three alternatives would change the forestwide habitat and population trend to increasing.

**Coconino NF Hairy Woodpecker Habitat and Population Trends**

In 2002 the Forest estimated that trends for snags in ponderosa pine habitats were probably declining (Forest Service 2002). However, recent studies by conducted on the Coconino NF Ganey and Vojta (2007 and 2012) suggest that large snag numbers and densities will increase in the short term. Despite these increases, densities of snags greater than 18 inches dbh 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 322,772 acres for ponderosa pine, which is approximately 36% of the PNVT for the three cover types across the forest.

The forestwide population trend for the hairy woodpecker is stable to increasing. Minor population decreases occur on a scale of 1 to 3 years, but are generally followed by a recovery (Forest Service 2002).

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 stablize 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.

Alternatives B, C, & D 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 USFWS 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 USFWS 1995). In the long term, three alternatives would change the forestwide habitat and population trend to increasing.

## Management Species Indicators 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 three action alternatives propose to mechanically thin 1,229 acres of aspen habitat , but only alternatives B and C include burning all these acres. Alternative D includes 32 acres of burn-only treatment. Up to 82 miles of barriers (fences or jackstrawing) 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 approximately 200 acres less habitat on the Coconino than alternatives B and C. 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 dbh size-classes.

#### Kaibab NF Red-naped sapsucker Habitat and Population Trends

The current forestwide trend for red-naped sapsuckers is stable to increasing and their habitat is stable. The Forestwide MIS Assessment (Forest Service 2010) shows a stable to decreasing population trend and a decreasing habitat trend in the future without aspen restoration. Alternative B and C would treat about 389 acres of aspen within the analysis area which is approximately 1 percent of the aspen habitat forestwide for both alternatives. Alternative D would treat 387 acres of aspen, which is approximately 1 percent of aspen forestwide (silviculture report). Late-seral aspen represents a subset of the overall aspen values.

In the short term, alternative A would not change the current forestwide trends for red-naped sapsuckers or their habitat. The long-term trend for both the forestwide habitat and population trends would be decreasing in alternative A.

The three action alternatives would continue the forestwide population and habitat trends as stable in the short-term. While they would improve habitat in the areas proposed for treatment, this would only represent 1 percent of the aspen on the forest and would not change the stable to decreasing population trend or the decreasing habitat trend in the long term.

#### Coconino NF Red-naped sapsucker Habitat and Population Trends

Alternative B and C would treat approximately 1,063 acres and 1,082 acres respectively of aspen within the analysis area which is approximately 11 percent of the aspen habitat forestwide for both 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 stable red-naped sapsucker forestwide habitat trend in the short or long term. Alternative A would not likely change the red-naped sapsucker forestwide population trend in the short term. However, in the long-term it is likely that the forestwide population trend would change to decreasing. The decreasing trend is 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 three 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 Species Indicators 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%. 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 will decrease the likelihood of stand replacing fire events and large-scale habitat loss over larger areas (Appendix 6).

All three action alternatives propose to mechanically thin and burn 1,229 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 than alternatives B and C. 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 dbh size-classes.

All three 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. All three alternatives would leave approximately 67% (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 (Appendix 8) which would increase the forage potential for mule deer in these areas.

#### Kaibab NF Mule Deer Habitat and Population Trends

Alterative A would not change forestwide habitat trend in neither the aspen or pinyon-juniper habitat in the short or long term. The early-seral aspen will continue to decline due to the lack of recruitment. The pinyon-juniper habitat will continue to be stable due to the fact that the project would only affect 1 percent of the habitat on the forest. Alternative A would not change the mule deer forestwide population trend in the short term, since the population trend is due mainly to hunting and not management actions. There is potential for a decreasing population trend forestwide in the long term due to the potential of large scale stand replacing wildfires.

While Alternatives B, C, and D would promote the development and recruitment of early-seral aspen habitat it would not change the short- or long-term early-seral forestwide habitat trend because it would only affect about 1 percent of the aspen forestwide. The action alternatives would also continue the current stable forestwide habitat trend for pinyon-juniper habitat due to the fact that less than 1 percent of the pinyon-juniper habitat forestwide will be affected. The action alternatives would likely move 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 the deer, however, forestwide population trends are more affected by hunting than forest management.

#### Coconino NF Mule Deer Habitat and Population Trends

Alterative A would not change forestwide habitat trend in either the aspen or pinyon-juniper habitat in the short or long term. The early-seral aspen will continue to decline due to the lack of recruitment. The pinyon-juniper habitat will continue to be stable because the project would only affect 2 percent of the habitat on the forest. Alternative A would not change the mule deer population trend in the short-term because the population trend is due mainly to hunting and not management actions. There is potential for a decreasing trend in the long term due to the potential of large scale stand replacing wildfires.

Alternatives B, C, and D 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 stable forestwide habitat trend for pinyon-juniper habitat due to the fact that less than 1 percent of the pinyon-juniper habitat forestwide would be affected. The action alternatives would likely keep the mule deer forestwide population trend at 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 more affected by hunting than forest management.

## Management Species Indicators 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 (Forest Service 2010).

All three 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. All three 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 (Appendix 8) which would improve habitat conditions for the juniper titmouse in these areas. Alternative D would treat the least amount of acres. Prescribed burns are designed to maintain desired forest structure, tree densities, snag densities and coarse woody debris 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).

#### Kaibab NF Juniper Titmouse Habitat and Population Trends

Alterative A would not change the forestwide habitat trend in pinyon-juniper habitat in the short- or long-term. Pinyon-juniper habitat will continue to be stable due to the fact that the project would only affect 1 percent of the habitat on the forest. Alternative A would not change the juniper titmouse forestwide population trend in the short-term or long-term.

While Alternatives B, C, and D would help reduce the tree density and develop understory components in the pinyon-juniper habitat, it would not change the short- or long-term forestwide habitat or population trend from stable due to the fact that less than 1 percent of the pinyon-juniper habitat forestwide would be affected.

#### Coconino NF Juniper Titmouse Habitat and Population Trends

Alterative A would not change forestwide habitat or population trend in the short- or long-term. The trends would continue to be stable due to the fact that the project would only affect 1 percent of the habitat on the forest.

While Alternatives B, C, and D would help reduce the tree density and develop understory components in the pinyon-juniper habitat, it would not change the short- or long-term forestwide habitat or population trend from stable due to the fact that less than 1 percent of the pinyon-juniper habitat forestwide will be affected.

## Management Species Indicators 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 48,493 acres of grasslands 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.

Alternative C would mechanically remove encroaching conifers and burn about 48,160 acres of grassland and about 579 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 8), 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 action alternatives 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 45,465  acres of savanna by thinning out encroaching pines. This would increase and improve pronghorn habitat as well as benefit pronghorn habitat connectivity. Removing encroaching trees followed by prescribed burning would invigorate productivity of grasses and forbs. Sight distances would be improved by all action 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 6).

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. And low shrubs can play a key role as hiding cover for fawns. Figure 3 (above) shows how the alternatives would provide for connectivity for the pronghorn open corridor areas. The use of 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 6).

**Kaibab NF Pronghorn Habitat and Population Trends**

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 likely not remove large conifer trees in the grasslands. However an additional 9,620 acres of grassland would be created in the long-term. These alternatives would keep the forestwide grassland habitat trend at stable to increasing depending on how much conifer and shrub are removed. The alternatives would likely keep 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. However, the forestwide population trends for pronghorn are largely influenced by hunting, drought, and loss of connectivity due to human development.

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 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. However, the forestwide population trends for pronghorn are largely influenced by hunting, drought, and loss of connectivity due to human development.

**Coconino NF Pronghorn Habitat and Population Trends**

There is approximately 22,622 acres of burning grassland within the analysis area (9 percent of total grassland acres) in alternative B and D. Alternative C has 22,622 acres of grassland treatments (mechanical and burning) within the analysis area. All alternatives would restore approximately 1,562 acres of historical grassland that is now considered pine habitat back toward grasslands.

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 keep the forestwide grassland habitat trend at stable to increasing depending on how much conifer and shrub are removed. The alternatives would likely boost the forestwide pronghorn population trend from 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. However, the forestwide population trends for pronghorn are largely influenced by hunting, drought, and loss of connectivity due to human development.

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. The alternative would 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, 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 140). 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 12. Cumulative effects can be an integral part of the effects analysis for wildlife and will be discussed for each species.

**Table 140. Area of Analysis for Cumulative Effects by Species**

| Area of Analysis | Species | Reason for Selection |
|---|---|---|
| Within analysis area | Pygme nuthatch, turkey, Abert's squirrel, hairy woodpecker, red-naped sapsucker, juniper titmouse | 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 these treatments under the 4FRI "no action" alternative 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.

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 and juniper titmouse 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 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, 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.

In summary, the following cumulative effects apply to the MIS for both the Coconino and Kaibab NFs: For the goshawk and pronghorn, the improvement of habitat across the southern part of the forest would not change the forest-wide habitat trend, but would help stabilize forest-wide population trends. The forest-wide 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 forest-wide population trend to stabilize. The tassel-eared squirrel, mule deer, elk, red-naped sapsucker, wild turkey, hairy woodpecker, and juniper titmouse forest-wide population and habitat trends would not change.

### Alternative B, C, and D

**Kaibab NF**

The planned thinning and burning of 35,790 to 50,041 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 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. The pygmy nuthatch forest-wide habitat trend would be improved by thinning projects that retain and enhance the large tree component within the ponderosa pine forest. The ponderosa pine savanna treatments would benefit the pronghorn by creating forage and corridors for movement between areas.

The proposed aspen treatments are planned for areas that are a high priority for restoration. While this would only impact about 4 percent of the forest aspen when combined with the proposed treatments in the action alternatives, these are areas most at risk of being lost in the near future. These treatments would have limited improvement of the red-naped sapsucker in the short term, but should improve their habitat in the long-term.

Fuelwood gathering and travel management requirements together help determine where the public collects fuelwood. Since travel off road is allowed in fuelwood areas only, this will limit how far the public will go to gather fuelwood. This will likely leave a high density of dead and down woody material in areas that are further from the road. Within fuelwood areas and close to roads less dead woody material will remain available and could fall below forest plan requirements for snags, logs, and dead and down woody material. 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 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 in ponderosa pine of 96,736 to 157,842 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 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.

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 the Kaibab.

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

### 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 XXX). 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, more large snags through time, and increasing understory response. Not incorporating these amendments would allow:

- uncharacteristically dense forest conditions, fewer big pine and oak trees, and increased fire risk for wildlife using forested habitats in 18 PACs (related to the proposed mechanical treatments in all action alternatives)
- uncharacteristically dense forest conditions, lower crown base height, and increased fire risk in 56 PACs (related to the proposed prescribed fire treatments in alternative C only)
- fewer PACs attaining the desired post-treatments conditions due to sequencing of treatments through time (all action alternatives)
- uncharacteristically dense forest conditions, fewer canopy openings, and fewer large pine and oak trees in restricted habitat that would be managed as threshold habitat where no resident MSOs exist on the Kaibab NF (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

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 maximum SDI), and prevent the restoration of grasslands and savanna. This would decrease the ability to maintain dense groups of trees along with shrub and herbaceous vegetation, decreasing foods for herbivores, granivores, insectivores, and so for carnivores as well. Grassland species and dispersing individuals of prey species (primarily rodents and lagomorphs) that aid in maintaining 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.

Not managing the proposed Garland Prairie RNA for the grassland characteristics it was intended to support would result in similar dynamics, i.e., the development of forest structural characteristics used by some species while reducing habitat effectiveness for open habitat species.

Currently, many migratory birds depend on habitats or habitat elements related to canopy openings or early seral conditions. Existing closed canopy forests limit or eliminate many of the necessary habitat components needed by these species. The desired condition of closed canopy tree groups interspersed with open rooting space that supports herbaceous vegetation would provide key habitat components for these species of status as well as species adapted to closed-canopy forests. Achieving this situation is the reason for the amendments 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 XXX. Affects to Migratory Bird 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 |
| Flammulated Owl | PIPO/openings/insects/snags | Degraded |
| Olive-sided Flycatcher | PIPO/openings/insects/snags | Degraded |
| Cordilleran Flycatcher | PIPO/insects/ oak/dense forest | Mixed |
| Grace's Warbler | PIPO/openings/insects/snags | Degraded |
| Lewis's Woodpecker | PIPO/openings/insects/snags | Degraded |
| Purple Martin | PIPO/openings/insects/snags | Degraded |
| Cassin's Finch | PIPO/openings/seeds | Degraded |
| Red-naped sapsucker | Site specific/ habitat not affected | None |
| Gray Vireo | Site specific/ habitat not affected | None |
| Pinyon Jay | Site specific/ habitat not affected | None |
| Juniper titmouse | Site specific/ habitat not affected | None |
| Black-throated Gray Warble | Site specific/ habitat not affected | None |
| Gray Flycatcher | Site specific/ habitat not affected | None |
| Swainson's Hawk | Open/Grassland | Degraded |
| Ferruginous Hawk | Open/Grassland | Degraded |
| Burrowing Owl (western) | Open/Grassland | Degraded |
| Grasshopper Sparrow | Open/Grassland | Degraded |
| Bendire's Thrasher | Open/Grassland | Degraded |

[1]PIPO = ponderosa pine forest

## Ponderosa Pine Forest

Table 141 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 141. Ponderosa Pine Treatment Acres by Alternative**

| Alternative | Mechanical thinning & burning | Burning Only | No Treatment |
|---|---|---|---|
| B | 386,725 | 120,483 | 4,970 |
| C | 384,041 | 128,137 | 242 |
| D | 386,724 | 100,508 | 24,945 |

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 dbh would be retained, with a preference for snags greater than 18 inches dbh, 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 deadtops 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 within a ¼ mile of nests and roosts during the breeding season (March 1 to August 31) if occupied
- If nest or roosts are not known no treatments will occur within ¼ mile buffer of core areas unless surveys indicate the PAC is unoccupied
- Within goshawk PFA, no treatments will occur from March 1 to September 30
- Manage for forest plan levels of coarse woody debris 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

APIF and the USFWS designated eight different species of bird to represent ponderosa pine habitat (Table 34, page 124).

## Aspen Habitat

Table 142displays by alternative how much treatment will occur within the aspen habitat. Treatment data is from silvicultural analysis for the project (Silviculture report).

**Table 142. Aspen Treatment Acres by Alternative**

| Alternative | Mechanical thinning & burning | Burning Only | No Treatment |
|---|---|---|---|
| B | 1229 | 223 | 19 |
| C | 1229 | 242 | 0 |
| D | 1229 | 32 | 210 |

All three action alternatives propose to mechanically thin and burn 1,229 acres of aspen habitat and would construct 82 miles of fence around most of the treated aspen to prevent ungulate grazing of the new sprouts. If aspen clones are treated and no fencing occur than the likelihood of the treated area be able to recruited large trees in the future is unlikely. Alternative D would burn approximately 210 acres fewer habitats on the Coconino than alternatives B and C (Silviculture report). Snag and burning requirements that are described in the ponderosa pine section would also apply to aspen treatments. APIF and the USFWS designated the red-naped sapsucker to represent ponderosa pine habitat.

### Pinyon-Juniper Habitat

Table 143 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 143. 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 |

The all three 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. All three 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 8). 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 the USFWS designated five different species of bird to represent ponderosa pine habitat.

### High Elevation Grassland Habitat

Table 144 displays how much treatment will occur within the grassland habitat by alternative. Treatment data is from the project silvicultural analysis (Silviculture report).

**Table 144. High Elevation Grassland Treatment Acres by Alternative**

| Alternative | Mechanical thinning & burning | Burning Only | No Treatment |
|---|---|---|---|
| B | 0 | 48,493 | 281 |
| C | 48,196 | 579 | 0 |
| D | 0 | 48,358 | 416 |

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 will 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.

For all species, thinning and burning would occur annually and be dispersed across the landscape, so only a portion of the species habitat would be treated within a single year. Annual project activities would overlap the nesting season, but much of the work would be implemented before and after the period where the young would be vulnerable to take. For all action alternatives, wildlife design feature include the following: 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 burning. Buffers will match forest plan direction. In addition, VSS 5 and 6 tree groups will not be targeted for removal. Potential effects to migratory birds from the action alternatives are shown in Table 145.

**Table 145. Migratory Bird Species and Their Associated Habitats Likely to be Effected 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, leading to loss of egg viability or injury or death to nestlings. There would be no measureable long-term negative effect to goshawk populations. |
| Flammulated Owl | Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, leading to loss of egg viability or injury or death to nestlings.<br><br>The three action alternatives for the most part will be retain all snags >12”. 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><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><br>Only a small percentage of snags would be removed and only a small percentage of the snags removed would likely have active nest sites. The removal of any eggs or fledgling would not result in a measurable negative effect to the flammulated owl population from any of the 3 action alternatives. |
| Olive-sided Flycatcher | Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, leading to loss of egg viability to or injury or death to nestlings. Unintential 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 3 action alternatives<br><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. |

| PIF High Priority Species and FWS BCC | Projected Changes Likely to Affect Species |
|---|---|
| Cordilleran Flycatcher | Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, 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 3 action alternatives. It would be rare for snags to be removed. All 3 action alternatives will maintain late-successional forest habitat and all three would move forests toward mature conditions. Live mature trees would not be targeted for removal during treatments except in rare circumstances.<br><br>The three action alternatives for the most part will be retain all snags >12”. 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><br>Thinning, snag removal, and burning during the breeding season could potentially kill the young of the year. Alternative D would have approximately 20,000 acres of less burning and could have less of impact than the other 2 action alternatives. |
| Grace’s Warbler | Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, leading to loss of egg viability or injury or death to nestlings.<br><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><br>Unintential 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 3 action alternatives. |
| Lewis’s Woodpecker | Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, leading to loss of egg viability or injury or death to nestlings.<br><br>This species is primary associated with pine savanna habitat. All 3 action alternatives would restore 45,469 acres of former and current pine savanna habitat. 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 unintential take of eggs or nestlings. However, none of the 3 action alternatives would be expected to result in a measurable negative effect to the Lewis’ woodpecker population. |

<table>
<tr><th>PIF High Priority Species and FWS BCC</th><th>Projected Changes Likely to Affect Species</th></tr>
<tr><td>Purple Martin</td><td>Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, leading to loss of egg viability or injury or death to nestlings.<br><br>This species is primary associated with pine savanna habitat. All 3 action alternatives would restore 45,469 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><br>Unintential take of eggs or nestlings would not result in a measurable negative effect to the purple martin population in any of the 3 action alternatives.</td></tr>
<tr><td>Cassin's Finch</td><td>Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, leading to loss of egg viability or injury or death to nestlings.<br><br>All three 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><br>There would be no measurable negative effect to the Cassin's finch population from any of the 3 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. Unintential take of eggs or nestlings would not result in a measurable negative effect to the Cassin's finch population with any of the 3 action alternatives.</td></tr>
<tr><td colspan="2">Aspen</td></tr>
<tr><td>Red-naped sapsucker</td><td>Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, leading to loss of egg viability or injury or death to nestlings.<br><br>The mechanical removal of ponderosa pine trees from aspen clones would help maintain older aspen being loss to conifer encroachment and make the trees more resilient to weather extremes.<br><br>The project occurs within 4 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. Unintential take of eggs or nestlings would not result in a measurable negative effect to the Cassin's finch population with any of the 3 action alternatives because.</td></tr>
<tr><td colspan="2">Pinyon-Juniper Woodland</td></tr>
</table>

| PIF High Priority Species and FWS BCC | Projected Changes Likely to Affect Species |
|---|---|
| Gray Vireo | The project only occurs within less than 1 percent of the pinyon-juniper that occurs over both forests. All 3 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, leading to loss of egg viability or injury or death to nestlings. Not all treatments would occur during the breeding season. Unintential take of eggs or nestlings would not result in a measurable negative effect to the gray vireo population from any of the 3 action alternatives. |
| Pinyon Jay | 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 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, leading to loss of egg viability or injury or death to nestlings. Not all treatments would occur during the breeding season. Unintential take of eggs or nestlings would not result in a measurable negative effect to the pinyon jay population from any of the 3 action alternatives. |
| 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, leading to loss of egg viability or injury or death to nestlings. Not all treatments would occur during the breeding season. Unintential take of eggs or nestlings would not result in a measurable negative effect to the juniper titmouse population from any of the 3 action alternatives. |
| Black-throated Gray Warbler | The project occurs within less than 1 percent of the pinyon-juniper that occurs over both forests. All 3 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, leading to loss of egg viability or injury or death to nestlings. Not all treatments would occur during the breeding season. Unintential take of eggs or nestlings would not result in a measurable negative effect to the black-throated gray warbler population from any of the 3 action alternatives.. |

| PIF High Priority Species and FWS BCC | Projected Changes Likely to Affect Species |
|---|---|
| Gray Flycatcher | The project occurs within less than 1 percent of the pinyon-juniper that occurs over both forests. All 3 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, leading to loss of egg viability or injury or death to nestlings. Not all treatments would occur during the breeding season. Unintential take of eggs or nestlings would not result in a measurable negative effect to the gray flycatcher population from any of the 3 action alternatives. |
| **High Elevation Grasslands** | |
| Swainson’s Hawk | All 3 action alternatives would burn in most of the grasslands and savanna treatments within the treatment area. Treatments would improve foraging habitat for the Swainson’s hawk. Alternative C 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. Unintential 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, 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.. |
| Ferruginous Hawk | All 3 action alternatives would burn in most of the grassland and savanna treatments within the treatment area. Treatments would improve foraging habitat for the ferruginous hawk. Alternative C 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, leading to loss of egg viability or injury or death to nestlings. However, ferrruginous hawks nest in a fairly narrow range of elevations in northern Arizona and have not been detected above 6,400 ft elevation (Corman and Wise-Gervais 2005). Over 99 percent of all treatments would occur at 6,500 feet elevation or higher, hence unintentional takeof 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.. |

| PIF High Priority Species and FWS BCC | Projected Changes Likely to Affect Species |
|---|---|
| Grasshopper Sparrow | All 3 action alternatives would burn in most of the grassland and savanna treatments within the treatment area. 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, leading to loss of egg viability or injury or death to nestlings.<br><br>The mechanical treatments in grasslands under alternative C could result in unintential 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 3 action alternatives. |
| Bendire's Thrasher | within the treatment area. 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, leading to loss of egg viability or injury or death to nestlings.<br><br>The mechanical treatments in grasslands under alternative C could result in unintential 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 3 action alternatives. |

## Important Bird Area

Most of the major vegetation cover types within the Anderson Mesa IBA would be affected by action alternatives (Table 146). However, only alternative C addresses conifer encroachment in grassland habitat.

**Table 146. Treatments by Acreage and Habitat Type**

| Treatments | Alternative B | Alternative C | Alternative D |
|---|---|---|---|
| Ponderosa pine mechanical/burning | 27,757 | 27,103 | 27,776 |
| Ponderosa pine Burn only | 2,683 | 3,558 | 1,371 |
| Ponderosa pine Grassland restoration | 954 | 954 | 954 |
| Ponderosa Pine Savanna | 7,770 | 7,770 | 7,770 |
| Aspen Burn only | 10 | 21 | 0 |
| Pinyon-juniper Operational burn | 476 | 476 | 455 |
| Grassland Burn Only | 4,696 | 2 | 4,696 |
| Grassland Conifer | 0 | 4,694 | 0 |

| Treatments | Alternative B | Alternative C | Alternative D |
|---|---|---|---|
| removal/ burning | | | |
| Oak woodland Operational burn | 173 | 173 | 173 |
| **Total acres** | **44,529** | **44,751** | **43,195** |

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. Alternative C 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

Because of their seasonal movement, the primary management concern for migratory birds is nesting habitat and, for bald eagles, winter roost sites. The cumulative analysis area for migratory birds is the project area. Past, present and reasonably foreseeable activities are listed Appendix 12. The effects of projects already implemented were used to describe existing conditions of the project area and will not be discussed in this section.

There are many on-going or planned projects that will thin ponderosa pine habitat. These thinning treatments vary greatly and include noncommercial thinning, group selection, sanitation thinning, and shelterwood cuts. Slash treatments associated with these thinning treatments include lopping and scattering, hand and dozer piling and burning, and prescribed burning. There is an estimated 86,290 acres of thinning from other projects within the treatment 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 153,211 acres of burning in the treatment 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 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% 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 B, C, and D

Resulting forest structure from planned thinning and burning of 243,917 acres of ponderosa pine habitat outside of the 4FRI would result in habitat resembling the historical range of variation. In the long-term, wildlife species are less likely to be adversely affected by treatments that result in habitat conditions consistent with those their evolutionary past and so are expected to respond positively to the ongoing and proposed thinning projects (Kalies et al. 2010). These treatments would improve habitat for most birds species associated with the ponderosa pine cover type in the long term (e.g., bark gleaners, woodpeckers, and flycatchers), but may negatively affect foliage gleaners in the short term (Patton and Gordon 1995, George et al. 2005).

The proposed aspen restoration is planned for areas that are a high priority for restoration on both forests. Cumulatively, this would treat the aspen outside of wilderness that are at most risk of being lost in the near future. These treatments would yield limited improvements for the red-naped sapsucker in the short term, but should improve their habitat components in the long-term.

Fuelwood gathering and travel management requirements together help determine where the public collects fuelwood. The public will be limited in where they can travel off road to gather fuelwood on both the Coconino and Kaibab NFs. This will likely leave higher densities of dead and down woody material in areas further from roads. Less dead woody material would be expected to remain within fuelwood areas and areas closer to roads. Designated fuelwood areas on the Kaibab NF may not always meet forest plan requirements once wood gathering activities are terminated. Areas adjacent to roads may be deficit on the Coconino NF. This could have a negative effect on species that use snags or down material in the ponderosa pine, aspen, and pinyon-juniper. In grasslands, the travel management requirements will benefit grassland species by preventing the cross country travel into their habitat.

Pinyon-juniper thinning and burning has the potential to both remove habitat and improve habitat for the birds that use this habitat type. The proposed activities could result in loss of young of year depending on timing of activities. The effects to Pinyon-juniper associated species are expected to be limited because only a small amount of this habitat would be treated within the cumulative effects analysis area.

ROW maintenance will help keep strips of land open and create the equivalent of relatively narrow, liner grasslands. While this may affect individual birds, there is not likely to be a cumulative effect to any species because of the limited space and spatial configuration of this habitat.

Development on private land and other federal lands continue to remove habitat within and adjacent to the project area. With the development of the additional training ranges on the Navajo Army Depot this will likely move more species out of area. The cover type with the most development occurring is within grasslands and savanna habitat. This will reduce the amount of ha

The Coconino NF has implemented an innovative management strategy to protect wetlands from grazing and prolonged drought within the Anderson Mesa IBA by regulating the timing and duration of livestock grazing in permitted areas. Wetlands are being protected from livestock by constructing fences that still allow passage of wildlife. Habitat restoration, including the restoration of grasslands, is in progress. Ranchers are actively engaged through the Diablo Trust and numerous conservation organizations have assisted in achieving conservation objectives for the site.

The cumulative effects for the migratory birds could result in some incidental mortality caused by project implementation activities. How much mortality would be proportional to how many acres are treated during the spring nesting season of April, May, June, and July. Seasonal restrictions would limit project implementation activities between March 1 and September 30 in goshawk nest area and PFAs and within MSO PACs, which would reduce potential of loss for species listed in ponderosa pine habitat. Prescribed burning occurs also 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 - Hiding and Thermal Cover

Forest plan direct for wildlife calls for at least 30 percent (Coconino) to 40 percent (Kaibab) cover. The Coconino 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. Restoration

Unit summaries are presented below to facilitate discussion (Table 147, Table 148, Table 149, and Table 150); subunit summaries are included in Appendix 5. The column Hiding/Thermal cover indicates areas that meet the definitions for both cover types. Restoration Units commonly support 30 to 50 percent hiding cover and 30 to 55 percent hiding cover. Exceptions include: Restoration Unit 3 (pine-oak is high in thermal cover); Restoration Unit 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 the no action alternative.

**Table 147. Percent Hiding (HC), 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 % Hiding/Thermal | | | | 2020 % Hiding/Thermal | | | | 2050 % Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RU | Acres | HC | Both | TC | No | HC | Both | TC | No | HC | Both | TC | No |
| Pine-Oak | 112,546 | 47 | 53 | 0 | 1 | 41 | 56 | 3 | 0 | 13 | 75 | 11 | 0 |
| CNF | 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 |
| KNF | 27,063 | 55 | 44 | 0 | 1 | 46 | 53 | 0 | 1 | 42 | 57 | 0 | 1 |
| 3 | 25,476 | 56 | 44 | 0 | 0 | 47 | 53 | 0 | 0 | 43 | 57 | 0 | 0 |
| 4 | 1,587 | 47 | 42 | 0 | 11 | 34 | 55 | 0 | 11 | 31 | 58 | 0 | 11 |
| Pine | 399,633 | 37 | 33 | 7 | 24 | 38 | 44 | 13 | 5 | 10 | 50 | 38 | 1 |
| CNF | 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 |
| KNF | 162,344 | 47 | 32 | 6 | 15 | 40 | 46 | 7 | 7 | 10 | 62 | 25 | 3 |
| 3 | 45,422 | 32 | 38 | 11 | 19 | 26 | 51 | 13 | 10 | 5 | 53 | 38 | 4 |
| 4 | 75,733 | 38 | 38 | 6 | 18 | 30 | 54 | 7 | 9 | 5 | 61 | 30 | 4 |
| 6 | 41,188 | 80 | 14 | 0 | 6 | 76 | 24 | 0 | 0 | 25 | 74 | 2 | 0 |
| **Total** | **512,178** | **39** | **37** | **5** | **19** | **39** | **47** | **11** | **4** | **11** | **56** | **32** | **1** |

**Table 148. Percent Hiding (HC), 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 % Hiding/Thermal | | | | 2020 % Hiding/Thermal | | | | 2050 % Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RU | Acres | HC | Both | TC | No | HC | Both | TC | No | HC | Both | TC | No |
| Pine-Oak | 112,546 | 47 | 53 | 0 | 1 | 36 | 51 | 4 | 9 | 12 | 65 | 14 | 9 |
| CNF | 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 |
| KNF | 27,063 | 55 | 44 | 0 | 1 | 44 | 42 | 0 | 13 | 28 | 59 | 0 | 13 |
| 3 | 25,476 | 56 | 44 | 0 | 0 | 45 | 42 | 0 | 13 | 28 | 59 | 0 | 13 |
| 4 | 1,587 | 47 | 42 | 0 | 11 | 33 | 42 | 0 | 24 | 25 | 51 | 0 | 24 |
| Pine | 399,633 | 37 | 33 | 7 | 24 | 22 | 18 | 11 | 49 | 4 | 27 | 29 | 40 |
| CNF | 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 |
| KNF | 162,344 | 47 | 32 | 6 | 15 | 31 | 16 | 3 | 50 | 10 | 36 | 18 | 36 |
| 3 | 45,422 | 32 | 38 | 11 | 19 | 16 | 14 | 5 | 64 | 10 | 14 | 22 | 54 |
| 4 | 75,733 | 38 | 38 | 6 | 18 | 18 | 18 | 3 | 61 | 8 | 27 | 25 | 40 |
| 6 | 41,188 | 80 | 14 | 0 | 6 | 72 | 14 | 0 | 14 | 14 | 75 | 2 | 10 |
| **Total** | **512,178** | **39** | **37** | **5** | **19** | **25** | **26** | **9** | **40** | **6** | **35** | **26** | **33** |

**Table 149. Percent Hiding (HC), 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**

| | | 2010 % Hiding/Thermal | | | | 2020 % Hiding/Thermal | | | | 2050 % Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RU | Acres | HC | Both | TC | No | HC | Both | TC | No | HC | Both | TC | No |
| Pine-Oak | 112,546 | 47 | 53 | 0 | 1 | 38 | 49 | 4 | 9 | 15 | 62 | 14 | 9 |
| CNF | 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 |
| KNF | 27,063 | 55 | 44 | 0 | 1 | 44 | 43 | 0 | 13 | 32 | 55 | 0 | 13 |
| 3 | 25,476 | 56 | 44 | 0 | 0 | 45 | 43 | 0 | 12 | 32 | 55 | 0 | 12 |
| 4 | 1,587 | 47 | 42 | 0 | 11 | 33 | 42 | 0 | 24 | 25 | 51 | 0 | 24 |
| Pine | 399,633 | 37 | 33 | 7 | 24 | 19 | 19 | 11 | 51 | 2 | 27 | 29 | 42 |
| CNF | 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 |
| KNF | 162,344 | 47 | 32 | 6 | 15 | 25 | 16 | 3 | 56 | 4 | 36 | 18 | 42 |
| 3 | 45,422 | 32 | 38 | 11 | 19 | 8 | 14 | 5 | 73 | 2 | 15 | 22 | 62 |
| 4 | 75,733 | 38 | 38 | 6 | 18 | 12 | 18 | 3 | 66 | 2 | 27 | 25 | 46 |
| 6 | 41,188 | 80 | 14 | 0 | 6 | 68 | 14 | 0 | 18 | 11 | 75 | 2 | 12 |
| **Total** | **512,178** | **39** | **37** | **5** | **19** | **23** | **26** | **9** | **42** | **5** | **35** | **26** | **34** |

**Table 150. Percent Hiding (HC), 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**

| | | 2010 % Hiding/Thermal | | | | 2020 % Hiding/Thermal | | | | 2050 % Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RU | Acres | HC | Both | TC | No | HC | Both | TC | No | HC | Both | TC | No |
| Pine-Oak | 112,546 | 47 | 53 | 0 | 1 | 34 | 53 | 4 | 9 | 15 | 63 | 14 | 9 |
| CNF | 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 |
| KNF | 27,063 | 55 | 44 | 0 | 1 | 40 | 46 | 0 | 13 | 35 | 52 | 0 | 13 |
| 3 | 25,476 | 56 | 44 | 0 | 0 | 41 | 46 | 0 | 13 | 35 | 52 | 0 | 13 |
| 4 | 1,587 | 47 | 42 | 0 | 11 | 29 | 47 | 0 | 24 | 26 | 50 | 0 | 24 |
| Pine | 399,633 | 37 | 33 | 7 | 24 | 27 | 21 | 10 | 42 | 10 | 27 | 26 | 37 |
| CNF | 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 |
| KNF | 162,344 | 47 | 32 | 6 | 15 | 36 | 19 | 3 | 42 | 16 | 36 | 15 | 34 |
| 3 | 45,422 | 32 | 38 | 11 | 19 | 21 | 20 | 6 | 54 | 17 | 16 | 18 | 50 |
| 4 | 75,733 | 38 | 38 | 6 | 18 | 23 | 24 | 4 | 49 | 13 | 29 | 20 | 38 |
| 6 | 41,188 | 80 | 14 | 0 | 6 | 75 | 11 | 0 | 14 | 20 | 70 | 1 | 9 |
| **Total** | **512,178** | **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. Restoration Units continue to meet or exceed forest plan direction in the year 2020, except for Restoration 3 under alternative C. The main difference between action alternatives and no action is in the year 2050 when much percentages of the area do not meet either hiding or thermal cover. This suggests wildlife cover can be met, even when using dated forms of evaluation, while successfully moving forest conditions 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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# Wildlife Appendices

# Appendix 1. Forest-wide direction for Vegetation Management, Mexican spotted owl, and northern goshawk common to the Coconino and Kaibab Forest Plans

## Mexican Spotted Owl

- Standards (CNF Forest Plan, pp. 65-65-1, Kaibab NF Forest Plan, pp. 22-26):
- Provide three levels of habitat management - protected, restricted, and other forest and woodland types to achieve a diversity of habitat conditions across the landscape.
- Protected areas include delineated protected activity centers; mixed conifer and pine oak forests with slopes greater than 40% 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.
- Restricted areas include all mixed-conifer, pine-oak, and riparian forests outside of protected areas.
- Other forest and woodland types include all ponderosa pine, spruce-fir, woodland, and aspen forests outside protected and restricted areas.
- Survey all potential spotted owl areas including protected, restricted, and other forest and woodland types within an analysis area plus the area 1/2 mile beyond the perimeter of the proposed treatment area.
- Establish a protected activity center at all Mexican spotted owl sites located during surveys and all management territories established since 1989.
- Allow no timber harvest except for fuelwood and fire risk abatement in established protected activity centers. For protected activity centers destroyed by fire, windstorm, or other natural disaster, salvage timber harvest or declassification may be allowed after evaluation on a case-by-case basis in consultation with US Fish and Wildlife Service.
- Allow no timber harvest except for fire risk abatement in mixed conifer and pine-oak forests on slopes greater than 40% where timber harvest has not occurred in the last 20 years.
- Limit human activity in protected activity centers during the breeding season..
- In protected and restricted areas, when activities conducted in conformance with these standards and guidelines may adversely affect other threatened, endangered, or sensitive species or may conflict with other established recovery plans or conservation agreements; consult with US Fish and Wildlife Service to resolve the conflict. Monitor changes in owl populations and habitat needed for delisting.

The Forest Plans describes guidelines within Protected, Restricted Threshold and Target Threshold lands in the following forest stratified MSO habitats:

### Restricted Areas (Mixed conifer, pine-oak, and riparian forests) (CNF Forest Plan, pp. 65-3 -65-5, Kaibab NF Land Management Plan, pp. 25-26)

- Manage to ensure a sustained level of owl nest/roost habitat well distributed across the landscape. Create replacement owl/roost habitat where appropriate while providing a diversity of stand conditions across the landscape to ensure habitat for a diversity of prey species.
- Emphasize uneven-aged management systems. However, both even-aged and uneven-aged systems may be used where appropriate to provide variation in existing stand structure and species diversity.
- Save all trees greater than 24 inches dbh.
- In pine-oak forests, retain existing large oaks and promote growth of additional oaks.
- Encourage prescribed fire and fire for resource benefits to reduce hazardous fuel accumulation. Thinning from below may be desirable or necessary before burning to reduce ladder fuels and the risk of crown fire. (add pages where found)
- Retain substantive amounts of key habitat components: snags 18 inches in diameter and larger, down logs over 12 inches midpoint diameter, hardwoods for retention, recruitment, and replacement of large hardwoods (add pages where found)
- Riparian areas: Emphasize maintenance and restoration of healthy riparian ecosystems through conformance with forest plan riparian standards and guidelines. Management strategies should move degraded riparian vegetation toward good condition as soon as possible. Damage to riparian vegetation, stream banks, and channels should be prevented.

### Forest Plan Vegetation Treatment Requirements by Habitat Type

- **Pine-Oak Restricted MSO Habitat**: Twenty percent of the pine-oak forest type (by area) provides MSO nest/roost characteristics – basal area > 150 $ft_2$, Gambel oak basal area > 20 $ft_2$, twenty 18”+ trees per acre, and 45% of stocking in trees > 12” diameter. All trees > 24” diameter, substantive amounts of snags > 18” diameter, down logs > 12” midpoint diameter, and large hardwoods are retained following management treatments.
- **Pine-Oak Protected MSO Habitat:** Trees greater than 9” dbh are retained following management treatments.

### Forest Plan Target Stand Densities within Restricted Threshold and Target Threshold Lands:

- **Pine-oak stands** –manage for 150 square feet of basal area in mature forest structure with the following distribution; (15% -trees12-18” dbh, 15% -trees 18-24” dbh, 15% -trees > 24” dbh)

## Northern Goshawk

Forest plan direction that relate to northern goshawk forest habitat apply to the forest and woodland communities described below that are outside of Mexican spotted owl protected and restricted areas (CNF Forest Plan, pp. 65-7 to 65-11, Kaibab NF Forest Plan, pp. 27 to 31):

- Manage for uneven-age forest conditions for live trees and retain live reserve trees, snags, downed logs, and woody debris levels throughout woodland, ponderosa pine, mixed conifer, and spruce-fir forest cover types. Manage for old age trees such that as much old forest structure as possible is sustained over time across the landscape. Sustain a mosaic of vegetation densities (overstory and understory), age classes and species composition across the landscape.
- Limit human activity in or near nest sites and Post-Fledgling Family Areas (PFAs) during the breeding season (March 1 through September 30).
- The distribution of vegetation structural stages (VSS) for ponderosa pine, mixed conifer and spruce-fir is 10% grass/forb/shrub (VSS 1), 10% seedling-sapling (VSS 2), 20% young forest (VSS 3), 20% mid-aged forest (VSS 4), 20% mature forest (VSS 5), 20% old forest (VSS 6). Distribution of habitat structures should be evaluated at the ecosystem management area level, at the midscale such as drainage, and at the small scale of site.

## Within Nesting Areas

- **General:** Provide unique nesting habitat conditions for goshawks. Important features include trees of mature to old age with high canopy cover.
- The structure of the vegetation within nest areas is associated with the forest type, and tree age, size, and density, and the developmental history of the stand. Table 5 of RM-217 presents attributes required for goshawks on locations with “low” and “high” site productivity.
- Preferred treatments to maintain the desired structure are to thin from below with non-uniform spacing and use of hand tools and fire to reduce fuel loads. Lopping and scattering of thinning debris is preferred if broadcast fire cannot be used. Piling of debris should be limited. When necessary, hand piling should be used to minimize compaction within piles and to minimize displacement and destruction of the forest floor and the herbaceous layer. Do not grapple or Dozer pile debris. Manage road densities at the lowest level possible to minimize disturbance in the nest area. Use small, permanent skid trails in lieu of roads for timber harvesting.
- **Spruce-Fir, Mixed Conifer and Ponderosa Pine Cover Types**: The nesting area contains only mature to old forest (VSS 5 & 6) having a canopy cover (measured vertically) between 50-70% with mid-aged (VSS 6) trees 200-300 years old. Non-uniform spacing of trees and clumpiness is desirable.
- **Woodland**: Maintain existing canopy cover levels.

## Within Post-Fledgling Family Areas

**General:** Provide for healthy sustainable forest environment for the post-fledgling family needs of goshawks. The principle difference between “within the PFA” and “outside the PFA” is the higher canopy cover within the PFA and smaller opening size within the post fledgling family area. Vegetative Structural stage distribution and structural conditions are the same within and outside the PFA.

**Ponderosa Pine**: Canopy Cover for mid-aged forest (VSS 4) should average 1/3 60+% and 2/3 50+%. Mature (VSS 5) and old forest (VSS 6) should average 50+%.

**Woodland:** Maintain existing canopy cover levels.

## Foraging Areas - Landscapes Outside Goshawk Post-Fledgling Family Areas

**General:** The distribution of vegetation structural stages for ponderosa pine, mixed conifer and spruce-fir forests is 10% grass/forb/shrub (VSS 1), 10% seedling-sapling (VSS 2), 20% young forest (VSS 3), 20% mid-aged forest (VSS 4), 20% mature forest (VSS 5), 20% old forest (VSS 6).

The distribution of VSS, tree density, and tree age are a product of site quality in the ecosystem management area. Use site quality to guide in the distribution of VSS, tree density and tree ages. Use site quality to identify and manage dispersal PFA and nest habitat at 2 to 2.5 mile spacing across the landscape.

Snags are 18" or larger dbh and 30 feet or larger in height, downed logs are 12 inches in diameter and at least 8 feet long, woody debris is 3 inches or larger on the forest floor, canopy cover is measured with vertical crown projection on average across the landscape.

The order of preferred treatment for woody debris is: 1) broadcast burning, 2) lopping & scattering, 3) hand piling or machine grapple piling, 4) dozer piling.

**Canopy Cover**: Canopy cover guidelines apply only to mid-aged to old forest structural stages (VSS 4, VSS 5, and VSS 6) and not to grass/forb/shrub to young forest structural stages (VSS 1, VSS 2, and VSS 3).

**Ponderosa Pine**: Canopy cover for mid-aged forest (VSS 4) should average 40+%, mature forest (VSS 5) should average 40+%, and old forest (VSS 6) should average 40+%. Opening size is up to 4 acres with a maximum width of up to 200 feet. 1 group of reserve trees, 3-5 trees per group, would be left if the opening is greater than an acre in size. Leave at least 2 snags, 3 downed logs, and 5-7 tons of woody debris per acre.

**Woodland**: manage for uneven age conditions to sustain a mosaic of vegetation densities (overstory and understory), age classes, and species composition well distributed across the landscape. Provide for reserve trees, snags, and down woody debris.

## Human Disturbance (CNF Forest Plan pp. 65-11, Kaibab NF Forest Plan, p. 31):

- Limit human activities in or near nest sites and post-fledging family area's during the breeding season so that goshawk reproductive success is not affected by human activities.
- The breeding season extends from March 1 through September 30.
- Low intensity ground fires are allowed at any time in all forested cover types, but high intensity crown fires are not acceptable in the post-fledging family area or nest areas. Avoid burning the entire home range of a goshawk pair in a single year. For fires planned in the occupied nest area, a fire management plan should be prepared. The fire management plan should minimize the risk of goshawk abandonment while low intensity ground fire burns in the nesting area. Prescribed fire within nesting areas should be

planned to move with prevailing winds away from the nest tree to minimize smoke and risk of crown fire developing and driving the adults off or consuming the nest tree.

## Ground Surface Layer (All forested cover types) (CNF Forest Plan, pp. 65-11 to 65-12, KNF Forest Plan, p. 31)

- Manage road densities at the lowest level possible. Where timber harvesting has been prescribed to achieve desired forest condition, use small, skid trails in lieu of roads.
- Piling of debris should be limited. When necessary, hand or grapple piling should be used to minimize soil compaction within piles and to minimize forest floor and herbaceous layer displacement and destruction.
- Limit dozer use for piling or scattering of logging debris so that the forest floor and herbaceous layer is not displaced or destroyed.

Note: 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. The desired condition is to convert all foraging area even-aged stands to the uneven-aged structural conditions shown in table 4 and convert all goshawk PFA/nest stands to the desired uneven-aged structural conditions shown in table

## Nonstructural Wildlife Habitat Improvement (CNF Forest Plan, p. 66, Kaibab NF Forest Plan, p. 31)

- Improve vegetation conditions through seeding a mixture of species of grass, forbs, forage, and browse species desirable to wildlife.
- Improve forage conditions by using prescribed fire where environmental analysis shows beneficial effects and in line with approved burning plans.
- Manage forage to increase threatened and endangered species and management indicator species where it is determined appropriate through the IRM and NEPA process.

## T&E Nonstructural Wildlife Habitat Improvement (CNF Forest Plan, p. 66)

- Improve T&E and sensitive species habitat. Improvement projects give priority to recovery of T&E species. Conform to approved recovery plans.

## Insect and Disease Management (CNF Forest Plan, p. 70)

- Habitat requirements for threatened, endangered, and sensitive species take precedence over insect and disease control.

## 10,000-Acre Blocks (10K Blocks) (Coconino NF Forest Plan, p. 70)

- Minimum Management Requirements are exceeded where it is good multiple-use management to do so, such as greater density of snags adjacent to meadows, riparian areas, and key water sources.
- Wildlife habitat objectives for each 10K Block are evaluated on an individual stand basis as well as for the entire block.

- Evaluate the need for wildlife forage in the 10K Blocks using the Habitat Capability Index, other available data and professional judgment and, where needed, adjust prescriptions to obtain it. These areas are stands of up to 10 acres with reduced GSL.

## Old-Growth (Coconino NF, pp. 32-33, Kaibab NF, pp. 32-33)

Guideline: Consider the effects of spatial arrangement on old-growth function, from groups to landscapes, including de facto allocations to old-growth such as goshawk nest sites, Mexican spotted owl protected activity centers, sites protected for species behavior associated with old-growth, wilderness, research natural areas, and other forest structures managed for old-growth function.

## Coconino NF Management Area Direction

### MA 3

Manage habitat for the following indicator species through ISM (p.117)

- Turkey
- Goshawk
- Pygmy nuthatch
- Elk
- Abert squirrel
- Red squirrel
- Hairy woodpecker
- Spotted owl

#### Raptors (pp. 123-124):

Maintain a current inventory of nest locations. A nest group consists of nest tree and adjacent trees and is maintained at least as follows unless environmental analysis indicates either more or less is needed:

- Cooper's hawk -- 15 acres of uncut area around active nests.
- Sharp-shinned hawk -- 10 acres of uncut area around active nests.
- Other raptors -- An area extending to 50 feet from active nests is left uncut.
- Bald eagle winter roosts -- Protect with a 300-foot radius uncut zone around the roost. Road development should avoid the roost and uncut zone.

Ospreys -- At the start of Forest Plan implementation, the only known osprey nesting area is at Lake Mary. The following Standards and Guidelines applyto this nesting area. As additional nesting territories are discovered, environmental analysis is done to determine if, and to what extent, these Standards and Guidelines apply:

- Restrict all logging activities within one-fourth of a mile of active nests from March 1 through August 15.
- Provide a 20-acre nest site of uncut area around each existing (occupied or unoccupied) nest.
- Provide at least 3 potential nest sites in preferred nesting habitat within Designated Bald Eagle/Osprey Emphasis Area(s). This potential nest site should be at least 5 acres of mature and overmature trees with at least 2 snags per acre greater than or equal to 20 inches. Use of uneven-age stands is optimal.
- Construct artificial nesting platforms as needed for habitat maintenance and improvement.
- Forest-wide, during 10K Block planning, give high priority to managing for snags within potential osprey habitat. Snags and old growth managed for osprey habitat contribute to the 10K Block requirements.
- Manage for at least 2 snags per acre of 20" or greater. Snags should be the height of the canopy or taller, on at least percent of the acres along the shorelines. Where necessary to provide sufficient perches and nest sites, take actions to create snags.
- Road construction or reconstruction should avoid osprey nest sites.
- New roads should not be constructed within 660 feet of nests.
- Where human disturbance is causing reproductive failure, evaluate the need to close the area from March 1 to at least August 15.
- In cooperation with the Arizona Game and Fish Department, develop an implement an osprey and wintering bald eagle public education program.

### Wildlife Cover (pp.: 124-125)

- Manage for at least 30 percent cover in 10K Blocks. Of this total at least one third is in thermal cover, one third is in hiding cover, and the remaining one third is in either thermal or hiding cover.
- Emphasize maintaining some thermal cover in known travelways and bedding areas. Emphasize maintaining some hiding cover adjacent to dependable water and key openings, along known travelways, and in pine stringers. Cover areas should be at least 200 feet wide; however, pine stringers less than this width may still be managed for hiding and thermal cover.
- Evaluate existing and potential cover on a stand by stand basis. Consider open road densities, topography, and non-commercial tree, shrub, and herbaceous species to determine effective cover.
- Protect and manage to include hiding and thermal cover known fawning and calving areas and defer logging activities from May 15 to June 30 in these areas.

### Species Size Class Acceptable Range

#### Ponderosa Pine - Hiding Cover

- 1 – 5” dbh 150 – 170 GSL

- 5 – 9" dbh 150 – 180 GSL
- 9 – 12" dbh 160 – 200 BA
- Area Size 15 – 25 acres

#### Ponderosa Pine - Thermal Cover

- 5 – 9" dbh 180 – 200 GSL
- 9 – 12" dbh 180 – 210 BA
- 12 – 15" dbh 200 – 240 BA
- Area Size 30 – 40 acres

### Squirrel Habitat (p. 125):

- Manage for at least 20 percent of potential habitat capability for red squirrels in 10K Blocks as determined by the Forest Habitat Capability Model. As needed to meet habitat capability, protect red squirrel primary caches at a density of one cache per 2 acres. Retain all trees within a 26-foot radius from the cache (1/20$^{th}$ acre) (mixed conifer only).
- Manage for at least 20 percent of potential habitat capability for Abert squirrels in 10K Blocks as determined by the Forest Habitat Capability Model.

### Spotted Owl and Bear Habitat (pp. 125-126):

- Whenever possible, areas managed for old-growth, bear, and spotted owls are the same. Evaluate owl and bear habitat needs **as well as cover** during project planning.
- In key mixed conifer bear habitat, manage for at least 30 percent of the mixed conifer to meet hiding cover needs. Give priority for cover management in drainage bottoms, heads of drainages, and isolated pockets of mixed conifer. Defer logging activities from April 15 to June 30 in known bear maternity areas.

### Turkey Nesting and Roosts (p. 126):

- Defer timber harvesting and slash treatment activities in turkey nesting areas from April 15 through June 30.
- Leave scattered patches of untreated slash within 1/2 mile of dependable water in actual or potential turkey nesting areas. Patches are at least 1/4 acre in size and cover at least 10 percent and not more than 20 percent of the harvested area.
- Slash is left untreated for at least 5 years, longer if it is determined that nesting is still occurring in the area. These guidelines will be evaluated and adjustments made, if necessary.
- Retain and/or develop an average of at least two turkey roost tree groups per section, in actual or potential turkey habitats.
- Retain and/or develop an average of at least four turkey roost tree groups per section in identified key turkey winter range.

### Gambel oak management direction – see silviculture

## MA 4

Manage for the following indicator species:

- Turkey
- Goshawk
- Pygmy nuthatch
- Elk
- Abert squirrel
- Red squirrel
- Hairy woodpecker
- Spotted owl

### Spotted Owl and Bear Habitat (p. 140):

Whenever possible, areas managed for old-growth, bear, and spotted owls are the same. Evaluate owl and bear habitat needs during project planning.

## MA 5

Manage for the following indicator species (p.141):

- Yellow bellied sapsucker
- Mule deer

### Structural Wildlife Habitat Improvements (p. 141)

Wildlife Fence to protect aspen regeneration from grazing or wildlife where necessary

## MA 6

Manage for the following indicator species (p.145):

- Elk
- Abert Squirrel
- Mule Deer
- Hairy Woodpecker

**Turkey Habitat:** Manage to retain and/or develop an average of at least four turkey roost tree groups per section in identified turkey winter range (p.147).

## MA 7 p. 148

- Wildlife habitat management emphasizes forage production on 0 to 15 percent slopes, in conjunction with firewood harvest using Integrated Stand Management (ISM). Old-growth, cover, and snags are generally provided on slopes greater than 15 percent. However, exceptions will occur if dispersion requirements for habitat components are not met on these steep slopes. Where necessary to meet 10K Block requirements or specific habitat needs, one or more of these components can be obtained through management emphasis on the gentler slopes.

Manage for the following indicator species:

- Plain titmouse
- Mule deer
- Elk
- Areas needing additional forage for elk and mule deer are given first priority in scheduling firewood/wildlife habitat treatments. Treatments are usually done in areas remote from intensive development and high road densities.
- Evaluate bear habitat needs during project planning in dense pinyon-juniper, areas adjacent to steep pinyon-juniper, or pinyon-juniper associated with chaparral species (p. 151).
- Created openings in areas that have been identified as historic big game winter range are designed so that an animal will be no more than 10 chains (660 feet) from hiding cover at any location within the opening. Harvested areas are separated from adjacent areas by at least an 8 chain wide untreated strip (p. 152).
- Cover corridors are laid out to connect treated areas or breaks in terrain to provide interconnecting cover corridors. Known or suspected routes of game travel are used to lay out cover corridors. Corridors are managed to create at least 60 percent crown cover, and are at least 8 chains wide (p. 152).
- Use steep, rocky, or otherwise unmanaged areas useable by game to satisfy wildlife cover requirements to the extent possible (MA 8). Cover requirements are considered on a 10K Block basis (p. 152).
- An average of three unburned piles per acre are left on areas with piled slash to provide cover for birds and small animals or leave lopped and scattered slash on 30 percent of treatment area (p. 153).
- Manage for at least 30 percent cover (p. 153).
- Emphasize cover management in travelways, bedding areas, reproductive areas, and adjacent to dependable waters and key openings (p. 153).
- Cover is managed to provide at least 60 percent crown cover and at least 8 chains wide. Manage for hiding and thermal cover in known fawning and calving areas (p. 153).
- Manage for small game and nongame by leaving an average of one slash pile per 3 acres in the woodland type and/or leave lopped and scattered slash on 30 percent of area harvested (p. 153).
- Manage pine stringers to emphasize wildlife habitat needs by maintaining turkey roosts and big game cover (p.154).

## Management Area 9 – p. 158

Manage for the following indicator species:

- Antelope
- Elk

## Management Area 10

Manage for the following indicator species (p.162)

- Antelope

Control invasion of undesirable plant species when necessary to improve and protect wildlife habitat values. Prescribed burning will be one specific practice used, especially where needed to improve wildlife habitat (p. 164)

## Management Area 12

Emphasize wildlife habitat, visual quality, fish habitat, and watershed condition on the wetlands, riparian forest, and riparian scrub (p.172).

Manage for the following indicator species (p. 172)

- Cinnamon teal
- Lincoln's sparrow
- Yellow breasted chat
- Lucy's Warbler
- Macroinvertebrates

Wetlands and open water containing emergent vegetation which provide nesting habitat are protected from disturbing uses that will harass nesting birds, such as activities that are noisy or would damage nests or nesting habitat from May 1 to July 15 (p.173).

Evaluate bear habitat needs during project planning. Defer logging activities from April 15 to June 30 in known bear maternity areas (p. 176).

## Management Area 13

Management Indicator Species for this MA are mule deer, pygmy nuthatch, and hairy woodpecker (p. 179).

## Management Area 14

Support research efforts that further define the habitat requirements of native fish and bat populations. Protect and/or restore habitat conditions that may be limiting these populations (p.185)

## Management Area 15

Evaluate bear habitat needs during project planning (p. 190).

## Management Area 18

No direction

## Management Area 20

On-the-ground design of the recovery area and adjacent stands will include maintenance of large animal movement to and from areas on either side of the highway. Factors such as density of trees, location of right-of-way fence and topography will be considered (p.206-4)

## Management Area 28 (p. 206-54)

Protect key elk, peregrine falcon, turkey and deer winter habitat. Protect turkey roosts from recreational activities, especially dispersed camping and motor vehicle traffic.

### FLEA p. 206-67

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. Monitor peregrine nesting success to determine if restrictions are effective.

Restrict human activities where active raptor nests are located. Species potentially impacted include the golden eagle, prairie falcon, Mexican spotted owl, and zone-tailed hawk. Protection distance will vary depending on the species, local topography, potential for disturbance, and breeding season for the species. Raptor surveys will be completed on site specific areas to determine protection distance.

### Wildlife Habitat p. 206-72-73, 75-76

Habitats support diverse, healthy populations of native plants and animals. A natural variety of plant species, age classes, and structures are present. The impacts of non-native plant and animal species are controlled and the introduction and maintenance of undesirable non-natives is discouraged. Threatened, endangered, sensitive, and management indicator species are maintained or recovering in the majority of the habitat.

Maintain wildlife travelways to help animals travel between summer and winter ranges, feeding and nesting areas, maternity areas, and dispersal areas. Travelways help ensure genetic mixing necessary for healthy populations.

#### Mexican Spotted Owl

**Guidelines**

Do not identify target threshold stands within the Urban/Rural Influence Zone. The allocation of target threshold habitat within the Lake Mary Watershed and Shultz Management Areas would better provide for long-term management of roost/nest habitat for the Mexican spotted owl. Approximately 26 percent of the Shultz Management Area and 11 percent of the Lake Mary Watershed should be managed for target-threshold conditions in the future, due to not allocating target threshold conditions in the URIZ. Within the FLEA area, survey habitat that potentially could be used for nesting, roosting, or breeding, and is within ½ mile of a proposed site-specific project boundary.

### Northern Goshawk

**Guidelines**

In the Urban/Rural Influence Zone, where possible, limit human activities within the 30-acre goshawk nest stand during the breeding season. In general however, do not curtail human activity such as informal dispersed recreation activities within the Post Fledging Family Areas (PFA). Social trails are likely to occur within portions of PFA's in the urban and rural influenced areas. Locate Forest Service system trails to avoid nest sites within PFA's, within the Urban/Rural Influence Zone. Emphasize the need to control pets on Forest Service system trails through education and enforcement.

### Bald Eagles

**Guidelines**

Bald eagle winter roosts and perch habitat will be evaluated for long-term viability. Silvicultural methods that encourage regeneration and growth of desirable trees may be used near roost sites. Groves of trees may be maintained to provide screening for roost and perch areas. Silvicultural practices will result in the growth of large diameter trees with open crowns in multi-layered stands. Prescribed fires to improve and protect roost areas may be used with effective protection of large trees and snags. Human activities will be managed so that disturbance does not interfere with the eagles'ability to use the site.

### Threatened and Endangered Species

**Guidelines**

Seek opportunities to add to our base of knowledge about human disturbance to T&E species. This could be a variety of methods that could include but are not limited to, monitoring, survey of habitat, survey of recreation uses, or trail counters. Consider options to gather information when planning, or implementing, or monitoring site-specific projects, or approving special uses or outfitter guides. Consider partnership opportunities with organizations or agencies to gather information outside of site-specific project planning. A variety of methods could be used to gather information including, but not limited to: monitoring, survey of habitat, survey of recreation uses, or trail counters. Share results and data among resource personnel and line officers for consideration in future projects with wildlife biologists and recreation staff to incorporate lessons learned into the next project. If analysis shows a need, management changes that could include, but are not limited to, relocating roads or trails, limiting season of use, designating types of activities, or reducing numbers of users could result if analysis shows a need.

Maintain connected patches of denser vegetation that, along with topography, provide travel corridors for wildlife to move through the FLEA area. Maintain the two corridors that occur in the Urban/Rural Influence Zone. They are in the vicinity of A1 Mountain/Fort Valley, Naval Observatory, and along the Rio de Flag.

For all the Management Areas in FLEA, Management Indicator species will be the same as they currently are for each original MA, which is based on vegetation type and slope. For example, lands that are covered with ponderosa pine on less than 40% slope will have the Management Indicator Species described for Management Area 3 in the *Forest Plan*.

Within the Urban/Rural Influence Zone, and in the Wildland Urban Interface (1U) as depicted on the Fire Management Analysis Zones map, do not apply the hiding and thermal cover guideline that requires 30 percent cover within a 10K Block. Distribute wildlife cover where needed within the FMAZ 1U without accruing unacceptable wildfire threat to nearby neighborhoods. Wherever possible, projects should retain cover conditions within wildlife travelways, MSO protected activity centers (PAC's), along canyon rims, and on steeper slopes. Projects within the FMAZ 1U, should attempt to retain 15 percent cover within a given section.*

Dense stand conditions on steep slopes and within MSO PAC's contribute to the targeted 15 percent cover condition. Cover conditions might exceed 15 percent per section due to the presence of steeper slopes or MSO PAC's. In the absence of steep slopes or MSO PAC'S site-specific projects could retain a maximum of 15 percent cover condition to maintain a wildlife travelway through a section. Projects do not have to retain cover conditions of 15 percent, if a given section poses a high fire hazard to nearby neighborhoods

### Management Area 31

Management Indicator Species (MIS) should be referenced by vegetation and landform type. For example, in pinyon/juniper woodland areas MIS are those listed for MA7 (p. 206-84)

### Management Area 32

Management Indicator Species (MIS) should be referenced by vegetation and landform type. For example, in pinyon/juniper woodland areas MIS are those listed for MA7 (p. 206-88)

### Management Area 33 p. 206-92

MIS should be referenced by vegetation and landform type. For example, in pinyon/juniper woodland areas MIS are those listed for MA7.

### Management Area 34

No direction

### Management Area 35 p.206-98, 100

MIS should be referenced by vegetation and landform type. For example, in ponderosa pine lands less than 40 percent slope MIS are those listed for MA3.

### Management Area 36

Take actions at Marshall Lake to continue use and enjoyment of Marshall Lake and to maintain important waterfowl nesting habitat. Continue maintenance of the Marshall Lake wetland in cooperation with the Arizona Game and Fish Department through such actions as matting, mowing or other actions that create waterholes in the reeds. Maintain the current boat ramp and enhance wildlife viewing opportunities. Consider making a portion of the lake and adjacent forested areas, an exclosure that prohibits dogs, people, and hunting during the waterfowl-nesting season of May 1 to July 15 to increase nesting success of upland game birds.

Refer to more recent management guidelines and conservation assessments that exist for bald eagle winter habitat management.

The designated bald eagle/osprey emphasis area should be expanded to include future perch and roost trees in key areas.

### Management Area 37 (p 206-111)

In the Primitive, Semi-primitive Non-motorized, and Semi-primitive Motorized ROS settings maintain large tracts of unfragmented habitat for turkey and bear.

### Management Area 38 (p 206-111, 116)

In the Fort Valley and A-1 Mountain areas, maintain the wildlife travelway that connects A-1Mountain, Observatory Mesa, and the slopes of the San Francisco Mountain. Lands west of A-1 Mountain in Semi-primitive Non-motorized ROS setting maintain large tracts of unfragmented habitat for turkey and bear

Avoid or limit human disturbance to rare species such as peregrine falcon and Arizona bugbane.

## Kaibab NF Land Management Plan – management unit direction

### GA 1 (pp. 50, 69-78)

#### Management Direction for Wildlife and Fish Resources

Provide for intensive management of wildlife and fish habitats. Make habitat surveys, analyses, and formulate plans in concert with the Arizona Game and Fish Department to ensure moderate level of habitat diversity and capability. Provide wildlife and fish resource integration and coordination in land and resource management planning. Formulate and execute habitat investments to improve habitat components and diversity through vegetative manipulations. Improved habitat diversity and capability accrue through the coordinated interaction of other planned resource practices with planned habitat vegetative manipulations. Develop resource habitat management plans for all threatened and endangered and sensitive plant and animal species. Maintain habitat inventory and management record system.

##### Standards and Guidelines

**Wildlife, Surveys, Planning, Prescriptions, Monitoring, Coop, and Administration**

Habitat management for Federally listed species will take precedence over unlisted species. Habitat management for endangered species will take precedence over threatened species. Habitat management for sensitive species will take precedence over non-sensitive species. Survey, inventory, monitor, and evaluate habitat diversity; species composition; impact of management activities; and the distribution and density of management indicator species, threatened and endangered species, and sensitive species. Evaluate habitat for those species in Threatened Native Wildlife in Arizona. Monitor management practices and evaluate their impact within occupied and potential habitats of Apache trout, bald eagle, and peregrine falcon. Determine need for consultation with USDI Fish and Wildlife Service. Implement recovery plans for threatened and endangered species. Prepare and implement an area management plan to conserve and protect the peregrine falcon in a manner consistent with recovery goals. Monitor management practices and evaluate their impact within occupied and potential habitats of candidate species. Manage habitats to sustain species viability and prevent listing as threatened and endangered. Take all reasonable precautions, consistent with policies regarding jeopardy to human life and property, during fire suppression, search and rescue, or other emergency operations to conserve and protect threatened and endangered species, candidate species, sensitive species and their habitats. Apply standards and guidelines on an assessment area basis, (approximately 10,000 acres) except for old-growth habitat, to ensure distribution of habitat components throughout the range of dependent species. Improve stand diversity an habitat for wildlife through Integrated Resource Management.

Survey and evaluate assessment areas during IRM. Design projects to achieve the following habitat standards:

- Forage.

i. Provide forage cover ratios of 40:60 to 60:40. in areas where TES species habitat requirements do not conflict.

ii. Give priority to areas in need of additional forage for elk and mule deer when scheduling pinyon-juniper fuelwood special cutting for wildlife habitat nonstructural improvement. Treatments are usually done in areas removed from disturbance to maximize habitat effectiveness.

iii. Increase efforts to resolve conflict with livestock grazing in all critical wildlife habitats to achieve resource management objectives. In areas of conflict, new winter grazing use by livestock will be allowed when such use does not adversely affect wildlife objectives. Allocate forage to (a) maximize habitat capability for threatened and endangered species and (b) provide habitat capability for indicator and harvest species in the range specified in the State Comprehensive Wildlife Plan. d. When determined that wildlife populations are damaging the range resource, the Forest Supervisor will advise the Arizona Game and Fish Department to address Wildlife population numbers and, or wildlife management to correct the problem.

- Cover.

i. Provide for at least 40 percent cover where TES species habitat requirements do not conflict.

ii. Emphasize cover in travelways, bedding areas, reproductive areas, and areas adjacent to water sources and openings. Cover areas will be at least 10 chains in width.

iii. Provide for hiding and thermal cover in fawning and calving areas. Restrict logging activities from May 15 to July 1 for elk and from June 15 to August 10 for mule deer.

iv. Provide for not less than 10 percent thermal cover in assessment areas. Emphasize thermal cover management in travelways, reproductive areas, and bedding areas.

v. Provide for not less than 10 percent hiding cover in assessment areas. Emphasize hiding cover adjacent to water sources and openings, along travelways, and in pine stringers. Hiding cover shall not be less than 10 chains in width.

- Snags and cavity, cull, and damaged trees.

i. Provide for the following snag and other tree objectives:

(1) Regionally consistent Standards and Guidelines apply for snag management in ponderosa pine, mixed conifer and spruce-fir cover types.

i. (2) Pinyon-juniper type: not less than 100 snags et al., 9 inches and larger DRC and 12 feet in height, per 100 acres over 65 percent of the forested area.

ii. Select larger trees for retention from the following categories in sequence:

(1) Existing snags and dying trees.L

(2) Living trees with cavities.

(3) Trees with dead tops, spike tops, and damaged tops.

(4) Living cull and damaged trees.

(5) Living diseased trees, excepting mistletoe infected trees, not accounted for in 1 through 4 above.

(6) Living healthy trees.

(7) Avoid retention of mistletoe infected trees.

(8) Intensively manage emphasis areas (forest opening edges, water sources) to meet snag et al. objectives.

**Turkey habitat.**

i. Leave not less than four turkey roost-tree groups per section in turkey winter range.

ii. Leave not less than two turkey roost-tree groups per section in turkey summer range.

iii. Emphasize turkey winter habitat in areas within 40 chains of pine stringers (pine stringers are defined as non-contiguous, linear communities of predominately ponderosa pine, up to 40 chains in width, that extend into pinyon-juniper woodland).

iv. Provide not less than 10 acres of untreated slash for nesting habitat within one-half mile of water. Consider slope, canopy distribution and distance to water in the selection of treatment areas.

v. Restrict activities in nesting areas from April 15 to July 1.

**Peregrine falcon habitat.**

i. Prohibit activities which disturb nesting birds between March 15 and August 15. If birds arrive in their territories before March 15, suspend disturbing activities immediately. Extend this period if the birds are strongly attached to the nest site after August 15.

ii. Take all reasonable precautions, consistent with policies regarding jeopardy to human life and property, during fire suppression, search and rescue, or other emergency operations from March 15 through August 15 to protect peregrine nesting sites and their confidentiality.

**Raptor habitat except northern goshawk and Mexican spotted owl.**

i. Retain raptor nest tree-groups and a nonactivity buffer around raptor nest sites as follows:

(1) Cooper's hawk: 7-chain buffer zone around the nest.

(2) Sharp-shinned hawk: 6-chain buffer zone around the nest.

(3) Bald eagle:

(a) Provide a 10-chain uncut buffer zone around existing and potential bald eagle winter roosts.

(b) Identify and protect foraging perches and potential roost sites.

(4) Osprey:

(a) Provide an 8-chain uncut buffer area around existing (occupied or unoccupied) nests.

(b) Restrict logging activities within 20 chains of active nest sites between April 1 and August 15.

(c) Provide, for every ten surface acres of water, not less than five acres of not less than four snags, with heights, equal to, or greater than, the surrounding trees, and not less than 20 inches in DBH, per acre, for potential osprey nesting sites.

(d) Provide uneven-aged and, or irregular-aged stand conditions within a 10-chain zone around aquatic areas with five or more surface-acres of water.

(e) Provide artificial nesting platforms as needed for habitat improvement.

(f) Prohibit road construction in roost areas and buffer zones.

(5) Others: 3-chain buffer zone around the nest.

**Tassel-eared squirrel habitat.**

i. Manage for at least 40 percent of potential habitat capability for tassel-eared squirrels in assessment areas as determined by the Forest Habitat Capability Model. To maintain habitat capability, retain one nest tree group per five acres. Retain all trees within a 26-foot one-half chain radius from the nest (1/20 acre ponderosa pine only). This does not apply in regeneration areas.

**Red squirrel habitat.**

a. Manage for at least 40 percent of potential habitat capability for red squirrels in assessment areas as determined by the Forest Habitat Capability Model. As needed to meet habitat capability, protect red squirrel primary caches at a density of within a 26-foot one-half chain radius from the cache (1/20 acre mixed-conifer

**Pronghorn antelope habitat.**

i. In key antelope ranges, maintain existing openings and create additional openings as provided for in Wildlife Non-structural Habitat Improvement. Provide for high forb composition (25 percent).

ii. In antelope range, remove all net wire fences; in the interim, modify every one half mile of such fence to facilitate movement.

**Wildlife Non-structural Habitat Improvement**

Do non-structural wildlife habitat improvement as specified in project level analysis and the following guidelines using special cutting, burning, seeding, and planting.

- Created openings in pinyon-juniper woodland.

i. Opening is not larger than 40 acres.

ii. The maximum width of the opening is 10 chains.

iii. The maximum sight distance within the opening is 15 chains.

iv. The minimum distance between any two openings is 10 chains.

v. Retreat these areas by burning and seeding at 20 to 40 year intervals.

vi. Coordinate identification and planning of treatment areas with the Arizona Game and Fish Department.

vii. Protect cliffrose plants larger than 4 inches DBH or 8 feet tall to the extent possible when prescribe burning. Protect where possible during prescribe burning activities stands of cliffrose where densities exceed 100 plants per acre and plants are at least 2 feet tall.

viii. Exclude livestock from seeded areas for not less than two of three growing seasons immediately following treatment.

- Gambel oak.

i. Manage Gambel oak for increased hard mast production, cavities, and deciduous foliage volume to promote and enhance wildlife habitat.

ii. Retain all standing oak trees eight inches and larger at DBH.

iii. Personal and commercial cutting of oak will be done in designated areas only from May 15 to October 15 inclusive

iv. Consider age class distribution in project planning.

- Alligator juniper.

v. Retain live, large alligator juniper for wildlife habitat where it occurs with ponderosa pine.

- Quaking aspen.

i. Treat aspen using special cutting methods.

ii. Optimum size of the treatment area is four acres although in some situations larger areas (10 acres+) can be treated.

iii. Prohibit grazing of improvement areas for not less than one growing season immediately following treatment.

iv. Remove coniferous understory during treatment.

- Sagebrush.

i. Periodically burn drainage bottoms dominated by sagebrush.

**Structural Habitat Improvement**

- Do structural habitat improvement as specified in project level analysis and the following guidelines:
- Install protective fences, watering structures, brush piles, road closure devices, nesting structures and pothole developments.
- Prevent livestock access to 70 percent of the shoreline of the stock tanks that have stable water levels with the capacity to grow emergent aquatic vegetation. In addition, fence up to five acres and seed to low height cover species.
- Provide for one permanent water source per square mile.
- Install structures to promote recharge of wet meadows and riparian areas.

- Construct, improve, and, or stabilize lakes to improve aquatic habitat for desirable fish species.
- Maintain or improve nesting cover and waterfowl forage on existing waterfowl islands and shorelines and in conjunction with construction of waterfowl islands.

**Also see sivliculture and fire sections which provide wildlife-related direction**

## GA 2 (pp. 35-36)

### Standards:

Formulate and portray, describe, or quantify management objectives and desired conditions for the landscape. In landscapes that involve habitat for threatened, endangered, or sensitive plant or animal species, formulate management objectives and desired conditions for each designated management territory. Formulate, design, and implement resource operations or improvements that contribute to the achievement or maintenance of these management objectives and desired conditions.

Formulate, design, and propose resource operations or improvements that contribute, over time, to the achievement or maintenance of desired resource or ecological conditions in landscapes. Consult when applicable: a. Survey and inventory protocols for TE&S species. b. Recovery plans and conservation strategies for TE&S species. c. Formal Consultation Reports.

Prepare a biological assessment and evaluation (BA&E) to document the effect of the selected action on the habitat and on each individual in the population of threatened or endangered species

For selected actions that require preparation of an environmental analysis or environmental impact statement, prepare a biological assessment and evaluation (BA&E) to document the effect of the selected action on the viability of the population of the sensitive species in the EMA.

### Planning Guidelines (pp. 39-40):

Planning guidelines provide guidance for planning resource operations or improvements in *EMAs* or landscapes.

Geographically identify and locate, the analysis area (aka affected area) relevant to each proposed intervention or resource improvement action.

#### Guidelines for Wildlife and Fish Resource Operations and Improvements (pp. 41-42):

- In other coniferous forest timberland:

i. Encourage and promote oak and aspen.

ii. Encourage diversity of plant species in the overstory, understory, and ground cover.

iii. Turkey summer and winter home ranges.

  (1) Provide not less than four roost-tree groups per 640 acres in winter range.

  (2) Provide not less than two roost-tree groups per 640 acres in summer range.

  (3) Minimize human disturbance in turkey nesting areas from April 15 to July 1.

iv. Provide one permanent water source per 640 acres.

- In seral grassland.

v. Maintain existing openings and create additional openings with high forb composition (25 percent).

vi. Provide one permanent water source per 640 acres.

- Establish an osprey nesting territory around existing nesting trees. Provide the following desired forest conditions in osprey nesting territories.

vii. Provide, for every ten surface acres of water, not less than five acres of mature and overmature trees with not less than four snags, with heights, equal to, or greater than, the surrounding trees, and not less than 18 inches in dbh, per acre, for potential osprey nesting sites.

**Also see sivliculture and fire sections which provide wildlife-related direction**

## GA 3 (pp. 69-78)

Same as described for GA 1

## GA 8 (pp. 69-78)

Same as described for GA 1

## GA 10 (pp. 36-38)

Standards, Planning Guidelines, and Direction for Wildlife and Fish Resource Operations and Improvements – see GA 2

ii. Minimize adverse activities within active nesting territories between April 1 and August 15.

iii. Provide uneven-aged or irregular-aged stand conditions within a 10-chain zone around aquatic areas with five or more surface-acres of water.

**Also See sivliculture and fire sections which provide wildlife-related direction**

# Appendix 2. Evaluation of the Status of Mexican Spotted Owl Habitat in Protected Activity Centers within the 4 Forest Restoration Initiative Treatment Area

A data review of 117 individual PACs occurring in and near the 4FRI project area was completed by biologists from the Coconino and Kaibab NFs, the FWS, and 4FRI team (see wildlife report). The results of this review indicated that 18 of 117 PACs were candidates for management treatments to reduce fire risk and improve the development and maintenance of habitat components important to MSO and their prey. See the MSO recovery plan for details on the habitat needs and habitat conditions for MSOs and their prey (USDI 1995).

Following this review, a series of field visits to individual PACs were conducted. Potential management objectives were defined based on site specific observations. The following represent notes and photographs from the field reviews.

## Friday, May 6, 2011

### 4FRI PAC Assessment Field Trip: Mayflower Tank, Bear Seep, & Red Raspberry

**Attendees:** Shaula Hedwall (USFWS), Bill Austin (USFWS), Cary Thompson (Flagstaff District Biologist/4FRI Wildlife), Preston Mercer (Mormon Lake AFMO), Mary Lata (4FRI-Fire), Neil McCusker (4FRI-Silviculture), Bill Noble (4FRI-Wildlife), Henry Provencio (4FRI-Team Lead) attended the 1st stop.

**Objectives:** Treatments must improve MSO habitat; reducing fire threat alone is not adequate reason for treating within PACs; achieving both is ideal.

**Discusssion:** All PACs are available for burning. The desire is for cooler burns when CWD is moist. Snags are particularly important within nest cores and can provide nest structure. All decay classes of logs are used by different prey species. Topography will require staging: when S slopes are ready N slopes will be cool & damp and could have snow present. When N slopes are ready, S slopes are likely too dry.

Preston: “Schedule” basically means maintenance, or how much time passes before return burning after first-entry. Most fuel reduction generally occurs in the first burn but tree mortality is cumulative within about 5-6 yrs post-treatment. The 2$^{nd}$ burn and beyond = maintenance. Need good descriptions of desired conditions so fire managers can determine how cool conditions should be, when a backing fire is necessary, levels of acceptable mortality, avoidance of igniting CWD, etc. Knowing more detail on DCs is key in translating objectives to practitioners. Knowing desired tons/ac of CWD allows assigning % reduction by fuels size class. Whereas effects analysis is by the numbers, treatment is visual. Treating 100 ac nest cores will be labor intensive and costly. Burning hotter (i.e., medium to medium-high) will achieve more in terms of fuels reduction but also loss of habitat structure. This would achieve results in 1-2 entries rather than piece-meal results from 3-4 entries. The reality note: fire will require a 30-yr window to get 2-3 treatments done. If every PAC has a different burn plan it is less likely it will all turn out as desired in the end. Can there be consistent DCs and consistent approaches to achieving them? Can flexibility be built into sec. 7 to allow for adaptive management?

### Mayflower Tank PAC (#30405022):

This PAC has steep slopes with heavy dead and down (estimated to be about 60 tons/ac in one area). Heavy fuels would burn too hot. This PAC could be burned when heavy fuels are still wet, but would be expensive as we would not be looking to meet fuels objectives in first or even second entry due to risk associated with heavy fuel loads. Some discussion of whether coarse woody debris could be removed or redistributed mechanically prior to fire entry, but due to slopes and working around trees, this may be difficult. Note: Thinning from below would not achieve much in the stand we were viewing due to limited development of small trees.

There are opportunities for aspen restoration treatments.

The PAC would have to be revisited to see remaining portions for treatment evaluation.

**Figure 50. Opening at edge of Mayflower Tank PAC; Heavy Surface Fuels Begin Immediately Within PAC Boundary**

### Bear Seep PAC (#30405031):

[We walked in from the 132 rd, crossed an open, forested flat, walked down into a roaded meadow, and up into the “nest draw”]  Except for the nest core area, the majority of this PAC is pure ponderosa pine or pretty open pine-oak that is ready for Rx fire. We walked into the northern portion of the PAC – the flat on top is open pine-oak that hits a mostly pure pine slope and then opens up into a meadow along the 240 Road.

Shaula: openings are not bad inside a PAC. 1 - 2 ac openings could be created in the flat area on top. Below it is **relatively dense with 12-14”** and some openings there could benefit prey spp. An objective could be maintaining/releasing oak (but see Abella et al for where soil type indicates oak could benefit from the effort to release them). Openings would need to be balanced with maintaining denser forest within the PAC in general.

Adjacent to the meadow on the south side of the 240 Road is a patch of aspen that could be opened up to improve conditions for the aspen. The Bear Seep nest core area is located up the drainage in the southwest portion of the PAC. This area consists of mixed conifer and **we would not recommend mechanical or burning treatments in the nest core** (at least from the 240 Road across the drainage to the rock wall that lines the western edge of the core area). The SE arm of the PAC and areas W of the 240 rd would benefit from treatment.

In general, treatments would focus on areas of lesser habitat and avoid patches of better habitat. The PAC can be treated to promote PCE’s and develop a groupy, clumpy structure (tree size and diversity); Neil commented an IT treatment would be appropriate in some areas; aspen and meadow treatments are viable options (at small scales) as are oak and presettlement pine release; openings in pure pine could enhance owls and their prey and contribute large down logs (areas are lacking in large (1000/hr fuels) dead and down. **A diameter cap would not make it worthwhile to treat due to the density of trees > 9” dbh.**

**Figure 51. Open, pine-oak flat on northern end of Bear Seep PAC.**

**Figure 52.Slope between 132A and 240 Road in Bear Seep PAC. This slope contained some oak, but area is transitioning to pine in flat below.**

**Figure 53. Meadow along 240 Road in Bear Seep PAC. The meadow could use some work to repair drainages and impacts from recreationists and other impacts (large dispersed camping area). Improving meadow condition could improve prey habitat for MSO.**

**Figure 54. Pure pine area between meadow and slope in Bear Seep PAC. Area definitely has potential for treatment (e.g., create groups/clumps, small openings to improve prey habitat).**

### Red Raspberry PAC (#30405003):

This PAC contains very diverse topography with many knobs and valleys that would seem to offer mechanical treatment opportunities in some areas and not others. Treatments could work with topography to protect microclimates, e.g., treat south facing slopes to protect drainages and north/northwest facing slopes from fire (avoid mechanical thinning in drainages). The southwest corner of the PAC contains pine-oak habitat that could be treated to enhance openings, reduce competition between pines (i.e., create, retain and enhance larger trees), and enhance Gambel oak patches on south-facing slopes. Leave denser patches of trees on north-facing aspects and drainages. This corner of the PAC would be easy to tie into treatments in the adjacent habitat to the southwest.

**The nest core area is mixed conifer and would not be recommended for mechanical treatment.** However, the meadow area/swale that contains Raspberry Tank could be treated to remove encroaching pine. The area north of the meadow is a fairly, open productive site consisting of many large ponderosa pines and some Gambel oak. This area is ready to burn without mechanical treatment. However, the historic BA was probably 40 - 60 and existing BA is in the 120 - 140 range. There are opportunities to enhance openings, open-up the oak, and overall to reduce basal area.

In general, areas that warrant treatment should result in oak and aspen release, meadow and seep restoration, creating gaps or releasing presettlement pine in the thickets of VSS 3s & 4s (except in known nest/roost areas). **Mechanical treatments would require thinning over 9" dbh to meet objectives.** It looks like at least trees 12"-14" would need to be cut.

**Figure 55. Meadow area east of Raspberry Tank in the Raspberry Tank PAC.**

**Figure 56. Fairly open pine-oak slope in northeast corner of PAC. Area consists of larger pines, but has little in the way of vertical heterogeneity.**

Red Raspberry PAC Burn Discussion-

- Need a plan for communicating specific ideas to those implementing treatments
- Lining of logs is not realistic or effective
- Burning technique and timing of burning (fuel moistures) are more important/effective
- Don’t expect conditions to be met in first burn entry
- First-entry burning reduces the most tons/acre, maintenance burns needed every 5-6 yrs
- Identify % mortality acceptable and/or % reduction needed
- If you exclude nest core there would be escalated fire behavior if nest core fuel density is higher than the area immediately adjacent and outside nest core
- Operational – need 20 year window for burning
- May need to burn in nest cores from an operational standpoint in some PACs

## Monday, May 9, 2011

### 4FRI PAC Assessment Field Trip: Knob Creek, T-Six, & Foxhole

**Attendees:** Shaula Hedwall (USFWS), Bill Austin (USFWS), Bill Noble (4FRI-Wildlife), Cary Thompson (Flagstaff District Biologist), Linda Wadleigh (Regional Fire Ecologist), Roger Joos (Kaibab South Zone Biologist), John DeLuca (Kaibab South Zone Biologist)

#### Knob Creek PAC (#30405029):

We walked north from 226E to hilltop and then north to the road and then southwest back to 226. PAC is very limited in terms of MSO habitat and there are no nest or roost locations documented. There are patches that contain Gambel oak, but oak is sparse in the majority of the PAC. The current core area does not meet Recovery Plan guidance and should be redrawn to include the entire length of the south-facing slope that runs along the drainage (drainage along the 226 Road). We recommend treating (mechanical and/or fire) the majority of the PAC. If fire is allowed to burn in the nest core, some mechanical treatment is recommended to enhance existing openings and create some breaks in the canopy. We do not want fire to result in torching or and want to minimize loss of CWD (see Graham et al. for guidance based on soil types – note that in PACs we’d generally be looking at the upper end of the recommended ranges). There are many pre-settlement pines throughout this PAC, including some nice groups of yellow pines within the nest core (especially once it is redrawn as the west end of the drainage), but they are commonly set amongst dense doghair thickets. Groups of yellow pine within the nest could perhaps be enhanced, but this would be a very specific prescription that should be created with the biologists and silviculturist to ensure protection of key habitat components in this relatively small area. The majority of the PAC is pure pine and very open. Treatments could be more aggressive, relative to other PAC recommendations, in the areas of non-MSO habitat.

In general, treatment objectives would include:

- Treating about 70% of PAC that really is not owl habitat

- Redraw nest buffer to include south-facing slope up to hilltop and westerly This is where most of the larger oak is located. There are three areas along the lower southern ridge that might provide nest/roost habitat.
- Enhance oaks
- Create openings among large groups of pine in the existing thickets (can go up to 2 acres)
- Manage for patches and larger groups
- Use natural features, such as swales, for openings
- Thin around yellow pines and larger oaks
- 7-20 tons/acre of large 1000/Hr fuels to maintain healthy soils in pondersosa pine (1 snag = about 10 tons/ac)
- Needs 2 years of survey (if owls are detected) to determine nest buffer
- Treat outside breeding season
- Abundant large snags throughout
- Could meet many objectives by thinning up to 9" but this would limit the ability to meet all objectives

These areas might not have resident owls due to existing conditions and enhancing prey habitat could benefit overall production in neighboring PACs.

*****This PAC should be a survey priority to help ascertain use/occupancy*****

**Figure 57 (L). This picture is very representative of most of the habitat within the Knob PAC. There are many pre-settlement pines, but also many small, deformed pines.**

**Figure 58 (R). Similar to Figure 57, there are many pre-settlement pines, but also many small, deformed pines Much of the PAC is very rocky, and contains alligator juniper with some Gambel oak interspersed throughout.**

**Figure 59. Area on slope in nest core that could benefit from limited mechanical treatment to enhance key habitat components.**

### T-Six PAC (#30405016):

Entire PAC, including nest core, is likely a candidate for mechanical and fire treatments. The core area where the historic roosts are located is currently in a state of degradation. Presettlement pines and large Gambel oaks occur throughout core area, but many trees of both spp are falling over due to stand conditions resulting from very dense regeneration, including many “whips,” that limits owl roost habitat value. Nest buffer is very decadent and in need of treatment, but as is, fire would likely kill presettlement trees. Mechanical treatments could focus on creating patches of habitat around pre-settlement trees that could be used for roosting by thinning, and in some cases, removal of dense patches of small diameter pine. [Note: Cary described work in Fort Valley where small trees were left around presettlement trees and snags to provide perches for fledglings.] Also need to focus treatment on how to maintain Gambel oak on this roost slope. Outside the roost area, the PAC is a mixture of very open, pre-settlement trees where fire alone could meet objectives except for some areas of dense ponderosa pine doghair thickets that could be thinned out to develop future owl habitat. Abundant, large snags throughout the rest of the PAC. Some portions of PAC either burned in Birdie Fire or were result of actions taken to suppress Birdie Fire. These areas really do not need additional treatment other than maintenance burning.


**Figure 60 (L). Historic roosts located in this area. Note Gambel oaks falling down and density of pine.**

**Figure 61 (R). Pre-settlement pines are getting out-competed by young and mid-aged trees**

**Figure 62. Area east of core area on flat. Many pre-settlement pines in this area with dense patches of smaller pines scattered around them.**

### Foxhole PAC (#30405038):

(Approached PAC from bridge across Bar M canyon) The western PAC area south of Bar M Canyon, sans steep slopes, is a candidate for mechanical treatment. The area consists of dense thickets of ponderosa pine with some oak – the oak need to be opened up if they are to persist. Abundant large snags exist throughout the area. We saw fewer oak and oak/alligator juniper in the lower slopes and more oak & juniper on the upper slopes. There are natural openings, including at the top of the hill in the SW ¼ of section 5. Parts of this area have large alligator juniper and some of the openings look like they were once open oak areas before the release of pine (from fire exclusion). There is also an extensive network of dispersed camping sites in this section of the PAC. Dwarf mistletoe infection is high in this area and there is currently very little in terms of what we would consider nesting/roosting MSO habitat. Treat mistletoe by strategically placing openings to put space between un- and less-infected trees and heavy mistletoe trees. Though we did not walk the portion of the PAC along Bar M Canyon, we did discuss leaving a buffer area along the canyon rim as a wildlife movement corridor.

We walked a loop, coming out the 9469D. PAC has a mixture of open and closed-canopy conditions. Would need to thin area before burning and reduce VSS 2 ladder fuels.

Treatments should:

- Protect snags
- Create groups of 20-60 trees
- Enhance oaks

**Figure 63. Dense ponderosa pine in SW of section 5 in Foxhole PAC.**

**Figure 64. One of many dispersed camping sites off the 9469D road within the Foxhole PAC.**

## Wednesday, June 15, 2011

### 4FRI PAC Assessment Field Trip: Archies & Crawdad

**Attendees:** Bill Noble, Neil McCusker, Cary Thompson

#### Archies PAC (#03040534):

This PAC is primarily pine-oak with a strong oak component. We parked along the 132 rd, near the junc with the 132D, and walked along the ridge top and overlooked the southwest facing slope. The slopes were dominated by VSS4s & 3s with scattered 5s. There were more large trees before and near the nest core and more younger trees as we worked our way towards the NE. There was a lot of oak >5” drc scattered through the pine, but few large-sized oak.

The ridge top is rocky with open pine-oak which becomes more of an oak savanna and less rocky as you leave the nest core and follow the ridge top to the northwest. There were pockets of heavy mistletoe infestation and bark beetle outbreaks along the flat ridge and southern slopes. These were more common at the start of the walk than they were at the far end of the ridge. Crowns were reduced, in poor shape and not providing much canopy cover.

There is not much treatment needed on the ridge top other than **removing 5-12” pine** from within and around clumps of oak. There are opportunities for mechanical treatment along the southwestern slopes. Mechanical and burning treatments could help protect the nest stand located on the northwestern slopes. There are opportunities to release oak and improve sustainability of the stand.

**Figure 65. Picture of the southwest ridge taken from the ridge top.**

We dropped off the northeast slope and walked back along the 132D road. Parts of this were more oak savanna like but there were also pockets of trees with many trees under 9” diameter. There were more large oak associated with the smaller pine. “Shelves” or small flat areas associated with the flanks of the ridge were pretty open, lacking large diameter pine, and supporting small-sized oak. Large herd of elk bedded down in the oak savanna. Trees along the base of the ridge were in large groups defined by sinuous openings. Some groups were thick with little pine, including a lot of bending whips. Individual trees were in a much healthier condition along the northwestern slopes. Forest on easterly side of rd is similar to the flats between the rd & the ridge **– 9” dbh limit not a problem** in terms of improving health/habitat with mechanical treatments.

Aspen stand along 132 on the lower slopes near Weimer Spring stretches the length of the drainage. Aspen overstory is dying out with no regeneration below. There is opportunity to restore this aspen stand and associated meadow to improve habitat for MSO prey.

Weimer Spring (located immediately adjacent to the PAC): There is a fence around Weimer Tank which Weimer Spring drains into. The fence is down in several places and is in need of repair. The spring is not fenced although meadow habitat could be restored to improve prey habitat. The tank was full of tiger salamander larvae.

**Figure 66. Oak provides the vertical heterogeneity in this PAC**

**Figure 67. Picture of area with many trees under 9" diameter.**

**Figure 68. Picture taken along FR132D facing west**

**Figure 69. Picture of oak savanna taken by FR 132D. Also depicts habitat along portions of the ridge top.**

### Crawdad PAC (#03040547):

We walked northwest from the junction of FR132 and FR133 along the southwestern slope and came around the second knob to the drainage. Headed east above the drainage and then south back to the road junction. Much of the southwestern slopes supports dense trees 12-18" diameter forming a single story stand with essentially no understory development. Oak was represented by a range of size classes, but not as prevalent in this PAC and is suppressed by the higher densities of pine. Treatments could build gaps around the oak and release individual oak trees amongst the groups. In this area we would likely **need to cut trees greater than 9” diameter (even a 12” dbh limit would be a challenge to create gaps)**. Bark beetle mortality occurred in groups as did mistletoe. Neil discussed thinning from below until you meet the desired basal area while featuring dominant and co-dominant trees. This would also reduce fire risk to the eastern slope where the majority of roosts are located. Small natural openings were present throughout and could be opened up a little more to enhance habitat for MSO prey.

Further up the slope dominant trees were more VSS 3s than 4s and forest was a bit more open. Still consistent but scattered oak and some pre-settlement pine. Near the 1st (main) knob the forest dominated by VSS 3s with fewer and smaller oak. A 2-track rd runs through the area. As we approached the saddle between knobs there were bigger pine + VSS 3s + successive openings. Oak clumps are largely overgrown with pine. Passed through the saddle and followed the drainage down where we saw a lot of old stumps, indicating an open forest where it’s currently relatively dense dominated by “stubby” trees. Potential to thin here (improve tree health, increase growth rates, open understory for prey). Followed the drainage down and forest opened more with small oak and more yellow pine. Slope was gentle, merging into flats where there was more understory and a young overstory, looking like small opening/meadow encroachment. Moved onto steeper slopes and circled back below ridge top: trees much denser, bigger (12 – 24+ dbh), and oak widely scattered.

**Figure 70. West hillside showing pre-settlement trees and openings with grass understory**

**Figure 71. Picture taken at same point facing south with a majority of trees 9”-18” diameter.**

**Figure 72. Picture of Crawdad PAC taken along the northeast slope.**

**Figure 73. Taken along the north slope of Crawdad PAC.**

# Tuesday, June 28, 2011

## 4FRI PAC Assessment Field Trip: Sawmill Springs

**Attendee:** Cary Thompson

### Sawmill Springs PAC (#0304070):

This PAC is Ponderosa pine with a strong Gambel oak component. Oak is present in all size classes with a large amount of oak regeneration. All size classes of ponderosa pine are also represented in this PAC and are growing in a clumpy groupy structure in many areas. Treatments could enhance groups of various sizes of pine and oak including younger ages of both species. This PAC has more regeneration than those previously assessed. In addition to oak regeneration Arizona rose and locust are present in the understory. Although there are pockets of dwarf mistletoe the PAC is healthy overall.

This is a structure we would want to maintain and treatments should focus on enhancing growth of young oak and maintaining this diversity of size classes. These areas have moderate levels of dead and down trees with mostly older, decaying large dead trees. This could probably be prescribed burned without thinning.

**Figure 74. Clumpy structure with small openings interspersed along FR 683**

I walked north to Sawmill Tank, then west to Sawmill Spring and along the drainage and up the slope. The slopes to the west of the spring are thick with pine trees (VSS4 and VSS5) and have a northerly aspect while the ridgetops are relatively rocky and open. Treatments to the south should focus on protecting these northerly slopes.

Overall, MSO habitat objectives cannot be met with a 9” cutting limit. While there is variability across the PAC, some areas need the flexibility of larger dbh size classes to enhance and maintain owl habitat characteristics.

**Figure 75. Northerly slope west of Sawmill Spring**

The slopes south of Sawmill Tanks had areas of dense VSS3 and VSS4 that did not have as much oak. Treatments in this area should focus on enhancing oak.

I would recommend thinning and burning treatments in the area east of the nest core and south of Sawmill Tank. There are large stands of dense areas of VSS3 and VSS4. Treatments should focus on developing larger trees and releasing oak.

**Figure 76. Area south of Sawmill Spring with dense VSS3 and VSS4**

Treatments adjacent to Sawmill Spring should focus on improving spring conditions. The vegetation in the area of the spring and tanks was in good condition and did not appear to have impacts from livestock. No leopard frogs were detected although the tanks and area leading from the spring appeared to be good habitat. No crawfish were found. I counted 6 species of butterflies in the area and 3 species of dragonflies. Monkeyflower, watercress and mint edge the spring with a large amount of emergent vegetation and bulrushes along the banks of the tanks. Large amounts of down woody debris blanket the stream. Rocky bluffs west of the spring and large woody debris likely provide additional habitat for MSO prey.

**Figure 77. Sawmill Tank (east Tank)**

**Figure 78. Sawmill Tank (west tank)**


**Figure 79. Sawmill Tank (west) looking west to Sawmill Spring**


**Figure 80. Looking east to Sawmill Tanks**


**Figure 81. Creek leading from spring to tanks**

**Figure 82. Sawmill Spring**

## Wednesday, August 10, 2011

### 4FRI PAC Assessment Field Trip: Clarke

**Attendees:** Patty Ringle, Shaula Hedwall, Cary Thompson, BN

Limestone soils make for very high site productivity, but many stands have very little oak. This is not representative of typical MSO habitat, but the birds are here. The owls could be here due to the lush understory supporting larger prey species populations.

Comments:

- Leave bigger groups in draws, on N-slopes, and smaller groups on S-facing slopes
- Suppressed trees under dripline of yellow pine serve as great MSO roosts
- Owls don’t roost in stands with Canopy Cover < 60% due to thermoregulation issues
- An interspace of 50’ is not likely to support much regeneration; interspaces of 150’ may be full of regeneration within 20 yrs
- Openings of ½ ac vs ≥ 1 ac are very similar in terms of regeneration; areas that can support regeneration will need retreatment to maintain tree-less space.

**Table 151. Field reviews for PACs proposed for treatment**

| PAC Name | Date | Participants |
|---|---|---|
| Mayflower<br>Bear Seep<br>Red Raspberry | 5/6/2011 | Preston Mercer – Mormon Lake AFMO<br>Neil McCusker- 4FRI Silviculturist<br>Mary Lata- 4FRI Fire Ecologist<br>Bill Austin- USFWS<br>Shaula Hedwall-USFWS<br>Bill Noble-4FRI Biologist<br>Cary Thompson- Flagstaff District Biologist<br>Henry Provencio-4FRI Team Leader |
| Knob<br>T-Six<br>Foxhole | 5/9/2011 | Linda Wadleigh – Regional Fire Ecologist<br>Bill Austin- USFWS<br>Shaula Hedwall-USFWS<br>Bill Noble-4FRI Biologist<br>Cary Thompson- Flagstaff District Biologist<br>John Deluca – Williams/Tusayan District Biologist<br>Roger Joos - Williams/Tusayan Biologist |
| Archies<br>Crawdad | 6/15/2011 | Bill Noble, Neil McCusker, Cary Thompson |
| Sawmill Springs | 6/28/2011 | Cary Thompson |
| Iris Tank | 7/12/2011 | Cary Thompson |
| Bar-M | 7/14/2011 | Cary Thompson |
| *Clark | 8/11/2011 | Patty Ringle – FS Silviculturist<br>Shaula Hedwall<br>Bill Noble<br>Cary Thomspon |

*The Clark PAC is not included in the 4FRI analysis. The field review was to assess a prescription with a 16”cap.

## PAC Review Summary

### Mayflower:

- Thin from below won’t accomplish much due to the lack of small trees;
- Some areas have very heavy fuel loads (est’d at 60 tons/ac);

- Opportunity for aspen restoration which would enhance prey habitat, foraging opportunity, and help with overall aspen ecology.

### Bear Seep:

- Flats along the 132 rd would benefit from 1 to 2 ac openings (Shaula) for prey/foraging/oak release;
- Some areas are dense in the 12” to 14” dbh range and could use thinning and potentially some openings;
- In general, we saw areas that would benefit from changing dense, continuous forest into a more groupy tree distribution with relatively small canopy gaps;
- Small scale aspen and meadow restoration opportunities within PAC;
- Oak and presettlement pine encroached and would benefit from release;
- Cannot meet above objectives with a 9” cap in this PAC;
- Nest core is MC, dense, and great owl habitat – don’t burn this nest core!

### Red Raspberry:

- Lots of small scale topography allows treating dry south slopes heavier to help protect north slopes that could be left dense;
- Enhance openings in pine-oak to benefit oak;
- Yellow pine in drier sites would benefit from an overall BA reduction to enhance sustainability;
- Opportunities for oak & aspen release and meadow restoration;
- Would require increasing diameter cap to something like 12-14” dbh;
- Nest core = MC and should not be burned.

### Knob Creek:

- Mechanical treatments recommended for most of the PAC, *including the nest core*;
- Many yellow pine and large oak are currently in dog hair thickets of young trees and would greatly benefit if released from competition;
- This PAC has a lot of pure pine that can be managed as groups & gaps, but make the groups large;
- Can use natural features such as swales for delineating openings;
- Work to retain snags that are abundant in this PAC;
- Many objectives could be met with 9” cap, but increasing this limit would allow more ecologically-based treatments.

## T-Six:

- Presettlement pine and large oak are falling over from competition as these stands unravel – dense regeneration includes many “whips” that limit value of owl habitat;
- **Recommend mechanical treatment in the nest core;**
- Many other stands are open and would not require mechanical treatments;
- Other stands would benefit from thinning or small group removal where pockets of dog hair pine exist.

## Foxhole:

- Oak will not persist in overly dense stands of young pine – much of the western portion of the PAC would benefit from mechanical treatment (except, of course, along the steep slopes);
- Need to protect snags and enhance oak;
- Groups of pine could range from 20 to 60 trees.

## Archies:

- This PAC has a strong oak component and the pine is dominated by VSS 3s and 4s;
- Releasing oak and removing some pine from pockets of oak savanna along ridge top would benefit owl habitat;
- Ridge top also had pockets of mistletoe and bark beetle and pine with with reduced canopies – may be able to thin (with a light touch) for general forest health reasons to sustain the stand and speed development of larger trees;
- There are opportunities to release oak, which would require cutting at least up to 12” dbh;
- Other side of ridge would do fine with 9” dbh limit and thinning pockets of unraveling dog hair pine would improve stand health/sustainability;
- Small areas of aspen and meadow need restoration.

## Crawdad:

- Stands needing treatment include single story, dense pine of 12 to 18” dbh with no understory and suppressed oak – this needs thinning and creation of gaps to create sustainable owl habitat – 9” dbh would preclude meeting these objectives;
- Bark beetle mortality and mistletoe present;
- Small natural openings could be enhanced for tree rooting zone and prey habitat;
- Further up slope forest opens but near top small oak are overtopped by pine;
- A couple other stands looked like historic meadows and open forest that are now encroached by VSS 3ish pines.

## Sawmill Springs:

- Much of the area is in good condition and benefit from a light touch to define tree groups;
- Treatments in other areas could aid in enhancing and retaining oak;
- Opposing slopes of drainage near spring have N & S aspects – treating the south slope could benefit this drier aspect and help protect the denser north slope;
- While much of the PAC is in relatively good shape, owl habitat objectives cannot be met by restricting treatments to 9” dbh.

# Appendix 3. Bridge Habitat for Canopy-Dependent Wildlife

Sarah Reif, Habitat Program Manager, Arizona Game and Fish Department, Flagstaff.

October 3, 2012

## Introduction

The 4FRI project would not achieve desired conditions on all treatment acres immediately post-treatment; as it will take time for the largely even-aged forests to progress into uneven-aged forests, for trees to mature into larger diameter classes, and for tree canopies within tree groups to reach the desired interlocking crown condition. Because of this, there is a concern that post-treatment conditions within the 4FRI project area would not provide sufficient habitat for canopy-dependent wildlife in the short term. The wildlife species of concern identified by our publics include the northern goshawk, the Mexican spotted owl, Abert's squirrel, turkey, mule deer, black bear, and some songbird species. The information provided below clarifies how post treatment conditions within the 4FRI project area would provide habitat for canopy-dependent wildlife in the short-term. We are referring to those areas as "bridge habitat", suggesting that these more densely-forested areas would be available to wildlife to bridge the time between treatment and the attainment of desired conditions across the broader landscape.

## Bridge Habitat at the Landscape Scale

For purposes of this discussion, the landscape is considered to be the 988,764 acre Four-Forest Restoration Initiative Coconino NF and Kaibab NF project area (Table 1). To clarify where and how much bridge habitat would be available to canopy-dependent wildlife at the landscape scale, some review of the acreage categories may be helpful. Table 1 displays an accounting of project area acres in terms of what was considered for management actions and what was excluded from consideration under this EIS. All treatment area acreages are calculated based on Alternative C because it is the preferred alternative and has the most comprehensive set of potential treatments that could impact canopy-dependent wildlife.

**Table 152. Acres of Treatment and Non-treatment Areas within the 4FRI Project Area.**

| | Description | Acres |
|---|---|---|
| Project Area | Total Area within 4FRI Project Boundary | 988,764 acres |
| Exclusions | Total Excluded Area within 4FRI Project Boundary | 395,553 acres |
| | Other Projects | 204,957 acres |
| | Special Management Areas (wilderness, Research Natural Areas, Inventoried Roadless Areas, Camp Navajo, and experimental forests) | 29,821 acres |
| | Non-FS Lands | 145,156 acres |
| | Miscellaneous (other cover types, no-treatment PAC core areas, inaccessible areas, etc.) | 15,618 acres |
| Treatment Area | Area within the Proposed Treatment Boundary (includes mechanical treatment and prescribed burning) | 593,211 acres |
| | PIPO Treatment Area | 512,178 acres |
| | Other Cover types Treatment Area | 81,033 acres |

At the landscape scale, there is a highly-diverse mosaic of patches that would vary in terms of overall density and openness post-treatment. Two bridge habitat categories (‘Other Projects’ and ‘Wilderness, Slopes, PACs’) are analyzed at the scale of the total project area to demonstrate the patch-mosaic of deferrals vs. treated areas across the larger landscape. The remaining bridge habitat categories are analyzed at the PIPO treatment scale (512,178 acres) to demonstrate how bridge habitat would persist where mechanical treatments and prescribed burning are proposed. The percentages provided for each category are not necessarily additive; some categories are merely subsets of other categories but they provide several different ways of looking at how we account for closed canopy species through our project design.

### Project Area Scale

**Other projects:** Excluded fuels reduction and forest restoration projects account for 204,957 (21 percent) acres of the total project area (988,764 acres). We can assume that some proportion of these projects would/do retain closed canopy conditions after treatment, or remain untreated. The average proportion of projects that go untreated on the Coconino and Kaibab National Forests is roughly 37 percent, due to site-scale factors such as archaeological and historical sites, wildlife deferrals, funding issues, and areas with insufficient road access (Northern Arizona Wood Supply Analysis p.17). Using this estimate of 37 percent remaining untreated; we can extrapolate that 8 percent (75,834 acres) of the total project area would likely remain in deferral simply due to site-scale logistics and protection measures on these excluded projects. Though data were not available to arrive at an accurate percentage of those excluded projects that remain in deferral or closed canopy condition, we assume that some proportion of this area would contribute to available habitat for canopy-dependent species.

**Wilderness Areas, Slopes >40 percent, and MSO PACs not identified for mechanical treatment.** These areas have not been identified for mechanical treatment (including 81 of 99 MSO PACs) and are generally characterized by dense forest conditions used by canopy-dependent wildlife. These areas account for 8 percent (79,382 acres) of the total project area.

## PIPO Treatment Area Scale

**Treated areas remaining in closed (10 to 25 percent open) to moderately-closed (25 to 40 percent open) condition post-treatment.** This category includes mechanically-treated and burn-only areas where post-treatment conditions maintain 60 to 90 percent forested cover. Included in the analysis were areas outside and within northern goshawk PFAs where post-treatment openness would be 10 to 25 percent and 25 to 40 percent, northern goshawk nest areas, MSO restricted and target/threshold habitats, and 18 Mexican spotted owl PACs proposed for mechanical treatment. Total acreage for this category is 213,084 or 42 percent of the PIPO treatment area. If we only look at areas that would remain in closed condition (75 to 90 percent forested) post-treatment, the total acreage is 84,632 or 17 percent of the PIPO treatment area. This percentage includes all those areas listed above, but excludes areas in the 25 to 40 percent open category. Table 153 provides acreages by post-treatment openness within the PIPO treatment area.

**Table 153. Acres of Proposed Treatment in terms of Post-treatment Openness**

| Post Treatment Openness Category | Acres | % of PIPO Treatment Area |
|---|---|---|
| Very Open | 56,692 | 11 |
| Open | 154,524 | 30 |
| *Mixed (LOPFA Burn Only)* | 87,879 | 17 |
| Moderately Closed | 128,452 | 25 |
| Closed | 84,632 | 17 |
| **Total** | **512,178** | **100** |

Table 154 provides a detailed summary of acreages and percentages for each treatment category within the PIPO treatment area in terms of post treatment density and contributions to bridge habitat. Figure 83 demonstrates the patch-mosaic of denser forests (post-treatment) relative to areas that will be more open after treatment. The narrative following the table and figure discusses habitat specific post treatment density.

**Table 154. Post-treatment Contributions to Bridge Habitat Provided by each Treatment Designation**

| Treatment | Post Treatment Density | Landscape Scale Bridge Habitat | Mid-Scale Bridge Habitat | Total Acres | % of PIPO Treatment Area |
|---|---|---|---|---|---|
| | **Low Density** | | | | |
| **Mechanical Treatment Areas** | Savanna/Grassland Restoration | - | - | 56,692 | 11% |
| | LOPFA 40-55% Interspace | - | Some | 141,628 | 28% |
| | PFA 40-55% Interspace | - | Some | 12,895 | 3% |
| | Low Density Total | | | 211,252 | 41% |
| | **Moderate Density** | | | | |
| | LOPFA 25-40% Interspace | X | X | 53,058 | 10% |
| | MSO Restricted | X | X | 63,191 | 12% |
| | PFA 25-40% Interspace | X | X | 4,800 | 1% |
| | Moderate Density Total | | | 121,050 | 24% |
| | **High Density** | | | | |
| | LOPFA 10-25% Interspace | X | X | 29,776 | 6% |
| | PFA 10-25% Interspace | X | X | 2,850 | 1% |
| | High Density Total | | | 32,626 | 6% |
| | **Very High Density** | | | | |
| | MSO Target/Threshold | X | X | 8,410 | 2% |
| | MSO PAC Mechanical | X | X | 10,741 | 2% |
| | Very High Density Total | | | 19,151 | 4% |
| | **Low/Moderate Density** | | | | |
| **Burn Only Areas** | LOPFA Burn Only | Some | Some | 87,879 | 17% |
| | **Low/Moderate Density Total** | | | 87,879 | 17% |
| | **Moderate/High Density** | | | | |
| | PFA Burn Only | X | X | 3,216 | 1% |
| | Restricted Burn Only | X | X | 4,187 | 1% |
| | **Moderate/High Density Total** | | | 7,403 | 1% |
| | **Very High Density** | | | | |
| | PFA Nest Area Burn Only | X | X | 6,839 | 1% |
| | Target/Threshold Burn Only | X | X | 303 | 0% |
| | Protected Burn Only | X | X | 25,714 | 5% |

| Treatment | Post Treatment Density | Landscape Scale Bridge Habitat | Mid-Scale Bridge Habitat | Total Acres | % of PIPO Treatment Area |
|---|---|---|---|---|---|
| | Very High Density Total | | | 32,856 | 6% |
| | **Grand Total** | | | **512,178** | **100%** |

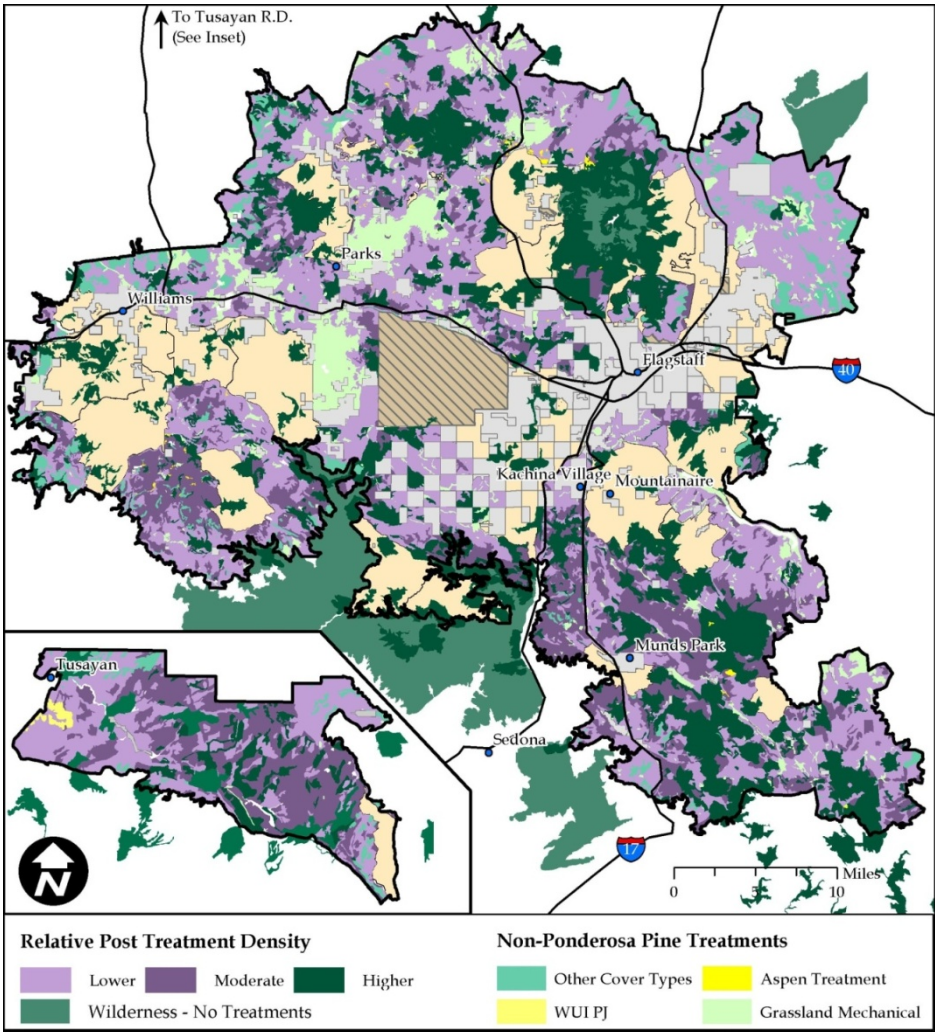


**Figure 83. Relative, Post-treatment Forest Density Across the 4FRI Project Area, Alternative C**

**Mexican spotted owl Protected, Target/Threshold, and Restricted Habitats:** These three habitat designations have specific guidelines per the Mexican Spotted Owl Recovery Plan to meet the denser forest conditions selected for by the owl. Within the 4FRI project, these designations could be ranked in terms of their forest density, and therefore their provision of bridge habitat for other closed-canopy species. Protected habitat is generally densely forested; target/threshold habitat is similar to protected; and restricted habitat is slightly less dense than protected but still more densely forested relative to the surrounding treated areas outside Mexican spotted owl designations.

- Protected owl habitat accounts for roughly 36,455 acres, which is 7 percent of the PIPO treatment area (Table 150 – MSO PAC Mechanical and Protected Burn Only). This designation includes 72 Protected Activity Centers (18 of which are proposed for some mechanical thinning) and slopes >40 percent. Protected owl habitat is designed to provide a multi-layered, more closed canopy condition relative to the other habitats in the PIPO treatment area, with an emphasis on managing for large trees (18" dbh or greater). The average BA for protected habitat, based on modeled projections for the year 2020, is 154 square feet per acre.
- Target/Threshold habitats include those areas that meet or are approaching protected habitat conditions, specifically within the pine-oak vegetation type. These areas account for 2 percent of the PIPO treatment area (Table 150 – 8,713 acres). Per the Mexican Spotted Owl Recovery Plan, the guideline within target/threshold habitats is to manage for ≥ 15 percent of total SDI in each of the three targeted ponderosa pine tree size classes (12 to18-inch dbh, 18 to 24-inch, and >24-inch), and a stand average of 110 to 150 square feet per acre basal area with a preponderance of large trees (≥18-inch dbh).
- Restricted habitat accounts for 67,378 acres (Table 150), which is 13 percent of the PIPO treatment area, and like target/threshold this is also specific to pine-oak in the 4FRI project. The guidelines for restricted habitat are less specific and operate in conjunction with ecosystem management and existing management guidelines. 4FRI objectives include managing for an abundance of ponderosa pine trees larger than 18-inch dbh, maintain tree form oak, and manage for a stand average of 70 to 90 square feet per acre basal area.

**Northern goshawk habitat:** Closed-canopy conditions would also be realized within areas managed according to the northern goshawk guidelines. Higher tree density, canopy cover, and larger group sizes would be retained in the PFAs and LOPFAs where the post-treatment density remains high (Table 150 - 10 to 25 percent interspace; 32,626 acres). Denser forest structure would also be retained in northern goshawk nest areas, all of which have been identified as burn only (Table 150 - 6,839 acres). Together, these categories account for 8 percent of the PIPO treatment area. In addition, PFA and LOPFA proposed for moderately-dense condition (25 to 40 percent interspace) account for 11 percent of the PIPO treatment area (Table 150). About 41 percent of the PIPO treatment area is LOPFA and PFA goshawk habitat proposed for low density condition (Table 150 - savanna/grassland restoration and 40 to 55 % interspace).

**Wildlife movement corridors:** Efforts were taken to ensure habitat connectivity for canopy-dependent wildlife at the landscape scale using data from known wildlife movement corridors for black bear, turkey, mule deer, and tassel-eared squirrels (Appendix 4; Arizona Game and Fish Department 2011). In areas where canopy-dependent wildlife corridors overlapped with proposed mechanical treatments, treatment intensities were strategically designed to leave stands with closed- or moderately-closed conditions post-treatment. In addition to stands that were already proposed to remain in at least moderately-closed condition, roughly 4,276 acres were actively changed from a more open treatment. Adjusted stands were located within 5 different wildlife movement corridors within the project area. This action was taken to ensure adequate retention of thermal and hiding cover for the wildlife that depends on closed-canopy conditions for their movement across the landscape. (The inverse was done for open-canopy dependent wildlife corridors, where treatment intensities were designed to create open- or very-open conditions post-treatment. Open-canopy corridors were identified for pronghorn, Gunnison's prairie dog, and American badger).

In summary, there are four key considerations with regard to bridge habitat for closed-canopy species at the landscape scale. 1) At the scale of the project area, a patch-mosaic of bridge habitat would remain available for canopy-dependent wildlife. At a minimum, 5 percent of the project area would be in deferral due to wilderness, slope, and MSO untreated PACs. Potentially another 8 percent of the project area would be in deferral as part of other excluded projects. 2) Roughly 1 in 5 acres (22 percent of the PIPO treatment area) would be managed as Mexican spotted owl habitat, creating conditions that also provide bridge habitat for other canopy-dependent wildlife. 3) Bridge habitat would be maintained across 42 percent of the PIPO treatment area, despite the use of mechanical and burning treatments. 4) Project area connectivity for closed-canopy species was specifically built into treatment designs separately from MSO and northern goshawk guidelines.

## Bridge Habitat at the Restoration-Unit (RU) Scale

At the RU scale (Figure ), there are additional ways of accounting for bridge habitat. Factors contributing to bridge habitat at the RU scale include the area remaining in closed and moderately-closed condition post treatment, and areas allocated for old growth.

**Treated areas remaining in a closed (<25 percent interspace) to moderately-closed (25 to 40 percent interspace) condition post-treatment:** Table 151 summarizes the range of post-treatment openness by RU, under alternative C (see also table 64 from the silviculture specialist's report, page 113). Overall ranges indicate a fairly diverse condition within RUs, with openness leaning toward the moderately-closed to closed side of the range. RU 1 has the highest percentage of post-treatment habitat in a closed condition, due in large part to ecological conditions such as soil, climate and site quality that result in a denser reference condition relative to the other restoration units. RU 1 also contains the highest proportion of MSO habitat relative to the other RUs. Note that RUs 3 and 4 include savanna, grassland and pine/sage habitats (e.g., Garland Prairie in RU 3, Government Prairie in RU 4pine sage in RU 6). Savanna and grassland restoration is based on soil characteristics and would account for a total of 56,692acres of very open treatment.

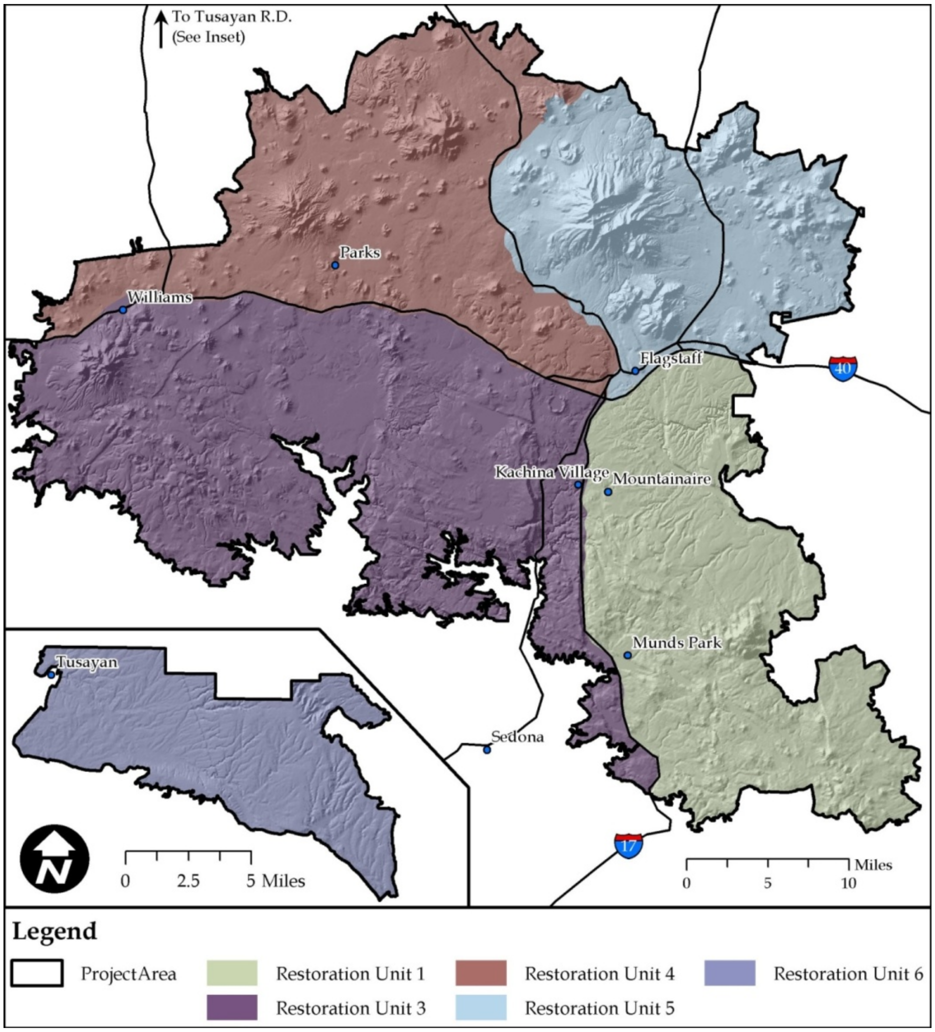


**Figure 84. Restoration Unit (RU) Boundaries within the 4FRI Project Area**

**Table 155. Proposed Post-treatment Openness Condition by RU**

| Restoration Unit | Very Open | Open | Mod. Closed | Closed |
|---|---|---|---|---|
| 1 | 10% | 32% | 20% | 21% |
| 3 | 12% | 34% | 41% | 12% |
| 4 | 18% | 39% | 30% | 13% |
| 5 | 2% | 5% | 87% | 6% |
| 6 | 0% | 21% | 65% | 14% |

**Areas allocated for old growth:** Desired conditions for old growth in ponderosa pine are provided by Forest Plan direction:

- 20 trees per acre at 18 inches dbh and at least 180 years old,
- 1 snag per acre at least 14 inches dbh and 25 feet tall,
- 2 down dead tree pieces 12 inches in diameter and 15 feet long,

- Basal area at least 90 square feet,
- Canopy cover at least 50 percent.

Old growth habitats play a crucial role for many wildlife species in ponderosa pine forests. The microhabitat diversity provided by the old trees, multi-storied canopies, and decadent trees/downed logs within old growth areas are rare across the landscape. As such, the Forest Plans direct for allocation and maintenance of at least 20 percent old growth forest within each Ecosystem Management Unit (EMU). For the purposes of the 4FRI project, the EMA most closely resembles the RU and old growth areas are allocated by RU (see table 38 in the silviculture specialist report). Since MSOs and to some extent northern goshawks are associated with old growth forests, it follows then that old growth is a subset of those habitats in the 4FRI project (see chapter 1, existing and desired conditions for more details). Forty (40) percent of the PIPO treatment area on the Coconino NF (128,994 acres) and 38 percent (65,810 acres) of the Kaibab NF are allocated for old growth. Current conditions in these areas most closely resemble old growth, but do not currently meet all the forest plan parameters of old growth. It is the intent of the 4FRI project to manage these areas according to old growth standards, moving them toward mature, diverse forest over time. Similar provisions were made for pinyon-juniper habitats.

## Bridge Habitat at the Mid-Scale

Bridge habitat for canopy-dependent wildlife would also occur at the mid-scale in the 4FRI project. It is expected that some densely-forested areas would be deferred simply due to the vagaries of implementation. The 4FRI 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. Those elements are described below.

**Desired conditions for bridge habitat.** During the implementation phase of the 4FRI project, treatment area specific prescriptions for mechanical thinning would be designed based on the desired conditions proposed in this environmental impact statement. The following subset of desired conditions helps ensure bridge habitat is maintained in the proposed project area (see chapter 1 purpose and need, for the full set of desired conditions):

- The desired condition is to restore tree density and pattern to the natural range of variability, while meeting forest plan requirements for Mexican spotted owl (hereafter referred to as MSO) protected and target/threshold habitat and goshawk nest areas.
- At the fine scale, the desired condition is a ponderosa pine ecosystem consisting of groups of trees that typically range in size from 0.1 acre to 1.0 acre in size. Tree group size exceeds 1-acre in size as needed to respond to site-specific conditions such as the presence of pre-settlement trees or mature, young trees that are developing old-tree characteristics.
- Tree groups in the mid-age and older VSS classes have canopies that provide moderate-to-closed conditions and connectivity for wildlife that are dependent on this type of habitat. These conditions are widely distributed on the landscape. At the landscape scale (extent of ponderosa pine vegetation), all canopy density conditions exist and provide for heterogeneity.
- Moderate-to-closed canopy conditions (and the connectivity between groups supporting these conditions) are met in a variety of ways: habitat for goshawk and MSO, steep slopes, buffers for several resources including bald eagle roosts, other raptor nests, caves,

and special designations that would not be treated (including wilderness and most research natural areas).

- There is a need to use management strategies that: (1) promote tree regeneration and understory vegetation, (2) move tree canopy density, tree group pattern and interspaces towards the historic range of variability, and (3) provide a mix of open, moderately-closed, and closed canopy conditions at the fine (group) to landscape (ponderosa pine vegetation) scale.
- There is a need to implement uneven-aged management strategies and manage for high-density, relatively uneven-aged stands in MSO restricted habitat, including target/threshold habitats to meet forest plan and MSO Recovery Plan requirements.

**Wildlife Design Features/Best Management Practices/Mitigation Measures.** These components of the project design provide safeguards for wildlife and other resources during the implementation phase. Those listed in Table 156 are those that best illustrate how stand-level design features would result in a well-distributed network of bridge habitat for wildlife across the larger landscape. For a more complete list of design features, BMPs, and mitigation, see appendix D of the DEIS, as well as the Silvicultural Design and Implementation Guide found in appendix E of the DEIS – attachment 1. See also table 36 of the wildlife specialists report. Silvicultural design features that contribute to bridge habitat are described in greater detail below.

**Old and Large Tree Implementation Plans:** In response to public input from several stakeholders that a design feature of the proposed action be no cutting of pre-settlement old-growth trees, the 4FRI project implements an Old Tree Implementation Plan. As such, old trees (approximately ≥ 150 years old) would be retained regardless of their diameter within the 4FRI project area. Exceptions would be made for threats to human health and safety and those rare circumstances where the removal of an old tree is necessary in order to prevent additional habitat degradation. Retention of old trees as individuals and groups will contribute significantly to bridge habitat, providing old growth structure for wildlife in the short term. Also in response to input from some stakeholders, alternative C includes a Large Tree Implementation Plan. The strategy identifies areas where large, post-settlement trees (≥16 inches dbh) would be retained and those exceptions where removal of large, young trees would be necessary to move toward ecological desired conditions. Exception categories include the WUI, and the following ecological sites where young tree encroachment is inhibiting ecological function: seeps and springs, riparian areas, wet meadows, grasslands, aspen forest and woodland, pine-oak forest, within-stand openings, and heavily-stocked stands (with a high basal area) generated by a preponderance of large, young trees. Elsewhere, those trees would be retained, adding to the stand-level provision of bridge habitat for canopy-dependent wildlife.

**Silvicultural Design and Implementation Guide:** Vertical and horizontal heterogeneity are important components of wildlife habitat in ponderosa pine forests. Restoring variability and diversity to forest structure and pattern is a central desired condition of the 4FRI project. The Silvicultural Design and Implementation Guide (hereafter ‘Implementation Guide’; appendix E of the DEIS – attachment 1) is intended to translate desired conditions, management direction, and design features into guidance for the District silviculturist responsible for writing site-specific prescriptions in the implementation phase. The intent is to balance the need for flexibility to adapt to on-the-ground realities, while ensuring adequate sideboards to minimize or avoid impacts to important resources. Below are some examples of how we would address maintenance of bridge habitat through the Implementation Guide.

**Implementation Guide - Mexican spotted owl habitat guidance:** Several features of the Implementation Guide treatment design for the Mexican spotted owl would serve as a proxy for other canopy-dependent wildlife. Design features for the owl are too numerous to list here, but those listed below serve to illustrate specifically how bridge habitat would be maintained at the mid-scale.

- Each PAC has a 100-acre, no mechanical treatment area around the known nest or roost sites.
- Each PAC to be thinned would have an upper diameter limit of trees that may be cut.
- Manage for 110 – 150 square feet of basal area (BA) in protected and target/threshold habitats, and 70-90 square feet BA in restricted other habitat.
- Individual trees and tree groups would occupy approximately 60-75 percent of the area within restricted other habitat.
- Treatments are designed to manage for old age trees to sustain as much old forest structure as possible across the landscape. Treatments would follow the Old Tree Implementation Strategy.
- No trees larger than 24-inch dbh would be cut.
- In restricted other habitat, tree groups on average would range in size from 0.1 – 1 acre with northerly aspects and highly productive microsites having larger average group sizes.
- In restricted other habitat, manage for tree groups with different age classes by retaining individual and clumps of vigorous ponderosa pine seedlings, saplings and poles within the larger mid-aged, mature or old tree groups.
- In restricted other habitat, interspace width between tree groups would average from 25 to 60 feet with a maximum width of 200 feet.
- Manage for large oaks and pine snags.

**Table 156. Design Features, BMPs, and Mitigation Measures Contributing to Bridge Habitat**

| Species/Resource | Description |
|---|---|
| Bald Eagle Nests | No mechanical treatments would occur within a 300-foot radius of bald eagle nest trees. |
| Bald Eagle Roosts | No mechanical treatments will occur around confirmed bald eagle roost sites (300' radius around roosts on the Coconino NF and a 10-chain radius on the Kaibab NF). |
| VSS 4s, 5s, & 6s | Within Group Density – Manage mid-aged tree groups for a range of density and structural characteristics by thinning approximately 50% of the mid-aged groups to the lower range of desired stocking conditions, approximately 20% each to the middle and upper range of desired stocking conditions and approximately 10% remain unthinned.<br><br>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 |
| Caves and Sinkholes | A 300-foot no mechanical treatment buffer unless mitigated by logical topographical breaks would be designated around cave entrances and sink-hole rims to protect cave ecosystems and reduce disturbance to bats. |
| 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 |
| Great Blue Herons | No dominant or co-dominant trees will be cut in rookeries. Nest trees will be prepped prior to prescribed burning. |
| Mexican Spotted Owls | Trees greater than 24" dbh would not be harvested. |
| Mixed Conifer | 4FRI activities will not include mechanical or fire treatments in the mixed conifer inclusions within the ponderosa pine forest (e.g., nest and roost buffers in Bear Seep and Red Raspberry PACs). Similarly, islands of ponderosa pine within mixed conifer forest will not be treated as part of this project. |
| Northern Leopard Frogs | A no-treatment buffer (no thinning, no direct ignition) ¼ mile distant from tanks in the vicinity of known northern leopard frog sites, or a buffer designated along logical topographic breaks. |
| Northern Leopard Frogs | A 200-ft protection zone (100' either side of streamcourse) will be established around designated stream courses for northern leopard frogs. There would be no thinning and no direct ignition of prescribed burning within the protection zones. Designated skid trail crossings through the buffer zones are allowed. |
| Raptor Nests | Forest Plan direction will be met for all raptor species: No mechanical treatment buffers would be designated around raptor nests. Sharp-shinned hawk nests = 10 acres, Cooper's hawk nests = 15 acres, osprey nests = 20 acres, other raptors = 50 acres. |
| Snags | Emphasize retention of snags ≥ 18" dbh. |
| Snags | Retain trees ≥ 18" dbh with dead tops, cavities, and lightning strikes wherever possible to provide cavity nesting/foraging habitat (i.e., the living dead) |

| Species/Resource | Description |
|---|---|
| Streamside management zones | On areas to be prescribed burned, establish filter strips (also known as streamside management zones). Applies to riparian and non-riparian streamcourses, and deferral widths range from 35 – 120 feet on each side of the streamcourse. |
| Turkeys | Retain 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. |
| Wildlife Cover | Gambel oak, juniper, and pinyon species may only be cut as necessary to facilitate logging operations (skid trails and landings) and by design as follows:<br>Within UEA, IT, SI, and WUI treatments, pinyon/juniper seedling/sapling and young/mid-aged trees may be cut within a 40' radius of individual or groups of old ponderosa pine (as defined in the old tree implementation strategy).<br>Within Savannah and WUI PJ mechanical treatment areas, pinyon/juniper seedling/sapling and young/mid-aged trees may be cut. |

**Implementation Guide - Northern goshawk habitat guidance:** Several features of the treatment design for the northern goshawk would serve as a proxy for other canopy-dependent wildlife. Design features are too numerous to list here, but a key few are highlighted to illustrate how bridge habitat would be maintained. Relevant design features from Table 156 are not repeated below.

- Treatments are designed to manage for old age trees, following the Old Tree Implementation Strategy.
- Treatments would strive to attain an overall stand average density ranging from 40 to 90 square feet of basal area and 15 to 40 percent of maximum stand density index (SDI). Density would vary within this range depending on treatment type, intensity, and existing stand structure.
- Tree group density would be managed to meet the canopy cover requirement of 40+ percent within mid-aged forest (VSS4), mature forest (VSS5), and old forest (VSS6) tree groups and to assure that 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 achieve overall stand average density targets, basal area (BA) and stand density index (SDI) within tree groups would often need to exceed the average target. Table 153 illustrates how this could work for BA (see Implementation Guide for greater detail). For example, a unit with a treatment intensity of 10-25, with an objective of 20% interspace and 80% treed, with 70% of treed area as groups and individuals and 10% as regeneration, and an overall target BA of 60 would require the tree groups to average 86 BA.
- Within group structure specific to mid-aged to old classes (VSS 4-6) includes open understories, interlocking tree crowns, abundant large limbs, and shade.
- Tree groups, on average, would range in size from 0.1 to 1 acre. Overall average group size would vary within this range depending on existing stand structure and pre-settlement tree evidence.
- Maximum interspace width of 200 feet.
- Maximum regeneration opening size of 4 acres or 200 feet wide.

- One group of reserve trees, three to five trees per group, would be left in created regeneration openings larger than 1 acre in size.
- Manage for large oaks.
- Within the proposed AGFD research areas, tree group size is dependent on experimental design and would range in size from 1 to 15 acres.

**Table 157. Excerpt from Section D of the 4FRI Implementation Guidelines**

| Treatment Intensity | % Of Area | | % Of Tree'd Area | | Avg. Group BA to Achieve Overall BA | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Interspace | Tree | Groups & Individuals | Regen. | 40 | 50 | 60 | 70 | 80 | 90 |
| 10-25 | **10** | **90** | 90 | 0 | | 56 | 67 | 78 | 89 | 100 |
| | | | 85 | 5 | | 59 | 71 | 82 | 94 | |
| | | | 80 | 10 | | 63 | 75 | 88 | 100 | |
| | | | 75 | 15 | | 67 | 80 | 93 | 107 | |
| | | | 70 | 20 | | 71 | 86 | 100 | 114 | |
| | **15** | **85** | 85 | 0 | | 59 | 71 | 82 | 94 | 106 |
| | | | 80 | 5 | | 63 | 75 | 88 | 100 | |
| | | | 75 | 10 | | 67 | 80 | 93 | 107 | |
| | | | 70 | 15 | | 71 | 86 | 100 | 114 | |
| | | | 65 | 20 | | 77 | 92 | 108 | 123 | |
| | **20** | **80** | 80 | 0 | | 63 | 75 | 88 | 100 | 113 |
| | | | 75 | 5 | | 67 | 80 | 93 | 107 | |
| | | | 70 | 10 | | 71 | 86 | 100 | 114 | |
| | | | 65 | 15 | | 77 | 92 | 108 | 123 | |
| | | | 60 | 20 | | 83 | 100 | 117 | 133 | |

In summary, bridge habitat would be managed for at the stand scale in 4 key ways: 1) desired conditions that strive to attain the full range of natural variability which would include areas for canopy-dependent wildlife, 2) design features/BMPs/mitigation measures that result in a well-distributed mosaic of small-scale deferrals in an otherwise mechanically-treated landscape, 3) implementation guidance for Mexican spotted owl habitat that retains higher forest density and stand-level canopy cover relative to the surrounding landscape, and 4) implementation guidance the northern goshawks that allows for higher density within tree groups given the contribution of interspaces and openings to overall stand averages.

## Conclusions about Bridge Habitat in the 4FRI Project

Closed-canopy, high-density forest conditions are currently common in the 4FRI project area. To achieve ecological objectives and modify landscape-scale fire behavior, 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 literature suggests that this was not the predominant condition. Nevertheless, it is the intent of the 4FRI project to provide bridge habitat for canopy-dependent wildlife to span the time between restoration treatments and achievement of desired conditions.

Potentially 13 percent of the landscape within the 4FRI project boundary would be deferred from treatment. Nearly 42 percent of the PIPO treatment area would remain in a moderately-closed to closed condition after treatment. Seventeen percent would remain in closed condition after treatment. Restoration Units near the Mogollon Rim would provide the greatest percentage of bridge habitat after treatment. Old growth allocations account for 38 percent of the PIPO treatment area and are well-distributed across the landscape. A patch-mosaic of small deferrals would be created in stands all across the 4FRI project area to provide safeguards for wildlife features such as nests and hiding cover. Implementation guidance in Mexican spotted owl 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. Monitoring would be an important test of this assumption, and adaptive management employed when outcomes prove otherwise.

## Literature Cited

Hampton, H.M., S.E. Sesnie, B.G. Dickson, J.M. Rundall, T.D Sisk, G.B. Snider, and J.D. Bailey. 2008. Analysis of Small-Diameter Wood Supply in Northern Arizona. Forest Ecosystem Restoration Analysis Project, Center for Environmental Sciences and Education, Northern Arizona University. 210pp.

# Appendix 4. Wildlife corridors for habitat connectivity.

Wildlife corridors were developed by the AGFD and include the pronghorn migration route from Garland Prairie to the west boundary of the treatment area, passing south of Bill Williams Mountain. Also see the Arizona Game and Fish Department 2011 report: The Coconino County Wildlife Connectivity Assessment: Report on Stakeholder Input (52 pages).

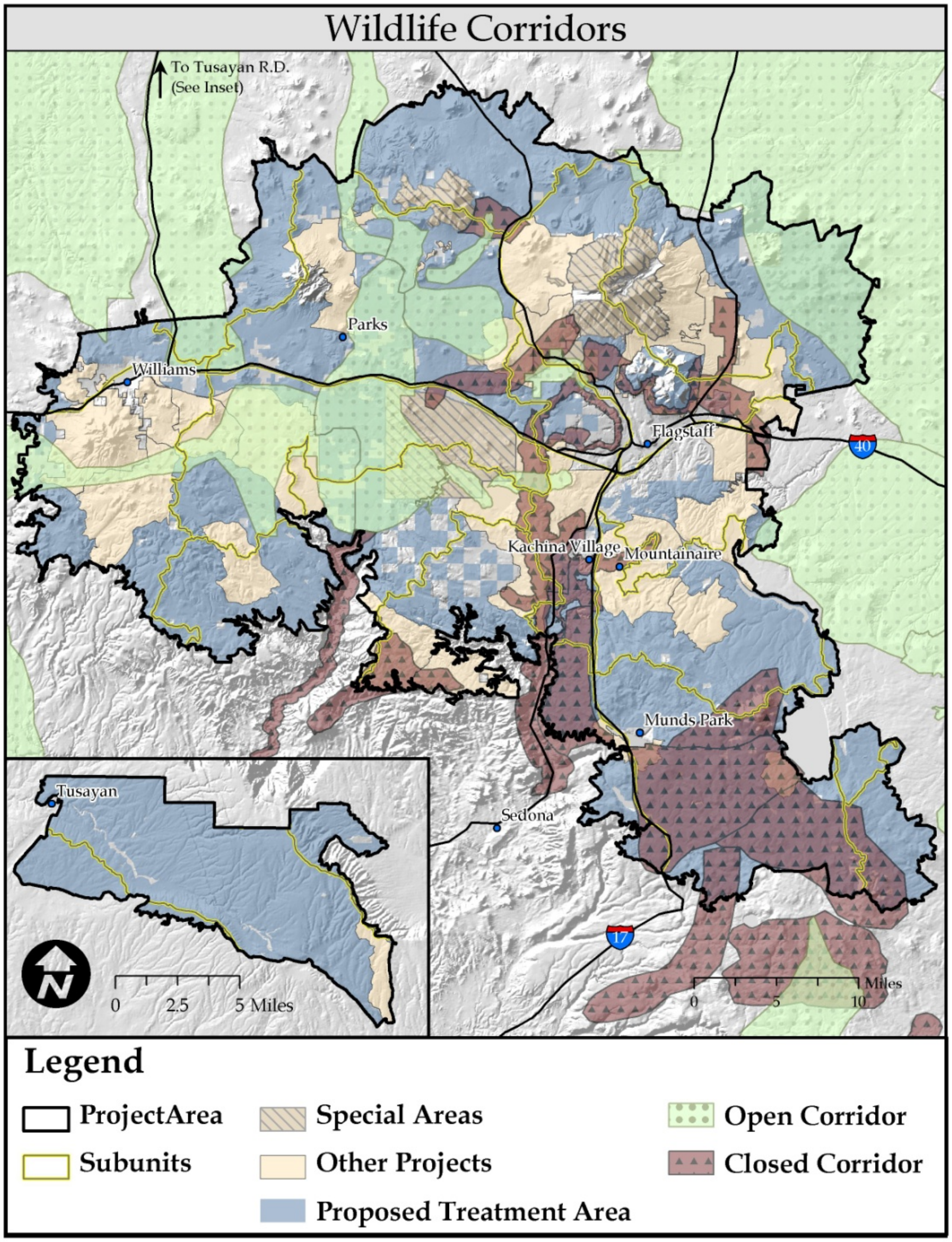


**Figure 85. Proposed Wildlife Habitat Wildlife Corridors for the 4 Forest Restoration Initiative**

# Appendix 5. Hiding and Thermal Cover Values by Subunit for All Alternatives

Table 158. Alternative A

| Alternative A | | 2010 Hiding/Thermal | | | | 2020 Hiding/Thermal | | | | 2050 Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subunit | Total Acres | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover |
| **Pine-Oak** | **112,546** | **52,678** | **59,196** | | **671** | **46,561** | **62,743** | **2,885** | **356** | **14,472** | **84,967** | **12,883** | **223** |
| **COF** | **85,482** | **37,664** | **47,329** | | **490** | **33,990** | **48,432** | **2,885** | **175** | **2,992** | **69,562** | **12,883** | **45** |
| 1 | 61,231 | 27,485 | 33,453 | | 293 | 24,133 | 35,060 | 1,907 | 130 | 2,496 | 48,479 | 10,256 | |
| 1-1 | 1,434 | 961 | 391 | | 82 | 776 | 635 | 24 | | 148 | 1,287 | | |
| 1-2 | 588 | 423 | 165 | | | 423 | 165 | | | | 588 | | |
| 1-3 | 15,957 | 7,056 | 8,901 | | | 5,698 | 9,978 | 281 | | 430 | 13,716 | 1,811 | |
| 1-4 | 3,598 | 1,601 | 1,996 | | 0 | 1,598 | 1,990 | 11 | | 58 | 2,753 | 787 | |
| 1-5 | 39,653 | 17,444 | 21,999 | | 210 | 15,638 | 22,292 | 1,591 | 130 | 1,859 | 30,135 | 7,658 | |
| 3 | 21,678 | 8,973 | 12,659 | | 46 | 8,709 | 12,126 | 798 | 45 | 204 | 19,583 | 1,847 | 45 |
| 3-3 | 3,493 | 1,294 | 2,153 | | 46 | 1,145 | 2,014 | 289 | 45 | 121 | 2,821 | 507 | 45 |
| 3-4 | 4,722 | 2,317 | 2,405 | | | 2,053 | 2,495 | 174 | | | 3,965 | 757 | |
| 3-5 | 13,463 | 5,362 | 8,101 | | | 5,510 | 7,617 | 335 | | 84 | 12,797 | 582 | |
| 4 | 547 | 257 | 290 | | | 149 | 367 | 31 | | | 439 | 108 | |
| 4-3 | 277 | 140 | 137 | | | 62 | 214 | | | | 200 | 77 | |

| Alternative A | | 2010 Hiding/Thermal | | | | 2020 Hiding/Thermal | | | | 2050 Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subunit | Total Acres | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover |
| 4-4 | 82 | 82 | | | | 51 | | 31 | | | 51 | 31 | |
| 4-5 | 188 | 36 | 153 | | | 36 | 153 | | | | 188 | | |
| 5 | 2,026 | 948 | 927 | | 151 | 999 | 880 | 148 | | 292 | 1,061 | 673 | |
| 5-1 | 1,166 | 653 | 513 | | | 593 | 425 | 148 | | 141 | 758 | 267 | |
| 5-2 | 861 | 295 | 414 | | 151 | 407 | 454 | | | 151 | 303 | 406 | |
| **KNF** | **27,063** | **15,015** | **11,868** | | **181** | **12,571** | **14,311** | | **181** | **11,480** | **15,405** | | **178** |
| 3 | 25,476 | 14,274 | 11,203 | | | 12,035 | 13,441 | | | 10,993 | 14,484 | | |
| 3-1 | 7,600 | 4,463 | 3,137 | | | 3,952 | 3,647 | | | 3,680 | 3,920 | | |
| 3-2 | 5,745 | 3,090 | 2,655 | | | 2,349 | 3,396 | | | 2,056 | 3,689 | | |
| 3-3 | 12,132 | 6,721 | 5,411 | | | 5,733 | 6,398 | | | 5,256 | 6,875 | | |
| 4 | 1,587 | 741 | 665 | | 181 | 536 | 870 | | 181 | 488 | 921 | | 178 |
| 4-3 | 116 | 116 | | | | | 116 | | | | 116 | | |
| 4-4 | 1,471 | 625 | 665 | | 181 | 536 | 754 | | 181 | 488 | 805 | | 178 |
| **Pine** | **399,633** | **147,677** | **129,961** | **27,098** | **94,897** | **150,633** | **176,271** | **53,441** | **19,288** | **41,141** | **201,327** | **152,364** | **4,801** |
| **COF** | **237,289** | **71,291** | **78,515** | **17,152** | **70,332** | **85,175** | **102,005** | **42,091** | **8,019** | **24,915** | **101,111** | **111,263** | |
| 1 | 84,562 | 31,820 | 30,685 | 5,818 | 16,240 | 35,069 | 37,639 | 8,002 | 3,852 | 8,199 | 43,390 | 32,974 | |
| 1-1 | 7,480 | 2,675 | 2,984 | 294 | 1,527 | 2,743 | 3,738 | 941 | 58 | 1,262 | 2,700 | 3,519 | |
| 1-2 | 5,928 | 2,091 | 1,528 | 424 | 1,885 | 2,327 | 2,926 | 448 | 227 | 396 | 3,023 | 2,509 | |
| 1-3 | 22,279 | 7,705 | 7,292 | 1,279 | 6,003 | 9,134 | 9,347 | 1,687 | 2,112 | 2,953 | 11,401 | 7,926 | |

| Alternative A | | 2010 Hiding/Thermal | | | | 2020 Hiding/Thermal | | | | 2050 Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subunit | Total Acres | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover |
| 1-4 | 13,687 | 7,229 | 3,479 | 266 | 2,712 | 7,816 | 5,004 | 444 | 424 | 981 | 7,970 | 4,736 | |
| 1-5 | 35,188 | 12,119 | 15,401 | 3,555 | 4,113 | 13,049 | 16,625 | 4,483 | 1,032 | 2,608 | 18,297 | 14,283 | |
| 3 | 36,649 | 11,793 | 19,341 | 1,967 | 3,548 | 12,544 | 19,970 | 2,881 | 1,253 | 2,829 | 22,190 | 11,630 | |
| 3-2 | 165 | 60 | 70 | 3 | 33 | 81 | 70 | 3 | 12 | 23 | 73 | 70 | |
| 3-3 | 11,559 | 3,603 | 6,345 | 324 | 1,286 | 3,840 | 6,429 | 840 | 450 | 622 | 7,694 | 3,243 | |
| 3-4 | 4,198 | 973 | 2,237 | 589 | 399 | 898 | 2,398 | 807 | 95 | 210 | 1,880 | 2,107 | |
| 3-5 | 20,727 | 7,157 | 10,689 | 1,051 | 1,830 | 7,726 | 11,073 | 1,232 | 697 | 1,974 | 12,542 | 6,211 | |
| 4 | 56,434 | 17,296 | 20,970 | 4,953 | 13,215 | 19,884 | 27,107 | 7,121 | 2,323 | 5,709 | 22,975 | 27,750 | |
| 4-3 | 24,954 | 5,707 | 9,452 | 1,904 | 7,891 | 7,358 | 12,310 | 3,498 | 1,788 | 3,138 | 7,395 | 14,421 | |
| 4-4 | 25,064 | 9,752 | 8,762 | 2,566 | 3,984 | 10,318 | 11,176 | 3,086 | 485 | 1,768 | 12,423 | 10,873 | |
| 4-5 | 6,417 | 1,837 | 2,755 | 483 | 1,341 | 2,208 | 3,622 | 537 | 50 | 803 | 3,158 | 2,457 | |
| 5 | 59,644 | 10,383 | 7,519 | 4,414 | 37,328 | 17,679 | 17,288 | 24,087 | 590 | 8,179 | 12,557 | 38,909 | |
| 5-1 | 19,449 | 5,046 | 4,418 | 1,309 | 8,677 | 9,339 | 6,413 | 3,375 | 322 | 5,262 | 5,924 | 8,263 | |
| 5-2 | 40,195 | 5,338 | 3,101 | 3,104 | 28,651 | 8,340 | 10,875 | 20,712 | 268 | 2,917 | 6,632 | 30,646 | |
| **KNF** | **162,344** | **76,386** | **51,447** | **9,946** | **24,565** | **65,458** | **74,267** | **11,350** | **11,269** | **16,226** | **100,216** | **41,101** | **4,801** |
| 3 | 45,422 | 14,529 | 17,113 | 5,215 | 8,565 | 11,620 | 23,293 | 6,129 | 4,380 | 2,343 | 23,920 | 17,441 | 1,718 |
| 3-1 | 11,205 | 4,506 | 4,268 | 1,034 | 1,397 | 3,640 | 5,544 | 1,113 | 907 | 1,153 | 6,403 | 3,271 | 378 |
| 3-2 | 16,975 | 2,737 | 7,129 | 2,816 | 4,293 | 2,157 | 9,300 | 3,523 | 1,994 | 606 | 6,844 | 8,994 | 530 |
| 3-3 | 17,242 | 7,287 | 5,716 | 1,366 | 2,874 | 5,822 | 8,449 | 1,492 | 1,479 | 584 | 10,672 | 5,176 | 811 |

| Alternative A | | 2010 Hiding/Thermal | | | | 2020 Hiding/Thermal | | | | 2050 Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subunit | Total Acres | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover |
| 4 | 75,733 | 29,026 | 28,647 | 4,731 | 13,329 | 22,420 | 41,203 | 5,221 | 6,889 | 3,776 | 45,934 | 22,940 | 3,083 |
| 4-2 | 7,381 | 2,836 | 1,759 | 833 | 1,953 | 1,871 | 3,404 | 1,222 | 884 | 319 | 4,275 | 2,587 | 201 |
| 4-3 | 29,965 | 14,327 | 9,047 | 1,375 | 5,217 | 11,432 | 14,252 | 1,201 | 3,080 | 1,491 | 20,146 | 6,731 | 1,598 |
| 4-4 | 38,386 | 11,862 | 17,841 | 2,523 | 6,160 | 9,116 | 23,546 | 2,799 | 2,925 | 1,966 | 21,514 | 13,622 | 1,284 |
| 6 | 41,188 | 32,831 | 5,687 | | 2,671 | 31,418 | 9,771 | | | 10,107 | 30,362 | 720 | |
| 6-2 | 5,069 | 4,198 | 539 | | 332 | 3,290 | 1,779 | | | 677 | 4,392 | 0 | |
| 6-3 | 32,635 | 25,844 | 4,526 | | 2,265 | 25,285 | 7,351 | | | 7,270 | 24,646 | 719 | |
| 6-4 | 3,484 | 2,789 | 622 | | 74 | 2,843 | 641 | | | 2,160 | 1,325 | | |
| **Total** | **512,178** | **200,355** | **189,158** | **27,098** | **95,568** | **197,194** | **239,015** | **56,325** | **19,644** | **55,614** | **286,294** | **165,247** | **5,024** |

**Table 159. Alternative B**

| Alternative B | | 2010 Hiding/Thermal | | | | 2020 Hiding/Thermal | | | | 2050 Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subunit | Total Acres | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover |
| **Pine-Oak** | **112,546** | **52,678** | **59,196** | | **671** | **40,466** | **57,679** | **4,220** | **10,181** | **13,824** | **73,292** | **15,311** | **10,119** |
| **COF** | **85,482** | **37,664** | **47,329** | | **490** | **28,468** | **46,237** | **4,220** | **6,557** | **6,226** | **57,447** | **15,311** | **6,498** |
| 1 | 61,231 | 27,485 | 33,453 | | 293 | 20,593 | 33,230 | 3,243 | 4,164 | 4,755 | 39,853 | 12,516 | 4,105 |
| 1-1 | 1,434 | 961 | 391 | | 82 | 874 | 358 | 24 | 179 | 126 | 1,130 | 0 | 179 |
| 1-2 | 588 | 423 | 165 | | | 329 | 171 | 0 | 88 | 92 | 408 | 0 | 88 |

| Alternative B | | 2010 Hiding/Thermal | | | | 2020 Hiding/Thermal | | | | 2050 Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subunit | Total Acres | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover |
| 1-3 | 15,957 | 7,056 | 8,901 | | | 4,622 | 9,699 | 466 | 1,170 | 869 | 11,791 | 2,127 | 1,170 |
| 1-4 | 3,598 | 1,601 | 1,996 | | 0 | 1,298 | 2,073 | 95 | 132 | 55 | 2,536 | 874 | 132 |
| 1-5 | 39,653 | 17,444 | 21,999 | | 210 | 13,470 | 20,929 | 2,658 | 2,595 | 3,613 | 23,988 | 9,516 | 2,536 |
| 3 | 21,678 | 8,973 | 12,659 | | 46 | 6,914 | 11,697 | 798 | 2,269 | 1,201 | 16,194 | 2,013 | 2,269 |
| 3-3 | 3,493 | 1,294 | 2,153 | | 46 | 726 | 2,243 | 289 | 235 | 159 | 2,446 | 654 | 235 |
| 3-4 | 4,722 | 2,317 | 2,405 | | | 1,510 | 2,671 | 174 | 367 | 143 | 3,455 | 757 | 367 |
| 3-5 | 13,463 | 5,362 | 8,101 | | | 4,677 | 6,783 | 335 | 1,667 | 899 | 10,294 | 603 | 1,667 |
| 4 | 547 | 257 | 290 | | | 187 | 300 | 31 | 28 | 0 | 410 | 108 | 28 |
| 4-3 | 277 | 140 | 137 | | | 62 | 214 | 0 | 0 | 0 | 200 | 77 | 0 |
| 4-4 | 82 | 82 | | | | 51 | 0 | 31 | 0 | 0 | 51 | 31 | 0 |
| 4-5 | 188 | 36 | 153 | | | 74 | 86 | 0 | 28 | 0 | 160 | 0 | 28 |
| 5 | 2,026 | 948 | 927 | | 151 | 774 | 1,010 | 148 | 95 | 270 | 989 | 673 | 95 |
| 5-1 | 1,166 | 653 | 513 | | | 528 | 456 | 148 | 35 | 141 | 723 | 267 | 35 |
| 5-2 | 861 | 295 | 414 | | 151 | 247 | 554 | 0 | 60 | 129 | 266 | 406 | 60 |
| **KNF** | **27,063** | **15,015** | **11,868** | | **181** | **11,998** | **11,442** | **0** | **3,624** | **7,597** | **15,845** | **0** | **3,621** |
| 3 | 25,476 | 14,274 | 11,203 | | | 11,468 | 10,769 | 0 | 3,239 | 7,203 | 15,035 | 0 | 3,239 |
| 3-1 | 7,600 | 4,463 | 3,137 | | | 3,495 | 3,015 | 0 | 1,090 | 2,356 | 4,154 | 0 | 1,090 |
| 3-2 | 5,745 | 3,090 | 2,655 | | | 2,266 | 2,778 | 0 | 700 | 1,239 | 3,806 | 0 | 700 |

| Alternative B | | 2010 Hiding/Thermal | | | | 2020 Hiding/Thermal | | | | 2050 Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subunit | Total Acres | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover |
| 3-3 | 12,132 | 6,721 | 5,411 | | | 5,707 | 4,976 | 0 | 1,449 | 3,608 | 7,075 | 0 | 1,449 |
| 4 | 1,587 | 741 | 665 | | 181 | 530 | 672 | 0 | 385 | 395 | 810 | 0 | 382 |
| 4-3 | 116 | 116 | | | | 74 | 29 | 0 | 13 | 0 | 103 | 0 | 13 |
| 4-4 | 1,471 | 625 | 665 | | 181 | 456 | 644 | 0 | 372 | 395 | 708 | 0 | 369 |
| **Pine** | **399,633** | **147,622** | **129,885** | **27,098** | **95,027** | **87,944** | **73,716** | **42,140** | **195,833** | **17,608** | **107,796** | **115,777** | **158,452** |
| **COF** | **237,289** | **71,291** | **78,515** | **17,152** | **70,332** | **37,572** | **48,084** | **37,249** | **114,384** | **1,624** | **49,771** | **86,479** | **99,415** |
| 1 | 84,562 | 31,820 | 30,685 | 5,818 | 16,240 | 8,710 | 13,153 | 13,877 | 48,822 | 1,173 | 13,020 | 28,711 | 41,657 |
| 1-1 | 7,480 | 2,675 | 2,984 | 294 | 1,527 | 1,258 | 951 | 1,204 | 4,067 | 236 | 1,614 | 2,826 | 2,803 |
| 1-2 | 5,928 | 2,091 | 1,528 | 424 | 1,885 | 317 | 853 | 386 | 4,373 | 70 | 728 | 1,329 | 3,801 |
| 1-3 | 22,279 | 7,705 | 7,292 | 1,279 | 6,003 | 2,058 | 1,281 | 3,189 | 15,751 | 494 | 2,333 | 5,980 | 13,472 |
| 1-4 | 13,687 | 7,229 | 3,479 | 266 | 2,712 | 1,294 | 2,597 | 1,460 | 8,336 | 112 | 2,765 | 3,873 | 6,937 |
| 1-5 | 35,188 | 12,119 | 15,401 | 3,555 | 4,113 | 3,784 | 7,470 | 7,639 | 16,295 | 262 | 5,580 | 14,703 | 14,644 |
| 3 | 36,649 | 11,793 | 19,341 | 1,967 | 3,548 | 4,996 | 8,866 | 5,296 | 17,491 | 90 | 8,231 | 13,447 | 14,880 |
| 3-2 | 165 | 60 | 70 | 3 | 33 | 10 | 78 | 5 | 73 | 0 | 52 | 40 | 73 |
| 3-3 | 11,559 | 3,603 | 6,345 | 324 | 1,286 | 1,160 | 1,725 | 1,965 | 6,708 | 2 | 2,162 | 3,819 | 5,576 |
| 3-4 | 4,198 | 973 | 2,237 | 589 | 399 | 196 | 669 | 1,057 | 2,276 | 15 | 285 | 1,860 | 2,037 |
| 3-5 | 20,727 | 7,157 | 10,689 | 1,051 | 1,830 | 3,630 | 6,394 | 2,269 | 8,434 | 73 | 5,731 | 7,728 | 7,194 |
| 4 | 56,434 | 17,296 | 20,970 | 4,953 | 13,215 | 8,016 | 12,022 | 7,660 | 28,736 | 330 | 11,163 | 20,277 | 24,665 |

| Alternative B | | 2010 Hiding/Thermal | | | | 2020 Hiding/Thermal | | | | 2050 Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subunit | Total Acres | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover |
| 4-3 | 24,954 | 5,707 | 9,452 | 1,904 | 7,891 | 4,261 | 4,976 | 2,766 | 12,952 | 126 | 5,389 | 8,698 | 10,741 |
| 4-4 | 25,064 | 9,752 | 8,762 | 2,566 | 3,984 | 2,400 | 5,057 | 4,090 | 13,517 | 204 | 3,986 | 9,059 | 11,816 |
| 4-5 | 6,417 | 1,837 | 2,755 | 483 | 1,341 | 1,355 | 1,989 | 804 | 2,268 | 0 | 1,788 | 2,520 | 2,109 |
| 5 | 59,644 | 10,383 | 7,519 | 4,414 | 37,328 | 15,850 | 14,043 | 10,416 | 19,334 | 32 | 17,357 | 24,043 | 18,212 |
| 5-1 | 19,449 | 5,046 | 4,418 | 1,309 | 8,677 | 8,347 | 4,266 | 2,844 | 3,992 | 7 | 8,934 | 7,187 | 3,321 |
| 5-2 | 40,195 | 5,338 | 3,101 | 3,104 | 28,651 | 7,503 | 9,777 | 7,572 | 15,342 | 25 | 8,422 | 16,856 | 14,892 |
| **KNF** | **162,344** | **76,331** | **51,371** | **9,946** | **24,696** | **50,372** | **25,631** | **4,891** | **81,449** | **15,984** | **58,025** | **29,299** | **59,037** |
| 3 | 45,422 | 14,474 | 17,037 | 5,215 | 8,696 | 7,489 | 6,432 | 2,277 | 29,224 | 4,657 | 6,425 | 9,849 | 24,490 |
| 3-1 | 11,205 | 4,506 | 4,268 | 1,034 | 1,397 | 2,970 | 1,586 | 557 | 6,092 | 1,939 | 2,224 | 2,327 | 4,715 |
| 3-2 | 16,975 | 2,682 | 7,054 | 2,816 | 4,424 | 2,009 | 2,126 | 1,014 | 11,826 | 1,207 | 1,827 | 4,375 | 9,565 |
| 3-3 | 17,242 | 7,287 | 5,716 | 1,366 | 2,874 | 2,511 | 2,720 | 706 | 11,305 | 1,511 | 2,374 | 3,148 | 10,209 |
| 4 | 75,733 | 29,026 | 28,647 | 4,731 | 13,329 | 13,317 | 13,484 | 2,559 | 46,374 | 5,709 | 20,631 | 18,768 | 30,625 |
| 4-2 | 7,381 | 2,836 | 1,759 | 833 | 1,953 | 1,563 | 583 | 238 | 4,997 | 860 | 1,422 | 1,332 | 3,767 |
| 4-3 | 29,965 | 14,327 | 9,047 | 1,375 | 5,217 | 6,780 | 6,237 | 764 | 16,185 | 1,973 | 12,970 | 6,337 | 8,685 |
| 4-4 | 38,386 | 11,862 | 17,841 | 2,523 | 6,160 | 4,974 | 6,663 | 1,557 | 25,192 | 2,876 | 6,238 | 11,100 | 18,172 |
| 6 | 41,188 | 32,831 | 5,687 | | 2,671 | 29,566 | 5,716 | 55 | 5,851 | 5,617 | 30,969 | 681 | 3,922 |
| 6-2 | 5,069 | 4,198 | 539 | | 332 | 4,338 | 151 | 0 | 580 | 578 | 4,049 | 0 | 442 |
| 6-3 | 32,635 | 25,844 | 4,526 | | 2,265 | 22,640 | 5,374 | 55 | 4,566 | 4,986 | 23,546 | 681 | 3,422 |

| Alternative B | | 2010 Hiding/Thermal | | | | 2020 Hiding/Thermal | | | | 2050 Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subunit | Total Acres | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover |
| 6-4 | 3,484 | 2,789 | 622 | | 74 | 2,588 | 191 | 0 | 705 | 53 | 3,373 | 0 | 58 |
| **Grand Total** | **512,178** | **200,300** | **189,082** | **27,098** | **95,698** | **128,410** | **131,394** | **46,361** | **206,013** | **31,432** | **181,088** | **131,088** | **168,571** |

**Table 160. Alternative C**

| Alternative C | | 2010 Hiding/Thermal | | | | 2020 Hiding/Thermal | | | | 2050 Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subunit | Total Acres | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover |
| **Pine-Oak** | **112,546** | **52,678** | **59,196** | | **671** | **42,641** | **55,314** | **4,685** | **9,906** | **16,731** | **70,038** | **15,932** | **9,844** |
| **COF** | **85,482** | **37,664** | **47,329** | | **490** | **30,606** | **43,794** | **4,685** | **6,397** | **8,067** | **55,145** | **15,932** | **6,338** |
| 1 | 61,231 | 27,485 | 33,453 | | 293 | 22,312 | 31,137 | 3,708 | 4,074 | 6,173 | 37,959 | 13,084 | 4,015 |
| 1-1 | 1,434 | 961 | 391 | | 82 | 874 | 358 | 24 | 179 | 126 | 1,130 | 0 | 179 |
| 1-2 | 588 | 423 | 165 | | | 329 | 171 | 0 | 88 | 92 | 408 | 0 | 88 |
| 1-3 | 15,957 | 7,056 | 8,901 | | | 5,142 | 9,079 | 655 | 1,081 | 1,469 | 11,124 | 2,283 | 1,081 |
| 1-4 | 3,598 | 1,601 | 1,996 | | 0 | 1,298 | 2,073 | 95 | 132 | 55 | 2,536 | 874 | 132 |
| 1-5 | 39,653 | 17,444 | 21,999 | | 210 | 14,669 | 19,456 | 2,934 | 2,594 | 4,431 | 22,760 | 9,927 | 2,535 |
| 3 | 21,678 | 8,973 | 12,659 | | 46 | 7,333 | 11,347 | 798 | 2,199 | 1,625 | 15,787 | 2,067 | 2,199 |
| 3-3 | 3,493 | 1,294 | 2,153 | | 46 | 888 | 2,081 | 289 | 235 | 332 | 2,219 | 707 | 235 |
| 3-4 | 4,722 | 2,317 | 2,405 | | | 1,726 | 2,455 | 174 | 367 | 360 | 3,238 | 757 | 367 |

| Alternative C | | 2010 Hiding/Thermal | | | | 2020 Hiding/Thermal | | | | 2050 Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subunit | Total Acres | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover |
| 3-5 | 13,463 | 5,362 | 8,101 | | | 4,719 | 6,811 | 335 | 1,597 | 933 | 10,330 | 603 | 1,597 |
| 4 | 547 | 257 | 290 | | | 187 | 300 | 31 | 28 | 0 | 410 | 108 | 28 |
| 4-3 | 277 | 140 | 137 | | | 62 | 214 | 0 | 0 | 0 | 200 | 77 | 0 |
| 4-4 | 82 | 82 | | | | 51 | 0 | 31 | 0 | 0 | 51 | 31 | 0 |
| 4-5 | 188 | 36 | 153 | | | 74 | 86 | 0 | 28 | 0 | 160 | 0 | 28 |
| 5 | 2,026 | 948 | 927 | | 151 | 774 | 1,010 | 148 | 95 | 270 | 989 | 673 | 95 |
| 5-1 | 1,166 | 653 | 513 | | | 528 | 456 | 148 | 35 | 141 | 723 | 267 | 35 |
| 5-2 | 861 | 295 | 414 | | 151 | 247 | 554 | 0 | 60 | 129 | 266 | 406 | 60 |
| **KNF** | **27,063** | **15,015** | **11,868** | | **181** | **12,035** | **11,520** | **0** | **3,509** | **8,664** | **14,893** | **0** | **3,506** |
| 3 | 25,476 | 14,274 | 11,203 | | | 11,505 | 10,847 | 0 | 3,124 | 8,270 | 14,083 | 0 | 3,124 |
| 3-1 | 7,600 | 4,463 | 3,137 | | | 3,495 | 3,015 | 0 | 1,090 | 2,356 | 4,154 | 0 | 1,090 |
| 3-2 | 5,745 | 3,090 | 2,655 | | | 2,305 | 2,810 | 0 | 630 | 1,674 | 3,441 | 0 | 630 |
| 3-3 | 12,132 | 6,721 | 5,411 | | | 5,706 | 5,023 | 0 | 1,404 | 4,240 | 6,489 | 0 | 1,404 |
| 4 | 1,587 | 741 | 665 | | 181 | 530 | 672 | 0 | 385 | 395 | 810 | 0 | 382 |
| 4-3 | 116 | 116 | | | | 74 | 29 | 0 | 13 | 0 | 103 | 0 | 13 |
| 4-4 | 1,471 | 625 | 665 | | 181 | 456 | 644 | 0 | 372 | 395 | 708 | 0 | 369 |
| **Pine** | **399,633** | **147,677** | **129,961** | **27,098** | **94,897** | **77,063** | **76,521** | **42,216** | **203,833** | **6,775** | **109,473** | **116,688** | **166,696** |
| **COF** | **237,289** | **71,291** | **78,515** | **17,152** | **70,332** | **36,188** | **50,409** | **37,399** | **113,292** | **0** | **51,022** | **87,137** | **99,131** |
| 1 | 84,562 | 31,820 | 30,685 | 5,818 | 16,240 | 7,537 | 13,203 | 13,858 | 49,964 | 0 | 13,025 | 28,736 | 42,801 |

| Alternative C | | 2010 Hiding/Thermal | | | | 2020 Hiding/Thermal | | | | 2050 Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subunit | Total Acres | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover |
| 1-1 | 7,480 | 2,675 | 2,984 | 294 | 1,527 | 1,022 | 951 | 1,204 | 4,303 | 0 | 1,614 | 2,826 | 3,039 |
| 1-2 | 5,928 | 2,091 | 1,528 | 424 | 1,885 | 246 | 853 | 386 | 4,443 | 0 | 728 | 1,329 | 3,871 |
| 1-3 | 22,279 | 7,705 | 7,292 | 1,279 | 6,003 | 1,564 | 1,332 | 3,170 | 16,214 | 0 | 2,338 | 6,005 | 13,937 |
| 1-4 | 13,687 | 7,229 | 3,479 | 266 | 2,712 | 1,182 | 2,597 | 1,460 | 8,448 | 0 | 2,765 | 3,873 | 7,049 |
| 1-5 | 35,188 | 12,119 | 15,401 | 3,555 | 4,113 | 3,522 | 7,470 | 7,639 | 16,557 | 0 | 5,580 | 14,703 | 14,905 |
| 3 | 36,649 | 11,793 | 19,341 | 1,967 | 3,548 | 4,923 | 10,012 | 5,179 | 16,535 | 0 | 8,636 | 13,783 | 14,230 |
| 3-2 | 165 | 60 | 70 | 3 | 33 | 10 | 78 | 5 | 73 | 0 | 52 | 40 | 73 |
| 3-3 | 11,559 | 3,603 | 6,345 | 324 | 1,286 | 1,158 | 2,188 | 1,906 | 6,307 | 0 | 2,507 | 3,812 | 5,240 |
| 3-4 | 4,198 | 973 | 2,237 | 589 | 399 | 181 | 669 | 1,057 | 2,290 | 0 | 285 | 1,860 | 2,052 |
| 3-5 | 20,727 | 7,157 | 10,689 | 1,051 | 1,830 | 3,574 | 7,077 | 2,211 | 7,865 | 0 | 5,792 | 8,070 | 6,865 |
| 4 | 56,434 | 17,296 | 20,970 | 4,953 | 13,215 | 7,910 | 13,151 | 7,946 | 27,428 | 0 | 12,004 | 20,575 | 23,855 |
| 4-3 | 24,954 | 5,707 | 9,452 | 1,904 | 7,891 | 4,223 | 5,351 | 2,839 | 12,541 | 0 | 5,668 | 8,774 | 10,512 |
| 4-4 | 25,064 | 9,752 | 8,762 | 2,566 | 3,984 | 2,332 | 5,810 | 4,303 | 12,619 | 0 | 4,548 | 9,282 | 11,234 |
| 4-5 | 6,417 | 1,837 | 2,755 | 483 | 1,341 | 1,355 | 1,989 | 804 | 2,268 | 0 | 1,788 | 2,520 | 2,109 |
| 5 | 59,644 | 10,383 | 7,519 | 4,414 | 37,328 | 15,818 | 14,043 | 10,416 | 19,366 | 0 | 17,357 | 24,043 | 18,244 |
| 5-1 | 19,449 | 5,046 | 4,418 | 1,309 | 8,677 | 8,340 | 4,266 | 2,844 | 3,999 | 0 | 8,934 | 7,187 | 3,328 |
| 5-2 | 40,195 | 5,338 | 3,101 | 3,104 | 28,651 | 7,478 | 9,777 | 7,572 | 15,367 | 0 | 8,422 | 16,856 | 14,916 |
| **KNF** | **162,344** | **76,386** | **51,447** | **9,946** | **24,565** | **40,874** | **26,112** | **4,817** | **90,540** | **6,775** | **58,451** | **29,551** | **67,566** |
| 3 | 45,422 | 14,529 | 17,113 | 5,215 | 8,565 | 3,553 | 6,565 | 2,234 | 33,071 | 747 | 6,719 | 9,841 | 28,116 |

| Alternative C | | 2010 Hiding/Thermal | | | | 2020 Hiding/Thermal | | | | 2050 Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subunit | Total Acres | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover |
| 3-1 | 11,205 | 4,506 | 4,268 | 1,034 | 1,397 | 1,516 | 1,586 | 557 | 7,546 | 379 | 2,224 | 2,327 | 6,275 |
| 3-2 | 16,975 | 2,737 | 7,129 | 2,816 | 4,293 | 1,075 | 2,211 | 1,001 | 12,687 | 176 | 2,012 | 4,356 | 10,431 |
| 3-3 | 17,242 | 7,287 | 5,716 | 1,366 | 2,874 | 962 | 2,768 | 675 | 12,838 | 192 | 2,483 | 3,158 | 11,409 |
| 4 | 75,733 | 29,026 | 28,647 | 4,731 | 13,329 | 9,223 | 13,831 | 2,528 | 50,150 | 1,470 | 20,764 | 19,030 | 34,470 |
| 4-2 | 7,381 | 2,836 | 1,759 | 833 | 1,953 | 893 | 583 | 238 | 5,667 | 132 | 1,422 | 1,332 | 4,496 |
| 4-3 | 29,965 | 14,327 | 9,047 | 1,375 | 5,217 | 5,483 | 6,237 | 764 | 17,481 | 708 | 12,970 | 6,337 | 9,950 |
| 4-4 | 38,386 | 11,862 | 17,841 | 2,523 | 6,160 | 2,846 | 7,011 | 1,527 | 27,002 | 630 | 6,371 | 11,361 | 20,024 |
| 6 | 41,188 | 32,831 | 5,687 | | 2,671 | 28,098 | 5,716 | 55 | 7,319 | 4,559 | 30,969 | 681 | 4,980 |
| 6-2 | 5,069 | 4,198 | 539 | | 332 | 4,086 | 151 | 0 | 832 | 457 | 4,049 | 0 | 563 |
| 6-3 | 32,635 | 25,844 | 4,526 | | 2,265 | 21,462 | 5,374 | 55 | 5,744 | 4,084 | 23,546 | 681 | 4,324 |
| 6-4 | 3,484 | 2,789 | 622 | | 74 | 2,550 | 191 | 0 | 743 | 18 | 3,373 | 0 | 93 |
| **Grand Total** | **512,178** | **200,355** | **189,158** | **27,098** | **95,568** | **119,704** | **131,835** | **46,901** | **213,739** | **23,506** | **179,511** | **132,620** | **176,541** |

**Table 161. Alternative D**

| Alternative D | | 2010 Hiding/Thermal | | | | 2020 Hiding/Thermal | | | | 2050 Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subunit | Total Acres | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover |
| **Pine-Oak** | **112,546** | **52,678** | **59,196** | | **671** | **38,144** | **60,164** | **4,024** | **10,213** | **16,841** | **70,437** | **15,234** | **10,033** |

| Alternative D | | 2010 Hiding/Thermal | | | | 2020 Hiding/Thermal | | | | 2050 Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subunit | Total Acres | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover |
| **COF** | **85,482** | **37,664** | **47,329** | | **490** | **27,186** | **47,683** | **4,024** | **6,589** | **7,470** | **56,366** | **15,234** | **6,412** |
| 1 | 61,231 | 27,485 | 33,453 | | 293 | 19,944 | 34,043 | 3,047 | 4,197 | 5,530 | 39,242 | 12,439 | 4,020 |
| 1-1 | 1,434 | 961 | 391 | | 82 | 615 | 616 | 24 | 179 | 186 | 1,069 | 0 | 179 |
| 1-2 | 588 | 423 | 165 | | | 360 | 141 | 0 | 88 | 92 | 408 | 0 | 88 |
| 1-3 | 15,957 | 7,056 | 8,901 | | | 4,564 | 9,757 | 466 | 1,170 | 1,180 | 11,480 | 2,127 | 1,170 |
| 1-4 | 3,598 | 1,601 | 1,996 | | 0 | 1,399 | 2,035 | 32 | 132 | 163 | 2,429 | 874 | 132 |
| 1-5 | 39,653 | 17,444 | 21,999 | | 210 | 13,006 | 21,495 | 2,525 | 2,627 | 3,908 | 23,856 | 9,439 | 2,450 |
| 3 | 21,678 | 8,973 | 12,659 | | 46 | 6,258 | 12,353 | 798 | 2,269 | 1,587 | 15,808 | 2,013 | 2,269 |
| 3-3 | 3,493 | 1,294 | 2,153 | | 46 | 752 | 2,216 | 289 | 235 | 159 | 2,446 | 654 | 235 |
| 3-4 | 4,722 | 2,317 | 2,405 | | | 1,763 | 2,418 | 174 | 367 | 252 | 3,346 | 757 | 367 |
| 3-5 | 13,463 | 5,362 | 8,101 | | | 3,742 | 7,719 | 335 | 1,667 | 1,177 | 10,016 | 603 | 1,667 |
| 4 | 547 | 257 | 290 | | | 129 | 359 | 31 | 28 | 15 | 396 | 108 | 28 |
| 4-3 | 277 | 140 | 137 | | | 62 | 214 | 0 | 0 | 0 | 200 | 77 | 0 |
| 4-4 | 82 | 82 | | | | 51 | 0 | 31 | 0 | 0 | 51 | 31 | 0 |
| 4-5 | 188 | 36 | 153 | | | 16 | 145 | 0 | 28 | 15 | 145 | 0 | 28 |
| 5 | 2,026 | 948 | 927 | | 151 | 856 | 928 | 148 | 95 | 338 | 920 | 673 | 95 |
| 5-1 | 1,166 | 653 | 513 | | | 502 | 481 | 148 | 35 | 210 | 654 | 267 | 35 |
| 5-2 | 861 | 295 | 414 | | 151 | 354 | 447 | 0 | 60 | 129 | 266 | 406 | 60 |

| Alternative D | | 2010 Hiding/Thermal | | | | 2020 Hiding/Thermal | | | | 2050 Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subunit | Total Acres | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover |
| **KNF** | **27,063** | **15,015** | **11,868** | | **181** | **10,958** | **12,481** | **0** | **3,624** | **9,371** | **14,072** | **0** | **3,621** |
| 3 | 25,476 | 14,274 | 11,203 | | | 10,503 | 11,735 | 0 | 3,239 | 8,956 | 13,282 | 0 | 3,239 |
| 3-1 | 7,600 | 4,463 | 3,137 | | | 3,386 | 3,124 | 0 | 1,090 | 3,152 | 3,358 | 0 | 1,090 |
| 3-2 | 5,745 | 3,090 | 2,655 | | | 2,051 | 2,994 | 0 | 700 | 1,636 | 3,409 | 0 | 700 |
| 3-3 | 12,132 | 6,721 | 5,411 | | | 5,066 | 5,617 | 0 | 1,449 | 4,168 | 6,516 | 0 | 1,449 |
| 4 | 1,587 | 741 | 665 | | 181 | 456 | 746 | 0 | 385 | 415 | 790 | 0 | 382 |
| 4-3 | 116 | 116 | | | | 0 | 103 | 0 | 13 | 0 | 103 | 0 | 13 |
| 4-4 | 1,471 | 625 | 665 | | 181 | 456 | 644 | 0 | 372 | 415 | 687 | 0 | 369 |
| **Pine** | **399,633** | **147,622** | **129,885** | **27,098** | **95,027** | **109,689** | **84,746** | **39,174** | **166,023** | **41,329** | **106,210** | **105,651** | **146,442** |
| **COF** | **237,289** | **71,291** | **78,515** | **17,152** | **70,332** | **51,868** | **53,374** | **33,642** | **98,405** | **15,833** | **48,063** | **81,561** | **91,833** |
| 1 | 84,562 | 31,820 | 30,685 | 5,818 | 16,240 | 17,531 | 15,720 | 11,254 | 40,058 | 10,158 | 13,040 | 25,182 | 36,183 |
| 1-1 | 7,480 | 2,675 | 2,984 | 294 | 1,527 | 1,973 | 1,116 | 1,364 | 3,027 | 1,233 | 1,041 | 2,787 | 2,419 |
| 1-2 | 5,928 | 2,091 | 1,528 | 424 | 1,885 | 1,135 | 775 | 376 | 3,642 | 543 | 892 | 1,096 | 3,399 |
| 1-3 | 22,279 | 7,705 | 7,292 | 1,279 | 6,003 | 3,963 | 1,672 | 3,135 | 13,509 | 3,212 | 2,082 | 5,115 | 11,870 |
| 1-4 | 13,687 | 7,229 | 3,479 | 266 | 2,712 | 3,660 | 3,114 | 556 | 6,356 | 2,127 | 3,552 | 2,641 | 5,367 |
| 1-5 | 35,188 | 12,119 | 15,401 | 3,555 | 4,113 | 6,800 | 9,042 | 5,822 | 13,524 | 3,043 | 5,473 | 13,544 | 13,128 |
| 3 | 36,649 | 11,793 | 19,341 | 1,967 | 3,548 | 6,654 | 9,246 | 5,780 | 14,968 | 1,946 | 7,991 | 12,536 | 14,177 |
| 3-2 | 165 | 60 | 70 | 3 | 33 | 10 | 80 | 3 | 73 | 10 | 42 | 40 | 73 |

| Alternative D | | 2010 Hiding/Thermal | | | | 2020 Hiding/Thermal | | | | 2050 Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subunit | Total Acres | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover | Hiding Only | Hiding/ Thermal | Thermal Only | Not Cover |
| 3-3 | 11,559 | 3,603 | 6,345 | 324 | 1,286 | 1,827 | 1,629 | 2,457 | 5,646 | 254 | 2,065 | 3,819 | 5,422 |
| 3-4 | 4,198 | 973 | 2,237 | 589 | 399 | 349 | 836 | 1,000 | 2,013 | 276 | 349 | 1,690 | 1,883 |
| 3-5 | 20,727 | 7,157 | 10,689 | 1,051 | 1,830 | 4,468 | 6,702 | 2,321 | 7,237 | 1,406 | 5,535 | 6,987 | 6,799 |
| 4 | 56,434 | 17,296 | 20,970 | 4,953 | 13,215 | 10,906 | 13,092 | 7,332 | 25,104 | 3,132 | 10,133 | 19,825 | 23,345 |
| 4-3 | 24,954 | 5,707 | 9,452 | 1,904 | 7,891 | 5,241 | 5,311 | 3,165 | 11,236 | 1,173 | 4,966 | 8,582 | 10,233 |
| 4-4 | 25,064 | 9,752 | 8,762 | 2,566 | 3,984 | 3,972 | 5,967 | 3,360 | 11,765 | 1,707 | 3,508 | 8,739 | 11,109 |
| 4-5 | 6,417 | 1,837 | 2,755 | 483 | 1,341 | 1,692 | 1,815 | 807 | 2,103 | 252 | 1,658 | 2,504 | 2,003 |
| 5 | 59,644 | 10,383 | 7,519 | 4,414 | 37,328 | 16,777 | 15,316 | 9,276 | 18,275 | 597 | 16,900 | 24,018 | 18,129 |
| 5-1 | 19,449 | 5,046 | 4,418 | 1,309 | 8,677 | 8,755 | 5,368 | 2,009 | 3,317 | 464 | 8,503 | 7,187 | 3,295 |
| 5-2 | 40,195 | 5,338 | 3,101 | 3,104 | 28,651 | 8,022 | 9,948 | 7,267 | 14,957 | 133 | 8,397 | 16,831 | 14,834 |
| **KNF** | **162,344** | **76,331** | **51,371** | **9,946** | **24,696** | **57,820** | **31,372** | **5,533** | **67,618** | **25,496** | **58,147** | **24,091** | **54,610** |
| 3 | 45,422 | 14,474 | 17,037 | 5,215 | 8,696 | 9,348 | 8,906 | 2,712 | 24,456 | 7,698 | 7,134 | 8,052 | 22,539 |
| 3-1 | 11,205 | 4,506 | 4,268 | 1,034 | 1,397 | 3,403 | 2,397 | 610 | 4,795 | 2,759 | 2,323 | 1,850 | 4,273 |
| 3-2 | 16,975 | 2,682 | 7,054 | 2,816 | 4,424 | 2,393 | 3,608 | 1,375 | 9,600 | 1,901 | 2,101 | 3,857 | 9,117 |
| 3-3 | 17,242 | 7,287 | 5,716 | 1,366 | 2,874 | 3,552 | 2,901 | 728 | 10,062 | 3,038 | 2,710 | 2,345 | 9,149 |
| 4 | 75,733 | 29,026 | 28,647 | 4,731 | 13,329 | 17,672 | 17,930 | 2,820 | 37,311 | 9,539 | 22,208 | 15,427 | 28,559 |
| 4-2 | 7,381 | 2,836 | 1,759 | 833 | 1,953 | 1,857 | 1,173 | 263 | 4,088 | 1,369 | 1,462 | 1,074 | 3,477 |
| 4-3 | 29,965 | 14,327 | 9,047 | 1,375 | 5,217 | 8,730 | 6,795 | 789 | 13,652 | 3,254 | 13,512 | 5,084 | 8,116 |

| Alternative D | | 2010 Hiding/Thermal | | | | 2020 Hiding/Thermal | | | | 2050 Hiding/Thermal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Subunit** | **Total Acres** | **Hiding Only** | **Hiding/ Thermal** | **Thermal Only** | **Not Cover** | **Hiding Only** | **Hiding/ Thermal** | **Thermal Only** | **Not Cover** | **Hiding Only** | **Hiding/ Thermal** | **Thermal Only** | **Not Cover** |
| 4-4 | 38,386 | 11,862 | 17,841 | 2,523 | 6,160 | 7,085 | 9,962 | 1,768 | 19,571 | 4,916 | 7,234 | 9,270 | 16,966 |
| 6 | 41,188 | 32,831 | 5,687 | | 2,671 | 30,801 | 4,537 | 0 | 5,851 | 8,259 | 28,806 | 612 | 3,512 |
| 6-2 | 5,069 | 4,198 | 539 | | 332 | 4,221 | 267 | 0 | 580 | 764 | 3,994 | 0 | 311 |
| 6-3 | 32,635 | 25,844 | 4,526 | | 2,265 | 23,960 | 4,109 | 0 | 4,566 | 7,291 | 21,586 | 612 | 3,146 |
| 6-4 | 3,484 | 2,789 | 622 | | 74 | 2,619 | 161 | 0 | 705 | 204 | 3,226 | 0 | 55 |
| **Grand Total** | **512,178** | **200,300** | **189,082** | **27,098** | **95,698** | **147,833** | **144,911** | **43,198** | **176,236** | **58,170** | **176,648** | **120,885** | **156,476** |

# Appendix 6. Status of Game Species and Their Potential Response to Treatments Within the Four Forest Restoration Initiative

The Arizona Game and Fish Department offered to participate in the planning related developing mechanical and prescribed burning treatments for the Four Forest Restoration Initiative. Their participation included updating population trends for game species that serve as Management Indicator Species on the Coconino and Kaibab National Forests. Summaries on species biology, ecology, and population trends were created by Sara Reif, Region 2 Habitat Program Manager, Arizona Game and Fish Department 2012.

## Tassel-eared squirrels

Tassel-eared squirrels (*Sciurus aberti*) are an indicator of early seral ponderosa pine habitat in both the Coconino and Kaibab Forest Plans. Preferred habitat structure is composed of intermediate to older aged forest (trees 9-22+ inches dbh; Dodd et al. 1998, Elson 1999). The tassel-eared squirrel is considered a ponderosa pine "obligate" species. It relies on ponderosa pine and associated hypogenous fungi (Keith 1965, Stephenson 1975, States et al. 1988, Austin 1990, Snyder 1992) for most of its diet, and its nests are placed almost exclusively in these pines (Halloran and Bekoff 1994, Snyder and Linhart 1994), which also provide escape cover from predators and movement corridors created by interlocking tree canopies (Stephenson and Brown 1980). Additional information on tassel-eared squirrels is available in the Forestwide MIS Status Reports for both the Coconino NF (USFS 2002) and the Kaibab NF (USFS 2010).

### Population Trend

Population estimates have not been directly measured for tassel-eared squirrel on the Coconino or Kaibab NF. Global heritage rating is G5, indicating populations are demonstrably secure, although they may be rare in part of its range. Heritage rating in Arizona is S5, indicating a secure population in the state (NatureServe 2002). AGFD data of statewide tree squirrel harvest indicate inherently variable but stable trends in hunter harvest from 1995 – 2004, and from 2004 – 2009 (AGFD 2011; Figure 86).Harvest rates between the two time periods are not directly comparable because different methodologies were used. Harvest rates do not include junior harvest and therefore likely underestimate annual harvest of tree squirrels. However, these data are compiled for all species of tree squirrels not just tassel-eared squirrels, and indicate the popularity of hunting squirrels rather than an index of density. AGFD biologists also postulate that since tassel-eared squirrels favor forests with tree densities, BA, and canopy cover less-frequently documented in the historic range of variability, current numbers are likely inflated compared to what might have been expected prior to European settlement (personal communication, S. Reif). However, squirrel density information from the 1800s is not available.

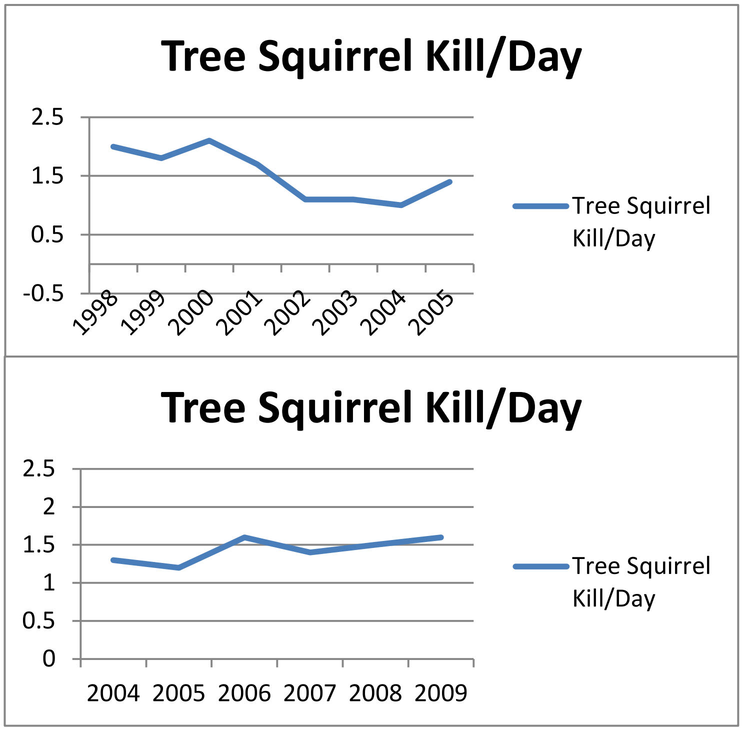


**Figure 86. Tree squirrel harvest per day in Arizona from 1998 – 2004, and from 2004 – 2009. Note: harvest rates between the two time periods are not directly comparable because different survey methodologies were used beginning in 2004 (though both methodologies were conducted simultaneously 2004-2005). Harvest rates do not include junior harvest and therefore likely underestimate annual harvest of tree squirrels.**

Additional population trend information is available for the Coconino NF, where AGFD feeding sign surveys were conducted from 2005 - 2010 in association with Forest Service vegetation management projects in the Flagstaff wildland-urban interface (Yarborough et al. 2010). Feeding sign survey results indicate a stable trend in tassel-eared squirrel abundance on the Forest (Figure 87).

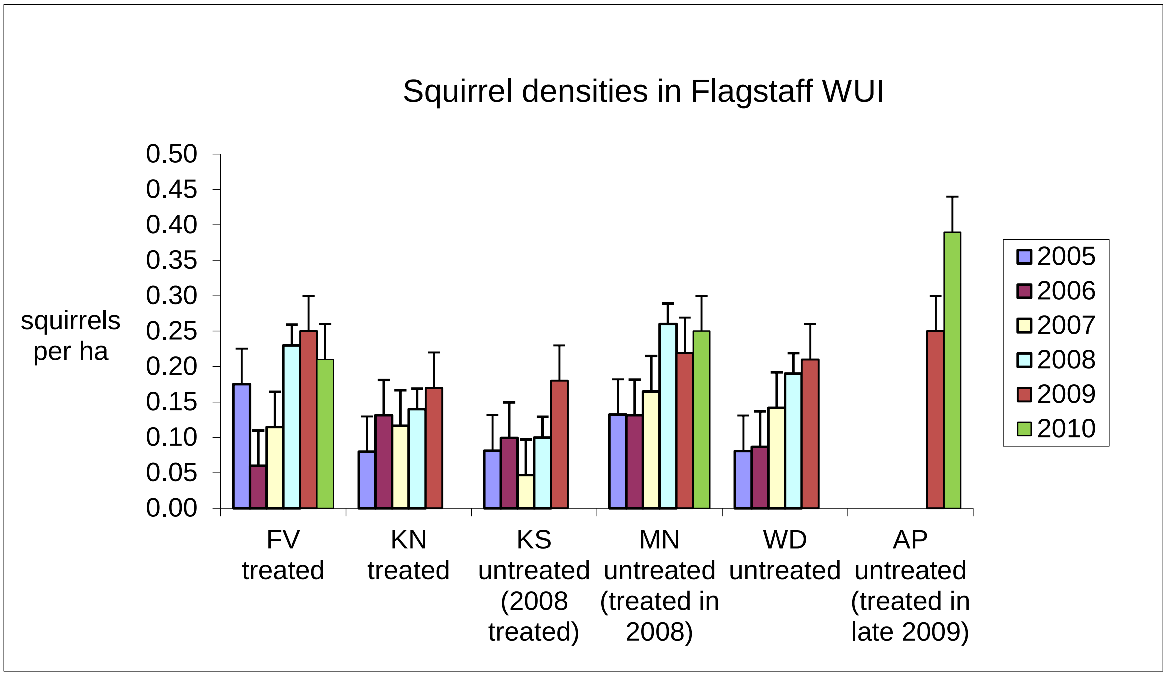


**Figure 87. Feeding sign survey results from 2005- 2010 in Fort Valley (FV), Kachina North (KN), Kachina South (KS), Mountainaire (MN), Woody Ridge (WD), and Airport (AP) study sites in the Flagstaff Wildland-Urban Interface. Treated refers to areas having received recent fuels reduction treatment in the form of mechanical thinning and/or prescribed fire. Untreated refers to areas not having received recent fuels reduction treatment. There is no difference between bolded and unbolded error bars in this graph.**

Squirrel data are also available for the Kaibab NF, where the Rocky Mountain Bird Observatory (RMBO) collected incidental observations of squirrels and their feeding sign during songbird surveys on the forest from 2005 – 2009 (Pavlacky 2011). In a report of the temporal trend in squirrel feeding sign on the Kaibab NF, RMBO found an increasing trend in squirrel sign from 2005 – 2009 (Figure 88). Inferences about local squirrel density on the South Kaibab NF are limited by the small sample size ($n$ = 5) of this study.

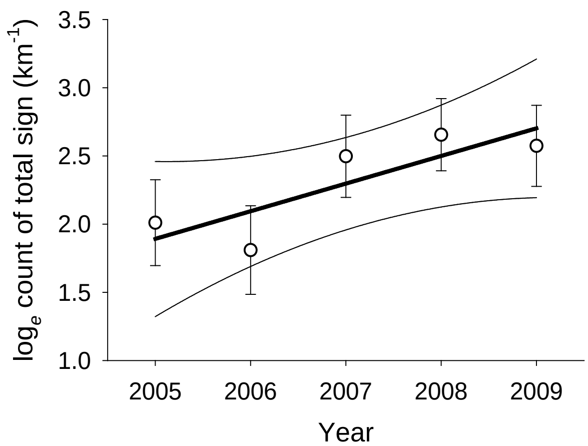


**Figure 88. The temporal trend for the log$_e$ count of tassel-eared squirrel total sign (km$^{-1}$) from 2005 to 2009 (Pavlacky 2011). The bold trend line is the predicted log$_e$ count of total sign (km$^{-1}$) and the upper and lower lines are 95% confidence limits. The open circles are the mean log$_e$ count of total sign (km$^{-1}$) for each year and the error bars are one standard error of the mean.**

## Habitat Use and Trend

Forest structure and composition is probably the most important habitat attribute for tassel-eared squirrels. Tassel-eared squirrels select for groups of older, larger ponderosa pine trees with high canopy density. They are not wide-ranging species; their home ranges vary from 4 ha up to 70 ha, with juvenile dispersal distances ranging between 0.5 – 0.89 miles (Farentinos 1979).

AGFD feeding sign survey data shows that areas with higher basal area and canopy cover as well as interlocking canopies contain the highest densities of squirrels (Yarborough et al. 2010). The squirrel's ability to access the growing pine shoots it depends on for food, as well as its ability to escape predators, is dependent on interlocking tree canopies especially during winter when snow accumulation can impede ground travel (Stephenson & Brown 1980). When snow is absent, tassel-eared squirrels will forage on the forest floor primarily for mycorrhizal fungi ('truffles') associated with pine tree roots (States et al. 1988). Tassel-eared squirrels also depend on ponderosa pine cones to meet their nutritional demands.

Nest trees are generally taller and larger than surrounding trees (62 ± 9 ft versus 44 ± 16 ft tall and 15 ± 3 in versus 11 ± 7 in dbh) (Halloran and Beckoff 1994). Prather et al. (2006) found that local basal area explained squirrel density in 9 northern Arizona studies, and Dodd et al. (1998) estimated optimal basal area for squirrels to be greater than 150 ft$^2$ per acre. Stand-level canopy cover of 40-50% probably represents a threshold for optimal tree squirrel habitat and is particularly important for recruitment (Dodd et al. 1998; Prather et al. 2006; Loberger et al. 2011). At the scale of the stand and the restoration unit, a continuously dense forest is not required for squirrels as long as denser patches of forest are retained for foraging, nesting, and escaping predators. Dodd et al. (2006) postulated that up to 75% 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.

### Effects of Thinning

Forest tree thinning under the goshawk guidelines 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-intensity treatments, the reduction in canopy connectedness will reduce safe travel routes for tassel-eared squirrels and expose them to higher rates of predation. These higher-intensity 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, tassel-eared squirrels may shift their patterns of nesting and foraging habitat use in response to restoration treatments because there will be a patch mosaic that includes untreated or lightly-treated areas. 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.

Despite the proposed reduction in dense forest conditions, 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 still provide squirrel habitat. Canopy connectivity can be retained in small groups rather than across whole landscapes. In the long term this should provide for more sustainable squirrel habitat over time because the risk of stand-replacing fire and therefore long-term degradation or loss of squirrel habitat will be significantly reduced (USFS 2010).

Proposed thinning treatments may cause visual or auditory disturbance to individual squirrels, although these effects would be short-term and limited in scope. Best management practices will direct operators to avoid removal of trees containing squirrel nests.

The inclusion of the Large Tree Retention Strategy (LTRS) and the incorporation of wildlife research will allow for higher basal area and canopy cover contributions from large-diameter trees, which should benefit tassel-eared squirrels for nesting and for winter cover. The larger forest patches created in the wildlife research project will increase the amount of optimal squirrel habitat available as well.

### Effects of Prescribed Burning

Disruption of normal behavioral patterns could occur to tassel-eared squirrels during burning activities, particularly since the proposed action calls for burning up to 60,000 acres annually. Effects would likely be due to direct disturbance by human presence during burning activities as well as smoke inhalation. However, human disturbance and smoke effects should be transitory in nature and short-term. Prescribed fire treatments are expected to be implemented twice in the next 10 years, which would increase the frequency of fire disturbance on tassel-eared squirrels. However, this fire frequency approximates the historic fire return interval with which squirrels evolved and should not result in dramatic shifts in squirrel behavior or habitat use.

### Effects of Aspen Treatments

Tassel-eared squirrel associations with aspen are not well-documented. Aspen treatments are not expected to impact this species.

### Effects of Stream/Spring Restoration

Tassel-eared squirrel associations with ephemeral streams and springs are not well-documented. Stream and spring restoration is not expected to impact this species.

### Effects of Road Closure/Obliteration

Little documentation exists to demonstrate that tassel-eared squirrels avoid or select for roads, so the effect of closures is unknown but assumed to be of benefit to the species since road-killed squirrels are commonly observed on both Forests.

Pile burning on steep slopes could disrupt normal behavioral patterns. Effects would likely be due to direct disturbance by human presence during burning activities as well as smoke inhalation. However, human disturbance and smoke effects should be transitory in nature and short-term and only in isolated patches across the project area. Grasslands are not selected for by tassel-eared squirrels, therefore the direct and indirect effects of this burning on squirrels are expected to be minimal.

## Literature Cited

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## Elk

Elk (*Cervus elaphus*) are an indicator of early-seral ponderosa pine for the Coconino and Kaibab NFs, and is an economically and socially important species. Elk are habitat generalists. In addition to occupying ponderosa pine forests, they graze grassland and woodland habitats as well as aspen and riparian areas. On both the Kaibab and Coconino NFs, elk occupy mountain meadows and forests in summer and move to lower-elevation pinyon-juniper woodland, conifer forest, and grasslands in winter (Hoffmeister 1986, USFS 2002, USFS 2010). Elk prefer grasses, and they also eat forbs, shrubs, and trees such as Gambel’s oak and quaking aspen (Boyd 1978, Burt and Grossenheider 1976, Hoffmeister 1986). They are a wide-ranging species; a recent study of elk movements on Camp Navajo indicates minimum convex polygon home range sizes for elk between 61.8 and 169.8 $mi^2$, with average daily movements of 3.1 miles (Partridge and Ingraldi 2007). Therefore, individuals will likely respond to changes in forest management at the scale of the restoration unit and the project area.

According to the Arizona Game and Fish Department (AGFD), the 4FRI project area includes portions of four elk herds (Figure 89; T. McCall, personal communication, October 2011). One herd includes Game Management Unit (GMU) 5A/5B/6A and occurs on the Coconino NF. The second herd includes 6B, 8, and Camp Navajo, which overlaps with both the Coconino and Kaibab NFs. The third is contained within GMU 7, which overlaps with both Forests. GMU 7 has some population exchange with the fourth herd in GMU 9, which occurs primarily on the Tusayan Ranger District of the Kaibab NF. It is important to note that elk that intermix among herds do not always go back to their respective GMU after winter, which complicates interpretation of both population- and habitat-utilization data for this species.

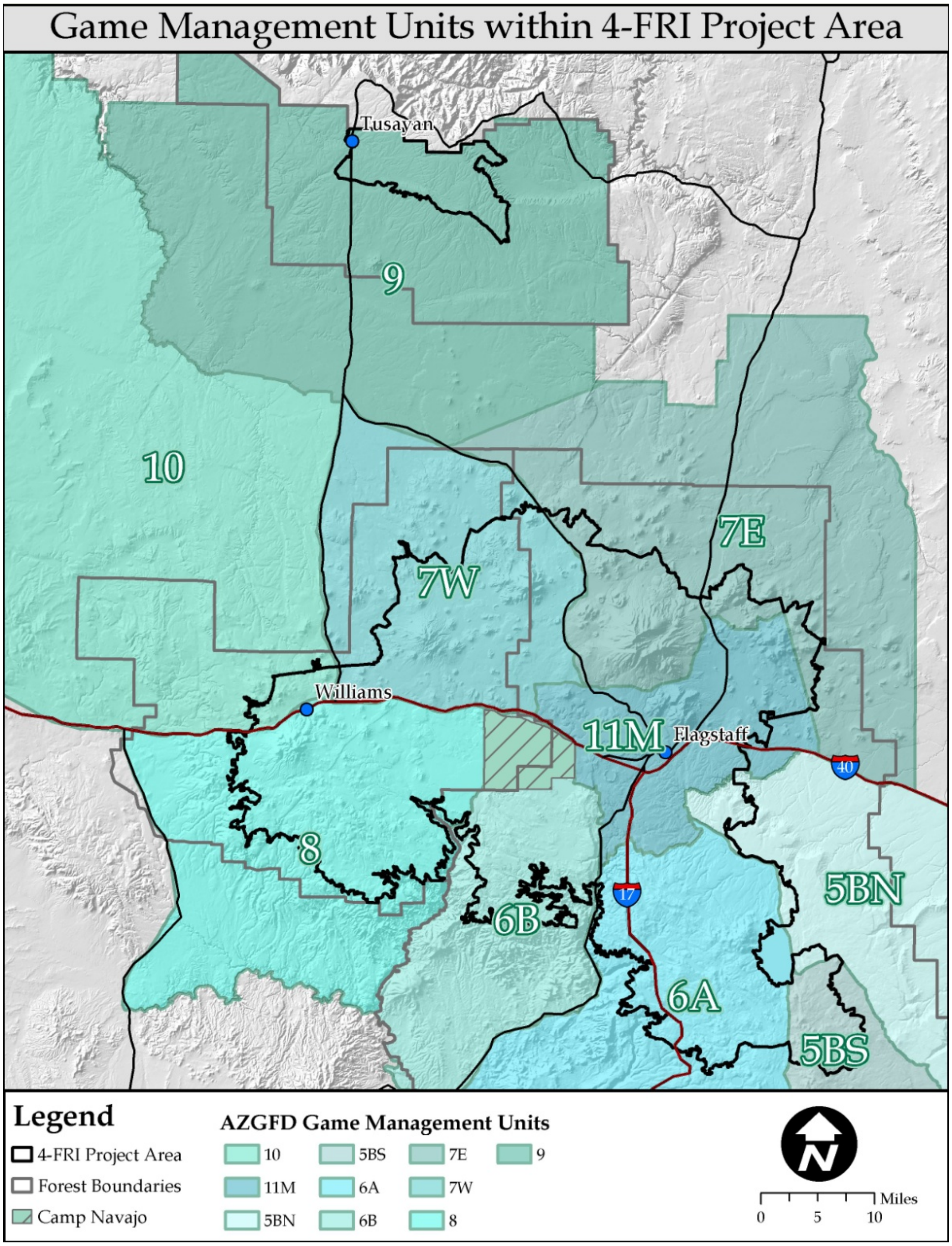


**Figure 89. Arizona Game and Fish Department Game Management Units within the 4FRI Project Area.**

## Population Trend

Because of their primary responsibilities for managing wildlife, the main data source for elk population trend comes from AGFD survey and hunt data, which shows a stable to decreasing trend in elk populations. Data used in this analysis were collected by game managers using a variety of methods including fixed-wing aircraft and helicopter surveys, and ground-based driving and horseback surveys when dense forest conditions precluded aerial counts. Survey methods vary across GMUs, and some methods vary across years for certain GMUs. The lack of consistency in survey methods is due in large part to the difficulty in detecting elk in heavy forested cover and because patterns of elk distribution are not consistent over time but rather move in response to shifts in precipitation patterns. However, this inconsistency makes interpretation of population data more difficult than it would be if methodologies and effort were consistent across GMUs and across years.

AGFD evaluates trends in elk populations based on 1) annual surveys (Figure 90), and 2) population estimates derived from a model that takes cow-calf ratios, bull:cow ratios, harvest, and estimated annual background mortality into consideration (Figure 91). Modeled mortality rates are based on limited available data from Brown (1994) and J. Gagnon unpublished data (AGFD; 2010). One limitation of this model is that it requires modelers to select a beginning population size for bulls and cows for which reliable data are lacking. Modelers must set beginning population size using anecdotal inference from earliest known survey numbers. For this reason, AGFD recommends greater emphasis on trends rather than absolute numbers. Population trend estimates are available from 1988 through 2009.

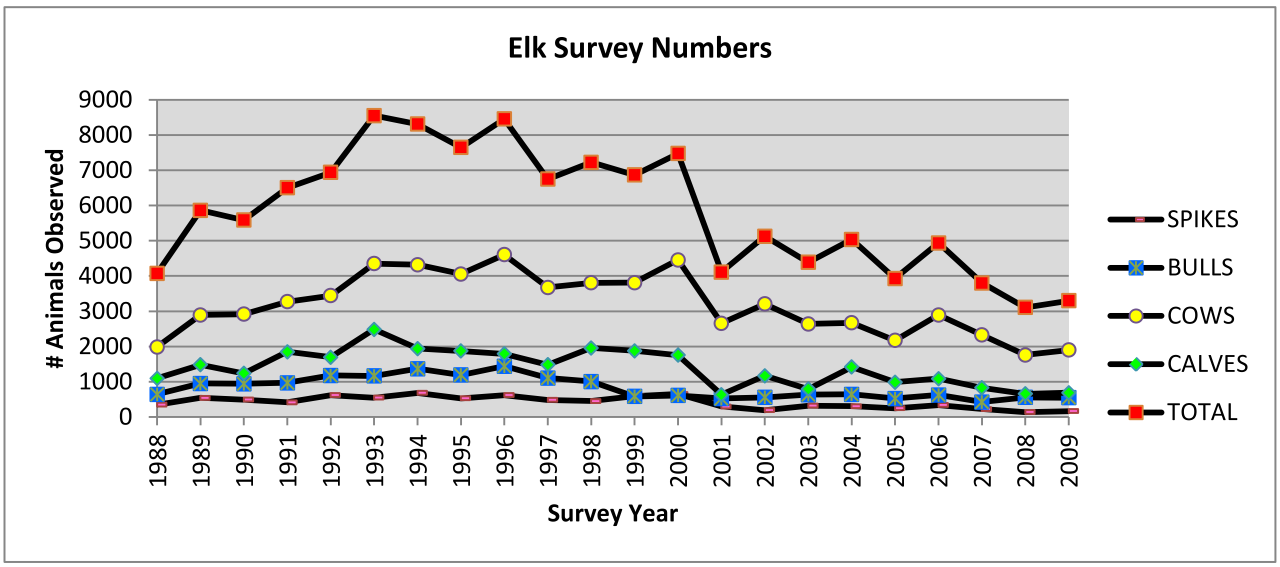


**Figure 90. Elk survey trends on the Coconino and Kaibab National Forests. Numbers are collected during annual surveys. Data are unpublished but available from AGFD Flagstaff Regional Office (C. Lutch, personal communication, November 2011).**

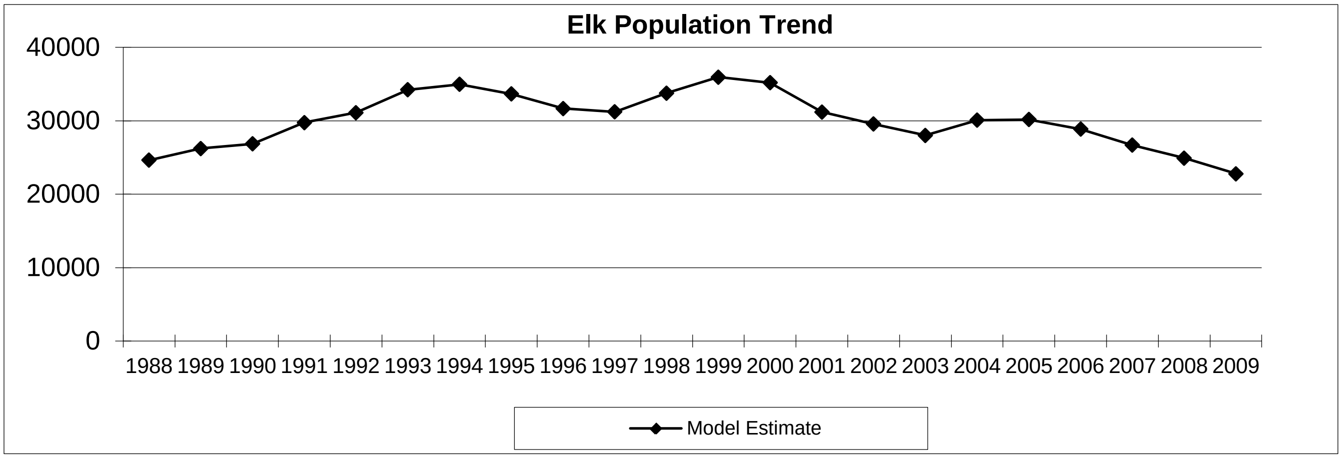


**Figure 91. Trend in estimates elk populations for the Coconino and Kaibab National Forests from 1988 – 2009. Includes Game Management Units 5A, 5B, 6A, 6B, Camp Navajo, 7, 8, and 9. Data are unpublished but available from the AGFD Flagstaff Regional Office (C. Lutch, personal communication, November 2011).**

Figure 90 and Figure 91 show a stable to decreasing trend in elk numbers over time on the Coconino and Kaibab National Forests, with a peak in the mid 1990s. From 1988 to 2008 elk populations increased by 9%, however more recent efforts to reduce populations in response to declines in habitat quality have led to a 33% decline in estimated elk numbers from 2000 – 2011 (with the last two years based on projected trend).

## Habitat Use

Elk select their habitat based on a relatively even ratio of forest (cover) to openings (forage) (Dealy 1985, Brown 1994). Forested cover is thought to be important for elk to protect against changes above and below critical tolerances (thermoregulation; Dealy 1985), and to provide places for elk to hide from human disturbance particularly along roadways or in areas of timber harvest (Ward 1976). Elk typically select hiding and thermal cover in areas with high canopy density (70%) and a low canopy-base height (6.5 feet) (Brown 1994). Tree size class is less important to elk as long canopy requirements are met, though elk bedding sites are often found in early seral forests with a high percentage of VSS 2 and 3 tree groups (Brown 1994). However, recent studies postulate thermal cover is not as important for elk as forage availability in terms of maintaining good body condition (Cook et al. 2004). Foraging areas are primarily openings in the forest canopy where perennial grasses and forbs are more readily available (Reynolds 1966). Elk also forage in areas dominated by Gambel oak and quaking aspen where they feed on sprouts and ramets. Forest management practices that create an interspersion forest tree groups and openings tend to improve habitat conditions for elk by increasing grassland primary productivity while still providing cover nearby (Johnson and Matchett 2001, Van Dyke and Darragh 2007).

High levels of elk utilization can have negative impacts on sensitive areas within the project area including aspen clones (Fairweather et al. 2008)and montane riparian areas including springs and ephemeral stream channels (Neary and Medina 1996). In aspen, elk utilization contributes to the overall lack of aspen recruitment from the young sucker stage into larger size classes. In springs, wet meadows, and stream channels, elk hoof action and vegetation trampling/removal contributes to geomorphic changes that cause erosion, channel widening, and overall degradation of those riparian systems (Neary and Medina 1996).

Current trends in elk habitat on both Forests are stable to increasing, due in large part to the increase in fuels reduction projects aimed at opening forest canopies which increases elk forage availability (USFS 2002, 2010). AGFD contemporary efforts to reduce elk populations have also contributed to the stable trend in habitat condition across the two forests, with the exception of aspen areas where ramet browse remains high (Fairweather et al. 2008).

## Habitat Changes

Continuing the current forest growth trajectory would continue to provide large patches of trees with higher basal area, canopy density, and interlocking crowns would provide thermal and hiding cover for elk. However, pine encroachment into grassy openings and meadows will continue to limit foraging habitat for elk. 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.

### Effects of Mechanical Thinning

Thinning small-diameter trees and prescribed burning in ponderosa pine 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, with expected benefits as soon as 1-2 years following prescribed fire (Canon et al. 1987 *in* Pilliod et al. 2006). 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 nesting and restricted habitat, NOGO nest stands, bald eagle roosts, caves, and areas excluded from mechanical treatment such as wilderness of slope >40%.

Thinning small-diameter trees and burning in gambel oak thickets could also reduce hiding and thermal cover for elk in the short term. This risk however, must be weighed against the risk of stand replacing fire events. Project design criteria for both habitats include tree thinning under the goshawk guidelines. This should result in a mosaic of interspersed vegetative structural stages including early-seral habitat, and will provide necessary habitat characteristics, such as bedding sites and open areas with increased forage for elk in the long term.

The inclusion of the LTRS would retain higher basal area and canopy cover contributions from large-diameter trees, which should benefit elk for thermal cover. Similarly, the larger forest patches retained in the watershed and wildlife research areas could provide additional areas for elk thermal and hiding cover.

Since elk also select for grasslands where increased herbaceous productivity provides foraging opportunities, the grassland treatments proposed in Alternative C will likely benefit elk.

Proposed thinning treatments may cause visual or auditory disturbance to individual elk, although these effects would be short-term. Best management practices will place seasonal restrictions on logging activities in known elk calving areas to reduce the likelihood of direct impacts.

### Effects of Prescribed Fire

Disruption of normal behavioral patterns could occur to elk during burning activities. Prescribed fire treatments would increase the frequency of fire disturbance on elk. Effects would likely be due to direct disturbance by human presence during burning activities as well as spatial displacement by fire and smoke. However, human disturbance and smoke displacement should be transitory in nature and short-term. Since elk are capable of moving several miles in any given day, it is likely they will be able to move out of fire and smoke paths in the event of prescribed burns.

### Effects of Aspen, Spring, and Ephemeral Channel Restoration

Exclusion of elk from aspen, springs, and ephemeral channels will limit their ability to access those forage and water resources. However, the increased herbaceous productivity resulting from forest thinning is likely to offset elk utilization of aspen and riparian areas. Springs and ephemeral channels do not represent reliable water sources for elk and exclusion of these areas should not have an impact given the relatively high availability of permanent, artificial water sources across the project area.

### Effects of Road Closure/Obliteration

Closure and obliteration of unauthorized roads will positively impact elk. Elk are known to avoid roads and heavily used recreational areas (Ward 1976).

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## Mule deer

Mule deer (*Odocoileus hemionus*) are an indicator of early-seral aspen and pinyon-juniper for the Coconino and Kaibab NFs, and is an economically and socially important species. Mule deer typically summer at higher elevations in aspen, mixed conifer, and ponderosa pine forests, and transition to winter in pinyon-juniper woodlands found at lower elevations (Hoffmeister 1986). Mule deer are browsers and prefer leaves and twigs from shrubs and trees over grasses. Home range size varies, depending upon availability of forage and cover. Mule deer in the vicinity of the Tusayan and Williams Ranger Districts (Kaibab NF) have an estimated home range 141.1 mile2 (±48.3) (Dodd et al. 2010). Since mule deer are relatively wide-ranging species, they are likely to respond to changes in forest management at small and large spatial scales.

### Population Trend

Mule deer are currently listed as G5, N5, and S5 (NatureServe 2010). The species is considered to be demonstrably widespread, abundant, and secure, globally, nationally (USA), and statewide (AZ).

Mule deer populations have fluctuated throughout history due to influences of precipitation, habitat quality, predation, and hunting pressure (Heffelfinger and Messmer 2003). Annual statewide survey data from 1946 – 2008 demonstrate this fluctuation in mule deer abundance, and show a contemporary decline in mule deer surveyed that began in the mid 1990s but has stabilized since 2004  (AGFD 2011, Figure 92). This is consistent with the Forestwide population trend determinations for both Forests (Coconino NF – decreasing (USFS 2002); Kaibab NF – stable to decreasing (USFS 2010)).

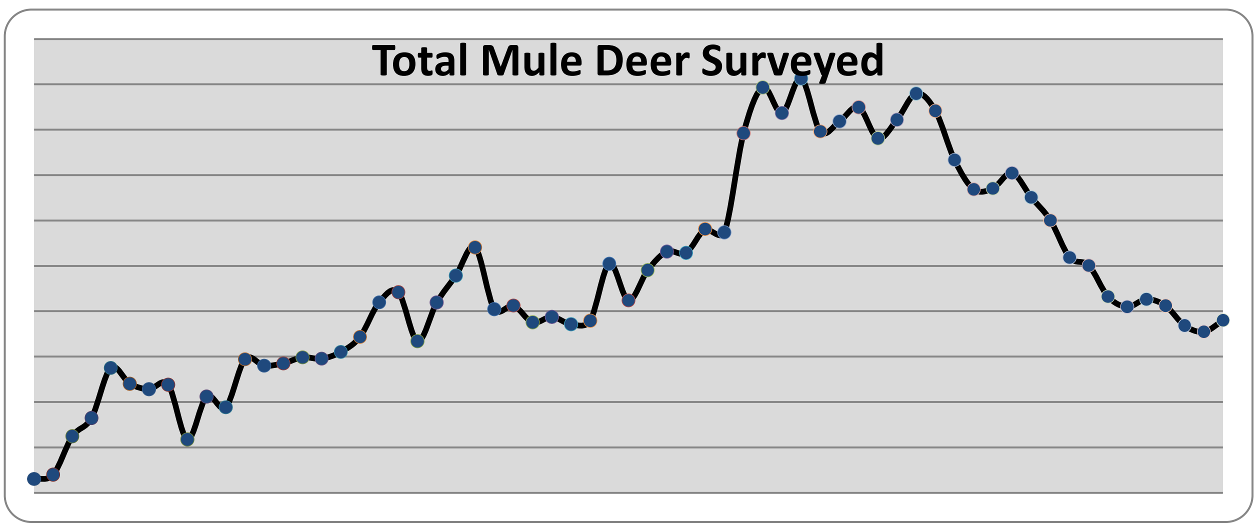


**Figure 92. Results of annual statewide mule deer surveys 1946 – 2010 (AGFD 2011).**

For the purpose of this analysis, data were compiled from files at the Flagstaff Regional Office of the Arizona Game and Fish Department in order to determine population trends on the Coconino and Kaibab NFs (T. McCall, AGFD, unpublished data, November 2011). The two best indicators for mule deer population trend are 1) the number of mule deer observed during annual surveys, and 2) number of fawns per 100 does. These two indicators are used because they are more reliable than population modeling estimations for mule deer. Given the inconsistency of survey methodologies, population model outputs and deer observed/hour of survey are less reliable than actual survey numbers (Tom McCall, personal communication, November 2011). Data are displayed by Game Management Unit (GMU; Figure 93, Figure 94, and Figure 95). For the Coconino NF, data are relevant from GMUs 5A and 5B (combined only for mule deer analysis), 6A, 6B, 7, and 8. For the Kaibab NF, data are relevant from GMUs 6B, 7, 8, and 9. All GMUs are relevant to the 4FRI project area.

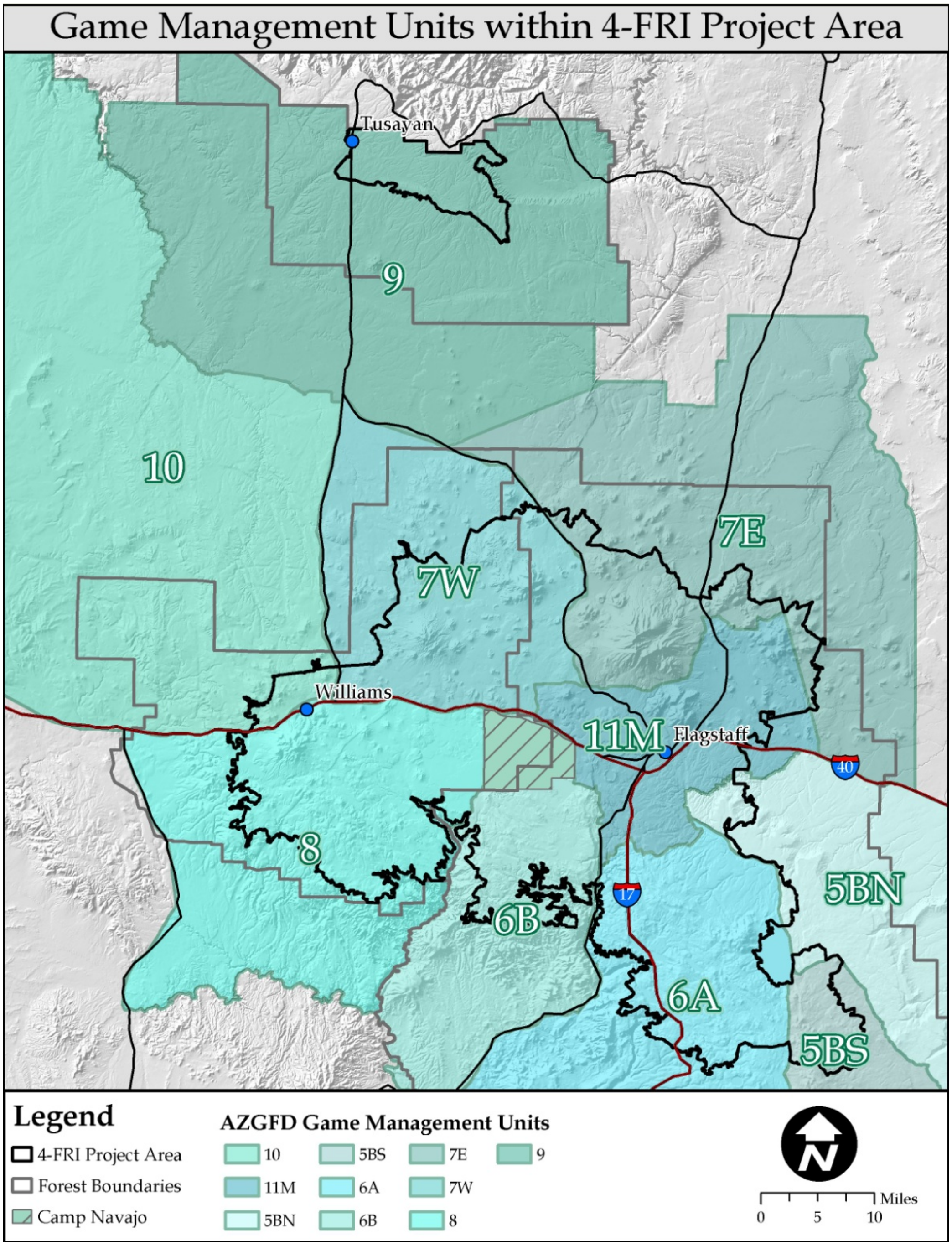


**Figure 93. Arizona Game and Fish Department Game Management Units within the 4FRI Project Area.**

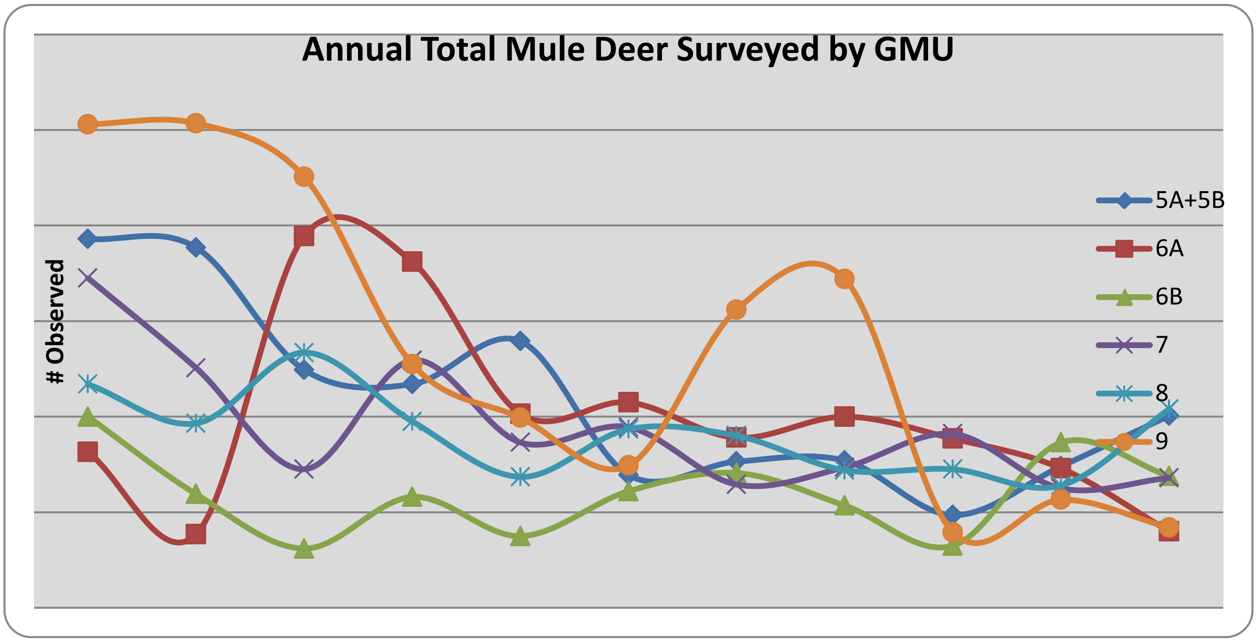


**Figure 94. Total number of mule deer surveyed by GMU, 2000 – 2010.**

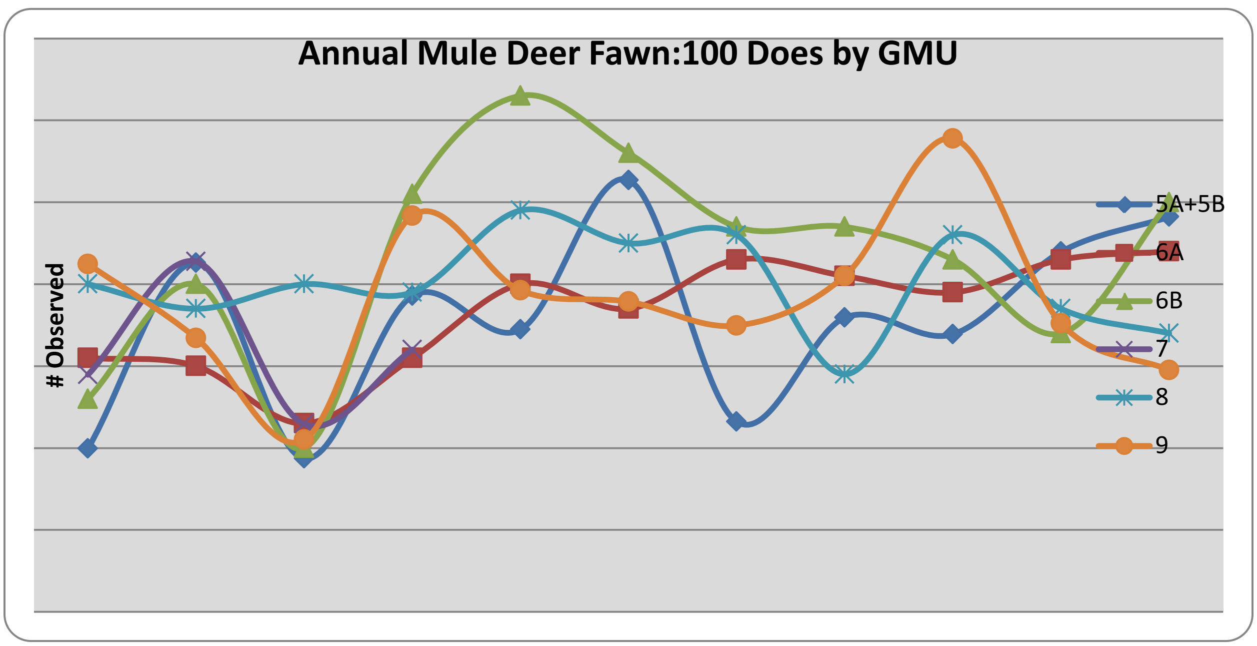


**Figure 95. Ratio of mule deer fawns per 100 does by GMU, 2000 – 2010.**

The declining to stable trend in mule deer surveyed over the last decade on the Coconino and Kaibab NFs is consistent with the statewide trend. The fawn:doe ratios indicate relatively stable trends in doe productivity over time across both Forests. Though currently stable, survey data suggest that overall mule deer populations are lower than they were a decade ago. Regional experts have attributed contemporary mule deer population decline to declines in the quality of their habitat (Mule Deer Working Group 2004).

## Habitat Use and Trend

Unlike cattle and elk, mule deer are not adapted to digest a diet high in grass; instead they rely primarily upon browse and forbs to meet their nutritional needs, particularly on their winter range when snow limits access to herbaceous ground cover (Wallmo and Regelin 1981). Important plants in a mule deer's diet include sagebrush (*Artemisia spp.*), cliffrose (*Cowania mexicana*), mountain-mahogany (*Cercocarpus ledifolius*), buckbrush (*Ceanothus cuneatus*), buckthorn (*Rhamnus spp.*), quaking aspen (*Populus tremuloides*), juniper (*Juniperus spp.),* and Gambel’s oak mast (*Quercus gambelii*). 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 (Mule Deer Working Group 2004).

Carrying capacity of winter range habitats is often the limiting factor for mule deer populations (Wallmo et al. 1977). Winter range for mule deer occurs primarily in pinyon-juniper communities which are largely outside the scope of the 4FRI project. However, summer range for mule deer occurs throughout the project in areas of ponderosa pine, pine-oak, pine-sage, aspen, and at springs and ephemeral channels particularly when water is available.

High levels of interspersion of forested cover and openings are favored by mule deer, particularly when a shrub, oak, or aspen component is present (Germaine et al. 2003, Wightman and Yarborough 2005). 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 bedsites located within denser hiding and thermal cover (Wightman and Yarborough 2005). In addition, mule deer prefer smaller openings and show higher fidelity to forested edge relative to elk and cattle (Dealy 1985). 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.

Mule deer commonly browse on aspen within the 4FRI project area. Aspen are declining on both Forests, due a combination of factors including drought, heavy frost events, disease and pathogens, fire suppression and ungulate herbivory (Fairweather et al. 2008). Aspen continues to be lost as successional processes result in pine, spruce or fir trees overtopping many of the clones. Some early seral stage aspen are being created through wildfire and management activities, which should benefit mule deer. However, management activities have not been implemented to a level, or over enough area, to prevent loss of aspen patches in the landscape and provide for adequate aspen recruitment.

Current conditions on both Forests do not provide optimal cover and foraging conditions for mule deer. Fire suppression over the last century has led increased tree densities and canopy closure, reducing forest openings, meadows, and grasslands. These changes have reduced both groundcover and the shrub layer, likely decreasing the carrying capacity of lands on both Forests. Deer may also be negatively affected by competition with elk and livestock on shared forage species if widespread hedging (e.g., shrubs on the Tusayan Ranger District) or actual elimination of forage occurs (e.g., aspen regeneration on the Peaks Ranger District (Coconino NF) and Williams Ranger District (Kaibab NF)).

## Potential Effects

Maintaining current conditions 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 diversity and productivity will continue to limit forage habitat for mule deer. Tree encroachment into openings and meadows will also limit mule deer foraging habitat. Early-seral aspen will continue to decline in the absence of natural disturbances such as fire and without management intervention. The current unnatural stand densities would threaten sustainability of mule deer habitat by creating risk for uncharacteristic, high-severity fire.

### Effects of Mechanical Thinning

Weather patterns such as precipitation are the primary driver of deer populations in the short term, but landscape scale habitat improvements such as 4FRI will make long term gains in deer abundance over time (Mule Deer Working Group 2004).

Thinning under the goshawk guidelines would result in a mosaic of interspersed vegetative structural stages that provide both bedding sites and foraging areas for mule deer. Cutting in early-seral pinyon-juniper on the Tusayan Ranger District would positively influence forage abundance by opening up the tree canopy and allowing sunlight to reach the forest floor. Thinning and burning in the pine-sage, pine-oak, and pure pine will also provide opportunities for browse increase which should positively influence mule deer populations over time.

Reducing tree densities and ladder fuels will reduce 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 nesting and restricted habitat, NOGO nest stands, bald eagle roosts, caves, and areas excluded from mechanical treatment such as wilderness and where slope >40%. Thinning small-diameter trees and burning in Gambel oak thickets could also reduce hiding and thermal cover for mule deer in the short term. This risk however, must be weighed against the increased likelihood for stand replacing fire events and mass habitat loss over larger areas.

Fencing around aspen will allow for recruitment of new ramets and creation of early-seral conditions but will preclude foraging mule deer unless fences are removed. Reduction in aspen forage will have localized impacts on deer but is not expected to have impacts at the population level given that other understory forage plants will likely increase following overstory reductions.

The inclusion of the LTRS and the incorporation of watershed and wildlife research areas would retain higher basal area, higher canopy cover, and larger forest patches because of the combined contributions from large-diameter trees. This should benefit mule deer in terms of cover and additional areas for mule deer daybeds.

Since mule deer also select for the forested edges of grasslands where increased herbaceous productivity provides foraging opportunities, grassland treatments should benefit mule deer.

Proposed thinning treatments may cause visual or auditory disturbance to individual mule deer, although these effects would be short-term. Best management practices will place seasonal restrictions on logging activities in known fawning areas to reduce the likelihood of direct impacts.

### Effects of Prescribed Fire

Landscape-scale application of prescribed fire will more closely simulate historic fire regimes, restoring disturbances that work to create patches of early seral forest, particularly enhancing areas of aspen. Enhancement of these features across the landscape will benefit mule deer.

Mule deer evolved in southwestern ponderosa pine forests that were characterized by frequent, low-severity fire. This frequent fire helped maintain herbaceous openings and meadows, which are important for mule deer foraging. Disruption of normal behavioral patterns could occur to mule deer during burning activities and prescribed fire maintenance treatments would increase the frequency of fire disturbance on mule deer. Effects would likely be due to direct disturbance by human presence during burning activities as well as smoke inhalation. However, human disturbance and smoke effects should be transitory in nature and short-term. Since mule deer are capable of moving several miles in any given day, it is likely they will be able to move out of smoke paths in the event of prescribed burns.

Cheatgrass has a profound negative impact on mule deer habitat quality through a process of invasion, competition with-, and eventual elimination of shrubs through unnatural acceleration of fire frequencies in pinyon-juniper and ponderosa pine systems (Mule Deer Working Group 2004). The risk of cheatgrass invasion following restoration treatments (McGlone et al. 2009) has the potential to negatively impact mule deer habitats in the long-term.

### Effects of Aspen, Spring, and Ephemeral Channel Restoration

Exclusion of mule deer from aspen, springs, and ephemeral channels will limit their ability to access those forage and water resources. However, the increased shrub and herbaceous productivity resulting from forest thinning is likely to offset mule deer utilization of aspen and riparian areas. Springs and ephemeral channels do not represent reliable water sources for mule deer and exclusion of these areas should not have an impact given the relatively high availability of permanent, artificial water sources across the project area.

### Effects of Road Closure/Obliteration

Closure and obliteration of unauthorized roads will positively impact mule deer. Mule deer are known to avoid roads and heavily used recreational areas (Mule Deer Working Group 2004).

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## Wild turkeys

Wild turkeys (*Meleagris gallopavo*) are an indicator of late-seral ponderosa pine forests, and are an economically and socially important species. Turkey roosts and nests are associated with groups of large pine trees on steep slopes, and they select foraging and loafing habitats within a mix of meadows, oak, and juniper. Turkeys are migratory in parts of their range, moving between lower elevations for wintering to higher elevations for breeding. Timing of movements can differ annually, depending upon snowfall and tree mast production (Wakeling 1991, Hoffman et al. 1993). 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 (Wakeling and Rogers 1995). Core home range size for turkeys is roughly 26-30 $mi^2$ (Wakeling 1991). Since turkeys are a relatively wide-ranging species, they are likely to respond to changes in forest management at small and large spatial scales.

### Population Trend

Wild turkeys are currently listed as G5, N5, and S5 (NatureServe 2010). The species is considered to be demonstrably widespread, abundant, and secure, globally, nationally (USA), and statewide (AZ).

Turkey populations in Arizona were fairly robust in the 1960s, but have been in steady decline since that time. Current estimates number the population between 15,000 and 20,000 birds, depending on climatic conditions (AGFD 2011a). Factors contributing to this decline include logging practices, increased human recreational use, fall hunting, disease, grazing, and long-term changes in climatic patterns (Wakeling 1991). Annual statewide survey data from 1960 to 2010 demonstrate a fluctuation in numbers with an overall declining trend (Figure 96; AGFD 2011a). The Coconino and Kaibab NFs represent the core of the turkey's distribution in Arizona, and unlike the statewide declining trend, populations on the two forests have been stable to increasing for the last several years (USFS 2002, 2010).

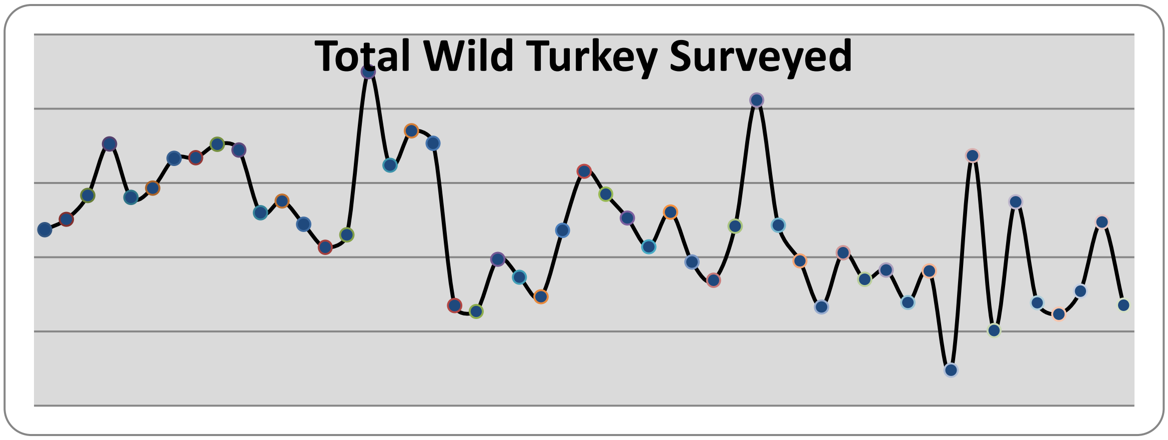


**Figure 96. Results of annual statewide turkey surveys 1946 – 2010 (AGFD 2011).**

Because of their primary responsibilities for managing wildlife, the main data source for turkey population trend comes from AGFD survey and hunt data. Up until the late 1960s, AGFD conducted standardized driving surveys for turkey. When turkey densities began decreasing, standard survey procedures did not provide good data because of the low number of observations along survey routes (Wakeling 1991). Since that time, AGFD has gotten more consistent and reliable information by using 1) the percent of archery hunters seeing turkeys during archery elk hunts, and 2) the number of turkeys harvested during the spring (T. McCall, AGFD, personal communication, November 2011). Data on percent hunters observing turkey and harvest data are available for 1997 – 2010 (Figure 97, Figure 98, Figure 99, and Figure 100).

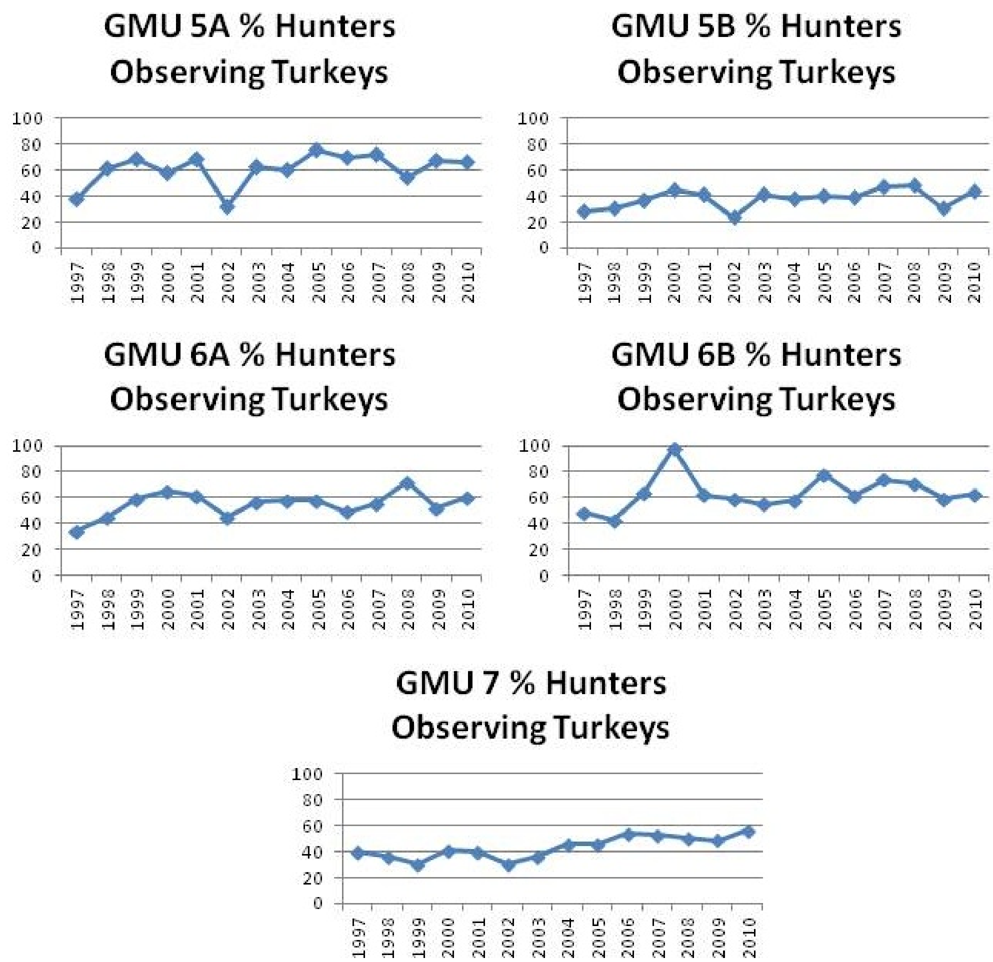


**Figure 97. Annual percentage of archery hunters observing wild turkey (1997 – 2010). Coconino National Forest, including Game Management Units 5A, 5B, 6A, 6B, and 7.**

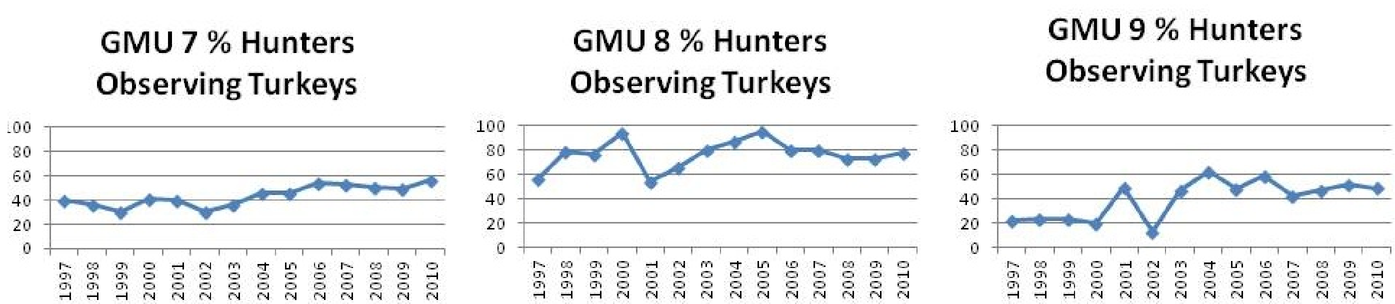


**Figure 98. Annual percentage of archery hunters observing wild turkey (1997 – 2010). Kaibab National Forest, including Game Management Units 7, 8, and 9.**

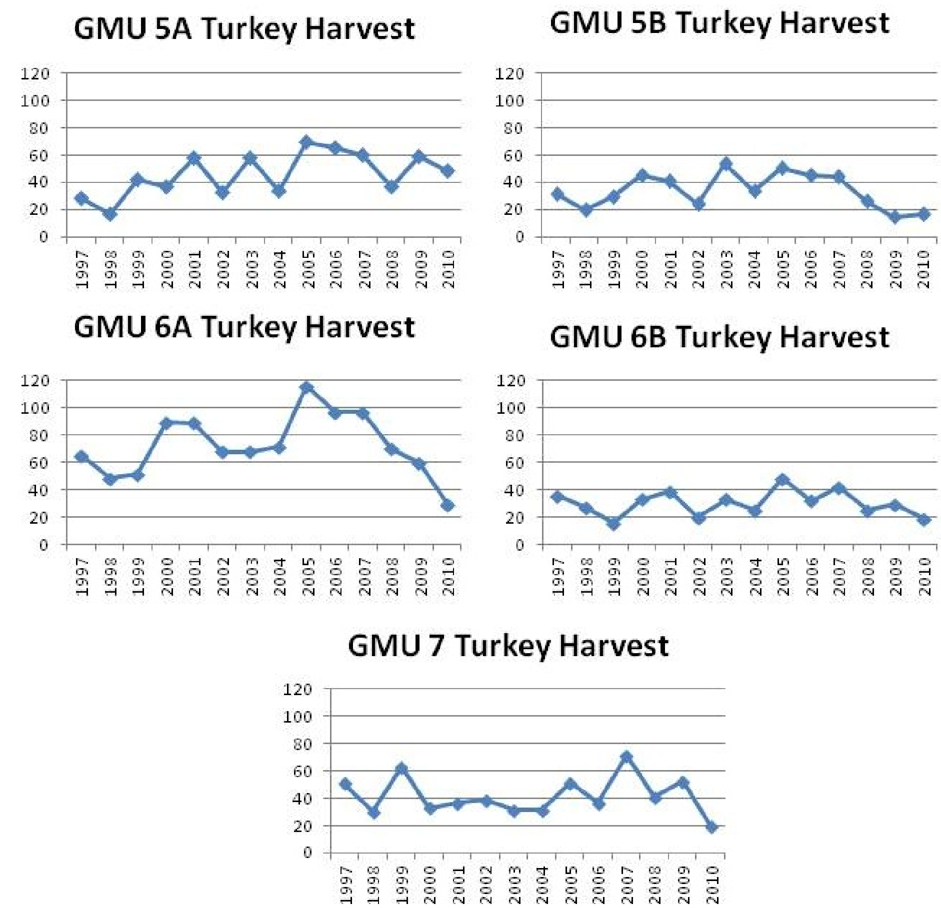


**Figure 99. Annual harvest rates for wild turkey (1997 – 2010). Coconino National Forest, including Game Management Units 5A, 5B, 6A, 6B, and 7.**

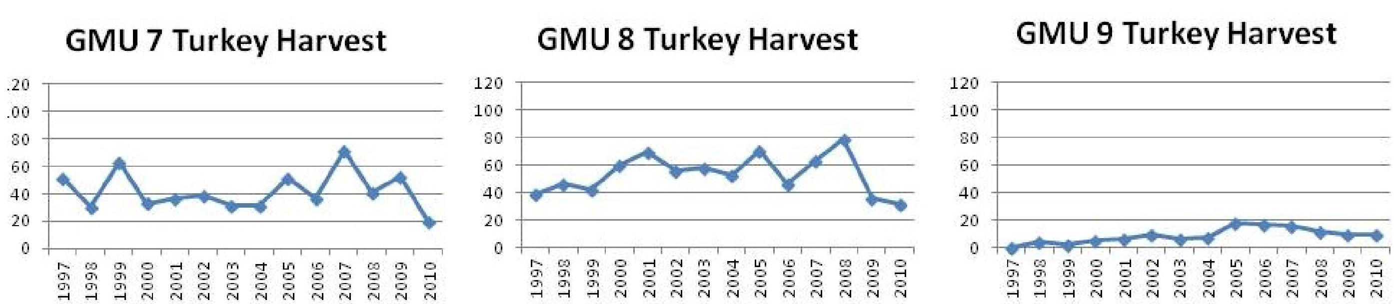


**Figure 100. Annual harvest rates for wild turkey (1997 – 2010). Kaibab National Forest, including Game Management Units 7, 8, and 9.**

Both indicators for turkey suggest a variable yet stable population trend within the 4FRI project area, on both National Forests.

## Habitat Use and Trend

Turkey habitat is typically described for four behaviors: nesting, roosting, foraging, and loafing. There have been several studies examining turkey habitat selection in ponderosa pine on the Mogollon Rim, primarily just east of the 4FRI project area within Arizona Game Management Unit 4A on the Apache-Sitgreaves National Forest (Wakeling 1991, Mollohan et al. 1995, Wakeling and Rogers 1995). The habitat description below is based on these references.

Nesting habitat is best characterized by steep slopes (>40%), with a clumpy-groupy forest structure dominated by trees in the VSS 5 and 6 size class. Turkeys nest on the ground up against rock cliffs, on the uphill side of large trees, or in slash. Canopy cover is typically high (50%) within 0.1 acres of the nest, with dense horizontal cover in the form of a low tree canopy base height, shrubs, or slash.

Roosting habitat is similar to nesting habitat in terms of steep slopes (again >40%), typically in the upper strata of canyons and drainages. Turkeys roost in tree groups that average 36 trees with DBH > 16”, where the roost tree is often >24” DBH. 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, however unlike in their nesting habitats turkeys select for a higher canopy base height (>24’) when roosting.

Clumpy-groupy forest structure is also important for turkeys in their foraging habitats, where they select for small forest openings (0.28 – 0.31 acres) for feeding. Openings can be natural meadows or early seral forests created by logging or natural disturbance, typically located on flatter terrain relative to nesting and roosting habitats. Turkeys select areas with a higher percent cover of forbs and grasses for feeding, and they select for areas of higher plant species richness (and higher invertebrate richness) during the poult-rearing phase. Acorn mast from Gambel’s oak can significantly increase the probability of overwinter survival and is connected to productivity in the following year.

Loafing is a behavior common among gallinaceous birds; it is a time when turkeys rest, preen, and take dust baths. Turkey loafing occurs in small (<1 ac) forested patches, adjacent to openings (within 100 ft), dominated by sapling and pole-sized trees, with higher TPA and BA relative to feeding or nesting sites. Course woody debris and fallen snags are commonly used in loafing habitats. Turkeys will also loaf in recently-thinned areas with broadcasted slash, as long as the residual tree density remains high.

## Potential Effects

Weather patterns such as precipitation are a driver of turkey populations in the short term, but landscape scale habitat improvements such as 4FRI will make long term gains in turkey abundance over time. Continuing on the current trajectory, forests 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 forage habitat for turkey. 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.

## Effects of Mechanical Thinning

Avoidance of mechanical thinning on slopes >40% will allow for maintenance of turkey nesting and roosting habitat, although risks from loss to fire will remain. Turkey roosting habitat characteristics overlap with MSO PAC characteristics, and the proposed thinning within the proposed PACs will improve turkey roosting habitat by raising canopy-base height and protecting larger trees from loss from fire. Treatments within NOGO nest stands, where occurring on steeper slopes, will also improve roosting habitat for turkeys. Areas with a high density of sapling and pole-sized trees will be thinned in order to meet desired conditions which will have lower trees per acre than turkey loafing sites. This will significantly reduce availability of turkey loafing habitat. However, loafing sites will still be provided in deferral areas and when site-specific conditions indicate appropriate designation of large groups of VSS 2 and 3 trees. Coarse woody debris requirements set forth in the Forest Plans will continue to provide substrates for turkey use in nesting and loafing areas.

Thinning under the goshawk guidelines will result in a mosaic of interspersed vegetative structural stages and openings that will provide increased understory production and therefore increased foraging habitat quality for turkey. The emphasis on creation of clumpy-groupy forest structure will improve a key component of nesting, roosting, and foraging habitat.

Mechanical thinning will be used to reduce overstory competition with Gambel oak, where appropriate. This action is expected to help increase acorn mast production (Okonburi 1999), a critically important food source for overwintering turkeys.

The use of AGFD connectivity data has been used inform spatial arrangement of mechanical thinning treatments that favor late-seral forest dwelling species such as turkey (AGFD 2011b). This treatment design, used in combination with soils information and historic evidences, will enhance connectivity for turkey populations.

Proposed thinning treatments may cause visual or auditory disturbance to individual turkey, although these effects would be short-term. Best management practices will place seasonal restrictions on logging activities in known nesting and roosting areas to reduce the likelihood of direct impacts.

The inclusion of the LTRS and the incorporation of watershed and wildlife research areas would retain higher basal area and canopy cover contributions from large-diameter trees, which should benefit turkeys for nesting and for roosting habitat. Similarly, the larger forest patches retained in the watershed and wildlife research areas could provide additional areas for turkey loafing, nesting, and roosting.

Since turkeys select for forested edges of grasslands where increased herbaceous productivity provides foraging opportunities, grassland treatments will likely benefit turkeys.

### Effects of Prescribed Fire

Landscape-scale application of prescribed fire will more closely simulate historic fire regimes, restoring disturbances that work to create openings, and increase resiliency in late-seral ponderosa pine forests. This is expected to benefit turkeys.

Burning shrubs, slash, and understory vegetation will reduce hiding and nesting cover for turkeys in the short term. Thinning and burning in Gambel oak thickets could reduce nesting and foraging habitat for turkeys in the short term. However, low- severity fire can increase diversity and productivity in grasses and forbs, in turn increasing the likelihood of higher invertebrate diversity, which will benefit turkeys especially in the poult-rearing phase. Benefits could be expected as soon as 1-2 years following prescribed fire (Canon et al. 1987 *in* Pilliod et al. 2006).

Less prescribed fire would reduce the direct impacts of burning and smoke. However, turkeys evolved in southwestern ponderosa pine forests that were characterized by frequent, low- severity fire. This frequent fire helped maintain herbaceous openings and meadows, which are important for turkey foraging. Reduced burning would also limit the quality of turkey habitat within the project area.

Disruption of normal behavioral patterns could occur to turkeys during burning activities. Prescribed fire treatments are expected to be implemented twice in the next 10 years, which would increase the frequency of fire disturbance on turkey. Effects would likely be due to direct disturbance by human presence during burning activities as well as smoke inhalation. However, human disturbance and smoke effects should be transitory in nature and short-term. Since turkeys are capable of moving several miles in any given day, it is likely they will be able to move out of smoke paths in the event of prescribed burns. Best management practices will place seasonal restrictions on burning activities in known nesting and roosting areas to reduce the likelihood of direct impacts.

### Effects of Aspen, Spring, and Ephemeral Channel Restoration

Fencing aspen, springs, and ephemeral channels will allow for recruitment of new aspen and creation of early-seral conditions. Turkeys could likely fly over fences when the protected area is large enough to allow them to negotiate the barrier, as in aspen. Fences would likely present barriers in small areas, such as spring exclosures. Ephemeral channels may be a mix of both. Reduction in forage will have localized impacts on turkey who will use those areas for foraging, but this is not expected to have impacts at the population level. Exclusion of turkey from springs and ephemeral channels will limit their ability to access those forage and water resources. However, the increased herbaceous and tree mast productivity resulting from forest thinning is likely to offset turkey utilization of riparian areas. Springs and ephemeral channels are less reliable water sources for turkey and exclusion of these areas should not have an impact given the relatively high availability of permanent, artificial water sources across the project area.

### Effect of Road Closures/Obliteration

Closure and obliteration of unauthorized roads will positively impact turkeys. Turkeys are known to avoid roads and heavily used recreational areas (Wakeling 1991).

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## Pronghorn

Pronghorn (*Antilocapra americana*) is an indicator of grassland habitats and an economically and socially important species. Pronghorn are associated with grasslands, meadows, and savannas on the Coconino and Kaibab National Forests 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 (Yoakum 2004). They evolved to avoid predation through sight and flight; habitats with low-growing vegetation and/or sparse tree density are important for pronghorn. Pronghorn avoidance of areas with high tree density and cover differs markedly from deer and elk patterns of habitat selection within the 4FRI project area. Home ranges have been measured in the vicinity of Wupatki and Sunset Crater National Monuments which are adjacent to the Coconino NF, and were estimated between 22.8 and 50.2 $mi^2$ for females and males, respectively (Ockenfels et al. 1997). Since pronghorn are relatively wide-ranging species, they are likely to respond to changes in forest management at small and large spatial scales.

**Population Trend**

Pronghorn are currently listed as G5, N5, and S5 (NatureServe 2010). The species is considered to be demonstrably widespread, abundant, and secure, globally, nationally (USA), and statewide (AZ).

A number of factors have been identified that affect pronghorn populations including severe weather, amount and timing of precipitation, habitat fragmentation, diet overlap with other grazers, reductions in fawn hiding cover, woody vegetation encroachment, predation, and nutritional concerns (Neff 1986, Ockenfels 1996). Annual statewide survey data from 1946 – 2010 demonstrate this fluctuation in pronghorn abundance, and show an expansive increase in pronghorn during the 1970s and 1980s, followed by a contemporary decline in pronghorn surveyed that began in the mid-1990s but has stabilized since 2005 (Figure 101 AGFD 2011a). Based on the contemporary decline, the determinations in both Forest Plans indicate a variable to decreasing population trend (USFS 2002, 2010).

Locally, there has been substantial focus on declining pronghorn populations on Anderson Mesa, an area which is included in GMUs 5A and 5B (Yoakum 2002). Pronghorn populations and productivity on Anderson Mesa have been declining significantly since the 1940s (Yoakum 2002). However, significant efforts have been taken to restore higher quality habitat for pronghorn in this area since 2002. The 4FRI project includes a portion of Anderson Mesa.

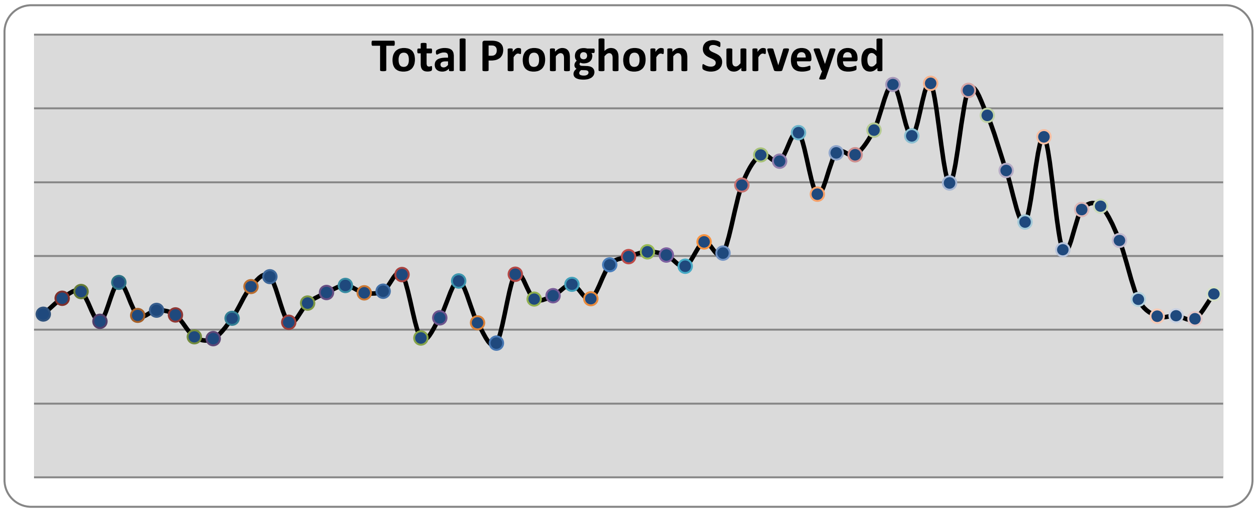


**Figure 101. Results of annual statewide pronghorn surveys 1946 – 2010 (AGFD 2011).**

Because of their primary responsibilities for managing wildlife, the main data source for pronghorn population trends comes from AGFD survey and hunt data. Data used in this analysis were collected by game managers using fixed-wing aerial surveys. Detection rates for pronghorn are highly variable across years depending on weather, annual green-up (affects surveyor's ability to see animals against an otherwise brown back-drop), and how pronghorn shift their distribution in response to localized precipitation patterns. This inconsistency makes interpretation of population data difficult and uncertain (T. McCall, personal communication, November 2011).

AGFD evaluates trends in pronghorn populations based on 1) annual surveys, and 2) model-derived population estimates. Data are displayed by Game Management Unit (GMU; Figure 102). The two best indicators for pronghorn population trend are 1) the number of pronghorn observed during annual surveys (Figure 103), and 2) number of fawns per 100 does observed during annual surveys (Figure 104). These two indicators are more reliable than population modeling estimations for pronghorn because of the uncertainty in certain model parameters such as starting population size and annual mortality rates (Tom McCall, personal communication, November 2011). For the Coconino NF, data are relevant from GMUs 5A, 5B, 6A, 6B, and 7. For the Kaibab NF, data are relevant from GMUs 7, 8, and 9. There is some intermingling of pronghorn herds across the two Forests, primarily between GMUs 6B and 8 as well as GMUs 7 and 9. All GMUs are relevant to the 4FRI project area.

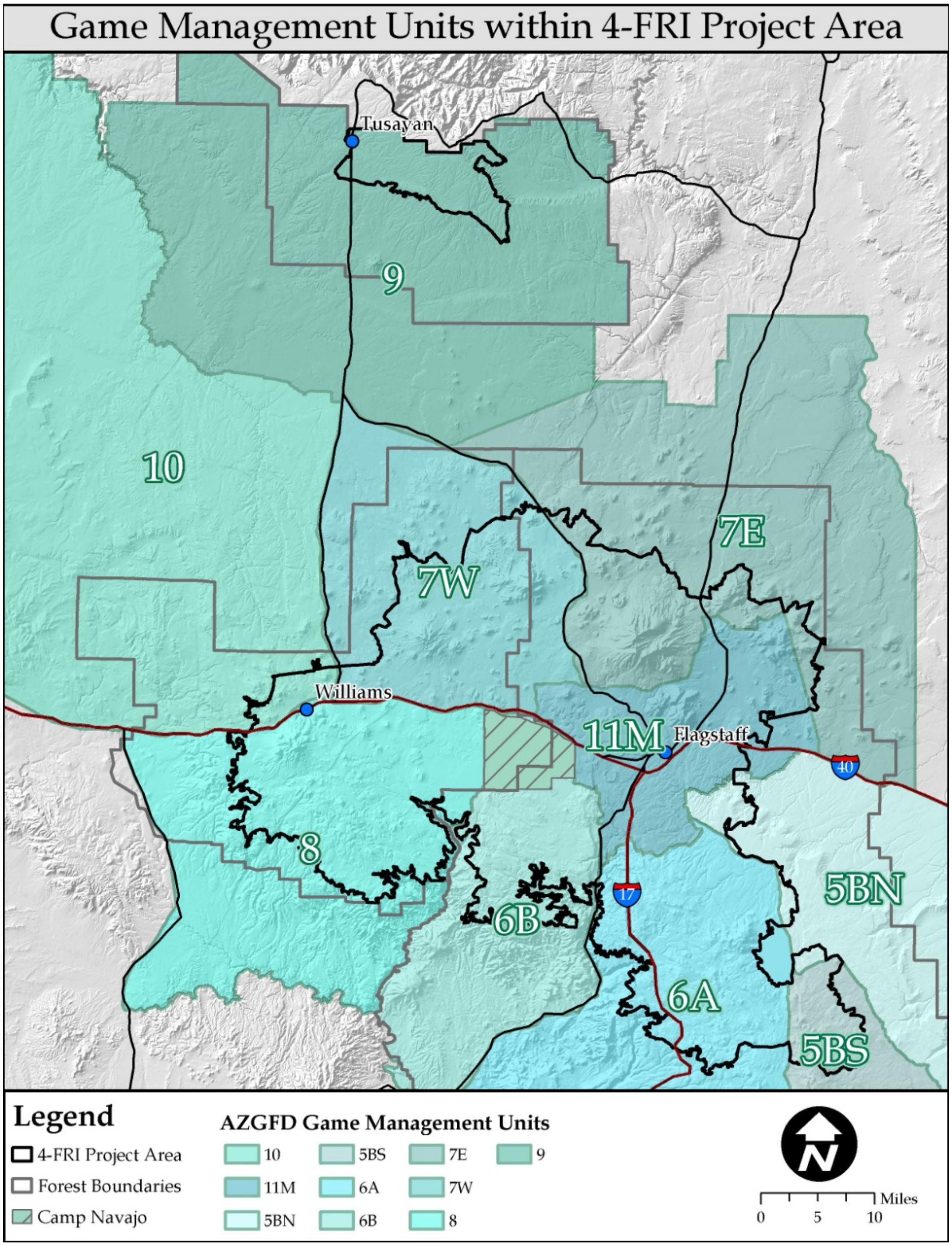


**Figure 102. Arizona Game and Fish Department Game Management Units within the 4FRI Project Area.**

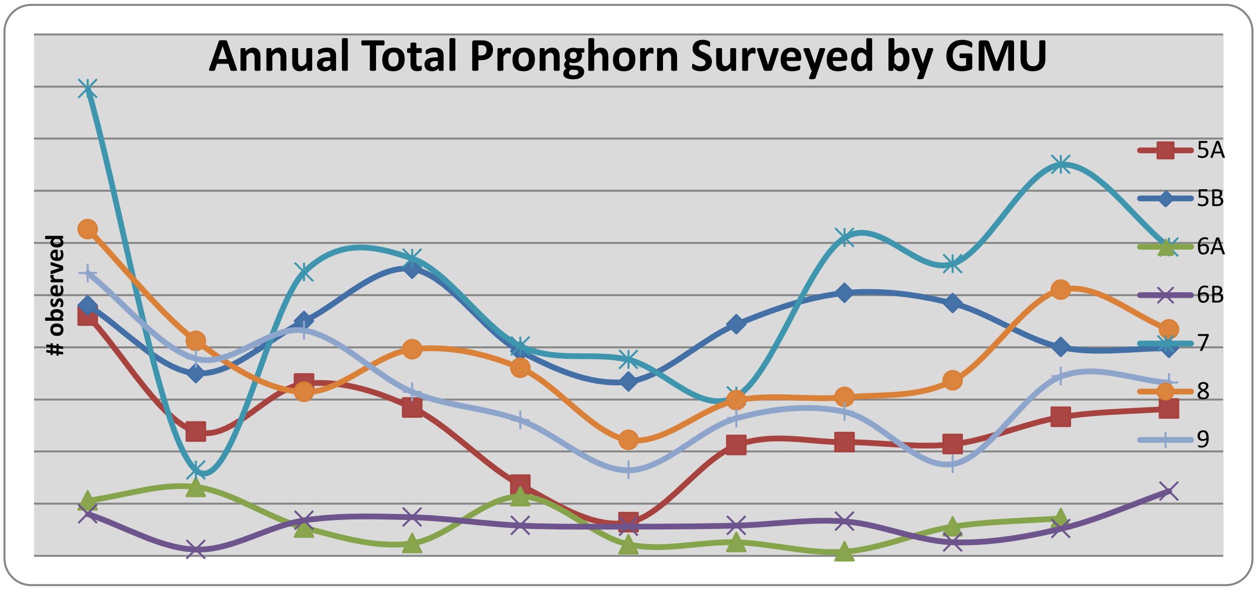


**Figure 103. Total number of pronghorn surveyed by Game Management Units within the 4FRI Project Area, 2001 – 2011.**

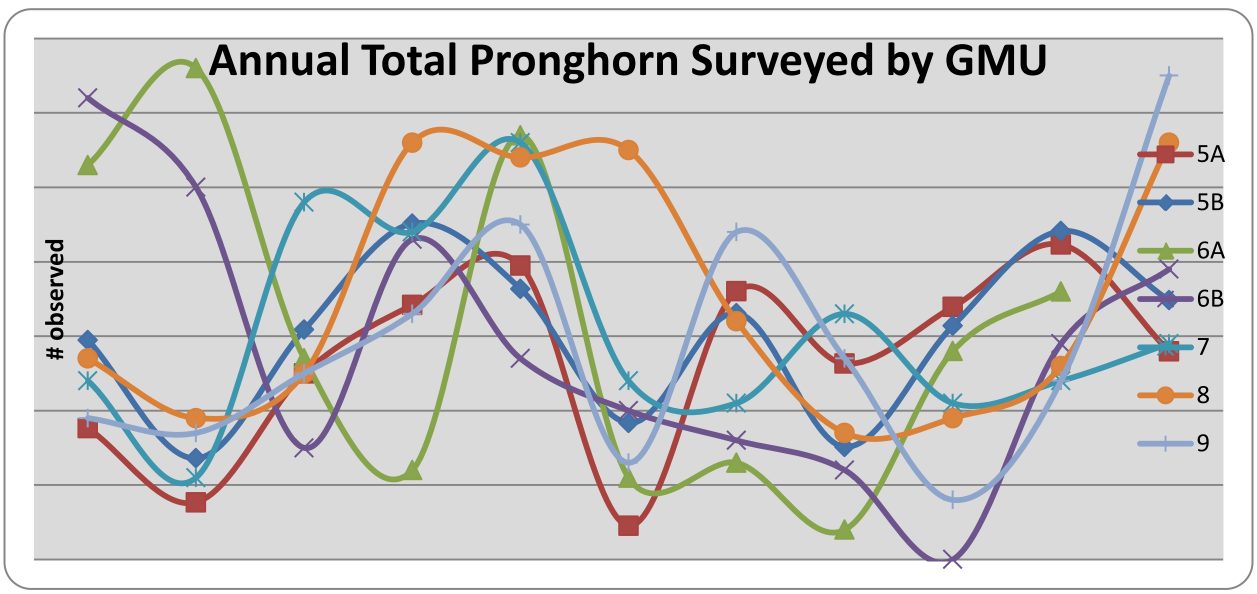


**Figure 104. Fawn:100 Does ratios for pronghorn surveyed by Game Management Units within the 4FRI Project Area, 2001 – 2011. Fawn:Doe ratios are an indicator of annual productivity, which is considered to be the limiting factor for pronghorn populations within the 4FRI project area.**

AGFD population estimates are then derived from a model that takes annual surveys, fawn:doe ratios, buck-doe ratios, harvest, and estimated annual background mortality into consideration. Modeled mortality rates are based on limited available data from AGFD. One limitation of this model is that it requires modelers to select a beginning population size for bucks and does for which reliable data are lacking. Modelers must set beginning population size using anecdotal inference from earliest known survey numbers. For this reason, AGFD recommends greater emphasis on trends rather than absolute numbers. Population trend estimates are available from 2002 through 2011 for both Forests (Figure 105 and Figure 106).

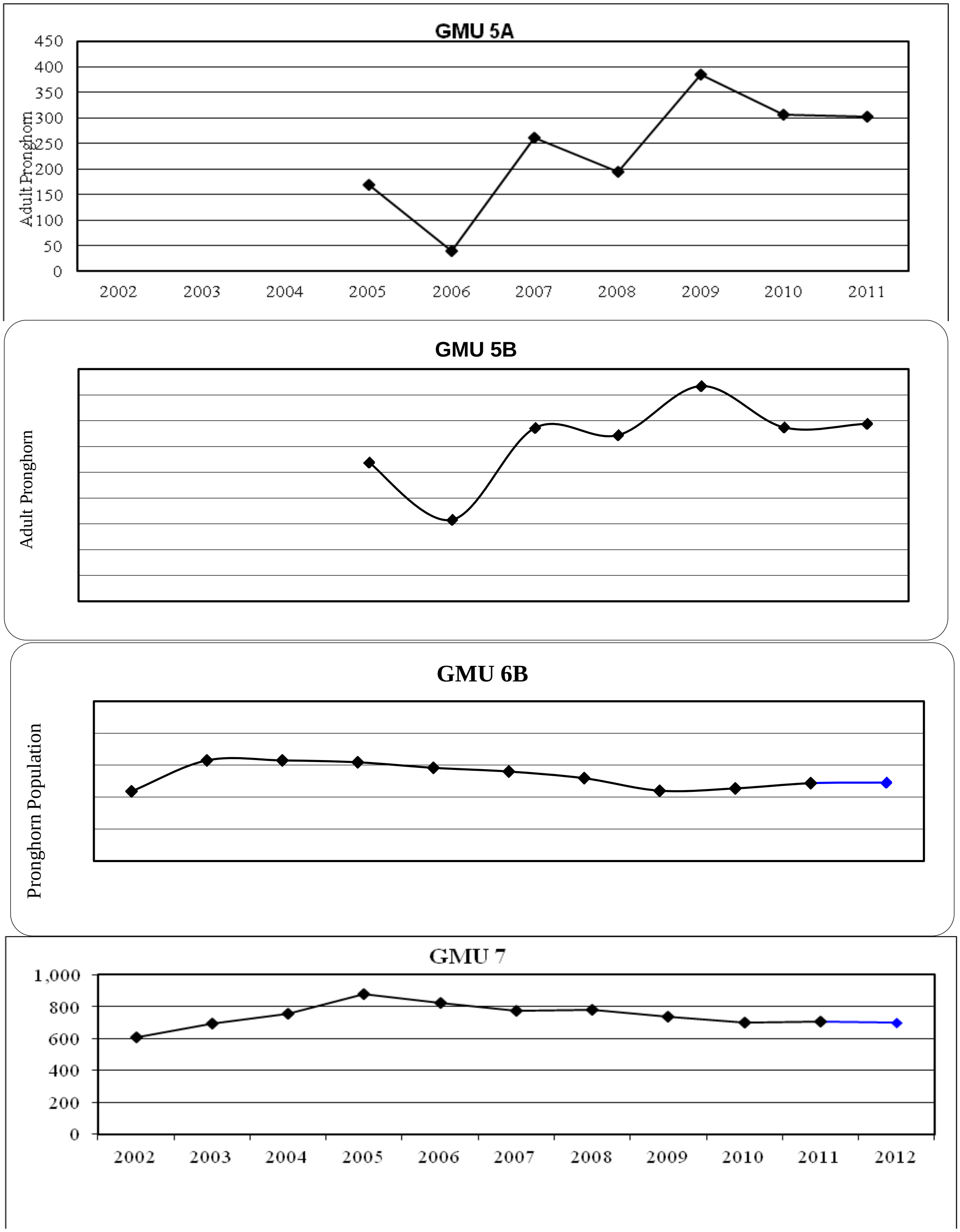


**Figure 105. Estimated population trends for pronghorn, 2002-2011, on the Peaks Ranger District of the Coconino National Forest, including Game Management Units 5A, 5B, 6B, and 7. (6A data were unavailable). Data are unpublished but available from the AGFD Flagstaff Regional Office (T. McCall, personal communication, October 2011)**.

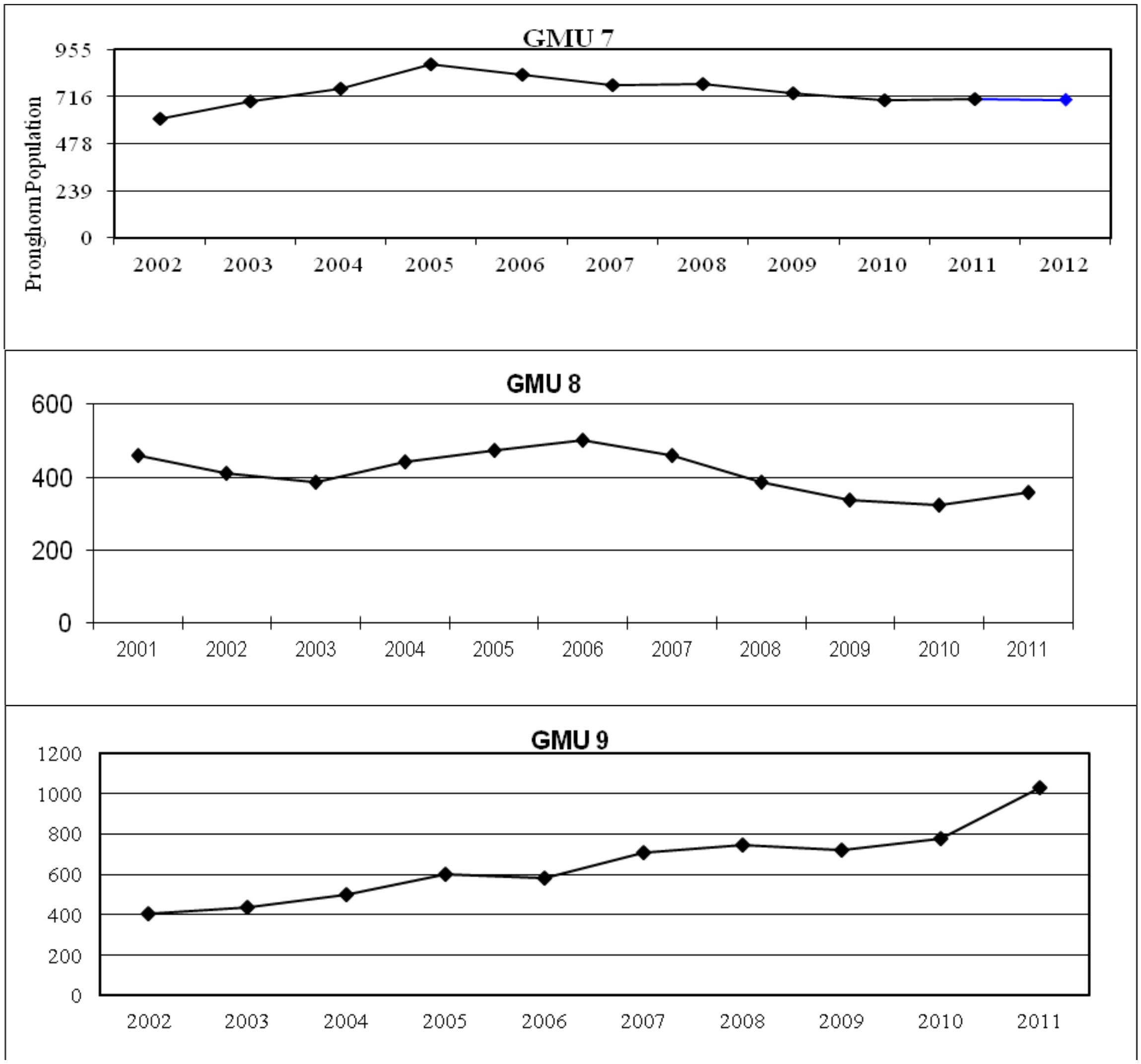


**Figure 106. Estimated population trends for pronghorn, 2002-2011, on the Kaibab National Forest, including Game Management Units 7 and 8 for the Williams Ranger District and Unit 9 for the Tusayan Ranger District. Data are unpublished but available from the AGFD Flagstaff Regional Office (T. McCall, personal communication, October 2011).**

Overall, population models for all GMUs within the 4FRI project area indicate a stable trend over the last decade.

## Habitat Use and Trend

Pronghorn are adapted for sight and flight; visibility and an ability to run at full speed in open, gentle terrain are crucial for predator avoidance. Pronghorn avoid areas of high tree and/or tall shrub density, preferring areas with <30% tree/shrub cover and where vegetation height is less than 0.61 m tall (Ockenfels et al. 1994). 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 (Neff 1986, Ockenfels et al. 1994, Ockenfels et al. 1996, AGFD 2002, Waddell et al. 2005). 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.

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 (Ockenfels et al. 1994). And low shrubs can play a key role as hiding cover for fawns (AGFD 2002).

Several local studies and plans 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 (Ockenfels et al. 1994, Ockenfels et al. 1996, AGFD 2002, Yoakum 2002, Waddell et al. 2005). These studies recommend removal of encroaching woody tree species from grasslands and savannahs as well as prescribed burning to reinvigorate production and diversity of understory forbs which have the highest nutritional value during fawning. Availability of water is also important for pronghorn, particularly for lactating females (Ockenfels et al. 1994).

## Potential Effects

### Effects of Mechanical Thinning

Availability of grasslands, meadows and savannas would continue to be limited for pronghorn use under current conditions. Tree density and canopy cover within historic meadows and grasslands 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. Grassland habitats will continue to decline in the absence of natural disturbances such as fire and without management intervention.

The restoration of historic grasslands and meadows and savanna by thinning encroaching pines will benefit pronghorn habitat connectivity and invigorate productivity of grasses and forbs. Specifically, grassland restoration activities in the vicinity of Garland Prairie would beneficial for pronghorn because of the crucial role Garland Prairie serves as fawning habitat. Thinning would improve sight distances and grass-forb species diversity. Grass-forb cover is expected to increase within 1-2 years post-treatment, which should improve pronghorn foraging and fawning habitats. Restoring large areas to open conditions preferred by pronghorn (<30% in forested cover) would significantly contribute to increases in pronghorn habitat.

The AGFD connectivity data can inform spatial arrangement of mechanical thinning treatments that favor grassland wildlife such as pronghorn (AGFD 2011b). This treatment design, used in combination with soils information and historic evidences, would enhance connectivity for pronghorn populations.

Proposed thinning treatments may cause visual or auditory disturbance to individual pronghorn, although these effects would be short-term.

### Effects of Prescribed Fire

Landscape-scale application of prescribed fire would more closely simulate historic fire regimes, restoring disturbances that work to maintain grasslands, meadows, and savannas. Low-intensity fire is expected to increase growth and diversity of herbaceous vegetation, which would provide increased forage in the long term, with expected benefits as soon as 1-2 years following prescribed fire (Canon et al. 1987 *in* Pilliod et al. 2006). These actions would benefit pronghorn.

Reducing acres of prescribed fire would reduce the direct impacts of burning and smoke. However, pronghorn in the south evolved on grasslands and savannas that were characterized by frequent. Fire helped maintain grassland boundaries, herbaceous openings, and the inherent connectivity of these habitats.

Disruption of normal behavioral patterns could occur to pronghorn during burning activities. Prescribed fire treatments would increase the frequency of fire disturbance on pronghorn. Effects would likely be direct disturbance by human activity during burning activities as well as displacement by fire and smoke. However, disturbance should be transitory in nature and short-term. Since pronghorn are capable of moving several miles in any given day, it is likely they will be able to move out of smoke paths in the event of prescribed burns. Burning in known fawning areas between April 15 and June 15 could impact young, less-mobile fawns.

Non-native, invasive plants can negatively impact pronghorn habitat quality through a process of invasion, competition, and eventual elimination of native grasses and forbs through unnatural acceleration of fire frequencies in pinyon-juniper and ponderosa pine systems. The risk of non-native plant invasion following restoration treatments has the potential to negatively impact pronghorn habitats in the long-term. Following Best Management Practices for noxious weed prevention should mitigate this threat.

### Effects of Aspen, Spring, and Ephemeral Channel Restoration

Pronghorn do not select for aspen habitats and would therefore not be affected by aspen restoration. Since pronghorn are highly mobile and relatively wide ranging, the small size of fence projects for aspen, spring, and ephemeral channel restoration activities will not impact pronghorn movement. Spring restoration, if located adjacent to grassland or savanna, is expected to improve habitat quality for pronghorn by improving available water sources in the long term.

### Effects of Road Closure/Obliteration

Closure and obliteration of unauthorized roads will positively impact pronghorn. Pronghorn are known to avoid roads and heavily used recreational areas (Ockenfels et al. 1996).

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# Appendix 7. Mexican Spotted Owl Biology and Ecology in Relation to the 4 Forest Restoration Initiative

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# Introduction

This report summarizes current the status and ecology of the Mexican spotted owl (MSO) within the Upper Gila Mountains Recovery Unit (UGM RU). It includes a review of the scientific literature. In particular, it includes summaries from the recent Rocky Mountain Research Station General Technical Report 256 (Ganey et al. 2011) which was written at the request of U.S. Forest Service personnel associated with the Four Forests Restoration Initiative (4FRI). 4FRI occurs entirely within the UGM RU which supports over half of the known population of Mexican spotted owls. Consequently, the UGM population is viewed as important to stability within the overall range of the owl, and management that impacts owls within the UGM RU could affect owl populations beyond that RU.

## Existing Conditions

The primary administrator of lands supporting MSOs in the Southwest is the FS. Most MSOs have been found in the 11 NFs of Arizona and New Mexico (Region 3 of the FS).

The MSO is widespread and the threats facing the owl vary by location. MSO densities, food habits, degree of isolation, and other aspects of their biology differ in different locations. For these reasons, the USFWS described 6 Recovery Units within the Southwest United States (Figure 107). Recovery Units were delineated based on the following information, presented in order of importance: (1) physiographic provinces, (2) biotic regimes, (3) perceived threats to owls or their habitat, (4) administrative boundaries, and (5) known patterns of owl distribution (USDI FWS 1995). The Coconino and Kaibab NFs occur in the UGM RU.

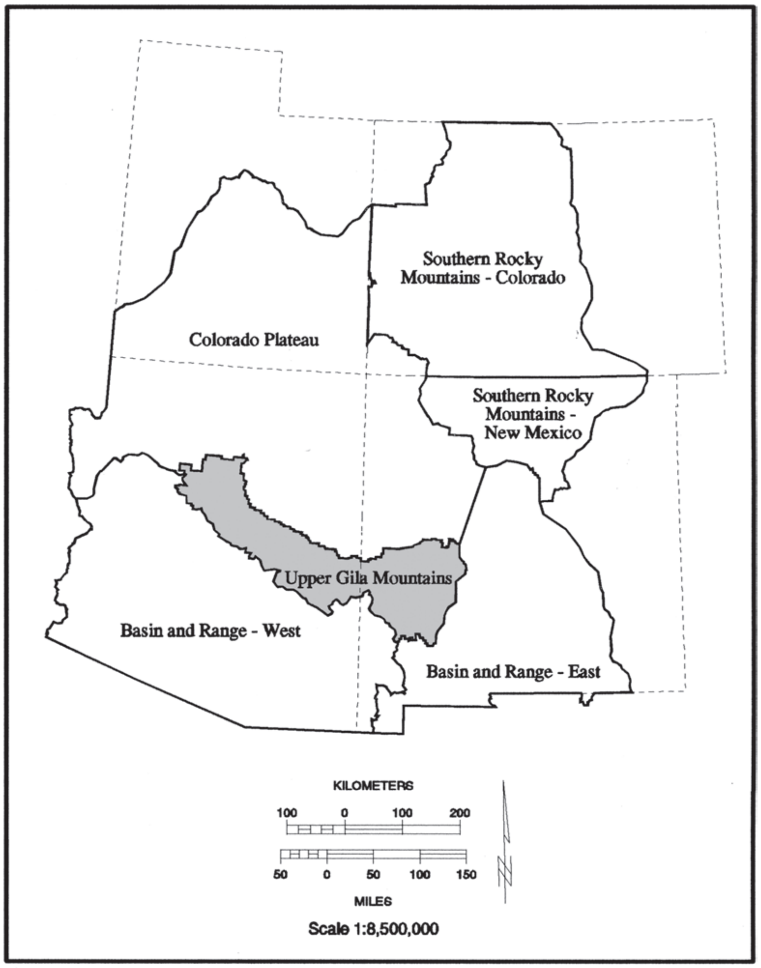


**Figure 107. Recovery Units within the United States recognized in the Mexican spotted owl Recovery Plan (USDI FWS 1995).**

## MSO Habitat

MSOs are described as nocturnal “perch and pounce predators” that locate prey from an elevated perch by sight or sound, then pounce on the prey, capturing it with their talons (USDI 1995). They commonly eat small- and medium-sized rodents such as woodrats, peromyscid mice, and microtine voles, but also consume bats, birds, reptiles, and arthropods. Their diet varies by geographic location. The vegetation within UGM RU has been described as a zonal pattern of grasslands within woodland and forest cover types (USDI 1995). Combined with the diverse topography, this creates abundant and widespread forest-meadow interfaces. Because of this interspersion of meadows and grasslands, MSOs in the UGM RU have a higher reliance on voles compared to other prey species and MSOs in other RUs (USDI 1995).

MSOs most commonly occur in mixed-conifer forests and canyons within the UGM RU. They also occur in ponderosa pine forests with developed Gambel oak understories. Gambel oak is considered a long-lived seral species in these forests (USDI 1995). A study on the Coconino NF found the presence of mature and old-growth oak an important factor in distinguishing MSO nest sites from all other plots types (May et al. 2004). They found MSO primarily nested in Gambel oak greater than 18 inches dbh (May et al. 2004). Alligator, Rocky Mountain, one-seed, and Utah juniper and pinyon pine also occur in pine and pine-oak forests of the Southwest.

Abella (2008) reported small Gambel oak have escalated since settlement in the late 1800s, with densities increasing from 4- to more than 63-fold. There are three basic growth forms in Gambel oak: shrubby thickets of small stems, pole-sized clumps, and large trees. Top-killed oak resprout prolifically and this can maintain the shrub form (Abella and Fule 2008). Historical fire return intervals in southwestern pine-oak often averaged 2 to 22 years (Weaver 1951, Cooper 1960, , Swetnam and Baison 1990, Covington et al. 1997, Fulé et al. 2003, Abella and Fule 2008). Local research documented oak can be maintained during low-intensity burning with more than 66 percent of oak less than six inches dbh alive at least five years after two prescribed burns (Abella and Fule 2008). Oak less than two inches dbh had survival rates less than 20 percent (Abella and Fule 2008) but resprouted vigorously (Fule et al. 2002).

Soil properties, species richness, plant cover, and the distribution of cool- and warm-season grasses are canopy-type specific (Abella 2009). Research on the Coconino NF found three to eight times greater plant cover in openings than any tree canopy type, supporting species that were infrequent below trees (Abella 2009). Similarly, some understory species occurred more frequently beneath Gambel oak canopies. There were no species that were most frequent below ponderosa pine (Abella 2009). Thinning pine can recreate canopy openings and maintain productive and diverse understories on this landscape (Abella 2009). Thinning pine also consistently increases oak diameter growth for promoting large oaks (Abella 2008).

The following section was extracted from Ganey et al. 2011: Although Forest Service managers do not manipulate populations of native wildlife directly, understanding life history and habitat use is fundamental for informed conservation planning. Conservation of wildlife populations requires information about the factors that influence vital rates and ultimately population growth. Similar to other spotted owl subspecies, average reproductive rates are generally low in MSO populations. Mexican spotted owls breed sporadically and do not nest every year (Gutiérrez and others 1995, White and others 1995, Stacey 2010). Reasons for this pattern of sporadic breeding are unknown, but temporal variation in food resources and weather are suspected to influence both the proportion of pairs nesting and the proportion fledging young. Survival estimates for MSOs within the UGM RU generally indicate relatively high survival rates for adult owls, intermediate survival rates for subadult owls, and relatively low survival of juvenile owls. While this pattern has been observed in the better-studied northern (Burnham and others 1996, Anthony and others 2006) and California subspecies of spotted owls (Franklin and others 2004, LaHaye and others 2004), temporal variation in survival rates appears to be greater in MSOs (Seamans and others 2002) than in the other subspecies. In a study of 2 MSO populations, Seamans et al. (2002) found that on the Coconino NF precipitation from the previous year explained 73% of temporal variation in reproductive output, and precipitation from the previous monsoon season explained 53% of the temporal variation in survival. In New Mexico, precipitation from the previous monsoon explained 42% of temporal variation in reproductive output, and precipitation from the previous winter explained 56% of temporal variation in owl survival. For both study areas, reproductive output varied more than survival across years. This life history strategy allows owls to reproduce when conditions are favorable and to survive unfavorable periods with little or no reproduction.

The amount and arrangement of suitable habitat likely drives patterns of owl distribution (UDSI FWS 1995: 83). In most spotted owl populations studied, however, differences in habitat composition and configuration among owl territories explained less of the variation in owl vital rates among these territories than did weather (Franklin and others 2000, Olson and others 2004, Blakesley and others 2005, Dugger and others 2005). These studies suggest that temporal variation in climate is more variable than spatial variation in habitat among occupied owl territories, and that climate therefore is an important driver of vital rates within occupied owl habitat. The studies focused on areas that owls had already selected as home ranges. These areas presumably represent high-quality spotted owl habitat. There is far less variability in habitat among these territories than between these territories and randomly available areas on the landscape. In at least some cases, aspects of within-territory habitat configuration that were optimal for survival were suboptimal for reproduction (Franklin and others 2000).

## MSO Prey Species

MSOs in the UGM RU take more microtine voles and fewer woodrats than owls in other RUs (USDI 1995). Peromycid mice are another key prey species, perhaps because they are ubiquitous in distribution and occupy variable habitats (USDI 1995). The inherent interspersion of forest and meadow as well as historical patterns of open pine-oak forest may have influenced available prey and the MSOs diet.

Graminoid species function as both food and cover for Mogollon voles. They select areas with high grass cover and selectively feed on grasses with $C_3$ photosynthetic pathways (“cool season” grasses that flower in late spring or early summer; Chambers and Doucett 2008). Conversely, microhabitat characteristics do not appear to explain deer mouse distribution as well as simpler macrohabitat features (Coppeto et al. 2006). When small mammal populations were measured against forest basal area (BA), both Mogollon voles and deer mice responded negatively to increasing BA (Bagne and Finch 2009, Kalies et al. 2012). Two studies conducted within the 4FRI area concluded Mogollon voles and deer mice responded positively to reductions in overstory BA, noting strong associations with understory vegetation (Converse et al. 2006, Kalies et al. 2012). Overall, small mammal communities can benefit from thinning treatments in western fire-prone ecosystems, particularly when a variety of forest structural types are retained for dense forest obligates (Converse et al. 2006, Noss et al. 2006, Kalies et al. 2012). Interestingly, Bagne and Finch (2009) found winter precipitation could have a negative effect on deer mouse populations, but thinning treatments focused on restoring forest structure reversed this trend. The Recovery Plan notes total prey biomass may be more influential on the owl’s fitness than abundance of any particular prey species (USDI 1995).

The following section was extracted from Ganey et al. 2011: The strong link between raptors and their food is well documented (Newton 1979). Understanding a predator’s food choices along with the natural and life history of its common prey species can provide practical information for conserving and enhancing the predator’s habitat. Several studies provided information on diets of Mexican spotted owls within the UGM RU based on examination of prey remains from regurgitated owl pellets. However, soft-bodied prey (for example, insects such as butterflies and moths; Lepidoptera) may be under represented in pellets.

Several studies have estimated prey abundance within ponderosa pine or ponderosa pine–Gambel oak forests within the UGM RU (Table 162). Estimates varied among studies, but abundance typically was both greater and more variable for deer mice than for most other species. Density of deer mice was the most variable, ranging from a high of 4.9 mice per acre (12.2 ha–1) during summer 1991 to a low of 1.3 mice ac–1 (3.3 ha–1) during winter. Relative abundance of brush mice and woodrats generally was low in all seasons and years.

**Table 162. Density (range in number per acre) of selected small mammals in ponderosa pine and ponderosa pine–Gambel oak forest, Arizona.**

| Source | Deer mouse | Brush mouse | Mexican woodrat | Pocket gopher |
|---|---|---|---|---|
| Goodwin and Hungerford (1979) | 2–19 | 6–20 | 2–10 | <0.2 |
| Block and others (2005) | 1–5 | 0–2 | 0–0.4 | |
| Kyle and Block (2000) | 0.4–4.7 | | | |
| Converse and others (2006) | 2.2–12.6[1] | 2.2–12.6[1] | 0–2.5 | |

[1] Estimate provided in Converse and others (2006) was for deer and brush mice combined.

Ward (2001) estimated biomass of prey species during summer within cover types (mid- and late-seral stage mixed–conifer forest, grassland, and ponderosa pine forest and pinyon-juniper–oak woodland) and evaluated variability in summer biomass among years. Biomass of all species except the Mexican woodrat differed significantly ($P < 0.05$) across years, and the year effect was nearly significant for woodrats ($P = 0.059$). Cover type by year interactions were observed for brush mice and both vole species, indicating that population trends were not always synchronous in different cover types. Similar interactions were not observed for deer mice and woodrats.

A study in the Sacramento Mountains, New Mexico (Basin and Range-East RU, Ward 2001) found that reproductive output of spotted owls was influenced by abundance of smaller rodents such as mice and voles in mixed-conifer forests. Abundance of these same prey species in two other cover types (montane meadow and xeric forest) had little influence. Temporal variability in abundance of these rodents was greater than spatial variability among cover types. That is, rodent abundance varied more among years than among cover types within year.

Available data on spotted owl diet composition suggest that owls are opportunistic predators that eat a wide variety of prey but typically prey primarily on a relatively few groups of small mammals that are active at night. Significant relationships between consumption of large prey and successful breeding have not been observed in Mexican spotted owls, and efforts to link owl reproduction to consumption of particular prey species have been mostly unsuccessful. In fact, owl reproduction appears most linked to combined biomass of multiple prey species (for example, Ward 2001), as might be expected in an opportunistic predator. Given the variation in habitat relationships across the small mammal community, a diversity of various habitat features across the landscape likely will best maintain high diversity, ensure maintenance of important ecological functions in that community (Kalies and Chambers 2010), and buffer against population fluctuations of individual prey species to provide a more constant food supply for the owl (Sureda and Morrison 1998, Ward 2001, Block and others 2005). An important consideration here is that many small mammals may respond to variation in habitat features at relatively fine scales and different species may respond to habitat features at different scales.

Because total prey biomass may be more influential on MSO fitness than the abundance of any individual prey species, the Recovery Plan (USDI 1995) recommends managers provide diverse habitats to support a diverse prey base. For example, Mexican voles are found in areas with high herbaceous cover, especially dense grass cover, while Mexican woodrats are typically found in areas with high shrub or understory tree cover, high down log volumes, and little herbaceous cover. Deer mice are ubiquitous, occupying areas with variable conditions whereas brush mice are restricted to areas with a strong oak component and dry, rocky substrates with sparse tree cover (USDI 1995).

Starvation, particularly for juveniles, was identified as a potentially important mortality factor in the Recovery Plan (USDI 1995). The Recovery Team identifies this as of particular concern where prey resources and availability are reduced in abundance.

# Upper Gila Mountain Recovery Unit

## Status of the Upper Gila Mountain Recovery Unit

The Apache-Sitgreaves, Coconino, Kaibab, and Tonto NFs that make up the 4FRI are within the Upper Gila Mountain Recovery Unit (UGM RU). These forests, along with 2 more in New Mexico encompass 42% of the RU (USDI 1995); the proposed 4FRI project occupies the western portion of the UGM RU. The UGM RU supports over half the known population of MSOs (Ganey et al. 2011) and is at significant risk of high-severity wildfire (USDI 1995). The Recovery Plan recommends recovery actions concentrate on: RUs with the highest owl populations and where significant threats exist; management within these RUs should emphasize alleviating the greatest threats; and that management actions should be tailored to the needs of the area under analysis (USDI 1995).

This RU lies within the largest contiguous ponderosa pine belt in the world. The owls appear to be more continuously distributed here, relative to other RUs, and show high levels of movement and gene flow. The central location of the UGM RU within the overall range of the MSO also facilitates gene flow across their range. Effects of management and effects from a lack of management within the UGM RU can impact MSOs beyond this RU. The UGM population is therefore important to the overall status of MSOs. 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 RU. 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 projects addressing MSOs and their habitat, 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 WWW). The intent of this report is to aid planners in evaluating potential benefits or impacts of management actions for MSOs and their habitat.

The remaining portion of this section was extracted from Ganey et al. 2011: Historical information on Mexican spotted owls throughout their range is sparse and anecdotal but clearly documents that these owls were present in the UGM RU. Referring to what is presumably the Blue Range Primitive Area and White Mountains of eastern Arizona, Ligon (1926:422) stated that MSOs were “…by no means as scarce in favored sections of their range as one unfamiliar with their habits might believe.” Bailey (1928; see also Steele 1927) also lists several locations where spotted owls were observed in this general region. Historical data for the western portion of the RU, where the 4FRI is proposing to begin forest treatments, are sparse. Huey (1930) collected an adult female spotted owl at the base of the San Francisco Peaks in June 1929. Beyond this, little is known about the historical distribution of MSOs within the UGM RU.

Today MSOs are known to be widely distributed within the UGM RU, with most locations occurring on National Forest System lands (see also USDI FWS 1995, Ward and others 1995). They are located on all six NFs within this RU and have a relatively continuous distribution throughout the UGM RU in contrast to a patchy distribution throughout much of the rest of their range.

An estimated 2,941 territorial adult or subadult owls occupied the UGM RU (excluding tribal lands, which were not included in the sampling frame). This estimate was rigorous but imprecise, with a 95% confidence interval ranging from 833–5,049 owls. Since 1989, when USFS began using standardized procedures to identify and record occupied MSO "sites", a cumulative total of 424 such sites have been documented in the UGM RU (USDI FWS 1995). This constitutes 55.9% of the known spotted owl sites documented range-wide (USDI FWS 1995). It is not possible to estimate abundance directly from these data, however, for the following reasons: these sites may indicate occupancy by either a single owl or a pair of owls, it is not known how many of these sites are occupied during any given year, and these surveys may not be effective at locating non-territorial individuals. These known owl sites are well distributed among the NFs comprising this RU, with the exception of the Kaibab NF. The Kaibab NF has few known owl sites, which contrasts sharply with the neighboring Coconino NF. The UGM RU contains the two forests with the greatest number of known sites (Gila and Coconino NFs) and three of the four top forests in terms of known sites (including the Apache-Sitgreaves NF).

## Metapopulation dynamics in UGM RU

The distributional pattern of MSOs is disjunct relative to other subspecies of spotted owl, making MSO dispersal an important consideration (USDI 1995). Providing for connectivity could buffer MSO populations "from stochastic variability through time by providing the opportunity for local population failures to be 'rescued' by immigration from other populations" (USDI 1995).

The following section was extracted from Ganey et al. 2011: The structure and spatial distribution of spotted owls at a range-wide scale suggests that groupings of individuals may occur as subpopulations, and that these subdivided populations may function as a metapopulation. Of the three spotted owl subspecies, the distribution of MSOs appears to most naturally resemble the metapopulation construct, with perceived subpopulations existing in useable habitat created by elevation gradients and disconnected mountain or canyon systems separated by a matrix of low-quality to non-useable habitat.

Keitt and others (1995, 1997) examined the spatial pattern of forest habitat patches across the range of the Mexican spotted owl. Patches of forest habitat in the range of the Mexican spotted owl showed a connectivity threshold of approximately 28 miles and the authors concluded that an organism capable of dispersing ≥28 mi (45 km) through inhospitable terrain, and with an average exponential dispersal distance of ≥9 mi (15 km), would perceive the landscape as a series of connected patches. They further concluded that Mexican spotted owls likely met these criteria, and that the Mexican spotted owl probably behaves as a classical metapopulation over much of its range. At this scale, the landscape consists of a set of large, more-or-less discrete habitat clusters. This suggests that owls could successfully disperse within habitat clusters with very high probability and disperse between clusters with much lower probability.

Keitt and others (1995, 1997) also attempted to identify habitat clusters most important to overall landscape connectivity, using maps based on forest and woodland cover to define clusters. The UGM RU emerged as the most important RU in this analysis because of its large area and relatively continuous forest habitat. They next conducted a second analysis aimed at emphasizing positional effects on landscape connectivity. The UGM RU again emerged as important in this analysis, due to both its large size and central location. Some small habitat clusters also emerged as important. Because of their locations, these clusters may serve as stepping stones between other, larger clusters and thus may be important to landscape connectivity despite supporting relatively few resident owls.

Barrowclough and others (2006) investigated genetic structuring in Mexican spotted owl populations. Their data suggested substantial gene flow among populations sampled in the Mogollon Rim–Upper Gila Mountains region of central Arizona and New Mexico, with more restricted gene flow among other populations (Barrowclough and others 2006). They recognized three major haplotypes within the range of the Mexican spotted owl. One haplotype was common in populations in the northwestern portion of the range and not found in the southeastern portion. A second haplotype was most common in the southeastern portion of the range, and not found in the northwestern portion. A third haplotype was found in all populations studied, but was most common in the UGM RU and in southern Arizona. All three haplotypes occurred in populations within the UGM RU, suggesting that this area is important in facilitating gene flow across the range of the Mexican spotted owl.

These findings highlight the importance of both large patches of habitat and of some small patches based on their location and consequent influence on landscape connectivity. The UGM RU is important in both contexts. This RU includes the largest contiguous area of habitat for Mexican spotted owls, and that is reflected in the large number of documented owls in that RU (Ganey and others 2004). This RU also is centrally located relative to other areas inhabited by Mexican spotted owls. The larger subpopulation in this RU likely serves as a core source population for supplying new recruits to proximal outlying locations and for facilitating gene flow throughout the range of the Mexican spotted owl.

## MSO Habitat

### Protected and Restricted Habitat

The authors of the MSO Recovery Plan ("Recovery Plan", USDI USFWS 1995) agreed that forests in the Southwest were outside the historical range of variation and are at high risk from uncharacteristic fire, insect, and disease events. They propose recovering MSO populations by sustaining adequate habitat quality and quantity through time and within the historical range of variation. They recommend managers emulate natural ecosystem processes to create landscape mosaics that balance natural variability and secure the landscape against uncharacteristic habitat loss. This coarse filter approach is expected to sustain biotic diversity, including most of the habitat conditions required by the owl and its prey, across the landscape (USDI 1995).

The Recovery Plan provides three levels of habitat management - protected, restricted, and other forest and woodland types to achieve a diversity of habitat conditions across the landscape. Protected areas include protected activity centers (PACs); 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. Restricted areas include all mixed-conifer, pine-oak, and riparian forests outside of protected areas. Other forest and woodland types include all ponderosa pine, spruce-fir, woodland, and aspen forests outside protected and restricted areas.

Protected areas receive the highest level of protection. PACs are at least 600 ac in size and based on known locations of owls. Within PACs are core areas of at least 100 acres intended to protect nesting and roosting habitat. Restricted habitat is less specific and intended to operate in conjunction with ecosystem management and existing management guidelines to provide for nest and roost habitat through time. A minimum of 10 percent of restricted habitat is designated T/Th and intended to identify those acres closest to currently meeting nesting and roosting habitat for the MSO. Key nesting and roosting habitat values are defined in the Recovery Plan (Table 163). It is assumed in the Recovery Plan that by meeting recommended levels for tree density and BA, adequate amounts of snags and logs (12 inches at mid-line and 8 feet long) should be present. These desired conditions must be met simultaneously for a stand to qualify as existing threshold habitat. They also represent minimum values that must be maintained where conditions meet or exceed these values. In project design, no stands simultaneously meeting or exceeding these minimum threshold values should be reduced below those values unless a larger landscape analysis of restricted areas shows a surplus of acres simultaneously meeting threshold values. Treatments that reduce fire risk, lessen threats from uncharacteristic levels of insects and forest disease, or meet other ecosystem objectives are allowed as long as overall values remain at or above nesting and roosting conditions. The scale at which the evaluation occurs can add subjectivity to the decision. The Recovery Plan estimated most FS project planning occurred at about the 10,000 ac level, which they describe as a “limited spatial scale” that precluded a review of MSO habitat at more meaningful ecological scales (USDI 1995).

**Table 163. Minimum values for achieving Target/Threshold stand conditions**

| Upper Gila Mountain Recovery Unit | Percent of Restricted Habitat | Percent of Total SDI by trees 12-18" dbh | Percent of Total SDI by trees 18-24" dbh | Percent of Total SDI by trees >24" dbh | Stand basal area | Trees per acre ≥ 18” dbh | Basal area of oak ≥ 5” dcr |
|---|---|---|---|---|---|---|---|
| Pine-oak forest | 10 | 15 | 15 | 15 | 150 | 20 | 20 |

Overall, MSO habitat elements are not on a sustainable trajectory within the UGM RU. Recent wildland fire history indicates wildfires are larger and are burning at higher severity. In 1910, only two crown fires were big enough to map in the ponderosa pine forests of the Kaibab Plateau. The larger of the two fires burned about 80 acres (Paxon 2011). In 1995, habitat loss from high severity wildland fire was identified as a primary risk in the Recovery Plan (USDI 1995), yet the three most active fire seasons in Arizona history have occurred since 2001, with nearly a million acres burned in 2011 alone (Paxon 2011).

Large snags cannot be created without large trees and both large trees and large snags are important to the MSO (USDI 1995). The Coconino and Kaibab forest plans call for an average of two snags per acre in ponderosa pine forests. However, these specifications may be unrealistic. Ganey (1999) found only 30% of ponderosa pine plots in un-logged sites met or exceeded USFS snag guidelines and Waskiewicz (2003) found pine snag densities well below FS guidelines in relatively undisturbed forests in northern Arizona. Fire promotes recruitment of large snags, but in one study conducted locally, 40% of fire-killed snags fell within seven years (Chambers and

Mast 2005). Over 80% of ponderosa pine snags created by high severity fire fell within 10-years post-fire (Chambers and Mast pers. comm.). Similar fall rates appear to occur for beetle-killed ponderosa pine trees (Chambers and Mast pers. comm.). Chambers and Mast (2005) found greater densities of large diameter snags in unburned plots vs. burned plots on the Coconino and Kaibab NFs. 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, but in 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 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 164). 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. While more trees were dying in the smaller size-classes, proportions of dying trees were greatest in the largest size classes. 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).

**Table 164. Number of dead Ponderosa pine trees per acre on the Kaibab National Forest portion of the 4FRI (FIA unpublished data).**

| Ranger District | Diameter class | | |
|---|---|---|---|
| | 5"-10.9" | 11"-14.9" | >=15" |
| **1995** | | | |
| Tusayan | 0.39 | 0.00 | 0.11 |
| Williams | 0.99 | 0.00 | 0.24 |
| Totals | 2.49 | 0.00 | 0.49 |
| **2007** | | | |
| Tusayan | 0.33 | 0.16 | 0.33 |
| Williams | 2.18 | 0.60 | 0.79 |
| Totals | 5.00 | 1.50 | 1.20 |

The proximate cause for the observed mortality observed by Ganey and Vojta (2011) was a complex of bark beetles likely mediated by long-term drought conditions. Insects and disease outbreaks are also a function of stand density. Increased stand densities create prime conditions for insect epidemics and disease outbreaks, particularly among older trees. Fungi and parasitic plants weaken structural integrity of stressed trees, making them more susceptible to bark beetle attacks (Filip 2007). Historically, the western pine beetle (*Dendroctonus sp*.) was the most aggressive and damaging insect in ponderosa pine forests on the Kaibab NF (Lynch et al. 2008). On the Kaibab NF, mountain pine beetle outbreaks occurred in the 1910s and 1970s, but mortality was reported at less than 3% (Lang and Stewart 1910, Lynch et al. 2008). Since 2003, damage by

*Dendroctonus* has been surpassed by the *Ips* genus, an aggressive beetle that favors denser forests. An unprecedented *Ips* outbreak damaged 60,000 acres on the Kaibab NF from 2002 to 2004 with 100% mortality occurring in some stands. In general, ponderosa pine mortality in the southwest has increased as a result of drought and more frequent bark beetle attacks (Kolb et al. 2007, Ganey and Vojta 2011).

Most beetle activity has decreased substantially since 2002, although the western pine beetle has remained active on the Coconino NF with over 5,000 acres of mortality reported in 2007 (USDA Southwest Region Forest Health 2008). Large mortality events in northern Arizona forests are typically infrequent, followed by relatively low mortality rates (Joel McMillin, pers. comm.). However, future drought cycles would be expected to again accelerate tree mortality from bark beetles. Ponderosa pine mortality associated with Ips and other bark beetles is expected to continue to occur throughout the region as a result of high populations and dispersal distances of beetles (Allender et al. 2008). While losses of big trees will assist in meeting snag guidelines in the short-term, it decreases the likelihood of meeting large tree (i.e., trees greater than 18 inches dbh) guidance in the Recovery Plan over the long-term.

Another result of current forest health issues in southwest ponderosa pine forests is an increase in large down logs. 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 ($p < 0.001$) during that same period. However, the changes documented here represent initial results from a drought-mediated pulse in tree mortality (Ganey and Vojta 2011).

The following section was extracted from Ganey et al. 2011: Available information suggests that Mexican spotted owls use relatively large home ranges, with smaller areas of concentrated use embedded within those home ranges. There are 4 spatial scales relevant to understanding space use by resident MSOs: territory, home range, activity center, and core area. Spotted owls are described as territorial in the sense that mated pairs defend a breeding territory, at least during the nesting season. Seasonal and longer-term fidelity to territories is often strong, with many owls remaining on the same territory year after year (Gutiérrez and others 1995). No direct estimates of territory size are available for MSOs within the UGM RU, but estimates of nearest-neighbor distances between adjacent pairs indicate mean distances of 1.5 mi in Arizona (n = 42 pairs; May and Gutiérrez 2002; Coconino NF) and 1.3. mi in New Mexico (n = 31 pairs; Peery and others 1999; Gila NF). This suggests that exclusive use areas average approximately 1,115 and 855 acres, respectively.

Home ranges are usually assumed to be larger than territories, although few studies have formally evaluated differences between territories and home ranges. Home-range size varied considerably among study areas, but the factors underlying that variation are unclear. Home ranges of adjacent pairs may overlap spatially, and the entire home range typically is not defended. Research sampling regimes and sample sizes have varied and studies were conducted in different years, making direct comparisons among studies difficult (Kernohan and others 2001). Consequently, observed differences among studies could be due to differences in methodology. We assume that some of the observed variation in home-range size is real rather than an artifact of methodology. Differences could be a result of local habitat quality including abundance of prey, biogeographic effects (for example, differences in climate pattern or biogeographic region), temporal variation (studies conducted in different years), or all of the above. There is evidence from outside the

UGM RU that local habitat composition and/or prey abundance can influence home-range size of spotted owls (Carey and others 1992, Zabel and others 1995, Ganey and others 2005).

Only one study within the UGM RU estimated size of seasonal home ranges (Ganey and others 1999). Home range size more than doubled from the breeding to the non-breeding season in this study (Table 165). Annual activity centers for owl pairs generally were less than half the size of home ranges, suggesting considerable concentration of activity in particular areas. This pattern also held in a comparison of seasonal activity centers of individual owls within a single study area (Table 165).

**Table 165. Area of home ranges or activity centers of radio-marked Mexican spotted owl pairs and individuals in ponderosa pine–Gambel oak forest during the breeding and non-breeding seasons. Data from Ganey and others 1999: Table 1. *N* = number of owl pairs or individual owls included in estimates. Home range estimates based on the 95% adaptive kernel estimator; activity centers based on the 75% adaptive kernel estimator.**

| Parameter | Breeding season[1] | | | Non-breeding season[1] | | |
|---|---|---|---|---|---|---|
| | *N* | Mean | *SE* | *N* | Mean | *SE* |
| **Owl pairs** | | | | | | |
| Home-range area[2] | 4 | 1303 | 214 | 7 | 2772 | 420 |
| Activity-center area[2] | 4 | 319 | 40 | 7 | 981 | 200 |
| % of home range[3] | 4 | 24.5 | | 7 | 35.4 | |
| **Individual owls** | | | | | | |
| Home-range area[2] | 8 | 971 | 173 | 14[4] | 2345 | 363 |
| Activity-center area[2] | 8 | 302 | 54 | 14[4] | 808 | 133 |
| % of home range[3] | 8 | 31.1 | | 14[4] | 34.5 | |

[1] Seasons: Breeding = 1 Mar–30 Aug, Non-breeding = 1 Sep–28 Feb.
[2] Area (acres; mean and standard error [*SE*]). To convert home-range or activity-center size to ha, divide by 2.47.
[3] Percent of seasonal home range contained within the activity center, calculated from table values as: (Activity-center area/Home-range area) * 100.
[4] Fourteen range estimates computed for 13 individual owls. One radio-marked female dispersed to a new territory during the study. Separate range estimates were computed for this owl in different years.

Resident owls concentrate activity around the nesting area during the breeding season, but they expand their range during the non-breeding season. Activity typically centers on the nest stand during the breeding season, even in years when resident pairs do not nest. Resident owls typically roost in or near the nest stand throughout the breeding season. Size of activity centers more than doubled during the non-breeding season, but overlap between seasonal activity centers was 83.3 percent of maximum potential overlap. This indicates that protection of breeding areas provides protection to areas and habitat used throughout the year.

### Critical Habitat

Critical habitat is defined in section 3(5)(A) of the Act as—(i) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the Act, on which are found those physical or biological features (I) essential to the conservation of the species and (II) that may require special management considerations or protection and; (ii) specific areas outside the geographical area occupied by the species at the time it is listed, upon a determination that such areas are essential for the conservation of the species. The term ‘‘conservation,’’ as defined in section 3(3) of the Act, means ‘‘the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary.’’

The USFWS has found that designation of statutory critical habitat provides little additional protection to most listed species, while consuming significant amounts of available conservation resources (USDI 2004). They concluded that comparable conservation can be achieved by implementation of laws and regulations obviating the need for critical habitat and that “its present system has evolved into a process that provides little real conservation benefit, is driven by litigation and the courts rather than biology, limits our ability to fully evaluate the science involved, consumes enormous agency resources, and imposes huge social and economic costs” (USDI 2004).

Critical habitat must be ‘‘essential to the conservation of the species.’’ Critical habitat designations identify, to the extent known using the best scientific and commercial data available, habitat areas that provide essential life cycle needs of the species. These are areas in which are found the primary constituent elements, as discussed below, and that may require special management considerations or protection. Critical habitat designations include, but are not limited to: space for individual and population growth and normal behavior; food, water, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, or rearing of offspring; and habitats that are protected from disturbance or are representative of the historic geographical and ecological distribution of a species. Primary constituent elements include those physical and biological features that support nesting, roosting, and foraging.

## Summary

It is important to have an understanding of the ecological relationships between MSO, their prey, and the respective habitats in order to assess the effects of proposed management. This document presents an overview that is intended to be part of the project record in support of the 4FRI effects analysis.

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# Appendix 8. Understory and Arthropod Responses to Overstory Cover and Fire: a Literature Review in Support of the 4 Forest Restoration Initiative

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**October, 2012**

## Introduction

One of the most substantial changes to wildlife habitat that could potentially be achieved by the 4FRI would be restoration of the ponderosa pine understory. Ponderosa pine forests commonly include up to seven overstory species within the 4FRI project area, including alligator juniper (*Juniperus deppeana* Steud.), aspen (*Populus tremuloides* Michx.), Gambel oak (*Quercus gambelii* Nutt.), limber pine (*P. flexi*lis James), one-seed juniper (*J. monosperma* (Engelm.) Sarg.), pinyon pine (*Pinus edulis* Engelm.), and ponderosa pine (*Pinus ponderosa* P. & C. Lawson var. *scopulorum* Engelm.). However, 84 to 95 percent of the overstory is commonly comprised of ponderosa pine trees (4FRI data, Fule et al. 2002, Bakker and Moore. 2007). In comparison, 300 to 600 plant species occur beneath the canopies of ponderosa pine forests in northern Arizona (Daniel Laughlin, personal communication 2011). Plot tallies from individual research efforts within the 4FRI area have reported 78 to 271 vascular plant species (Griffis et al. 2001, Abella and Covington 2006, Laughlin et al. 2008, Nyoka 2010, Laughlin et al. 2011, Stoddard et al. 2011).

"Ecosystem services," such as climate regulation, air purification, water purification, crop pollination, etc., are a subset of ecosystem functions useful to humans (Kremen et al. 2007). The services provided by ecosystem can often be characterized by the component populations, species, functional groups, food webs, or habitat types that collectively produce the service (Kremen et al. 2007). 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 Wagner 2006, Moisset and Buchmann. 2011). Arthropods are also 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). Environmental factors that alter the spatial and temporal distribution of floral resources influence arthropod community composition (Buddle 2006, Kremen et al. 2007, Moisset and Buchmann 2011). Restoring diversity and connectivity in the herbaceous layer can restore more complex food webs (Meyer and Sisk. 2001, Samways 2005, Huffman et al. 2009, Negrón et al. 2009). These interrelations tie back to wildlife forage, cover, and ecosystem health. Moore et al. (2006) concluded that the herbaceous understory should be a prime focus of land managers involved with forest restoration and conservation biology activities in southwestern ponderosa pine forests.

## Descriptions from the 19$^{th}$ Century

Ponderosa pine forests of northern Arizona, including both overstory structure and pattern and understory pattern and composition, have changed dramatically since the late 1800's. A century ago the pine forests were dominated by widely-spaced large trees with a more open forest floor dominated by herbaceous species (Cooper 1960). Many early expeditions described the natural conditions in what is now the 4FRI area:

- In 1851 navy Lieutenant Edward Fitzgerald Beale received orders from Jefferson Davis, Secretary of War, to survey a wagon route from Fort Defiance (some thirty miles southeast of Canyon de Chelly) to the Colorado River (Davis 2001). When he approached the San Francisco Mountains and ascended into the ponderosa pine forest (on the present day Peaks Ranger District, Coconino National Forest) he commented “We traveled rapidly over lovely country of forest and mountain valley, which continually drew exclamations of delight and surprise from every member of the party … we passed successive vales and glades, filled with verdant grass knee high to our mules, dotted with flowers, and the edges skirted by gigantic pines…” (Beale 1858 as quoted in Davis 2001).
- “The country was beautifully undulating, and although we usually associate the idea of barrenness with the pine regions, it was not so in this instance; every foot being covered with the finest grass, and beautiful broad grassy vales extending in every direction. The forest was perfectly open and unencumbered with brush wood, so that the travelling was excellent." (Beale 1858 as quoted in Cooper 1960).
- Looking out from the north slope of Mount Sitgreaves (now the Williams Ranger District, Kaibab National Forest), Beale observed “The fine spring attracts numerous antelopes, which appear and disappear as they glance rapidly through the fine open forest” (Beale 1858 as quoted in Davis 2001).
- Beal later commented that the ponderosa pine forests were "… the most beautiful region I ever remember to have seen in any part of the world. A vast forest of gigantic pines, intersected frequently with open glades, sprinkled all over with mountains, meadows, and wide savannahs, and covered with the richest grasses ..." (quoted by Bell 1870).
- Lt. Joseph C. Ives commanded an army detachment in 1858 and marched to the north base of Bill Williams Mountain (now the Williams Ranger District, Kaibab National Forest). Like previous explorers who passed this way, he was enchanted by the extensive grass growing beneath widely spaced pines (Davis 2001).
- In July 1858, John Udell was part of a party of settlers following Beale’s wagon route along the 35th parallel, bound for California. As the train approached the eastern foothills of the San Francisco Mountain (now the Peaks Ranger District, Coconino National Forest), Udell continued to express delight over the blanket of grass clothing the highland valleys under an open forest of ponderosa pine (Davis 2001).
- C. Hart Merriam based his life zone concept largely on a study of vertical vegetation zones on the San Francisco Mountains. In describing his study area he said, "The lava plateau above about 2130 meters (7000 feet) is covered throughout with a beautiful forest of stately pines (Pinus ponderosa) which average at least 33 meters (100 feet) in height. There is no undergrowth to obstruct the view, and after the rainy season the grass beneath the trees is knee-deep in places, but the growth is sparse on account of the rocky nature of the surface" (Merriam 1890).

Since this time, heavy tree harvest, fire exclusion, overgrazing, and more recently, climate change, has created a 120-year anomaly in terms of fire behavior which has altered the trajectory of stand development, ecosystem function, and spatial pattern of ponderosa pine in northern Arizona (Pearson 1950, Arnold 1950, Cooper 1960, Covington and Moore 1994, Moore et al. 2004, Roos and Swetnam 2012).

## Historical Range of Variation

Historic increases in tree density have led to increased canopy closure, fueled in part by the cessation of frequent, low-severity surface fire that limited survival of tree seedlings (Covington et al. 1997, Fule et al. 2002, Noss et al. 2006, Sanchez Meador et al. 2010). High seedling establishment rates due to an unusual distribution of moisture in 1919 contributed to today's forest conditions as did similar, lesser seed crops in 1910, 1914, and 1929 (Arnold 1950). With tree recruitment abnormally high relative to the historical record and an interruption in the fire return interval, an 8 to 21-fold increase in tree density occurred in the ponderosa pine forests within the 4FRI project area (Fule´ et al. 2002). Monitoring of long-term exclosures identified a doubling of total tree canopy cover, a tripling of tree density, an increase of 40 percent in tree basal area (square feet per acre), and a predominance of smaller trees between 1941 and 2004 (Bakker and Moore 2007). Forest conditions within the 4FRI project area under the historical range of variation were estimated to have been 23 to 60 trees per acre (Covington et al. 1993, Fulé et al. 1997, Moore et al. 2008). Post-settlement conditions within the project area include over 400 trees per acre to over 2,471 trees per acre (Fulé et al. 1997, Fule´ et al. 2002, Abella and Covington 2006, Moore et al. 2008). Whereas presettlement forests were dominated by older and larger trees, today's forests are characterized by relatively small, young trees (USDI 1995, Fulé et al. 1997, Fule´ et al. 2002, Moore et al. 2004, Abella and Covington 2006).

Tree group size and shape can be thought of as the building blocks of landscape-scale forest structure in the ponderosa pine system of northern Arizona (Laughlin et al. 2006). The influx of trees post-fire exclusion has altered the forest pattern as well as the forest structure. In stark contrast to today's relatively homogeneous forests, presettlement forests were relatively open and dominated by groups of trees with larger and more frequent grass openings (Covington et al. 1997, Fule´ et al. 2002, Moore et al. 2004). Pre-settlement forest patches in the Gus Pearson Natural Area within the 4FRI project area averaged 0.14 ac (0.055 ha) in size with a range of 0.05-0.27 ac (0.02–0.11 ha) (Laughlin et al. 2006). These values are similar to the ranges described by White (0.05-0.72 ac [0.02–0.29 ha]; 1985) and Cooper (0.15-0.32 ac [0.06–0.13 ha]; 1960). Individual tree groups ranged from 2 to over 40 trees (White 1985). Rather than a matrix of tree groups defined by an interspersion of grassy, open patches, today's forests consist of small openings within extensive areas of dense pine trees which, in turn, exerts a negative effect on the understory community (Laughlin et al. 2006). Infilling of forests and expansion of trees into openings can affect plant community structure and composition, water and nutrient cycles, understory biomass production, wildlife habitat, biodiversity, and fire patterns across the landscape (Tausch et al. 2009).

## Understory Response to Overstory Changes

A strong and inverse relationship exists between understory and overstory production (Cooper 1960 Clary and Ffolliott 1966, Clary 1969, Ffolliott 1983, Hart et al. 2005, Healy 1989, Bojorquez Tapia et al. 1990, Moore et al. 2004, Bakker and Moore 2007, Kennedy et al. 2009, Hodson et al. 2010, Laughlin et al. 2011, Stoddard et al. 2011). In 1901 and 1902 a deficiency in seedlings and saplings was reported by forest managers in what is now the Coconino National Forest, with the forest floor being "more fully occupied by herbaceous species" (Arnold 1950). Successful seed crop years occurred in 1910, 1914, 1929, and most notably in 1919. Afterwards, an abundance of young pine became established across extensive areas northern AZ. Young pine trees filtering into virgin timber, extending into natural grassland openings, and restocking cut-over areas created an abundance of young trees across much of what is now the 4FRI project area

(Arnold 1950). In contrast to the open forest conditions described above, uncharacteristically dense pine forests began to decrease available sunlight, intercept precipitation and compete for soil nutrients throughout the 1900s (reviewed in Laughlin et al. 2005). Resulting reductions in herbaceous cover were noted by the 1930s (Arnold 1950). Herbaceous understory cover can decrease by 4 to 5-fold as canopy cover increases from 10 percent to 100 percent (Arnold 1950, Hodson et al. 2010). Under uneven-aged ponderosa pine forests, the relationship between canopy and herbaceous density was linear but variable. In even-aged forests, each 1 percent decrease in ground cover density was equal to a loss of 150 lbs air-dry grass yield (Arnold 1950).

Local research quantified the relationship between understory and overstory basal area. Studies were conducted on different portions of the Coconino National Forest within or adjacent to what is now the 4FRI project area (Clary and Ffolliott 1966, Pearson and Jameson 1967, Bakker and Moore 2007). The Rocky Mountain Forest and Range Experiment Station described relationships between basal area and herbaceous production in both the northern and southern portions of the Coconino National Forest in the 1960s (Clary and Ffolliott 1966, Pearson and Jameson 1967). Researchers working north of Flagstaff found that as basal area increased from 0 to 50, herbaceous production dropped from greater than 650 pounds per acre to 100 pounds per acre; when overstory basal area increased above 50, herbaceous production decreased to only 45 pounds per acre (Pearson and Jameson 1967).

Clary and Ffolliott (1966) conducted research south of Flagstaff determined herbaceous production was higher when the overstory basal area was below 95 and was significantly ($p \leq 0.10$) higher when basal area was below 70. Average herbaceous production was higher on thinned plots. However, this trend reversed at levels equal to or higher than 100 basal area. While production continued to decrease with increasing basal area, unthinned plots had higher herbaceous production than thinned plots once basal area was greater than or equal to 100 (Clary and Ffolliott 1966). This may be a result of management activities releasing trees with the best growth potential that subsequently outcompeted the herbaceous layer for available water and nutrients. Another long-term study conducted on the Coconino NF found understory plant cover decreased by 21 percent and plot-level understory species richness declined an average of about two species per square yard as ponderosa pine basal area increased from an average of 17 in the early 1900s to 126 in 2007 (Laughlin et al. 2011). Predicted herbaceous production responses to basal area must be regarded as estimates because they cannot account for the distribution of basal area in the stand, e.g., trees in a northern Arizona ponderosa pine stand had equal basal area in 1876 and 1949, but density was more than 4 times greater in 1949, indicating that there were many small trees (Moore et al. 2004).

Bakker and Moore (2007) examined understory plant production relative to increased ponderosa pine abundance by using a series of five livestock grazing exclosures established in 1912 (Arnold 1950). All 5 sites were located within about 15 miles of Flagstaff. They found that, as overstory increased between 1941 and 2004, understory decreases occurred in shrubs (69 percent), graminoids (39 percent), and forbs (82 percent). Total herbaceous cover decreased by 59 percent. They determined that understory vegetation was more strongly controlled by the ponderosa pine overstory than by recent livestock grazing or by differences between years (Bakker and Moore 2007).

As research on the relationship between canopy cover and understory biomass production continued in the latter part of the twentieth century, different studies assessed the strength of different variables for evaluating overstory productivity. This work has generated different equations to describe the relationship. Despite the number of studies, the shape and function of the resulting graphs have been the same: an increasing overstory slowly reduces the understory until a threshold in forest canopy is met, and then a sudden plunge in herbaceous production occurs as canopy density continues to increase. While the nature of the equation, slope of the line, and specific threshold values vary, the shape and response function of the curves have remained the same among studies and across decades of study. Forest cover greatly exceeding this threshold is now the normal condition in northern Arizona ponderosa pine forests. As a result, depauperate understories have also become common. Moir commented in 1966 that “Continued tree production unchecked by fire or artificial tree thinning appears to lead towards total or near-total herb suppression.” Treatments intended to move forests towards the historical range of variation, but which failed to open forest canopies enough to move below this threshold effect, were identified as limiting understory response by several researchers working in what is now the 4FRI (Bradford et al. 2009, Scudieri 2009, Stoddard et al. 2011).

## Forest Floor Conditions

Uncharacteristically dense forests that change forest floor conditions potentially change the site ecology. Solar radiation under dense pine canopies can reduce ground-level light to as low as 20 percent of full daylight conditions (Meyer and Sisk 2001, Moir 1966). In graminoids, decreased solar radiation reduces inflorescence production (Moir 1966). Only high-fidelity understory species persist beneath dense canopies versus a wider range of herbaceous species in more open conditions, (Abella and Covington 2006).

Soil organic matter and nitrogen availability affect understory species richness and plant cover (Laughlin et al. 2007). Soils with greater nitrogen content can sustain greater understory plant abundance (Laughlin et al. 2007). However, in a long-term study in what is now the 4FRI project area, the amount of nitrogen stored in the overstory increased 600 percent between 1909 (plot establishment) and 2002 and were 31 percent higher in overstory nitrogen than the estimated level before fire exclusion in 1876 (Moore et al. 2004). Phosphorous and potassium showed similar changes: aboveground phosphorous storage in trees increased by 475 percent and 53 percent since plot establishment and fire exclusion dates, respectively; increases in potassium were 528 percent and 41 percent since plot establishment and fire exclusion, respectively (Moore et al. 2004). Overstory biomass increased when open stands dominated by large trees with proportionally more stem wood converted to closed stands of smaller, younger trees with a high proportion of foliage and leaf area (Moore et al. 2004). In general, changes in overstory nutrient storage suggest diminished nutrient turnover and decreased nutrient availability to other ecosystem components such as understory plants and non-arboreal herbivores (Moore et al. 2004). Net nitrogen transformation rates and soil microflora activity decreased under dense forests canopies (Moir 1966, Kaye et al. 2005, Boyle et al. 2005). Soil nitrogen is strongly related to understory species richness (Laughlin et al. 2007). Decreasing nutrient concentrations in the mineral soil can lead to less palatable herbaceous plants for wildlife (Mattson 1980). Nutrients occurring in canopy biomass rather than in soil, along with the slow release of nitrogen by pine needles, might be leading to long-term shifts in the understory plant community (Laughlin et al. 2011).

Decreases in available sunlight, precipitation and soil nutrients select for slower growing shade- and stress-tolerant plants. Overstory changes may be selecting for understory species that more slowly acquire and conserve mineral nutrients (Laughlin et al. 2011). Over time these conditions, along with decreases in available sunlight and precipitation, select for plants that are shorter, flower earlier and contain lower nutritional value for wildlife (Moir 1966, Kaye et al. 2005, Laughlin and Abella 2007, Laughlin et al. 2011). Laughlin et al. (2011) observed long-term shifts toward communities dominated by shorter plants with larger seed mass and lower specific root length under dense forest canopies. Uncharacteristically dense overstory structure is not only reducing total herbaceous production, but is also changing understory species composition, changing floristic assemblages and reducing the amount and timing of blooms. These changes can affect seed production and availability, lead to reduced plant diversity, and reduced functional diversity of understory communities, (Laughlin et al. 2005). Moreover, they directly affect vertebrate wildlife in terms of altered forage and cover, and indirectly through altered arthropod communities.

Increased tree densities and lack of fire in the 4FRI project area have allowed increased accumulation of pine litter (i.e., freshly fallen organic material). The results of research on the effects of litter on understory species in northern Arizona have been varied. Moore et al. (2006) demonstrated that thinning-only treatments (i.e., no reduction in litter) produced equal increases in herbaceous production compared to thinning plus burning treatments (i.e., litter was reduced through the use of fire). However, they suggested their study design may have obscured the effects of litter because raking associated with the fire treatment may have affected the soil seed bank in the O horizon. Removal of the upper soil horizons can also remove concentrations of $NH^{4+}$ (ammonium), an important source of nitrogen for many plant species in the O horizon (Gundale et al. 2005). Laughlin et al. (2007) used multivariate modeling to account for species richness and litter depth and found no significant correlation. Instead, they concluded nitrogen availability and density of the pine overstory primarily drove understory species richness. Abella and Covington (2007) detected no increase in plant cover or richness after two years of pine litter removal. They too cited soil seed bank removal combined with limited pretreatment herbaceous vegetation as potentially preventing a response. In addition, Abella and Covington (2007) described shading, belowground competition for water and nutrients, or other tree-associated factors as more strongly limiting understory communities.

However, other studies in ponderosa pine forests of northern Arizona concluded total plant cover, cover of major grass species, and overall plant species composition were negatively correlated with litter (Laughlin and Abella 2007, Laughlin et al. 2007, Scudieri 2009). Total plant cover and cover of major grass species were positively correlated with bare ground (Scudieri 2009). Laughlin and Abella (2007) concluded plant species appear to respond so strongly to pine litter that variations in litter depth alone could shift community composition. The relationship was found to be so strong that, in another study, litter depth was used as a predictor variable for herbaceous response to overstory changes (Clary 1969). In finding no significant correlation between litter depth and herbaceous species richness, Laughlin et al. (2007) hypothesized plot size may have been a factor, i.e., in ecosystem studies, the effect of litter may be lost at the 1/12 ac scale. Given the varied responses among studies, perhaps site variability as influenced by other variables such as soils or geomorphology, in addition to whether the upper soil horizons are removed, influence the degree to which litter influences understory production. In summary, litter depth appears to exert a strong negative influence on understory productions in several, but not all studies conducted in what is now the 4FRI project area.

An indirect effect of accumulating pine litter is the slowing of soil decomposition rates due to high resin, lignin, and other compounds resistant to chemical breakdown in pine needles (Moir 1966, Laughlin et al. 2011). In addition, dense forest conditions create selection pressure for herbaceous understory species with slower decomposition rates (Laughlin et al. 2010). The decreased organic input from grasses and forbs combined with slower decomposition can alter soil properties that impose direct and indirect constraints on understory species diversity (Laughlin et al. 2007). Soil texture and pH constrain growing conditions, limiting sites where plant species might occur (Laughlin and Abella 2007). Decaying pine needles, charred wood, and leachate from needles, wood, and bark significantly reduce germination and growth rates of understory species (Lodhi and Killingbeck 1982, Abella 2006).

Litter thickness and weight are also negatively correlated with seed bank accumulation for both total and native perennial species richness in ponderosa pine forests studied within the 4FRI project area (Black et al. 2007). Seed banks are typically a reflection of the seed rain from existing vegetation, although native graminoids are more common and perennial forbs sparse in the soil seed bank (Buddle et al. 2006, Black et al. 2007, Bradford et al. 2009). Seed banks, overall and specifically for native perennials, have been found to be richer and larger in patches where aboveground understory vegetation is most abundant which, unfortunately, indicates they may be less useful for increasing native understory vegetation in dense pine forest where existing understory vegetation is already depauperate (Black et al. 2007). However, soil seed banks also vary across southwestern ponderosa pine forests with little correlation found between the seed bank and above-ground vegetation in other areas (Meyer and Sisk 2001, Buddle et al. 2006,). Patches with open canopies, typically near old trees, support larger and richer soil seed banks than patches of denser canopies containing many closely spaced small trees (Black et al. 2007). Thick duff layers can lead to higher soil temperatures when fire moves through, resulting in seed mortality in the soil bank (Buddle et al. 2006, Hart et al. 2005, Elizabeth Blaker, personal communications, 2011). Dense overstory canopies limit understory species composition and seed production and therefore will continue to reduce or prevent herbaceous recovery, thus hindering recovery of associated habitat elements essential to a host of vertebrate and invertebrate species.

In summary, 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 being translocated into forest canopies while slower nitrogen mineralization and nitrification rates are occurring 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, changing the understory community. Declines in total cover and species richness resulting from current forest conditions have been documented throughout the $20^{th}$ 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 understory diversity, with potential impacts moving up through community trophic levels.

# Relationships of Understory Development to Arthropods

## Introduction

Invertebrates occupy all forested habitats and have diverse functional roles including detritivores, fungivores, herbivores, predators and parasitoids, and pollinators (Schmidt and Jacobson 2005, Short and Negron 2003). Invertebrates, to which arthropods belong, compose over half the animal diversity across broad forested landscapes (Schmidt and Jacobson 2005). There are 26 Orders of insects within the phylum Arthropoda, but most insects in North America belong to only 8 of these (Stokes 1983). These 8 Orders, plus the Class Arachnida, are of particular importance to the wildlife species considered under 4FRI. Here “arthropod” is primarily being used to refer to key invertebrate prey items selected by birds and mammals (Martin et al. 1961, Capinera 2010). Billions of individuals representing thousands of species may reside in a single northern goshawk territory (Short and Negron 2003). Arthropods are of concern because vegetation composition affects the behavior and structure of arthropod communities (Samways 2005). Current forest conditions in Southwest ponderosa pine forests have been summarized as appearing unfavorable for most insect pollinators (Nyoka 2010).

A healthy herbaceous layer is fundamental to maintaining diverse arthropod communities. Conversely, increased homogeneity of once patchy habitat leads to loss of specialized habitat important to arthropod populations such as diversity of overstory species, variability in soil conditions, herbaceous and coniferous litter depth, snags and large woody debris, fragmentation of habitats, and decreases in herbaceous cover and species richness (Laughlin et al. 2004, Samways 2005, Schmidt and Jacobson 2005, Capinera 2010, Laughlin et al. 2010). Several studies have described the effects of thinning, thinning and burning, clear cutting, and wildfire on arthropod populations which, in many cases resulted in entire community shifts (e.g., Strohecker et al. 1968, McIver et al. 1992, Schmidt and Jacobson 2005, Buddle et al. 2006, Coleman and Rieske 2006, Matveinen-Huju and Koivula 2008, Moisset and Buchmann 2011). What is not known is to what degree current arthropod communities reflect the loss of overstory heterogeneity over the last 100-plus years. Changes in land-use and landscape structure influence arthropods, including pollinators, their target plants, and plant/pollinator interactions at individual, population and community scales (Kremen et al. 2007).

Flowering plants provide foliage, pollen, and nectar and are of significant importance to many families of arthropods (Holland 1984, Capinera 2010, Shaula Hedwall, personal communications 2011). Pollen is high in crude protein (10 to 30 percent) and contains fat and minerals; nectar is the principal source of easily digestible carbohydrates for arthropods (Chen et al. 2006, Capinera 2010). It is critically important that flowers are common throughout the growing season, i.e., they must be available both spatially and temporally to sustain many families of arthropods (Capinera 2010). Many arthropods overwinter as adults and require nectar and pollen when they emerge in the early spring while adults of other species emerge in the late summer and require nectar and pollen to mate or feed developing larvae (Stokes 1983, Mooney et al. 2010). A diversity of flowering plants that bloom throughout the spring and summer supports a diverse pollinator assemblage. However, few plant species are capable of flowering throughout the growing season. Therefore, a variety of flowering species ensures food availability for nectar generalists as well as supporting the many insects with host-specific requirements. A diverse community of insect pollinators requires diversity of native flowers and vice versa (Black et al. 2007).

## Pollinators

Arthropods have been assisting plant fertilization since the radiation of the Angiospemae during the Cretaceous Period (144-65 million years ago) by allowing these plants to exist in widely separated locations (Capinera 2010). While plants provide required foods for many insects, insects provide the mechanism for cross pollination. Cross pollination, or genetic mixing between plants, requires pollen from one flower reaching the reproductive parts of another flower. Some plants such as grasses and trees use wind to transport pollen, requiring the production of a great deal of pollen and the right circumstance to ensure it reaches other flowers of the same species (Stokes 1983). Conversely, 60 to 90 percent of wild plants require animal pollinators to collect and transport pollen (Stokes 1983, Kremen et al. 2007, Mooney et al. 2010, Nyoka 2010). Insects are the chief pollinators and flowers have evolved hundreds of different strategies designed to lure them in, providing food in exchange for genetic mixing (Stokes 1983). Pollination in the wild is mostly accomplished by bees and wasps, flies, and butterflies and moths (Waltz and Covington 2004, Black et al. 2007, Capinera 2010). Plant pollination by insects is one of the most widespread ecosystem services in terrestrial environments and is essential to maintaining biodiversity (Black et al. 2007). A study in what is now the 4FRI project area found 20 percent of the total sampled arthropods were either pollinators or their diet consisted mainly of flower parts (Huffman et al. 2009). Pollinators have been called a keystone group in terrestrial ecosystems because of the range of ecological services they provide to natural ecosystems (Black et al. 2007). Insect pollinator abundance and species richness are strongly correlated with plant cover availability of floral resources (Nyoka 2010).

The pollinator community affects wildlife directly and indirectly. Pollination of flowering plants concentrates insects, making them easier prey for wildlife (Capinera 2010). Herbaceous response can increase 4 to 5 fold in openings (Arnold 1950, Hodson et al. 2010) and insects can be 25 times more abundant in openings than under forest canopies, providing a primary food source for young wild turkeys and other birds (Healy 1989). The tie between invertebrate prey and their predators is strong enough that butterfly diversity can be a predictor of bird abundance and diversity (Black et al. 2007). Most plants that produce colorful flowers do so to attract insects (Capinera 2010). Each flowering plant species usually has a small guild of pollinators which coevolved with them to ensure their pollination (Mooney et al. 2010). Without pollinators, many plants would decline or disappear and the most highly coevolved mutualistic species are the most at risk (Capinera 2010). Successful pollination results in production of fruits and seeds, providing important wildlife foods (Black et al. 2007, Capinera 2010). The decline or loss of these resources would likely result in declines in the birds and mammals that depend on fruit and seed production (Williams 2011), which in turn can affect higher trophic level predators that feed on them.

The decline of pollinators and the services they provide has been described for decades, including evidence of declines at local and regional scales and evidence of elevated extinction rates across taxa (Kremen et al. 2007). Habitat loss and fragmentation in the United States has adversely affected pollinator species, particularly native bees (Mooney et al. 2010). The situation for pollinators caused sufficient concern that the National Research Council of the National Academy of Sciences issued a report titled “Status of Pollinators in North America” in 2006 and again in 2007 [http://dels.nas.edu/Report/Status-Pollinators-North-America]. Pollinators alter foraging behavior in response to changes in landscape structure: they follow corridors of vegetation to reach nectar or pollen sources, avoid edges created by roads, and increase energy expenditure in simplified landscapes where few alternative flower resources occur (as reviewed in Kremen et al. 2007). Fortunately, most pollinators have similar needs: open, sunny areas; high diversity and availability of host plants for food, pollen, and nectar sources; and a variety of microclimates to provide food and shelter under changing weather and climate conditions (Julie McIntyre, personal communications). Pollinators respond to habitat restoration with evidence of species abundance, species richness, and ecosystem function being restored (Williams 2011). One sign of progress towards restored habitat is less redundancy in pollinators visiting the same plants (Williams 2011).

## Connectivity (summarized from Samways 2005 except where noted)

In addition to direct habitat loss, the disruption of the herbaceous layer fragments insect habitat. Anthropogenic filters can create a sufficiently large matrix devoid of flowers, creating a barrier to pollinator movement, e.g., decreased sunlight levels that limit plant species richness can create barriers to movement and nesting (Kremen et al. 2007). Increased anthropogenic filters reduce arthropod movement across the landscape and can result in increased population isolation. One insect species may be losing the potential to disperse while another is losing a larval host plant. Population isolation can result in increased mutation/recombination, providing more phenotypic variation and potential adaptability or lead to increased risk of extirpation. This loss of habitat connectivity is occurring worldwide and has been described as “devastating.” Both area and isolation effect patch occupancy (Ferraz, et al. 2007). Avoiding population isolation means maintaining gene flow. Inbreeding depression has been demonstrated to increase extinction risk in some butterflies and may be more widespread in plants and insects than previously thought. Efforts to maintain or create habitat corridors to facilitate movement in fragmented landscapes were demonstrated to be important to invertebrates and plants (Gilbert-Norton et al. 2010).

An emerging strategy in landscape management is to move the transformed landscape back towards something resembling the structure, composition, and function of the original landscape. This encompasses habitat characteristics to which arthropods are sensitive and maintains them in as near natural a state as possible. A range of successional habitats with an emphasis on heterogeneity has been shown to maintain arthropod species richness. Conserving arthropod diversity is heavily dependent on maintaining both large and small patches of high quality habitat. “High quality” refers in part to heterogeneity. Providing both direct habitat connectivity and habitat stepping stones facilitates landscape movement. Managing for habitat stepping stones allows genetic and demographic augmentation of isolated habitat patches by immigrants and facilitates possible recolonization of unoccupied patches (Britten et al. 2003). Currently, patches of non-native invasive species such as dalmation toadflax (*Linaria dalmatica*), common mullein (*Verbascum thapsus*), and thistles (*Cirsium spp.*), all of which commonly invade sites after forest management activities, may provide the only substantial islands of pollen and nectar for insect pollinators in ponderosa pine forests undergoing initial treatments (Nyoka 2010).

## Ecological Interrelations

Habitat fragmentation can result in non-random extinction of insect populations as influenced by a species’ dispersal ability (Fleishman et al. 2002, Samways 2005). Butterfly data has shown that species of intermediate mobility declined most in fragmented landscapes, followed by species of low mobility, whereas species of high mobility survived well (Samways 2005). Flight-limited species are vulnerable to local extinction as remnant patches become smaller and more isolated (Samways 2005). Worldwide an estimated 11,200 insect species have gone extinct, with an estimated 162 species disappearing within the United States (Capinera 2010).

Patch quality is additive upon patch size and isolation (Fleishman et al. 2002, Samways 2005). For many arthropods, the loss of their host plant means they also disappear (Fleishman et al. 2002, Capinera 2010). Diversity of both arthropod predators and herbivores display linear relationships with vascular plant diversity (Samways 2005). Plant species richness, plant functional groups, and most importantly, plant species composition are important determinants of arthropod diversity (Holland 1984, Fleishman et al. 2002, Samways 2005, Matveinen-Huju and Koivula 2008, Shaula Hedwall, personal communications 2011). For example, some families of bees are known as “long-tongued” and favor deep flowers while other families are short-tongued bees and only able to take advantage of shallow flowers such as those of the daisy, aster family or carrot family (Mooney et al. 2010). Heterogeneity at all levels, from tree groups to landscapes and structurally as well as spatiotemporally, is important to ensure insect diversity (Strohecker et al. 1968, Samways 2005).

Arthropods are key drivers of ecosystem structure and function. They pollinate many flowering plants, decompose organic material, release nutrients back into the ecosystem, and provide the largest food source in almost every ecosystem (Waltz and Covington 2004, Wilson 1987 from Schmidt and Jacobson 2005, Kremen et al. 2007). Arthropods include both hosts and parasites and serve as prey for a variety of animals, including birds, mammals, herptofauna, and other arthropod species (Black 2005). Arthropod communities interacting with plant communities drive trophic interactions between vertebrate predators and invertebrate prey. For example, recent evidence suggests that predators and parasites strongly influence the population dynamics of bark beetles. Natural enemies can reduce *Ips typographus* reproduction by 83 percent with woodpeckers accounting for 28 percent of mortality of low bark beetle populations, 84 percent during outbreaks, and broods were reduced by 98 percent by woodpeckers on heavily worked trees. Additional mortality was caused by bark removal, thereby increasing access of parasitoids and predators and also increasing solar radiation, thereby drying-out bark beetle larvae (reviewed in Black 2005). In general, the functional importance of an ecosystem service provider depends on both its effectiveness at performing the service and its abundance (Kremen 2005).

Community function and related ecosystem services depend in part on densities, biomass, and interactions of species within the community (Kremen 2005). Diversity confers a stabilizing effect on community structure. More diverse communities provide more stable services than less diverse or simpler communities. These compensatory responses are poorly understood at community levels. In some instances, the importance and contributions of ecosystem service providers has been measured or estimated (Table 166). It is unknown how reduced species abundance, decreasing species richness or local extinctions affect community stability and related services (adapted from Kremen 2005).

**Table 166. Networks of Ecosystem Functions. Adapted from Kremen 2005.**

| Service | Provider/Trophic Level | Unit(s) of Measure | Spatial Scale of Services Provided |
|---|---|---|---|
| Air Purification | Micro-organisms, Plants | Biogeochemical Cycles, Populations, Species, Functional Groups | Regional - Global |

| Service | Provider/Trophic Level | Unit(s) of Measure | Spatial Scale of Services Provided |
|---|---|---|---|
| Water Purification | Vegetation, Soil micro-organisms, aquatic invertebrates, Aquatic micro-organisms, | Populations, Species, Functional Groups, Communities, Habitats | Local - Regional |
| Drought Mitigation | Vegetation | Communities, Habitats | Local - Regional |
| Pollination | Insects, Birds, Mammals | Populations, Species, Functional Groups | Local |
| Pest Control | Invertebrate parasitoids and predators, and vertebrate predators | Populations, Species, Functional Groups | Local |
| Detoxification/ Decomposition of Wastes | Leaf litter & soil invertebrates, Soil micro-organisms, Aquatic micro-organisms | Populations, Species, Functional Groups, Communities, Habitats | Local - Regional |
| Soil generation and fertility | Leaf litter & soil invertebrates, Soil micro-organisms, | Populations, Species, Functional Groups | Local |
| Seed Dispersal | Ants, Birds, Mammals | Populations, Species, Functional Groups | Local |
| Climate Stability | Vegetation | Communities, Habitats | Local - Global |
| Ecosystem Goods | Species Diversity | Populations, Species, Communities, Ecosystems | |
| Aesthetic/cultural | Biodiversity | Populations, Species, Communities, Ecosystems | Local - Global |

## Arthropods as Food (summarized from Capinera 2010 except where noted)

An animal’s diet has a fundamental influence on its behavior and ecology, including choice of habitat associations, niche selection, foraging and dispersal behaviors, and population structure and dynamics. The potential of 4FRI to restore both the herbaceous and arthropod communities in the understory can benefit a wide range of wildlife. About ⅓ of the families (33.6 percent) within the Class Mammalia eat primarily arthropods while another ⅓ (32.7 percent) eat vegetation and over 35 percent of families in the Class Aves eat arthropods. Arthropods are not only consumed by insectivorous species, but also by omnivores and as alternate prey for carnivores when preferred prey is not available. Arthropods are highly digestible and provide a high yield of metabolizable energy per unit intake, making them a desirable food item for small mammals (Merritt 2010). Nutrition levels of arthropods are typically much higher than most plant-based foods. Based on a review of stomach analyses, key prey items for wildlife (by Order) commonly include: hymenoptera, lepidoptera, coleoptera, orthoptera, diptera, homoptera, and arachnids (Martin et al. 1961). These insect families represent highly nutritious foods, consisting of 25 to 67 percent protein and 10 to 39 percent fat. In contrast, native grasses are commonly 10 to 15 percent protein (Texas A&M Extension Service). Because of the nutritional advantages of invertebrate prey, many birds and mammals select them when raising immature offspring and in autumn when foliage losses nutrition through the seasonal curing process. Arthropods are also an important component in the diets of most amphibians and reptiles. Habitat restoration can potentially redistribute arthropods which, given their importance as food resources, can affect the distribution of vertebrate wildlife populations (Meyer and Sisk 2001). These effects have potential to cascade through the ecosystem and influence food web dynamics at many different scales (Huffman et al. 2009).

## Arthropod Orders

Below is a summary of the habitat relations for key Orders of arthropod prey. Each Order of arthropod, and many specific families or species within these Orders, have specific habitat requirements. Most invertebrates occupy distinctly different habitats during their life cycle (Schmidt and Jacobson 2005). Their habitat needs are influenced by overstory structure, principally tree and canopy density. Edges are key habitat for many families of insects (Stokes 1983). Links between arthropods and vertebrate species described below principally come from Martin et al. (1961) and Capinera (2010). These authors used data determined directly from stomach analyses, or, in some cases, scat analysis (Capinera 2010) to identify predator/prey relations. This information is included here because these Orders represent key arthropod prey for a range of vertebrate wildlife species, their habitat relationships tie directly to understory health and proposed treatment effects for the 4FRI. Maintaining the interrelationships between Orders of insects are important to ecosystem function and restoration (from Stokes 1983 unless otherwise noted).

### Lepidopterans (“scaly-winged,” including butterflies and moths):

Both butterflies and moths can require specific plant species as larvae and become nectar generalists as adults, encompassing a broad range of ecological niches (Waltz and Covington 2004). The female oviposits on or near a specific species or genera of plant and, once the eggs hatch, the plant serves as the species-specific food for the larvae (Stokes 1983, Waltz and Covington 2004). How the female distinguishes between plants in a given forest or meadow is unknown. Examples include the common white and sulphur butterflies (Family Pieridae) which usually oviposit on mustards (whites) or legumes (sulphurs). Once the adults emerge they feed on nectar. Mating behavior includes aerial flights above meadows or lush weeds.

Work with the Nokomis Fritillary (*Speyeria nokomis ssp*) indicated probability of occupancy increased with increasing larval host-plant abundance and percent cover of adult nectar sources, but decreased as conifer litter reached heavy levels, perhaps as a result of impeded oviposition (Fleishman et al. 2002). The Family Nymphalidae includes *S. n. nokomis* and *S. n. nitocris*. *Nokomis* require water flow and violets (Ferris and Fisher 1971). They are nearly always in seep areas with constant water flow surrounded by willow thickets. Larvae require violets as their foodplant and typically grow in the understory of the seeps but are sparse in thickets. The surrounding area is relatively arid and can include sagebrush and juniper. Willow can be related to this habitat, but this may be because a spurious correlation with the rest of the butterflies immediate environment. The habitat for *nitocris* is lush Canadian Zone meadows or along mountain streams that feed such meadows. The adults feed upon red thistles of various species and tend to fly at higher elevations than *nokomis*. They have been collected from 5400’ to 8500’ elevation and appear to be more common at higher elevations. *nokomis* has been recorded from

Gila, Coconino, Greenlee, Navajo, and Apache Cos. in Arizona and from New Mexico. *nitocris* is found along the Mogollon Rim and White Mountains of Arizona and the eastward extension of this terrain into NM. Both subspecies are quite local, but *nitocris* can be found in high concentrations. Female *nitocris* tend to stay in dense vegetation, including tall grasses and willows along the streams associated with their habitat (Ferris and Fisher 1971).

The adults overwinter under loose bark and feed on sap and early blooming shrubs. Monarch butterflies (family Danaudae) are best known for their long-distance migrations. They feed on milkweed as larvae from which they collect toxins that reduce predation in their adult stage. Adults prefer open habitat with abundant flowers. However, they seek dense vegetation for mating. Because of these specific ties and the quick response to habitat change, the lepidoptera can be indicators of ecosystem change (Waltz and Covington 2004).

Butterflies preferentially forage on species with tubular bright pink or red flowers and plentiful nectar (Nyoka 2010). In the Southwest, particularly within the 4FRI area, butterflies pollinate catchfly (Silene, Caryophyllaceae), honeysuckle (Lonicera, Caprifoliaceae), phlox (Phlox, Polemoniaceae), cryptantha (Cryptantha, Boraginaceae), willows (Salix spp), Gambel oak (Quercus gambelii Nutt.), juniper (Juniperous spp), buckbrush (Ceanothus fenderli Gray), Rumex species, columbines (Aquilegea spp.), several beard-tongue (Penstemon spp.), paintbrushes (Castilleja spp.), cliffrose (Cowania mexicana D. Don.), buckwheat (Eriogonum spp.), asters (Asteracea spp), legumes (Leguminosae spp), saltbush (Atriplex spp), New Mexico locust (Robinia neomexicana), sage (Artemisia spp), grasses (graminoids), and milkweed (Asclepias, Asclepiadaceae) (Holland 1984, Nyoka 2010, Julie McIntyre,personal communication, 2011). Moth-pollinated plants such as evening primrose (Oenothera) share similar features with butterfly flowers, but open at night and are generally paler in color (Nyoka 2010).

Presence of a butterfly or moth species indicates presence of the larval host plant, as well as sufficient adult food resources (Waltz and Covington 2004). In addition to the presence of specific species, microclimate conditions have been shown to control foraging rates of many arthropods, including butterflies and moths (Meyer and Sisk 2001, Waltz and Covington 2001). Butterfly species increase proportionally with patch size and butterfly species richness is highest on heterogeneous landscapes (Samways 2005). In order to provide functional habitat so that the full diversity of moths and butterflies is retained, the right plant species need to flower at the right times with a broad enough distribution to account for individual butterflies, populations of butterflies, and their respective meta-populations.

Lepidoptera have many natural predators including frogs and lizards, birds (including hummingbirds), small mammals such as shrews (*Soricidae*) and mice (*Peromycus spp*), and many species of carnivorous insects and spiders (Capinera 2010). Mexican spotted owls (*Strix occidentalis lucida*) will prey on moths opportunistically (Ganey et al. 2011). Hence, they are an important component of the natural food web. In addition, moths are key food items for bats on the Southwest Regional Forester’s Sensitive Species list, including Allen's lappet-browed bat (*Idionycteris phyllotis*), pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*), and spotted bats (*Euderma maculatum*) which feed almost exclusively on lepidopterans (Jones and Rydell 2003, AZGFD 2001, Painter et al. 2009).

### Hymenoptera (“membrane-winged,” including ants, bees, and wasps):

The Order Hymenoptera includes a wide variety of species and a wide variety of ecosystem services. Hymenopterids include decomposers, fungivores, herbivores, predators, parasitoids, and pollinators (Short and Negron 2003). Ants are in the Family Fomicidae. Nests are frequently located and sometimes even designed to absorb heat from the sun to warm the colony during the night. The presence of a canopy or lack thereof influences not only the species of ants present, but also the ecological functional groups present within the Family Formicidae (Strohecker et al. 1968). Habitat ties can be so strong amongst ant species that Stephens and Wagner (2006) concluded the maintenance of a diversity of ant functional groups and species in northern Arizona ponderosa pine forests required a diversity of forest conditions. Conversely, forest conditions outside of the range of historical variability will support a diversity of ant species and functional groups also outside the historical range of variability. The loss of functional groups can affect ecological processes, e.g., there is a linear correlation between above ground ant activity measured as the number of species and below ground decomposition processes measured as soil microbial biomass (Samways 2005).

#### Bees

Bees descended from wasps and are entirely vegetarian, feeding on pollen and nectar. Globally there are seven families of bees, six of which occur in North America (Shaula Hedwall, personal communications 2011). The members of the five most common families, Apidae, Halictidae, Andrenidae, Megachilidae, and Colletidae, can be found throughout the North American continent and include 4,000 species of native bees in the United States (Mooney et al. 2010). Over 99 percent of bee species are solitary (Super family Apoidea) and do not form societies like bumblebees (native species) or honeybees (introduced from Europe). Bees are the principal pollinators in most ecosystems and are likely to be an important component of the pollinator fauna in restored ponderosa pine forests (Nyoka 2010).

Bees use a diverse range of habitats, requiring habitat components such as herbaceous diversity and density, including grasses, forbs, and shrubs, and a flower bloom succession that lasts from spring until autumn (Shaula Hedwall, personal communications 2011). The two most common bee families in the ponderosa pine forests of northern Arizona are Halictidae and Apidae (see below; David Smith, personal communication, 2011). All species within the Halictidae family nest in ground tunnels. Nests seem to be a limiting factor and competition may occur over a suitable site. Suitable nest sites require openings with bare patches of dry, packed earth for their burrows. Females dig burrows in the soil and collect pollen which they store along with their eggs in the burrow, sealing off the tunnel when they are done. When the eggs hatch, the larvae feed on the stored pollen. They pupate and eventually emerge as adults. In many species of solitary bees, the males may be territorial and patrol areas near flowers, fending off other male bees and even other species of insects that might feed on the flowers. Adults overwinter in underground burrows. When they emerge in early spring they rely on early blooming flowers and catkins that provide pollen and nectar for food.

Leaf-cutter bees (family Megachilidae) use conifer resin, plant hairs, mud, or a mix of the above to build nests in the ground, in hollow stems, or in holes bored in wood (Grigarick and Stange 1968). Ponderosa pine forests provide important nest substrate (snags and logs) for many leaf-cutter bee species. Specimens collected in California have been associated with over 100 different species of flowering plants distributed in 35 different families (Grigarick and Stange 1968).

The family Apidae includes bumblebees (genus *Bombus*). Bumblebees are some of the most common bee species in northern Arizona (Elizabeth Blaker, personal communications, 2011). Fertilized females overwinter and emerge in early spring when they search for nectar sources and nest sites. The most suitable nest locations are abandoned rodent and mole burrows. It is estimated that about 10 percent of all nests are taken over by other queens. Once a queen has a nest she collects herbaceous material to line the nest and also to pile around the nest entrance. This is thought to function in part as camouflage because of the typically short supply of preferred nest locations. Camouflaging nest entrances may also protect against invading queens of both *Bombus* as well as the parasitic subgenus *Psithyrus* (Family Apidae).

Within the 4FRI area bumblebees prefer meadows with high concentration of flowers (Elizabeth Blaker, personal communications, 2011). They commonly forage in meadows near springs, forest edges, and in or adjacent to aspen. Bumblebees commonly visit aspen clones, especially early in the season (Elizabeth Blaker, personal communications, 2011) where flowers often bloom prior to the trees fully leafing out. They occur in relatively open ponderosa pine forest; dense forest is not good habitat for bumblebees because there are not enough flowers to attract them. Arizona bugbane (*Cimicifuga arizonica*: Ranunculacaea), a plant species managed under a conservation agreement between the Forest Service and the U.S. Fish and Wildlife Service, occurs on the Kaibab and Coconino National Forests. It is pollinated by 3 bumblebee species. The flowering peak for *C. arizonica* coincides with the seasonal maximal colony size of bumblebees. The western bumblebee (*Bombus occidentalis*) depends upon *C. arizonica* as a pollen source (Pilliod et al. 2006). The western bumblebee was once widespread throughout the western states, but has declined in many areas.

Honeybees (*Apis mellifera*) were brought to North America by European settlers in the 1600s, underscoring the importance of pollinators to human crops (Mooney et al. 2010). They have since become naturalized and are likely contributing to the decline of native pollinators. They favor large patches of flowers from which they can make maximize the collection of pollen and nectar with the least amount of energy. While bees from the same hive will visit many different species of flowers, individual bees tend to visit the same species of flowers. This is believed to allow the efficiencies of specialization so that a bee knows how and where to collect nectar and pollen in a given flower. Bees are so flower-specific that only about three percent of an individual bee's pollen load is from more than one type of flower. Having a hive of specialized individual bees that allows for each bee to specialize on a different flower may be part of the reason why honeybees are such effective competitors with our native solitary bee species. Pollination by bees is required for 15 to 30 percent of US food production, but honey bee populations have been steadily declining for the past 50 years (Kremen et al. 2007).

Nesting and over-wintering habitat are key elements for maintaining bees across a landscape, especially for the many solitary bee species. The availability of nesting sites or materials may be equally as important as foraging resources to solitary bees (Nyoka 2010). Like the floral resources themselves, habitat for ground burrows, i.e., open ground receiving direct solar radiation, can be a limiting factor. Ground-nesting behaviors by bees aerate and enrich soils (Mooney et al. 2010). Similarly, standing dead trees are important nesting habitats for 30 percent of native bees (Mooney et al. 2010). Snags and down wood with holes created by beetles or other insects serve as nests for species in several families, particularly in the family Megachilidae, while carpenter bees can excavate their own tunnels in soft wood (Mooney et al. 2010). As in foraging and pollinating, a diverse array of habitat components provides for diversity in the bee assemblage.

The response of bee individuals, populations and communities to land-use change is largely driven by the spatial and temporal distribution of floral, nesting and over-wintering resources (Kremen et al. 2007). Bees depend exclusively on pollen and nectar for food during both adult and larval stages and preferentially forage on plants that provide both (Nyoka 2010). Herbaceous species important to bees within the 4FRI project area include mule fat (*Baccharis* spp.), milkvetch (*Astragalus*), trefoil (*Lotus*), showy milkweed (*Asclepias speciosa*), all wild buckwheats (Eriognum spp.), goldenrod (Solidago spp.), beardtongue (*Penstemon spp*), yellow beeplant (*Cleome lutea*), mints (Lamiaceae), figworts (Scrophulariaceae), hyacinth, dandelions, rocky mountain iris, thistle, lavender, blueweed, yellow owl clover, yellow clover, prairie clover, sunflowers, locoweed (*Oxytropis*), silvery lupine (*Lupinus argenteus*), rabbitbrush (*Chrysothamnus spp*.), currents, gooseberries, locust (*Robinia*), and *Cimicifuga arizonica* (Stokes 1983, Pilliod et al. 2006, Shaula Hedwall, personal communication 2011). There may be some obligate plant-pollinator relationships in ponderosa pine forests as well, such as the bee *Andrena astragali* (Andrenidae) that serves as a pollen specialists for death camas (*Zigadenus*, Liliaceae) and globemallow (*Sphaeralcea*, Malvaceae) (Nyoka 2010).

### Wasps

Wasps are different from bees in that they are predaceous while in the larval stage. Adult wasps feed on nectar and are important pollinators. The family Vespidae includes paper wasps and hornets or yellow jackets. They feed primarily on other insects, especially soft-bodies larvae of moths and butterflies. “Paper” nests are full of eggs, larvae, and adults, which provide easily digestible, high protein food for mammals like black bears. Male wasps emerge in late summer or fall and feed on flower pollen.

Numerous wasp families feed on pollen and nectar as adults, but are important parasitoids on many ponderosa pine pests. The family Ichneumonidae is one of the largest families of all insects. They and the closely related family Braconidae make up the majority of parasitoid insects. Parasitoid species differ from parasitic species in that they eventually kill their hosts, while parasites may weaken, but typically do not kill their host species. Species from both families lay their eggs on or in other insects. The larvae develop inside their hosts and emerge when they are ready to pupate. Ichneumons use edge habitat and are important parasitoids of ponderosa pests such as ponderosa pine tip moth (*Rhyacionia zozana*), pandora moth (*Cloradia pandora*), and ponderosa pine budworm (*Choristongura lambertiana*). They also commonly select caterpillars like tussock moths (family Liparidae) and tent caterpillars (moth family Lasiocampidae), other butterflies, and aphids. The mechanism for locating their host is unknown. Tent caterpillars can defoliate extensive areas of aspen within the ponderosa pine zone and ichneumon wasps are an important parasitoid of the pupal stage (Batzer et al. 1995). There are thousands of species of Braconids and each species usually seeks a specific host species. Adult braconids feed on the nectar of flowers or the honeydew secreted by aphids or treehoppers. Braconid larvae are important parasitoids on ponderosa pine beetle pests such as *Ips sp*. and *Dendroctonus sp*. Other important wasp families that prey on forest pests include Specidae and Chalcidoidae.

Hymenopterans are prey items for some Management Indicator Species of the Coconino and Kaibab National Forests as well as many of the migratory birds that occur on both forests. Management Indicator Species include red-naped sapsuckers, hairy woodpeckers, pygmy nuthatches, and turkeys; migratory birds include Lewis’ woodpecker, purple martins, and olive-sided flycatchers for which hymenopterans are the primary prey item; and another pollinator group, the hummingbirds, also consume hymenoptera. Hymenopterans are food for least chipmunks (*Eutamias minimus*) and northern flickers, both of which are key prey items for Northern goshawks (Reynolds et al. 1992), another Management Indicator Species for both forests. Northern flickers prey on ants in the understory and nocturnal swarms of winged ants are preyed on by bats (Jones and Rydell 2003).

### Homoptera ("same winged", including cicadas [Cicadudae], leafhoppers [Cicadellidae] and aphids [Aphidae]):

Homopterans are primarily herbivores (Short and Negron 2003) and, in general, prefer open country like meadows, savannas, and grasslands and overwinter at the base of grasses. They represent key prey items for other arthropods, especially Hymenopterans, Coleopterans, and Arachnids. Aphids are also an important prey of hairy woodpeckers and leafhoppers are eaten by shrews.

### Coleoptera ("sheath-winged"):

Beetles are the most specious and often the most abundant insects (Capinera 2010). Coleopterans perform multiple ecosystem services, including predators of other arthropods (Carabids), scavengers and detritivores that are instrumental in decomposition and nutrient cycling (Scarabaeinae and Tenebrionids), fungivores that assist in distributing fungal spores (Curculionidae), herbivores (Scarabaeinae), and bark beetles that contribute to the creation of snags and woody debris (e.g., the families Curculionidae and Scolytinae are common within the 4FRI project area) (Short and Negron 2003, Schmidt and Jacobson 2005). Many species of ground nester bees (e.g., the Families Apidae, Andrenidae, Halictidae, Megachilidae, and Colletidae) use holes in dead wood made by beetles for their nest locations (Mooney et al. 2010). Holes drilled in tree boles by beetles can provide nest sites for other species, including native bees occurring within the ponderosa pine forests of the 4FRI area (Laughlin et al. 2007). Because of the diversity in the Order Coleoptera, no single forest condition can be labeled as optimum in providing beetle habitat. However, microclimatic conditions affected by overstory conditions have been shown to control foraging rates of beetles (Meyer and Sisk 2001). Beetle species richness is highest on heterogeneous landscapes (Samways 2005, Moisset and Buchmann 2011).

Both larvae and adults in the Family Cicindelidae are predators and prefer open habitat warmed by the sun. They feed on ants, caterpillars, flies, and aphids. Members of the Familes Cerambycidae (longhorned beetle), Cantharidae (soldier beetle), and Bupresidae (flat-headed borers) lay eggs in either live or dead wood. Their larvae feed on other insects in the soil or under bark and some species may take two to three years to mature. Adults feed on aphids, other insects, pollen, and nectar. Some species can specialize on certain species of moths including some that are considered agricultural pests. Particular species of flowers can function as both food and mating sites for some beetles. One species of longhorned beetle and related species in the family Buprestidae live in forested habitat and burrow into dead wood. The females seek out trees that have recently been cut or recently died and deposits their eggs in bark crevices. The larvae feed under the bark and once they pupate, the adults overwinter under the bark.

Bark beetles (Family Scolytidae) spend most of their life inside the wood. The adults emerge to find new trees, mate, and lay eggs under the bark of living trees. Some species tunnel in the cambium of the wood and some species tunnel in the bark. Within the 4FRI, the primary bark beetle species associated with ponderosa pine mortality are a complex of *Ips* beetles including: the Arizona five-spined *Ips*, *Ips lecontei* (Swaine), the pine engraver beetle, *Ips pini* (Say), *Ips* *calligraphus* (Germar), *Ips latidens* (LeConte), *Ips knausi* Swaine and *Ips integer* (Eichhoff) (Laughlin and Moore 2008). The probability of ponderosa pine mortality caused by bark beetles was positively correlated with tree density (Laughlin and Moore 2008). They are capable of killing trees if enough adults successfully burrow under the bark and the resulting tunnels girdle the tree. Once they are successful the adult emits a pheromone that attracts more beetles and who lay their eggs in the weakened tree. At this point it is unlikely the tree will live much longer. Once beetles successfully hatch and emerge from host trees their numbers are such that even healthy trees succumb to the onslaught of successive attacks. While the resulting snags serve as wildlife habitat, they do not persist long (Carol Chambers and Joy Mast, personal communications, 2008).

Beetles are relatively ineffective pollinators, yet they remain an important group owing to their sheer abundance on flowers. A study of soft-winged flower beetles (Melyridae, subfamily Dasytinae) in western North America suggests that species in this group contribute to the pollination of numerous plant genera common to ponderosa pine forests, including forbs such as cinquefoil (*Potentilla*, Rosaceae), yarrow (*Achillea*, Asteraceae), and fleabane (*Erigeron*, Asteraceae), as well as several shrubs, including rose (*Rosa*, Rosaceae), currant (*Ribes*, Grossulariaceae), buckbrush (*Ceanothus*, Rhamnaceae), and snakeweed (*Gutierrezia*, Asteraceae) (Mawdsley 2003).

Coleopterans are an important food for woodpeckers (including red-naped and hairy), bark foraging birds (including pygmy nuthatches), grassland birds, olive-sided flycatchers, purple martins, turkeys, hummingbirds, and northern leopard frogs (Martin et al. 1961, Kennedy et al. 2009, Capinera 2010). All life stages of some beetles provide food for woodpeckers and bark gleaners such as nuthatches, chickadees, and creepers. Beetles are an especially important prey item for small mammals, including shrews, mice, and chipmunks (Capinera 2010). Large bats with more powerful jaws will eat beetles, including big brown bats (*Eptesicus fuscus*) and the greater western mastiff-bat (*Eumops perotis*; Jones and Rydell 2003), a Sensitive Species for the Southwest Region of the U.S. Forest Service. In addition, large mammals like foxes and bears also select for beetles. Mexican spotted owls feed on beetles with relatively high frequency (USDA USFWS 1995).

### Diptera (“two wings,” includes flies):

Dipterans serve in a wide range of ecosystem roles, including detritivores, fungivores, herbivores, predators, and pollinators (Short and Negron 2003). In general, fly species from this order tend to be generalist pollinators (Nyoka 2010). Kearns (1992) found 20 different fly families that visited flowers. The most abundant flower-visiting flies were hover flies (Family Syrphidae; Kearns 1992). Flies are more effective pollinators than butterflies (Waltz and Covington 2004) but less efficient pollinators than bees (Nyoka 2010). However, they replace bees as dominant pollinators at higher elevations (Kearns 1992), which may include ponderosa pine forest. Their effectiveness as pollinators is due to high visitation rates and the fact they preferentially forage on open, bowl-shaped flowers or short-tubed members of the Asteraceae (Nyoka 2010). Flies are important pollinators of some understory species such as Lewis flax (Linum lewisii), sandmat (Chamaesyce, Euphorbiaceae), buckwheat (Eriogonum, Polygonaceae), and some lilies (Liliaceae), such as death camas (Zigadenus) and mariposa lily (Calochortus) (Nyoka 2010).

Flies in the Family Tachinidae are the most important parasitoids of forest pests, particularly moth larvae (Stireman 2005). Adult Tachinid flies lay eggs on moth larvae, including ponderosa pine pests such as Pandora moths and ponderosa pine tip moths. The young flies hatch, then feed upon and kill their host.

An unusual family within this Order is the robber fly (Asilidae). Adult robber flies prey on nearly all other flying insects. They are common and often beneficial in controlling insect pests. Adults intercept prey in midair, launching from perches on leaves or twigs in edge habitat. Only about 15 percent of all flights result in capture of prey and if they are unsuccessful from a particular perch, they move to a new location. While hunting, they too become the hunted and are consumed by a variety of bird species and mice, including hummingbirds and purple martins. Robber flies are one of the main foods for purple martins. Interestingly, flies made up less than 1 percent of the diet of olive-sided flycatchers (Capinera 2010). Dipterans are among the most abundant nocturnal insects in temperate climates, making them important prey for many smaller bats, including western pipistrelle (Pipistrellus hesperus) and various myotis (Myotis spp) (Jones and Rydell 2003).

### Orthoptera (“straight wings”, including grasshoppers, crickets, and katydids):

Orthopterans are typically relatively large herbivores and as such, provide prey for a variety of vertebrate wildlife. The life cycles of crickets and grasshoppers are similar. Most overwinter in the egg stage and nymphs hatch from the eggs between late spring and late summer. They prefer open areas with dense vegetation. Turkeys, woodpeckers, flycatchers, martins and grassland birds feed on orthopterans. Additionally, shrews, chipmunks, and spiders feed on them too.

### Class Arachnida (includes hunting spiders and web-building; from Steele (2011) unless otherwise noted):

Arachnids are one of the most species-rich and numerous taxa in the arthropod community (Buddle et al. 2006). Spiders may dwell in the ground, under rocks, among grasses, on plants, in tree branches, in caves, and on water. All of these habitats are present in the ponderosa pine forests of the 4FRI analysis area, as influenced by topography, geology, and microclimate. Hunting spiders include jumping spiders, wolf spiders, and crab spiders. They rely on stealth, quickness, and relatively acute eyesight to stalk, ambush, or directly attack their quarry. They tend to be more ground-dwelling and mobile. Web-building spiders include widow, cob web, and orb spiders and tarantulas. They typically produce silken structures (sheet, tangle, or flat radiating orb) in locations most likely to passively intercept prey. Web-building spiders tend not to travel as extensively as the hunting spiders and usually take advantage of the higher portions of the forest understory to deploy their webs. Most spiders live either one to two seasons. The diversity in spider species relates to diversity in habitat requirements. In general, relatively small changes in habitat structure can have profound effects on spider species composition and relative abundances (McIver et al. 1992). Maintaining a broad array of spider species requires a heterogeneous landscape.

Similar to herbaceous species, spiders respond to overstory-induced changes in understory structure and microclimate (McIver et al. 1992, Stephens and Wagner 2006). Prey and microenvironment are largely influenced by canopy closure, moisture, and litter depth (McIver et al. 1992, Stephens and Wagner 2006). Hunting spiders are more common in open habitats and web builders dominate dense forest habitats (McIver et al. 1992, Stephens and Wagner 2006). One reason mobile hunting spiders may be more common in open-canopy habitat is in response to ant densities, another mobile predator that is more common in open habitats (McIver et al.

1992). Grasshoppers are an abundant and common prey in open habitats (McIver et al. 1992). Hairy woodpeckers, red-naped sapsuckers, pygmy nuthatches, and turkeys, all MIS, prey on spiders. Shrews (Merriam's and the least shrew are Sensitive Species for the Southwest Region of the Forest Service) and least chipmunks (a goshawk prey item) also eat spiders.

### Summary

Arthropods play multiple ecological roles, including: crucial roles in decomposition and energy and nutrient cycling; inoculating litter with fungal spores and indirectly affecting plant productivity; modifying vegetation architecture, nutrient uptake, and plant growth rates; snag creation; and they exert a tremendous influence on sympatric arthropod populations through predation and parasitism on their prey species (Short and Negron 2003, Capinera 2010). Decreases in understory biomass and shifts in plant assemblages directly affect arthropod communities. Forest overstory changes such as the loss of host plants for specific arthropod species, decrease in solar radiation reaching the ground, changes in forest floor moisture and litter depth, reduced herbaceous cover, loss of edge and meadow habitat, and fragmentation of understory connectivity all affect the arthropod community. These changes can further influence ecosystem function on many trophic levels. The arthropod community in southwest ponderosa pine forests has surely changed in association with forest habitat changes (Short and Negron 2003).

In general, human impacts have modified the landscape through fragmentation, degradation and destruction of natural habitats and the creation of new anthropogenic habitats (Kremen et al. 2007). Locally the degree of understory habitat loss and fragmentation is extreme and extensive and further loss through attrition continues to occur. The arthropod community is tied to plant species richness, total ground cover of the understory, and changes in microhabitat. Therefore, it is reasonable to assume that environmental changes that alter the spatial and temporal distribution of floral resources have led to declines in abundance and composition of arthropod populations as well. Managing for mobile organisms and the services they provide requires considering not only the local scale where services are delivered, but also a landscape scale that reflects both the spatial distribution of resources and the foraging and dispersal movements of the organisms themselves (Kremen et al. 2007). Changes in arthropod populations may be directly affecting vertebrate wildlife species, including Threatened species, MIS, Sensitive Species, migratory birds, and key prey vertebrate prey species.

## Effects of Management Treatments

### Proposed actions under the 4FRI

Proposed treatments under the 4FRI largely include combinations of thinning and prescribed burning. Currently, large stands of relatively closed canopy, homogeneous, young to mid-aged forest are common across the landscape. Thinning objectives include moving forests dominated by even-aged and evenly sized trees to uneven-aged conditions defined by small groups of trees and interspersed forest gaps. Forest gaps or interspaces are not intended to regenerate trees, but are rooting zones to support tree groups. Silvicultural prescriptions include meadow, savanna, and grassland restoration, aspen restoration, and retaining and enhancing Gambel oak. Under the proposed 4FRI action alternatives, B proposes to treat 388,526 acres with mechanical and prescribed fire treatments; alternative C proposes to treat 434,038 acres with mechanical and prescribed fire treatments; and alternative D proposes to treat 388,526 acres with mechanical treatments only. There are additional burn-only treatments where the objective is to facilitate fire treatments in neighboring areas while avoiding the creation of additional fire lines. Overall, alternative B proposes burning 587,924 acres; alternative C proposes burning 593,211 acres; and alternative D proposes burning 178,852 acres. Slash from timber operations under alternative D would be mechanically treated across about 388,427 acres.

Goals for prescribed burning include reducing surface fuels and raising crown base height to reduce the threat of future crown fire. Additional components of the 4FRI project include restoration of 74 springs and 39 miles of ephemeral channel restoration. One of the primary project objectives is to restore conditions that allow frequent fire to return to the landscape as a relatively quickly moving, low severity surface fire.

Several metrics are commonly used in the scientific literature to describe understory response to overstory changes, including plant biomass, plant cover, species richness, and community composition. The literature summary below is from studies comparing current forest conditions, thinned forests, thinned and burned forests, and post-wildfire stands.

## Understory Response to Thinning and Burning (all studies occurred in northern Arizona ponderosa pine unless otherwise noted)

Understory response to overstory removal varies considerably, largely depending on the amount of residual overstory left after treatment. Clary and Ffolliott (1966) found that ground flora biomass was higher in thinned than unthinned stands with residual basal area values of 22 to78, but there was no significant difference among treatments when post-thinning basal area exceeded 78. This threshold effect is reflected in the myriad equations used to predict understory response that display similar patterns when graphed (see Bojorquez Tapia et al. 1990 and Moore and Deiter 1992). Sabo et al. (1990) concluded that thinning basal area to less than 43.5 results in understory standing crop levels consisting of mostly native late successional plants. In addition to post-treatment basal area, other factors affecting understory response were trees per acre, time since treatment, and annual precipitation.

Light commercial thinning, with or without prescribed burning, did not significantly increase the proportion of herbaceous colonizers moving into stand understories compared to unmanaged control areas (Sabo et al. 2009). This is in agreement with other studies that have minimal treatments that retain high tree densities have little impact on plant community production or composition (reviewed in Sabo et al. 2009). Unmanaged stands in this study were characterized by high tree density, low disturbance, and few colonizing plant species (Sabo et al. 2009).

Research on changes in species richness or diversity after treatment has reached mixed conclusions. Thinning and burning in Arizona ponderosa pine increases some ground flora species, has no apparent impact on others, and negatively affects some species (reviewed in Abella 2004). However, understory changes are limited until a threshold in overstory openness is achieved. Abella and Covington (2006) found that total mean species richness did not differ significantly among control, low-, and medium-intensity thinning treatments, but a richness of about five species per square yard was twice as high in a high intensity thinning (reducing density 85 percent to 56.7 trees per acre) than in other treatments. Griffis et al. (2001) reported post-treatment mean native forb species richness was similar across treatments including control stands (mean basal area equaled 139), thinned stands (residual mean basal area equaled 83), and in thinned and burned stands (residual basal area equaled 65). They concluded remaining basal area may have been too high to affect species richness. In a study examining the effects of 30 years of repeated prescribed fires at varying frequencies on understory abundance and composition, Scudieri (2009) concluded the weak treatment response was primarily due to high overstory basal area at the study sites.

Covington et al. (1997) reported that ground flora biomass in thinning-only treatments was almost four times greater than in thin and prescribed burn treatments in patches dominated by postsettlement trees. However, measurements were taken about a year after burning and the O-horizon was raked away as part of site preparation before burning (Covington et al. 1997), potentially affecting the soil seed bank. Andariese and Covington (1986) found that in mature stands ground flora biomass did not differ significantly between burn and control plots at sites burned two and five years before sampling but did differ at a site burned seven years previously. Stoddard et al. (2011) had similar findings, concluding plant community changes were likely still occurring six years after treatments. In a rare long-term study on overstory manipulation, species richness did not differ among treatments for 10 years (Laughlin et al. 2008). Thinning alone did not increase species richness, but thinning plus repeated burning increased species richness 11 and 12 years after initial treatment (Laughlin et al. 2008). Fifteen new species were present in years 12 and 13 that were not present at the beginning of the study (Laughlin et al. 2008).

Stoddard et al. (2011) tracked understory species richness and cover across three levels of thinning intensity plus a control. They found results were highly variable among experimental blocks, but observed strong trends of increasing richness and cover in treated stands. Plant community composition was still in flux by the sixth year after treatment (Stoddard et al. 2011). Species richness was positively related to both the percent change in canopy cover ($r^2 = 0.27$, $P < 0.0001$) and basal area ($r^2 = 0.38$, $P < 0.0001$) as a result of tree removal. Total plant cover more than doubled in the low-intensity units and more than quadrupled in the high-intensity units as compared to the control units. Plant cover was positively correlated to both the percent change in canopy cover ($r^2 = 0.24$, $P < 0.0001$) and tree basal area ($r^2 = 0.28$, $P < 0.0001$; Stoddard et al. 2011). In summary, thinning the overstory can increases species richness if treatments allow enough sunlight to reach the forest floor and if conditions are monitored long enough through time.

Total biomass of herbaceous standing crop increased rapidly and was significantly higher post-treatment in another long-term ecosystem experiment. Moore et al. (2006) evaluated responses to three restoration treatments: 1) thinning from below, 2) thinning from below plus prescribed burning, and 3) an untreated control (Moore et al 2006). While treatments yielded a significant increase in total biomass of herbaceous vegetation over the control throughout the entire post-treatment period, total biomass did not differ between thinning and thinning and burning treatments (Moore et al. 2006).

Abella and Covington (2006) evaluated community compositional differences (i.e., species presence and abundance) among treatments. They reported subtle but positive native species compositional differences between control plots and thin and burn plots three years after treatment. In another study, community composition diverged among treatments 5 years after initial treatment, and compositional changes were again greatest in the thin and burn treatment (Laughlin et al. 2008). Fire is a factor because it decreases accumulated litter and resulting smoke at ground level provides a cue for initiating seed germination in some species (Buddle et al. 2006).

Thinning indirectly affects ground flora through other interrelated ecosystem components such as soil nutrients and plant-mycorrhizae associations (Abella 2004). Arbuscular mycorrhizae are generally associated with herbaceous understory plants in pine forests and are different from the ectomycorrhizae generally associated with trees and woody shrubs (Hart et al. 2005). In a review of tree thinning and prescribed burning on understory vegetation, Abella (2004) reported arbuscular mycorrhizae more abundant on thinned and burned plots than on control plots. Abella (2004) also described the negative correlation between soil O-horizon thickness, a mix of leaf litter, minerals, and organic matter (The Cooperative Soil Survey 2001), and ground flora biomass. O-horizon thickness in ponderosa pine has increased during the past century because of fire suppression and increased tree densities; prescribed burning therefore benefits ground flora by reducing O-horizons (Covington and Sackett 1984).

Available soil nutrients often increase following burning (Covington and Sackett 1992). In Abella's (2004) review of thinning and burning in ponderosa pine forests, he concludes that availability of greater concentrations of nitrogen (N) and potassium leads to higher foliage nutrient concentrations in plants for grazers. In Montana, soil ammonium remained elevated through year three after thin-and-burn treatments in ponderosa pine forests; net N mineralization, nitrification, and NO3– (nitrate) concentrations were also significantly greater in the thin-and-burn treatments than all other treatments during year one and net nitrification rates remained elevated through year three (Gundale et al. 2005). Differences in N-cycling and availability among treatments can influence the composition of the biotic community that establishes following treatment. Results from plant community models suggest that net nitrification was indirectly related to plant species richness via a positive relationship between species richness and nitrifier abundance (Laughlin et al. 2010).

Laughlin et al. (2010) concluded their models indicated species-rich plant communities dominated by C3 graminoids and legumes were associated with soils that have high abundances of nitrifiers. Graminoids using C3 photosynthetic pathways dominated herbaceous response after both thinning and thinning-and-burning treatments (Moore et al. 2006). Many herbivores selectively feed on C3 plants over C4 plants, including Mogollon voles (Chambers and Doucett 2008), because C3 plants have higher nutritional content and digestibility (Gannes et al. 1998).

Actinomycetes are a broad group of bacteria that consume soil organic matter, plant litter, and simple carbon compounds, releasing the nutrients in these substances for use by living plants. Actinomycetes are particularly effective at breaking down tough substances like cell walls of plants, even under harsh soil conditions (USDI BLM 2011). Lignin, a component of cell walls, is often the most difficult portion of plant biomass to degrade (DeAngelis et al. 2011). Fire suppression activities over the past 120 years in ponderosa pine-dominated forests have resulted in large increases in pine and other conifer litter input, and a concurrent reduction in herbaceous litter inputs both above and below-ground (Kaye et al. 2005). These changes in litter quality have apparently altered the mutually dependent soil microflora (Hart et al. 2005). Management activities that change soil nutrients can shift dominance of decomposers from bacterial to fungal, leading to subsequent changes in ground flora species assemblages (USDI BLM 2011). Over the long-term, fire exclusion may have modified soil communities, including mutually dependent soil microflora, via plant-induced changes in the soil environment (Hart et al. 2005). These differences in soil characteristics may influence stand productivity and understory species composition in the future (Gundale et al. 2005). Thin-and-burn treatments can lead to increased actinomycete activity, as indicated by phospholipid fatty acid profiles (Gundale et al. 2005).

Understanding the interactions between microbial and macroscopic components of a given ecosystem function could be critical for managing for these services (Kremen et al. 2007).

The importance of N as a structuring component of plant communities should be particularly strong in systems limited by N such as ponderosa pine ecosystems (Gundale et al. 2005). The native grass species that reportedly dominated the understory of historical ponderosa pine forests likely relied on rapid nitrogen cycling promoted by the frequent return of surface fire. Ponderosa pine-dominated forests have some of the shortest historical fire-return intervals of any forest type, and thus the evolutionary role of fire in shaping these forests is likely strong (Hart et al. 2005). Plant–soil feedbacks such as those described above may be even more fundamental to the long-term maintenance and stability of fire-adapted forests than direct nutrient mineralizing effects (Hart et al. 2005). Correlation analysis revealed that variation in fine fuel consumed was tightly correlated with net N mineralization and net nitrification (Gundale et al. 2005). Thinning and prescribed burning can affect microbial communities by increasing solar penetration to the forest floor, causing chemical alteration of the forest floor and associated changes in the mineral soil microclimate (Meyer and Sisk 2001, Hart et al. 2005). Two cycles of burning in thin-and-burn treatments reduced leaf nitrogen concentration of trees compared with the thin alone treatment (Wallin et al. 2004), suggesting more N was absorbed at or below ground level.

Soils under trees established in the last century have retained the biological, chemical, and physical imprints of the grass vegetation that occupied these areas before the pine invasion (Covington et al. 1997). The fact that pine invasion has not yet fundamentally altered the functional capabilities of the soil microbial community increases the chances that microbial communities that establish in restored grass openings following tree removal will be within the historical range of variation (Boyle et al. 2005).

## Response by Taxa

While species-specific response to management is largely directed by which species are present before treatments, effects to understory vegetation can vary by taxa. Native graminoids, especially bunchgrasses, commonly dominate the herbaceous layer under dense ponderosa pine forests in northern Arizona (Griffis et al. 2001, Stoddard et al. 2011). This is true for unmanaged, thinned, and thinned-and-burned stands (Griffis et al. 2001, Stoddard et al. 2011). However, biomass response of graminoids varies by treatment intensity with one study reporting more than a 470 percent increase in graminoid cover in high-intensity units compared to a 53 percent increase in control units compared to pretreatment measurements (Stoddard et al. 2011). In this study, all three levels of thinning intensity were also treated with broadcast prescribed burning. Griffis et al. (2001) also found abundance of native graminoids increased significantly with treatment intensity through thinned and burned stands, but abundance decreased significantly in stands that experienced high-severity wildfire.

Waltz and Covington (2004) found little difference between treated and control forests in terms of species richness of forbs serving as host plant and nectar plants for butterflies two years after thinning and burning treatments. Plant communities did shift from an annual forb community 1-year post-treatment unit to more perennial forbs and grasses 3-years post-treatment. There was also an accompanying increase in diversity of flowering species (Waltz 2001). Griffis et al. (2001) reported thinning-and-burning yielded the greatest species richness value for native forbs and higher native forb abundance than either unmanaged or thinned-only stands. Reintroducing fire into northern Arizona pine forest systems was reported to increase species richness and abundance of native annuals by others as well (Laughlin et al. 2004, 2005, 2006; Moore et al. 2006). About half of the new species colonizing the area after thinning and burning were native annuals (Laughlin et al. 2008). Legumes and forbs exhibited a four to five year lag before responding to the thinning and thinning-and-burning treatments (Moore et al 2006). Annual and biennial plants showed a large biomass increase approximately five years after implementation of the composite treatment (Moore et al 2006). Native forbs constituted between 12% and 30% of the total standing crop across all treatment types ten or more years after treatment, with higher percentages of forbs related to higher treatment intensities (Sabo et al. 2009).

In general, shrubs respond negatively to fire. Many native shrub species decreased significantly with treatment intensity, although shrub response to fire intensity can vary by species (Griffis et al. 2001). In one study, burning resulted in 17 to 32 percent mortality of shrubs whereas zero to five percent of shrubs died on unburned plots (Huffman and Moore 2004). Mortality of burned plants was positively related to amount of forest floor consumed during prescribed fires. One growing season after fire, surviving burned plants responded by producing long resprouts. Current-year branches were consistently longer on burned than unburned plants only where plots were protected from mule deer and elk (Huffman and Moore 2004). Unburned plants had more current-year branches and greater biomass than burned plants. However, no seedlings emerged on unburned plots but were found on 44 precent of burned plots (Huffman and Moore 2004). Decreasing tree density was positively correlated with Fendler ceanothus (Ceanothus fendleri Gray) current-year branch length, biomass, and leaf area (Huffman and Moore 2004).

Response of non-native forbs varies by disturbance (Table 167). High-severity wildfire tends to favor exotic species (Griffis et al. 2001). Non-native forbs constituted 3 percent of the total standing crop on plots thinned to a low basal area and prescribed burned compared to 26 percent on wildfire stands (Sabo et al. 2009). Nonetheless, this response may be ameliorated through time. Immediately following thinning and burning treatments, nonnative species cover comprised 6 percent of the total cover where treatment-induced disturbances were the greatest (Stoddard et al. 2011). However, the initial increase in nonnative species did not persist and was reduced by half six years after treatment (Stoddard et al. 2011).

**Table 167. Understory response to forest disturbance.**

| | Changes Relative To Control Plots | | | |
|---|---|---|---|---|
| **Understory Characteristic** | **Thinning** | **Thinning & Burning** | **High Severity Wildfire** | **Citation(s)** |
| Plant Species Richness | Increase | Increase | Increase (but includes a higher percentage of exotic species) | Stoddard et al. 2011 |
| Total Biomass | Increase | Increase | Increase (but includes a higher percentage of exotic species) | Moore et al. 2006 |
| Graminoids | Increase | Greatest Increase | Decrease | Griffis et al. 2001; Stoddart et al. 2011 |

| | Changes Relative To Control Plots | | | |
|---|---|---|---|---|
| **Understory Characteristic** | **Thinning** | **Thinning & Burning** | **High Severity Wildfire** | **Citation(s)** |
| Forbs | Increase | Greatest Increase | Increase | Griffis et al. 2001; Laughlin et al. 2004, 2005, 2006; Moore et al. 2006 |
| Shrubs | Increase | Increase/ Decrease | Decrease | Huffman and Moore 2004; Griffis et al. 2001 |
| Gambel Oak | Increase | Increase | Decrease | Abella and Fulé 2008 |
| Soil Nutrients | Increase | Greatest Increase | Increase (greater pulse in magnitude, but with lower potential to affect plant growth over time) | Meyerand Sisk 2001; Gundale et al. 2005; Hart et al. 2005; Covington and Sackett 1992; Abella 2004 |
| Actinomycete | Increase (after herbaceous vegetation increases) | Increase | Decrease (patchy response depends on site-specific severity) | Gundale et al. 2005; Hart et al. 2005 |
| Arbuscular Mycorrhizae | Increase (after herbaceous vegetation increases) | Increase | Decrease (patchy response depends on site-specific severity) | Covington and Sackett 1984; Abella 2004 |
| Community Composition | Increase | Increase | Increase | Covington and Sackett 1992; Abella 2004; Laughlin et al. 2008 |
| Litter | Decreased Rate of Accumulation | Decrease | Decrease | Scudieri 2009 |
| Native Plant Species | Increase | Increase | Increase (in the long-term) | Griffis et al. 2001; Laughlin et al. 2004, 2005, 2006; Moore et al. 2006 |
| Exotic Plant Species | Increase? | Increase (in short-term) | Greatest Increase | Griffis et al. 2001; Sabo et al. 2009; Stoddard et al. 2011 |

Prescribed fire without mechanical alteration of the overstory reduces surface fuels, but does not appear to affect much change in understory vegetation. Only minimal effects on understory abundance and composition were detected after 30 years of repeated prescribed fires at varying time frequencies at two ponderosa pine sites in northern Arizona (Scudieri 2009). The weak treatment response was primarily due to high overstory basal area that occurred at monitored sites (Scudieri 2009). In another study, direct effects of prescribed burning included significant reductions in leaf-litter cover and depth, but no differences were significant for herbaceous cover or shrub cover the following year (Coleman and Rieske 2006).

## Gambel Oak Response

Frequent fire is part of Gambel oak's evolutionary environment. Historical fire return intervals often averaged less than 19 years in pine-oak forests and multiple growth forms of the species persisted in frequently burned forests (Abella and Fule 2008). Densities of small-diameter oaks have sharply increased in the 140 years since fire exclusion following Euro-American settlement (Abella 2008a). Gambel oak densities in northern Arizona increased from 32 per acre in 1883 to 191 per acre in 1994 (summarized in Abella 2008a).

Trees affect soil moisture, nutrients, microclimates, and other environmental variables at that forest floor. Openings in oak canopies support more plant cover, more herbaceous species, and greater frequencies of some grasses compared to openings in pine forests (summarized in Abella 2009). Unlike needle-cast beneath pine, oak litter is looser, less resinous, and moister which may have resulted in decreased fire intensities (Abella and Fule 2008). Oak clumps containing multiple, widely spaced stems appear optimal for maintaining relatively high understory species richness by facilitating the coexistence of plant species requiring either open or closed-canopy environments (Abella 2008b).

Thinning relatively homogeneous stands of ponderosa pine into groups of trees with adjacent interspaces can stimulate oak regeneration, creating highly variable patches of Gambel oak sprouts (Fule et al. 2002). Thinning pine trees likely produces the largest and most persistent enhancement of oak diameter growth compared to thinning or prescribed burning of oak (summarized in Abella 2008b). Fire can be used to manage Gambel oak densities and growth forms while maintaining large oaks during low-intensity burning. More than 66 percent of oak greater than 6 inches in diameter were alive at least 5 years after two prescribed fires. Survival was low (less than 20 percent) for small diameter Gambel oak (less than two inches diameter) after prescribed fire (Abella and Fule 2008). Waltz and Covington (2004) documented a loss of Gambel oak after restoration-based thinning and burning treatments, but variability in response across treated units prevented statistically significant results. Top-killed oaks resprout prolifically, suggesting that fire can maintain oak browse and cover for wildlife. Burning and thinning oak can temporarily reduce densities, but these treatments may result in longer term increases because of oak's prolific sprouting ability. Elevated oak density could constitute key intermediary tree structure after thinning to mediate impacts of rapid forest structure alteration to some wildlife species, especially during the time required to reestablish large-tree pine structure. There also is less evidence that elevated oak densities represent a negative ecosystem-level effect as compared to high densities of ponderosa pine.

While acorn production is cyclic, oaks 10 to 15 inches in diameter, with 80 to 100 percent live crown, yield the most acorns. Oaks less than 5 inches or greater than 18 inches in diameter produced few acorns. Management strategies that promote large oaks with vigorous crowns, such as thinning pine trees, likely will increase acorn production (summarized in Abella 2008b).

Gambel oak communities provide a diverse array of habitats. Gambel oak provides food, cover, and nesting/fawning habitat (Moir et al. 1997). Managing for low-growing forms of oak, particularly shrub thickets, will produce the greatest amount of accessible forage for ungulates. Gambel oak foliage comprised eight to 77 percent of whitetail deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*), and elk (*Cervus canadensis*) diets in pine-oak forests (Reynolds et al. 1970 in Abella 2008a). Brushy oak forms can provide fawning cover for deer (Moir et al. 1997). Densities of invertebrates and song birds are higher in Gambel oak communities. Gambel oak is used by both foliage and cavity nesters and provides roost habitat for bat species (Moir et al. 1997, Chambers, personal communication 2009). Gambel oak is host for at least four species of butterfly larvae (McIntyre, personal communication 2011). One butterfly species, the Arizona Sister (*Limenitis bredowii*), relies on Gambel oak foliage as a caterpillar host and oak tree sap for adult nectaring. Waltz & Covington (2004) reported decreases in the Arizona Sister after restoration treatments. Gambel oak was not thinned with the restoration treatment, but mortality occurred with prescribed fire.

## Forest Resiliency

Precipitation and drought appear to be the primary factors affecting total herbaceous biomass (Moore et al. 2006). Drought can overwhelm understory response to overstory thinning and prescribed fire (David Huffman, personal communication 2011). Fulé et al. (2002) reported sharp declines in understory plant cover and species richness across a spectrum of treatment intensities, including control stands, when precipitation was only 61% of average post-treatment. They concluded that drought counteracted any detectable treatment effects. Several years later, Moore et al. (2006) described precipitation levels 75 percent below average that again reduced herbaceous biomass. In general, graminoids had been increasing several years since treatment and continued to increase until a series of severe droughts reduced standing crop to pretreatment levels (Moore et al 2006). Drought years have been common since the late 1990s (Figure 112 through Figure 114) and seem to favor graminoids with C4 photosynthetic pathways (reviewed in Moore et al. 2006). Plants with C4 photosynthetic pathways are less palatable to wildlife (Gannes et al. 1998) but are more efficient in their water-use (Moore et al. 2006).

Drought affects forest structure directly in terms of potential tree mortality and indirectly through related pathways, including changes in arthropod populations. In general, ponderosa pine mortality in the southwest has increased as a result of drought and more frequent bark beetle attacks (Kolb et al. 2007, Ganey and Vojta 2011). Severe drought from 2001 to 2004 led to increases in bark beetle populations (Negrón et al. 2009). Mortality was pervasive in ponderosa pine across northern Arizona, with a 74 percent increase of pine trees dying from 2002 to 2007 compared to the number dying from 1997 to 2002 (Ganey and Vojta 2011). A severe bark beetle outbreak represents a strong ‘‘thinning from above’’ disturbance (Klenner and Arsenault 2009). Mortality rates tend to be lower for smaller diameter trees and higher for larger trees (Klenner and Arsenault 2009, Ganey and Vojta 2011). Outbreaks can be extensive and have long-term consequences for canopy closure and overstory structure and significantly alter fuel complexes and fire behavior over time (Klenner and Arsenault 2009, Negrón et al. 2009). Forests with diverse tree species and age classes are less likely to develop large insect outbreaks (Black 2005). Ganey and Vojta (2011) concluded that the forests of northern Arizona are not resilient to climate change, and that treatments to increase resilience to climate change may be appropriate.

In a review of research conducted at the G.A. Pearson Natural Area, Fort Valley Experimental Forest outside Flagstaff, Moore et al. (2008) described trees greater than 140 years old responding with greater water uptake, stomatal conductance, net photosynthetic rate, and leaf nitrogen concentration in the first year after thinning. These physiological changes persisted through at least the seventh year post-treatment (Moore et al. 2008). In another study, thinning consistently increased bole basal area increment starting in the second post-treatment year and continuing for the next 10 years, except in the severe drought of 2002 (Kolb et al. 2007). Thinning also reduced crown dieback over the first 10 years post-treatment (Kolb et al. 2007). While growth was similar for trees in both thin-only and thin-and-burn treatments in most post-treatment years (Kolb et al. 2007), resin flow defense against bark beetles was consistently stimulated by only the thin-and-burn treatment (Wallin et al. 2004). Thinning and prescribed burning in ponderosa pine forests are expected to enhance understory vegetation directly and indirectly improve understory conditions by increasing old tree resiliency to drought and thus move elements of overstory structure towards the historical range of variation.

Drought affects arthropod populations too. While these changes are not often detected and the ramifications to forest health are not always understood, fundamental ecosystem pathways are affected. From 2003 to 2004 carabid ground beetle abundance decreased to only about one third of the levels measured from 1998 to 2000. This plummet in the population was ascribed to changes in annual precipitation in northern Arizona. In the extreme drought of 2002 no carabids were found within ponderosa pine sample plots (Chen et al. 2006). In dry years, small forest openings may provide cooler and moister microclimates than those in larger, more exposed meadows. These microclimates appear to maintain flowering plants required by nectar feeding butterflies and other pollinating insects that, in some years, may be limited or absent in larger, drier meadows (Julie McIntyre, USFWS, personal communications 2011). These islands of nectar flowers within the forest matrix may act as stepping stones, providing population connectivity and promoting dispersal and genetic exchange of pollinating insects (Julie McIntyre, USFWS, personal communications 2011).

## Arthropod Response to Management Treatments

### Bark Beetles

Changes in forest structure over the last century as a result of anthropogenic factors are likely to increase susceptibility to *Ips*-caused ponderosa pine mortality in the Southwest (Negrón et al. 2009). These changes in forest structure have implications for species dependent on mature overstory trees and large snags for foraging and nesting, particularly in pure stands of ponderosa pine dominated by trees in larger size classes (Klenner and Arsenault 2009). Current forests that exceed the historical range of variation are at greater risks of uncharacteristic mortality levels resulting from beetle attacks (Lynch et al. 2008). In combination with past harvesting of ponderosa pine forests over the last century, this may further compromise the ability to provide future habitat conditions for wildlife associated with large trees, snags, and logs (Klenner and Arsenault 2009, Ganey and Vojta 2011). Silvicultural prescriptions can facilitate the development of mature conditions in ponderosa pine stands impacted by beetles (Klenner and Arsenault 2009, Ganey and Vojta 2011). Thinning forests to decrease tree competition can also benefit pollinating parasitoid wasps and flies which attack pine beetles and moth larvae to feed their own larvae (David Smith, personal communication 2011).

## Ground Beetles

Tenebrionid beetles, which are forest floor scavengers, were found at higher richness and diversity in ponderosa pine stands of northern Arizona 13 to 14 years after fuel reduction treatments (thinning alone and thinning with prescribed burning) compared to untreated stands (Chen et al. 2006). Villa-Castillo and Wagner (2002) found diversity of ground beetle species increased as the level of stand disturbance increased (unmanaged, thinned, thinned and burned, and wildfire). However, thin-only stands did not significantly vary from unmanaged stands in overall species assemblage and both had the lowest species richness values. Although species richness was low in unmanaged and thin-only stands, abundance was generally high. However, the higher abundance on unmanaged and thinned treatments was accounted for by a single species. Similarly, Chen et al. (2006) described thin-only stands as having the highest species evenness. Fuel reduction treatments consistently increased species richness and Shannon diversity measurements for carabids, but did not cause a pronounced shift in their community assemblage (Chen et al. 2006).

Stands that were thinned with a similar intensity, but with a prescribed burn applied three to four years after thinning, had significantly different ground beetle assemblages. Species richness for ground beetle species assemblages was higher on thinned-and-burned and high-severity wildfire-burned stands than either unmanaged or thin-only stands (Villa-Castillo and Wagner 2002). Chen et al. (2006) found that community assemblages of both carabids and tenebrionids had the highest species richness and diversity in high-severity wildfire-burned stands. Villa-Castillo and Wagner (2002) found a shift toward an assemblage dominated by open-area species in stands created by high-severity wildfire (Villa-Castillo and Wagner 2002). Ordinations of carabid and tenebrionid community assemblages at two-dimensional scales showed that wildfire stands (greater than 90% basal area consumed during wildfire in 1996) were clearly separated from all other stand types for both taxa (Chen et al. 2006). Villa-Castillo and Wagner (2002) concluded a mosaic of forest conditions likely provides refugia for recolonizing beetles and prevents competitively dominant species from monopolizing resources. Chen et al. (2006) concluded mechanical fuel reduction treatments are an important management strategy to maintain high invertebrate species diversity in southwestern ponderosa pine forest ecosystems. Heterogeneity is important to species richness of all taxa although different taxa are related to different measures of heterogeneity such as structure and composition. No single forest condition can be labeled as optimum in providing habitat (Chen et al. 2006).

## Spiders

Relatively small changes in habitat structure can have profound effects on spider species composition, in part because wandering spiders are largely replaced by web-building species as litter composition changes (reviewed in McIver et al. 1992). A study in Finland looked at the effects of a range of logging intensities on spider assemblages (Matveinen-Huju and Koivula 2008). Gap felling preserved some forest species while also supporting colonization of open-habitat species and thinning treatments preserve forest-floor spider assemblages found in unlogged control stands (Matveinen-Huju and Koivula 2008). Work in western Oregon documented a succession of spider species present in association with different ages of forest stands (McIver et al. 1992). Some species are present in areas without a forest canopy and others reside in old-growth stands. A mosaic of age-classes and structural characteristics supports the most diverse spider communities.

A study in Alberta looked at aspen-dominated stands within coniferous forests that were either clearcut or burned in high-severity wildfire (Buddle et al. 2006). Species abundance and species richness was greater in cut versus burned stands for almost three decades post-disturbance (Buddle et al. 2006). This is probably due, in part, to the complete or partial reduction of the organic horizon that occurs following most wildfires (Buddle et al. 2006). Spiders and other generalist predators may be re-colonizing the wildfire landscape from refugia missed by the fire. However, there is evidence that wildfire is crucial to some unique elements of litter-dwelling arthropods in young aspen forests (Buddle et al. 2006). Spiders apparently mostly recover to pre-disturbance assemblages after clearcutting in about 30 years (McIver et al. 1992). The post-disturbance assemblage continued developing 70 years after logging (Buddle et al. 2006) and it is not known how long full recovery takes (Matveinen-Huju and Koivula 2008).

### Ants

Stephens and Wagner (2006) assessed changes occurring in ground foraging ant functional groups with four treatments (unmanaged, thinned, thinned and broadcast burned, and high-severity wildfire) in northern Arizona ponderosa pine-bunchgrass ecosystems. Ant functional groups and individual species differed significantly by treatment. Different functional groups were dominant under different levels of disturbance severity and suppressed or excluded other functional groups that were less suited to the particular disturbance intensity. Unmanaged forest stands were characterized by high tree densities, high basal area, and dominated by the opportunist functional group. Thinned stands, also dominated by the opportunist functional group, had a similar ant assemblage as the unmanaged stands, but the coarse woody debris functional group was more abundant in thinned stands. The generalist group was up to 25 percent more abundant in the wildfire areas than any other treatment condition. They occurred at very low (less than five percent) abundance in the thinned stands for both years. Conversely, relative abundance of coarse woody debris specialists was highest in thinned sites and lowest in wildfire sites, being at least 10 percent more abundant on thinned sites than wildfire sites. Specialized slave makers were most abundant in unmanaged and thinned sites and were rarely or not observed in thinned-and-burned or wildfire sites (Stephens and Wagner 2006). The variety in ant functional groups among treatment types underscores how different the ecosystem composition may be in today’s forests relative to the historical range of variation. Stephens and Wagner (2006) concluded that in order to maintain a diversity of ant functional groups and species in northern Arizona ponderosa pine forests, a diversity of forest conditions should be maintained. McIver et al. (2006) concluded that several species of ants made up the majority of invertebrate predator biomass in clear cuts. Only one species was present in old-growth forests (McIver et al. 2006). Maintaining a diversity of habitat types should support ecologically diverse ant functional groups (Stephens and Wagner 2006).

### Butterflies

The primary threat to many butterfly species is habitat loss (Black et al. 2007, Selby 2007). In general, increased light to the forest floor increases the overall butterfly population. In addition, as specific host and nectar plants become more established in opened areas, more specialized butterfly species are also likely to move into restored forest areas (reviewed in Meyer et al. 2001, Julie McIntyre, USFWS, personal communication 2011). Butterflies associated with open habitats are likely to be attracted to restoration treatments in Southwest ponderosa pine systems (Meyer et al. 2001).

After restoration-based treatments were implemented in ponderosa pine forest in northern Arizona, butterfly species richness and abundance were 2 and 3 times greater, respectively, in treated units than in paired control forests 1 year after treatment, and 1.5 and 3.5 times greater, respectively, 2 years after treatment (Waltz and Covington 2004). Ordination of butterfly assemblages in control and treatment units showed significant separation after restoration treatments. Waltz and Covington (2004) also reported insolation (light intensity) was significantly greater in treated forests after restoration.

Species such as Speyeria nokomis nokomis and S. n. nitocris may benefit from meadow restoration and restoration of ephemeral drainages. S. n. nitocris fly in open, sunny habitats but females also search out host plants in edge habitats. Their host plant, Violoa nephrophylla Greene, is typically found in moist or spring-fed meadows (Julie McIntyre, USFWS, personal communication 2011). Maintaining habitat supporting the host plant along with a diversity of flowering nectar sources (especially purple and yellow flowers), will help support this species (Julie McIntyre, USFWS, personal communication 2011). Work with the Nokomis Fritillary (Speyeria nokomis apacheana) indicated probability of occupancy increased with increasing larval host-plant abundance and percent cover of adult nectar sources (Fleishman et al. 2002). Occupancy decreased as litter reached heavy levels, perhaps as a result of impeded ovipositing (Fleishman et al. 2002), suggesting prescribed burning could maintain their habitat. Butterflies should benefit from management that provides key micro-habitat components such as increased understory, particularly flowering forbs, and higher light intensity and higher temperatures at the forest floor (Meyers et al. 2001, Selby 2007).

### Pollinators

Ponderosa pine forest conditions across the Intermountain West appear to be increasingly unfavorable for most insect pollinators (Nyoka 2010). Most pollinators have similar needs: open, sunny areas, high herbaceous diversity, and availability of host plants and nectar sources. Some early-successional disturbance-based forb communities, with a variety of microclimates, may provide refugia under changing conditions (Julie McIntyre, personal communication 2011.). Overstory thinning and prescribed burning have the potential to improve habitat for pollinating taxa (Nyoka 2010; Table 3). Overstory thinning and prescribed burning can increase: nest site availability, solar radiation at ground level, and the abundance and diversity of flowering plant resources, resulting in improved habitat for most pollinating insects (Black et al. 2007, Nyoka 2010).

## Arthropod Response to High-Severity Fire

Herbaceous species richness and abundance of native graminoids both decreased significantly in stands that experienced high-severity wildfire (Griffis 2001). Wildfire produced the greatest abundance of forbs, but also the greatest abundance of exotic forbs (Griffis 2001). Vegetative cover occurred over less than half the area after the Hochderffer wildfire in 1996 that killed over 95 percent of the trees (Sabo et al. 2009). Following the fire, native graminoids and forbs contributed the largest proportion to total herbaceous biomass (Sabo et al. 2009). Nearly half of the total native graminoid biomass occurring on wildfire plots was comprised of colonizing species. Nonnative forbs were not detected on unmanaged, thinned, and thinned and burned stands eight years later, but constituted seven percent of the total vegetative biomass on wildfire stands. In the ninth year post-fire, 22 percent of total vegetative biomass was contributed by nonnative forbs (Sabo et al. 2009). This pronounced presence of non-native forbs on wildfire sites was largely attributed to common mullein (Verbascum thapsus L.). In addition to mullein, other nonnative forbs, in decreasing order, were: Dalmatian toadflax (*Linaria dalmatica* (L.) P. Mill.), yellow salsify (*Tragopogon dubius* Scop.), Russian thistle (*Salsola kali* L.), prickly lettuce (*Lactuca serriola* L.), common dandelion (*Taraxacum officinale* G.H. Weber ex Wiggers), lambsquarters (*Chenopodium album* L. var. album), and bull thistle (*Cirsium vulgare* (Savi) Ten.) (Sabo et al. 2009). The most severely disturbed wildfire site supported the greatest standing crop of native and non-native colonizing species (Sabo et al. 2009).

Fire creates a nutrient pulse back into the soil. As the time between fires lengthens, the pulse of nutrients released from the fire increases in magnitude. However, the extended time between nutrient pulses means there is a lower potential to affect plant growth over the fire-free period (Hart et al. 2005). In contrast, higher frequency and low-severity fire, like those managed in prescribed burning, produces a lower magnitude nutrient pulse more frequently, enhancing soil nutrient balances and aiding herbaceous vegetation more consistently.

## Fire and Arthropods

Prescribed burning primarily affects the arthropod community by changing understory conditions. In southeastern pine-oak forest, leaf-litter arthropod abundance remained low the year following an early-season, low-intensity burn (Coleman and Rieske 2006). Recovery of leaf-litter arthropods was evident two-growing seasons after the burn. While this was low-intensity fire, it was also a first entry burn. In a paired site that had been burned three years previously, no long-term effects of multiple burning on leaf-litter arthropods were detected. Leaf-litter arthropod diversity was not affected by either burn regime but abundance was greater at multiple-burned sites. Prescribed burning that created a mosaic, i.e., pockets of less intense or incomplete fires as well as hotter burn areas, retained higher leaf litter and supported a greater abundance of arthropods (Coleman and Rieske 2006). Three years between prescribed burns appeared adequate to replenish leaf-litter habitat and allow arthropod abundance to rebound to comparable unburned levels (Coleman and Rieske 2006).

A study in a California oak woodland habitat that tracked wildfire effects on a specific flowering forb found plants growing in burned environments were taller and pollen-tubes grew faster than plants growing in unburned sites (Travers 1999). There is a relationship between pollen-tube growth and pollen production, suggesting plants in burned environments better support pollinators and that they would have a competitive advantage in the fertilization of ovules (Travers 1999). Pollen performance appears to depend on both the genetic background of pollen recipient plants and the growth environment of pollen donors (Travers 1999). If pollen performance is limited by nutrient availability, then post-fire increases in soil nutrient content should lead to improved rates of pollen-tube growth in individuals growing after the fire (Travers 1999). If these results can be extrapolated to other flowering plants, then prescribed fire should benefit pollinators by enhancing pollen production. Overall diversity and abundance of nectar or pollen feeding arthropods may increase in response to increased nectar resources (Waltz and Covington 2004). A 50-year chronosequence of a Mediterranean pine–shrub community regenerating following fire found bee community composition closely tracked floral composition and associated rewards (Potts et al. 2003b cited in Kremen et al. 2007).

Direct impacts from high-severity wildfire can be very different from prescribed burns (Table 168). In deciduous-dominated stands (Populus), fewer arthropods were caught in stands originating from wildfire than in those developing after clearcutting for almost three decades post-disturbance (Buddle et al. 2006). This was probably due, in part, to the complete or partial reduction of the O-horizon that occurs following most wildfires (Buddle et al. 2006). Landscape-scale high-severity fires can create extensive areas of powdery soil substrates unsuitable for ground-nesting bees, and widely scattered patches of floral resources dominated by low-reward annual species in the short-term (Nyoka 2010). The probable outcome of continued fire suppression is an increase in high-severity, stand replacing wildfires (Covington and Moore 1994, Covington et al. 1997) as seen in the Rodeo-Chediski fire of 2002 (464,556 acres) and the Wallow fire in 2011 (538,049 acres).

**Table 168. Arthropod response to management treatments.**

| | Changes Relative To Untreated Plots | | | |
|---|---|---|---|---|
| Arthropod Species | Thinning | Thinning & Burning | High Severity Wildfire | Citatons |
| Bark Beetles | Decrease | Decrease | Increase (surviving trees weakened by fire are more vulnerable) | Lynch et al. 2008; Negrón et al. 2009 |
| Ground Beetles | Increase | Increase | Increase (but dominated by open-habitat species) | Villa-Castillo and Wagner 2002; Chen et al. 2006 |
| Spiders | Increase | Increase | Mixed (depends on burn patterns and severity) | McIver et al. 1992; Buddle et al. 2006; Matveinen-Huju and Koivula 2008 |
| Ants | Increase | Mixed | Mixed | Stephens and Wagner 2006 |
| Butterflies | Increase | Increase | Decrease | Meyers et al. 2001; Waltz and Covington 2004; Selby 2007 |
| Pollinators | Increase | Greatest Increase | Decrease in the short-term; increase in long-term | Travers 1999; Kremen et al. 2007; Nyoka 2010 |

# Understory Conditions in the 4FRI analysis Area

## Historic Conditions

In 1909, research was initiated in ponderosa pine forests on the Coconino National Forest by Gus Pearson and follow-up work was completed by Moore et al. (2004). Based on detailed stand information and management history, a model was built to predict forest characteristics before logging and fire exclusion altered stand conditions. Basal area was used to estimate understory biomass from 1876, the year of the last wildfire and before any logging occurred, to present. Moore et al. (2004) also used models from other areas within the proposed 4FRI treatment area and from the Beaver Creek watershed adjacent to the 4FRI treatment area boundary to estimate historic understory biomass. Overall, they estimated a decrease in understory biomass of over 50 percent since 1876.

## Current Conditions

Range managers have been monitoring forage production with a survey technique known as the Parker 3-Step. Each "step" represents a different data-collection method performed at fixed points and transects designed to be reread through time. A Parker cluster typically consisted of three 100 foot-long transects and plants were recorded every foot along each transect (step 1). Range conditions were evaluated (step 2) and photographs taken at permanent photo points (step 3). Originally, any perennial plant encountered every foot along permanent transects were tallied ("hits"). After transects had been read for years it was felt the data was not sensitive enough to accurately represent range conditions. They were modified to include plant hits and "dots." If no plant occurred where the hit landed, the closest plant within a 180° arc off transect was included. Dots expanded the dataset, but lack of a spatial component associated with dots make them difficult to assess. While the data is not suited for rigorous analysis, they preserve a record of plant species occurring on the landscape and the frequency in which they occurred. This method was considered state-of-the-art, but in recent years it has been replaced with more ecologically sensitive measures. Nevertheless, the Parker dataset represents the most comprehensive herbaceous vegetation dataset with repeat measures in northern Arizona. The record goes back to the 1950s. Parker transects were intended to be read every decade and readings within the 4FRI treatment area occurred as recently as 2010.

There are 121 Parker cluster within the soil types occurring in the 4FRI area. Data from the original surveys for these transects were put into an electronic format (Dave Brewer, Ecological Restoration Institute). Data summaries for hits (Figure 108) show deceases in herbaceous cover since the 1980s. An obvious increase in trees occurred along transects since the 1960s, but even trees declined since the 1980s. Dots provide higher frequencies and indicate grasses and trees have increased while other plant taxa decreased during this same time period (Figure 109).

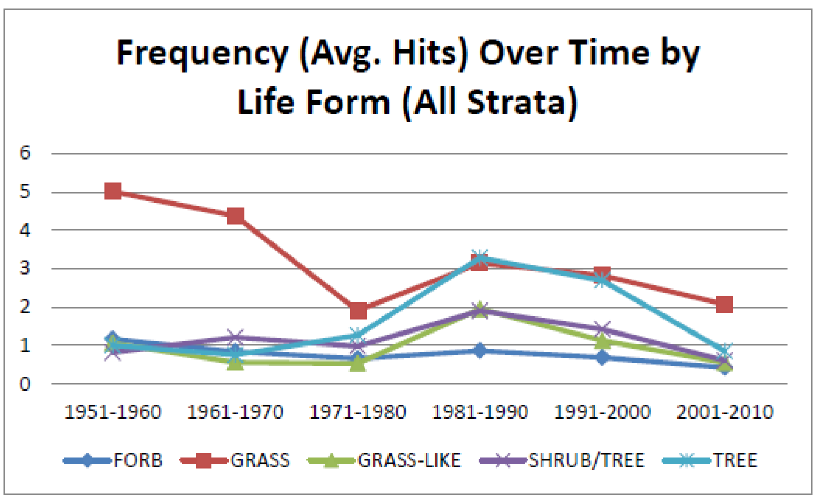


**Figure 108. Plant frequency trends along Parker transects (hits) occurring in soil strata within the 4FRI area**

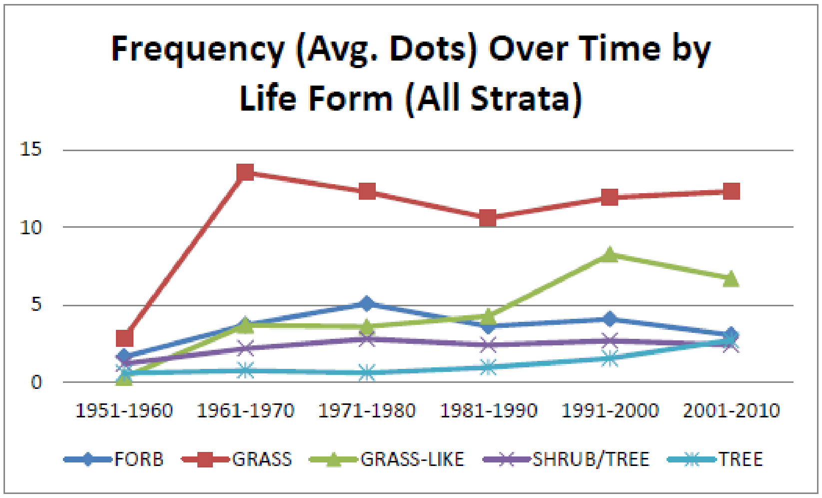


**Figure 109. Plant frequency trends adjacent to Parker transects (dots) occurring in soil strata within the 4FRI area**

Figure 110 displays changes in $C_3$ ("cool season") and $C_4$ ("warm season") plants over time based on hits. Increases for both groups occurred in the 1970s and have had decreasing trends since the 1980s. Warm season plants, primarily blue grama grass, have been dominant on the landscape, but the degree of dominance has decreased through time. Cool season plants have been decreasing at a faster rate than warm season plants since the post-1980s decline. The pattern changes when dots are used, with warm season plants continuing to increase since the 1980s and cool season plants only decreasing since the 1990s (Figure 111).

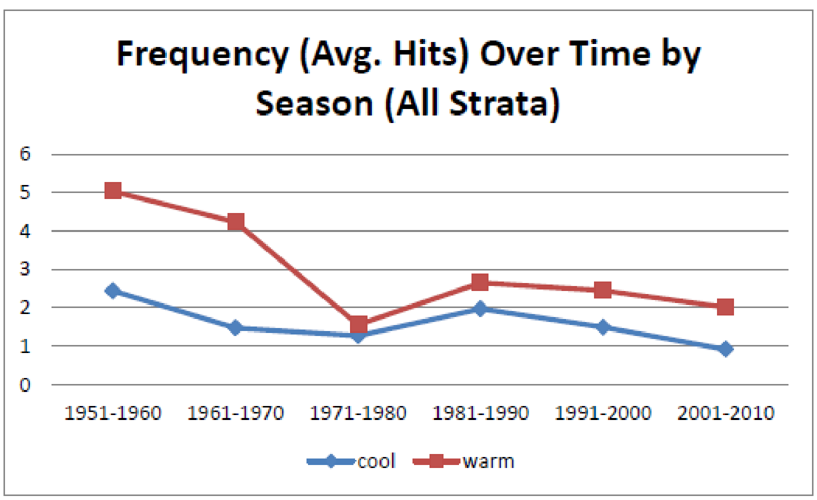


**Figure 110. Plant frequency trends along Parker transects (hits) occurring in soil strata within the 4FRI area**

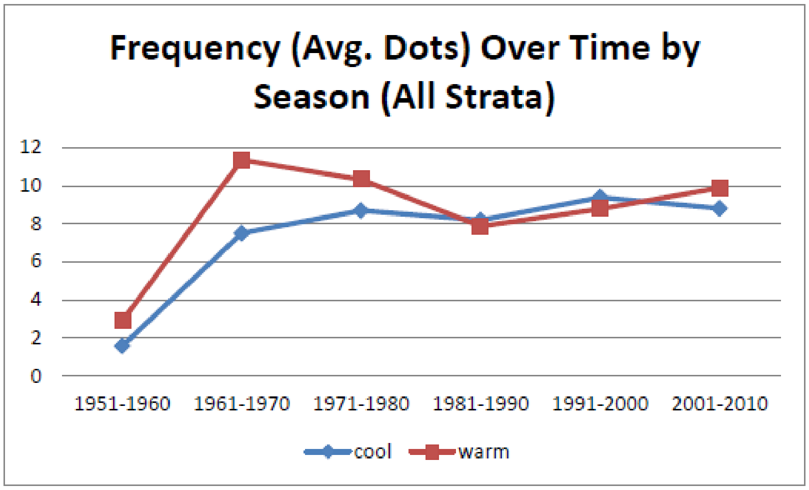


**Figure 111. Trends for cool (C3 pathways) and warm (C4 pathways) season plants adjacent to Parker transects (dots) occurring in soil strata within the 4FRI area**

Key to trends in vegetation is precipitation patterns. Flagstaff is relatively centrally located in the 4FRI treatment area and precipitation history for Flagstaff shows that, with exception, annual precipitation exceeded the 10-year average (Figure 112). However, annual precipitation in northern Arizona is bimodal, principally occurring as winter snow or summer (monsoon) rain. Winter precipitation is key for maintaining cool season plants while warm season plants are tied more to monsoon rains. An examination of winter precipitation illustrates the number of years with below average snowfall (Figure 113). Monsoon rains more often occurred at or above the 10-year average (Figure 114). Note that the drought that started in 2000 affected both summer and winter precipitation.

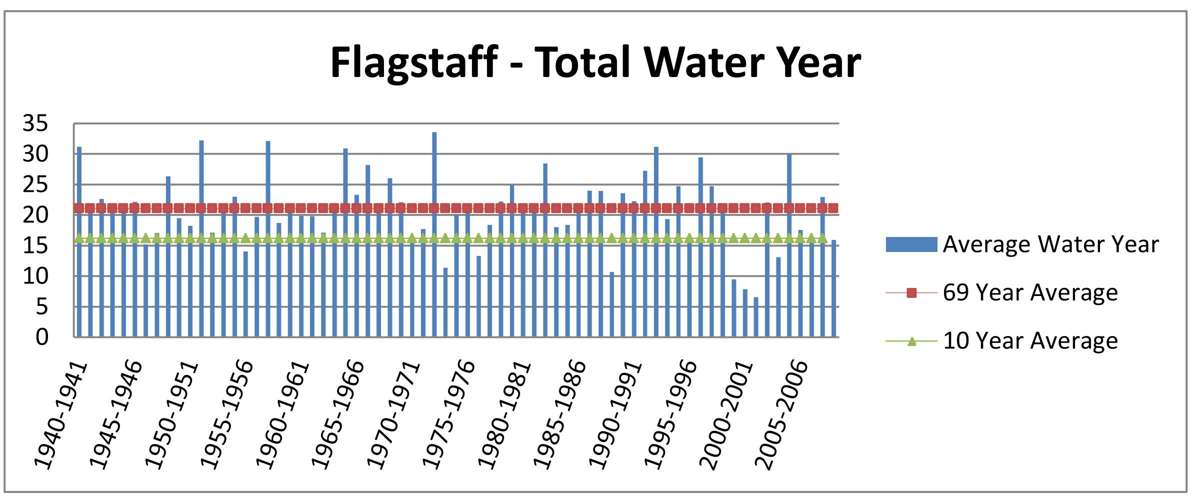


**Figure 112. Annual precipitation patterns for Flagstaff, Arizona, 1940 to 2009**

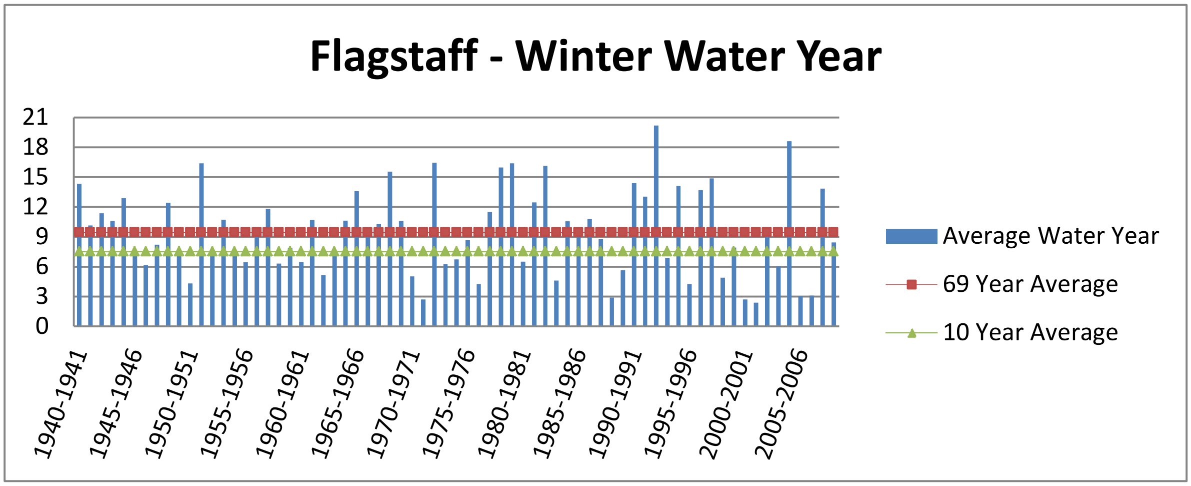


**Figure 113. Winter precipitation for Flagstaff, Arizona, 1940 to 2009**

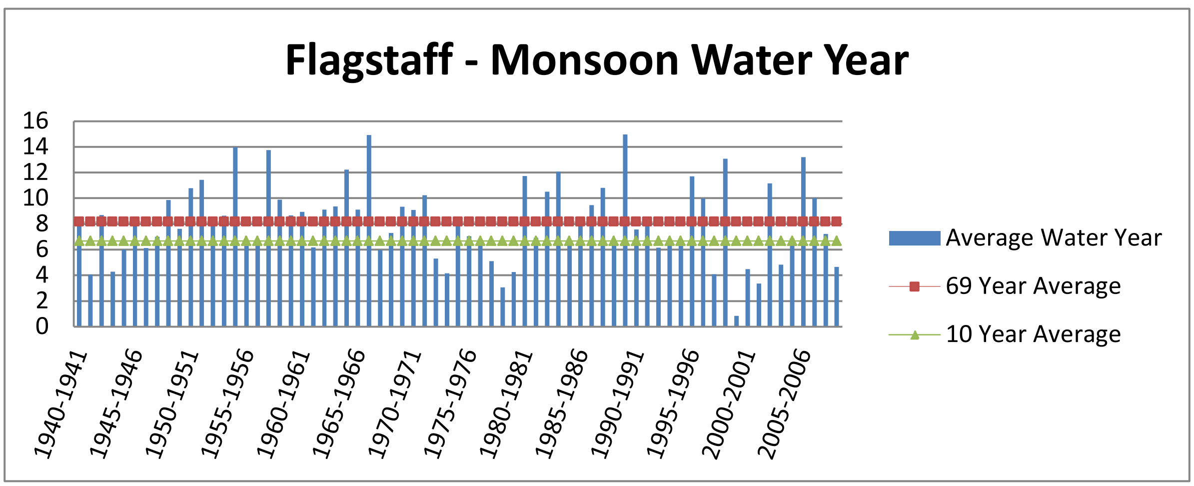


**Figure 114. Summer precipitation for Flagstaff, Arizona, 1940 to 2009**

## Predicting Future Conditions

As described above, there is a strong and predictable relationship between overstory closure, tree density, and understory production. Decades of research using local vegetation data across the ponderosa pine forests of northern Arizona have resulted in many models for predicting understory response. While the associated Y-intercepts and coefficients vary between models, the resulting response functions are the same: the relationship between the input (forest structure) and the output (understory biomass) is inversely related and curvilinear. As forest density increases understory development decreases. The reduction in herbaceous biomass is small at first and then rapidly declines. At a certain level of forest development the rate of decrease in herbaceous production levels off, becoming nearly asymptotic in dense, closed canopy conditions as the understory response approaches zero.

Understory biomass predictions vary by soil type (Bennet et al. 1987, Ffolliott 1983, Laughlin and Abella 2007). At broad scales, most soil series within the 4FRI project area are dominated by basalt or limestone parent materials. Soil chemistry, texture, and topography all effect biomass production (Clary and Ffolliott 1966, Covington and Sackett 1992, Abella and Covington 2006, McGlone et al. 2009). However, under dense canopy cover understory biomass yield is similar between soil types (Clary and Ffolliott 1966, Bennett et al. 1987). Differences in biomass yield between different soil types is more fully expressed under open the canopy cover (Bennett et al. 1987).

A variety of approaches have evolved to classify landscapes or ecosystems. One approach uses terrestrial ecosystems, which have been defined as the conceptual representation of the obligatory relationship between soil, vegetation, and climate (Robertson et al. 2003). A Terrestrial Ecosystem Survey (TES) consists of the systematic examination, description, and classification of soil, vegetation, and climate which are integrated with other ecosystem components, such as landform, geology, and geomorphology (Robertson et al. 2003). The unique combination of terrestrial ecosystems and appropriate phase criteria (i.e., slope, texture of the surface layer, soil depth, etc.) define an ecological map unit. TES meets the requirements of the National Hierarchal Framework of Ecological Units, a land classification system for classifying and mapping of the Earth into progressively smaller areas of increasingly uniform ecological potentials. TES mapping is done at the landscape scale with a resolution of 40-acres. Identification of the soil component meets the standards and follows the policies and procedures outlined in the National Cooperative Soil Survey program. The description and classification of soils meets the criteria established in *Soil Taxonomy: A Basic System of Soil Classification for Making and Interpreting Soil Surveys* (2nd edition, 1999), the *Soil Survey Manual,* and the “National Soil Survey Handbook” (Robertson et al. 2003). A TES was completed for both the Coconino and Kaibab National Forests (Brewer et al. 1991, Miller et al. 1995).

Bojorquez Tapia et al. (1990) developed and statistically analyzed 18 herbage production/forest overstory regression equations based on over 20 years of data from the Beaver Creek drainage, a sub-watershed adjacent to the 4FRI project boundary on the Coconino NF. The area was dominated by ponderosa pine forest occurring on soils with basaltic parent material. The authors reported associated statistical measures for the equations, including the coefficient of determination, to compare how well the predictive models matched the actual data. In this application, a coefficient of determination ($r^2$) is the proportion of variability in a data set accounted for by the model. It reflects the goodness of fit, or how well the regression matches the actual data values. An $r^2$ of 0.0 indicates none of the variability in the dataset is explained by the model and a value1.0 is when the model perfectly fits the data. An $r^2$ of 0.4 can indicate a reasonable fit in natural resource models. Through a series of statistical evaluations, Bojorquez Tapia et al. (1990) concluded 16 of the 18 equations did not meet their evaluation criteria. The top model was logarithmic using basal area as the measure of overstory with an $r^2$ of 0.703 (Table 168). The authors clarified that the intent of the model development was for long-term planning purposes and not for predicting herbage production in a particular year (Bojorquez Tapia et al. 1990).

In a similar effort, Deiter (1991) evaluated eight models for predicting understory biomass using a variety of overstory stand density measures on stands from the North Kaibab Ranger District of the Kaibab National Forest. This work was done in ponderosa pine forest on limestone soils. One of the equations was a nonlinear regression model using basal area. This equation represented a comparable approach to Bojorquez Tapia et al. (1990) using the same overstory variable. Deiter's (1991) equation for limestone soils had an $r^2$ of 0.671 (Table 169).

**Table 169. Selected models for relating understory production to overstory basal area in ponderosa pine forests of northern Arizona. The response variable Y equals understory production.**

| Regression Equation | Parent Soil | $r^2$ | Study |
|---|---|---|---|
| $\text{Log (Y)} = 2.794 – 0.348 \times 10^{-1} \text{ (BA)}$ | Basalt | 0.703 | Bojorquez Tapia et al. 1990 |
| $\text{Square root (Y)} = 6.5894 + 32.488 \times \ln^{(-0.0511*BA)}$ | Limestone | 0.671 | Deiter 1991 |

The equations described above were developed from data within their respective study areas. It is not valid to extrapolate the models using the coefficients derived from the respective source data to predict understory biomass yield in other watersheds. In order to predict actual herbaceous biomass yield, site specific data should be collected to calculate new coefficient values. Additional measures such as litter depth, topography, interactions of soil nutrients and microflora, and other factors could affect the accuracy of the predictions. Nevertheless, the models in Table 168 were used to create a **relative index** of herbaceous response to overstory manipulations across the 4FRI treatment area. The yield values do not represent actual predictions of expected pounds per acre of biomass. The output, biomass yield, represents a relative measure of change between actual treatment prescriptions based on basal area of forest stand structure before and after treatments are implemented.

This approach was pursued because of the consistently similar response function from a variety of models developed over the last several decades within the ponderosa pine forests of northern Arizona. The strong link between overstory, as assessed by basal area, and understory has been demonstrated by a variety of authors. Rather than make actual predictions, the models identified by Bojorquez Tapia et al. (1990) and Deiter (1991) were used as a means to uniformly compare understory response to changes in overstory structure. The equations were applied across the 4FRI treatment area stratified by parent soil material. This approach allows an objective comparison of management actions based on stand-by-stand treatment outputs to evaluate this fundamental aspect of wildlife habitat. These estimates of change display relative changes in biomass yield under different treatment scenarios. The relative change was generated for each individual ponderosa pine stand across the treatment area and summarized by the 19 sub-units with proposed fire or mechanical treatments. Relative indices were developed for basalt and limestone soils only as no equations were found for deep cinder soils.

Abella and Covington (2006) examined geomorphology, soils and vegetation in ponderosa pine stands on the Coconino NF near Flagstaff. They classified 10 different ecosystem types using diagnostic environmental features and characteristic herbaceous species. Black cinder soils with purplefringe (*Phacelia sericea* Graham) common in the understory had the driest surface soils, lowest plant cover, and fewest understory species of any of the classified ecosystems; next on this gradient were red cinders with yellow ragleaf (*Bahia dissecta*) (Abella and Covington 2006). The black cinder system, with gravelly, surficial volcanic cinders, typically had more open grown forest but with low ground-flora cover. The red cinder system had sandy loam soils, slow tree growth, and moderate ground-flora cover. Both systems are relatively xeric, but in addition, movement of the cinders may further impede understory development in black cinders. Harsh growing conditions in black cinders appear to favor annual versus perennial understory plants. Growth rates of ponderosa pine were slowest in red cinders. Surface soils in the black cinders were deemed “inhospitable” and ponderosa pine growth rates were variable, but on average, once a tree became established rapid diameter growth occurred. Both systems principally occur around the San Francisco Peaks, although cinder inclusions are found across the 4FRI treatment area. While no models exist for estimating understory response after overstory thinning, we expect a limited response because of the growing conditions in cinder soils. Abella and Covington (2006) noted that the red cinder systems were rare historically, but over 30 percent of their area has been burned by crown fires since 1950, indicating a need for ecologically-based treatments despite the limited response in understory vegetation.

The equations for basalt and limestone described above were included in the database calculations and a relative understory response value was generated for each stand, for each reporting year, for each alternative. Proposed treatments under the 4FRI will occur over the course of 10 or more years. However, there is no way to predict when a particular acre might receive treatment. For the purposes of forest simulation modeling, the following assumptions were made: the year 2010 represents existing conditions; all mechanical treatments occur in the year 2012; first-entry burning treatments would happen in 2015; maintenance burns would follow in 2019; and 2020 is the first year post-treatment (see the Silviculture and Fire Ecology Reports for details). Modeling out to the years 2030 and 2050 was conducted to track forest changes through time. Modeling assumes no further reductions in overstory after treatments implemented under 4FRI. In order to meet the desired conditions of the 4FRI we expect further treatments will be necessary. This assumption omits the effects of additional prescribed fire or low-severity wildfire. By excluding future low-severity burning another negative bias is introduced into the model results, further dampening the biomass yield index below what could be reasonably expected.

There are several key limits to this modeling approach. One is soil based. There are 96 TES units across the 4FRI project area. These were grouped by dominant parent material and each soil TES was combined into one of three categories: basalt, limestone, or cinder (Rory Steinke, Coconino NF and Christopher MacDonald, Kaibab NF, personal communication). This greatly simplifies the variety found in the project area by assigning one output for each soil type that fell within either “basalt” or “limestone” and was used consistently for generating output across alternatives.

Another limit to this approach is basing output on basal area. The basal area value in the model represents a simple average across the stand. Using basal area alone as an overstory measure does not address tree density. Deiter (1990) provides an example of two 1-acre stands each with the same basal area. One stand has trees that average six inches dbh and the other has trees averaging 24 inches dbh. If the If the basal area was 44 $ft^2$ the first stand would have 229 trees and the second stand 14 trees. This translates to big differences between stands in terms of area beneath overstory canopy and the amount of area with no canopy. Where the landscape is dominated by open grown stands, the biomass yield value will be low compared to what would actually occur on the ground. This bias is likely slight for existing stand conditions (year 2010), but for post-treatment years when many of the stands will have groups of trees with intervening gaps, the index value will be increasingly biased towards underrepresenting the response values. Most of the mechanical treatments are designed to create openings among currently homogeneous stand structure. The stand basal area value represents an average of openings and tree groups, but does not account for the site-specific effects that the resulting tree groups and canopy openings will have on the understory. However, this bias is consistently applied to all stands under all alternatives across all time periods. Therefore, the result is still a robust value in terms of comparing relative change.

## Summary of Effects by Alternative

Each alternative treats slightly different acreages and contains differences between amounts of treatment types. Alternative D limits broadcast burning to less than 50 percent of the area proposed in alternatives B and C; alternative A includes no burning. The differences that fire makes on herbaceous response is not at all represented here. Therefore, effects on seed banks, changes in soil nutrients, the effects of those changes on soil micorflora and hence indirect change to plant development, and the reduction in litter layer and affects to the O-horizon are not included here. This too represents a negative bias in that the estimated biomass response will be lower than expected by not including a fire-effects component.

Finally, the results show the differences between treatments, but do not include any effects of grazing. Domestic grazing and grazing by wild ungulates may increase or decrease through time. The trend in numbers of large ungulate grazers, domestic or wild, will have direct effects on the potential improvements in understory conditions. Should overall grazing pressure increase, there may be no benefits realized in understory communities, associated arthropod communities, and their effects on vertebrate wildlife.

The number of proposed treatments times the number of alternatives times the number of time periods equals a lot of individual values. Summary graphs are presented by subunit to capture the differences between alternatives in a spatial manner across the treatment area. At the landscape level, the results of the modeling effort in terms of response function match expectations based on the scientific literature (Figure 115). The no action alternative witnesses a continued decline in herbaceous biomass. Also expected was the similar pattern for each of the action alternatives. This is the same response function described in the literature. The year 2020 shows the response to reductions in canopy and, to a limited extent (i.e., as reflected in the stand averages), the creation of interspaces and canopy openings. This response declines as the accelerated tree growth increases canopy cover through time. The rate of decline in understory development increases through time as trees continue to grow. The number of acres treated varies between alternatives. Alternative C treats the most acres and elicits the greatest response in understory. Alternatives B and D treat the same number of acres mechanically, but alternative D does not include broadcast burning across all the mechanical treatments as alternative B does and there are about 20,640 fewer acres of prescribed-burn only treatments. Alternative D treats the fewest acres of the action alternatives and generates the least response in understory biomass.

Understory response consistently varies by treatment intensity in the literature. Treatment response is more nuanced across the 4FRI landscape. While group selection consistently produced a three- to four-fold increase in understory response, other patterns were not as obvious. Treatment designs were based on individual stand conditions. More open stands were modeled with lighter treatments and closed stands were modeled with heavier treatments, except in areas like Mexican spotted owl habitat. Management direction for Mexican spotted owl habitat followed direction in the Mexican spotted owl Recovery Plan (USDI 1995). Like treatment intensity, existing herbaceous biomass is correlated with existing overstory conditions. Stands designated for higher intensity mechanical treatments tend to have higher tree densities and so support low levels of understory development. Stands designated for lower intensity mechanical levels are already more open and so currently support higher levels of understory development. Similar post-treatment results occurred in terms of total yield and percent increase of the herbaceous response because of the correlation that both management prescriptions and existing understory conditions have with overstory. This validates the assumption that overstory conditions in stands identified for heavier tree removal have canopy conditions that are more closed. Stands that are more open are, in turn, getting lighter treatments. This relationship between existing conditions and treatment intensity ameliorates the output. Stands identified for savanna and grassland restoration currently support higher levels of understory biomass than the forest treatments, indicating these treatments are also well placed.

Figure 115 shows average per acre understory yield through time for all treatment acres. Results below present total yield by subunit, i.e., average per acre yield multiplied by the number of acres. Individual subunits vary by size, total acres treated, kinds of treatments, and the mix of soil types within them. This leads to marked variation across the landscape, e.g., subunits within restoration units 1 and 3 have more acres of grassland and savanna treatment; subunits 4-3 and 4-4 have thousands of acres of loose cinder soil; restoration unit 6 is all limestone; and subunits with extensive areas of Mexican spotted owl habitat have different management objectives than areas outside of owl habitat.

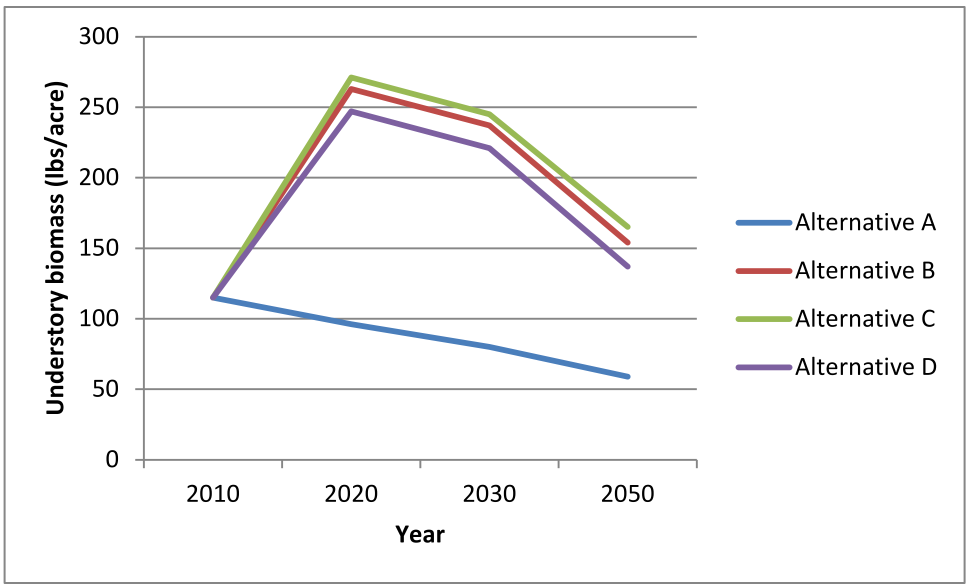


**Figure 115. Average per-acre understory biomass yield (pounds) by alternative based on modeled changes in basal area under the 4FRI (see Affected Environment Section for alternative descriptions)**

## Restoration Unit 1

Rather than display the average response per acre, as shown in Figure 115, the values below represent total yield or the relative biomass response multiplied by the number of acres per subunit. Values are reported in units of 1000, i.e., five thousand thousands equals 5 million pounds of biomass. All graphs are scaled the same to facilitate comparisons between subunits.

Restoration Unit 1 is east of Flagstaff and south of I-40 (see Figure 2 for map of subunits). Subunits 1-1, 1-2, and 1-4 show a similar response for the action alternatives and an apparently limited response relative to alternative A (Figure 116, Figure 117, Figure 118, Figure 119, and Figure 120). However, the tables beneath the graphs show a consistent doubling to tripling of forage values, totaling millions of pounds of herbaceous biomass. Subunits 1-3 and 1-5 mirror the scale of change indicated in Figure 1 and show more separation between alternatives. These two subunits have significantly more savanna treatments than the other subunits in Restoration 1. On average, alternative D leaves denser forest conditions and hence produces lower values in understory biomass production (Figures 116 to 120 and Tables 172 to 176).

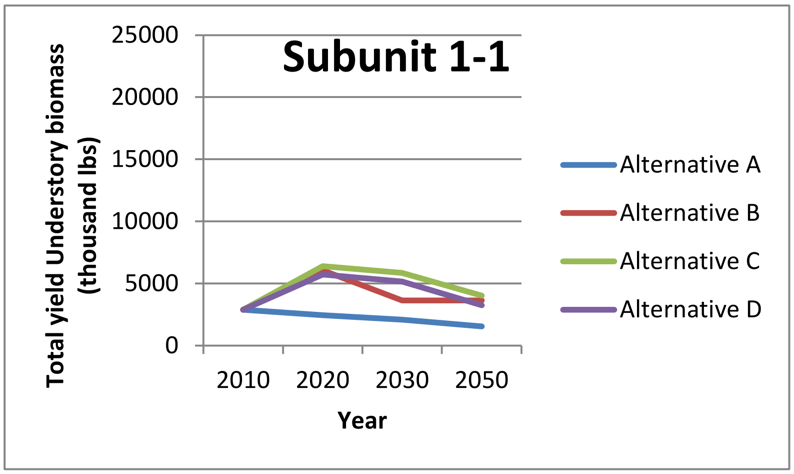


**Figure 116. Total biomass yield (pounds) in Subunit 1-1, based on modeled changes in basal area**

**Table 170. Subunit 1-1 (10,169 acres) Total Yield (thousand pounds)**

| Treatments | 2010 | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| Alternative A | 2877.827 | 2450.729 | 2084.645 | 1555.857 |
| Alternative B | 2877.827 | 6070.893 | 3630.333 | 3630.333 |
| Alternative C | 2877.827 | 6396.301 | 5857.344 | 4016.755 |
| Alternative D | 2877.827 | 5725.147 | 5165.852 | 3254.08 |

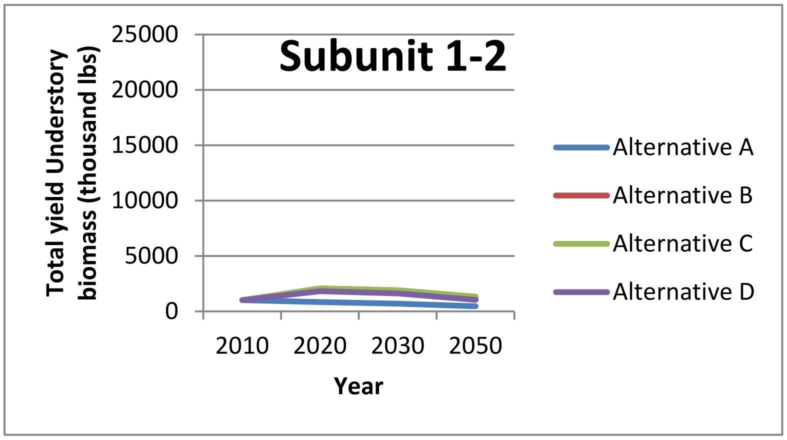


**Figure 117. Total biomass yield (pounds) in Subunit 1-2, based on modeled changes in basal area**

**Table 171. Subunit 1-2 (8,054 acres) Total Yield (thousand pounds)**

| Treatments | 2010 | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| Alternative A | 1006.75 | 821.508 | 676.536 | 459.078 |
| Alternative B | 1006.75 | 1965.176 | 1763.826 | 1191.992 |
| Alternative C | 1006.75 | 2085.986 | 1892.69 | 1336.964 |
| Alternative D | 1006.75 | 1812.15 | 1610.8 | 1030.912 |

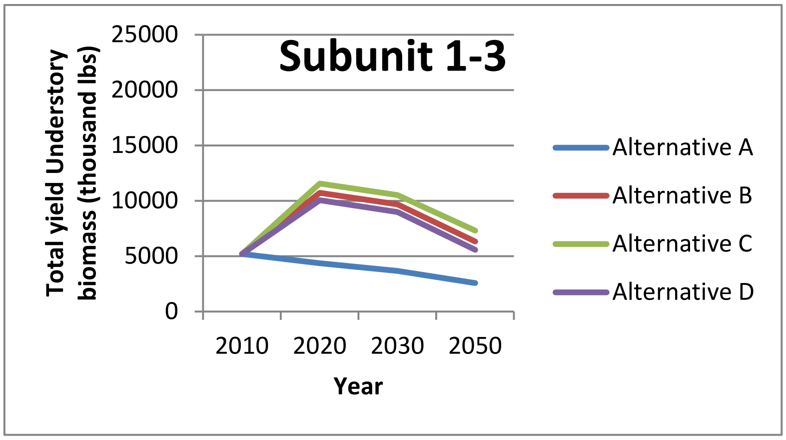


**Figure 118. Total biomass yield (pounds) in Subunit 1-3, based on modeled changes in basal area**

**Table 172. Sub-unit 1-3 (41,577 acres) Total Yield (thousand pounds)**

| Treatments | 2010 | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| Alternative A | 5197.125 | 4365.585 | 3658.776 | 2577.774 |
| Alternative B | 5197.125 | 10726.866 | 9687.441 | 6319.704 |
| Alternative C | 5197.125 | 11558.406 | 10518.981 | 7317.552 |
| Alternative D | 5197.125 | 10061.634 | 8980.632 | 5571.318 |

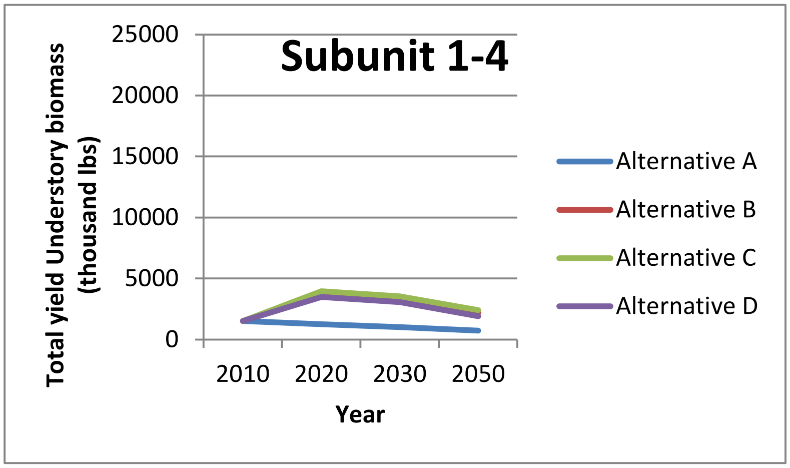


**Figure 119. Total biomass yield (pounds) in Subunit 1-4, based on modeled changes in basal area**

**Table 173. Subunit 1-4 (18,326 acres) Total Yield (thousand pounds)**

| Treatments | 2010 | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| Alternative A | 1521.058 | 1246.168 | 1026.256 | 733.04 |
| Alternative B | 1521.058 | 3775.156 | 3371.984 | 2199.12 |
| Alternative C | 1521.058 | 3958.416 | 3555.244 | 2400.706 |
| Alternative D | 1521.058 | 3481.94 | 3078.768 | 1905.904 |

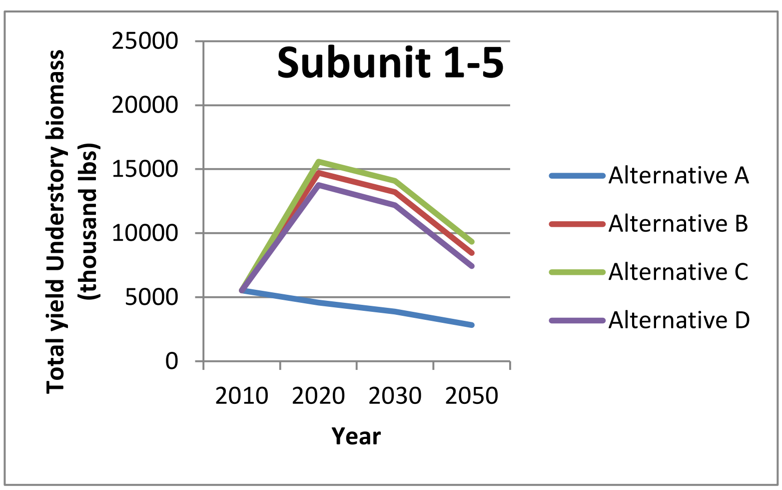


**Figure 120. Total biomass yield (pounds) in Subunit 1-5, based on modeled changes in basal area**

**Table 174. Subunit 1-5 (79,098) Total Yield (thousand pounds)**

| Treatments | 2010 | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| Alternative A | 5536.86 | 4587.684 | 3875.802 | 2847.528 |
| Alternative B | 5536.86 | 14712.228 | 13209.366 | 8463.486 |
| Alternative C | 5536.86 | 15582.306 | 14079.444 | 9333.564 |
| Alternative D | 5536.86 | 13763.052 | 12181.092 | 7435.212 |

## Restoration Unit 3

Restoration Unit 2 was designated early in the project formulation and does not include management treatments. Restoration Unit 3 is west of I-17 and south of I-40. Biomass production is consistently much higher in each subunit in this restoration unit as a result of higher intensity mechanical treatments including more acres of grassland and savanna restoration (Figure 121, Figure 122, Figure 123, Figure 124, and Figure 125 and associated Table 175, Table 176, Table 177, Table 178, and Table 179). This restoration unit includes work in and around Garland Prairie and an east-west open canopy corridor designed by the Arizona Game and Fish Department to facilitate seasonal pronghorn movement across much of the width of the Williams Ranger District. The corridor follows known movements of pronghorn and includes areas of young, dense forest.

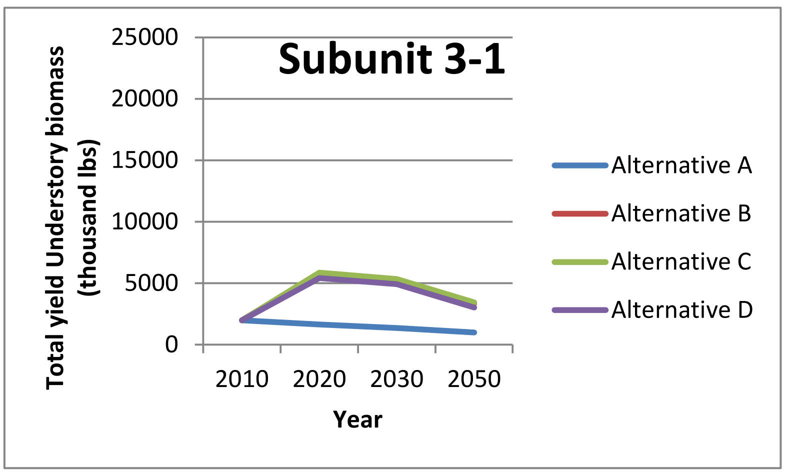


**Figure 121. Total biomass yield (pounds) in Subunit 3-1, based on modeled changes in basal area**

**Table 175. Subunit 3-1 (23,178 acres) Total Yield (thousand pounds)**

| Treatments | 2010 | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| Alternative A | 1993.308 | 1645.638 | 1367.502 | 996.654 |
| Alternative B | 1993.308 | 5794.5 | 5261.406 | 3360.81 |
| Alternative C | 1993.308 | 5864.034 | 5330.94 | 3453.522 |
| Alternative D | 1993.308 | 5423.652 | 4913.736 | 3013.14 |

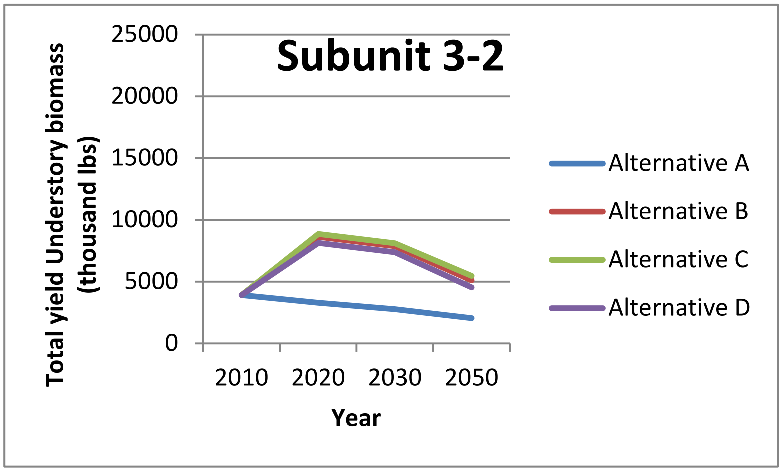


**Figure 122. Total biomass yield (pounds) in Subunit 3-2, based on modeled changes in basal area**

**Table 176. Subunit 3-2 (32,826 acres) Total Yield (thousand pounds)**

| Treatments | 2010 | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| Alternative A | 3906.294 | 3282.6 | 2757.384 | 2035.212 |
| Alternative B | 3906.294 | 8633.238 | 7878.24 | 5088.03 |
| Alternative C | 3906.294 | 8863.02 | 8108.022 | 5449.116 |
| Alternative D | 3906.294 | 8140.848 | 7385.85 | 4529.988 |

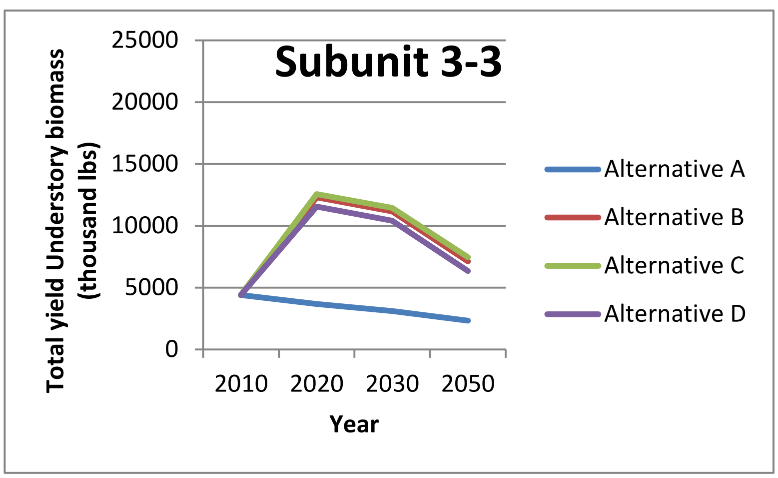


**Figure 123. Total biomass yield (pounds) in Subunit 3-3, based on modeled changes in basal area**

**Table 177. Subunit 3-3 (48,462 acres) Total Yield (thousand pounds)**

| Treatments | 2010 | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| Alternative A | 4410.042 | 3683.112 | 3101.568 | 2326.176 |
| Alternative B | 4410.042 | 12309.348 | 11146.26 | 7123.914 |
| Alternative C | 4410.042 | 12551.658 | 11437.032 | 7463.148 |
| Alternative D | 4410.042 | 11533.956 | 10419.33 | 6348.522 |

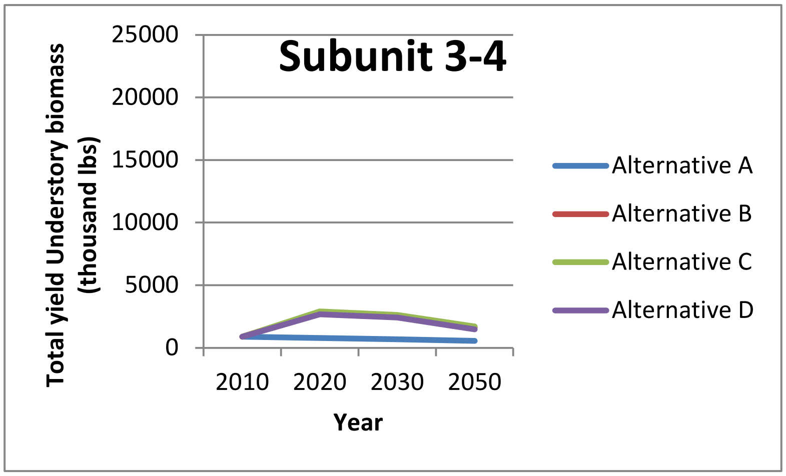


**Figure 124. Total biomass yield (pounds) in Subunit 3-4, based on modeled changes in basal area**

**Table 178. Subunit 3-4 (9,019 acres) Total Yield (thousand pounds)**

| Treatments | 2010 | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| Alternative A | 892.881 | 775.634 | 685.444 | 559.178 |
| Alternative B | 892.881 | 2831.966 | 2561.396 | 1641.458 |
| Alternative C | 892.881 | 2904.118 | 2633.548 | 1713.61 |
| Alternative D | 892.881 | 2678.643 | 2417.092 | 1470.097 |

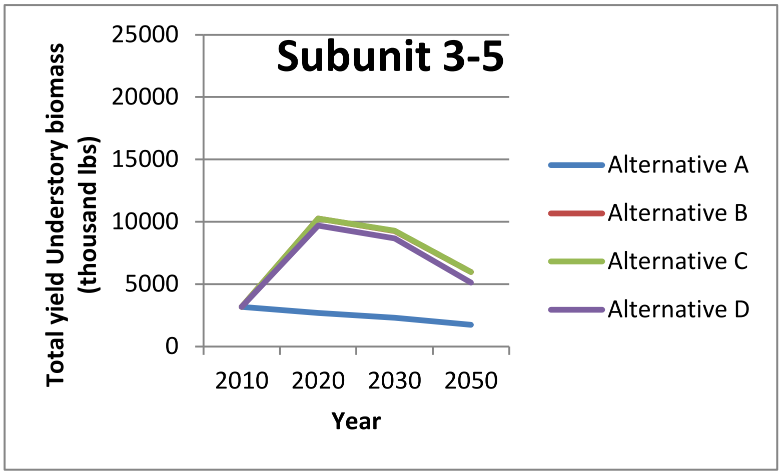


**Figure 125. Total biomass yield (pounds) in Subunit 3-5, based on modeled changes in basal area**

**Table 179. Subunit 3-5 (36,392 acres) Total Yield (thousand pounds)**

| Subunit 3-5 | Total Yield (Thousand pounds) | | | (36,392 ac) |
|---|---|---|---|---|
| **Treatments** | **2010** | **2020** | **2030** | **2050** |
| Alternative A | 3166.104 | 2693.008 | 2292.696 | 1746.816 |
| Alternative B | 3166.104 | 10262.544 | 9243.568 | 5968.288 |
| Alternative C | 3166.104 | 10262.544 | 9279.96 | 5968.288 |
| Alternative D | 3166.104 | 9680.272 | 8661.296 | 5131.272 |

## Restoration Unit 4

Restoration Unit 4 is north of I-40 and mostly northwest of Flagstaff, including part of the Peaks Ranger District and much of the Williams Ranger District. There is little limestone in this Unit and, in addition, inclusions of loose cinder. Government Prairie is in this Restoration Unit as is a north-south pronghorn movement corridor developed by the Arizona Game and Fish Department. Subunits 4-3 and 4-4 are about 67,000 and 81,500 acres respectively and the potential understory response is reflected in Figure 126, Figure 127, Figure 128, Figure 129 and associated Table 180, Table 181, Table 182, and, Table 183. Similarly, subunit 4-2 and 4-5 are about 10,200 and 7,000 acres respectively. The contrast in multiplying biomass yield by acres can be seen below. At this scale, differences in understory response between alternative A and the action alternatives seems minimal in subunit 4-5 but represents 2- to 3-fold improvement. Alternative D again produces the lowest response of the action alternatives.

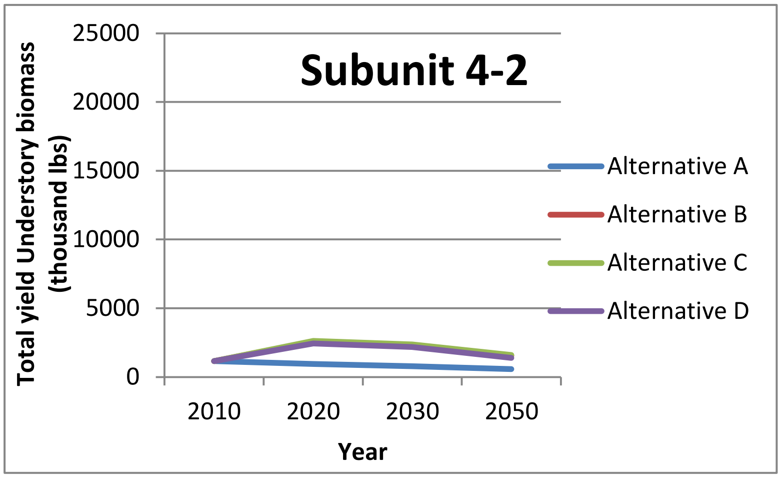


**Figure 126. Total biomass yield (pounds) in Subunit 4-2, based on modeled changes in basal area**

**Table 180. Subunit 4-2 (10,231 acres) Total Yield (thousand pounds)**

| Treatments | 2010 | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| Alternative A | 1145.872 | 951.483 | 787.787 | 562.705 |
| Alternative B | 1145.872 | 2567.981 | 2312.206 | 1544.881 |
| Alternative C | 1145.872 | 2619.136 | 2363.361 | 1606.267 |
| Alternative D | 1145.872 | 2424.747 | 2168.972 | 1391.416 |

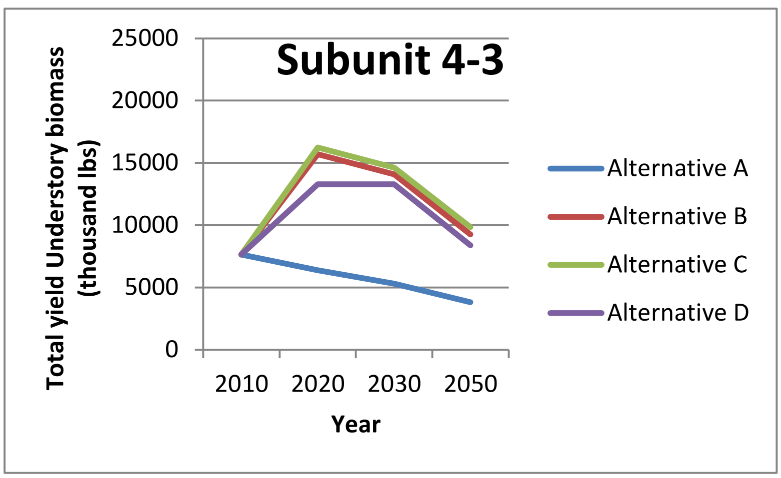


**Figure 127. Total biomass yield (pounds) in Subunit 4-3, based on modeled changes in basal area**

**Table 181. Subunit 4-3 (67,047 acres) Total Yield (thousand pounds)**

| Subunit 4-3 | TOTAL YIELD (Thousand pounds) | | | (67,047 ac) |
|---|---|---|---|---|
| **Treatments** | **2010** | **2020** | **2030** | **2050** |
| Alternative A | 7643.358 | 6369.465 | 5296.713 | 3821.679 |
| Alternative B | 7643.358 | 15688.998 | 14079.87 | 9252.486 |
| Alternative C | 7643.358 | 16225.374 | 14616.246 | 9855.909 |
| Alternative D | 7643.358 | 13275.306 | 13275.306 | 8380.875 |

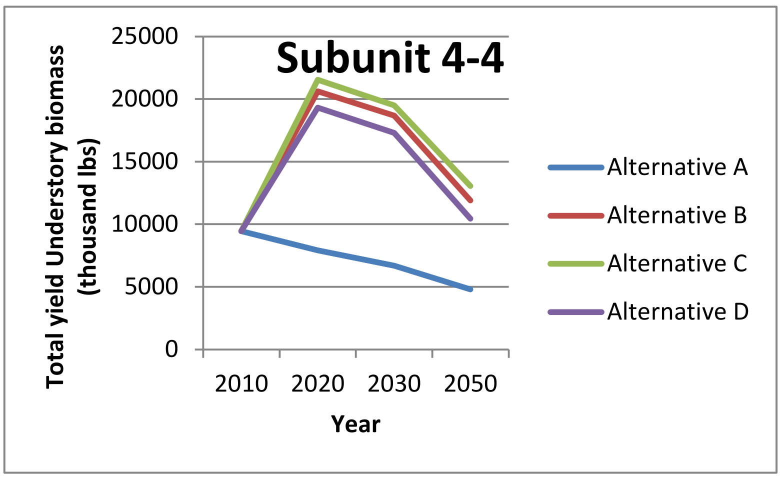


**Figure 128. Total biomass yield (pounds) in Subunit 4-4, based on modeled changes in basal area**

**Table 182. Subunit 4-4 (81,541 acres) Total Yield (thousand pounds)**

| Treatments | 2010 | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| Alternative A | 9458.756 | 7909.477 | 6686.362 | 4810.919 |
| Alternative B | 9458.756 | 20629.873 | 18672.889 | 11904.986 |
| Alternative C | 9458.756 | 21526.824 | 19488.299 | 13046.56 |
| Alternative D | 9458.756 | 19325.217 | 17286.692 | 10437.248 |

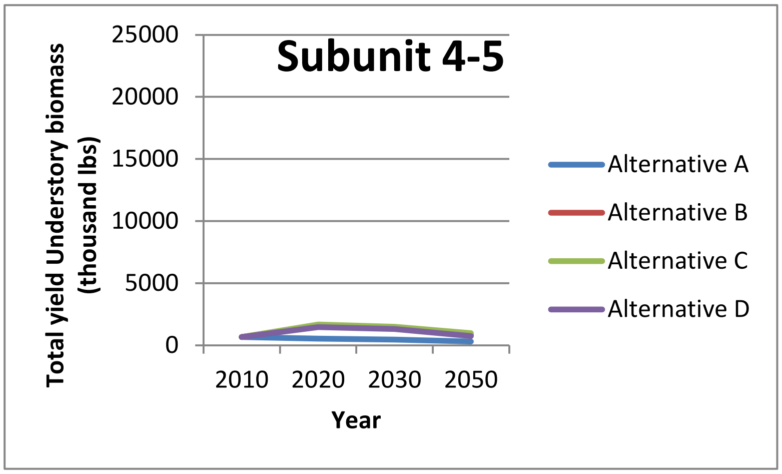


**Figure 129. Total biomass yield (pounds) in Subunit 4-5, based on modeled changes in basal area**

**Table 183. Subunit 4-5 (6,985 acres) Total Yield (thousand pounds)**

| Treatments | 2010 | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| Alternative A | 670.56 | 551.815 | 454.025 | 321.31 |
| Alternative B | 670.56 | 1585.595 | 1410.97 | 859.155 |
| Alternative C | 670.56 | 1683.385 | 1508.76 | 977.9 |
| Alternative D | 670.56 | 1480.82 | 1306.195 | 754.38 |

## Restoration Unit 5

Restoration Unit 5 is northeast of Flagstaff and north of I-40. Limestone is nearly absent from the Unit and subunit 5-2 has over 3,000 acres of loose cinders (the latter is not included in yield calculations). In addition, subunit 5-2 has nearly 34,000 acres of proposed burn-only treatment in each of the action alternatives. Differences in biomass response are still apparent between most alternatives in this subunit despite the acres of burn only and loose cinders, (Figure 130, Figure 131, and associated Table 184 and Table 185). Alternative C includes over 1,700 acres of grassland restoration in subunit 5-2.

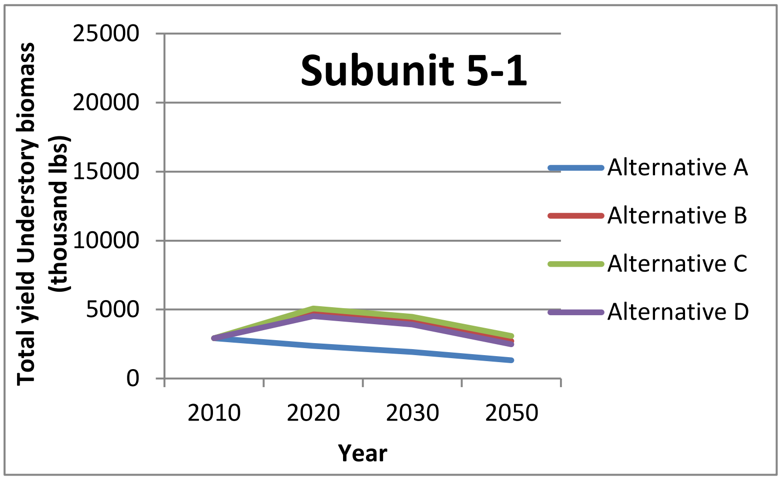


**Figure 130. Total biomass yield (pounds) in Subunit 5-1 based on modeled changes in basal area**

**Table 184. Subunit 5-1 (24,210 acres) Total Yield (thousand pounds)**

| Treatments | 2010 | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| Alternative A | 2929.41 | 2372.58 | 1936.8 | 1331.55 |
| Alternative B | 2929.41 | 4745.16 | 4115.7 | 2711.52 |
| Alternative C | 2929.41 | 5084.1 | 4478.85 | 3074.67 |
| Alternative D | 2929.41 | 4527.27 | 3922.02 | 2493.63 |

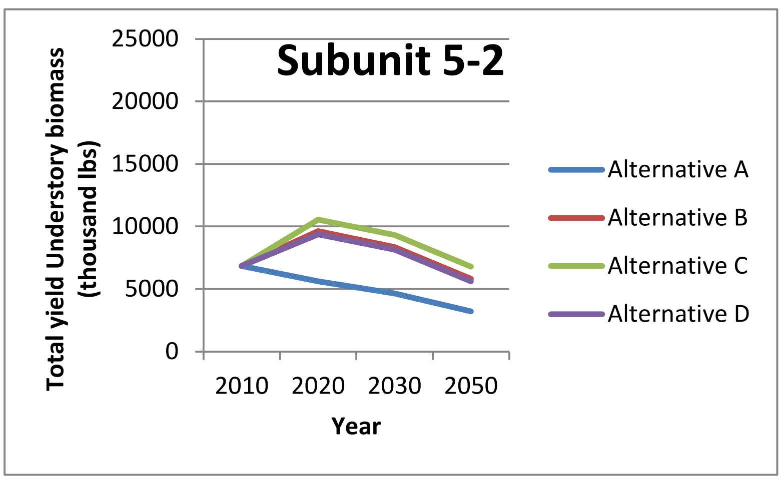


**Figure 131. Total biomass yield (pounds) in Subunit 5-2, based on modeled changes in basal area**

**Table 185. Subunit 5-2 (53,520 acres) Total Yield (thousand pounds)**

| Subunit 5-2 | Total Yield (Thousand pounds) | | | (53,520 ac) |
|---|---|---|---|---|
| **Treatments** | **2010** | **2020** | **2030** | **2050** |
| Alternative A | 6850.56 | 5619.6 | 4656.24 | 3211.2 |
| Alternative B | 6850.56 | 9633.6 | 8349.12 | 5833.68 |
| Alternative C | 6850.56 | 10543.44 | 9312.48 | 6797.04 |
| Alternative D | 6850.56 | 9366 | 8135.04 | 5619.6 |

## Restoration Unit 6

Restoration Unit 6 is on the Tusayan Ranger District south of the Grand Canyon National Park. The subunits are all limestone soil and subunit 6-2 includes pine-sage treatments. The largest biomass response for this restoration unit occurs in subunit 6-3. The line for alternative B is hidden by alternative C because of nearly identical understory responses. Alternative D again has the lowest response identified for any action alternative (Figure 132, Figure 133, Figure 134, and associated Table 186, Table 187, and Table 188). Subunit 6-4 has one of the most muted responses with over 80 percent of the treatment consisting of burn-only treatments. As noted above, this analysis does not account for ecosystem contributions of prescribed fire.

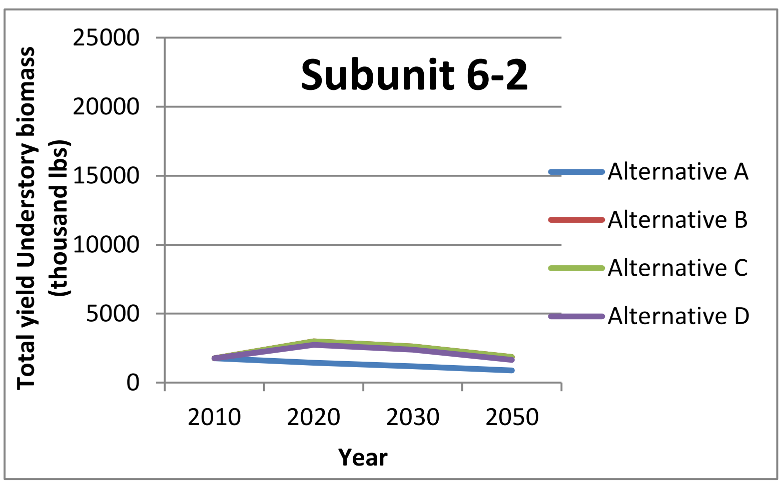


**Figure 132. Total biomass yield (pounds) in Subunit 6-2, based on modeled changes in basal area**

**Table 186. Subunit 6-2 (5,552 acres) Total Yield (thousand pounds)**

| Treatments | 2010 | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| Alternative A | 1765.536 | 1443.52 | 1193.68 | 888.32 |
| Alternative B | 1765.536 | 2992.528 | 2631.648 | 1859.92 |
| Alternative C | 1765.536 | 2992.528 | 2631.648 | 1859.92 |
| Alternative D | 1765.536 | 2748.24 | 2398.464 | 1654.496 |

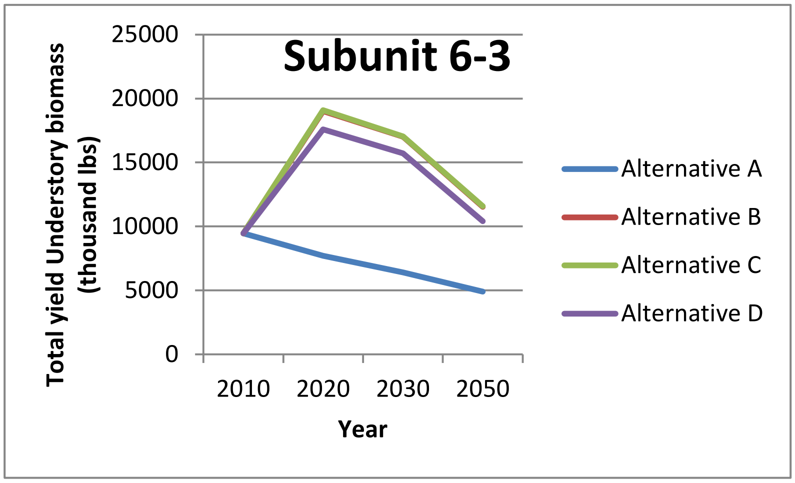


**Figure 133. Total biomass yield (pounds) in Subunit 6-3, based on modeled changes in basal area**

**Table 187. Subunit 6-3 (34,156 acres) Total Yield (thousand pounds)**

| Treatments | 2010 | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| Alternative A | 9461.212 | 7719.256 | 6421.328 | 4918.464 |
| Alternative B | 9461.212 | 19024.892 | 17009.688 | 11544.728 |
| Alternative C | 9461.212 | 19093.204 | 17043.844 | 11578.884 |
| Alternative D | 9461.212 | 17590.34 | 15711.76 | 10417.58 |

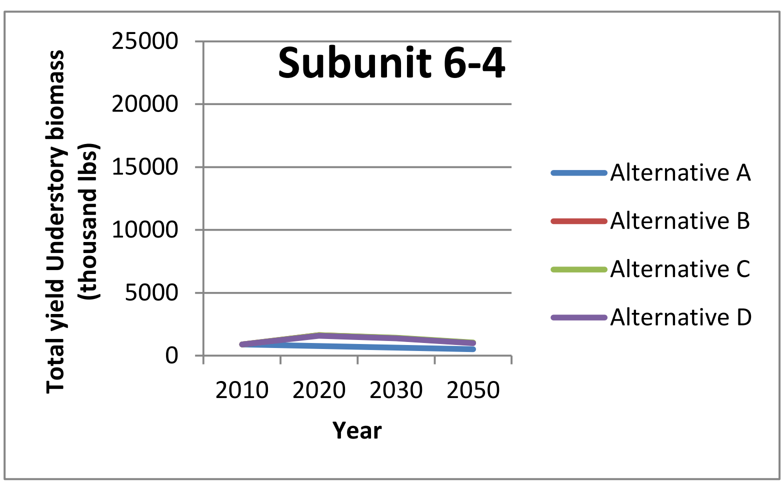


**Figure 134. Total biomass yield (pounds) in Subunit 6-4, based on modeled changes in basal area**

**Table 188. Subunit 6-4 (3,870 acres) Total Yield (thousand pounds)**

| Treatments | 2010 | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| Alternative A | 901.71 | 762.39 | 654.03 | 522.45 |
| Alternative B | 901.71 | 1629.27 | 1420.29 | 1037.16 |
| Alternative C | 901.71 | 1644.75 | 1435.77 | 1052.64 |
| Alternative D | 901.71 | 1575.09 | 1373.85 | 994.59 |

## Summary and Effects to Wildlife

Understory biomass would consistently continue to decline across all subunits under alternative A. Alternative C consistently provides the greatest response in herbaceous biomass over all other alternatives. Conversely, alternative D does the least to move understory conditions back towards the historical range of variation relative to the other action alternatives. Alternative B is similar to alternative C, although with fewer acres treated. Where subunit graphs apparently display overlapping lines for two or all three action alternatives, the actual yield values in the tables can show differences of millions of pounds of forage. The equations were derived to address biomass yield, but the output represents a diversity of plants providing food and cover for a wide range of wildlife species from ground dwelling arthropods to granivorous and insectivorous avian species. The herbaceous response affects soil chemistry by altering the ratios of organic input and changes soil microflora, including mycorrhizea, and fire behavior. While alternative D frequently mirrors the other action alternatives in terms of yield through time, the associated benefits of low-intensity fire will not be realized because of the restricted broadcast burning related to this alternative. At the site or stand scale, this limit means no nutrient pulse into the soil, no decrease in litter layer, and none of the associated changes to soil chemistry and microflora. In addition, the heterogeneity in microhabitat resulting from thinning and burning will be less, limiting the important change to existing homogeneity. While alternative D improves understory conditions and greatly improves biomass response over alternative A, the improvements consistently remain below the other action alternatives.

Moore and Deiter (1992) concluded overstory density effects on understory production were most predictable for grasses, sedges, and forbs while shrubs showed only a slight response to changing overstory density. Cool-season plants showed a much stronger relationship with overstory density than did warm-season plants. As a rule, cool-season grasses, sedges, and forbs responded more predictably to changes in stand density than did warm-season vegetation regardless of the plant type (Moore and Deiter 1992). Implementation of 4FRI could potentially reverse the declining trend in $C_3$ plants, particularly under alternative C. Forest floor depth is estimated to have increased 73.5% increase since 1876 (Moore et al. 2004). All alternatives action would reduce litter depth across the 4FRI treatment area, but the change would be most extensive under alternative C and most restricted in alternative D.

Increasing the understory should directly benefit the arthropod community. Changes in the understory are expected to include more flowering forbs and the plants should be more widely distributed. Thinning and creating canopy gaps under currently homogeneous forest cover would contribute towards reconnecting isolated pockets of herbaceous cover, reversing the trend of increasing fragmentation of pollinator habitat. Increasing herbaceous productivity, including leaf, root, fruit, and seed development, improves bird and mammal forage directly (plants) and indirectly (arthropods). Upper trophic-level species like raptors and terrestrial carnivores should benefit from improvements to prey species habitat.

The most abundant foods on earth are plants and insects and so it is no surprise that the most abundant small mammals are rodents (largely herbivores/granivores) and bats (largely insectivores) (Merritt 2010). Mice and mouse-like rodents have been labeled the most important small mammal in terms of their effect on the environment and as a staple food for predators (Merritt 2010). In general, small mammal communities can benefit from thinning treatments in fire-prone ecosystems, particularly when heterogeneity of forest structure is retained (Converse et al. 2006a, Noss et al. 2006, Kalies et al. 2012). Kalies et al. (2012) found five of eight small mammal species responded positively in terms of occupancy to forest thinning treatments (golden-mantled ground squirrel, Mogollon vole, gray-collared chipmunk, deer mouse, rock squirrel). One of three species that responded negatively, Botta’s pocket gopher, responded positively to open forest structural conditions, but negatively to treatments that reduced tree BA and density. The two remaining species, tassel-eared squirrels and Mexican woodrats, responded negatively to treatment unless specific habitat features were retained (Kalies et al. 2012). All but the latter two species had inverse relationships in terms of occupancy to pine BA and responded positively to understory cover. Kalies et al. (2012) concluded that all eight small mammal species can benefit from restoration treatments. Kalies et al. (2012) and Converse et al. (2006b) concluded thinning treatments will have positive effects on small mammal biomass but Bagne and Finch (2009) found thinning did not change total small mammal abundance. Converse et al. (2006b) stated response of small mammal populations to thinning would be greatest in areas where tree densities are especially high. While reestablishing the understory herbaceous layer can benefit many small mammals, small fossorial mammals can, in turn, be important agents in maintaining the ecology of grassland and savanna systems (Yoshihara et al. 2009, Ganey and Chambers 2011). Table 189 lists expected impacts to key mammal and bird species within the 4FRI treatment area.

Understory restoration is expected to enhance cover for ground-nesting birds and increase forage for insectivores, frugivores, and granivores. While studies rarely correlate avian response to understory development directly, work has been done relating thinning and burning to bird communities. In a comparison of forest structure, George et al. (2005) compared bird communities between an old-growth stand of ponderosa pine containing a relatively open canopy, large snags, and developed understory, with a dense second-growth ponderosa pine forest in California. Overall bird species composition was similar between sites; most of the species detected at only one site were rare at the site where they were detected. They found woodpeckers, bark gleaners, and flycatchers all more abundant in the old-growth forest. Foliage gleaners were more abundant in second-growth (George et al. 2005). While the connection between foliage gleaners and younger forest was not clear, mid-age pine trees tend to have more foliage volume than older trees and foliage gleaners are cup-nesters (George et al. 2005) and may prefer the denser crowns of younger trees. They also found the presence of flying arthropods greater in the old-growth and positively associated with ground vegetation, down wood, shrubs, and saplings (George et al. 2005).

Hurteau et al. (2008) looked at effects of thinning and prescribed burning treatments on birds in ponderosa pine forests on the Kaibab and Coconino National Forests. They did not find effects to species richness or evenness. Although some individual species increased (e.g., western bluebirds) and some decreased (e.g., mountain chickadees) they determined the modest effects treatments had on the avian community warranted implementing prescribed surface fire after thinning projects. Thinning and burning effects were evaluated specifically for western bluebirds in northwestern Arizona and the authors described increased herbaceous ground cover and Gambel oak density as likely improving invertebrate assemblages and thus improving forage abundance for nesting bluebirds (Wightman and Germaine 2006). A project in the Black Hills, South Dakota, reported overall species richness was generally lower in ponderosa pine forest with overstory canopy cover greater than 40 percent compared to ponderosa pine forest with less than 40 percent canopy cover (Mills et al. 2000). Most changes in forest structure will benefit some species and negatively impact others. Creating a mosaic of forest conditions following treatments may be the most suitable approach for a wide range of forest passerines (Hurteau et al. 2008).

Table 189 presents a list of birds and mammals identified as Threatened, Sensitive, Management Indicator Species, migratory birds, or primary prey of goshawks in the Southwest (Reynolds et al. 1992) and occurring in the 4FRI treatment area. Included in the table are expected responses to understory changes resulting from overstory treatments.

**Table 189. Short-term (10 years) effects of increased understory production on selected wildlife species; see text for detail**

| Species Status | Species | Habitat Link(s) | Nature of Link | Species Response |
|---|---|---|---|---|
| Threatened and Endangered Species | Mexican Spotted Owl | Vertebrate Prey | Indirect through effects to small mammals, birds, and key arthropod species | Positive |
| Management Indicator Species | Abert Squirrel | Overstory Manipulation | Indirect through interruption of tree canopy; decrease in mycorrhizea fruiting bodies | Negative |
| Management Indicator Species | Northern Goshawk | Vertebrate Prey | Indirect through birds and small mammals | Positive |
| Management Indicator Species | Pygmy Nuthatch | Invertebrate Prey and Nesting and Foraging Habitat | Direct through increase in invertebrates; Indirect through promotion of large trees and snags | Positive |
| Management Indicator Species | Turkey | Invertebrate Prey, Hard Mast, and Cover | Direct through increase in understory and invertebrates | Positive |
| Management Indicator Species | Elk | Herbaceous Food and Calving Cover | Direct through understory growth | Positive |
| Management Indicator Species | Hairy Woodpecker | Overstory Manipulation | Indirect through promotion of large trees and snags | Positive |
| Management Indicator Species | Red-naped Sapsucker | Invertebrate Prey (especially ants) | Direct through increase in invertebrates; Indirect through promotion of large trees and | Positive |

| Species Status | Species | Habitat Link(s) | Nature of Link | Species Response |
|---|---|---|---|---|
| | | | snags | |
| Management Indicator Species | Mule Deer | Herbaceous Food and Fawning Cover | Direct through understory growth | Positive |
| Management Indicator Species | Juniper Titmouse | Hard Mast and Cover | Indirect through promotion of large, open grown trees | Positive |
| Management Indicator Species | Pronghorn | Herbaceous Food and Fawning Cover | Direct through understory growth | Positive |
| Sensitive Species | Ferruginous Hawk | Vertebrate Prey | Indirect through increase in habitat for small mammals and birds | Positive |
| Sensitive Species | American Peregrine Falcon | Vertebrate Prey and open habitat | Indirect through increase in prey habitat (food and cover) | Positive |
| Sensitive Species | Baird's Sparrow | Herbaceous Food and Cover | Direct through increase in understory and invertebrates | Positive |
| Sensitive Species | Merriam's Shrew | Invertebrate Prey | Direct through increase in invertebrates | Positive |
| Sensitive Species | Dwarf Shrew | Invertebrate Prey | Direct through increase in invertebrates | Positive |
| Sensitive Species | Western Red Bat | Invertebrate Prey | Direct through increase in invertebrates | Positive |
| Sensitive Species | Spotted Bat | Invertebrate Prey | Direct through increase in invertebrates | Positive |
| Sensitive Species | Allen's Lappet-Browed Bat | Invertebrate Prey | Direct through increase in invertebrates | Positive |
| Sensitive Species | Pale Townsend's Big-Eared Bat | Invertebrate Prey | Direct through increase in invertebrates | Positive |
| Sensitive Species | Greater Western Mastiff Bat | Invertebrate Prey | Direct through increase in invertebrates | Positive |
| Sensitive Species | Mogollon Vole | Invertebrate Prey and Cover | Direct through increase in understory and invertebrates | Positive |
| Sensitive Species | Long-Tailed Vole | Invertebrate Prey and Cover | Direct through increase in understory and invertebrates | Positive |
| Migratory Birds | Bark Gleaners | Invertebrate Prey | Indirect through promotion of | Positive |

| Species Status | Species | Habitat Link(s) | Nature of Link | Species Response |
|---|---|---|---|---|
| | | | large, open grown trees | |
| Migratory Birds | Foliage Gleaners | Decrease in Dense Mid-aged Canopy (Food & Cover?) | Indirect Through Overstory Habitat Changes | Negative |
| Migratory Birds | Insectivores | Invertebrate Prey | Direct through increase in invertebrates | Positive |
| Selected Goshawk Prey | American Robin | Invertebrate Prey | Direct through increase in invertebrates | Positive |
| Selected Goshawk Prey | Band-tailed Pidgeon | Hard and Soft Mast | Direct through increase in foraging habitat | Positive |
| Selected Goshawk Prey | Cottontail | Herbaceous Food and Cover | Direct through increase in understory and invertebrates | Positive |
| Selected Goshawk Prey | Golden-Mantled Ground Squirrel | Herbaceous Food and Cover | Direct through increase in understory and invertebrates | Positive |
| Selected Goshawk Prey | Mourning Dove | Forage (especieally graminoid production) and Nest Site Structure | Direct through increase in foraging habitat; Indirect through improved nest structure | Positive |
| Selected Goshawk Prey | Northern Flicker | Invertebrate Prey | Direct through increase in invertebrates (especially ants) | Positive |
| Selected Goshawk Prey | Stellar's Jay | Invertebrate Prey and Mast Production | Direct through increase in invertebrates (especially beetles, grasshoppers, and wasps) | Positive |
| Selected Goshawk Prey | Wiiliamson's Sapsucker | Forest Structure, Invertebrate Prey, and Mast Production | Indirect: Nests in aspen and dense forest. Direct: feeds on Invertebrates, sap, and mast. | Positive |

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# Appendix 9. Existing Forest Structure in Goshawk Habitat by Subunit (SU) and Restoration Unit (RU)

**Table 190. Existing Forest Structure – Uneven-Aged Goshawk PFA and Nest Stands**

| | Percent of Area by Vegetative Structural Stage (dbh) | | | | | |
|---|---|---|---|---|---|---|
| Area | 1 – Grass/ Forb/Shrub (0.0 – 0.9”) | 2 – Seedling/ Sapling (1.0 – 4.9”) | 3 – Young Forest (5.0 – 11.9”) | 4 – Mid-age Forest (12.0 – 17.9”) | 5 – Mature Forest (18.0 – 23.9”) | 6 – Old Forest (24.0” +) |
| SU 1-1 | 0% | 0% | 100% | 0% | 0% | 0% |
| SU 1-2 | 0% | 0% | 38% | 6% | 27% | 29% |
| SU 1-3 | 0% | 0% | 21% | 71% | 7% | 0% |
| SU 1-4 | 0% | 0% | 0% | 90% | 0% | 10% |
| SU 1-5 | 0% | 0% | 66% | 13% | 7% | 14% |
| **RU 1** | **0%** | **0%** | **41%** | **42%** | **9%** | **8%** |
| SU 3-1 | 0% | 0% | 23% | 55% | 22% | 0% |
| SU 3-2 | 0% | 0% | 8% | 84% | 8% | 0% |
| SU 3-3 | 0% | 0% | 25% | 44% | 11% | 20% |
| SU 3-5 | 0% | 0% | 60% | 25% | 15% | 0% |
| **RU 3** | **0%** | **0%** | **23%** | **56%** | **11%** | **9%** |
| SU 4-2 | 0% | 0% | 40% | 25% | 22% | 13% |
| SU 4-3 | 0% | 2% | 33% | 49% | 14% | 2% |
| SU 4-4 | 0% | 0% | 18% | 48% | 25% | 9% |
| SU 4-5 | 0% | 0% | 0% | 34% | 66% | 0% |
| **RU 4** | **0%** | **1%** | **28%** | **45%** | **19%** | **6%** |
| SU 5-1 | 0% | 0% | 16% | 54% | 21% | 9% |

| Area | Percent of Area by Vegetative Structural Stage (dbh) | | | | | |
|---|---|---|---|---|---|---|
| | 1 – Grass/ Forb/Shrub (0.0 – 0.9”) | 2 – Seedling/ Sapling (1.0 – 4.9”) | 3 – Young Forest (5.0 – 11.9”) | 4 – Mid-age Forest (12.0 – 17.9”) | 5 – Mature Forest (18.0 – 23.9”) | 6 – Old Forest (24.0” +) |
| SU 5-2 | 0% | 0% | 10% | 44% | 25% | 20% |
| **RU 5** | **0%** | **0%** | **13%** | **49%** | **23%** | **15%** |
| SU 6-2 | 0% | 1% | 6% | 58% | 11% | 24% |
| SU 6-3 | 0% | 2% | 61% | 4% | 13% | 20% |
| **RU 6** | **0%** | **2%** | **56%** | **8%** | **13%** | **20%** |
| **All** | **0%** | **1%** | **34%** | **39%** | **15%** | **11%** |

**Table 191 PFAs: Existing Forest Structure – Even Aged Goshawk PFA and Nest Stands**

| Area | Percent of Area by Vegetative Structural Stage (dbh) | | | | | |
|---|---|---|---|---|---|---|
| | 1 – Grass/ Forb/Shrub (0.0 – 0.9”) | 2 – Seedling/ Sapling (1.0 – 4.9”) | 3 – Young Forest (5.0 – 11.9”) | 4 – Mid-age Forest (12.0 – 17.9”) | 5 – Mature Forest (18.0 – 23.9”) | 6 – Old Forest (24.0” +) |
| SU 1-1 | -% | -% | -% | -% | -% | -% |
| SU 1-2 | 0% | 0% | 71% | 29% | 0% | 0% |
| SU 1-3 | 0% | 0% | 30% | 70% | 0% | 0% |
| SU 1-4 | 0% | 0% | 81% | 19% | 0% | 0% |
| SU 1-5 | 0% | 0% | 25% | 75% | 0% | 0% |
| **RU 1** | **0%** | **0%** | **50%** | **50%** | **0%** | **0%** |
| SU 3-1 | 2% | 0% | 34% | 51% | 13% | 0% |
| SU 3-2 | 0% | 0% | 21% | 66% | 13% | 0% |

| Area | Percent of Area by Vegetative Structural Stage (dbh) 1 – Grass/ Forb/Shrub (0.0 – 0.9”) | 2 – Seedling/ Sapling (1.0 – 4.9”) | 3 – Young Forest (5.0 – 11.9”) | 4 – Mid-age Forest (12.0 – 17.9”) | 5 – Mature Forest (18.0 – 23.9”) | 6 – Old Forest (24.0” +) |
|---|---|---|---|---|---|---|
| SU 3-3 | 13% | 0% | 34% | 51% | 3% | 0% |
| SU 3-5 | 32% | 0% | 0% | 68% | 0% | 0% |
| **RU 3** | **11%** | **0%** | **28%** | **55%** | **6%** | **0%** |
| SU 4-2 | 4% | 0% | 22% | 36% | 38% | 0% |
| SU 4-3 | 1% | 0% | 27% | 67% | 4% | 1% |
| SU 4-4 | 0% | 0% | 40% | 50% | 10% | 0% |
| SU 4-5 | 0% | 0% | 34% | 61% | 5% | 0% |
| **RU 4** | **1%** | **0%** | **31%** | **58%** | **9%** | **1%** |
| SU 5-1 | 4% | 0% | 60% | 25% | 9% | 2% |
| SU 5-2 | 0% | 0% | 8% | 68% | 17% | 7% |
| **RU 5** | **3%** | **0%** | **42%** | **40%** | **12%** | **4%** |
| SU 6-2 | 3% | 0% | 58% | 0% | 40% | 0% |
| SU 6-3 | 8% | 14% | 40% | 19% | 14% | 6% |
| **RU 6** | **7%** | **12%** | **41%** | **18%** | **16%** | **5%** |
| **All** | **3%** | **1%** | **35%** | **52%** | **8%** | **1%** |

**Table 192. Existing Forest Structure – Even-Aged Goshawk LOPFA: Stands**

| Percent of Area by Vegetative Structural Stage (dbh) |
|---|

| Area | 1 – Grass/ Forb/Shrub (0.0 – 0.9”) | 2 – Seedling/ Sapling (1.0 – 4.9”) | 3 – Young Forest (5.0 – 11.9”) | 4 – Mid-age Forest (12.0 – 17.9”) | 5 – Mature Forest (18.0 – 23.9”) | 6 – Old Forest (24.0” +) |
|---|---|---|---|---|---|---|
| SU 1-1 | 1% | 1% | 38% | 47% | 2% | 10% |
| SU 1-2 | 5% | 0% | 47% | 44% | 4% | 0% |
| SU 1-3 | 1% | 1% | 48% | 45% | 1% | 4% |
| SU 1-4 | 2% | 0% | 53% | 43% | 2% | 0% |
| SU 1-5 | 1% | 0% | 44% | 42% | 9% | 3% |
| **RU 1** | **2%** | **<1%** | **46%** | **44%** | **5%** | **3%** |
| SU 3-1 | 2% | 1% | 31% | 53% | 13% | 0% |
| SU 3-2 | 6% | 0% | 14% | 56% | 22% | 1% |
| SU 3-3 | 4% | 0% | 37% | 50% | 7% | 1% |
| SU 3-4 | 0% | 3% | 29% | 58% | 8% | 2% |
| SU 3-5 | 3% | 1% | 34% | 58% | 4% | 0% |
| **RU 3** | **4%** | **0%** | **31%** | **54%** | **10%** | **1%** |
| SU 4-2 | 4% | 0% | 27% | 42% | 25% | 2% |
| SU 4-3 | 11% | 0% | 32% | 50% | 7% | 1% |
| SU 4-4 | 4% | 0% | 33% | 54% | 8% | 1% |
| SU 4-5 | 12% | 0% | 32% | 49% | 7% | 0% |
| **RU 4** | **7%** | **0%** | **32%** | **52%** | **8%** | **1%** |
| SU 5-1 | 36% | 0% | 25% | 30% | 8% | 1% |
| SU 5-2 | 19% | 0% | 16% | 55% | 7% | 3% |
| **RU 5** | **26%** | **0%** | **20%** | **44%** | **7%** | **2%** |

| Area | Percent of Area by Vegetative Structural Stage (dbh) | | | | | |
|---|---|---|---|---|---|---|
| | 1 – Grass/ Forb/Shrub (0.0 – 0.9”) | 2 – Seedling/ Sapling (1.0 – 4.9”) | 3 – Young Forest (5.0 – 11.9”) | 4 – Mid-age Forest (12.0 – 17.9”) | 5 – Mature Forest (18.0 – 23.9”) | 6 – Old Forest (24.0” +) |
| SU 6-2 | 5% | 4% | 84% | 6% | 1% | 0% |
| SU 6-3 | 4% | 2% | 78% | 11% | 5% | 1% |
| SU 6-4 | 2% | 1% | 87% | 10% | 0% | 0% |
| **RU 6** | **4%** | **2%** | **79%** | **10%** | **4%** | **1%** |
| **All** | **7%** | **0%** | **36%** | **47%** | **8%** | **1%** |

**Table 193. Existing Forest Structure – Uneven-Aged Goshawk LOPFA Stands**

| Area | Percent of Area by Vegetative Structural Stage (dbh) | | | | | |
|---|---|---|---|---|---|---|
| | 1 – Grass/ Forb/Shrub (0.0 – 0.9”) | 2 – Seedling/ Sapling (1.0 – 4.9”) | 3 – Young Forest (5.0 – 11.9”) | 4 – Mid-age Forest (12.0 – 17.9”) | 5 – Mature Forest (18.0 – 23.9”) | 6 – Old Forest (24.0” +) |
| SU 1-1 | 0% | 1% | 32% | 54% | 10% | 3% |
| SU 1-2 | 0% | 4% | 45% | 41% | 8% | 2% |
| SU 1-3 | 0% | 4% | 38% | 34% | 15% | 9% |
| SU 1-4 | 0% | 0% | 62% | 29% | 3% | 6% |
| SU 1-5 | 0% | 1% | 27% | 52% | 14% | 5% |
| **RU 1** | **0%** | **2%** | **37%** | **43%** | **12%** | **6%** |
| SU 3-1 | 0% | 5% | 42% | 36% | 12% | 4% |
| SU 3-2 | 0% | 0% | 18% | 38% | 23% | 21% |
| SU 3-3 | 0% | 2% | 38% | 42% | 10% | 8% |

| Area | Percent of Area by Vegetative Structural Stage (dbh) | | | | | |
|---|---|---|---|---|---|---|
| | 1 – Grass/ Forb/Shrub (0.0 – 0.9”) | 2 – Seedling/ Sapling (1.0 – 4.9”) | 3 – Young Forest (5.0 – 11.9”) | 4 – Mid-age Forest (12.0 – 17.9”) | 5 – Mature Forest (18.0 – 23.9”) | 6 – Old Forest (24.0” +) |
| SU 3-4 | 0% | 0% | 17% | 47% | 24% | 12% |
| SU 3-5 | 0% | 4% | 37% | 42% | 5% | 11% |
| **RU 3** | **0%** | **2%** | **32%** | **41%** | **13%** | **11%** |
| SU 4-2 | 0% | 2% | 33% | 42% | 22% | 0% |
| SU 4-3 | 0% | 1% | 38% | 31% | 16% | 14% |
| SU 4-4 | 0% | 1% | 34% | 43% | 14% | 8% |
| SU 4-5 | 0% | 0% | 34% | 50% | 7% | 10% |
| **RU 4** | **0%** | **1%** | **36%** | **38%** | **15%** | **10%** |
| SU 5-1 | 0% | 13% | 15% | 37% | 8% | 27% |
| SU 5-2 | 0% | 0% | 12% | 8% | 24% | 56% |
| **RU 5** | **0%** | **3%** | **13%** | **14%** | **20%** | **50%** |
| SU 6-2 | 0% | 1% | 55% | 18% | 10% | 15% |
| SU 6-3 | 0% | 5% | 64% | 18% | 5% | 7% |
| SU 6-4 | 0% | 0% | 77% | 4% | 3% | 16% |
| **RU 6** | **0%** | **4%** | **64%** | **16%** | **6%** | **10%** |
| **All** | **0%** | **2%** | **35%** | **32%** | **14%** | **17%** |

# Appendix 10. Relative Changes in Vegetation Structural Stage (VSS) within Northern Goshawk (NGH) Habitat by Alternative.

## Alternative A – Percent VSS in NGH Nest/PFA/dPFA Habitat by Restoration Unit

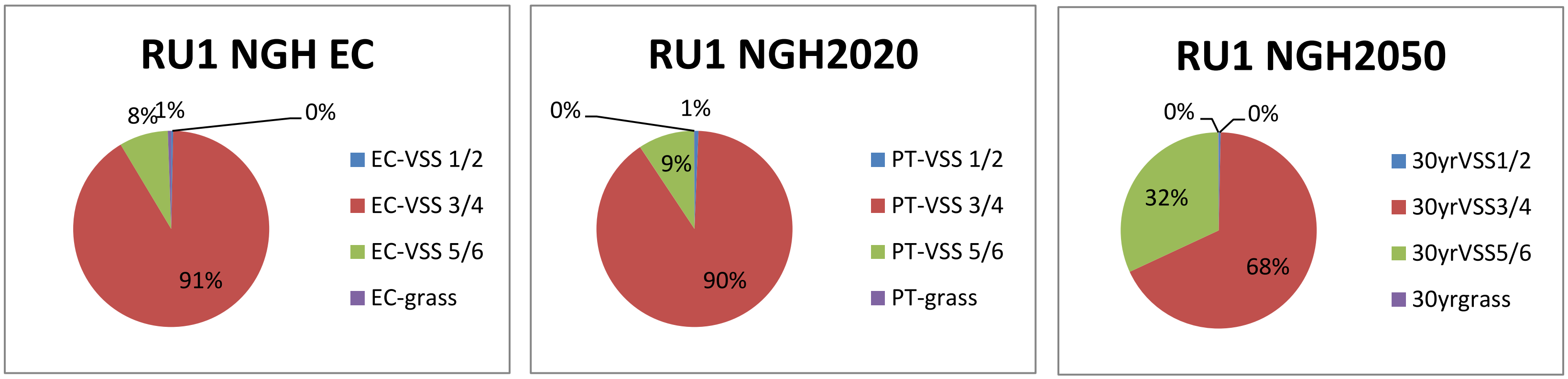


**Figure 135. Alternative A Restoration Unit 1 Changes in VSS within Northern Goshawk Habitat Over Time**

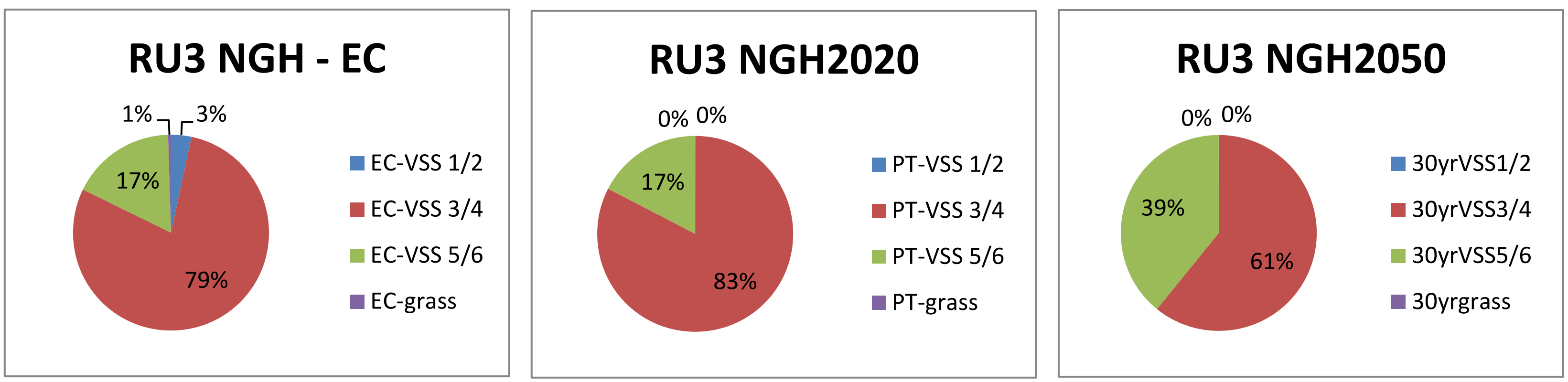


**Figure 136. Alternative A Restoration Unit 3 Changes in VSS within Northern Goshawk Habitat Over Time**

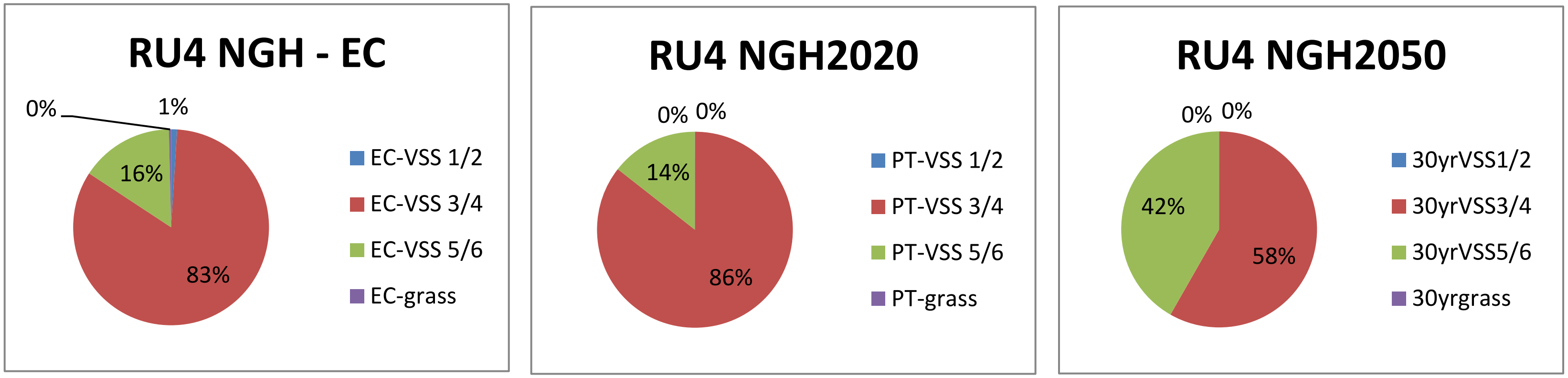


**Figure 137. Alternative A Restoration Unit 4 Changes in VSS within Northern Goshawk Habitat Over Time**

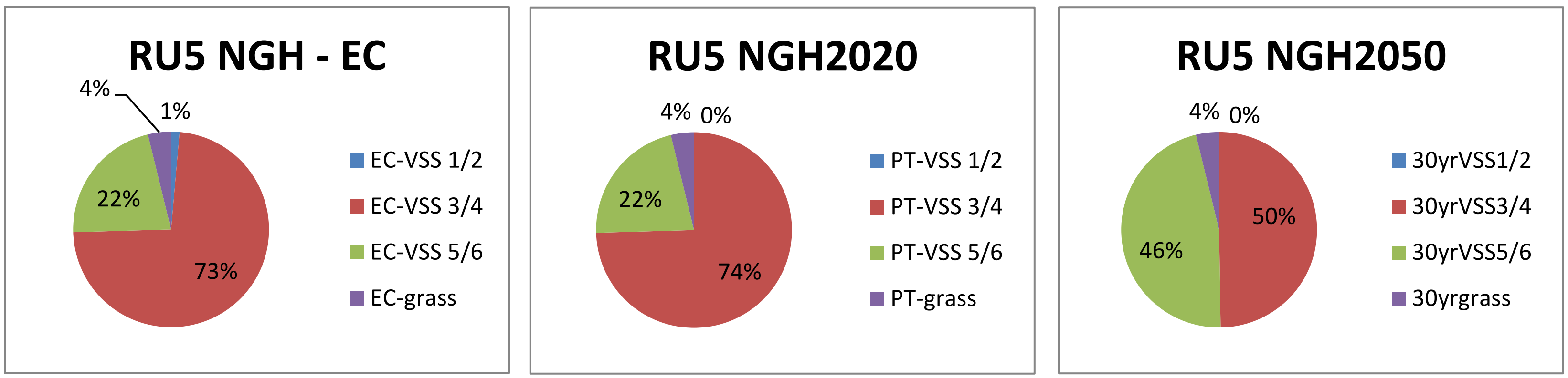


**Figure 138. Alternative A Restoration Unit 5 Changes in VSS within Northern Goshawk Habitat Over Time**

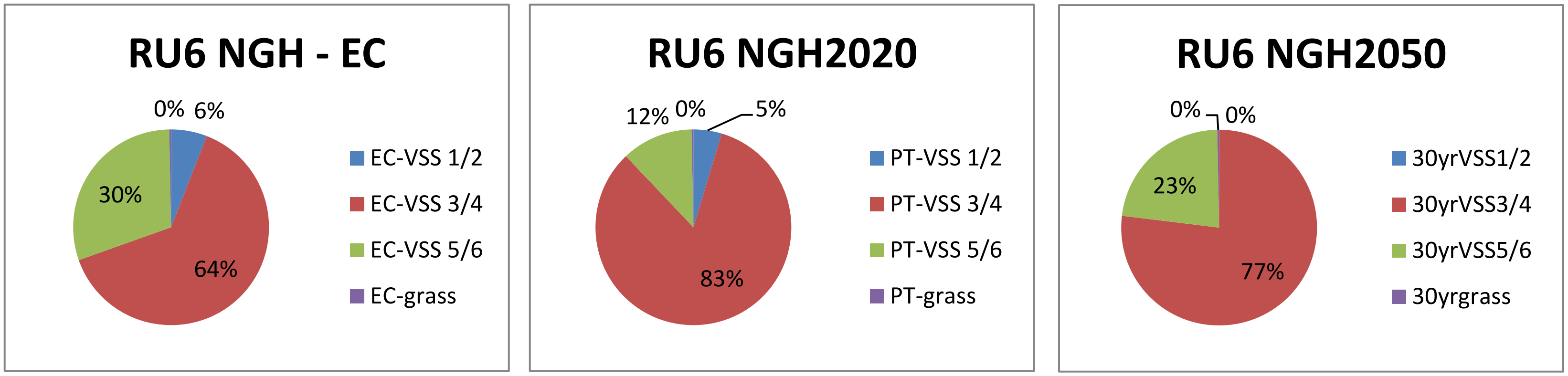


**Figure 139. Alternative A Restoration Unit 6 Changes in VSS within Northern Goshawk Habitat Over Time**

## Alternative B and C -- Percent VSS in NGH Nest/PFA/dPFA Habitat by Restoration Unit

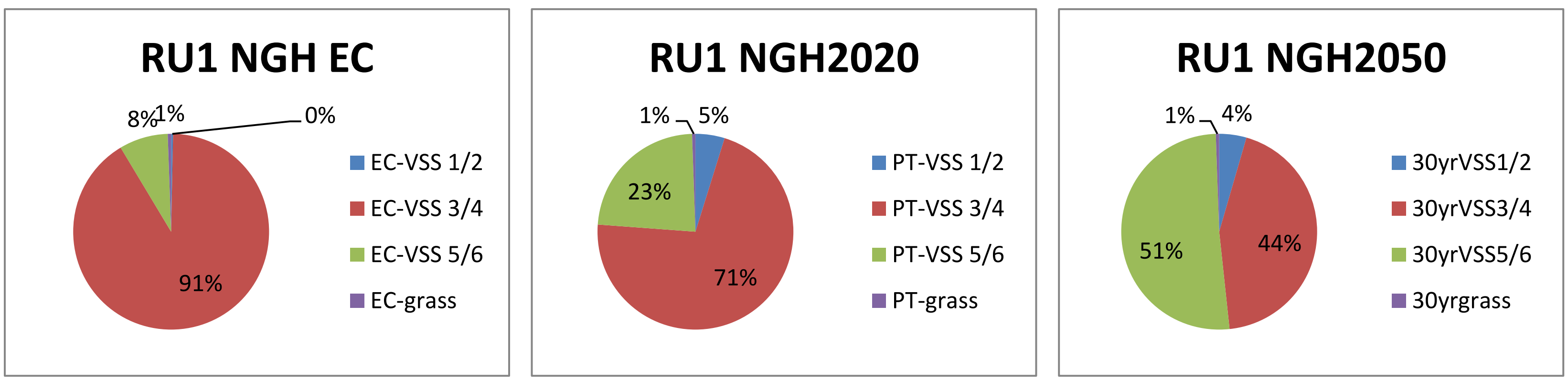


**Figure 140. Alternative B and C Restoration Unit 1 Changes in VSS within Northern Goshawk Habitat Over Time**

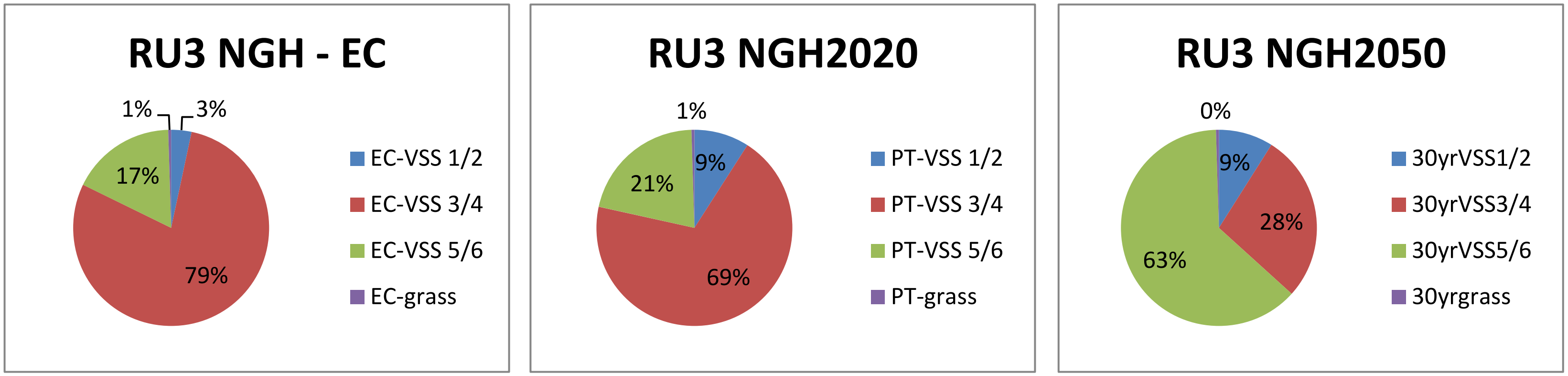


**Figure 141. Alternative B and C Restoration Unit 3 Changes in VSS within Northern Goshawk Habitat Over Time**

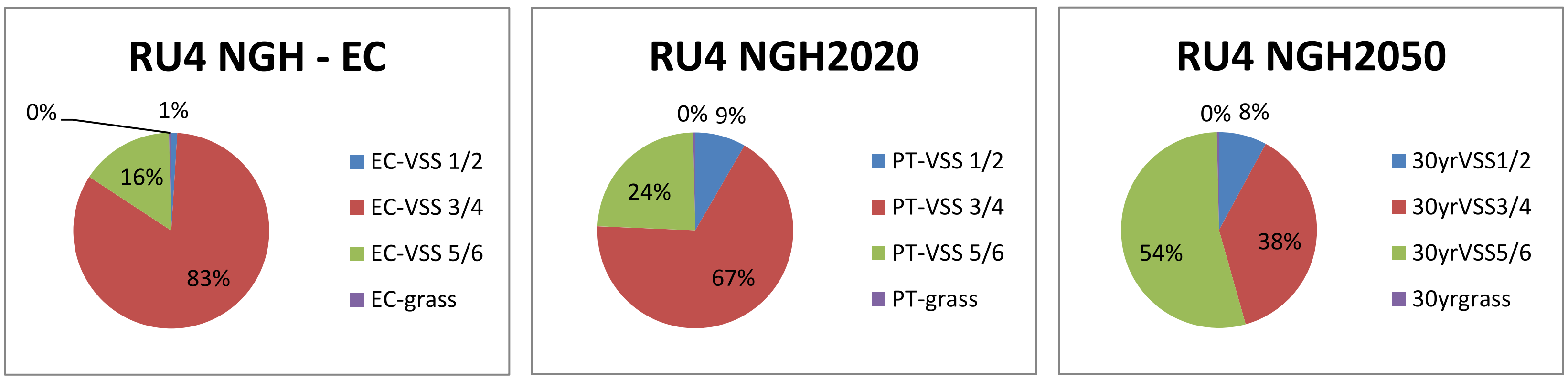


**Figure 142. Alternative B and C Restoration Unit 4 Changes in VSS within Northern Goshawk Habitat Over Time**

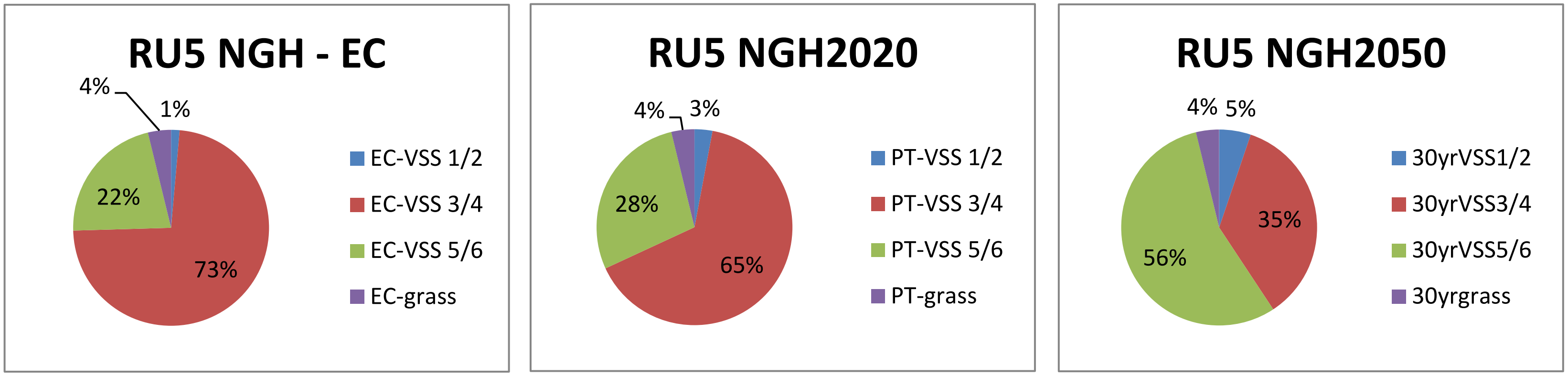


**Figure 143. Alternative B and C Restoration Unit 5 Changes in VSS within Northern Goshawk Habitat Over Time**

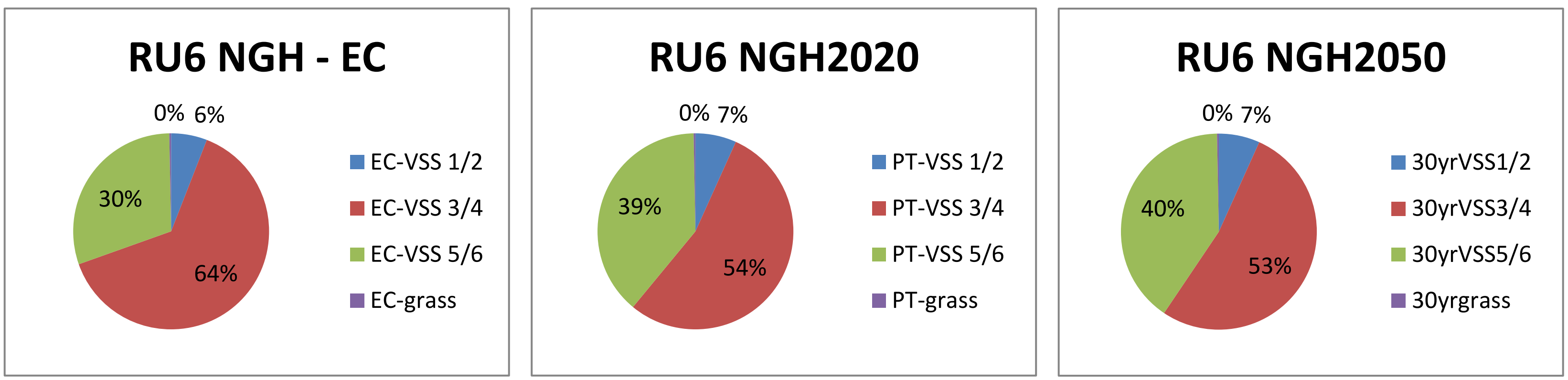


**Figure 144. Alternative B and C Restoration Unit 6 Changes in VSS within Northern Goshawk Habitat Over Time**

## Alternative D -- Percent VSS in NGH Nest/PFA/dPFA Habitat by Restoration Unit

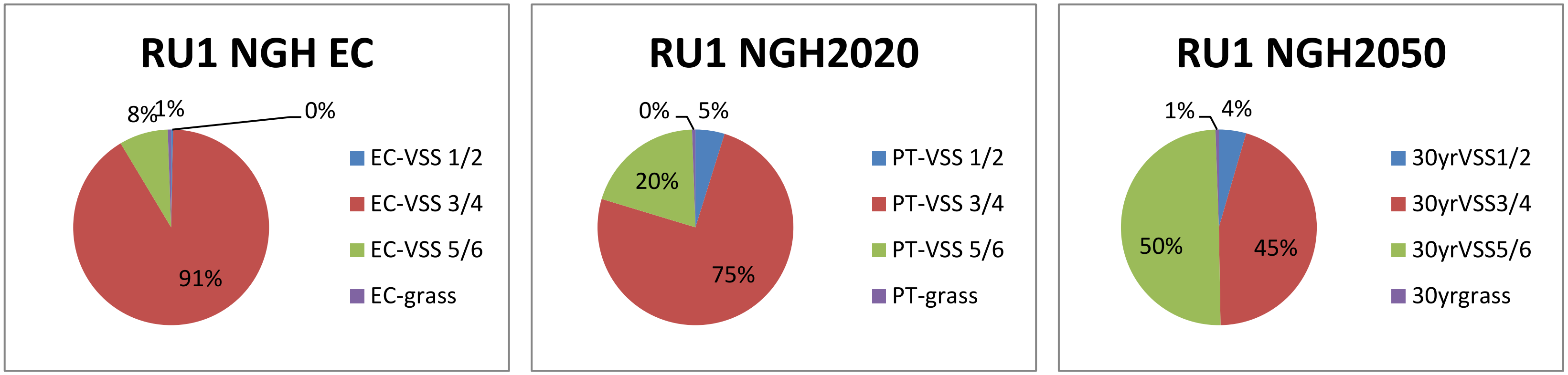


**Figure 145. Alternative D Restoration Unit 1 Changes in VSS within Northern Goshawk Habitat Over Time**

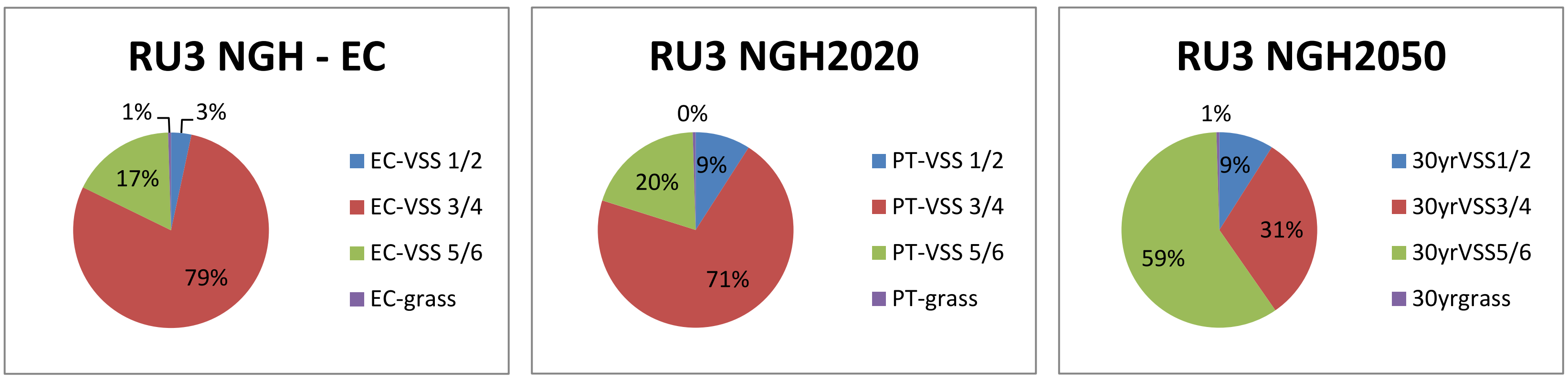


**Figure 146. Alternative D Restoration Unit 3 Changes in VSS within Northern Goshawk Habitat Over Time**

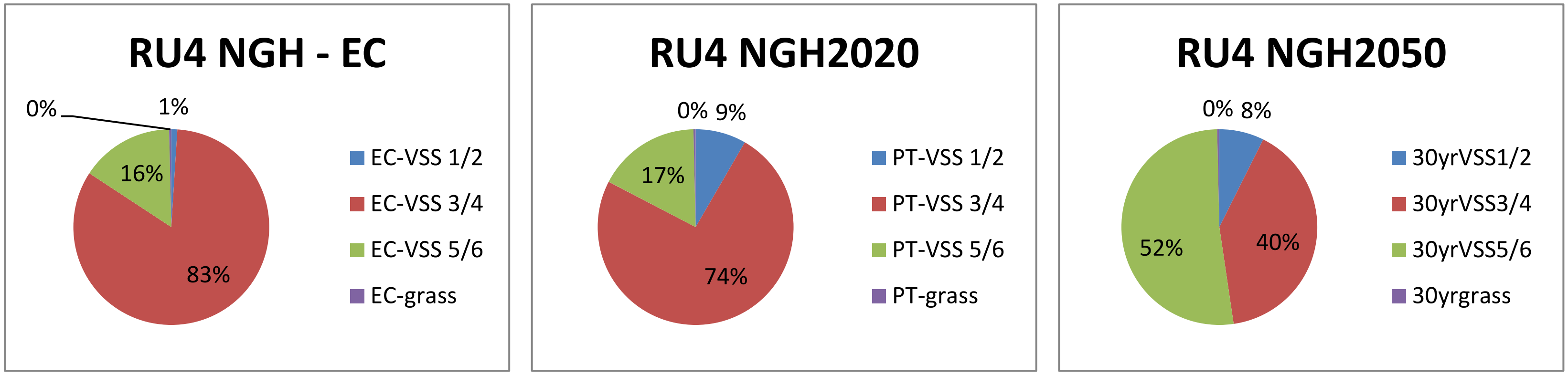


**Figure 147. Alternative D Restoration Unit 4 Changes in VSS within Northern Goshawk Habitat Over Time**

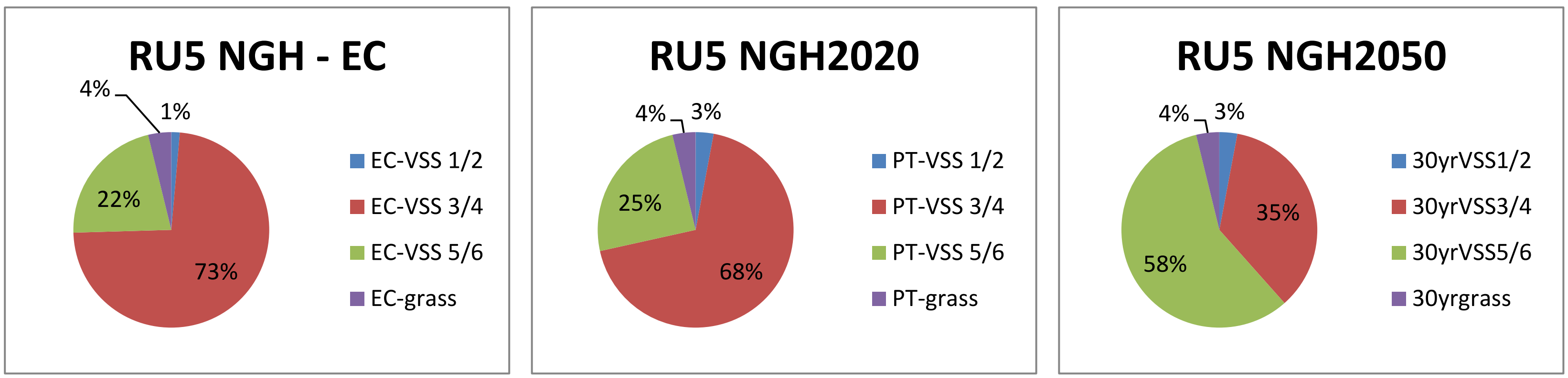


**Figure 148. Alternative D Restoration Unit 5 Changes in VSS within Northern Goshawk Habitat Over Time**

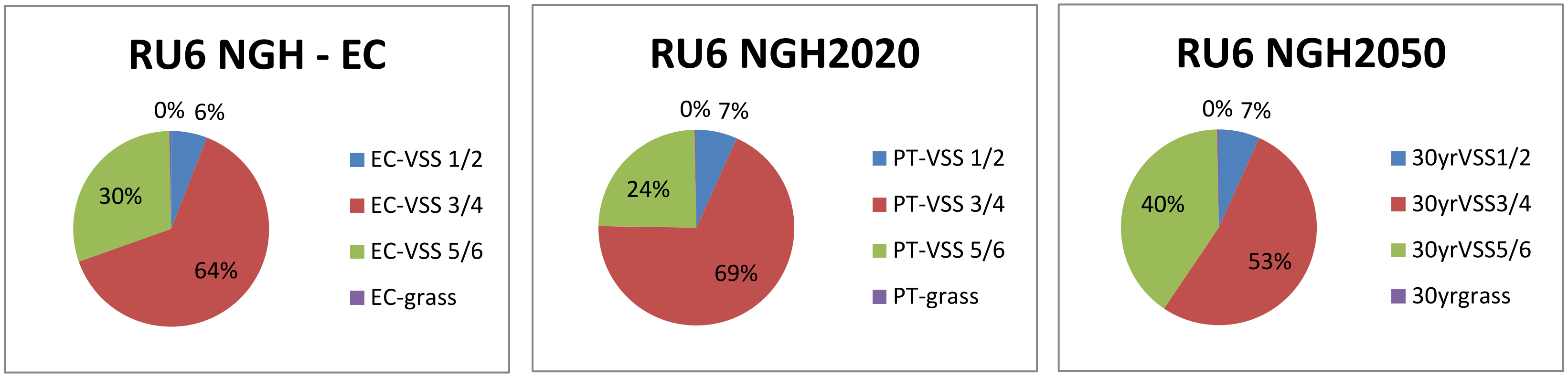


**Figure 149. Alternative D Restoration Unit 6 Changes in VSS within Northern Goshawk Habitat Over Time**

# Appendix 11. Forest Plan VDDT modeling

VDDT modeling was used in the Coconino NF plan revision effort. The current vegetation is classified by existing structural stages and forest development is modeled over time. The VDDT model was run at the mid-scale level (100 to 1,000 acres). The percentage of canopy cover is an average of interspace (openings) and tree cover across the entire defined area (e.g., 100 to 1,000 acres). Averaging across areas means any individual location can have more or less canopy closure than what the model shows. The same approach was applied to diameter class.

VDDT runs for early and late seral ponderosa pine habitat were developed for plan revision on the Coconino NF. Early seral habitat was defined as states B, C, F and G (Table 194) and late seral habitat was defined as states E, I, K, and M.

**Table 194. VDDT states and definitions**

| State | Definition |
|---|---|
| A | Grass, forb, shrubland; <10% canopy cover |
| B | Seeding/sapling, open; <10% canopy cover |
| C | Small trees, open; 10-30% canopy cover; 5-10” diameter class |
| D | Medium trees, open, single story; 10-30% canopy cover; 10-20” diameter class |
| E | Very large trees, open, single story; 10-30% canopy cover; 20+” diameter class |
| F | Seeding/sapling, closed; >30% canopy closure; 0-5” diameter class |
| G | Small trees, closed; >30% canopy closure; 5-10” diameter class |
| H | Medium trees, closed, single-story; >30% canopy closure; 10-20” diameter class |
| I | Very large trees, closed, single-story; >30% canopy closure; 20+” diameter class |
| J | Medium trees, open, multi-story; 10-30% canopy closure; 10-20” diameter class |
| K | Very large trees, open, multi-story; 10-30% canopy closure; 20+” diameter class |
| L | Medium trees, closed, multi-story; >30% canopy closure; 10-20” diameter class |
| M | Very large trees, closed, multi-story; >30% canopy closure; 20+” diameter class |
| N | Uncharacteristic wildfire; <10% canopy cover |

Table 195displays the percentages and acres of VDDT states converted to forest-wide totals of early and late seral habitat.

**Table 195. Early and Late Seral Ponderosa Pine on the Coconino NF**

| State | % Forest-wide | Acres |
|---|---|---|
| **Early Seral States** | | |
| B | 0.00 | 0 |
| C | 19.30 | 152,836 |
| F | 0.00 | 0 |
| G | 0.00 | 0 |
| **Sum** | **19.3** | **152,836** |
| **Late Seral States** | | |
| E | 1.00 | 7,919 |
| I | 5.20 | 41,179 |
| K | 1.00 | 7,919 |
| M | 3.00 | 23,757 |
| **Sum** | **10.2** | **80,774** |
| Total | 29.5 | 233,610 |
| **Forest Total** | **100.00** | **791,897** |

# Appendix 12. Cumulative Effects

**Table 196. Description of Past Projects by Ranger District (RD) on the Kaibab (K) and Coconino (C) National Forests**

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| K-Williams | Williams High Risk Pre Commerical Thin | 2001 (decision) | Activities database shows 756 acres thinned, machine piled and burned in 2002 to 2003 | No project records could be located |
| K-Williams | Potato Hill Habitat Improvement | 2003 (decision) | Total acres: 1,275<br>Mechanically remove juniper and pinyon on 1,275 acres that range up to 6” drc or 12” dbh<br>Slash offered as firewood with only lop and scatter occuring for 300 feet along FR 144 | Objective: improve wildlife habitat<br>Categorized as past due to decision date and scope of project |
| K-Williams | Frenchy | 2003 (decision) | Total Mechanical: 9,319 -<br>Total Fire: 9,319 acres<br>6,529 acres implemented to date<br>Total commercial treatments – 8,227 acres<br>Commercial: Intermediate thin – 2,878 acres<br>Croup Selection – 1,876 acres<br>Savanna/meadow restoration – 2,125 acres<br>Sanitation – 43 acres<br>Individual tree selection – 53 acres<br>Non-commercial - 1,092 acres | Objective: Restore forest health, reduce fuel accumulations, improve wildlife habitat diversity, increase large, old trees<br>Note: Decision states: This alternative proposes over 800 additional acres of full restoration treatments between Moose Ranch and Garland Prairie. This area would be managed for an average canopy cover of less than 40 percent over time – no plan amendment was included<br>Categorized as on-going – DN/FONSI in hard copy files has decision date of 1990<br>See Pomeroy and KA – on-going thin and prescribed burn – broadcast burn (6,529 acres accounts for removing KA and Pomeroy acres) categorized as ongoing due to restoration |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | | | Non Commercial: 256 acres of intermediate thin, 473 acres of savanna/meadow restoration, 405 acres of large oak/juniper/yellow pine release, 78 acres of sanitation<br>Broadcast burning over entire EMU over time, 12.9 miles of road obliteration, 17.3 miles of road closures, forest plan amendment (remove timber suitability), seeding of native grasses in areas wh ere soil was disturbed and tree density is below moderate | emphasis of the project |
| K- Williams | Dogtown Fuels Reduction Project | 2004 (decision) | Total Acres: 8,209, implementation began in 2004 – 6,509 acres implemented with 1,700 acres left to implement in 2013<br>Treatments: (1) 3,105 acres – irregular/sanitation thinning (1,307 ac. Is for misteltoe), (2) 300 acres – group selection, (3) 480 acres – grassland maintenance/fuels reduction, (4) 6,085 acres – prescribed burning, (5) 3,912 – slash treatments, (6) 344 acres – deferred from treatment, (7) 18 miles – road closed | Objective: reduce hazardous fuels and associated fire risk<br>Categorized as both past (6,509 acres implemented) and on-going due to 1,700 acres being part of shelf stock (2013) |
| K-Williams | Clover High Fuels Reduction | 2004 | 385 acres implemented by 2004 -thin, machine pile, burn | No project records could be located |
| K-Williams | Pineaire Fuels Reduction | 2004 (decision) | Total acres: 650 acres of treatments, implemented 2004 to 2009<br>(1) 302 acre of commerical low thinning, (2) 91 acres of non-commercial low thinning 9"dbh, (3) 56 acres low thinning, (4) 150 acres of whole tree skidding, (4) 645 acres of broadcast burn (post pile/burn), (5) 169 acres of | Objective: reduce fuel hazards around communities<br>Categorized as past due to decision |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | | | pile/burn (0 miles of road proposed for closure or decommission) | |
| K-Williams | Williams Follow-up Mistletoe Treatment Project | 2004 (decision) | Total Acres: 368<br>Non commericial misteltoe sanitation on 368 acres within 13 separate sites<br>Slash piles burned | Objective: forest health<br>Categorized as past due to date of decision and scope of project ] |
| K-Williams | Government Mountain/Coleman Aspen Restoration | 2005 (decision) | Total acres: 75<br>75 acres of conifer removal up to 16” dbh within aspen<br>Construct wire fencing totaling 3,000 feet around 11 acres of (of 51 total acres of aspen) aspen sprouts | Encourage and promote aspen and protect from heavy browse<br>Categorized as past due to date of decision and scope of project (75 acres) |
| K - Williams | Garland Prairie Grassland Restoration | 2005 (decision) | Total acres: 500<br>Mehcanical – 500 acres<br>Lop, pile, burn – 47 acres<br>Treatment: Cut encroaching ponderosa pine and juniper trees. Treats 500 acres of 14,000-acre total Garland Prairie. Lop and scatter fuels to address visual concerns (Overland Trail and TH, I-40, Sycamore Rim Trail)(0 miles of road proposed for closure or decommission) | Objective: improve wildlife habitat including pronhorn fawning, nursing, movement, migration,and sighting distance and elk winter and summer range<br>Categorized as past due to date of decision and scope of project |
| K- Williams | City Project | 2005 (decision) | Total acres: 12,400, implemented 2006 to 2010 with 600 acres left to implement in 2014<br>Acres of mechanical: 8667<br>Thinning: (1) commercial - sawtimber 9” dbh + – 4,918 acre (19,672 CCF), (2) commercial Roundwood 5-9” dbh – 1,339 acres (16,093 CCF), (3) noncommercial | Objective: Reduce tree densities and hazardous fuels to improve forest health and sustainabiliy, reduce potential for high severity fire into the City of Williams and its watershed, provide for public and firefighter safety<br>Addresses 12,400 acres of high priority treatmetn area identified in the Greater Williams CWPP |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | | | thinning – 2,366 acres, (4) Savanna Restoration – 41 acres, (5) Aspen Restoration – 3 acres, wood product total: 35,765 CCF (0 miles of road proposed for closure or decommission)<br><br>Prescribed Burning – entire project including first-entry underburning with no mechanical – 2,300 acres, burning with non-commerical thin post fire – 963 acres<br><br>Slash piling and burning – 3,000 acres<br><br>(= 9,400 acres of prescribed fire, and 3,000 acres of pile/burning) | Categorized as past as DN/FONSI does not reference maintenance burning and ongoing as 600 mechanical acres (= 600 acres of prescribed fire) planned to be implemented in 2014 |
| K-Williams | Kendrick Prescribed Burning | 2005-2006 (implemented) | Total Acres: Unknown – need data from Kaibab | |
| K – Williams | Flag Tank Aspen Restoration | 2007 (decision) | Total acres: 36<br><br>22 acres – mechanical<br><br>36 ares - prescribed fire<br><br>Treatments: Cut conifers up to 20” dbh and fence three aspen on approximately 22 acres: (1) no yellow pines cut, (2) all trees cut by hand, no commericial sales | Objective: prevent futher loss of aspen<br><br>Categorized as past given date of decision and total acres to be treated |
| K-Williams | Ida Grassland Maintenance Project | 2008 (decision) | Total Acres: 1,800<br><br>Treatments: (1) Thin juniper and ponderosa pine less than 12” dbh on encroached grasslands with agra-axe and chainsaws, (2) Pile and burn residual slash within 3 years of treatment (0 miles of road proposed for closure or decommission) | Categorized as past – Kaibab web information states project was implemented in 2010<br><br>GIS for 4 FRI depicts project boundary |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| K-Williams | Bill Williams Cap Fuels Reduction | 2009 (decision) | Total acres: 10<br><br>Thinning trees up to 12" dbh and removal of 17 to 25 trees > 10" dbh near structures: remove approx. 175 trees per acre < 5" dbh and 20 trees/acre between 5 and 12" dbh, predominantly douglas and white fir – thin to overall basal area of 170 to 140 sq. ft per acre<br><br>Hand piling/burning of 80% of slash, prescribed fire in northern portion of project area, and maintenance burns (0 miles of road proposed for closure or decommission) | Objective: Reduce hazardous fuels on 10 acres at the top of Bill Williams Mountain to protect electronic site<br><br>Implemented in 2010<br><br>Categorized as both past and on-going due to maintenance burns |
| K-Williams | Community Tank Grassland Restoration Project | 2011 (decision) | Acres implemented: 185 thinning/burning<br><br>Treatments: Restore grassland condition in meadow and ponderosa pine savanna – 1,050 acres, Prescribed Burn 1,400 acres with re-entry burns over 20 year period, Remove 1 miles of fence (pronghorn), Obliterate 2.2 miles of road | Part of shelf stock – 865 acres left to implement in 2013 – 185 acres categorized as past<br><br>Retains all yellow pines, uses evidence-based approach for old trees<br><br>Categorized as on-going/current project due to maintenance burns |
| K-Tusayan | Ten X and Red Horse Mudersbach Timber Sale | 1998 (decision) | Total Mechanical Treatment Acres: 324 acres<br><br>Total Prescribed Fire: 3,500 acres<br><br>Treatments:<br><br>41 acres of natural reforestation to increase age class distribution<br><br>10 miles of road obliterated for watershed conditions<br><br>Guzzler construction (9,000 gal tank) – improve distributation of reliable water<br><br>85 acres of pinyon juniper thinned – improve cliffrose | Objective: forest health (vigor, distribution, understory and forage), reduce hazardous fuels, improve water sources and watershed<br><br>No information available via hard copy or electronic project records – gathered information from PALS and GIS shape files<br><br>Categorized as past due to date and decision does not mention maintenance burns |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | | | understory to increase browse<br>198 acres of thinning to remove encroaching pinyon juniper from ponderosa pine to improve growth<br>3,500 acres of prescribed burn – reduce haz fuels, imrove forage and plant vigior | |
| K-Tusayan – outside project area | Upper Basin Project | 2000 (decision) | Total acres: 1,884<br>1,884 acres of sagebrush and grassland prescribed burning | Objective: Improve and maintain grassland and winter range habitat<br>Categorized as past due to decision date and no mention of maintenance burning |
| K-Tusayan | Tusayan West | 1998-2001 | 850 acres total: (1) 549 acres of thinning, (2) 850 acres of prescribed burning, (3) 75 miles of road obliteration | No project record located – found in airport fuels cum effects |
| K-Tusayan | Tusayan South/Boggy Tank | 2000-2002 | Tusayan South – 1,100 acres of fuel reduction, Boggy Tank – 1,848 acres of fuels reduction<br>2000 – 2,948 acres completed in 2000 and 2012 is ongoing (2,948) no information could be located in terms of road decommission or road closure | No project record – found in airport fuels cum effects categorized as on-going in Airport Fuels cum effects |
| K-Tusayan | Anita project | 2002 | 100 miles of road obliteration | No project record located – found in airport fuels cum effects |
| K-Tusayan | Ten X Pre-Commercial Thinning Project | 2004 (decision) | Total Acres implemented 2,761 acres<br>Total Treatment Acres: 2,761<br>Mechanical = 1, 780 acres<br>909 acres – thin ponderosa pine that has dense stocking up to 9” dbh with 60 to 70 residual trees/acre of which there are 20 to 35 larger trees, fuels lopped and scattered | Objective: improve forest health, stand and tree resilience and vigor, improve understory diversity 2,761 acres<br>Categorized as past due to decision date and 700 acres categorized as ongoingdue to maintenance burns |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | | | 871 acres – thinning of ponderosa pine that has extreme stocking up to 9" dbh with 60 to 70 residual trees/acre of which there are 20 to 35 larger trees, fuels lopped and scattered 700 acres of underburning only, 1,700 acres of thining and burning and 250 acres of burn-thin-burn, maintenance burns to occur several years after first-entry burning (0 miles of road proposed for closure or decommission) | |
| K-Tusayan | Topeka Fuels Reduction Project | 2004 (decision) | Total acres: 1,100<br><br>Non-commercial mechanical thinning and prescribed burning on 1,100 acres with fuelwood collection and slash treatments: (1) Burn Only – 702 acres in low to moderately dense pinyon-juniper woodland with some ponderosa pine, (2) Thin and burn to 75 to 100 trees/acre – 1,095 acres in pinyon pine and juniper (9 to 12" dbh), ponderosa pine (9" dbh and less) and Gambel oak , Slash lopped and scattered and slash piles burned (0 miles of road proposed for closure or decommission) | Objective: Reduce fuels within the urban interface areas around Tusayan and adjacent to the Grand Canyon NP<br><br>Categorized as past due to date of decision and scope of project |
| K-Tusayan | Moqui Antelope Habitat Improvement Project | 2006 (decision) | Total Acres: 1,300 Moqui, 1,690 Red Butte<br><br>2,990 total thin/burn<br><br>Remove encroaching trees on 2,990 acres of grassland/woodland | Objective: antelope habitat and watershed improvement<br><br>Categorized as past project due to date of decision, scope of project, and estiamted date for implementation (08/2006) |
| K-Tusayan | Scott | 2001-2007 (implementation) | From 2002 to 2004 – 421 acres of pre-commercial thin and 300 acres machine piled and burned 2002 to 2007 – 9,434 acres broadcast burned | No project records could be found other than shape files |
| K- Tusayan | X-Fire Hazard | 2009 (decision) | Total acres: 140: | Categorized as past due to scope and date of decision |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | Tree Removal | | Treatments: Remove hazard trees that have 80 percent of greater total crown damage, are tall enough to impact a road/fence, and pose a threat to falling towards a road/fence on 140 acres along FR 302, 303, 688, 835 and 2709, Charlie Trick Tank Road and ½ mile of fence south of 835 road, along 1 mile of private along 302 road | |
| K-Tusayan | O'Connell | Pre-2009 | 500 acres of grassland improvement, sagebrush mowing | No project record found in airport fuels cum effects |
| K-Tusayan | Tusayan Wildlife Waters Project | 2008 (decision)<br>2008-2010 Implemented | 24 water developments constructed<br>Sites include 255-259, 372-373, 391, 972, 1019, 3 waters along old Highway 64 (ADOT assist), and 1186 (see GIS)<br>Four waters developed in the Triangle (see GIS data)<br>6 of 24 had new pipeline constructed<br>Data per Colby Walton, ADGF Wildlife Manager and John DeLuca<br>Note: More waters developed than displayed on map | Digitized points<br>Objective: provide for water needs for wildlife, reduce hauling costs, improve elk habitat use patterns to reduce impacts to vegetation and soil resources around existing water developmetns<br>Relevant to this project in terms of ungulate dispersal per Bill |
| C-Flagstaff | Arboretum WUI | 2000 | 602 acres total:<br>62 acres – UEA<br>38 acres – 9" dbh and less<br>100 acres of hand felling, bunchers, or machines<br>612 acres of prescribed burning<br>602 acres of thin/burn – past and 602 acres of | Objective: reduce fuel loading, fuel ladders, and overall fire hazards within the WUI and reduce fire potential to The Arboretum and Dry Lake Caldera<br>Cateogirzed as both past (602 acres of thin/burn) and ongoing (602 acres of burn) |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | | | maintenance burn – ongoing | |
| C-Mogollon Rim – Peaks RD | Fort Valley | 2000 | 1,700 acres of thinning less than 16" dbh<br>Road closures<br>Trail relocation<br>Retore meadow and riparian habitat<br>EA and DN so convoluted that it is impossible to figure out how many miles of road were proposed for closure | Categorized as past due to volume and year'<br>There have been numerous Fort Valley projects from 1999 to present |
| C-Flagstaff | A-1 MultiProduct Timber Sale (in PALS) East M-P, A-1 West, A-1 East | 2000-2002 | Three projects totaling 14,155 acres of which 8,274 acres is broadcast burn, 364 acres is pile burn and 5,517 acres is thinning (no details available)<br>Insufficient details to provide information on road decommission or closures | 13,463 acre-boundary found in GIS, acreage is from GFFP 2010 data summary<br>Assume 14,155 acres implemented (past) and 8,274 acres is ongoing maintenance burning |
| C-Flagstaff | Rocky Park Fuels Reduction | 2001 | Total acres thinned: 5,651 acres<br>Total acres prescribed burned – 8,000 acres<br>2,196 acres – thin up to 12" dbh ponderosa pine<br>800 acres – thin up to 12" dbh with openings averaging 1 acre in size – turkey and eagle<br>700 acres – thin up to 12" dbh –yellow pine competition reduction<br>700 acres – thin up to 12" dbh with openings averaging 1 acre – for turkey winter habitat<br>700 acres- thin up to 12"dbh with openings between 2-5 | Objective: recduce fire potential<br>Categorized as past as no mention of maintenance burns |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | | | acres for turkey summer habitat<br>225 acres – thin up to 9” dbh – MSO protected<br>330 acres- thin up to 12” dbh - MSO restricted<br>8,000 acres- burn only<br>200 acres- meadow restoration<br>Noxious weeds<br>No roads proposed for closure or decommission | |
| C-Flagstaff | Lake Mary Fuels Reduction (PALS : Lake Mary Meadows Tow Fuel Reduction) | 2005 | 2 projects including 3,245 acres of prescribed burning and 1,845 acres of thinning: 1,616 acres of broadcast burning, 1,824 acres of thinning (no details) and 1,629 acres of broadcast burning –<br>No information on whether road closure or decommission was part of the decision | Only shape files could be retreived from corporate data, numbers are from GFFP data<br>PALS project description:<br>Meadow restoration and fuels reduction to be accomplished by removing pine encroachment on grassland soils. |
| C-Flagstaff | APS Hazard Tree Removal | 2003 | 315 acres broadcast burn | Data from GFFP data - past |
| C-Flagstaff | APS Powerline | 2007 (decision) | Flagstaff to Happy Jack - construction of 46 miles of 12kV distribution powerline including vegetation clearing on 167 acres (30 feet in width)<br>Past: 46 miles of construction/167 acres of clearing<br>Ongoing: 167 acres of vegetation clearing maintenance | See project details - assume construction and vegetetion clearing is complete due to date of decision and that maintenance on 167 acres is ongoing **– part of forest-wide acre summary (ongoing)** |
| C-Mogollon Rim | Blue Ridge 69 KV | 2005 (decision) | 11 miles of powerline with 2-acre substation<br>50 acres of tree removal and 1,300 acres of prescribed | See spatial data<br>Categorized as on-going due to powerline maintenance and |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | Transmission Line | | burn and maintenance burning every 5 to 7 years<br>Past: 50 acres thin and 1,300 acres burn<br>Ongoing: 1,300 acres maintenance burning | maintenance burns in DN/FONSI – **part of forest-wide acre summary (ongoing)** |
| C-Flagstaff | Doney Park | 2007 decision | 1.75 miles of 69 kV line from US Highway 89 to existing 69 Kv line - 8.48 acres<br>Past – 8.48 acres vegetation clearing<br>Ongoing – maintenance (8.48 acre) | Categorized as both past and ongoing due to maintenance (8.48 acre) – **part of forest-wide acre summary (ongoing)** |
| C-Flagstaff | Kachina Village | 2003 | Thin 4,800 acres (3,801 acres implemented) broadcast and maintenance burn 6,229 acres (2,147 acres of burning implemented)<br>No road closure or decomission included | Implementation acres data from GFFP report – project objective: improve declining forest health and reduce wildfire potential |
| C-Mogollon Rim | Apache Maid Grass CE | 2004 | 54,528 acres of hand cutting (lop and scatter) invasive pine and juniper trees within pastures of the Apache Maid Allotment<br>No road clsoure or road decommission included | Objective: grassland maintenance |
| C-Flagstaff | Woody Ridge Forest Restoration Project | 2004 | Total acres of maintenance prescribed (broadcast) burning: 11,184 acres.<br>Mechanical RX: 7,987 ac. (completed)<br>Fire RX: 11,184 acres (completed)<br>1,286 –thin/burn for antelope<br>2,945 – burn only<br>MSO PAC thin/burn – 71 acres | Objective: reduce fire risk and improve forest health, restore travelways for antelope and bear<br>Maintenance burning every 3 to 10 years<br>Categorized as both past (7,897 ac. thin and 11,184 burn) and ongoing due to maintenance burns (11,184 ac) |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | | | PFA thin/burn – 228 acres<br>MSO target thin/burn – 252 acres<br>Turkey thin/burn – 660 acres<br>Fire Risk Reduction thin/burn – 3,494<br>Wildlife movement thin/burn – 89<br>UEA thin/burn – 2,519<br>No road closure or decomission included<br>14.5 miles of new non-motorized trail constructed and 3 miles of social trail obliterated | |
| C-Flagstaff | Mormon Lake Fuels Reduction | 2005 | 2,388 acres thinned and prescribed (broadcast) burned – confusing descption of acres to be treated<br>Past: 2,388 acres thin/burn<br>Ongoing: 2,388 acres burn<br>No road closure or decommission included but system and non-system road segments converted to non-motorized trails | Objective: fuels reduction<br>Categorized as both past and ongoing due to maintenance burns |
| C-Flagstaff | Skunk Canyon Prescribed Burn Fuel Reduction | 2005 decision | 831 acres of low intensity groundfire in 50 to 200 acre blocks – maintain with burning every 5 to 9 years in up to 400-acre blocks<br>Past: 831 acres burn<br>Ongoing: 831 acres maintenance burn<br>No road closure or decommission included | Objective: Reduce fuel loading and fire hazard within WUI<br>Categorized as past and ongoing due to maintenance burning |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| Coconino/ GFFP | Elden | 2006 | 193 acres of fuels reduction – cooperatively thinned<br>Categorized as past due to small volume<br>No road closure or decomission included | No project record located – project referenced in Eastside Fuels DN |
| Coconino/ Flagstaff<br>(GFFP) | Eastside Fuels Reduction and Forest Health | 2006 | Total thin/burn acres: 7,819 acres thin and 20,197 acre burn:<br>3,819 acres of UEA, 3,404 acres up to 12" dbh, 377 acres fuelbreaks, 220 acres of grassland restoration, 20,197 acres of prescribed burning, some grassland and aspen restoration<br>Past: 7,819 acres thin and 20,197 acres burn<br>Ongoing: 20,197 acres of maintenance burning<br>No road closure or decommission included | Objective: fuels reduction (WUI) with some restoration<br>Categorize as past and ongoing due to maintenance burns |
| C-Mogollon Rim | East Clear Creek Watershed Heatlh Improvement | 2006 | Total project acres: 16,228:<br>1,645 acres of thinning less than 9" dbh<br>83 acres of thinnig less than 16 inch dbh- implemented<br>14,500 acres of prescribed and maintenance burning – implemented and ongoing<br>Decommmission 30 miles of road and 14 miles of previously closed road – implemented<br>Past:83 acres thin, 14,500 burn<br>4,700 acres planned for thin (1,562) and burn (4,700) in 2013 | Objective: restore understory and overstory health and diversity, reduce potential for stand-replacing fire and road impacts on watershed and riparian habitat<br>Categorized as both past and ongoing due to mainentenace burns<br>83 acres thinned, 14,500 burned<br>Ongoing: 1,562 thin, 4,700 burn |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| C-Flagstaff | Elk Park Fuels Reduction and Forest Health | 2007 | 4,700 acres of UEA in ponderosa pine<br>6,400 acres of prescribed burning<br>Hoxworth Spring crossing improvement and 0.80 mile of road construction/relocation out of meadow<br>Past: 1,800 ac. thining completed and 3,500 ac. burning<br>Ongoing: 2,900 acres planned (2012) thin and burn | No mention of maintenance burning in DN/FONSI |
| C-Flagstaff | Little Draw Aspen | 2009 | 53 aspen exclosures on 107 acres w/fencing<br>No road closure or decomission included | Implemented 2010 |
| C-Flagstaff | Munds Park Fuels Reduction | 2009 (decision) | Thin 990 acres of ponderosa pine - complete<br>2,950 acres of first-entry and maintenance prescribed burns – first-entry burn complete<br>No road closure or decomission included | Reduce fire risk<br>Categorized as both past and ongoing due to maintenance burns |
| C-Flagstaff | Munds Park CE | 2007 (decision) | Thin 990 acres<br>Intital and maintenance burns on 2,950 acres<br>No road closure or decomission included | Objective: reduce fire hazard rating in WUI |
| C-Flagstaff | Slate Mountain Pronghorn Habitat Restoration Phase III | 2010 | 2,250 acres of grassland restoration – hand cut encroaching ponderosa pine and juniper<br>No road closure or decomission included | Categorized as past due to date of decision |
| C-Flagstaff | Shultz Fire BAER | 2010-2011 | 150 snags removed within 100 feet of road on 17.5 miles of road - Waterline Road | Categorized as past |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | | | 22 snags removed in Weatherford PAC<br>29 snags removed in Pipeline PAC<br>2 acres of disturbance within MSO habitat – reconstruction activities – 0.525 acres lost in Pipeline PAC and 0.435 acres lost in Weatherford PAC, 0.75 acres lost in restricted habitat | |

**Table 197. Description of Past Projects by Other Agencies or Private Lands**

| Agency/ Owner | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| Department of Defense | Camp Navajo | 2003-2010 | 1,636 acres of broadcast burning | Camp Navajo Data, no data available prior to 2003 |
| Department of Defense | Camp Navajo Westside Buffer Thinning and Prescribed Fire Project | 2006-2011 | 1,045 acres of mechanical thin and broadcast burn | retain trees > 18"dbh, removed excess density of trees between 5” to 18"dbh to an average stand basal area of 50 |
| Department of Defense | Camp Navajo Tornado Fuels Reduction Project | 2012 | 854 acres – removed storm damaged trees | Data from Camp Navajo |
| GFFP/State Forestry | AZ State Forestry | 2000 to 2010 | 1,310 acres of private land thinned through State Forestry grants | Data from AZ State Forestry |

| | | | | |
|---|---|---|---|---|
| | | | Past due to need to implement during funding window | |

**Table 198. Wildfires**

| Forest | Year | Fire Class/Name | Acres |
|---|---|---|---|
| **Coconino NF** | **2001-2010** | **Various Class C Fires (10 – 99.9 acres)** | **2,205** |
| Coconino NF | 2009 | Class D/Cinder Hills-256 | 256 |
| Coconino NF | 2000 | Class D/Clover-111 | 111 |
| Coconino NF | 2003 | Class D/Fry-179 | 179 |
| Coconino NF | 2004 | Class D/Good-119 | 119 |
| Coconino NF | 2008 | Class D/Late-140 | 140 |
| Coconino NF | 2008 | Class D/OH -196 | 196 |
| Coconino NF | 2009 | Class D/Reservoi-170 | 170 |
| Coconino NF | 2006 | Class D/Sawmill-244 | 244 |
| Coconino NF | 2005 | Class D/Tater-166 | 166 |
| Coconino NF | 2006 | Class D/Towel-279 | 279 |
| Coconino NF | 2002 | Class D/Tram-197 | 197 |
| Coconino NF | 2006 | Class D/Woody-107 | 107 |
| **Coconino NF** | **2000-2009** | **Total Class D Fire Acres** | **2,164** |
| Coconino NF | 2010 | Class E/89 Mesa - 523 | 523 |
| Coconino NF | 2009 | Class E/Bear – 272 | 272 |
| Coconino NF | 2005 | Class E/Bull Run -884 | 884 |
| Coconino NF | 2002 | Class E/Five Mile -379 | 379 |

| | | | |
|---|---|---|---|
| Coconino NF | 2006 | Class E/Knife-589 | 589 |
| Coconino NF | 2006 | Class E/La Barranca -836 | 836 |
| Coconino NF | 2000 | Class E/Pipe -634 | 634 |
| Coconino NF | 2002 | Class E/Springer-882 | 882 |
| Coconino NF | 2010 | Class E/Tuba -300 | 300 |
| **Coconino NF** | **2000-2010** | **Total Class E Fire Acres (300 – 999 acres)** | **5,299** |
| Coconino NF | 2006 | Class F/Brins -4,317 | 4,317 |
| Coconino NF | 2000 | Class F/Golf-1,470 | 1,470 |
| Coconino NF | 2010 | Class F/Hardy-281 | 281 |
| Coconino NF | 2001 | Class F/Leroux-1,113 | 1,113 |
| Coconino NF | 2003 | Class F/Mormon-2,712 | 2,712 |
| Coconino NF | 2002 | Class F/Packrat-3,006 | 3,006 |
| Coconino NF | 2000 | Class F/Power-1,527 | 1,527 |
| Coconino NF | 2009 | Class F/Taylor-3,538 | 3,538 |
| Coconino NF | 2004 | Class F/Webber-1,411 | 1,411 |
| Coconino NF | 2000 | Class F/Willow - 1,488 | 1,488 |
| **Coconino NF** | **2000-2010** | **Total Class F Fire Acres (1,000 – 4,9999 acres)** | **20,863** |
| Coconino NF | 2007 | Class G/Birdie-5,018 | 5,018 |
| Coconino NF | 2004 | Class G/Jacket-17,218 | 17,218 |
| Coconino NF | 2003 | Class G/Lizard-5,220 | 5,220 |
| Coconino NF | 2010 | Class G/Schultz-15,065 | 15,065 |
| Coconino NF | 2000 | Glass G/Pumpkin* | 7,020 |

| | | | |
|---|---|---|---|
| **Coconino NF** | **2003-2010** | **Total Class G Fire Acres (≥ 5,000 acres)** | **59,541** |
| Kaibab NF | 2009 | Class E/Indian | 107 |
| Kaibab NF | 2009 | Class E/Twin | 1,617 |
| Kaibab NF | 2010 | Class E/Juniper | 470 |
| Kaibab NF | 2010 | Class E/Scott | 492 |
| **Kaibab NF** | **2000-20010** | **Total Class E Fire Acres (300-999 acres)** | **2,686** |
| Kaibab NF | 2008 | Class F/X | 2,060 |
| Kaibab NF | 2009 | Class F/Ruby | 4,671 |
| Kaibab NF | 2009 | Class F/Rae | 1,392 |
| Kaibab NF | 2009 | Class F/Miller | 3,160 |
| Kaibab NF | 2009 | Class F/Anderson | 1,238 |
| Kaibab NF | 2010 | Class F/Hobble | 2,227 |
| **Kaibab NF** | **2000-2010** | **Total Class F Fire Acres (1,000-4,999 acres)** | **14,748** |
| Kaibab NF | 2000 | Pumpkin* | 8,759 |
| Kaibab NF | 2002 | Trick | 5,572 |
| Kaibab NF | 2009 | Wildhorse | 7,450 |
| **Kaibab NF** | **2000-2010** | **Total Class G Fire Acres (≥ 5,000 acres)** | **21,781** |
| *Coconino and Kaibab NFs | 2000 | Class G/Pumpkin | 15,779 total<br>(8,759 acres on Kaibab NF, 7,020 acres on the Coconino NF) |

**Table 199. Descriptions of Current/Ongoing Projects by Ranger District (RD) on the Kaibab (K) and Coconino (C) National Forests**

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| K-Williams | Pomeroy – part of Frenchy (2003) | 2012 | 1,740 acres to be implemented - mechanical and prescribed fire | Part of shelf stock - |
| K-Williams | KA – part of Frenchy (2003) | 2012 | 1,050 acres to be implemented – mechanical and prescribe fire | Part of shelf stock |
| K-Tusayan | Russell Vegetation Management Project | 2011 (decision) | Planned Treatments: 5,000 acres non-commericial thinning (less than 9" dbh) and 8,000 acres of prescribed fire | Objective: vegetation improvement, fuels<br>Categorized as ongoing/current project due to 4th quarter 2011 decision date |
| K-Williams | Community Tank Grassland Restoration Project | 2011 (decision) | Treatments: Restore grassland condition in meadow and ponderosa pine savanna – 1,050 acres, Prescribe Burn 1,400 acres with re-entry burns over 20 year period, Remove 1 miles of fence (pronghorn), Obliterate 2.2 miles of road | Part of shelf stock – 865 acres left to implement in 2013 – 185 acres categorized as past<br>Retains all yellow pines,<br>uses evidence-based approach for old trees<br>Categorized as on-going/current project due to maintenance burns |
| K-Williams | Bill Williams Cap Fuels Reduction | 2009 (decision) | Total Acres: 10<br>Thinning trees up to 12" dbh and removal of 17 to 25 trees > 10" dbh near structures: remove approx. 175 trees per acre < 5" dbh and 20 trees/acre between 5 and 12" dbh, predominantly douglas and white fir – thin to overall basal area of 170 to 140 sq. ft per acre<br>Hand piling/burning of 80% of slash, prescribed fire in | Objective: Reduce hazardous fuels on 10 acres at the top of Bill Williams Mountain to protect electronic site<br>Vegetation and fire implemented in 2010<br>Categorized as both past and on-going due to maintenance burns |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | | | northern portion of project area, and maintenance burns | |
| K-Tusayan | Ten X Pre-Commercial Thinning Project | 2004 (decision) | Ongoing Acres: 700 acres of burn | Objective: improve forest health, stand and tree resilience and vigor, improve understory diversity<br>Categorized as past (2,761 acres of mechanical and burning) and ongoingdue to maintenance burns (700 acres) |
| K- Tusayan | Airport Fuels Reduction Project | 01/2009 (decision) | Total mechanical is 2,961<br>Total Burn: 2,961<br>Thin from below 2,225 acres of pinyon-juniper and retain large, older trees, Slash disposal – lopped, scattered, piled/burned, prescribe fire with first and second entry<br>602 acres of ponderosa pine: prescribe burn, thin from below, prescribe burn with a third burn being a broadcast and jackpot ignition<br>134 acres of sagebrush-grassland: thin, regain all pre-settlement trees using evidence-based approach, jackpot burning to create small openings<br>In all project area, managing for less than 5 percent mortality in pipo and large diameter oak<br>Maintenance burns scheduled on a 5 to 15-year cycle | Objective: pinon/juniper: recreate stand condtions created by mixed fire severity to create contiguous patches alternativing between stand replacement and no fire effects<br>Categorized as on-going due to maintenance burns |
| K-Williams | South Williams Prescribed Burn #51 | 2005 (decision) | Prescribed burning within grassland openings on 290 acres to remove small diameter ponderosa pine and pinyon/juniper tree encroachment with small dozer line constructed along the west and east boundaries of the Coleman Lake Site and on a portion of the Whiting site | Objective: Improve and maintain grassland species, stimulate decadent grass, forbs and browse plants, restore periodice burning into the ecosytem<br>Categorized as on-going due to use of fire to maintain |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | | | boundary. First burn occuring in 2006 and maintenance burns would occur every 5 to 10 years | grassland openings |
| K-Tusayan | Long Jim Fuels Reduction | 2005 (decision) | Past 913 acres mechanical<br>Past Burn: 1,175 acres<br>Ongoing: 1,175 acres burning<br>Total acres: 1,300<br>Burn Only – 462 acres –light stocking of small diameter pinyon, juniper and pockets of ponderosa pine<br>Mechanically thin up to 12” dbh and burn – 713 acres in ponderosa pine, pinyon pine, juniper and Gambel oak<br>Agra-axe or Agra-mow trees up to 12” dbh and burn – 200 acres – scattered ponderosa pine, pinyon pine, juniper, and Gambel oak and sagebrush openings on flatter terrain<br>Post mechanical treatment broadcast burn with maintenance burning occuring<br>Mechanical – 713,200 = 913 acres<br>Burn: 462, 713 – 1,175 acres | Objective – improve ecosystem health and sustainabiliyt and reduce risk of intense stand replacement fire to private property , Tusayan and Grand Canyon NP, addresses priority in Tusayan CWPP<br>Categorized as on-going due to to inclusino of maintenance burning in CE |
| K- Williams | Dogtown Fuels Reduction Project | 2004 (decision) | Total Acres: 8,209, implementation began in 2004 – 6,509 acres implemented with 1,700 acres left to implement in 2013<br>Treatments: (1) 3,105 acres – irregular/sanitation thinning (1,307 ac. Is for misteltoe), (2) 300 acres – group selection, (3) 480 acres – grassland | Objective: reduce hazardous fuels and associated fire risk<br>Categorized as both past (6,509 acres implemented) and on-going due to 1,700 acres being part of shelf stock (2013) |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | | | maintenance/fuels reduction, (4) 6,085 acres – prescribed burning, (5) 3,912 – slash treatments, (6) 344 acres – deferred from treatment, (7) 18 miles – road closed | |
| K-Williams | Twin | 2005 (decision) | Total acres: 1,400 acres<br><br>Treatments: 1,400 acres of prescribed burning to reduce fire risk in the Greater Williams Area CWPP: (1) Thin, Prune, Pile Burn, Firelines, Reburn areas previously treated up to 2001, mortality in yellow pipo not to exceed 5 percent of the project area, mortality of black-bark pipo greater than 12” dbh not to exceed 10 percent, gambel oak mortality greater than 5” drc not to exceed 15 percent – part of the Hat Allotment Mtn Plan EA?? Per information in Twin project record (project description is not consistent with files on hand at the district that are dated in the 1990s) | Objectives: firefighter and public safety; reduce the potential for wildland fire to enter private property from the forest; reduce the risk for uncharacteristically intense stand-replacement wildland fires by creating openings in the forest canopy, reducing forest fuel loads (dead and down woody debris), reducing ladder fuels (includes increasing the distance from the ground to lower live tree branches), and lowering tree densities; protect watershed condition and soil productivity; and prevent the spread of high-intensity wildland fire into the City of Williams watershed.<br><br>DN-FONSI not specific on whether maintenance burns would occur<br><br>Categorized as on-going due to assumption that maintenance burns within a CWPP would be needed |
| K- KNF | Treament of Noxious Weeds – 3 forests | 2004 (decision) | Incorporated into forest plan direction | NEPA Completed in 2004<br><br>Categorized as on-going |
| K-Williams | Frenchy | 2003 (decision) | Total Mechanical: 9,319 -<br><br>Total Fire: 9,319 acres<br><br>6,529 acres implemented to date<br><br>Total commercial treatments – 8,227 acres | Objective: Restore forest health, reduce fuel accumulations, improve wildlife habitat diversity, increase large, old trees<br><br>Note: Decision states: This alternative proposes over 800 additional acres of full restoration treatments between Moose Ranch and Garland Prairie. This area would be |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | | | Non-commercial - 1,092 acres<br>Commercial: Intermediate thin – 2,878 acres<br>Croup Selection – 1,876 acres<br>Savanna/Meadow restoration – 2,125 acres<br>Sanitation – 43 acres<br>Individual tree selection – 53 acres<br>Non Commercial: 256 acres of intermediate thin, 473 acres of savanna/meadow restoration, 405 acres of large oak/juniper/yellow pine release, 78 acres of sanitation<br>Broadcast burning over entire EMU over time,<br>12.9 miles of road obliteration, 17.3 miles of road closures, forest plan amendment (remove timber suitability), seeding of native grasses in areas wh ere soil was disturbed and tree density is below moderate | managed for an average canopy cover of less than 40 percent over time – no plan amendment was included<br>Categorized as on-going – DN/FONSI in hard copy files has decision date of 1990<br>See Pomeroy and KA – on-going thin and prescribed burn – broadcast burn (6,529 acres accounts for removing KA and Pomeroy acres) categorized as ongoing due to restoration emphasis of the project |
| | Williams and Tusayan fuelwood policy | 2011 (current) | Cross-country motorized use not permitted<br>Dead limbs may not be removed from live trees<br>Ponderosa Pine – Only dead, standing trees less than 12 inches in diameter (38 inches in circumference) or less than 15 feet in height may be removed<br>Pinyon Pine – Only dead, standing trees less than 10 inches in diameter (32 inches in circumference) or less than 12 feet in height may be removed.<br>Gambel Oak – Only dead, standing trees less than 8 inches in diameter (25 inches in circumference) or less | |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | | | than 12 feet in height may be removed. In addition, dead, standing oak may only be removed between June 1 and September 30.<br><br>Juniper – Only dead, standing trees less than 20 inches in diameter (68½ inches in circumference) or less than 15 feet in height may be removed.<br><br>Aspen – Only dead, standing trees less than 12 inches in diameter (38 inches in circumference) or less than 12 feet in height may be removed. In addition, dead, standing aspen may only be removed between June 1 and September 30.<br><br>Green Juniper – diameter size limits apply by specific area | |
| K-Tusayan | Tusayan Travel Management | 2011 (decision) | 566 miles of open road:<br><br>Changes: (1) 143 miles of open road become admin, (2) 15 miles of spur roads added, (3) game retrieval within one mile of all desginated roads, | Relevant to this project |
| K–Williams | Williams Travel Management | 2011 (decision) | Close 380 miles of open road, add 16 miles of spur roads that includes 8 miles of closed road and unauthorized user created routes, add 18 miles of spur roads, allow big game retrieval within 1 mile of open roads | Categorized as current/ongoing due to decision date |
| K-Williams | Radio Hill Road Obliteration | 2005 (decision) | Close 50 miles of road, decommission or obliterate 67.3 miles of road | Objective: Improve wildlife habitat, protect heritage resources, maintain serviceable road system<br><br>Categorized as on-going due to miles of road and date of decision |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| C-Flagstaff | A-1 East M-P, A-1 West, A-1 East | 2000-2002 | Three projects totaling 14,155 acres of which 8,274 acres is broadcast burn, 364 acres is pile burn and 5,517 acres is thinning (no details available)<br>Past mechanical: 14,155 acres<br>Past burning: 8,636 acres (broadcast burn, pile burn)<br>Ongoing: 8,274 acres maintenance burn | 13,463 acre-boundary found in GIS, acreage is from GFFP 2010 data summary<br>Assume 14,155 acres implemented (past) and 8,274 acres is ongoing maintenance burning |
| K-Tusayan | Tusayan South/Boggy Tank | 2000-2002 | Tusayan South – 1,100 acres of fuel reduction, Boggy Tank – 1,848 acres of fuels reduction<br>2000 – 2,948 acres completed in 2000 and 2012 is ongoing (2,948 acres) | No project record – found in airport fuels cum effects categorized as on-going in Airport Fuels cum effects<br>2,948 acres completed in 2000 and 2012 is ongoing (2,948 acres) |
| K-Tusayan | Tusayan East | 2002 | 2,600 acres of fuels reduction | No project record – shape files in O drive – found in airport fuels cum effects categorized as on-going in Airport Fuels cum effects |
| K-Forest-wide | Grazing Allotments | Current | 28 grazing allotments authorizing 340,394 acres of livestock (cattle, sheep, horse) grazing wtihin project area – see spatial data for allotment location.<br>Allotments managed for 30 to 40 percent maximum forage utilization<br>Grazing systems range from rest rotation to deferred rotation<br>Forest-wide there are 38 grazing allotments covering 1,414,000 or 92 percent of the forest. | Anita, Bellemont, Big Springs, Cameron, Chalender, Crova, Cowboy Tank, Davenport Lake, Elk Springs, Government Mtn, Government Prairie, Hat, Homestead, Juan Tank, Kendrick Mountain, Mooney Mtn, Mortiz Lake, Pine Creek, Pomeroy, Rain Tank, Seven C Bar, Sitgreaves, Smoot Lake, Spitz Hill, Squaw Mtn, Tule, Twin Tanks, Garland Prairie |
| Coconino/GFFP | Arboretum Fuels | 2000 | 602 acres cooperatively thinned and prescribed burned: 62 acres UEA, 38 acres 9" dbh and less, hand felling, bunchers, tractor systems – 100 acres, 602 acres | Objective: reduce fuel loading, fuel ladders, and overall fire hazards within the WUI and reduce fire potential to The |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | Reduction | | prescribed burning<br>Categorize as 602 acres past thin/burn and 602 acres of ongoing maintenance burns | Arboretum and Dry Lake Caldera –<br>GFFP data shows 61 acres of thin and 763 acres of broadcast burn implemented |
| C-Flagstaff | Woody Ridge Forest Restoration Project | 2004 | Total acres of maintenance prescribed (broadcast) burning: 8,599<br>1,286 –thin/burn for antelope<br>2,945 – burn only<br>MSO PAC thin/burn – 71 acres<br>PFA thin/burn – 228 acres<br>MSO target thin/burn – 252 acres<br>Turkey thin/burn – 660 acres<br>Fire Risk Reduction thin/burn – 3,494<br>Wildlife movement thin/burn – 89<br>UEA thin/burn – 2,519 | Objective: reduce fire risk and improve forest health, restore travelways for antelope and bear<br>Maintenance burning every 3 to 10 years<br>Categorized as both past and ongoing |
| C-Flagstaff and Mogollon RD | Post-Tornado Resource Protection and Recovery Project | Current (2011 decision) | Remove downed material from the tornado corridor on approximately 3,990 acres and treat areas with evidence of bark beetle<br>infestation on a maximum of approximately 14,766 acres adjacent to the tornado corridor on the<br>Flagstaff and Mogollon Rim Ranger Districts. Total maximum acreage for treatment is 18,756 acres; however treatment in the buffer will only occur in areas showing signs of bark beetle infestation and therefore, | Treatments could occur for approximately five years (see DN/FONSI) post-decision (2011 to 2016) dependent on bark beetle activity |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | | | the area treated may be much smaller. | |
| C - Flagstaff | Hart Prairie Fuels Reduction | 2010 (decision) | 9,815 acres thin/burn total<br>3,790 acres – ponderosa pine restoration – 2-40 trees/group, 0.7 acres in size, BA 50 sf or greater in VSS 4-6 – intital and maintenance burning<br>250 acres – mixed conifer restoration groups of trees up to 4 acres in size with BA of approx 50-120 sf – pile and broadcast burn<br>3,215 acres – aspen restoration with prescribed fire<br>30 acres- thin from below on steep slopes up to 9" dbh<br>1,515 acres – meadow restoration<br>965 acres – burn only<br>25 acres- slope stabilization<br>25 acres-Bebbs willow restoration<br>Spirng exclosures, water tank/catchmetn relocation | Objective – move towards historic natural conditions including fire regime<br>Categorized as ongoing due to date of decision, size of project, and maintenance burning |
| C-Flagstaff | Munds Park Fuels Reduction | 2009 (decision) | 2,950 acres of maintenance prescribed burns | Reduce fire risk<br>Categorized as both past and ongoing due to maintenance burns |
| Coconino | power lines, oil and gas lines, natural gas/FERC, meter sites, gas | 2012 existing permits | 30,710 acres forest-wide | right-of-way vegetation clearing for maintenance purposes and to reduce fire risk (includes Flagstaff to Happy Jack 2007, Blue Ridge 69 kV transmission line 2005, Doney Park 2007, Sandvig Young 2011) |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | compression and substation sites* | | | |
| Kaibab NF | power lines, oil and gas lines, natural gas/FERC, meter sites, gas compression and substation sites* | 2012 existing permits | 1,634 acres of right- of-way vegetation clearing for maintenance purposes and to reduce fire risk | Forest-wide |
| C-Mogollon Rim | East Clear Creek Watershed Heatlh Improvement | 2006 | Total project acres: 16,228:<br>1,645 acres of thinning less than 9" dbh<br>83 acres of thinnig less than 16 inch dbh- implemented<br>14,500 acres of prescribed and maintenance burning – implemented and ongoing<br>Decommmission 30 miles of road and 14 miles of previously closed road – implemented<br>Past:83 acres thin, 14,500 burn<br>4,700 acres planned for thin (1,562) and burn (4,700) in 2013 | Objective: restore understory and overstory health and diversity, reduce potential for stand-replacing fire and road impacts on watershed and riparian habitat<br>Categorized as both past and ongoing due to mainentenace burns<br>83 acres thinned, 14,500 burned<br>Ongoing: 1,562 thin, 4,700 burn |
| C-Flagstaff | Mormon Lake Fuels Reduction | 2005 | 2,388 acres thinned and prescribed (broadcast) burned – confusing descption of acres to be treated<br>Past: 2,388 acres thin/burn | Objective: fuels reduction<br>Categorized as both past and ongoing due to maintenance burns |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | | | Ongoing: 2,388 acres burn | |
| C-Flagstaff | Skunk Canyon Prescribed Burn Fuel Reduction | 2005 decision | 831 acres of low intensity groundfire in 50 to 200 acre blocks – maintain with burning every 5 to 9 years in up to 400-acre blocks<br>Past: 831 acres burn<br>Ongoing: 831 acres maintenance burn | Objective: Reduce fuel loading and fire hazard within WUI<br>Categorized as past and ongoing due to maintenance burning |
| Coconino/ Flagstaff<br>(GFFP) | Eastside Fuels Reduction and Forest Health | 2006 | Total thin/burn acres: 7,819 acres thin and 20,197 acre burn<br>3,819 acres of UEA, 3,404 acres up to 12” dbh, 377 acres fuelbreaks, 220 acres of grassland restoration, 20,197 acres of prescribed burning, some grassland and aspen restoration<br>Past: 7,819 acres thin and 20,197 acres burn<br>Ongoing: 20,197 acres of maintenance burning | Objective: fuels reduction (WUI) with some restoration<br>Categorize as past and ongoing due to maintenance burns |
| C-Flagstaff | Munds Park Fuels Reduction | 2009 (decision) | 2,950 acres of maintenance prescribed burns | Reduce fire risk<br>Categorized as both past and ongoing due to maintenance burns |
| CNF | Travel Management | 2011 decision | Travel Management for CNF | Designates 3,136 miles as open, and provides for motorized access for game retrieval on 991,793 acres, 43,313 acres open to motorized dispersed camping |
| CNF | Bob’s | ?? | 2,000 acres planned for implementation in 2012 | |
| CNF | Clark’s | ?? | 1,600 acres planned for implementation in 2012 | |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| C-Flagstaff | Elk Park Fuels Reduction and Forest Health | 2007 | 4,700 acres of UEA in ponderosa pine<br>6,400 acres of prescribed burning<br>Hoxworth Spring crossing improvement and road construction/decommission<br>Past: 1,800 ac. thining completed and 3,500 ac. burning<br>Ongoing: 2,900 acres planned (2012) thin and burn | No mention of maintenance burning in DN/FONSI |
| C-Flagstaff | Jack Smith Schultz | | 2,000 acres planned for implementation in 2012 | Ongoing |
| | Weatherford | | 1,000 acres planned for implementation in 2013 | Ongoing |
| | Railroad | | 250 acres planned for implementation in 2013 | Ongoing |
| GFFP | GFFP | 2012 | 100 acres of thinning and prescribed burning | 100 acres of private property made up of 20 parcels within the GFFP boundary - ongoing |

**Table 200. Descriptions of Reasonably Foreseeable Projects by Ranger District (RD) on the Kaibab (K) and Coconino (C) National Forests**

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| K- Williams | Aspen Restoration Project | 2012 - NEPA in progress | Treat 402 acres of aspen within 69 stands and prescribed fire | Objective: Thin conifers, fencing, jackstrawing, prescribed fire, and cutting diseased or dying aspen within stands to encourage regeneration<br>Categorized as reasonably foreseeable project due to NEPA status |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| K-Williams | McCracken Project | 2012- NEPA in progress | Planned treatments: 3,597 acres – group selection, 2,049 acres – shelterwood, 17 acres – irregular thinning, 43 acres – sanitation, 87 acres – aspen release, 806 acres – meadow restoration, 3,551 acres – pine/woodland savanna, 1,053 acres – woodland thinning,4,049 acres – pre-commercial thinning<br><br>Total thinning acres: 15,262<br><br>Total prescribed fire: 17,337 | Paroject Objective: move towards uneven-aged forest structure, reduce mistletoe, restore meadows, savanna, and woodlands<br><br>part of shelf stock – 2014 implementation<br><br>Categorized as reasonably foreseeable project due to NEPA status |
| K-Tusayan | Ten X-Fire Planting | 2010 (scoping) – NEPA on hold | Plant 12 acres of ponderosa pine seedlings with 15 plantations that range in from 0.3 to 2.5 acres.<br><br>Construct 8' hog wire fence around plantations | Objective: restore vegetation in high severity burn area<br><br>Planting within X-Fire perimeter within 815 acre high severity burn<br><br>Categorized as reasonably foreseeable due to project status |
| K-Williams | Bill Williams Mountain Restoration Project (EIS) | 2012- In progress | 11,650 acress of veg treatment, 15,200 acres of RX Burn: (1) 11,100 acres – treat up to 40 percent slopes, (2) treat 200 acres with specialized equipment helicopter, (3) treat 350 acres greater than 40 percent slopes, (4) 2,500 non-commericial thinning, (5) 15,200 acres of prescribed fire, (6) 23 miles of new road construction, (7) 16 miles of temporary road construction, (8) obliterate 28 miles of poorly located roads, (9) 1 mile of new trail and trailhead construction, (10) 3 plan amendments: remove 8,954 acres from timber suitability, treat greater than 40% slopes, deviate in goshawk PFA nest areas | Categorized as reasonably foreseeable due to NEPA status (underway) |
| KNF/CNF | Rock Pit Development: Coconino and | 2012 (forseeable) | 39 material pits to support road maintenance for all projects across the Forests | Road maintenance – see GIS spatial data |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | Kaibab National Forests | | | |
| Department of Defense | Camp Navajo Westside Buffer Thinning and Prescribed Fire Project | 2013 | 1,269 acres of mechanical thin<br>530 acres of broadcast burn<br>968 acres of mechanical thin and broadcast burn | |
| Department of Defense | AZARNG Thinning, Burning | 2013 | 17,049 acres – mechanical thin, hand thin, slash treatment and prescribed fire – reduce tree density in 5" dbh to 18" dbh | Ponderosa pine, pine-oak and grasslands to mitigate fire risk, provide diversity in forest conditions, ecosystem health |
| GFFP Projects | GFFP | 2013-2014 | 535 acres of vegetation thinning and prescribed fire on private land parcels within 180,000-acre GFFP boundary | 245 acres (5 private land parcels) in 2013, 190 acres (4 to 10 parcels) in 2014, and 100 acres of prescribed burning through 2014 |
| C-Flagstaff | Marshall Fuels Reduction | 2011 (decision) | Total thinning acres: 10,800 ac.<br>Total prescribed fire acres: 6,260 ac.<br>4,220 acres – ponderosa pine restoration -maintain approximately 40-50% canopy cover with groups<br>of three to 20 trees in 0.1 to 1 acres patches and openings in between of up to one to four acres in size and retain and enhance existing groups of older, larger trees (typically 18" diameter at breast height [dbh] or greater<br>3,590 acres – grassland restoation – mechanical or hand thin of conifers, prescribed burning | Project objective: reduce the risk of wildfire, improve forest health and associated habitats in the Marshall Project Area, according to Coconino National Forest Plan guidance. There is a need to move vegetation toward conditions that support natural and desirable fire behavior with healthy and sustainable forests, woodlands, meadows, and wetlands.<br>Categorized as foreseeabe as appeal period is complete. |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| | | | 2,000 acres – transition zone mehcanical and prescribed burning (pile, broadcast,maintenance burning up to 20 years)<br>700 acres - MSO PAC Fuels reduction – 9” dbh<br>200 acres – hand thinning up to 9” dbh – steep slopes<br>90 acres – meadow restoration – thin/pile burn, maintenance burn<br>350 acres – burn-only around wetlands and stands with low tree densities<br>230 acres – waterfowl habiat restoration - burning | |
| C-Flagstaff | Turkey/Barney Pasture Forest Health Restoration | 2012 | Thin in dwarf misteltoe<br>Create Helispot<br>Liberation Cut<br>MSO PAC RX at least up to 9” dbh<br>8 acres- hand thinning around Turkey Butte<br>260 acres- tornado salvage | PA under development |
| CNF | Western Area Power Administration | 2012- Foreseeable | 4,584 acres of vegetation thinning (equates to 9,572 total trees removed) to remove trees that may impinge on power line – of this 1,770 acres is within ponderosa pine, 8 acres of aspen, 10 acres of cottonwood/willow riparian, 25 acres of wetland cienega, 35 acres montane/subalpine grass, 175 acres semi-desert grass, 810 acres pinyon-juniper evergreen shrub, 1,280 acres p/j woodland - EA underway | Hazard tree removal |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| C-MR | Upper Beaver Watershed Fuel Reduction | 2010 (decision) | 2,000 acres planned for 2013<br>Vegetation treatments by a variety of prescriptions on about 15,807 acres (about 5,897 acres are within the WUI), Prescribed burning on about 31,162 acres (about 10,870 acres are within the WUI), Maintenance burning on about 43,906 acres (about 15, 024 acres are within the WUI) | reduce the areas at risk to stand-replacement wildfire that threatens people, private property and natural resource values within the WUI. |
| C-Flagstaff | Wing Mountain Fuels Reduction and Forest Health | 2012 (under analysis) | Total acres thinning: 10,190 acres<br>Total acres pile/burn and prescribe burn: 10,767 acres<br>Pondeosa pine thin and pile/prescribe/maintenance burn – 7,079 acres<br>Pondeosa pine thin and pile/prescribe/maintenance burn in goshawk PFA – 959 acres and 456 acres = 1,415 acres<br>Aspen thin/burn – 1,422 acres<br>Thin from below and burn – 352 acres<br>MSO habitat thin/burn: 542 acres<br>Grassland thin/burn: 629 acres<br>Grassland/pine savanna thin/burn – 173 acres<br>Presribe-burn only – 577 acres<br>Spring restoration – Maxwell and Big Leroux (fencing) | Restoration in ponderosa pine, mountain grassland, pine savanna, aspen and spring r(Maxwell and Big Leroux), road decommission |
| AZ State Lands Dept, | Grapevine Canyon Wind | 2012 analysis in progress | 22 miles southeast of Flagstaff, AZ - general locatiob is south of I—40 to Happy Jack – 200 ft ROW – construction on 8.5 miles of NFSL and constructin of | |

| Forest/RD | Project | Year | Planned Treatments by Type and Size (acres) | Project Objective |
|---|---|---|---|---|
| C-Flagstaff | Project | | 15-acre switchyard | |
| C-Flagstaff | Flagstaff Watershed Protection/ Fuels Reduction | 2013 analysis initiated | Dry Lake Hills – 2,523 ac<br>Upper Lake Mary – 1,147 ac | |

## Mexican Spotted Owls

The cumulative effects boundary was identified as the 4FRI project area (nearly 989,000 acres) plus a ½ mile buffer around the entire project area to identify any activities that might affect MSOs within the 4FRI landscape, e.g., habitat changes in PACs straddling the boundary, disturbance, or effects from burning. This was considered adequate because the 112,546 acres of MSO habitat occurring within the 593,211 acres of treatment is patchily distributed. Adding an additional ½ mile area around the project area should adequately capture past, present, and reasonably foreseeable actions that may cause additive effects to the direct and indirect impacts already analyzed for the MSO. Once this geographic boundary was established, the Tusayan ranger district (RU-6) was dropped from further analysis because there is no designated MSO habitat or records of MSO sightings on this district. The balance of the project area boundary includes most of two ranger districts. Gathering and extracting data from all past, present, and reasonably foreseeable projects across this large of an area required some assumptions to be made. Style and detail of reporting has varied by through time, by project, and among administrative units. To account for this variation and use the best (most comprehensive) available data for identifying treatments within MSO habitat (both spatially and through time), individual project boundaries were overlaid with MSO habitat in a Geographic Information System. Values of five acres or less were assumed to be a result of spatial mapping errors and dropped from the analysis. Acres and types of treatments occurring within MSO habitat were pulled project by project from FACTS, the Forest Service database of record. Dates are when accomplishments were entered into FACTS. This list was reviewed for any known omissions of work in MSO habitat, resulting in the addition of four more projects from the Flagstaff ranger district. Projects occurring in protected and restricted habitat are displayed for past projects (Table 201), current projects (Table 203, Table 204Table 203), and reasonably foreseeable projects (Table 205 and Table 206). Acres of past and current treatments in protected and restricted habitat are summarized by activity in Table 207.

**Table 201. Past Projects and Total Acres [Except Where Indicated] Overlapping MSO Protected Habitat**

| Project Name and Treatments | Acres | Year(s) |
|---|---|---|
| **City** | **64** | |
| Precommercial Thin | 64 | 2006 |
| **Kachina Village Forest Health Project** | **659** | |
| Precommercial Thin | 659 | 2005-2007 |
| **Kendrick Rx Burn** | **7** | |
| Invasives - Biocontrol, Classic | 7 | 2006 |
| **Mint Springs Analysis Area** | **134** | |
| Commercial Thin | 134 | 2007 |
| **Mormon Lake Basin Fuel Reduction Project** | **298** | |
| Commercial Thin | 260 | 2007-2008 |
| Piling of Fuels, Hand or Machine | 38 | 2009 |
| **Munds Park Roads and Trails** | **[7.57]** | |
| Obliteration of User-created Trails [Miles] | [3.32] | 2007-2009 |

| Project Name and Treatments | Acres | Year(s) |
|---|---|---|
| Obliteration/Closure of Roads [Miles] | [3.01] | 2007-2009 |
| Trail Construction: Non-motorized (Miles) | [1.24] | 2007-2009 |
| **Pumpkin Fire Logs** | **230** | |
| Burning of Piled Material | 152 | 2004 |
| Invasives - Biocontrol, Classic | 78 | 2007-2009 |
| **Ritter 10K Block** | **31** | |
| Precommercial Thin | 31 | 2007 |
| **Spring Valley Urban/Wildland Interface** | **10** | |
| Site Preparation for Natural Regeneration - Other | 10 | 2009 |
| **Twin** | **26** | |
| Precommercial Thin | 13 | 2008 |
| Thinning for Hazardous Fuels Reduction | 13 | 2008 |
| **Grand Total** | **1,458** | |

**Table 202. Past Projects and Total Acres [Except Where Indicated] Overlapping MSO Restricted Habitat**

| Project Name/Activity | Acres | Year(s) |
|---|---|---|
| **City** | **967** | |
| Broadcast Burning - Covers a majority of the unit | 177 | 2008 |
| Piling of Fuels, Hand or Machine | 281 | 2006-2009 |
| Precommercial Thin | 509 | 2005-2008 |
| **Dogtown** | **1,495** | |
| Broadcast Burning - Covers a majority of the unit | 170 | 2008 |
| Burning of Piled Material | 112 | 2009 |
| Piling of Fuels, Hand or Machine | 438 | 2005-2009 |
| Precommercial Thin | 945 | 2005-2008 |
| **Frenchy Vegetation/Fuels Management** | **213** | |
| Animal Damage Control for Reforestation | 18 | 1998 |
| Disease Control | 23 | 2003 |
| Precommercial Thin | 58 | 2005-2009 |
| Thinning for Hazardous Fuels Reduction | 56 | 2003 |
| Underburn - Low Intensity (Majority of Unit) | 99 | 2004 |
| **Kachina Village Forest Health Project** | **6** | |
| Precommercial Thin | 6 | 2005 |

| Project Name/Activity | Acres | Year(s) |
|---|---|---|
| **Mormon Lake Basin Fuel Reduction Project** | **547** | |
| Commercial Thin | 447 | 2007-2008 |
| Piling of Fuels, Hand or Machine | 42 | 2009 |
| Precommercial Thin | 59 | 2007 |
| **Munds Park Roads and Trails** | **[19.98]** | |
| Obliteration of User-created Trails (Miles) | [9.33] | 2007-2009 |
| Obliteration/Closure of Roads (Miles) | [4.71] | 2007-2009 |
| Road to Trail Conversion (Miles) | [1.76] | 2007-2009 |
| Trail Construction: Non-motorized (Miles) | [3.34] | 2007-2009 |
| Trail Construction: Motorized (Miles) | [0.84] | 2007-2009 |
| **Twin** | **1,057** | |
| Broadcast Burning - Covers a majority of the unit | 1,024 | 2009 |
| Precommercial Thin | 12 | 2008 |
| Thinning for Hazardous Fuels Reduction | 12 | 2008 |
| Underburn - Low Intensity (Majority of Unit) | 9 | 1999-2004 |
| **Upper Beaver Creek** | **11** | |
| Wildland Fire Use | 11 | 2009 |
| **Grand Total** | **4,299** | |

### Table 203. Current and Ongoing Projects and Total Acres [Except Where Indicated] Overlapping MSO Protected Habitat

| Project Name | Acres | Year(s) |
|---|---|---|
| **City** | **1,014** | |
| Piling of Fuels, Hand or Machine | 507 | 2010 |
| Precommercial Thin | 507 | 2010 |
| **Jack Smith/Schultz Fuel Reduction and Forest Health** | **30** | |
| Site Preparation for Natural Regeneration - Manual | 30 | 2011 |
| **Kendrick Rx Burn** | **28** | |
| Invasives - Pesticide Application | 28 | 2011 |
| **Pumpkin Fire Logs** | **584** | |
| Invasives - Pesticide Application | 584 | 2011 |
| **Schultz BAER** | **12** | |
| Site Preparation for Natural Regeneration - Manual | 12 | 2011 |
| **Schultz Fire Salvage, Rehabilitation, and Regeneration** | **1,239/[33]** | |

| Project Name | Acres | Year(s) |
|---|---|---|
| Road Reconditioning | [1.2] | Ongoing |
| Hazard Tree Removal (Roads and Trails) | [3.9] | Ongoing |
| Conifer Restoration and Aspen Regeneration Protection | 1,239 | Ongoing |
| **Spring Valley Urban/Wildland Interface** | | |
| Watershed Resource Non-Structural Improvements Erosion Cont | 33 | 2010 |
| **Woody Ridge Forest Restoration Project** | **30** | |
| Broadcast Burning - Covers a majority of the unit | 30 | 2012 |
| **Grand Total** | **2,969** | |

**Table 204. Current and Ongoing Projects and Treatment Types (Acres) Overlapping MSO Restricted Habitat**

| Project Name | Acres | Year(s) |
|---|---|---|
| **City** | **422** | |
| Burning of Piled Material | 111 | 2010-2011 |
| Invasive Weed Control | 8 | 2,010 |
| Piling of Fuels, Hand or Machine | 147 | 2010-2011 |
| Precommercial Thin | 156 | 2010-2011 |
| **Clover High** | **6** | |
| Invasive Weed Control | 6 | 2,010 |
| **Dogtown** | **362** | |
| Broadcast Burning - Covers a majority of the unit | 170 | 2010-2011 |
| Burning of Piled Material | 52 | 2010 |
| Piling of Fuels, Hand or Machine | 140 | 2010 |
| **Eastside Fuels Reduction and Forest Health** | **167** | |
| Broadcast Burning - Covers a majority of the unit | 167 | 2010-2011 |
| **Frenchy Vegetation/Fuels Management** | **453** | |
| Broadcast Burning - Covers a majority of the unit | 36 | 2010 |
| Burning of Piled Material | 110 | 2010-2011 |
| Commercial Thin | 147 | 2010 |
| Group Selection Cut | 67 | 2010 |
| Precommercial Thin | 93 | 2010 |
| **Kachina Village Forest Health Project** | **83** | |
| Broadcast Burning - Covers a majority of the unit | 83 | 2011 |
| Woody Ridge Forest Restoration Project | 574 | |

| Project Name | Acres | Year(s) |
|---|---|---|
| Broadcast Burning - Covers a majority of the unit | 7 | 2012 |
| Burning of Piled Material | 567 | 2012 |
| **Munds Park Fuels Reduction** | **1,451** | |
| Hand Thin up to 9” dbh | 139 | Ongoing |
| Commercial Thin | 356 | Ongoing |
| Broadcast Burn | 1,451 | Ongoing |
| **Grand Total** | **3,518** | |

### Table 205. Reasonably Foreseeable Projects and Total Acres Overlapping MSO Protected Habitat

| Project Name | Total Acres |
|---|---|
| Aspen Restoration Project | 8 |
| Bill Williams Mountain Restoration | 1,311 |
| Elk Park Fuels Reduction and Forest Health Project | 851 |
| Flagstaff Watershed Protection | 3,200 |
| Mahan-Landmark | 26 |
| Marshall | 1,451 |
| Schultz Fire Rehabilitation | 143 |
| Turkey/Barney Pasture | 2,468 |
| Upper Beaver Creek | 17 |
| WAPA | 32 |
| Wing Mountain | 650 |
| **Grand Total** | **10,155** |

### Table 206. Reasonably Foreseeable Projects and Total Acres Overlapping MSO Restricted Habitat

| Project Name | Acres |
|---|---|
| Bill Williams Mountain Restoration | 1,585 |
| Elk Park Fuels Reduction and Forest Health Project | 1,793 |
| Flagstaff Watershed Protection | 242 |
| Marshall | 1,089 |
| McCracken | 8,861 |
| Rock Pits COF | 7 |
| Rock Pits KNF | 26 |
| Turkey/Barney Pasture | 9,870 |

| Project Name | Acres |
|---|---|
| Upper Beaver Creek | 12 |
| Wing Mountain | 315 |
| **Grand Total** | **23,803** |

**Table 207. Acres of Current and Ongoing Treatments in Mexican Spotted Owl Habitat Summarized From the Above Tables**

| Activity | Protected Habitat (Acres) | Restricted Habitat (Acres) |
|---|---|---|
| Piling of Fuels | 545 | 1,048 |
| Hand Thin | 0 | 139 |
| Pre-commercial Thinning | 1,274 | 1,838 |
| Group Selectin Harvest | 0 | 67 |
| Commercial Thinning | 394 | 950 |
| Thinning to Reduce Hazardous Fuels | 13 | 68 |
| Animal Control Damage | 0 | 18 |
| Invasive Weed Treatments | 697 | 14 |
| Pile Burning | 152 | 952 |
| Wildfire | 0 | 11 |
| Erosion Control | 33 | 0 |
| Broadcast Burning | 30 | 3,393 |
| Conifer and Aspen Regeneration | 1,239 | 0 |
| Obliteration of User-created Trails (Miles) | 3.32 | 9.33 |
| Obliteration/Closure of Roads (Miles) | 3.01 | 4.71 |
| Road to Trail Conversion (Miles) | 0 | 1.76 |
| Trail Construction: Non-motorized (Miles) | 1.24 | 3.34 |
| Trail Construction: Motorized (Miles) | 0 | 0.84 |
| **Total** | **4,385** | **8,518** |

# Appendix 13. Northern Leopard Frog Designated Occupied and Critical Breeding Sites

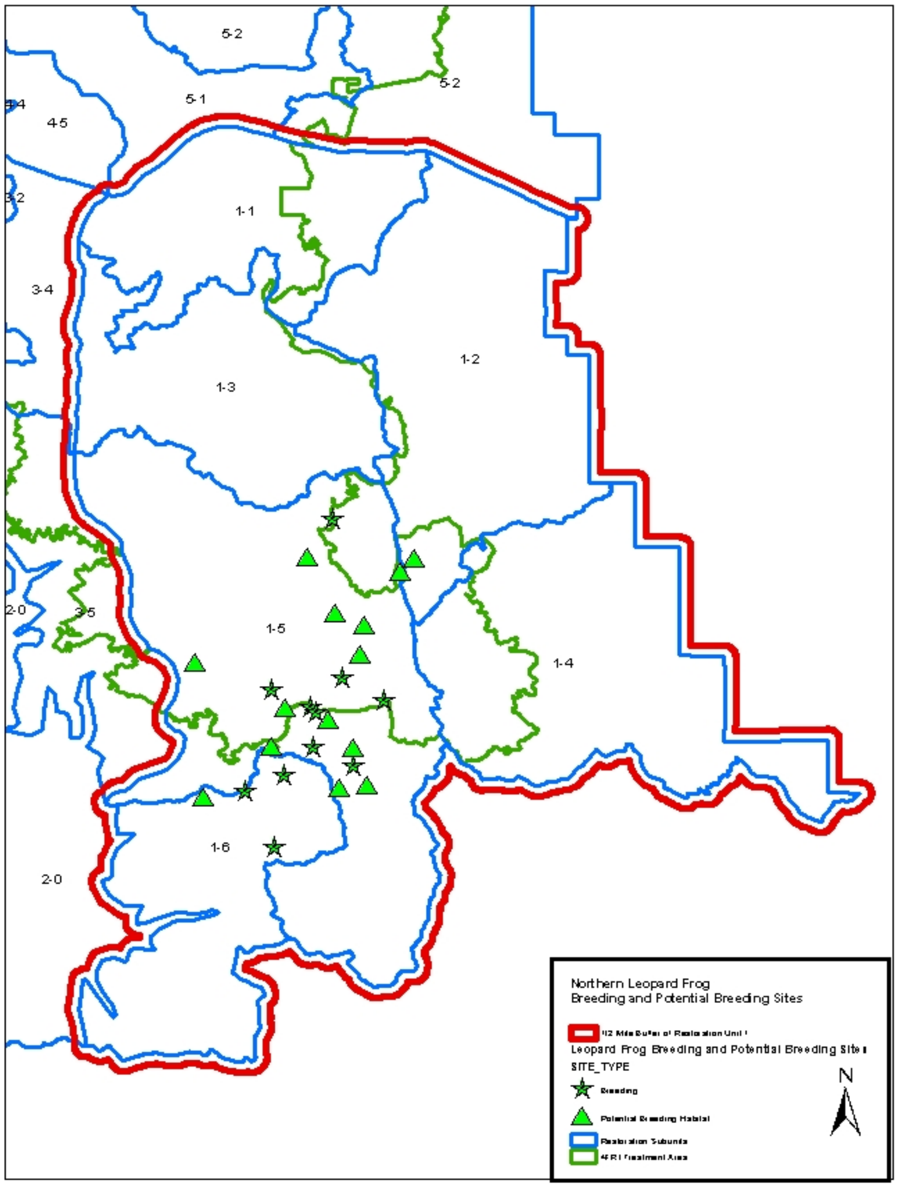


**Figure 150. Breeding (Star) and Potential Breeding (Triangle) Sites in and Near the 4FRI Treatment Area (Green Lines) by Subunit (Blue Lines)**

**Table 208. Northern Leopard Frog Occupied/Critical Breeding Sites within ¼ mile of the Project Area**

| Site Name | Note | Sub Unit |
|---|---|---|
| *Allan Lake* | Breeding | 1-5 |
| *Brolliar Park Tank* | Breeding | 1-5 |
| *Little Daisy Tank* | Breeding | 1-5 |
| *Round Up Park Tank* | Breeding | 1-5 |
| Gash Mountain Tank | Breeding | 1-5 |
| Dairy Springs Tank | Breeding | 1-5 |

*Italic* indicates breeding site is within the treatment area

**Table 209. Northern Leopard Frog Potential Breeding Sites within ¼ mile of the Project Area**

| Site Name | Note | Sub Unit |
|---|---|---|
| *Potato Tanks - Upper and Lower* | Potential Breeding | 1-5 |
| Cow Tank | Potential Breeding | 1-5 |
| *Mulholland Tank* | Potential Breeding | 1-5 |
| *Un-mapped Tank (west of Fulton Canyon)* | Potential Breeding | 1-5 |
| Winsor Tank | Potential Breeding | 1-5 |
| *Burn Tank* | Potential Breeding | 1-5 |
| *Hennesey Tank/Wallace Lake* | Potential Breeding | 1-5 |
| *Flying M Tank /Ashurst Run* | Potential Breeding/also within the NLF Corridor | 1-2 |
| Elk Tank | Potential Breeding | 1-5 |
| *Ohaca Tank* | Potential Breeding | 1-5 |

*Italic* indicates potential breeding site is within the treatment area

**Table 210. NLF Potential Breeding Sites outside Treatment Area and ¼ mile buffer but inside Analysis Area**

| Site Name | | Sub Unit |
|---|---|---|
| Butch Tank | Breeding | 1-5 |
| Unnamed (Ollie) | Potential Breeding | 1-5 |
| Pratt Park | Breeding | 1-5 |
| Natural Tank | Potential Breeding | 1-5 |
| Steven's Tank (West of Jones Mountain) | Potential Breeding | 1-5 |
| Cinder Tank | Potential breeding | 1-6 |
| Rarick Tank | Breeding | 1-6 |
| Stoneman Lake | Breeding | 1-6 |
| Bar-T-Bar #2 | Breeding | 1-6 |

**Table 211. Potential Habitat the Ashurst/Kinnikinick – Mormon Lake Northern Leopard Frog Corridor (AGFD 2011)**

| Site Name | | Sub Unit |
|---|---|---|
| *Wallace Lake/Hennesey* | Potential Breeding. Borders also within project area. | 1-5 |
| *Flying M – Ashurst Run* | Potential Breeding – In project. Occupied in 2008. | 1-2 |
| Mud Lake | | 1-4 |
| Mud Lake Tank | | 1-4 |
| Loading Chute Tank | | 1-2 |
| Ashurst Lake | | 1-2 |
| Ashurst Run (Flying M) | PVT | 1-2 |
| VJ Tank | Within ¼ mile of project. Occupied in 2008 | 1-2 |
| *Wallace Tank* | In project | 1-2 |
| *Tony's Tank* | In project | 1-2 |
| *Rogue Tank* | In project | 1-2 |
| Kinnickinick Reservoir | | 1-4 |
| Morton Lake | East of Kinnickinick | 1-4 |

*Italic* indicates potential habitat is within the treatment area

**Table 212. NLF Tanks within Potential Habitat within the Treatment Area**

| SubUnit | Number of Tanks |
|---|---|
| 1-1 | 1 |
| 1-2 | 7 |
| 1-3 | 3 |
| 1-4 | 8 |
| 1-5 | 55 (12 Breeding or Potential Breeding) |
| 3-2 | 3 |
| 3-3 | 12 |
| 3-4 | 5 |
| 3-5 | 11 |
| 4-4 | 6 |
| 5-1 | 2 |
| TOTAL | 942 (12 Breeding or Potential Breeding) |

# Appendix 14. Miles of Road Maintenance, Construction, and Decommissioning by Individual PAC

**Table 213. Miles of roads proposed for decommissioning within PAC-Only habitat.**

| Forest | PAC_Name | Road Miles Decommissioned in PAC | Total Road Miles in PAC | Total Proposed for Decommissioning (%) |
|---|---|---|---|---|
| COF | Aspen Spring | 0.5 | 0.8 | 60 |
| | Bar M | 0.3 | 4.8 | 6 |
| | Bear Jaw | 0.2 | 0.2 | 100 |
| | Bear Seep | 0.1 | 3.8 | 2 |
| | Blade Tank | 0.6 | 2.8 | 21 |
| | Bonita Tank | 0.0 | 4.3 | 1 |
| | Bristow Tank/Limpios | 0.8 | 4.3 | 18 |
| | Casner | 1.4 | 2.4 | 60 |
| | Casner Cabin | 0.2 | 0.6 | 41 |
| | Clark | 2.6 | 5.0 | 51 |
| | Coyote Park | 0.8 | 0.8 | 100 |
| | Dry Lake | 0.0 | 0.7 | 5 |
| | Fain Mountain | 0.7 | 4.0 | 17 |
| | Frank | 0.5 | 3.2 | 15 |
| | Frog Tank | 1.5 | 3.7 | 41 |
| | Fry | 0.6 | 1.0 | 60 |
| | Gash Mountain | 0.1 | 3.7 | 3 |
| | Harding Point | 0.8 | 1.1 | 74 |
| | Hochderffer | 1.0 | 2.4 | 40 |
| | Holdup | 1.0 | 2.3 | 41 |
| | Howard Mountain | 0.9 | 3.4 | 25 |
| | Iowa Camp | 3.8 | 7.0 | 54 |
| | Jack Smith | 2.0 | 4.1 | 49 |
| | James Canyon | 1.8 | 2.5 | 70 |
| | Jeep | 1.3 | 1.5 | 84 |
| | Kelly | 1.4 | 2.1 | 64 |

| Forest | PAC_Name | Road Miles Decommissioned in PAC | Total Road Miles in PAC | Total Proposed for Decommissioning (%) |
|---|---|---|---|---|
| | Lake #1/Seruchos | 1.0 | 3.8 | 25 |
| | Little Spring | 2.4 | 3.0 | 81 |
| | Lockwood | 0.2 | 3.2 | 7 |
| | MB Smith | 2.9 | 4.8 | 60 |
| | Milos Butte | 0.6 | 3.3 | 18 |
| | Mint Spring | 0.5 | 1.5 | 38 |
| | Moore Well/Rock Dike | 0.4 | 3.0 | 12 |
| | Mormon Mountain | 0.4 | 2.8 | 14 |
| | Mt Elden | 0.2 | 1.6 | 13 |
| | Mustang | 1.6 | 4.4 | 38 |
| | Orion Spring | 0.9 | 2.3 | 40 |
| | Pierce Tank | 1.4 | 2.2 | 64 |
| | Pipeline | 0.2 | 2.4 | 9 |
| | Pumphouse Wash | 1.6 | 1.9 | 86 |
| | Racetrack Tank | 1.1 | 2.0 | 54 |
| | Red Hill | 0.7 | 2.6 | 27 |
| | Red Raspberry | 1.3 | 6.8 | 19 |
| | Rock Top | 1.0 | 5.3 | 20 |
| | Roundup | 0.5 | 2.7 | 17 |
| | Sawmill Springs | 0.2 | 3.5 | 5 |
| | Schultz Creek | 0.1 | 0.7 | 20 |
| | Snowbowl Road | 0.9 | 3.5 | 25 |
| | Sterling | 0.1 | 1.1 | 10 |
| | Stock Tank | 0.2 | 0.2 | 100 |
| | T Bird | 0.4 | 1.9 | 20 |
| | Two Holes | 0.5 | 3.3 | 15 |
| | Weatherford | 0.8 | 4.9 | 16 |
| | Weimer Springs | 0.4 | 5.1 | 8 |
| | Woods | 0.8 | 6.4 | 12 |

| Forest | PAC_Name | Road Miles Decommissioned in PAC | Total Road Miles in PAC | Total Proposed for Decommissioning (%) |
|---|---|---|---|---|
| | Woody Ridge | 0.0 | 0.0 | 74 |
| KNF | Sitgreaves | 0.1 | 0.6 | 13 |
| **Grand Total for 56 PACs:** | | **48.0** | **235.4** | **20** |

**Table 214. Miles and percent of roads decommissioned within core areas on the Coconino NF**

| PAC_Name | Road Miles Decommissioned | Total Road Miles | Percent of Total Miles Decommissioned |
|---|---|---|---|
| Casner | 0.68 | 0.68 | 100 |
| Clark | 0.93 | 0.93 | 100 |
| Frog Tank | 0.07 | 0.67 | 11 |
| Holdup | 0.33 | 0.33 | 100 |
| Howard Mountain | 0.23 | 0.84 | 28 |
| Iowa Camp | 0.59 | 0.59 | 100 |
| Jeep | 0.69 | 0.69 | 100 |
| Lake #1/Seruchos | 0.02 | 0.94 | 2 |
| Little Spring | 0.26 | 0.58 | 44 |
| MB Smith | 0.37 | 0.37 | 100 |
| Mint Spring | 0.01 | 0.08 | 16 |
| Mustang | 0.56 | 0.61 | 92 |
| Orion Spring | 0.01 | 0.41 | 1 |
| Red Raspberry | 0.09 | 0.12 | 71 |
| **Grand Total for 14 Core Areas:** | **4.86** | **19.67** | **24.7** |

**Table 215. Road Maintenance for Hauling and Construction of Temporary Roads (Miles) in PACs**

| PAC Treatments | PAC Name | Road Maintenance | Temporary Road Construction | Grand Total |
|---|---|---|---|---|
| Mechanical | Archies | 2.18 | | 2.18 |
| | Bar M | 3.55 | | 3.55 |
| | Bear Seep | 3.20 | 0.27 | 3.47 |
| | Bonita Tank | 2.76 | 1.17 | 3.93 |
| | Crawdad | 3.54 | | 3.54 |
| | Foxhole | 2.21 | | 2.21 |
| | Frank | 2.53 | | 2.53 |
| | Holdup | 1.88 | | 1.88 |
| | Iris Tank | 3.12 | | 3.12 |

| PAC Treatments | PAC Name | Road Maintenance | Temporary Road Construction | Grand Total |
|---|---|---|---|---|
| | Knob | 4.20 | | 4.20 |
| | Lake #1/Seruchos | 1.18 | 1.37 | 2.55 |
| | Lee Butte | 5.84 | | 5.84 |
| | Mayflower Tank | 0.99 | | 0.99 |
| | Red Hill | 2.21 | | 2.21 |
| | Red Raspberry | 6.07 | 0.30 | 6.37 |
| | Rock Top | 4.28 | | 4.28 |
| | Sawmill Springs | 1.96 | | 1.96 |
| | T6 Tank | 5.40 | | 5.40 |
| **Mechanical Treatment Group Total** | | **57.10** | **3.12** | **60.22** |
| **Burn Only Treatment Group** | **Blade Tank** | **1.24** | | **1.24** |
| | Boondock | 0.04 | | 0.04 |
| | Bristow Tank/Limpios | 0.53 | | 0.53 |
| | Casner | 1.53 | | 1.53 |
| | Casner Cabin | 0.18 | | 0.18 |
| | Coulter Ridge | 2.95 | 1.76 | 4.71 |
| | Coyote Park | 0.22 | 0.05 | 0.27 |
| | Dairy Spring | 0.01 | | 0.01 |
| | De Toros | 0.33 | | 0.33 |
| | Fain Mountain | 0.11 | | 0.11 |
| | Frog Tank | 2.77 | | 2.77 |
| | Fry | 0.32 | | 0.32 |
| | Gash Mountain | 0.90 | | 0.90 |
| | Girdner | 1.69 | | 1.69 |
| | Harding Point | 0.82 | | 0.82 |
| | Howard Mountain | 2.51 | | 2.51 |
| | Iowa Camp | 2.26 | | 2.26 |

| PAC Treatments | PAC Name | Road Maintenance | Temporary Road Construction | Grand Total |
|---|---|---|---|---|
| | James Canyon | 0.00 | | 0.00 |
| | Jeep | 0.60 | 0.22 | 0.83 |
| | Kelly | 0.59 | | 0.59 |
| | Kendrick | 0.20 | | 0.20 |
| | Lockwood | 0.00 | 0.00 | 0.01 |
| | Meadow Tank | 0.22 | | 0.22 |
| | Milos Butte | 0.46 | | 0.46 |
| | Mint Spring | 0.56 | | 0.56 |
| | Moore Well/Rock Dike | 0.55 | 0.26 | 0.82 |
| | Mormon Mountain North | 0.63 | | 0.63 |
| | Mt Elden | 1.42 | 0.20 | 1.62 |
| | Mustang | 0.65 | | 0.65 |
| | Nestor | 0.00 | | 0.00 |
| | Orion Spring | 0.01 | | 0.01 |
| | Pierce Tank | 1.48 | | 1.48 |
| | Pumphouse Wash | 0.27 | | 0.27 |
| | Racetrack Tank | 0.32 | 0.02 | 0.34 |
| | Rattlesnake | 0.00 | | 0.00 |
| | Schultz Creek | 0.20 | 0.33 | 0.53 |
| | Spruce Tank | 0.23 | | 0.23 |
| | Sterling | 0.15 | | 0.15 |
| | Stock Tank | 0.17 | | 0.17 |
| | T Bird | 1.03 | | 1.03 |
| | Two Holes | 2.64 | | 2.64 |
| | Upper West Fork | 0.37 | 0.01 | 0.38 |
| | Volunteer | 0.21 | 0.07 | 0.28 |
| | Weatherford | 1.41 | | 1.41 |
| | Weimer Springs | 2.04 | | 2.04 |
| | Woods | 1.09 | | 1.09 |

| PAC Treatments | PAC Name | Road Maintenance | Temporary Road Construction | Grand Total |
|---|---|---|---|---|
| **Burn Only Treatment Group Total** | | **35.94** | **2.92** | **38.86** |
| **Grand Total** | | **93.04** | **6.04** | **99.08** |

# Appendix 15. Summary of Treatments in MSO Habitats by Alternative

**Table 216. Comparison of PAC treatments among alternatives**

| Treatments | Alternative A | Alternative B | Alternative C | Alternative D |
|---|---|---|---|---|
| Mechanically Thin | No Action | Up to 16" dbh in 18 PACs | Up to 18" dbh in 18 PACs | Up to 16" dbh in 18 PACs |
| Prescribed Burn | No Action | Prescribe burn 72 PACs (no nest cores) | Prescribe burn 72 PACs including 56 nest cores | No prescribe burning would occur in PACs |

**Table 217. Summary of treatments (acres) by alternative in MSO Habitat**

| | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|
| MSO Habitat | Total Acres | Mechanical | Prescribed Burning | Mechanical | Prescribed Burning | Mechanical | Prescribed Burning |
| PAC Outside Core Area | 30,716 | 10,741 | 30,716 | 10,741 | 30,716 | 10,741 | 0 |
| Core Area | 4,850 | 0 | 0 | 0 | 4,850 | 0 | 0 |
| Protected Other | 889 | 0 | 889 | 0 | 889 | 0 | 889 |
| **Protected Total** | **36,455** | **10,741** | **31,605** | **10,741** | **36,455** | **10,741** | **889** |
| Target & Threshold | 8,713 | 8,412 | 8,713 | 8,410 | 8,713 | 8,412 | 301 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Restricted Other | 67,378 | 65,024 | 67,378 | 63,191 | 67,378 | 65,024 | 2,354 |
| **Restricted Total** | **76,091** | **73,436** | **76,091** | **71,601** | **76,091** | **73,436** | **2,655** |
| **Grand Total** | **112,546** | **84,177** | **107,696** | **82,342** | **112,546** | **84,177** | **3,543** |

**Table 218. Alternative B: Summary of Treatments in MSO Habitats by Subunit (SU).**

| SU | MSO Habitat | Burn Only | MSO Restricted Treatment | MSO Target Treatment | MSO Threshold Treatment | PAC Treatment | No Treatment | Grand Total |
|---|---|---|---|---|---|---|---|---|
| **1-1** | **PAC Core Area** | | | | | | **192** | **192** |
| | PAC Outside Core Area | 112 | | | | | 786 | 898 |
| | Protected Outside PAC | | | | | | 222 | 222 |
| | Restricted | | 1,193 | | | | 1,434 | 2,627 |
| | Target/Threshold | | | 105 | | | 153 | 257 |
| **1-1 Total** | | **112** | **1,193** | **105** | | | **2,787** | **4,196** |
| 1-2 | Restricted | | 588 | | | | | 588 |
| **1-2 Total** | | | **588** | | | | | **588** |
| 1-3 | PAC Core Area | | | | | | 1,020 | 1,020 |
| | PAC Outside Core Area | 2,388 | | | | 2,527 | 1,333 | 6,248 |

| SU | MSO Habitat | Burn Only | MSO Restricted Treatment | MSO Target Treatment | MSO Threshold Treatment | PAC Treatment | No Treatment | Grand Total |
|---|---|---|---|---|---|---|---|---|
| | Protected Outside PAC | 92 | | | | | 30 | 122 |
| | Restricted | | 7,799 | | | | 3,474 | 11,272 |
| | Target/Threshold | | | 1,988 | 414 | | 544 | 2,946 |
| **1-3 Total** | | **2,480** | **7,799** | **1,988** | **414** | **2,527** | **6,400** | **21,608** |
| 1-4 | PAC Core Area | | | | | | 301 | 301 |
| | PAC Outside Core Area | 1,781 | | | | 515 | | 2,297 |
| | Restricted | | 883 | | | | | 883 |
| | Target/Threshold | | | 118 | | | | 118 |
| **1-4 Total** | | **1,781** | **883** | **118** | | **515** | **301** | **3,598** |
| 1-5 | PAC Core Area | | | | | | 3,136 | 3,136 |
| | PAC Outside Core Area | 10,944 | | | | 7,027 | 163 | 18,133 |
| | Protected Outside PAC | 555 | | | | | | 555 |
| | Restricted | | 15,958 | | | | 1,617 | 17,575 |
| | Target/Threshold | | | 1,729 | 459 | | 213 | 2,401 |
| **1-5 Total** | | **11,499** | **15,958** | **1,729** | **459** | **7,027** | **5,129** | **41,801** |

| SU | MSO Habitat | Burn Only | MSO Restricted Treatment | MSO Target Treatment | MSO Threshold Treatment | PAC Treatment | No Treatment | Grand Total |
|---|---|---|---|---|---|---|---|---|
| 3-1 | PAC Outside Core Area | | | | | | 112 | 112 |
| | Restricted | 20 | 7,269 | | | | 15,105 | 22,394 |
| | Target/Threshold | | | 0 | 311 | | 1,228 | 1,539 |
| **3-1 Total** | | **20** | **7,269** | **0** | **311** | | **16,445** | **24,045** |
| 3-2 | Restricted | 159 | 4,666 | | | | 5,287 | 10,111 |
| | Target/Threshold | 74 | | 631 | 215 | | 941 | 1,861 |
| 3-2 Total | | 233 | 4,666 | 631 | 215 | | 6,227 | 11,972 |
| 3-3 | PAC Core Area | | | | | | 254 | 254 |
| | PAC Outside Core Area | 366 | | | | 647 | 182 | 1,195 |
| | Protected Outside PAC | 45 | | | | | | 45 |
| | Restricted | 1,736 | 10,927 | | | | 3,867 | 16,529 |
| | Target/Threshold | 227 | | 1,068 | 355 | | 520 | 2,170 |
| **3-3 Total** | | **2,375** | **10,927** | **1,068** | **355** | **647** | **4,823** | **20,193** |
| 3-4 | PAC Core Area | | | | | | 265 | 265 |
| | PAC Outside Core Area | 1,546 | | | | | 763 | 2,309 |

| SU | MSO Habitat | Burn Only | MSO Restricted Treatment | MSO Target Treatment | MSO Threshold Treatment | PAC Treatment | No Treatment | Grand Total |
|---|---|---|---|---|---|---|---|---|
| | Protected Outside PAC | 146 | | | | | 6 | 153 |
| | Restricted | | 2,447 | | | | 620 | 3,067 |
| | Target/Threshold | | | 318 | | | 338 | 656 |
| **3-4 Total** | | **1,692** | **2,447** | **318** | | | **1,992** | **6,449** |
| 3-5 | PAC Core Area | | | | | | 141 | 141 |
| | PAC Outside Core Area | 1,127 | | | | 26 | 2,527 | 3,679 |
| | Protected Outside PAC | 47 | | | | | 38 | 86 |
| | Restricted | 410 | 11,115 | | | | 10,408 | 21,933 |
| | Target/Threshold | | | 561 | 139 | | 1,759 | 2,459 |
| **3-5 Total** | | **1,584** | **11,115** | **561** | **139** | **26** | **14,874** | **28,298** |
| 4-3 | PAC Core Area | | | | | | 212 | 212 |
| | PAC Outside Core Area | 186 | | | | | 947 | 1,133 |
| | Protected Outside PAC | | | | | | 27 | 27 |
| | Restricted | 29 | 87 | | | | | 116 |
| **4-3 Total** | | **214** | **87** | | | | **1,186** | **1,488** |

| SU | MSO Habitat | Burn Only | MSO Restricted Treatment | MSO Target Treatment | MSO Threshold Treatment | PAC Treatment | No Treatment | Grand Total |
|---|---|---|---|---|---|---|---|---|
| 4-4 | PAC Core Area | | | | | | 195 | 195 |
| | PAC Outside Core Area | 257 | | | | | 878 | 1,136 |
| | Protected Outside PAC | 3 | | | | | 133 | 135 |
| | Restricted | | 1,271 | | | | 5 | 1,277 |
| | Target/Threshold | | | | | | 28 | 28 |
| **4-4 Total** | | **260** | **1,271** | | | | **1,239** | **2,770** |
| 4-5 | Restricted | | 188 | | | | 15 | 204 |
| **4-5 Total** | | | **188** | | | | **15** | **204** |
| 5-1 | PAC Core Area | | | | | | 267 | 267 |
| | PAC Outside Core Area | 808 | | | | | 1,832 | 2,640 |
| | Restricted | | 234 | | | | 526 | 760 |
| | Target/Threshold | | | | | | 9 | 9 |
| **5-1 Total** | | **808** | **234** | | | | **2,634** | **3,676** |
| 5-2 | PAC Outside Core Area | 461 | | | | | 2,143 | 2,605 |
| | Restricted | | 399 | | | | 129 | 528 |

| SU | MSO Habitat | Burn Only | MSO Restricted Treatment | MSO Target Treatment | MSO Threshold Treatment | PAC Treatment | No Treatment | Grand Total |
|---|---|---|---|---|---|---|---|---|
| | Target/Threshold | | | | | | 263 | 263 |
| **5-2 Total** | | **461** | **399** | | | | **2,535** | **3,396** |
| **Grand Total** | | **23,519** | **65,024** | **6,518** | **1,894** | **10,741** | **66,587** | **174,283** |

**Table 219. Alternative C: Summary of Treatments in MSO Habitats by Subunit (SU)**

| SU | MSO Habitat | Burn Only | MSO Restricted Treatment | MSO Target Treatment | MSO Threshold Treatment | PAC Treatment | No Treatment | Grand Total |
|---|---|---|---|---|---|---|---|---|
| 1-1 | PAC Core Area | 25 | | | | | 166 | 192 |
| | PAC Outside Core Area | 112 | | | | | 786 | 898 |
| | Protected Outside PAC | | | | | | 222 | 222 |
| | Restricted | | 1,193 | | | | 1,434 | 2,627 |
| | Target/Threshold | | | 105 | | | 153 | 257 |
| **1-1 Total** | | **137** | **1,193** | **105** | | | **2,761** | **4,196** |
| 1-2 | Restricted | | 588 | | | | | 588 |
| **1-2 Total** | | | **588** | | | | | **588** |
| 1-3 | PAC Core Area | 749 | | | | | 271 | 1,020 |

| SU | MSO Habitat | Burn Only | MSO Restricted Treatment | MSO Target Treatment | MSO Threshold Treatment | PAC Treatment | No Treatment | Grand Total |
|---|---|---|---|---|---|---|---|---|
| | PAC Outside Core Area | 2,388 | | | | 2,527 | 1,333 | 6,248 |
| | Protected Outside PAC | 92 | | | | | 30 | 122 |
| | Restricted | 594 | 7,205 | | | | 3,474 | 11,272 |
| | Target/Threshold | | | 1,988 | 414 | | 544 | 2,946 |
| **1-3 Total** | | **3,823** | **7,205** | **1,988** | **414** | **2,527** | **5,652** | **21,608** |
| 1-4 | PAC Core Area | 301 | | | | | | 301 |
| | PAC Outside Core Area | 1,781 | | | | 515 | | 2,297 |
| | Restricted | | 883 | | | | | 883 |
| | Target/Threshold | | | 118 | | | | 118 |
| **1-4 Total** | | **2,082** | **883** | **118** | | **515** | | **3,598** |
| 1-5 | PAC Core Area | 2,981 | | | | | 155 | 3,136 |
| | PAC Outside Core Area | 10,944 | | | | 7,027 | 163 | 18,133 |
| | Protected Outside PAC | 555 | | | | | | 555 |
| | Restricted | 6 | 15,952 | | | | 1,617 | 17,575 |
| | Target/Threshold | | | 1,729 | 459 | | 213 | 2,401 |

| SU | MSO Habitat | Burn Only | MSO Restricted Treatment | MSO Target Treatment | MSO Threshold Treatment | PAC Treatment | No Treatment | Grand Total |
|---|---|---|---|---|---|---|---|---|
| **1-5 Total** | | **14,486** | **15,952** | **1,729** | **459** | **7,027** | **2,148** | **41,801** |
| 3-1 | PAC Outside Core Area | | | | | | 112 | 112 |
| | Restricted | 20 | 7,269 | | | | 15,105 | 22,394 |
| | Target/Threshold | | | 0 | 311 | | 1,228 | 1,539 |
| **3-1 Total** | | **20** | **7,269** | **0** | **311** | | **16,445** | **24,045** |
| 3-2 | Restricted | 625 | 4,200 | | | | 5,287 | 10,111 |
| | Target/Threshold | 76 | | 629 | 215 | | 941 | 1,861 |
| **3-2 Total** | | **701** | **4,200** | **629** | **215** | | **6,227** | **11,972** |
| 3-3 | PAC Core Area | 254 | | | | | | 254 |
| | PAC Outside Core Area | 366 | | | | 647 | 182 | 1,195 |
| | Protected Outside PAC | 45 | | | | | | 45 |
| | Restricted | 2,036 | 10,627 | | | | 3,867 | 16,529 |
| | Target/Threshold | 227 | | 1,068 | 355 | | 520 | 2,170 |
| **3-3 Total** | | **2,929** | **10,627** | **1,068** | **355** | **647** | **4,568** | **20,193** |
| 3-4 | PAC Core Area | 265 | | | | | | 265 |

| SU | MSO Habitat | Burn Only | MSO Restricted Treatment | MSO Target Treatment | MSO Threshold Treatment | PAC Treatment | No Treatment | Grand Total |
|---|---|---|---|---|---|---|---|---|
| | PAC Outside Core Area | 1,546 | | | | | 763 | 2,309 |
| | Protected Outside PAC | 146 | | | | | 6 | 153 |
| | Restricted | | 2,447 | | | | 620 | 3,067 |
| | Target/Threshold | | | 318 | | | 338 | 656 |
| **3-4 Total** | | **1,957** | **2,447** | **318** | | | **1,727** | **6,449** |
| 3-5 | PAC Core Area | 39 | | | | | 102 | 141 |
| | PAC Outside Core Area | 1,127 | | | | 26 | 2,527 | 3,679 |
| | Protected Outside PAC | 47 | | | | | 38 | 86 |
| | Restricted | 877 | 10,648 | | | | 10,408 | 21,933 |
| | Target/Threshold | 0 | | 560 | 139 | | 1,759 | 2,459 |
| **3-5 Total** | | **2,090** | **10,648** | **560** | **139** | **26** | **14,835** | **28,298** |
| 4-3 | PAC Core Area | 91 | | | | | 121 | 212 |
| | PAC Outside Core Area | 186 | | | | | 947 | 1,133 |
| | Protected Outside PAC | | | | | | 27 | 27 |
| | Restricted | 29 | 87 | | | | | 116 |

| SU | MSO Habitat | Burn Only | MSO Restricted Treatment | MSO Target Treatment | MSO Threshold Treatment | PAC Treatment | No Treatment | Grand Total |
|---|---|---|---|---|---|---|---|---|
| **4-3 Total** | | **305** | **87** | | | | **1,095** | **1,488** |
| 4-4 | PAC Core Area | 22 | | | | | 173 | 195 |
| | PAC Outside Core Area | 257 | | | | | 878 | 1,136 |
| | Protected Outside PAC | 3 | | | | | 133 | 135 |
| | Restricted | | 1,271 | | | | 5 | 1,277 |
| | Target/Threshold | | | | | | 28 | 28 |
| **4-4 Total** | | **281** | **1,271** | | | | **1,217** | **2,770** |
| 4-5 | Restricted | | 188 | | | | 15 | 204 |
| **4-5 Total** | | | **188** | | | | **15** | **204** |
| 5-1 | PAC Core Area | 124 | | | | | 143 | 267 |
| | PAC Outside Core Area | 808 | | | | | 1,832 | 2,640 |
| | Restricted | | 234 | | | | 526 | 760 |
| | Target/Threshold | | | | | | 9 | 9 |
| **5-1 Total** | | **931** | **234** | | | | **2,510** | **3,676** |
| 5-2 | PAC Outside Core Area | 461 | | | | | 2,143 | 2,605 |

| SU | MSO Habitat | Burn Only | MSO Restricted Treatment | MSO Target Treatment | MSO Threshold Treatment | PAC Treatment | No Treatment | Grand Total |
|---|---|---|---|---|---|---|---|---|
| | Restricted | | 399 | | | | 129 | 528 |
| | Target/Threshold | | | | | | 263 | 263 |
| **5-2 Total** | | **461** | **399** | | | | **2,535** | **3,396** |
| **Grand Total** | | **30,204** | **63,191** | **6,516** | **1,894** | **10,741** | **61,737** | **174,283** |

**Table 220. Alternative D: Summary of Treatments in MSO Habitats by Subunit (SU)**

| SU | MSO Habitat | Burn Only | MSO Restricted Treatment | MSO Target Treatment | MSO Threshold Treatment | PAC Treatment | No Treatment | Grand Total |
|---|---|---|---|---|---|---|---|---|
| 1-1 | PAC Core Area | | | | | | 192 | 192 |
| | PAC Outside Core Area | | | | | | 898 | 898 |
| | Protected Outside PAC | | | | | | 222 | 222 |
| | Restricted | | 1,193 | | | | 1,434 | 2,627 |
| | Target/Threshold | | | 105 | | | 153 | 257 |
| **1-1 Total** | | | **1,193** | **105** | | | **2,898** | **4,196** |
| 1-2 | Restricted | | 588 | | | | | 588 |
| **1-2** | | | **588** | | | | | **588** |

| SU | MSO Habitat | Burn Only | MSO Restricted Treatment | MSO Target Treatment | MSO Threshold Treatment | PAC Treatment | No Treatment | Grand Total |
|---|---|---|---|---|---|---|---|---|
| **Total** | | | | | | | | |
| 1-3 | PAC Core Area | | | | | | 1,020 | 1,020 |
| | PAC Outside Core Area | | | | | 2,527 | 3,721 | 6,248 |
| | Protected Outside PAC | 92 | | | | | 30 | 122 |
| | Restricted | | 7,799 | | | | 3,474 | 11,272 |
| | Target/Threshold | | | 1,988 | 414 | | 544 | 2,946 |
| **1-3 Total** | | **92** | **7,799** | **1,988** | **414** | **2,527** | **8,788** | **21,608** |
| 1-4 | PAC Core Area | | | | | | 301 | 301 |
| | PAC Outside Core Area | | | | | 515 | 1,781 | 2,297 |
| | Restricted | | 883 | | | | | 883 |
| | Target/Threshold | | | 118 | | | | 118 |
| **1-4 Total** | | | **883** | **118** | | **515** | **2,082** | **3,598** |
| 1-5 | PAC Core Area | | | | | | 3,136 | 3,136 |
| | PAC Outside Core Area | | | | | 7,027 | 11,106 | 18,133 |
| | Protected Outside PAC | 555 | | | | | | 555 |

| SU | MSO Habitat | Burn Only | MSO Restricted Treatment | MSO Target Treatment | MSO Threshold Treatment | PAC Treatment | No Treatment | Grand Total |
|---|---|---|---|---|---|---|---|---|
| | Restricted | | 15,958 | | | | 1,617 | 17,575 |
| | Target/Threshold | | | 1,729 | 459 | | 213 | 2,401 |
| **1-5 Total** | | **555** | **15,958** | **1,729** | **459** | **7,027** | **16,073** | **41,801** |
| 3-1 | PAC Outside Core Area | | | | | | 112 | 112 |
| | Restricted | 20 | 7,269 | | | | 15,105 | 22,394 |
| | Target/Threshold | | | 0 | 311 | | 1,228 | 1,539 |
| **3-1 Total** | | **20** | **7,269** | **0** | **311** | | **16,445** | **24,045** |
| 3-2 | Restricted | 159 | 4,666 | | | | 5,287 | 10,111 |
| | Target/Threshold | 74 | | 631 | 215 | | 941 | 1,861 |
| **3-2 Total** | | **233** | **4,666** | **631** | **215** | | **6,227** | **11,972** |
| 3-3 | PAC Core Area | | | | | | 254 | 254 |
| | PAC Outside Core Area | | | | | 647 | 548 | 1,195 |
| | Protected Outside PAC | 45 | | | | | | 45 |
| | Restricted | 1,736 | 10,927 | | | | 3,867 | 16,529 |
| | Target/Threshold | 227 | | 1,068 | 355 | | 520 | 2,170 |
| **3-3** | | **2,008** | **10,927** | **1,068** | **355** | **647** | **5,189** | **20,193** |

| SU | MSO Habitat | Burn Only | MSO Restricted Treatment | MSO Target Treatment | MSO Threshold Treatment | PAC Treatment | No Treatment | Grand Total |
|---|---|---|---|---|---|---|---|---|
| **Total** | | | | | | | | |
| 3-4 | PAC Core Area | | | | | | 265 | 265 |
| | PAC Outside Core Area | | | | | | 2,309 | 2,309 |
| | Protected Outside PAC | 146 | | | | | 6 | 153 |
| | Restricted | | 2,447 | | | | 620 | 3,067 |
| | Target/Threshold | | | 318 | | | 338 | 656 |
| **3-4 Total** | | **146** | **2,447** | **318** | | | **3,538** | **6,449** |
| 3-5 | PAC Core Area | | | | | | 141 | 141 |
| | PAC Outside Core Area | | | | | 26 | 3,654 | 3,679 |
| | Protected Outside PAC | 47 | | | | | 38 | 86 |
| | Restricted | 410 | 11,115 | | | | 10,408 | 21,933 |
| | Target/Threshold | | | 561 | 139 | | 1,759 | 2,459 |
| **3-5 Total** | | **458** | **11,115** | **561** | **139** | **26** | **16,001** | **28,298** |
| 4-3 | PAC Core Area | | | | | | 212 | 212 |
| | PAC Outside Core Area | | | | | | 1,133 | 1,133 |

| SU | MSO Habitat | Burn Only | MSO Restricted Treatment | MSO Target Treatment | MSO Threshold Treatment | PAC Treatment | No Treatment | Grand Total |
|---|---|---|---|---|---|---|---|---|
| | Protected Outside PAC | | | | | | 27 | 27 |
| | Restricted | 29 | 87 | | | | | 116 |
| **4-3 Total** | | **29** | **87** | | | | **1,372** | **1,488** |
| 4-4 | PAC Core Area | | | | | | 195 | 195 |
| | PAC Outside Core Area | | | | | | 1,136 | 1,136 |
| | Protected Outside PAC | 3 | | | | | 133 | 135 |
| | Restricted | | 1,271 | | | | 5 | 1,277 |
| | Target/Threshold | | | | | | 28 | 28 |
| **4-4 Total** | | **3** | **1,271** | | | | **1,496** | **2,770** |
| 4-5 | Restricted | | 188 | | | | 15 | 204 |
| **4-5 Total** | | | **188** | | | | **15** | **204** |
| 5-1 | PAC Core Area | | | | | | 267 | 267 |
| | PAC Outside Core Area | | | | | | 2,640 | 2,640 |
| | Restricted | | 234 | | | | 526 | 760 |
| | Target/Threshold | | | | | | 9 | 9 |

| SU | MSO Habitat | Burn Only | MSO Restricted Treatment | MSO Target Treatment | MSO Threshold Treatment | PAC Treatment | No Treatment | Grand Total |
|---|---|---|---|---|---|---|---|---|
| **5-1 Total** | | | **234** | | | | **3,442** | **3,676** |
| 5-2 | PAC Outside Core Area | | | | | | 2,605 | 2,605 |
| | Restricted | | 399 | | | | 129 | 528 |
| | Target/Threshold | | | | | | 263 | 263 |
| **5-2 Total** | | | **399** | | | | **2,997** | **3,396** |
| **Grand Total** | | **3,543** | **65,024** | **6,518** | **1,894** | **10,741** | **86,562** | **174,283** |
| | | | | | | | | |

**Table 221. PAC Treatment Summaries for Overstory Structure by Alternative**

| Forest Attribute | Alternative A | Alternative B | Alternative C | Alternative D |
|---|---|---|---|---|
| **Mechanical PAC Treatment Group (*n*=18)** | **No Action** | **Thinning Only Outside Core Areas** | **Thinning and Burning Outside Core Areas** | **Thinning Only Outside Core Ares** |
| % of SDI 12-18" DBH | 28 | 27 | 25 | 28 |
| % of SDI 18-24" DBH | 23 | 28 | 30 | 28 |
| % of SDI >24" DBH | 12 | 14 | 16 | 14 |
| TPA >18" DBH | 27 | 29 | 29 | 29 |
| Ponderosa Pine BA | 135 | 122 | 116 | 126 |
| Gambel Oak BA | 18 | 20 | 21 | 20 |
| All BA | 173 | 160 | 155 | 163 |
| **Burn Only PAC Treatment Group (n=54)** | **No Action** | **Prescribed Burn Only** | **Prescribed Burn Only** | **No Treatments** |
| % of SDI 12-18" DBH | 28 | 28 | 28 | 28 |
| % of SDI 18-24" DBH | 22 | 22 | 22 | 22 |
| % of SDI >24" DBH | 11 | 11 | 11 | 11 |
| TPA >18" DBH | 28 | 28 | 28 | 28 |
| Ponderosa Pine BA | 125 | 123 | 122 | 125 |
| Gambel Oak BA | 22 | 23 | 23 | 22 |
| All BA | 185 | 183 | 183 | 185 |

**Table 222. PAC Treatment Summaries for Prey Habitat by Alternative**

| Forest Attribute | Alternative A | Alternative B | Alternative C | Alternative D |
|---|---|---|---|---|
| **Mechanical PAC Treatment Group (*n*=18)** | **No Action** | **Thinning Only Outside Core Areas** | **Thinning and Burning Outside Core Areas** | **Thinning Only Outside Core Ares** |
| Snags 12-18" DBH | 5.6 | 4.2 | 3.7 | 4.4 |
| Snags >12" DBH | 7.1 | 5.7 | 5.2 | 5.9 |
| Snags >18" DBH | 1.5 | 1.5 | 1.5 | 1.5 |
| CWD | 10.3 | 6.6 | 5.8 | 9.3 |
| Logs per Acre | 5.7 | 5.0 | 4.8 | 5.2 |
| Understory Index | 40 | 53 | 59 | 49 |
| **Burn Only PAC Treatment Group (n=54)** | **No Action** | **Prescribed Burn Only** | **Prescribed Burn Only** | **No Treatments** |
| Snags 12-18" DBH | 6.3 | 5.9 | 5.8 | 6.3 |
| Snags >12" DBH | 8.0 | 7.7 | 7.6 | 8.0 |
| Snags >18" DBH | 1.8 | 1.8 | 1.8 | 1.8 |
| CWD | 12.5 | 9.0 | 8.4 | 12.5 |
| Logs per Acre | 7.9 | 7.0 | 6.9 | 7.9 |
| Understory Index | 41 | 44 | 44 | 41 |

# Appendix 16. Summary of Habitat Changes by Alternative in MSO Protected Habitat

**Table 223. Changes in MSO Habitat Components, Including Ponderosa Pine (% of SDI and PP) and Gambel Oak (GO) by Individual PAC**

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| PAC | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| **Burn Only Treatment Group** | | | | | | | | | |
| **Blade Tank** | | | | | | | | | |
| % of SDI 12-18" DBH | 33 | 33 | 28 | 33 | 28 | 33 | 28 | 33 | 28 |
| % of SDI 18-24" DBH | 13 | 15 | 23 | 16 | 24 | 16 | 24 | 15 | 23 |
| % of SDI >24" DBH | 7 | 7 | 11 | 8 | 11 | 8 | 11 | 7 | 11 |
| TPA >18" DBH | 15 | 19 | 29 | 19 | 30 | 19 | 30 | 19 | 29 |
| PP Basal Area | 121 | 126 | 128 | 121 | 126 | 121 | 126 | 126 | 128 |
| GO Basal Area | 20 | 21 | 22 | 21 | 23 | 21 | 23 | 21 | 22 |
| All Basal Area | 165 | 174 | 190 | 169 | 188 | 168 | 188 | 174 | 190 |
| Snags 12-18" DBH | 3.4 | 4.3 | 6.8 | 5.7 | 6.4 | 5.9 | 6.4 | 4.3 | 6.8 |
| Snags >12" DBH | 4.1 | 5.1 | 8.7 | 6.4 | 8.3 | 6.6 | 8.2 | 5.1 | 8.7 |
| Snags >18" DBH | 0.7 | 0.7 | 1.9 | 0.7 | 1.9 | 0.7 | 1.9 | 0.7 | 1.9 |
| CWD | 6.1 | 8.1 | 13.2 | 3.9 | 9.5 | 3.3 | 8.9 | 8.1 | 13.2 |
| Logs per Acre | 2.5 | 3.6 | 8.2 | 2.4 | 7.3 | 2.3 | 7.2 | 3.6 | 8.2 |
| Understory Index | 29 | 25 | 18 | 27 | 18 | 27 | 18 | 25 | 18 |
| **Boondock** | | | | | | | | | |
| % of SDI 12-18" DBH | 29 | 28 | 26 | 28 | 25 | 28 | 25 | 28 | 26 |
| % of SDI 18-24" DBH | 13 | 15 | 21 | 16 | 21 | 16 | 21 | 15 | 21 |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| PAC | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| % of SDI >24" DBH | 8 | 9 | 11 | 9 | 11 | 9 | 11 | 9 | 11 |
| TPA >18" DBH | 17 | 20 | 29 | 20 | 29 | 20 | 29 | 20 | 29 |
| PP Basal Area | 125 | 129 | 130 | 124 | 127 | 124 | 127 | 129 | 130 |
| GO Basal Area | 24 | 25 | 26 | 25 | 27 | 25 | 27 | 25 | 26 |
| All Basal Area | 173 | 182 | 196 | 176 | 195 | 176 | 195 | 182 | 196 |
| Snags 12-18" DBH | 3.3 | 4.1 | 6.4 | 5.4 | 6.0 | 5.5 | 6.0 | 4.1 | 6.4 |
| Snags >12" DBH | 4.1 | 5.0 | 8.4 | 6.3 | 8.0 | 6.4 | 8.0 | 5.0 | 8.4 |
| Snags >18" DBH | 0.8 | 0.9 | 2.0 | 0.9 | 2.0 | 0.9 | 2.0 | 0.9 | 2.0 |
| CWD | 6.1 | 8.1 | 13.4 | 3.5 | 9.1 | 3.3 | 9.0 | 8.1 | 13.4 |
| Logs per Acre | 2.2 | 3.4 | 7.9 | 2.2 | 7.0 | 2.2 | 7.0 | 3.4 | 7.9 |
| Understory Index | 23 | 20 | 15 | 22 | 16 | 22 | 16 | 20 | 15 |
| **Bristow Tank/Limpios** | | | | | | | | | |
| % of SDI 12-18" DBH | 26 | 26 | 25 | 26 | 24 | 26 | 24 | 26 | 25 |
| % of SDI 18-24" DBH | 13 | 14 | 18 | 14 | 18 | 14 | 18 | 14 | 18 |
| % of SDI >24" DBH | 9 | 9 | 12 | 10 | 12 | 10 | 12 | 9 | 12 |
| TPA >18" DBH | 13 | 15 | 23 | 15 | 23 | 15 | 23 | 15 | 23 |
| PP Basal Area | 97 | 102 | 109 | 99 | 106 | 98 | 106 | 102 | 109 |
| GO Basal Area | 18 | 19 | 22 | 20 | 22 | 20 | 23 | 19 | 22 |
| All Basal Area | 139 | 150 | 172 | 146 | 171 | 145 | 170 | 150 | 172 |
| Snags 12-18" DBH | 2.3 | 2.8 | 4.9 | 3.6 | 4.7 | 3.9 | 4.6 | 2.8 | 4.9 |
| Snags >12" DBH | 2.9 | 3.5 | 6.5 | 4.3 | 6.2 | 4.6 | 6.1 | 3.5 | 6.5 |
| Snags >18" DBH | 0.7 | 0.7 | 1.5 | 0.7 | 1.5 | 0.7 | 1.5 | 0.7 | 1.5 |
| CWD | 5.4 | 6.8 | 10.8 | 3.6 | 8.0 | 2.8 | 7.2 | 6.8 | 10.8 |
| Logs per Acre | 2.9 | 3.7 | 6.9 | 2.5 | 6.0 | 2.3 | 5.9 | 3.7 | 6.9 |
| Understory Index | 52 | 41 | 25 | 44 | 26 | 44 | 26 | 41 | 25 |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| **PAC** | **2010** | **2020** | **2050** | **2020** | **2050** | **2020** | **2050** | **2020** | **2050** |
| **Casner** | | | | | | | | | |
| % of SDI 12-18" DBH | 30 | 31 | 28 | 31 | 28 | 31 | 28 | 31 | 28 |
| % of SDI 18-24" DBH | 13 | 15 | 21 | 15 | 22 | 16 | 22 | 15 | 21 |
| % of SDI >24" DBH | 6 | 7 | 10 | 7 | 10 | 7 | 10 | 7 | 10 |
| TPA >18" DBH | 15 | 18 | 27 | 18 | 28 | 18 | 28 | 18 | 27 |
| PP Basal Area | 121 | 125 | 129 | 121 | 127 | 120 | 126 | 125 | 129 |
| GO Basal Area | 22 | 23 | 24 | 23 | 25 | 23 | 25 | 23 | 24 |
| All Basal Area | 164 | 173 | 190 | 168 | 188 | 167 | 188 | 173 | 190 |
| Snags 12-18" DBH | 3.0 | 3.9 | 6.4 | 5.0 | 6.0 | 5.4 | 5.9 | 3.9 | 6.4 |
| Snags >12" DBH | 3.6 | 4.6 | 8.1 | 5.7 | 7.7 | 6.0 | 7.6 | 4.6 | 8.1 |
| Snags >18" DBH | 0.6 | 0.7 | 1.7 | 0.7 | 1.7 | 0.7 | 1.7 | 0.7 | 1.7 |
| CWD | 5.9 | 7.7 | 12.6 | 4.2 | 9.4 | 3.2 | 8.4 | 7.7 | 12.6 |
| Logs per Acre | 2.2 | 3.3 | 7.3 | 2.4 | 6.6 | 2.1 | 6.4 | 3.3 | 7.3 |
| Understory Index | 32 | 26 | 18 | 29 | 19 | 29 | 19 | 26 | 18 |
| **Casner Cabin** | | | | | | | | | |
| % of SDI 12-18" DBH | 26 | 25 | 20 | 25 | 20 | 25 | 20 | 25 | 20 |
| % of SDI 18-24" DBH | 15 | 17 | 20 | 17 | 21 | 17 | 21 | 17 | 20 |
| % of SDI >24" DBH | 17 | 17 | 19 | 18 | 20 | 18 | 20 | 17 | 19 |
| TPA >18" DBH | 18 | 21 | 28 | 21 | 29 | 21 | 29 | 21 | 28 |
| PP Basal Area | 105 | 109 | 110 | 105 | 108 | 105 | 108 | 109 | 110 |
| GO Basal Area | 16 | 16 | 17 | 16 | 18 | 16 | 18 | 16 | 17 |
| All Basal Area | 149 | 158 | 178 | 154 | 177 | 154 | 177 | 158 | 178 |
| Snags 12-18" DBH | 2.8 | 3.3 | 4.8 | 4.3 | 4.4 | 4.3 | 4.4 | 3.3 | 4.8 |
| Snags >12" DBH | 4.2 | 4.7 | 7.3 | 5.8 | 6.9 | 5.8 | 6.9 | 4.7 | 7.3 |
| Snags >18" DBH | 1.3 | 1.5 | 2.5 | 1.5 | 2.5 | 1.5 | 2.5 | 1.5 | 2.5 |

| PAC | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| CWD | 7.8 | 9.3 | 13.6 | 4.0 | 8.9 | 4.0 | 8.9 | 9.3 | 13.6 |
| Logs per Acre | 8.0 | 9.0 | 12.9 | 5.4 | 10.1 | 5.4 | 10.1 | 9.0 | 12.9 |
| Understory Index | 150 | 133 | 105 | 137 | 106 | 137 | 106 | 133 | 105 |
| **Cave Springs** | | | | | | | | | |
| % of SDI 12-18" DBH | 38 | 38 | 29 | 38 | 28 | 38 | 28 | 38 | 29 |
| % of SDI 18-24" DBH | 15 | 18 | 27 | 18 | 28 | 18 | 28 | 18 | 27 |
| % of SDI >24" DBH | 6 | 7 | 12 | 7 | 13 | 7 | 13 | 7 | 12 |
| TPA >18" DBH | 15 | 18 | 32 | 18 | 32 | 18 | 32 | 18 | 32 |
| PP Basal Area | 109 | 114 | 118 | 110 | 116 | 110 | 116 | 114 | 118 |
| GO Basal Area | 14 | 14 | 15 | 14 | 16 | 14 | 16 | 14 | 15 |
| All Basal Area | 147 | 157 | 176 | 152 | 174 | 152 | 174 | 157 | 176 |
| Snags 12-18" DBH | 3.2 | 4.3 | 6.9 | 5.9 | 6.4 | 5.9 | 6.4 | 4.3 | 6.9 |
| Snags >12" DBH | 3.7 | 4.9 | 8.8 | 6.5 | 8.3 | 6.5 | 8.3 | 4.9 | 8.8 |
| Snags >18" DBH | 0.5 | 0.6 | 1.9 | 0.6 | 1.9 | 0.6 | 1.9 | 0.6 | 1.9 |
| CWD | 6.3 | 8.0 | 12.8 | 3.3 | 8.7 | 3.3 | 8.7 | 8.0 | 12.8 |
| Logs per Acre | 3.9 | 5.0 | 9.7 | 3.1 | 8.3 | 3.1 | 8.3 | 5.0 | 9.7 |
| Understory Index | 108 | 96 | 76 | 100 | 78 | 100 | 78 | 96 | 76 |
| **Coulter Ridge** | | | | | | | | | |
| % of SDI 12-18" DBH | 33 | 33 | 29 | 34 | 29 | 34 | 29 | 33 | 29 |
| % of SDI 18-24" DBH | 13 | 16 | 23 | 16 | 23 | 16 | 23 | 16 | 23 |
| % of SDI >24" DBH | 7 | 7 | 10 | 7 | 10 | 7 | 10 | 7 | 10 |
| TPA >18" DBH | 14 | 18 | 28 | 18 | 29 | 18 | 29 | 18 | 28 |
| PP Basal Area | 121 | 125 | 130 | 121 | 128 | 120 | 127 | 125 | 130 |
| GO Basal Area | 20 | 20 | 22 | 21 | 22 | 21 | 22 | 20 | 22 |
| All Basal Area | 161 | 170 | 187 | 165 | 185 | 164 | 185 | 170 | 187 |

| PAC | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| Snags 12-18" DBH | 3.3 | 4.1 | 6.5 | 5.5 | 6.1 | 5.7 | 6.0 | 4.1 | 6.5 |
| Snags >12" DBH | 3.9 | 4.8 | 8.3 | 6.1 | 7.8 | 6.4 | 7.8 | 4.8 | 8.3 |
| Snags >18" DBH | 0.6 | 0.7 | 1.7 | 0.7 | 1.7 | 0.6 | 1.7 | 0.7 | 1.7 |
| CWD | 5.8 | 7.6 | 12.5 | 3.8 | 9.0 | 3.1 | 8.4 | 7.6 | 12.5 |
| Logs per Acre | 2.0 | 3.1 | 7.3 | 2.2 | 6.6 | 2.0 | 6.5 | 3.1 | 7.3 |
| Understory Index | 35 | 29 | 20 | 31 | 20 | 32 | 20 | 29 | 20 |
| **Coyote Park** | | | | | | | | | |
| % of SDI 12-18" DBH | 28 | 28 | 26 | 28 | 26 | 28 | 26 | 28 | 26 |
| % of SDI 18-24" DBH | 12 | 15 | 20 | 15 | 20 | 15 | 20 | 15 | 20 |
| % of SDI >24" DBH | 8 | 8 | 10 | 8 | 11 | 8 | 11 | 8 | 10 |
| TPA >18" DBH | 15 | 19 | 27 | 19 | 27 | 19 | 27 | 19 | 27 |
| PP Basal Area | 122 | 126 | 128 | 122 | 126 | 121 | 125 | 126 | 128 |
| GO Basal Area | 24 | 26 | 27 | 26 | 28 | 26 | 28 | 26 | 27 |
| All Basal Area | 169 | 178 | 193 | 174 | 192 | 172 | 192 | 178 | 193 |
| Snags 12-18" DBH | 3.1 | 3.9 | 6.4 | 5.1 | 6.0 | 5.3 | 6.0 | 3.9 | 6.4 |
| Snags >12" DBH | 3.8 | 4.7 | 8.2 | 5.8 | 7.8 | 6.1 | 7.8 | 4.7 | 8.2 |
| Snags >18" DBH | 0.7 | 0.8 | 1.8 | 0.8 | 1.8 | 0.8 | 1.8 | 0.8 | 1.8 |
| CWD | 5.9 | 7.8 | 13.0 | 4.0 | 9.5 | 3.2 | 8.7 | 7.8 | 13.0 |
| Logs per Acre | 1.9 | 3.0 | 7.2 | 2.1 | 6.6 | 2.0 | 6.4 | 3.0 | 7.2 |
| Understory Index | 25 | 21 | 16 | 23 | 16 | 24 | 17 | 21 | 16 |
| **Crater Spring Tank** | | | | | | | | | |
| % of SDI 12-18" DBH | 41 | 41 | 33 | 41 | 33 | 41 | 33 | 41 | 33 |
| % of SDI 18-24" DBH | 12 | 15 | 26 | 15 | 27 | 15 | 27 | 15 | 26 |
| % of SDI >24" DBH | 4 | 4 | 7 | 5 | 7 | 5 | 7 | 4 | 7 |
| TPA >18" DBH | 14 | 18 | 33 | 18 | 33 | 18 | 33 | 18 | 33 |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| **PAC** | **2010** | **2020** | **2050** | **2020** | **2050** | **2020** | **2050** | **2020** | **2050** |
| PP Basal Area | 141 | 146 | 149 | 140 | 147 | 140 | 147 | 146 | 149 |
| GO Basal Area | 20 | 20 | 21 | 21 | 22 | 21 | 22 | 20 | 21 |
| All Basal Area | 177 | 185 | 199 | 179 | 198 | 179 | 198 | 185 | 199 |
| Snags 12-18" DBH | 4.5 | 5.6 | 8.3 | 7.8 | 7.6 | 7.8 | 7.6 | 5.6 | 8.3 |
| Snags >12" DBH | 5.0 | 6.2 | 10.0 | 8.4 | 9.2 | 8.4 | 9.2 | 6.2 | 10.0 |
| Snags >18" DBH | 0.5 | 0.6 | 1.7 | 0.6 | 1.7 | 0.6 | 1.7 | 0.6 | 1.7 |
| CWD | 6.4 | 8.6 | 14.1 | 3.5 | 9.6 | 3.5 | 9.6 | 8.6 | 14.1 |
| Logs per Acre | 1.7 | 3.0 | 7.9 | 2.0 | 7.3 | 2.0 | 7.3 | 3.0 | 7.9 |
| Understory Index | 22 | 19 | 14 | 21 | 15 | 21 | 15 | 19 | 14 |
| **Dairy Spring** | | | | | | | | | |
| % of SDI 12-18" DBH | 34 | 33 | 25 | 33 | 25 | 33 | 25 | 33 | 25 |
| % of SDI 18-24" DBH | 15 | 18 | 25 | 18 | 25 | 18 | 25 | 18 | 25 |
| % of SDI >24" DBH | 9 | 9 | 14 | 10 | 14 | 10 | 14 | 9 | 14 |
| TPA >18" DBH | 16 | 20 | 31 | 20 | 31 | 20 | 31 | 20 | 31 |
| PP Basal Area | 107 | 112 | 114 | 108 | 112 | 108 | 112 | 112 | 114 |
| GO Basal Area | 16 | 17 | 18 | 17 | 18 | 17 | 18 | 17 | 18 |
| All Basal Area | 152 | 162 | 180 | 157 | 178 | 157 | 178 | 162 | 180 |
| Snags 12-18" DBH | 3.2 | 4.0 | 6.3 | 5.4 | 5.9 | 5.4 | 5.9 | 4.0 | 6.3 |
| Snags >12" DBH | 3.9 | 4.9 | 8.5 | 6.2 | 8.1 | 6.2 | 8.1 | 4.9 | 8.5 |
| Snags >18" DBH | 0.7 | 0.8 | 2.2 | 0.8 | 2.2 | 0.8 | 2.2 | 0.8 | 2.2 |
| CWD | 6.3 | 8.0 | 13.0 | 3.2 | 8.8 | 3.2 | 8.8 | 8.0 | 13.0 |
| Logs per Acre | 3.7 | 4.9 | 9.7 | 3.0 | 8.3 | 3.0 | 8.3 | 4.9 | 9.7 |
| Understory Index | 39 | 32 | 22 | 34 | 23 | 34 | 23 | 32 | 22 |
| **De Toros** | | | | | | | | | |
| % of SDI 12-18" DBH | 38 | 37 | 30 | 38 | 30 | 38 | 30 | 37 | 30 |

| PAC | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| % of SDI 18-24" DBH | 13 | 16 | 26 | 17 | 26 | 17 | 26 | 16 | 26 |
| % of SDI >24" DBH | 6 | 6 | 9 | 6 | 9 | 6 | 9 | 6 | 9 |
| TPA >18" DBH | 16 | 20 | 33 | 20 | 34 | 20 | 34 | 20 | 33 |
| PP Basal Area | 138 | 142 | 145 | 137 | 142 | 137 | 142 | 142 | 145 |
| GO Basal Area | 21 | 21 | 21 | 21 | 22 | 21 | 22 | 21 | 21 |
| All Basal Area | 178 | 186 | 200 | 180 | 198 | 180 | 198 | 186 | 200 |
| Snags 12-18" DBH | 4.4 | 5.5 | 7.9 | 7.4 | 7.2 | 7.4 | 7.2 | 5.5 | 7.9 |
| Snags >12" DBH | 5.0 | 6.2 | 9.8 | 8.1 | 9.1 | 8.1 | 9.1 | 6.2 | 9.8 |
| Snags >18" DBH | 0.6 | 0.7 | 1.9 | 0.7 | 1.9 | 0.7 | 1.9 | 0.7 | 1.9 |
| CWD | 6.4 | 8.6 | 14.3 | 3.5 | 9.6 | 3.5 | 9.6 | 8.6 | 14.3 |
| Logs per Acre | 2.0 | 3.4 | 8.5 | 2.2 | 7.7 | 2.2 | 7.7 | 3.4 | 8.5 |
| Understory Index | 21 | 18 | 14 | 20 | 14 | 20 | 14 | 18 | 14 |
| **Fain Mountain** | | | | | | | | | |
| % of SDI 12-18" DBH | 36 | 35 | 27 | 35 | 27 | 35 | 27 | 35 | 27 |
| % of SDI 18-24" DBH | 14 | 17 | 25 | 18 | 25 | 18 | 26 | 17 | 25 |
| % of SDI >24" DBH | 8 | 8 | 12 | 8 | 12 | 8 | 12 | 8 | 12 |
| TPA >18" DBH | 16 | 20 | 32 | 20 | 32 | 20 | 32 | 20 | 32 |
| PP Basal Area | 122 | 126 | 129 | 123 | 127 | 122 | 126 | 126 | 129 |
| GO Basal Area | 18 | 18 | 19 | 18 | 20 | 18 | 20 | 18 | 19 |
| All Basal Area | 165 | 173 | 190 | 170 | 188 | 168 | 188 | 173 | 190 |
| Snags 12-18" DBH | 3.9 | 4.7 | 7.0 | 5.9 | 6.6 | 6.3 | 6.5 | 4.7 | 7.0 |
| Snags >12" DBH | 4.6 | 5.5 | 9.1 | 6.7 | 8.7 | 7.1 | 8.6 | 5.5 | 9.1 |
| Snags >18" DBH | 0.7 | 0.8 | 2.1 | 0.8 | 2.1 | 0.8 | 2.1 | 0.8 | 2.1 |
| CWD | 6.3 | 8.3 | 13.6 | 4.4 | 10.2 | 3.4 | 9.2 | 8.3 | 13.6 |
| Logs per Acre | 2.9 | 4.2 | 9.3 | 2.9 | 8.3 | 2.7 | 8.1 | 4.2 | 9.3 |

| PAC | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| Understory Index | 31 | 26 | 18 | 28 | 19 | 28 | 19 | 26 | 18 |
| **Fisher Point** | | | | | | | | | |
| % of SDI 12-18" DBH | 15 | 14 | 11 | 14 | 11 | 14 | 11 | 14 | 11 |
| % of SDI 18-24" DBH | 14 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| % of SDI >24" DBH | 30 | 31 | 30 | 32 | 30 | 32 | 30 | 31 | 30 |
| TPA >18" DBH | 17 | 18 | 21 | 18 | 21 | 18 | 21 | 18 | 21 |
| PP Basal Area | 65 | 67 | 68 | 66 | 67 | 66 | 67 | 67 | 68 |
| GO Basal Area | 9 | 9 | 12 | 9 | 12 | 9 | 12 | 9 | 12 |
| All Basal Area | 112 | 124 | 154 | 122 | 153 | 122 | 153 | 124 | 154 |
| Snags 12-18" DBH | 1.3 | 1.0 | 1.8 | 1.3 | 1.7 | 1.3 | 1.7 | 1.0 | 1.8 |
| Snags >12" DBH | 3.6 | 3.4 | 4.7 | 3.8 | 4.5 | 3.8 | 4.5 | 3.4 | 4.7 |
| Snags >18" DBH | 2.4 | 2.5 | 3.0 | 2.5 | 2.9 | 2.5 | 2.9 | 2.5 | 3.0 |
| CWD | 10.9 | 11.7 | 14.1 | 5.4 | 8.9 | 5.4 | 8.9 | 11.7 | 14.1 |
| Logs per Acre | 18.1 | 18.5 | 20.6 | 10.8 | 14.4 | 10.8 | 14.4 | 18.5 | 20.6 |
| Understory Index | 211 | 180 | 127 | 185 | 128 | 185 | 128 | 180 | 127 |
| **Frog Tank** | | | | | | | | | |
| % of SDI 12-18" DBH | 30 | 30 | 27 | 30 | 27 | 30 | 27 | 30 | 27 |
| % of SDI 18-24" DBH | 16 | 18 | 23 | 18 | 23 | 18 | 23 | 18 | 23 |
| % of SDI >24" DBH | 8 | 8 | 12 | 8 | 12 | 8 | 12 | 8 | 12 |
| TPA >18" DBH | 16 | 19 | 28 | 20 | 28 | 20 | 28 | 19 | 28 |
| PP Basal Area | 120 | 125 | 130 | 121 | 128 | 120 | 128 | 125 | 130 |
| GO Basal Area | 21 | 22 | 23 | 22 | 24 | 22 | 24 | 22 | 23 |
| All Basal Area | 161 | 170 | 186 | 165 | 185 | 165 | 185 | 170 | 186 |
| Snags 12-18" DBH | 2.7 | 3.5 | 5.8 | 4.8 | 5.5 | 5.0 | 5.4 | 3.5 | 5.8 |
| Snags >12" DBH | 3.3 | 4.3 | 7.6 | 5.5 | 7.3 | 5.7 | 7.2 | 4.3 | 7.6 |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| PAC | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| Snags >18" DBH | 0.6 | 0.7 | 1.8 | 0.7 | 1.8 | 0.7 | 1.8 | 0.7 | 1.8 |
| CWD >3" | 5.5 | 7.2 | 11.8 | 3.6 | 8.5 | 2.9 | 7.9 | 7.2 | 11.8 |
| Logs per Acre | 2.0 | 3.0 | 6.9 | 2.1 | 6.3 | 1.9 | 6.1 | 3.0 | 6.9 |
| Understory Index | 34 | 28 | 20 | 30 | 21 | 31 | 21 | 28 | 20 |
| **Fry** | | | | | | | | | |
| % of SDI 12-18" DBH | 31 | 31 | 28 | 31 | 28 | 31 | 28 | 31 | 28 |
| % of SDI 18-24" DBH | 12 | 14 | 21 | 15 | 21 | 15 | 21 | 14 | 21 |
| % of SDI >24" DBH | 7 | 7 | 9 | 7 | 10 | 7 | 10 | 7 | 9 |
| TPA >18" DBH | 14 | 17 | 27 | 17 | 27 | 17 | 27 | 17 | 27 |
| PP Basal Area | 121 | 126 | 130 | 121 | 127 | 121 | 127 | 126 | 130 |
| GO Basal Area | 22 | 23 | 25 | 23 | 26 | 23 | 26 | 23 | 25 |
| All Basal Area | 163 | 173 | 189 | 167 | 187 | 167 | 187 | 173 | 189 |
| Snags 12-18" DBH | 3.3 | 4.1 | 6.6 | 5.6 | 6.1 | 5.6 | 6.1 | 4.1 | 6.6 |
| Snags >12" DBH | 3.9 | 4.7 | 8.2 | 6.2 | 7.7 | 6.2 | 7.7 | 4.7 | 8.2 |
| Snags >18" DBH | 0.6 | 0.7 | 1.6 | 0.6 | 1.6 | 0.6 | 1.6 | 0.7 | 1.6 |
| CWD | 5.7 | 7.6 | 12.5 | 3.1 | 8.4 | 3.1 | 8.4 | 7.6 | 12.5 |
| Logs per Acre | 1.6 | 2.7 | 6.7 | 1.8 | 6.1 | 1.8 | 6.1 | 2.7 | 6.7 |
| Understory Index | 98 | 87 | 72 | 93 | 74 | 93 | 74 | 87 | 72 |
| **Gash Mountain** | | | | | | | | | |
| % of SDI 12-18" DBH | 33 | 34 | 30 | 34 | 30 | 34 | 30 | 34 | 30 |
| % of SDI 18-24" DBH | 14 | 17 | 24 | 17 | 24 | 17 | 24 | 17 | 24 |
| % of SDI >24" DBH | 6 | 6 | 10 | 6 | 10 | 6 | 10 | 6 | 10 |
| TPA >18" DBH | 15 | 18 | 29 | 18 | 30 | 18 | 30 | 18 | 29 |
| PP Basal Area | 128 | 133 | 138 | 129 | 136 | 128 | 136 | 133 | 138 |
| GO Basal Area | 21 | 22 | 23 | 22 | 24 | 22 | 24 | 22 | 23 |

| PAC | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| All Basal Area | 167 | 175 | 190 | 170 | 189 | 169 | 189 | 175 | 190 |
| Snags 12-18" DBH | 3.1 | 4.1 | 6.8 | 5.5 | 6.4 | 5.9 | 6.2 | 4.1 | 6.8 |
| Snags >12" DBH | 3.6 | 4.8 | 8.4 | 6.2 | 8.0 | 6.5 | 7.9 | 4.8 | 8.4 |
| Snags >18" DBH | 0.5 | 0.6 | 1.7 | 0.6 | 1.6 | 0.6 | 1.6 | 0.6 | 1.7 |
| CWD | 5.9 | 7.7 | 12.6 | 4.0 | 9.2 | 3.2 | 8.4 | 7.7 | 12.6 |
| Logs per Acre | 2.0 | 3.1 | 7.1 | 2.2 | 6.5 | 2.0 | 6.4 | 3.1 | 7.1 |
| Understory Index | 29 | 25 | 18 | 27 | 19 | 27 | 19 | 25 | 18 |
| **Girdner** | | | | | | | | | |
| % of SDI 12-18" DBH | 32 | 33 | 29 | 33 | 28 | 33 | 28 | 33 | 29 |
| % of SDI 18-24" DBH | 12 | 14 | 21 | 15 | 22 | 15 | 22 | 14 | 21 |
| % of SDI >24" DBH | 9 | 9 | 13 | 9 | 13 | 9 | 13 | 9 | 13 |
| TPA >18" DBH | 14 | 16 | 27 | 16 | 27 | 16 | 27 | 16 | 27 |
| PP Basal Area | 111 | 115 | 120 | 111 | 118 | 110 | 117 | 115 | 120 |
| GO Basal Area | 17 | 18 | 20 | 18 | 21 | 18 | 21 | 18 | 20 |
| All Basal Area | 152 | 161 | 180 | 157 | 178 | 156 | 178 | 161 | 180 |
| Snags 12-18" DBH | 2.5 | 3.5 | 6.1 | 4.8 | 5.7 | 5.0 | 5.6 | 3.5 | 6.1 |
| Snags >12" DBH | 3.1 | 4.2 | 7.8 | 5.4 | 7.4 | 5.7 | 7.3 | 4.2 | 7.8 |
| Snags >18" DBH | 0.6 | 0.7 | 1.7 | 0.7 | 1.7 | 0.7 | 1.7 | 0.7 | 1.7 |
| CWD | 6.1 | 7.7 | 12.2 | 4.0 | 9.0 | 3.2 | 8.3 | 7.7 | 12.2 |
| Logs per Acre | 3.8 | 4.7 | 8.6 | 3.2 | 7.5 | 2.9 | 7.3 | 4.7 | 8.6 |
| Understory Index | 40 | 33 | 22 | 36 | 23 | 36 | 23 | 33 | 22 |
| **Harding Point** | | | | | | | | | |
| % of SDI 12-18" DBH | 26 | 24 | 22 | 25 | 22 | 25 | 22 | 24 | 22 |
| % of SDI 18-24" DBH | 27 | 29 | 29 | 30 | 29 | 30 | 29 | 29 | 29 |
| % of SDI >24" DBH | 7 | 9 | 16 | 10 | 16 | 10 | 16 | 9 | 16 |

| PAC | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| TPA >18" DBH | 31 | 35 | 40 | 35 | 40 | 35 | 40 | 35 | 40 |
| PP Basal Area | 145 | 147 | 149 | 144 | 148 | 144 | 148 | 147 | 149 |
| GO Basal Area | 20 | 20 | 20 | 20 | 21 | 20 | 21 | 20 | 20 |
| All Basal Area | 184 | 189 | 202 | 185 | 201 | 185 | 201 | 189 | 202 |
| Snags 12-18" DBH | 3.0 | 4.7 | 6.2 | 5.9 | 5.7 | 5.9 | 5.7 | 4.7 | 6.2 |
| Snags >12" DBH | 3.7 | 6.1 | 9.1 | 7.2 | 8.6 | 7.2 | 8.6 | 6.1 | 9.1 |
| Snags >18" DBH | 0.8 | 1.4 | 3.0 | 1.3 | 2.9 | 1.3 | 2.9 | 1.4 | 3.0 |
| CWD | 7.1 | 8.8 | 14.1 | 3.8 | 9.4 | 3.8 | 9.4 | 8.8 | 14.1 |
| Logs per Acre | 6.0 | 7.1 | 12.4 | 4.3 | 9.8 | 4.3 | 9.8 | 7.1 | 12.4 |
| Understory Index | 99 | 93 | 84 | 97 | 84 | 97 | 84 | 93 | 84 |
| **Howard Mountain** | | | | | | | | | |
| % of SDI 12-18" DBH | 34 | 33 | 27 | 33 | 27 | 33 | 27 | 33 | 27 |
| % of SDI 18-24" DBH | 14 | 17 | 24 | 17 | 24 | 17 | 24 | 17 | 24 |
| % of SDI >24" DBH | 8 | 8 | 12 | 8 | 12 | 8 | 12 | 8 | 12 |
| TPA >18" DBH | 16 | 20 | 31 | 20 | 31 | 20 | 31 | 20 | 31 |
| PP Basal Area | 120 | 124 | 127 | 121 | 124 | 120 | 124 | 124 | 127 |
| GO Basal Area | 19 | 20 | 20 | 20 | 21 | 20 | 21 | 20 | 20 |
| All Basal Area | 165 | 174 | 190 | 170 | 189 | 169 | 188 | 174 | 190 |
| Snags 12-18" DBH | 3.5 | 4.4 | 6.8 | 5.7 | 6.4 | 6.0 | 6.3 | 4.4 | 6.8 |
| Snags >12" DBH | 4.3 | 5.2 | 8.9 | 6.5 | 8.5 | 6.8 | 8.4 | 5.2 | 8.9 |
| Snags >18" DBH | 0.7 | 0.8 | 2.1 | 0.8 | 2.1 | 0.8 | 2.1 | 0.8 | 2.1 |
| CWD | 6.3 | 8.3 | 13.5 | 4.2 | 9.9 | 3.4 | 9.1 | 8.3 | 13.5 |
| Logs per Acre | 3.0 | 4.2 | 9.1 | 2.9 | 8.1 | 2.7 | 7.9 | 4.2 | 9.1 |
| Understory Index | 30 | 25 | 18 | 27 | 19 | 27 | 19 | 25 | 18 |
| **Iowa Camp** | | | | | | | | | |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| PAC | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| % of SDI 12-18" DBH | 27 | 29 | 28 | 29 | 28 | 29 | 28 | 29 | 28 |
| % of SDI 18-24" DBH | 11 | 13 | 19 | 13 | 19 | 13 | 19 | 13 | 19 |
| % of SDI >24" DBH | 7 | 7 | 9 | 7 | 9 | 7 | 9 | 7 | 9 |
| TPA >18" DBH | 13 | 16 | 24 | 16 | 24 | 16 | 24 | 16 | 24 |
| PP Basal Area | 116 | 121 | 124 | 116 | 121 | 115 | 121 | 121 | 124 |
| GO Basal Area | 25 | 26 | 28 | 26 | 29 | 27 | 29 | 26 | 28 |
| All Basal Area | 163 | 172 | 188 | 167 | 187 | 166 | 187 | 172 | 188 |
| Snags 12-18" DBH | 2.5 | 3.3 | 6.2 | 4.4 | 5.9 | 4.7 | 5.8 | 3.3 | 6.2 |
| Snags >12" DBH | 3.1 | 3.9 | 7.7 | 5.0 | 7.3 | 5.3 | 7.3 | 3.9 | 7.7 |
| Snags >18" DBH | 0.6 | 0.6 | 1.5 | 0.6 | 1.5 | 0.6 | 1.5 | 0.6 | 1.5 |
| CWD | 5.7 | 7.5 | 12.3 | 4.1 | 9.1 | 3.1 | 8.2 | 7.5 | 12.3 |
| Logs per Acre | 1.8 | 2.7 | 6.3 | 2.1 | 5.8 | 1.8 | 5.6 | 2.7 | 6.3 |
| Understory Index | 29 | 24 | 18 | 27 | 18 | 27 | 18 | 24 | 18 |
| **James Canyon** | | | | | | | | | |
| % of SDI 12-18" DBH | 32 | 32 | 28 | 32 | 28 | 32 | 28 | 32 | 28 |
| % of SDI 18-24" DBH | 13 | 15 | 22 | 16 | 22 | 16 | 22 | 15 | 22 |
| % of SDI >24" DBH | 7 | 7 | 10 | 8 | 11 | 8 | 11 | 7 | 10 |
| TPA >18" DBH | 15 | 19 | 29 | 19 | 29 | 19 | 29 | 19 | 29 |
| PP Basal Area | 124 | 128 | 130 | 123 | 128 | 123 | 128 | 128 | 130 |
| GO Basal Area | 22 | 23 | 24 | 23 | 25 | 23 | 25 | 23 | 24 |
| All Basal Area | 169 | 178 | 193 | 173 | 192 | 172 | 192 | 178 | 193 |
| Snags 12-18" DBH | 3.3 | 4.2 | 6.7 | 5.6 | 6.3 | 5.8 | 6.3 | 4.2 | 6.7 |
| Snags >12" DBH | 4.0 | 5.0 | 8.6 | 6.3 | 8.2 | 6.5 | 8.1 | 5.0 | 8.6 |
| Snags >18" DBH | 0.7 | 0.8 | 1.9 | 0.7 | 1.9 | 0.7 | 1.9 | 0.8 | 1.9 |
| CWD | 6.1 | 8.1 | 13.3 | 3.8 | 9.4 | 3.3 | 8.9 | 8.1 | 13.3 |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| **PAC** | **2010** | **2020** | **2050** | **2020** | **2050** | **2020** | **2050** | **2020** | **2050** |
| Logs per Acre | 2.3 | 3.5 | 7.9 | 2.4 | 7.1 | 2.2 | 7.0 | 3.5 | 7.9 |
| Understory Index | 102 | 93 | 81 | 98 | 82 | 98 | 82 | 93 | 81 |
| **Jeep** | | | | | | | | | |
| % of SDI 12-18" DBH | 35 | 36 | 31 | 36 | 30 | 36 | 30 | 36 | 31 |
| % of SDI 18-24" DBH | 12 | 14 | 23 | 15 | 23 | 15 | 24 | 14 | 23 |
| % of SDI >24" DBH | 6 | 6 | 10 | 6 | 10 | 6 | 10 | 6 | 10 |
| TPA >18" DBH | 12 | 15 | 27 | 15 | 27 | 15 | 27 | 15 | 27 |
| PP Basal Area | 107 | 113 | 119 | 110 | 117 | 108 | 116 | 113 | 119 |
| GO Basal Area | 17 | 18 | 19 | 18 | 20 | 18 | 20 | 18 | 19 |
| All Basal Area | 146 | 156 | 176 | 154 | 175 | 151 | 174 | 156 | 176 |
| Snags 12-18" DBH | 2.8 | 3.6 | 6.4 | 4.4 | 6.3 | 5.2 | 6.0 | 3.6 | 6.4 |
| Snags >12" DBH | 3.3 | 4.2 | 8.0 | 4.9 | 7.8 | 5.8 | 7.5 | 4.2 | 8.0 |
| Snags >18" DBH | 0.5 | 0.5 | 1.5 | 0.5 | 1.5 | 0.5 | 1.5 | 0.5 | 1.5 |
| CWD | 5.8 | 7.4 | 11.9 | 5.1 | 9.9 | 3.0 | 8.0 | 7.4 | 11.9 |
| Logs per Acre | 2.7 | 3.7 | 7.5 | 2.8 | 6.9 | 2.3 | 6.6 | 3.7 | 7.5 |
| Understory Index | 45 | 37 | 24 | 39 | 25 | 40 | 25 | 37 | 24 |
| **Kelly** | | | | | | | | | |
| % of SDI 12-18" DBH | 29 | 29 | 27 | 29 | 27 | 29 | 27 | 29 | 27 |
| % of SDI 18-24" DBH | 13 | 15 | 20 | 15 | 21 | 15 | 21 | 15 | 20 |
| % of SDI >24" DBH | 9 | 9 | 12 | 9 | 12 | 9 | 12 | 9 | 12 |
| TPA >18" DBH | 15 | 18 | 26 | 18 | 27 | 18 | 27 | 18 | 26 |
| PP Basal Area | 120 | 124 | 128 | 120 | 126 | 119 | 125 | 124 | 128 |
| GO Basal Area | 23 | 24 | 25 | 24 | 26 | 24 | 26 | 24 | 25 |
| All Basal Area | 164 | 173 | 190 | 169 | 188 | 168 | 188 | 173 | 190 |
| Snags 12-18" DBH | 2.7 | 3.5 | 5.9 | 4.7 | 5.6 | 4.9 | 5.5 | 3.5 | 5.9 |

| PAC | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| Snags >12" DBH | 3.5 | 4.3 | 7.7 | 5.5 | 7.4 | 5.8 | 7.3 | 4.3 | 7.7 |
| Snags >18" DBH | 0.8 | 0.8 | 1.8 | 0.8 | 1.8 | 0.8 | 1.8 | 0.8 | 1.8 |
| CWD | 6.2 | 8.0 | 12.7 | 4.1 | 9.1 | 3.3 | 8.4 | 8.0 | 12.7 |
| Logs per Acre | 3.1 | 4.0 | 7.8 | 2.7 | 6.8 | 2.5 | 6.7 | 4.0 | 7.8 |
| Understory Index | 107 | 97 | 82 | 101 | 83 | 102 | 83 | 97 | 82 |
| **Kendrick** | | | | | | | | | |
| % of SDI 12-18" DBH | 32 | 35 | 54 | 36 | 53 | 36 | 53 | 35 | 54 |
| % of SDI 18-24" DBH | 1 | 9 | 24 | 10 | 25 | 10 | 25 | 9 | 24 |
| % of SDI >24" DBH | 1 | 1 | 3 | 1 | 3 | 1 | 3 | 1 | 3 |
| TPA >18" DBH | 1 | 2 | 7 | 2 | 7 | 2 | 7 | 2 | 7 |
| PP Basal Area | 20 | 27 | 48 | 25 | 44 | 25 | 44 | 27 | 48 |
| GO Basal Area | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| All Basal Area | 22 | 29 | 53 | 28 | 49 | 28 | 49 | 29 | 53 |
| Snags 12-18" DBH | 0.6 | 0.9 | 1.6 | 1.2 | 1.5 | 1.2 | 1.5 | 0.9 | 1.6 |
| Snags >12" DBH | 0.8 | 1.1 | 2.5 | 1.4 | 2.4 | 1.4 | 2.4 | 1.1 | 2.5 |
| Snags >18" DBH | 0.2 | 0.2 | 0.9 | 0.2 | 0.9 | 0.2 | 0.9 | 0.2 | 0.9 |
| CWD | 6.5 | 6.4 | 6.4 | 2.3 | 3.1 | 2.3 | 3.1 | 6.4 | 6.4 |
| Logs per Acre | 0.1 | 0.2 | 1.2 | 0.2 | 1.2 | 0.2 | 1.2 | 0.2 | 1.2 |
| Understory Index | 411 | 359 | 233 | 371 | 252 | 371 | 252 | 359 | 233 |
| **Lockwood** | | | | | | | | | |
| % of SDI 12-18" DBH | 27 | 28 | 27 | 28 | 27 | 28 | 27 | 28 | 27 |
| % of SDI 18-24" DBH | 12 | 14 | 19 | 14 | 19 | 14 | 19 | 14 | 19 |
| % of SDI >24" DBH | 7 | 8 | 10 | 8 | 10 | 8 | 10 | 8 | 10 |
| TPA >18" DBH | 15 | 18 | 26 | 18 | 26 | 18 | 26 | 18 | 26 |
| PP Basal Area | 122 | 126 | 129 | 121 | 126 | 121 | 126 | 126 | 129 |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| PAC | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| GO Basal Area | 25 | 27 | 28 | 27 | 29 | 27 | 29 | 27 | 28 |
| All Basal Area | 171 | 180 | 195 | 174 | 193 | 174 | 193 | 180 | 195 |
| Snags 12-18" DBH | 2.9 | 3.7 | 6.3 | 5.1 | 5.9 | 5.1 | 5.9 | 3.7 | 6.3 |
| Snags >12" DBH | 3.6 | 4.4 | 8.0 | 5.8 | 7.6 | 5.8 | 7.6 | 4.4 | 8.0 |
| Snags >18" DBH | 0.7 | 0.8 | 1.7 | 0.8 | 1.7 | 0.8 | 1.7 | 0.8 | 1.7 |
| CWD | 5.9 | 7.8 | 12.9 | 3.2 | 8.6 | 3.2 | 8.6 | 7.8 | 12.9 |
| Logs per Acre | 1.9 | 3.0 | 7.0 | 1.9 | 6.2 | 1.9 | 6.2 | 3.0 | 7.0 |
| Understory Index | 24 | 21 | 16 | 23 | 16 | 23 | 16 | 21 | 16 |
| **MB Smith** | | | | | | | | | |
| % of SDI 12-18" DBH | 30 | 31 | 29 | 31 | 29 | 31 | 29 | 31 | 29 |
| % of SDI 18-24" DBH | 12 | 14 | 20 | 14 | 21 | 14 | 21 | 14 | 20 |
| % of SDI >24" DBH | 7 | 8 | 10 | 8 | 10 | 8 | 10 | 8 | 10 |
| TPA >18" DBH | 13 | 16 | 26 | 16 | 26 | 16 | 26 | 16 | 26 |
| PP Basal Area | 114 | 119 | 124 | 115 | 122 | 114 | 121 | 119 | 124 |
| GO Basal Area | 20 | 21 | 23 | 22 | 24 | 22 | 24 | 21 | 23 |
| All Basal Area | 155 | 165 | 184 | 160 | 182 | 159 | 182 | 165 | 184 |
| Snags 12-18" DBH | 2.8 | 3.5 | 6.0 | 4.9 | 5.6 | 5.0 | 5.6 | 3.5 | 6.0 |
| Snags >12" DBH | 3.4 | 4.2 | 7.6 | 5.5 | 7.2 | 5.7 | 7.1 | 4.2 | 7.6 |
| Snags >18" DBH | 0.7 | 0.7 | 1.6 | 0.7 | 1.6 | 0.7 | 1.6 | 0.7 | 1.6 |
| CWD | 5.9 | 7.6 | 12.1 | 3.6 | 8.5 | 3.1 | 8.1 | 7.6 | 12.1 |
| Logs per Acre | 2.8 | 3.7 | 7.3 | 2.5 | 6.5 | 2.3 | 6.3 | 3.7 | 7.3 |
| Understory Index | 39 | 32 | 21 | 35 | 21 | 35 | 22 | 32 | 21 |
| **Meadow Tank** | | | | | | | | | |
| % of SDI 12-18" DBH | 25 | 22 | 18 | 22 | 18 | 22 | 18 | 22 | 18 |
| % of SDI 18-24" DBH | 36 | 38 | 33 | 38 | 34 | 38 | 34 | 38 | 33 |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| PAC | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| % of SDI >24" DBH | 13 | 15 | 23 | 16 | 24 | 16 | 24 | 15 | 23 |
| TPA >18" DBH | 31 | 34 | 36 | 34 | 36 | 34 | 37 | 34 | 36 |
| PP Basal Area | 118 | 123 | 132 | 122 | 130 | 121 | 130 | 123 | 132 |
| GO Basal Area | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| All Basal Area | 138 | 145 | 161 | 144 | 160 | 142 | 160 | 145 | 161 |
| Snags 12-18" DBH | 1.4 | 2.5 | 3.1 | 3.0 | 3.1 | 3.4 | 2.9 | 2.5 | 3.1 |
| Snags >12" DBH | 2.1 | 3.7 | 5.9 | 4.2 | 5.8 | 4.5 | 5.6 | 3.7 | 5.9 |
| Snags >18" DBH | 0.7 | 1.2 | 2.7 | 1.2 | 2.7 | 1.2 | 2.7 | 1.2 | 2.7 |
| CWD | 4.2 | 5.1 | 8.5 | 3.8 | 7.5 | 2.1 | 5.8 | 5.1 | 8.5 |
| Logs per Acre | 2.9 | 3.8 | 7.9 | 3.5 | 7.9 | 2.3 | 6.7 | 3.8 | 7.9 |
| Understory Index | 55 | 48 | 34 | 49 | 35 | 49 | 35 | 48 | 34 |
| **Milos Butte** | | | | | | | | | |
| % of SDI 12-18" DBH | 33 | 32 | 27 | 32 | 27 | 32 | 27 | 32 | 27 |
| % of SDI 18-24" DBH | 13 | 16 | 23 | 16 | 23 | 16 | 23 | 16 | 23 |
| % of SDI >24" DBH | 7 | 8 | 11 | 8 | 11 | 8 | 11 | 8 | 11 |
| TPA >18" DBH | 17 | 20 | 31 | 21 | 31 | 21 | 31 | 20 | 31 |
| PP Basal Area | 131 | 135 | 137 | 131 | 134 | 130 | 134 | 135 | 137 |
| GO Basal Area | 22 | 23 | 24 | 23 | 24 | 23 | 25 | 23 | 24 |
| All Basal Area | 176 | 185 | 199 | 180 | 197 | 179 | 197 | 185 | 199 |
| Snags 12-18" DBH | 3.8 | 4.7 | 7.0 | 6.0 | 6.6 | 6.3 | 6.5 | 4.7 | 7.0 |
| Snags >12" DBH | 4.6 | 5.6 | 9.1 | 6.9 | 8.6 | 7.2 | 8.5 | 5.6 | 9.1 |
| Snags >18" DBH | 0.7 | 0.8 | 2.0 | 0.8 | 2.0 | 0.8 | 2.0 | 0.8 | 2.0 |
| CWD | 6.3 | 8.4 | 13.9 | 4.2 | 10.1 | 3.4 | 9.3 | 8.4 | 13.9 |
| Logs per Acre | 2.2 | 3.5 | 8.3 | 2.4 | 7.5 | 2.3 | 7.4 | 3.5 | 8.3 |
| Understory Index | 22 | 19 | 14 | 20 | 15 | 21 | 15 | 19 | 14 |

| PAC | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| **Mint Spring** | | | | | | | | | |
| % of SDI 12-18" DBH | 34 | 34 | 29 | 34 | 29 | 34 | 29 | 34 | 29 |
| % of SDI 18-24" DBH | 13 | 16 | 24 | 17 | 24 | 17 | 24 | 16 | 24 |
| % of SDI >24" DBH | 6 | 7 | 10 | 7 | 10 | 7 | 10 | 7 | 10 |
| TPA >18" DBH | 16 | 19 | 31 | 19 | 31 | 19 | 31 | 19 | 31 |
| PP Basal Area | 128 | 132 | 135 | 128 | 133 | 127 | 133 | 132 | 135 |
| GO Basal Area | 20 | 21 | 22 | 21 | 22 | 21 | 22 | 21 | 22 |
| All Basal Area | 169 | 177 | 193 | 173 | 192 | 171 | 191 | 177 | 193 |
| Snags 12-18" DBH | 3.6 | 4.6 | 7.0 | 5.9 | 6.6 | 6.3 | 6.5 | 4.6 | 7.0 |
| Snags >12" DBH | 4.3 | 5.3 | 8.9 | 6.7 | 8.4 | 7.0 | 8.3 | 5.3 | 8.9 |
| Snags >18" DBH | 0.6 | 0.7 | 1.9 | 0.7 | 1.9 | 0.7 | 1.9 | 0.7 | 1.9 |
| CWD | 6.2 | 8.1 | 13.3 | 4.4 | 9.9 | 3.3 | 9.0 | 8.1 | 13.3 |
| Logs per Acre | 2.3 | 3.5 | 8.1 | 2.5 | 7.4 | 2.3 | 7.2 | 3.5 | 8.1 |
| Understory Index | 29 | 24 | 17 | 26 | 17 | 26 | 18 | 24 | 17 |
| **Moore Well/Rock Dike** | | | | | | | | | |
| % of SDI 12-18" DBH | 31 | 31 | 27 | 31 | 26 | 31 | 26 | 31 | 27 |
| % of SDI 18-24" DBH | 13 | 15 | 22 | 16 | 22 | 16 | 22 | 15 | 22 |
| % of SDI >24" DBH | 10 | 11 | 14 | 11 | 15 | 11 | 15 | 11 | 14 |
| TPA >18" DBH | 17 | 20 | 29 | 20 | 30 | 20 | 30 | 20 | 29 |
| PP Basal Area | 121 | 125 | 127 | 121 | 125 | 120 | 124 | 125 | 127 |
| GO Basal Area | 19 | 19 | 20 | 20 | 21 | 20 | 21 | 19 | 20 |
| All Basal Area | 166 | 174 | 190 | 169 | 188 | 169 | 188 | 174 | 190 |
| Snags 12-18" DBH | 3.0 | 4.1 | 6.3 | 5.3 | 6.0 | 5.6 | 5.9 | 4.1 | 6.3 |
| Snags >12" DBH | 3.8 | 5.0 | 8.4 | 6.2 | 8.1 | 6.4 | 8.0 | 5.0 | 8.4 |
| Snags >18" DBH | 0.7 | 0.9 | 2.1 | 0.9 | 2.1 | 0.9 | 2.1 | 0.9 | 2.1 |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| PAC | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| CWD | 6.5 | 8.3 | 13.4 | 4.3 | 9.9 | 3.5 | 9.1 | 8.3 | 13.4 |
| Logs per Acre | 4.2 | 5.3 | 9.9 | 3.5 | 8.6 | 3.3 | 8.4 | 5.3 | 9.9 |
| Understory Index | 30 | 25 | 18 | 27 | 19 | 28 | 19 | 25 | 18 |
| **Mormon Mountain North** | | | | | | | | | |
| % of SDI 12-18" DBH | 32 | 34 | 31 | 34 | 31 | 34 | 31 | 34 | 31 |
| % of SDI 18-24" DBH | 10 | 13 | 21 | 13 | 21 | 13 | 21 | 13 | 21 |
| % of SDI >24" DBH | 5 | 5 | 7 | 5 | 7 | 5 | 7 | 5 | 7 |
| TPA >18" DBH | 12 | 15 | 26 | 15 | 27 | 15 | 27 | 15 | 26 |
| PP Basal Area | 128 | 133 | 137 | 127 | 134 | 127 | 134 | 133 | 137 |
| GO Basal Area | 24 | 26 | 27 | 26 | 28 | 26 | 28 | 26 | 27 |
| All Basal Area | 171 | 179 | 195 | 174 | 193 | 173 | 193 | 179 | 195 |
| Snags 12-18" DBH | 3.1 | 4.1 | 7.1 | 5.8 | 6.5 | 5.9 | 6.5 | 4.1 | 7.1 |
| Snags >12" DBH | 3.6 | 4.6 | 8.5 | 6.3 | 7.9 | 6.4 | 7.9 | 4.6 | 8.5 |
| Snags >18" DBH | 0.5 | 0.6 | 1.4 | 0.5 | 1.4 | 0.5 | 1.4 | 0.6 | 1.4 |
| CWD | 5.9 | 7.9 | 12.9 | 3.6 | 9.0 | 3.2 | 8.6 | 7.9 | 12.9 |
| Logs per Acre | 1.5 | 2.5 | 6.3 | 1.7 | 5.8 | 1.7 | 5.8 | 2.5 | 6.3 |
| Understory Index | 24 | 21 | 16 | 23 | 16 | 23 | 16 | 21 | 16 |
| **Mt Elden** | | | | | | | | | |
| % of SDI 12-18" DBH | 31 | 32 | 28 | 32 | 28 | 32 | 28 | 32 | 28 |
| % of SDI 18-24" DBH | 12 | 13 | 20 | 14 | 20 | 14 | 21 | 13 | 20 |
| % of SDI >24" DBH | 9 | 10 | 12 | 10 | 12 | 10 | 12 | 10 | 12 |
| TPA >18" DBH | 13 | 16 | 26 | 16 | 26 | 16 | 26 | 16 | 26 |
| PP Basal Area | 113 | 117 | 121 | 113 | 119 | 112 | 118 | 117 | 121 |
| GO Basal Area | 20 | 21 | 22 | 21 | 23 | 21 | 23 | 21 | 22 |
| All Basal Area | 157 | 166 | 185 | 162 | 184 | 161 | 183 | 166 | 185 |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| PAC | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| Snags 12-18" DBH | 2.7 | 3.5 | 6.1 | 4.6 | 5.7 | 5.0 | 5.6 | 3.5 | 6.1 |
| Snags >12" DBH | 3.5 | 4.3 | 7.8 | 5.5 | 7.5 | 5.8 | 7.4 | 4.3 | 7.8 |
| Snags >18" DBH | 0.8 | 0.9 | 1.8 | 0.9 | 1.8 | 0.9 | 1.7 | 0.9 | 1.8 |
| CWD | 6.9 | 8.5 | 13.1 | 5.3 | 10.2 | 3.6 | 8.7 | 8.5 | 13.1 |
| Logs per Acre | 4.8 | 5.7 | 9.3 | 4.8 | 8.7 | 3.4 | 7.7 | 5.7 | 9.3 |
| Understory Index | 36 | 30 | 20 | 31 | 20 | 32 | 21 | 30 | 20 |
| **Mustang** | | | | | | | | | |
| % of SDI 12-18" DBH | 34 | 35 | 27 | 35 | 27 | 35 | 27 | 35 | 27 |
| % of SDI 18-24" DBH | 13 | 16 | 24 | 16 | 24 | 16 | 24 | 16 | 24 |
| % of SDI >24" DBH | 7 | 8 | 13 | 8 | 13 | 8 | 13 | 8 | 13 |
| TPA >18" DBH | 12 | 15 | 27 | 15 | 27 | 15 | 27 | 15 | 27 |
| PP Basal Area | 93 | 98 | 104 | 95 | 101 | 94 | 101 | 98 | 104 |
| GO Basal Area | 14 | 15 | 17 | 15 | 18 | 15 | 18 | 15 | 17 |
| All Basal Area | 136 | 146 | 167 | 143 | 165 | 142 | 165 | 146 | 167 |
| Snags 12-18" DBH | 2.3 | 3.2 | 6.0 | 4.2 | 5.7 | 4.5 | 5.6 | 3.2 | 6.0 |
| Snags >12" DBH | 2.8 | 3.7 | 7.7 | 4.8 | 7.4 | 5.1 | 7.3 | 3.7 | 7.7 |
| Snags >18" DBH | 0.5 | 0.6 | 1.7 | 0.6 | 1.7 | 0.6 | 1.7 | 0.6 | 1.7 |
| CWD | 5.9 | 7.3 | 11.7 | 3.7 | 8.6 | 3.0 | 7.9 | 7.3 | 11.7 |
| Logs per Acre | 3.8 | 4.7 | 8.7 | 3.1 | 7.5 | 2.8 | 7.3 | 4.7 | 8.7 |
| Understory Index | 50 | 41 | 27 | 43 | 28 | 44 | 28 | 41 | 27 |
| **Nestor** | | | | | | | | | |
| % of SDI 12-18" DBH | 34 | 33 | 27 | 33 | 27 | 33 | 27 | 33 | 27 |
| % of SDI 18-24" DBH | 13 | 16 | 24 | 17 | 24 | 17 | 24 | 16 | 24 |
| % of SDI >24" DBH | 7 | 8 | 11 | 8 | 11 | 8 | 11 | 8 | 11 |
| TPA >18" DBH | 16 | 20 | 31 | 20 | 31 | 20 | 31 | 20 | 31 |

| PAC | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| PP Basal Area | 127 | 131 | 134 | 127 | 131 | 126 | 131 | 131 | 134 |
| GO Basal Area | 21 | 21 | 22 | 21 | 23 | 21 | 23 | 21 | 22 |
| All Basal Area | 170 | 179 | 194 | 174 | 193 | 173 | 192 | 179 | 194 |
| Snags 12-18" DBH | 3.8 | 4.7 | 7.0 | 6.1 | 6.6 | 6.3 | 6.5 | 4.7 | 7.0 |
| Snags >12" DBH | 4.5 | 5.5 | 9.0 | 6.8 | 8.6 | 7.1 | 8.5 | 5.5 | 9.0 |
| Snags >18" DBH | 0.7 | 0.8 | 2.0 | 0.8 | 2.0 | 0.8 | 2.0 | 0.8 | 2.0 |
| CWD | 6.2 | 8.2 | 13.6 | 4.2 | 9.9 | 3.3 | 9.1 | 8.2 | 13.6 |
| Logs per Acre | 2.2 | 3.5 | 8.4 | 2.5 | 7.6 | 2.3 | 7.4 | 3.5 | 8.4 |
| Understory Index | 26 | 22 | 16 | 24 | 17 | 25 | 17 | 22 | 16 |
| **O'Leary Peak** | | | | | | | | | |
| % of SDI 12-18" DBH | 36 | 36 | 27 | 36 | 27 | 36 | 27 | 36 | 27 |
| % of SDI 18-24" DBH | 15 | 17 | 26 | 18 | 26 | 18 | 26 | 17 | 26 |
| % of SDI >24" DBH | 8 | 9 | 15 | 9 | 15 | 9 | 15 | 9 | 15 |
| TPA >18" DBH | 12 | 15 | 27 | 15 | 27 | 15 | 27 | 15 | 27 |
| PP Basal Area | 78 | 84 | 90 | 80 | 88 | 80 | 88 | 84 | 90 |
| GO Basal Area | 8 | 9 | 12 | 9 | 12 | 9 | 12 | 9 | 12 |
| All Basal Area | 117 | 129 | 153 | 125 | 151 | 125 | 151 | 129 | 153 |
| Snags 12-18" DBH | 2.2 | 2.9 | 5.5 | 4.1 | 5.2 | 4.1 | 5.2 | 2.9 | 5.5 |
| Snags >12" DBH | 2.7 | 3.5 | 7.3 | 4.7 | 7.0 | 4.7 | 7.0 | 3.5 | 7.3 |
| Snags >18" DBH | 0.5 | 0.6 | 1.8 | 0.6 | 1.8 | 0.6 | 1.8 | 0.6 | 1.8 |
| CWD | 5.8 | 7.0 | 10.9 | 2.8 | 7.5 | 2.8 | 7.5 | 7.0 | 10.9 |
| Logs per Acre | 4.6 | 5.5 | 9.5 | 3.3 | 7.9 | 3.3 | 7.9 | 5.5 | 9.5 |
| Understory Index | 80 | 63 | 37 | 69 | 39 | 69 | 39 | 63 | 37 |
| **Orion Spring** | | | | | | | | | |
| % of SDI 12-18" DBH | 30 | 31 | 30 | 31 | 29 | 31 | 29 | 31 | 30 |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| PAC | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| % of SDI 18-24" DBH | 13 | 15 | 21 | 15 | 21 | 15 | 21 | 15 | 21 |
| % of SDI >24" DBH | 6 | 6 | 10 | 7 | 10 | 7 | 10 | 6 | 10 |
| TPA >18" DBH | 12 | 15 | 25 | 15 | 25 | 15 | 25 | 15 | 25 |
| PP Basal Area | 105 | 111 | 119 | 106 | 116 | 106 | 116 | 111 | 119 |
| GO Basal Area | 16 | 17 | 19 | 17 | 20 | 17 | 20 | 17 | 19 |
| All Basal Area | 138 | 149 | 172 | 144 | 170 | 144 | 170 | 149 | 172 |
| Snags 12-18" DBH | 3.0 | 3.4 | 5.3 | 4.7 | 5.0 | 4.7 | 5.0 | 3.4 | 5.3 |
| Snags >12" DBH | 3.5 | 3.9 | 6.8 | 5.3 | 6.4 | 5.3 | 6.4 | 3.9 | 6.8 |
| Snags >18" DBH | 0.5 | 0.5 | 1.4 | 0.5 | 1.4 | 0.5 | 1.4 | 0.5 | 1.4 |
| CWD | 4.9 | 6.3 | 10.3 | 2.5 | 6.9 | 2.5 | 6.9 | 6.3 | 10.3 |
| Logs per Acre | 1.4 | 2.3 | 5.7 | 1.5 | 5.2 | 1.5 | 5.2 | 2.3 | 5.7 |
| Understory Index | 58 | 46 | 27 | 50 | 28 | 50 | 28 | 46 | 27 |
| **Pierce Tank** | | | | | | | | | |
| % of SDI 12-18" DBH | 36 | 36 | 31 | 36 | 30 | 36 | 30 | 36 | 31 |
| % of SDI 18-24" DBH | 13 | 16 | 24 | 16 | 25 | 16 | 25 | 16 | 24 |
| % of SDI >24" DBH | 5 | 5 | 9 | 5 | 9 | 6 | 9 | 5 | 9 |
| TPA >18" DBH | 15 | 18 | 30 | 18 | 31 | 18 | 31 | 18 | 30 |
| PP Basal Area | 131 | 136 | 141 | 131 | 138 | 130 | 138 | 136 | 141 |
| GO Basal Area | 20 | 21 | 22 | 21 | 22 | 21 | 22 | 21 | 22 |
| All Basal Area | 170 | 178 | 195 | 173 | 193 | 173 | 193 | 178 | 195 |
| Snags 12-18" DBH | 3.6 | 4.7 | 7.3 | 6.5 | 6.7 | 6.6 | 6.6 | 4.7 | 7.3 |
| Snags >12" DBH | 4.1 | 5.3 | 9.0 | 7.1 | 8.4 | 7.2 | 8.3 | 5.3 | 9.0 |
| Snags >18" DBH | 0.5 | 0.6 | 1.7 | 0.6 | 1.7 | 0.6 | 1.7 | 0.6 | 1.7 |
| CWD | 6.1 | 8.0 | 13.2 | 3.6 | 9.1 | 3.3 | 8.9 | 8.0 | 13.2 |
| Logs per Acre | 2.1 | 3.3 | 7.7 | 2.2 | 6.9 | 2.1 | 6.9 | 3.3 | 7.7 |

| PAC | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| Understory Index | 28 | 23 | 16 | 25 | 17 | 25 | 17 | 23 | 16 |
| **Powerline Tank** | | | | | | | | | |
| % of SDI 12-18" DBH | 25 | 28 | 31 | 28 | 31 | 28 | 31 | 28 | 31 |
| % of SDI 18-24" DBH | 11 | 12 | 16 | 12 | 17 | 12 | 17 | 12 | 16 |
| % of SDI >24" DBH | 6 | 6 | 8 | 6 | 8 | 6 | 8 | 6 | 8 |
| TPA >18" DBH | 10 | 12 | 20 | 12 | 20 | 12 | 20 | 12 | 20 |
| PP Basal Area | 100 | 107 | 115 | 102 | 112 | 101 | 112 | 107 | 115 |
| GO Basal Area | 20 | 22 | 25 | 22 | 26 | 22 | 26 | 22 | 25 |
| All Basal Area | 139 | 150 | 173 | 145 | 171 | 144 | 171 | 150 | 173 |
| Snags 12-18" DBH | 1.9 | 2.3 | 4.8 | 3.3 | 4.6 | 3.5 | 4.6 | 2.3 | 4.8 |
| Snags >12" DBH | 2.4 | 2.8 | 5.9 | 3.7 | 5.7 | 4.0 | 5.6 | 2.8 | 5.9 |
| Snags >18" DBH | 0.5 | 0.4 | 1.1 | 0.4 | 1.1 | 0.4 | 1.1 | 0.4 | 1.1 |
| CWD | 4.7 | 6.0 | 9.7 | 3.1 | 7.0 | 2.4 | 6.4 | 6.0 | 9.7 |
| Logs per Acre | 1.2 | 1.8 | 4.2 | 1.3 | 3.9 | 1.2 | 3.8 | 1.8 | 4.2 |
| Understory Index | 54 | 43 | 26 | 47 | 27 | 48 | 27 | 43 | 26 |
| **Pumphouse Wash** | | | | | | | | | |
| % of SDI 12-18" DBH | 33 | 33 | 29 | 33 | 29 | 33 | 29 | 33 | 29 |
| % of SDI 18-24" DBH | 14 | 16 | 23 | 16 | 23 | 17 | 23 | 16 | 23 |
| % of SDI >24" DBH | 8 | 8 | 11 | 8 | 12 | 8 | 12 | 8 | 11 |
| TPA >18" DBH | 17 | 20 | 31 | 20 | 31 | 20 | 31 | 20 | 31 |
| PP Basal Area | 133 | 137 | 140 | 133 | 138 | 132 | 137 | 137 | 140 |
| GO Basal Area | 21 | 22 | 22 | 22 | 23 | 22 | 23 | 22 | 22 |
| All Basal Area | 174 | 181 | 196 | 177 | 195 | 176 | 194 | 181 | 196 |
| Snags 12-18" DBH | 3.3 | 4.6 | 7.0 | 6.0 | 6.5 | 6.3 | 6.4 | 4.6 | 7.0 |
| Snags >12" DBH | 4.0 | 5.3 | 8.9 | 6.8 | 8.4 | 7.0 | 8.3 | 5.3 | 8.9 |

| PAC | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| Snags >18" DBH | 0.6 | 0.8 | 1.9 | 0.8 | 1.9 | 0.8 | 1.9 | 0.8 | 1.9 |
| CWD | 6.4 | 8.4 | 13.6 | 4.3 | 9.9 | 3.5 | 9.2 | 8.4 | 13.6 |
| Logs per Acre | 3.3 | 4.4 | 8.9 | 3.2 | 8.0 | 2.8 | 7.7 | 4.4 | 8.9 |
| Understory Index | 78 | 72 | 62 | 75 | 63 | 76 | 63 | 72 | 62 |
| **Racetrack Tank** | | | | | | | | | |
| % of SDI 12-18" DBH | 27 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 |
| % of SDI 18-24" DBH | 11 | 13 | 18 | 13 | 18 | 13 | 19 | 13 | 18 |
| % of SDI >24" DBH | 7 | 7 | 9 | 7 | 10 | 7 | 10 | 7 | 9 |
| TPA >18" DBH | 13 | 16 | 24 | 16 | 24 | 16 | 24 | 16 | 24 |
| PP Basal Area | 115 | 119 | 123 | 115 | 121 | 114 | 120 | 119 | 123 |
| GO Basal Area | 25 | 26 | 28 | 26 | 29 | 26 | 29 | 26 | 28 |
| All Basal Area | 162 | 171 | 188 | 167 | 187 | 165 | 186 | 171 | 188 |
| Snags 12-18" DBH | 2.4 | 3.2 | 5.9 | 4.3 | 5.6 | 4.5 | 5.6 | 3.2 | 5.9 |
| Snags >12" DBH | 3.0 | 3.8 | 7.4 | 4.9 | 7.1 | 5.2 | 7.1 | 3.8 | 7.4 |
| Snags >18" DBH | 0.6 | 0.7 | 1.5 | 0.6 | 1.5 | 0.6 | 1.5 | 0.7 | 1.5 |
| CWD | 5.6 | 7.4 | 12.1 | 3.7 | 8.7 | 3.0 | 8.0 | 7.4 | 12.1 |
| Logs per Acre | 1.9 | 2.8 | 6.2 | 1.9 | 5.6 | 1.8 | 5.5 | 2.8 | 6.2 |
| Understory Index | 31 | 26 | 18 | 28 | 19 | 28 | 19 | 26 | 18 |
| **Rattlesnake** | | | | | | | | | |
| % of SDI 12-18" DBH | 36 | 35 | 26 | 35 | 26 | 35 | 26 | 35 | 26 |
| % of SDI 18-24" DBH | 15 | 18 | 26 | 18 | 26 | 18 | 26 | 18 | 26 |
| % of SDI >24" DBH | 8 | 9 | 14 | 9 | 14 | 9 | 15 | 9 | 14 |
| TPA >18" DBH | 15 | 19 | 31 | 19 | 31 | 19 | 31 | 19 | 31 |
| PP Basal Area | 103 | 107 | 110 | 104 | 108 | 104 | 108 | 107 | 110 |
| GO Basal Area | 14 | 14 | 15 | 14 | 16 | 14 | 16 | 14 | 15 |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| PAC | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| All Basal Area | 146 | 156 | 175 | 152 | 173 | 152 | 173 | 156 | 175 |
| Snags 12-18" DBH | 3.2 | 4.0 | 6.4 | 5.3 | 6.0 | 5.4 | 6.0 | 4.0 | 6.4 |
| Snags >12" DBH | 3.8 | 4.8 | 8.5 | 6.1 | 8.2 | 6.2 | 8.1 | 4.8 | 8.5 |
| Snags >18" DBH | 0.7 | 0.8 | 2.2 | 0.8 | 2.2 | 0.8 | 2.2 | 0.8 | 2.2 |
| CWD | 6.3 | 8.0 | 12.9 | 3.6 | 9.0 | 3.2 | 8.8 | 8.0 | 12.9 |
| Logs per Acre | 4.1 | 5.2 | 10.1 | 3.4 | 8.7 | 3.2 | 8.6 | 5.2 | 10.1 |
| Understory Index | 43 | 35 | 24 | 38 | 25 | 38 | 25 | 35 | 24 |
| **Roundup** | | | | | | | | | |
| % of SDI 12-18" DBH | 36 | 36 | 29 | 36 | 28 | 36 | 28 | 36 | 29 |
| % of SDI 18-24" DBH | 14 | 17 | 25 | 17 | 26 | 18 | 26 | 17 | 25 |
| % of SDI >24" DBH | 7 | 8 | 12 | 8 | 12 | 8 | 12 | 8 | 12 |
| TPA >18" DBH | 14 | 18 | 30 | 18 | 30 | 18 | 30 | 18 | 30 |
| PP Basal Area | 113 | 117 | 122 | 114 | 120 | 113 | 119 | 117 | 122 |
| GO Basal Area | 16 | 17 | 18 | 17 | 18 | 17 | 19 | 17 | 18 |
| All Basal Area | 152 | 161 | 179 | 158 | 178 | 157 | 177 | 161 | 179 |
| Snags 12-18" DBH | 3.1 | 4.1 | 6.6 | 5.3 | 6.3 | 5.7 | 6.2 | 4.1 | 6.6 |
| Snags >12" DBH | 3.7 | 4.7 | 8.5 | 5.9 | 8.1 | 6.4 | 8.0 | 4.7 | 8.5 |
| Snags >18" DBH | 0.6 | 0.6 | 1.8 | 0.6 | 1.8 | 0.6 | 1.8 | 0.6 | 1.8 |
| CWD | 6.0 | 7.7 | 12.5 | 4.2 | 9.4 | 3.1 | 8.5 | 7.7 | 12.5 |
| Logs per Acre | 3.0 | 4.1 | 8.5 | 2.8 | 7.6 | 2.5 | 7.5 | 4.1 | 8.5 |
| Understory Index | 39 | 33 | 23 | 35 | 23 | 35 | 23 | 33 | 23 |
| **Schultz Creek** | | | | | | | | | |
| % of SDI 12-18" DBH | 23 | 20 | 19 | 20 | 19 | 20 | 19 | 20 | 19 |
| % of SDI 18-24" DBH | 21 | 21 | 19 | 22 | 20 | 22 | 20 | 21 | 19 |
| % of SDI >24" DBH | 7 | 9 | 14 | 9 | 14 | 9 | 14 | 9 | 14 |

| PAC | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| TPA >18" DBH | 20 | 22 | 26 | 23 | 26 | 23 | 26 | 22 | 26 |
| PP Basal Area | 101 | 105 | 118 | 101 | 114 | 101 | 114 | 105 | 118 |
| GO Basal Area | 17 | 17 | 18 | 17 | 19 | 17 | 19 | 17 | 18 |
| All Basal Area | 139 | 151 | 176 | 146 | 173 | 146 | 173 | 151 | 176 |
| Snags 12-18" DBH | 1.7 | 2.7 | 4.0 | 3.6 | 3.6 | 3.6 | 3.6 | 2.7 | 4.0 |
| Snags >12" DBH | 2.1 | 3.5 | 5.8 | 4.3 | 5.4 | 4.3 | 5.4 | 3.5 | 5.8 |
| Snags >18" DBH | 0.4 | 0.7 | 1.8 | 0.7 | 1.7 | 0.7 | 1.7 | 0.7 | 1.8 |
| CWD | 4.4 | 5.6 | 9.3 | 2.3 | 6.4 | 2.3 | 6.4 | 5.6 | 9.3 |
| Logs per Acre | 2.7 | 3.5 | 6.8 | 2.2 | 5.7 | 2.2 | 5.7 | 3.5 | 6.8 |
| Understory Index | 59 | 43 | 24 | 47 | 26 | 47 | 26 | 43 | 24 |
| **Spruce Tank** | | | | | | | | | |
| % of SDI 12-18" DBH | 34 | 35 | 30 | 35 | 30 | 35 | 30 | 35 | 30 |
| % of SDI 18-24" DBH | 12 | 15 | 23 | 15 | 23 | 15 | 23 | 15 | 23 |
| % of SDI >24" DBH | 6 | 6 | 10 | 6 | 10 | 6 | 10 | 6 | 10 |
| TPA >18" DBH | 13 | 16 | 27 | 16 | 28 | 16 | 28 | 16 | 27 |
| PP Basal Area | 112 | 117 | 123 | 113 | 121 | 113 | 121 | 117 | 123 |
| GO Basal Area | 17 | 18 | 20 | 18 | 20 | 18 | 21 | 18 | 20 |
| All Basal Area | 150 | 160 | 180 | 155 | 178 | 154 | 178 | 160 | 180 |
| Snags 12-18" DBH | 3.1 | 3.9 | 6.4 | 5.3 | 5.9 | 5.5 | 5.9 | 3.9 | 6.4 |
| Snags >12" DBH | 3.6 | 4.4 | 7.9 | 5.8 | 7.5 | 6.0 | 7.5 | 4.4 | 7.9 |
| Snags >18" DBH | 0.5 | 0.6 | 1.6 | 0.5 | 1.5 | 0.5 | 1.5 | 0.6 | 1.6 |
| CWD | 5.7 | 7.3 | 11.9 | 3.4 | 8.4 | 3.0 | 8.0 | 7.3 | 11.9 |
| Logs per Acre | 2.2 | 3.2 | 7.1 | 2.1 | 6.4 | 2.0 | 6.3 | 3.2 | 7.1 |
| Understory Index | 43 | 35 | 23 | 38 | 24 | 39 | 24 | 35 | 23 |
| **Sterling** | | | | | | | | | |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| PAC | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| % of SDI 12-18" DBH | 21 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 |
| % of SDI 18-24" DBH | 10 | 11 | 13 | 11 | 13 | 11 | 13 | 11 | 13 |
| % of SDI >24" DBH | 23 | 24 | 24 | 24 | 25 | 24 | 25 | 24 | 24 |
| TPA >18" DBH | 19 | 20 | 25 | 20 | 25 | 20 | 25 | 20 | 25 |
| PP Basal Area | 126 | 127 | 128 | 122 | 125 | 122 | 125 | 127 | 128 |
| GO Basal Area | 16 | 17 | 19 | 17 | 19 | 17 | 19 | 17 | 19 |
| All Basal Area | 165 | 171 | 187 | 165 | 185 | 165 | 185 | 171 | 187 |
| Snags 12-18" DBH | 1.6 | 3.2 | 4.7 | 4.6 | 4.3 | 4.6 | 4.3 | 3.2 | 4.7 |
| Snags >12" DBH | 2.8 | 4.6 | 6.9 | 5.9 | 6.5 | 5.9 | 6.5 | 4.6 | 6.9 |
| Snags >18" DBH | 1.2 | 1.3 | 2.2 | 1.3 | 2.2 | 1.3 | 2.2 | 1.3 | 2.2 |
| CWD | 7.8 | 9.4 | 13.8 | 4.4 | 9.5 | 4.4 | 9.5 | 9.4 | 13.8 |
| Logs per Acre | 10.4 | 11.1 | 14.4 | 6.6 | 11.1 | 6.6 | 11.1 | 11.1 | 14.4 |
| Understory Index | 62 | 55 | 41 | 58 | 42 | 58 | 42 | 55 | 41 |
| **Stock Tank** | | | | | | | | | |
| % of SDI 12-18" DBH | 26 | 27 | 31 | 28 | 31 | 28 | 31 | 27 | 31 |
| % of SDI 18-24" DBH | 17 | 19 | 23 | 19 | 23 | 20 | 23 | 19 | 23 |
| % of SDI >24" DBH | 8 | 9 | 13 | 9 | 13 | 9 | 13 | 9 | 13 |
| TPA >18" DBH | 12 | 13 | 19 | 13 | 19 | 13 | 19 | 13 | 19 |
| PP Basal Area | 71 | 78 | 93 | 76 | 91 | 75 | 90 | 78 | 93 |
| GO Basal Area | 8 | 9 | 12 | 9 | 12 | 9 | 12 | 9 | 12 |
| All Basal Area | 89 | 100 | 127 | 97 | 124 | 96 | 124 | 100 | 127 |
| Snags 12-18" DBH | 1.2 | 1.3 | 2.5 | 1.9 | 2.4 | 2.1 | 2.4 | 1.3 | 2.5 |
| Snags >12" DBH | 1.7 | 1.8 | 3.7 | 2.4 | 3.7 | 2.6 | 3.6 | 1.8 | 3.7 |
| Snags >18" DBH | 0.4 | 0.5 | 1.3 | 0.5 | 1.2 | 0.5 | 1.2 | 0.5 | 1.3 |
| CWD | 3.8 | 4.3 | 6.2 | 2.3 | 4.6 | 1.6 | 4.0 | 4.3 | 6.2 |

| PAC | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| Logs per Acre | 0.4 | 0.9 | 2.9 | 0.7 | 2.9 | 0.6 | 2.8 | 0.9 | 2.9 |
| Understory Index | 146 | 123 | 77 | 128 | 81 | 129 | 82 | 123 | 77 |
| **T Bird** | | | | | | | | | |
| % of SDI 12-18" DBH | 32 | 34 | 32 | 34 | 32 | 34 | 32 | 34 | 32 |
| % of SDI 18-24" DBH | 10 | 12 | 20 | 13 | 21 | 13 | 21 | 12 | 20 |
| % of SDI >24" DBH | 5 | 5 | 7 | 5 | 7 | 5 | 7 | 5 | 7 |
| TPA >18" DBH | 12 | 15 | 26 | 15 | 26 | 15 | 26 | 15 | 26 |
| PP Basal Area | 128 | 133 | 138 | 128 | 135 | 127 | 135 | 133 | 138 |
| GO Basal Area | 25 | 26 | 28 | 26 | 28 | 26 | 29 | 26 | 28 |
| All Basal Area | 172 | 181 | 196 | 176 | 195 | 175 | 195 | 181 | 196 |
| Snags 12-18" DBH | 3.0 | 4.0 | 7.0 | 5.4 | 6.6 | 5.8 | 6.4 | 4.0 | 7.0 |
| Snags >12" DBH | 3.5 | 4.5 | 8.4 | 5.9 | 7.9 | 6.3 | 7.8 | 4.5 | 8.4 |
| Snags >18" DBH | 0.5 | 0.6 | 1.4 | 0.5 | 1.4 | 0.5 | 1.4 | 0.6 | 1.4 |
| CWD | 6.0 | 7.9 | 13.0 | 4.1 | 9.4 | 3.3 | 8.6 | 7.9 | 13.0 |
| Logs per Acre | 1.6 | 2.6 | 6.3 | 1.8 | 5.8 | 1.7 | 5.7 | 2.6 | 6.3 |
| Understory Index | 23 | 20 | 15 | 22 | 15 | 22 | 16 | 20 | 15 |
| **Two Holes** | | | | | | | | | |
| % of SDI 12-18" DBH | 33 | 32 | 27 | 32 | 27 | 32 | 27 | 32 | 27 |
| % of SDI 18-24" DBH | 13 | 16 | 23 | 16 | 23 | 16 | 23 | 16 | 23 |
| % of SDI >24" DBH | 7 | 8 | 11 | 8 | 11 | 8 | 11 | 8 | 11 |
| TPA >18" DBH | 16 | 19 | 30 | 20 | 30 | 20 | 30 | 19 | 30 |
| PP Basal Area | 124 | 128 | 131 | 124 | 129 | 123 | 128 | 128 | 131 |
| GO Basal Area | 20 | 21 | 22 | 21 | 23 | 21 | 23 | 21 | 22 |
| All Basal Area | 166 | 175 | 192 | 171 | 190 | 170 | 190 | 175 | 192 |
| Snags 12-18" DBH | 3.7 | 4.5 | 6.7 | 5.7 | 6.3 | 6.0 | 6.2 | 4.5 | 6.7 |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| **PAC** | **2010** | **2020** | **2050** | **2020** | **2050** | **2020** | **2050** | **2020** | **2050** |
| Snags >12" DBH | 4.3 | 5.2 | 8.6 | 6.5 | 8.2 | 6.8 | 8.1 | 5.2 | 8.6 |
| Snags >18" DBH | 0.7 | 0.8 | 1.9 | 0.8 | 1.9 | 0.8 | 1.9 | 0.8 | 1.9 |
| CWD | 5.9 | 7.9 | 13.1 | 4.1 | 9.7 | 3.2 | 8.8 | 7.9 | 13.1 |
| Logs per Acre | 2.1 | 3.3 | 7.9 | 2.4 | 7.2 | 2.1 | 7.1 | 3.3 | 7.9 |
| Understory Index | 30 | 25 | 17 | 27 | 18 | 27 | 18 | 25 | 17 |
| **Upper West Fork** | | | | | | | | | |
| % of SDI 12-18" DBH | 35 | 34 | 28 | 34 | 27 | 34 | 27 | 34 | 28 |
| % of SDI 18-24" DBH | 13 | 16 | 24 | 17 | 25 | 17 | 25 | 16 | 24 |
| % of SDI >24" DBH | 9 | 9 | 12 | 9 | 12 | 9 | 12 | 9 | 12 |
| TPA >18" DBH | 17 | 22 | 33 | 22 | 33 | 22 | 33 | 22 | 33 |
| PP Basal Area | 136 | 139 | 141 | 135 | 138 | 134 | 138 | 139 | 141 |
| GO Basal Area | 20 | 20 | 21 | 20 | 21 | 20 | 21 | 20 | 21 |
| All Basal Area | 177 | 185 | 199 | 180 | 198 | 180 | 198 | 185 | 199 |
| Snags 12-18" DBH | 4.2 | 5.2 | 7.3 | 6.7 | 6.8 | 7.0 | 6.7 | 5.2 | 7.3 |
| Snags >12" DBH | 5.0 | 6.1 | 9.5 | 7.5 | 9.0 | 7.9 | 8.9 | 6.1 | 9.5 |
| Snags >18" DBH | 0.8 | 0.9 | 2.2 | 0.9 | 2.2 | 0.9 | 2.2 | 0.9 | 2.2 |
| CWD | 6.7 | 8.8 | 14.4 | 4.4 | 10.4 | 3.6 | 9.7 | 8.8 | 14.4 |
| Logs per Acre | 3.2 | 4.5 | 9.7 | 3.0 | 8.5 | 2.9 | 8.5 | 4.5 | 9.7 |
| Understory Index | 90 | 84 | 74 | 87 | 75 | 88 | 75 | 84 | 74 |
| **Volunteer** | | | | | | | | | |
| % of SDI 12-18" DBH | 32 | 31 | 26 | 31 | 26 | 31 | 26 | 31 | 26 |
| % of SDI 18-24" DBH | 17 | 20 | 25 | 20 | 25 | 20 | 25 | 20 | 25 |
| % of SDI >24" DBH | 9 | 9 | 13 | 10 | 14 | 10 | 14 | 9 | 13 |
| TPA >18" DBH | 19 | 23 | 32 | 23 | 32 | 23 | 32 | 23 | 32 |
| PP Basal Area | 125 | 129 | 133 | 126 | 131 | 125 | 130 | 129 | 133 |

| PAC | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| GO Basal Area | 19 | 19 | 20 | 19 | 20 | 19 | 21 | 19 | 20 |
| All Basal Area | 165 | 173 | 189 | 169 | 188 | 169 | 188 | 173 | 189 |
| Snags 12-18" DBH | 3.2 | 4.2 | 6.3 | 5.5 | 5.9 | 5.7 | 5.8 | 4.2 | 6.3 |
| Snags >12" DBH | 4.0 | 5.2 | 8.5 | 6.4 | 8.1 | 6.6 | 8.0 | 5.2 | 8.5 |
| Snags >18" DBH | 0.8 | 1.0 | 2.2 | 0.9 | 2.2 | 0.9 | 2.2 | 1.0 | 2.2 |
| CWD | 6.4 | 8.2 | 13.1 | 4.4 | 9.7 | 3.4 | 8.8 | 8.2 | 13.1 |
| Logs per Acre | 3.8 | 4.9 | 9.5 | 3.6 | 8.5 | 3.1 | 8.0 | 4.9 | 9.5 |
| Understory Index | 107 | 97 | 81 | 100 | 82 | 101 | 82 | 97 | 81 |
| **Walnut 33** | | | | | | | | | |
| % of SDI 12-18" DBH | 23 | 23 | 25 | 24 | 25 | 24 | 25 | 23 | 25 |
| % of SDI 18-24" DBH | 11 | 12 | 16 | 13 | 17 | 13 | 17 | 12 | 16 |
| % of SDI >24" DBH | 8 | 8 | 10 | 8 | 10 | 9 | 10 | 8 | 10 |
| TPA >18" DBH | 13 | 16 | 22 | 16 | 22 | 16 | 22 | 16 | 22 |
| PP Basal Area | 111 | 115 | 117 | 111 | 115 | 110 | 114 | 115 | 117 |
| GO Basal Area | 27 | 29 | 31 | 29 | 32 | 29 | 33 | 29 | 31 |
| All Basal Area | 159 | 169 | 185 | 165 | 184 | 163 | 184 | 169 | 185 |
| Snags 12-18" DBH | 2.2 | 2.8 | 5.6 | 3.7 | 5.4 | 4.0 | 5.3 | 2.8 | 5.6 |
| Snags >12" DBH | 2.9 | 3.5 | 7.1 | 4.4 | 6.8 | 4.6 | 6.8 | 3.5 | 7.1 |
| Snags >18" DBH | 0.7 | 0.7 | 1.4 | 0.7 | 1.4 | 0.7 | 1.4 | 0.7 | 1.4 |
| CWD | 5.3 | 7.1 | 11.7 | 3.8 | 8.7 | 2.9 | 7.8 | 7.1 | 11.7 |
| Logs per Acre | 1.3 | 2.3 | 5.5 | 1.6 | 5.1 | 1.5 | 5.0 | 2.3 | 5.5 |
| Understory Index | 120 | 109 | 94 | 114 | 95 | 115 | 96 | 109 | 94 |
| **Weimer Springs** | | | | | | | | | |
| % of SDI 12-18" DBH | 33 | 33 | 29 | 33 | 29 | 33 | 29 | 33 | 29 |
| % of SDI 18-24" DBH | 12 | 14 | 22 | 15 | 22 | 15 | 22 | 14 | 22 |

| PAC | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| % of SDI >24" DBH | 6 | 6 | 9 | 7 | 9 | 7 | 9 | 6 | 9 |
| TPA >18" DBH | 13 | 17 | 28 | 17 | 28 | 17 | 28 | 17 | 28 |
| PP Basal Area | 125 | 129 | 132 | 124 | 130 | 124 | 130 | 129 | 132 |
| GO Basal Area | 22 | 23 | 25 | 24 | 26 | 24 | 26 | 23 | 25 |
| All Basal Area | 166 | 175 | 191 | 169 | 189 | 169 | 189 | 175 | 191 |
| Snags 12-18" DBH | 3.4 | 4.3 | 7.0 | 5.9 | 6.5 | 6.0 | 6.5 | 4.3 | 7.0 |
| Snags >12" DBH | 4.0 | 4.9 | 8.6 | 6.6 | 8.1 | 6.6 | 8.1 | 4.9 | 8.6 |
| Snags >18" DBH | 0.6 | 0.6 | 1.6 | 0.6 | 1.6 | 0.6 | 1.6 | 0.6 | 1.6 |
| CWD | 5.9 | 7.8 | 13.0 | 3.3 | 8.8 | 3.2 | 8.7 | 7.8 | 13.0 |
| Logs per Acre | 1.7 | 2.8 | 7.0 | 1.9 | 6.3 | 1.8 | 6.3 | 2.8 | 7.0 |
| Understory Index | 27 | 23 | 17 | 25 | 17 | 25 | 17 | 23 | 17 |
| **Weir** | | | | | | | | | |
| % of SDI 12-18" DBH | 32 | 34 | 29 | 34 | 29 | 34 | 29 | 34 | 29 |
| % of SDI 18-24" DBH | 12 | 14 | 22 | 15 | 22 | 15 | 22 | 14 | 22 |
| % of SDI >24" DBH | 6 | 7 | 11 | 7 | 11 | 7 | 11 | 7 | 11 |
| TPA >18" DBH | 11 | 14 | 25 | 14 | 25 | 14 | 25 | 14 | 25 |
| PP Basal Area | 98 | 103 | 109 | 99 | 106 | 99 | 106 | 103 | 109 |
| GO Basal Area | 17 | 18 | 21 | 19 | 21 | 19 | 21 | 18 | 21 |
| All Basal Area | 141 | 152 | 172 | 147 | 170 | 147 | 170 | 152 | 172 |
| Snags 12-18" DBH | 2.1 | 2.9 | 5.9 | 4.3 | 5.6 | 4.3 | 5.6 | 2.9 | 5.9 |
| Snags >12" DBH | 2.6 | 3.5 | 7.5 | 4.8 | 7.1 | 4.9 | 7.1 | 3.5 | 7.5 |
| Snags >18" DBH | 0.5 | 0.5 | 1.5 | 0.5 | 1.5 | 0.5 | 1.5 | 0.5 | 1.5 |
| CWD | 5.8 | 7.3 | 11.6 | 3.3 | 8.1 | 3.0 | 7.8 | 7.3 | 11.6 |
| Logs per Acre | 3.3 | 4.1 | 7.6 | 2.6 | 6.6 | 2.5 | 6.5 | 4.1 | 7.6 |
| Understory Index | 46 | 38 | 25 | 41 | 26 | 41 | 26 | 38 | 25 |

| PAC | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| **Woods** | | | | | | | | | |
| % of SDI 12-18" DBH | 29 | 30 | 27 | 30 | 27 | 30 | 27 | 30 | 27 |
| % of SDI 18-24" DBH | 12 | 14 | 20 | 14 | 21 | 15 | 21 | 14 | 20 |
| % of SDI >24" DBH | 9 | 10 | 12 | 10 | 12 | 10 | 12 | 10 | 12 |
| TPA >18" DBH | 14 | 17 | 26 | 17 | 26 | 17 | 26 | 17 | 26 |
| PP Basal Area | 117 | 121 | 125 | 117 | 123 | 116 | 122 | 121 | 125 |
| GO Basal Area | 21 | 22 | 24 | 22 | 24 | 22 | 24 | 22 | 24 |
| All Basal Area | 159 | 168 | 186 | 163 | 184 | 162 | 184 | 168 | 186 |
| Snags 12-18" DBH | 2.7 | 3.5 | 6.0 | 4.8 | 5.6 | 5.0 | 5.5 | 3.5 | 6.0 |
| Snags >12" DBH | 3.6 | 4.4 | 7.7 | 5.7 | 7.3 | 5.8 | 7.2 | 4.4 | 7.7 |
| Snags >18" DBH | 0.8 | 0.9 | 1.7 | 0.8 | 1.7 | 0.8 | 1.7 | 0.9 | 1.7 |
| CWD | 6.4 | 8.1 | 12.7 | 4.0 | 9.0 | 3.4 | 8.4 | 8.1 | 12.7 |
| Logs per Acre | 3.8 | 4.7 | 8.3 | 3.1 | 7.1 | 2.9 | 7.0 | 4.7 | 8.3 |
| Understory Index | 34 | 29 | 20 | 31 | 20 | 31 | 20 | 29 | 20 |
| **Burn Only Treatment Group** | | | | | | | | | |
| % of SDI 12-18" DBH | 31 | 32 | 28 | 32 | 28 | 32 | 28 | 32 | 28 |
| % of SDI 18-24" DBH | 13 | 15 | 22 | 16 | 22 | 16 | 22 | 15 | 22 |
| % of SDI >24" DBH | 8 | 8 | 11 | 8 | 11 | 8 | 11 | 8 | 11 |
| TPA >18" DBH | 15 | 18 | 28 | 18 | 28 | 18 | 28 | 18 | 28 |
| PP Basal Area | 117 | 121 | 125 | 117 | 123 | 116 | 122 | 121 | 125 |
| GO Basal Area | 20 | 21 | 22 | 21 | 23 | 21 | 23 | 21 | 22 |
| All Basal Area | 158 | 168 | 185 | 163 | 183 | 162 | 183 | 168 | 185 |
| Snags 12-18" DBH | 3.0 | 3.8 | 6.3 | 5.1 | 5.9 | 5.3 | 5.8 | 3.8 | 6.3 |
| Snags >12" DBH | 3.6 | 4.6 | 8.0 | 5.8 | 7.7 | 6.0 | 7.6 | 4.6 | 8.0 |
| Snags >18" DBH | 0.7 | 0.7 | 1.8 | 0.7 | 1.8 | 0.7 | 1.8 | 0.7 | 1.8 |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| PAC | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| CWD | 6.0 | 7.8 | 12.5 | 3.9 | 9.0 | 3.2 | 8.4 | 7.8 | 12.5 |
| Logs per Acre | 2.8 | 3.9 | 7.9 | 2.6 | 7.0 | 2.4 | 6.9 | 3.9 | 7.9 |
| Understory Index | 48 | 41 | 30 | 44 | 31 | 44 | 31 | 41 | 30 |
| **Mechanical Treatment Group** | | | | | | | | | |
| **Archies** | | | | | | | | | |
| % of SDI 12-18" DBH | 33 | 34 | 33 | 36 | 34 | 36 | 34 | 35 | 34 |
| % of SDI 18-24" DBH | 10 | 14 | 25 | 16 | 28 | 16 | 29 | 15 | 27 |
| % of SDI >24" DBH | 4 | 5 | 8 | 5 | 9 | 5 | 9 | 5 | 9 |
| TPA >18" DBH | 8 | 11 | 24 | 11 | 24 | 11 | 24 | 11 | 24 |
| PP Basal Area | 88 | 97 | 117 | 90 | 110 | 88 | 108 | 93 | 115 |
| GO Basal Area | 17 | 18 | 21 | 19 | 25 | 19 | 25 | 19 | 25 |
| All Basal Area | 115 | 126 | 155 | 118 | 146 | 117 | 144 | 122 | 151 |
| Snags 12-18" DBH | 1.1 | 1.5 | 2.9 | 2.3 | 2.7 | 2.6 | 2.8 | 1.4 | 2.4 |
| Snags >12" DBH | 1.2 | 1.6 | 3.4 | 2.4 | 3.2 | 2.7 | 3.3 | 1.5 | 2.8 |
| Snags >18" DBH | 0.1 | 0.1 | 0.4 | 0.1 | 0.5 | 0.1 | 0.5 | 0.1 | 0.4 |
| CWD | 3.4 | 4.0 | 6.0 | 1.8 | 3.9 | 1.5 | 3.7 | 4.0 | 5.6 |
| Logs per Acre | 0.3 | 0.5 | 1.8 | 0.4 | 1.7 | 0.4 | 1.8 | 0.5 | 1.6 |
| Understory Index | 72 | 58 | 34 | 65 | 39 | 68 | 41 | 61 | 36 |
| **Bar M** | | | | | | | | | |
| % of SDI 12-18" DBH | 21 | 23 | 23 | 26 | 21 | 26 | 20 | 26 | 21 |
| % of SDI 18-24" DBH | 17 | 18 | 20 | 24 | 26 | 25 | 28 | 23 | 26 |
| % of SDI >24" DBH | 9 | 10 | 14 | 13 | 18 | 13 | 20 | 12 | 18 |
| TPA >18" DBH | 19 | 21 | 27 | 22 | 29 | 22 | 30 | 22 | 29 |
| PP Basal Area | 132 | 135 | 139 | 112 | 121 | 106 | 116 | 114 | 124 |
| GO Basal Area | 15 | 16 | 19 | 16 | 23 | 16 | 23 | 16 | 22 |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| **PAC** | **2010** | **2020** | **2050** | **2020** | **2050** | **2020** | **2050** | **2020** | **2050** |
| All Basal Area | 164 | 168 | 178 | 140 | 158 | 133 | 153 | 143 | 161 |
| Snags 12-18" DBH | 3.8 | 3.8 | 4.9 | 3.9 | 3.2 | 4.0 | 2.8 | 3.2 | 3.2 |
| Snags >12" DBH | 5.0 | 5.0 | 6.7 | 5.0 | 4.9 | 5.1 | 4.6 | 4.3 | 5.0 |
| Snags >18" DBH | 1.2 | 1.2 | 1.8 | 1.1 | 1.7 | 1.1 | 1.8 | 1.1 | 1.7 |
| CWD | 6.0 | 8.2 | 12.9 | 4.4 | 8.1 | 3.4 | 7.0 | 8.6 | 11.7 |
| Logs per Acre | 2.3 | 4.0 | 8.4 | 2.9 | 7.1 | 2.6 | 6.7 | 4.0 | 7.7 |
| Understory Index | 34 | 31 | 25 | 50 | 35 | 55 | 38 | 46 | 32 |
| **Bear Seep** | | | | | | | | | |
| % of SDI 12-18" DBH | 22 | 21 | 20 | 24 | 22 | 23 | 21 | 23 | 23 |
| % of SDI 18-24" DBH | 19 | 20 | 23 | 25 | 28 | 25 | 28 | 24 | 27 |
| % of SDI >24" DBH | 21 | 21 | 24 | 26 | 31 | 26 | 32 | 25 | 30 |
| TPA >18" DBH | 22 | 24 | 30 | 24 | 30 | 24 | 30 | 24 | 30 |
| PP Basal Area | 119 | 125 | 132 | 116 | 121 | 113 | 119 | 118 | 123 |
| GO Basal Area | 11 | 11 | 13 | 11 | 14 | 11 | 14 | 11 | 14 |
| All Basal Area | 139 | 148 | 167 | 137 | 152 | 134 | 150 | 140 | 153 |
| Snags 12-18" DBH | 1.8 | 2.2 | 3.9 | 2.8 | 3.7 | 2.6 | 3.4 | 2.1 | 3.9 |
| Snags >12" DBH | 2.9 | 3.2 | 5.7 | 3.7 | 5.7 | 3.5 | 5.5 | 3.0 | 5.9 |
| Snags >18" DBH | 1.0 | 1.0 | 1.8 | 0.9 | 2.0 | 0.9 | 2.1 | 0.9 | 2.0 |
| CWD | 4.8 | 6.1 | 9.7 | 2.3 | 5.9 | 2.3 | 5.7 | 6.1 | 9.0 |
| Logs per Acre | 2.1 | 3.2 | 6.4 | 2.0 | 5.4 | 2.0 | 5.3 | 3.1 | 6.2 |
| Understory Index | 45 | 38 | 28 | 46 | 36 | 48 | 37 | 44 | 35 |
| **Bonita Tank** | | | | | | | | | |
| % of SDI 12-18" DBH | 35 | 35 | 28 | 38 | 23 | 38 | 19 | 39 | 23 |
| % of SDI 18-24" DBH | 16 | 19 | 30 | 24 | 38 | 26 | 40 | 23 | 37 |
| % of SDI >24" DBH | 5 | 6 | 9 | 7 | 11 | 8 | 13 | 7 | 11 |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| PAC | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| TPA >18" DBH | 19 | 22 | 36 | 23 | 40 | 24 | 41 | 23 | 40 |
| PP Basal Area | 136 | 142 | 148 | 116 | 130 | 107 | 122 | 120 | 134 |
| GO Basal Area | 27 | 27 | 27 | 28 | 29 | 28 | 30 | 28 | 29 |
| All Basal Area | 173 | 181 | 196 | 155 | 183 | 145 | 175 | 159 | 187 |
| Snags 12-18" DBH | 3.4 | 5.3 | 8.2 | 5.6 | 5.4 | 5.0 | 4.5 | 3.8 | 5.6 |
| Snags >12" DBH | 4.0 | 6.0 | 9.9 | 6.2 | 7.2 | 5.6 | 6.5 | 4.4 | 7.6 |
| Snags >18" DBH | 0.5 | 0.7 | 1.7 | 0.6 | 1.8 | 0.6 | 2.0 | 0.6 | 1.9 |
| CWD | 5.3 | 7.4 | 13.2 | 3.7 | 8.4 | 2.9 | 7.1 | 7.7 | 11.4 |
| Logs per Acre | 1.3 | 2.6 | 7.6 | 2.1 | 6.5 | 1.7 | 5.9 | 2.6 | 6.3 |
| Understory Index | 27 | 22 | 16 | 35 | 21 | 42 | 25 | 32 | 20 |
| **Crawdad** | | | | | | | | | |
| % of SDI 12-18" DBH | 40 | 41 | 37 | 41 | 36 | 41 | 32 | 41 | 36 |
| % of SDI 18-24" DBH | 11 | 14 | 24 | 16 | 29 | 18 | 32 | 16 | 27 |
| % of SDI >24" DBH | 6 | 7 | 8 | 8 | 10 | 9 | 12 | 7 | 10 |
| TPA >18" DBH | 13 | 16 | 28 | 16 | 30 | 17 | 31 | 16 | 29 |
| PP Basal Area | 125 | 133 | 148 | 120 | 136 | 109 | 128 | 124 | 140 |
| GO Basal Area | 21 | 22 | 24 | 22 | 25 | 22 | 25 | 22 | 24 |
| All Basal Area | 151 | 161 | 180 | 146 | 170 | 136 | 162 | 151 | 173 |
| Snags 12-18" DBH | 2.4 | 2.7 | 4.5 | 4.0 | 3.7 | 3.8 | 2.6 | 2.3 | 3.9 |
| Snags >12" DBH | 2.7 | 3.1 | 5.5 | 4.4 | 4.8 | 4.2 | 3.8 | 2.7 | 5.0 |
| Snags >18" DBH | 0.3 | 0.4 | 1.0 | 0.4 | 1.1 | 0.4 | 1.2 | 0.4 | 1.1 |
| CWD | 4.3 | 5.5 | 8.6 | 2.8 | 5.8 | 2.2 | 4.9 | 5.6 | 8.1 |
| Logs per Acre | 0.6 | 1.4 | 4.0 | 1.1 | 3.7 | 1.1 | 3.6 | 1.4 | 3.8 |
| Understory Index | 42 | 33 | 21 | 42 | 27 | 50 | 31 | 38 | 25 |
| **Foxhole** | | | | | | | | | |

| PAC | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| % of SDI 12-18" DBH | 23 | 25 | 28 | 27 | 27 | 27 | 24 | 27 | 27 |
| % of SDI 18-24" DBH | 10 | 12 | 15 | 17 | 20 | 19 | 23 | 16 | 19 |
| % of SDI >24" DBH | 8 | 9 | 10 | 11 | 13 | 11 | 14 | 10 | 13 |
| TPA >18" DBH | 13 | 15 | 20 | 16 | 22 | 16 | 23 | 16 | 22 |
| PP Basal Area | 132 | 135 | 143 | 109 | 124 | 99 | 114 | 113 | 130 |
| GO Basal Area | 12 | 13 | 14 | 13 | 19 | 13 | 20 | 13 | 18 |
| All Basal Area | 167 | 171 | 184 | 140 | 164 | 129 | 155 | 145 | 170 |
| Snags 12-18" DBH | 2.4 | 3.1 | 5.1 | 3.3 | 2.9 | 3.4 | 2.8 | 2.2 | 2.9 |
| Snags >12" DBH | 2.9 | 3.7 | 6.0 | 3.7 | 3.8 | 3.9 | 3.6 | 2.6 | 3.7 |
| Snags >18" DBH | 0.6 | 0.6 | 0.9 | 0.5 | 0.8 | 0.5 | 0.8 | 0.5 | 0.8 |
| CWD | 5.7 | 7.5 | 11.4 | 3.9 | 6.6 | 3.1 | 5.8 | 7.9 | 9.8 |
| Logs per Acre | 1.7 | 2.6 | 5.0 | 2.0 | 4.1 | 1.8 | 4.0 | 2.7 | 4.4 |
| Understory Index | 28 | 25 | 21 | 47 | 31 | 56 | 36 | 42 | 28 |
| **Frank** | | | | | | | | | |
| % of SDI 12-18" DBH | 32 | 32 | 25 | 38 | 28 | 38 | 27 | 37 | 29 |
| % of SDI 18-24" DBH | 14 | 17 | 26 | 20 | 35 | 21 | 36 | 20 | 33 |
| % of SDI >24" DBH | 13 | 14 | 16 | 16 | 19 | 16 | 20 | 15 | 19 |
| TPA >18" DBH | 16 | 19 | 29 | 20 | 30 | 20 | 31 | 20 | 30 |
| PP Basal Area | 125 | 129 | 130 | 118 | 120 | 113 | 117 | 121 | 123 |
| GO Basal Area | 13 | 14 | 16 | 14 | 17 | 14 | 17 | 14 | 17 |
| All Basal Area | 145 | 150 | 158 | 136 | 141 | 131 | 137 | 139 | 143 |
| Snags 12-18" DBH | 4.2 | 5.1 | 6.6 | 5.6 | 5.8 | 5.6 | 5.4 | 4.6 | 6.1 |
| Snags >12" DBH | 4.9 | 5.9 | 8.4 | 6.4 | 7.9 | 6.4 | 7.6 | 5.4 | 8.1 |
| Snags >18" DBH | 0.7 | 0.8 | 1.8 | 0.8 | 2.1 | 0.8 | 2.2 | 0.8 | 2.0 |
| CWD | 4.7 | 6.4 | 11.1 | 3.4 | 7.8 | 2.6 | 6.9 | 6.6 | 10.5 |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| PAC | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| Logs per Acre | 1.2 | 2.5 | 7.2 | 2.0 | 6.8 | 1.7 | 6.5 | 2.5 | 7.0 |
| Understory Index | 44 | 41 | 37 | 51 | 51 | 56 | 54 | 49 | 49 |
| **Holdup** | | | | | | | | | |
| % of SDI 12-18" DBH | 28 | 28 | 27 | 30 | 23 | 31 | 22 | 30 | 23 |
| % of SDI 18-24" DBH | 14 | 14 | 21 | 17 | 27 | 19 | 28 | 17 | 26 |
| % of SDI >24" DBH | 15 | 16 | 19 | 20 | 25 | 21 | 27 | 19 | 24 |
| TPA >18" DBH | 15 | 17 | 25 | 17 | 25 | 17 | 25 | 17 | 25 |
| PP Basal Area | 123 | 130 | 139 | 110 | 119 | 105 | 114 | 113 | 122 |
| GO Basal Area | 5 | 5 | 6 | 5 | 7 | 5 | 7 | 5 | 6 |
| All Basal Area | 134 | 144 | 156 | 121 | 135 | 115 | 129 | 125 | 138 |
| Snags 12-18" DBH | 1.2 | 1.7 | 5.4 | 2.5 | 4.4 | 2.6 | 4.1 | 1.6 | 4.7 |
| Snags >12" DBH | 1.8 | 2.5 | 7.3 | 3.2 | 6.6 | 3.4 | 6.3 | 2.3 | 6.8 |
| Snags >18" DBH | 0.6 | 0.7 | 1.9 | 0.8 | 2.1 | 0.8 | 2.2 | 0.8 | 2.1 |
| CWD | 3.8 | 4.6 | 7.7 | 2.2 | 5.5 | 1.8 | 5.1 | 4.9 | 7.7 |
| Logs per Acre | 1.0 | 1.7 | 5.1 | 1.3 | 5.1 | 1.3 | 5.1 | 1.8 | 5.3 |
| Understory Index | 54 | 44 | 37 | 66 | 55 | 74 | 61 | 62 | 52 |
| **Iris Tank** | | | | | | | | | |
| % of SDI 12-18" DBH | 32 | 31 | 25 | 32 | 24 | 32 | 22 | 32 | 24 |
| % of SDI 18-24" DBH | 18 | 21 | 28 | 26 | 34 | 28 | 36 | 26 | 34 |
| % of SDI >24" DBH | 8 | 9 | 12 | 11 | 15 | 11 | 16 | 10 | 15 |
| TPA >18" DBH | 21 | 24 | 33 | 25 | 34 | 25 | 34 | 25 | 34 |
| PP Basal Area | 140 | 142 | 137 | 124 | 123 | 117 | 118 | 127 | 126 |
| GO Basal Area | 20 | 22 | 26 | 23 | 27 | 23 | 28 | 23 | 27 |
| All Basal Area | 166 | 169 | 176 | 151 | 160 | 143 | 156 | 153 | 163 |
| Snags 12-18" DBH | 5.1 | 5.9 | 8.1 | 6.0 | 6.2 | 6.1 | 5.4 | 5.1 | 6.2 |

| PAC | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| Snags >12" DBH | 6.1 | 7.2 | 10.8 | 7.2 | 9.1 | 7.3 | 8.4 | 6.3 | 9.1 |
| Snags >18" DBH | 1.0 | 1.3 | 2.7 | 1.2 | 3.0 | 1.2 | 3.0 | 1.2 | 2.9 |
| CWD | 5.8 | 8.1 | 14.0 | 4.3 | 9.6 | 3.5 | 8.5 | 8.5 | 13.1 |
| Logs per Acre | 2.0 | 3.7 | 10.0 | 2.8 | 8.9 | 2.6 | 8.6 | 3.9 | 9.5 |
| Understory Index | 38 | 35 | 31 | 44 | 40 | 49 | 44 | 42 | 38 |
| **Knob** | | | | | | | | | |
| % of SDI 12-18" DBH | 28 | 31 | 33 | 33 | 34 | 33 | 32 | 33 | 34 |
| % of SDI 18-24" DBH | 15 | 16 | 20 | 18 | 23 | 20 | 25 | 18 | 23 |
| % of SDI >24" DBH | 7 | 8 | 13 | 9 | 14 | 9 | 15 | 9 | 14 |
| TPA >18" DBH | 11 | 13 | 21 | 13 | 22 | 13 | 22 | 13 | 22 |
| PP Basal Area | 107 | 116 | 134 | 104 | 125 | 97 | 119 | 108 | 129 |
| GO Basal Area | 8 | 10 | 12 | 10 | 13 | 10 | 14 | 10 | 13 |
| All Basal Area | 129 | 139 | 163 | 126 | 152 | 119 | 146 | 131 | 157 |
| Snags 12-18" DBH | 0.7 | 1.3 | 3.5 | 2.2 | 2.9 | 2.2 | 2.4 | 1.0 | 3.0 |
| Snags >12" DBH | 0.9 | 1.5 | 4.0 | 2.4 | 3.4 | 2.5 | 2.9 | 1.2 | 3.5 |
| Snags >18" DBH | 0.3 | 0.2 | 0.5 | 0.2 | 0.5 | 0.2 | 0.5 | 0.2 | 0.5 |
| CWD | 3.4 | 4.2 | 6.6 | 2.0 | 4.4 | 1.7 | 3.8 | 4.3 | 6.0 |
| Logs per Acre | 0.5 | 0.8 | 2.0 | 0.6 | 2.0 | 0.6 | 2.0 | 0.9 | 1.9 |
| Understory Index | 67 | 56 | 35 | 65 | 41 | 72 | 44 | 61 | 38 |
| **Lake #1/Seruchos** | | | | | | | | | |
| % of SDI 12-18" DBH | 29 | 29 | 30 | 32 | 29 | 34 | 29 | 31 | 29 |
| % of SDI 18-24" DBH | 13 | 13 | 20 | 16 | 24 | 17 | 26 | 15 | 23 |
| % of SDI >24" DBH | 6 | 7 | 7 | 8 | 10 | 8 | 10 | 7 | 9 |
| TPA >18" DBH | 13 | 15 | 23 | 15 | 26 | 15 | 27 | 15 | 25 |
| PP Basal Area | 123 | 133 | 156 | 110 | 137 | 101 | 128 | 115 | 144 |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| PAC | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| GO Basal Area | 19 | 19 | 20 | 20 | 21 | 20 | 22 | 19 | 21 |
| All Basal Area | 148 | 161 | 190 | 136 | 170 | 127 | 164 | 142 | 178 |
| Snags 12-18" DBH | 1.2 | 1.9 | 4.1 | 2.7 | 3.3 | 2.6 | 2.8 | 1.5 | 3.1 |
| Snags >12" DBH | 1.4 | 2.2 | 4.6 | 3.0 | 3.8 | 2.8 | 3.3 | 1.7 | 3.6 |
| Snags >18" DBH | 0.2 | 0.3 | 0.5 | 0.2 | 0.5 | 0.2 | 0.6 | 0.2 | 0.5 |
| CWD | 4.3 | 5.1 | 8.6 | 2.4 | 5.3 | 2.1 | 4.5 | 5.5 | 7.7 |
| Logs per Acre | 0.3 | 0.8 | 2.6 | 0.6 | 2.6 | 0.6 | 2.3 | 0.8 | 2.4 |
| Understory Index | 44 | 34 | 18 | 48 | 25 | 57 | 28 | 43 | 21 |
| **Lee Butte** | | | | | | | | | |
| % of SDI 12-18" DBH | 34 | 35 | 35 | 35 | 33 | 33 | 29 | 34 | 33 |
| % of SDI 18-24" DBH | 10 | 13 | 25 | 19 | 33 | 23 | 35 | 18 | 32 |
| % of SDI >24" DBH | 3 | 4 | 4 | 5 | 6 | 5 | 8 | 4 | 6 |
| TPA >18" DBH | 10 | 14 | 27 | 16 | 29 | 17 | 29 | 16 | 29 |
| PP Basal Area | 134 | 142 | 155 | 111 | 131 | 100 | 120 | 116 | 134 |
| GO Basal Area | 13 | 13 | 14 | 13 | 15 | 13 | 16 | 13 | 15 |
| All Basal Area | 155 | 164 | 183 | 132 | 158 | 120 | 148 | 137 | 161 |
| Snags 12-18" DBH | 3.0 | 3.8 | 6.5 | 4.0 | 4.5 | 3.9 | 3.7 | 2.9 | 5.0 |
| Snags >12" DBH | 3.2 | 4.2 | 7.8 | 4.4 | 5.9 | 4.3 | 5.1 | 3.3 | 6.4 |
| Snags >18" DBH | 0.3 | 0.4 | 1.4 | 0.4 | 1.4 | 0.4 | 1.4 | 0.4 | 1.4 |
| CWD | 4.6 | 6.2 | 10.6 | 3.1 | 6.3 | 2.8 | 5.7 | 6.9 | 9.6 |
| Logs per Acre | 0.5 | 1.3 | 4.9 | 1.3 | 4.2 | 1.3 | 4.2 | 1.7 | 4.5 |
| Understory Index | 39 | 31 | 22 | 52 | 32 | 64 | 39 | 47 | 31 |
| **Mayflower Tank** | | | | | | | | | |
| % of SDI 12-18" DBH | 29 | 29 | 24 | 29 | 24 | 28 | 22 | 29 | 24 |
| % of SDI 18-24" DBH | 14 | 17 | 21 | 19 | 22 | 21 | 23 | 19 | 22 |

| PAC | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| % of SDI >24" DBH | 5 | 6 | 8 | 6 | 9 | 6 | 9 | 6 | 8 |
| TPA >18" DBH | 13 | 17 | 24 | 17 | 25 | 17 | 25 | 17 | 25 |
| PP Basal Area | 100 | 103 | 102 | 94 | 98 | 86 | 91 | 97 | 101 |
| GO Basal Area | 32 | 33 | 38 | 34 | 44 | 35 | 44 | 34 | 43 |
| All Basal Area | 146 | 154 | 173 | 145 | 177 | 138 | 172 | 149 | 180 |
| Snags 12-18" DBH | 3.3 | 4.4 | 7.1 | 5.0 | 4.9 | 4.4 | 4.3 | 3.5 | 5.4 |
| Snags >12" DBH | 3.8 | 4.9 | 8.7 | 5.4 | 6.5 | 4.9 | 5.9 | 4.0 | 7.0 |
| Snags >18" DBH | 0.5 | 0.5 | 1.7 | 0.5 | 1.6 | 0.5 | 1.6 | 0.5 | 1.6 |
| CWD | 4.5 | 6.4 | 11.6 | 2.6 | 6.7 | 2.6 | 6.4 | 6.4 | 10.0 |
| Logs per Acre | 0.9 | 2.0 | 6.3 | 1.4 | 4.9 | 1.4 | 4.8 | 2.0 | 5.3 |
| Understory Index | 48 | 41 | 26 | 47 | 26 | 53 | 28 | 44 | 25 |
| **Red Hill** | | | | | | | | | |
| % of SDI 12-18" DBH | 31 | 33 | 31 | 34 | 25 | 34 | 23 | 34 | 26 |
| % of SDI 18-24" DBH | 18 | 20 | 26 | 24 | 30 | 25 | 32 | 24 | 30 |
| % of SDI >24" DBH | 5 | 6 | 10 | 7 | 12 | 7 | 13 | 7 | 12 |
| TPA >18" DBH | 22 | 23 | 32 | 24 | 36 | 24 | 37 | 24 | 36 |
| PP Basal Area | 153 | 156 | 157 | 129 | 141 | 119 | 131 | 132 | 144 |
| GO Basal Area | 11 | 11 | 10 | 11 | 11 | 11 | 11 | 11 | 11 |
| All Basal Area | 178 | 186 | 198 | 159 | 190 | 149 | 182 | 163 | 192 |
| Snags 12-18" DBH | 1.9 | 4.0 | 7.8 | 4.2 | 4.7 | 4.1 | 4.1 | 2.9 | 5.0 |
| Snags >12" DBH | 2.1 | 4.8 | 9.6 | 4.8 | 6.1 | 4.7 | 5.6 | 3.5 | 6.4 |
| Snags >18" DBH | 0.2 | 0.8 | 1.8 | 0.6 | 1.4 | 0.6 | 1.5 | 0.6 | 1.4 |
| CWD | 5.3 | 6.8 | 12.9 | 3.6 | 8.0 | 2.9 | 7.0 | 7.4 | 11.1 |
| Logs per Acre | 1.5 | 2.3 | 6.7 | 1.6 | 5.1 | 1.6 | 5.0 | 2.4 | 5.5 |
| Understory Index | 44 | 40 | 36 | 53 | 39 | 61 | 43 | 50 | 38 |

| PAC | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| **Red Raspberry** | | | | | | | | | |
| % of SDI 12-18" DBH | 30 | 29 | 25 | 30 | 23 | 31 | 23 | 30 | 24 |
| % of SDI 18-24" DBH | 16 | 19 | 24 | 22 | 27 | 22 | 28 | 21 | 27 |
| % of SDI >24" DBH | 9 | 9 | 12 | 11 | 16 | 11 | 16 | 11 | 15 |
| TPA >18" DBH | 15 | 18 | 27 | 19 | 28 | 19 | 28 | 19 | 28 |
| PP Basal Area | 87 | 93 | 107 | 86 | 99 | 84 | 97 | 89 | 102 |
| GO Basal Area | 21 | 21 | 23 | 23 | 26 | 23 | 26 | 22 | 25 |
| All Basal Area | 136 | 145 | 171 | 137 | 164 | 135 | 163 | 141 | 167 |
| Snags 12-18" DBH | 2.6 | 3.3 | 4.4 | 3.9 | 3.9 | 3.9 | 3.8 | 2.8 | 4.1 |
| Snags >12" DBH | 3.2 | 4.0 | 5.8 | 4.5 | 5.2 | 4.5 | 5.0 | 3.4 | 5.4 |
| Snags >18" DBH | 0.6 | 0.7 | 1.4 | 0.6 | 1.3 | 0.6 | 1.2 | 0.6 | 1.3 |
| CWD | 5.3 | 7.2 | 10.9 | 2.7 | 6.6 | 2.7 | 6.5 | 6.9 | 10.1 |
| Logs per Acre | 2.8 | 3.9 | 7.2 | 2.4 | 5.6 | 2.4 | 5.6 | 3.8 | 6.6 |
| Understory Index | 56 | 47 | 31 | 59 | 39 | 61 | 40 | 55 | 36 |
| **Rock Top** | | | | | | | | | |
| % of SDI 12-18" DBH | 33 | 34 | 28 | 35 | 27 | 35 | 25 | 35 | 27 |
| % of SDI 18-24" DBH | 14 | 16 | 24 | 18 | 27 | 19 | 28 | 18 | 27 |
| % of SDI >24" DBH | 5 | 6 | 8 | 7 | 10 | 7 | 10 | 6 | 9 |
| TPA >18" DBH | 14 | 16 | 26 | 16 | 27 | 16 | 28 | 16 | 28 |
| PP Basal Area | 109 | 115 | 123 | 103 | 114 | 95 | 108 | 107 | 117 |
| GO Basal Area | 12 | 13 | 14 | 13 | 15 | 13 | 16 | 13 | 15 |
| All Basal Area | 139 | 148 | 168 | 136 | 160 | 128 | 157 | 141 | 163 |
| Snags 12-18" DBH | 3.1 | 3.7 | 5.3 | 4.4 | 4.4 | 4.2 | 3.7 | 3.0 | 4.6 |
| Snags >12" DBH | 3.6 | 4.2 | 6.7 | 4.9 | 5.9 | 4.6 | 5.2 | 3.5 | 6.1 |
| Snags >18" DBH | 0.5 | 0.5 | 1.5 | 0.5 | 1.4 | 0.5 | 1.5 | 0.5 | 1.5 |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| PAC | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| CWD | 5.0 | 6.5 | 10.3 | 3.2 | 6.8 | 2.6 | 5.9 | 6.6 | 9.6 |
| Logs per Acre | 1.6 | 2.6 | 5.9 | 1.8 | 5.1 | 1.8 | 4.9 | 2.6 | 5.5 |
| Understory Index | 55 | 46 | 30 | 56 | 37 | 62 | 38 | 52 | 34 |
| **Sawmill Springs** | | | | | | | | | |
| % of SDI 12-18" DBH | 35 | 36 | 32 | 39 | 35 | 39 | 34 | 39 | 35 |
| % of SDI 18-24" DBH | 15 | 16 | 22 | 19 | 26 | 19 | 26 | 18 | 25 |
| % of SDI >24" DBH | 5 | 6 | 10 | 7 | 12 | 7 | 13 | 7 | 12 |
| TPA >18" DBH | 14 | 16 | 25 | 16 | 26 | 16 | 27 | 16 | 26 |
| PP Basal Area | 114 | 122 | 133 | 113 | 129 | 109 | 127 | 116 | 133 |
| GO Basal Area | 13 | 14 | 17 | 14 | 20 | 14 | 21 | 14 | 20 |
| All Basal Area | 136 | 147 | 169 | 135 | 158 | 131 | 155 | 139 | 161 |
| Snags 12-18" DBH | 2.2 | 2.6 | 5.6 | 3.5 | 3.9 | 3.7 | 3.5 | 2.2 | 4.0 |
| Snags >12" DBH | 3.0 | 3.4 | 7.0 | 4.2 | 5.0 | 4.3 | 4.7 | 2.8 | 5.2 |
| Snags >18" DBH | 0.8 | 0.7 | 1.3 | 0.7 | 1.2 | 0.7 | 1.2 | 0.7 | 1.2 |
| CWD | 4.4 | 5.6 | 9.0 | 3.0 | 6.0 | 2.2 | 5.1 | 5.6 | 8.0 |
| Logs per Acre | 1.2 | 2.0 | 5.1 | 1.6 | 4.4 | 1.4 | 4.1 | 2.0 | 4.5 |
| Understory Index | 51 | 41 | 27 | 52 | 33 | 56 | 35 | 47 | 31 |
| **T6 Tank** | | | | | | | | | |
| % of SDI 12-18" DBH | 26 | 26 | 24 | 29 | 24 | 29 | 23 | 29 | 24 |
| % of SDI 18-24" DBH | 12 | 14 | 20 | 17 | 26 | 18 | 27 | 16 | 25 |
| % of SDI >24" DBH | 16 | 16 | 17 | 19 | 22 | 20 | 23 | 18 | 21 |
| TPA >18" DBH | 13 | 16 | 23 | 16 | 24 | 16 | 24 | 16 | 24 |
| PP Basal Area | 106 | 114 | 128 | 99 | 115 | 93 | 110 | 102 | 119 |
| GO Basal Area | 12 | 13 | 15 | 13 | 16 | 13 | 16 | 13 | 16 |
| All Basal Area | 127 | 138 | 155 | 119 | 137 | 112 | 133 | 123 | 142 |

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| **PAC** | **2010** | **2020** | **2050** | **2020** | **2050** | **2020** | **2050** | **2020** | **2050** |
| Snags 12-18" DBH | 1.7 | 2.1 | 4.7 | 2.7 | 3.8 | 2.7 | 3.3 | 1.8 | 3.9 |
| Snags >12" DBH | 2.2 | 2.6 | 6.3 | 3.2 | 5.5 | 3.3 | 5.0 | 2.4 | 5.6 |
| Snags >18" DBH | 0.5 | 0.5 | 1.6 | 0.5 | 1.7 | 0.6 | 1.7 | 0.5 | 1.7 |
| CWD | 3.7 | 4.6 | 7.7 | 2.2 | 5.2 | 1.9 | 4.7 | 4.9 | 7.3 |
| Logs per Acre | 0.9 | 1.6 | 4.4 | 1.2 | 4.1 | 1.1 | 4.1 | 1.7 | 4.4 |
| Understory Index | 67 | 55 | 39 | 73 | 55 | 78 | 58 | 67 | 50 |
| **Mechanical Treatment Group** | | | | | | | | | |
| % of SDI 12-18" DBH | 30 | 31 | 28 | 33 | 27 | 33 | 25 | 33 | 28 |
| % of SDI 18-24" DBH | 14 | 16 | 23 | 20 | 28 | 21 | 30 | 19 | 28 |
| % of SDI >24" DBH | 8 | 9 | 12 | 11 | 14 | 11 | 16 | 10 | 14 |
| TPA >18" DBH | 15 | 18 | 27 | 18 | 29 | 18 | 29 | 18 | 29 |
| PP Basal Area | 120 | 126 | 135 | 110 | 122 | 103 | 116 | 113 | 126 |
| GO Basal Area | 16 | 16 | 18 | 17 | 20 | 17 | 21 | 17 | 20 |
| All Basal Area | 148 | 156 | 173 | 138 | 160 | 131 | 155 | 142 | 163 |
| Snags 12-18" DBH | 2.6 | 3.4 | 5.6 | 3.9 | 4.2 | 3.8 | 3.7 | 2.7 | 4.4 |
| Snags >12" DBH | 3.1 | 4.0 | 7.1 | 4.5 | 5.7 | 4.4 | 5.2 | 3.3 | 5.9 |
| Snags >18" DBH | 0.6 | 0.6 | 1.5 | 0.6 | 1.5 | 0.6 | 1.5 | 0.6 | 1.5 |
| CWD | 4.7 | 6.2 | 10.3 | 3.0 | 6.6 | 2.5 | 5.8 | 6.4 | 9.3 |
| Logs per Acre | 1.3 | 2.2 | 5.7 | 1.6 | 5.0 | 1.6 | 4.8 | 2.3 | 5.2 |
| Understory Index | 47 | 40 | 29 | 53 | 37 | 59 | 40 | 49 | 35 |

**Table 224. Changes in MSO Habitat Components: Protected Habitat by Individual Subunit, Including Ponderosa Pine (Trees by dbh Size-Class and PP) and Gambel Oak (GO)**

| | Alternative A | | | Alternative B | | | Alternative C | | | Alternative D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subunit | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 |
| **1-3** | | | | | | | | | | | | |
| Trees 12 – 18” dbh | 30% | 31% | 29% | 30% | 31% | 29% | 30% | 31% | 29% | 30% | 31% | 29% |
| Trees 18 – 23.9” dbh | 11% | 13% | 20% | 11% | 14% | 21% | 11% | 14% | 21% | 11% | 14% | 21% |
| Trees ≥ 24” dbh | 6% | 6% | 9% | 6% | 7% | 9% | 6% | 7% | 9% | 6% | 7% | 9% |
| TPA>18" | 14 | 17 | 27 | 14 | 17 | 27 | 14 | 17 | 27 | 14 | 17 | 27 |
| Snags/Ac >12" | 3.67 | 4.62 | 8.33 | 3.67 | 6.21 | 7.83 | 3.67 | 6.21 | 7.83 | 3.67 | 6.21 | 7.83 |
| PP BA | 130 | 134 | 136 | 130 | 127 | 132 | 130 | 127 | 132 | 130 | 127 | 132 |
| GO BA | 29 | 30 | 33 | 29 | 30 | 35 | 29 | 30 | 35 | 29 | 30 | 35 |
| Logs/Ac | 1.79 | 2.85 | 6.84 | 1.79 | 1.85 | 6.14 | 1.79 | 1.85 | 6.14 | 1.79 | 1.85 | 6.14 |
| CWD>3" | 5.96 | 7.92 | 13.03 | 5.96 | 3.26 | 8.67 | 5.96 | 3.26 | 8.67 | 5.96 | 3.26 | 8.67 |
| Understory Index | 23.67 | 20.12 | 15.28 | 23.67 | 22.49 | 15.71 | 23.67 | 22.49 | 19.09 | 23.67 | 22.49 | 15.71 |
| **1-5** | | | | | | | | | | | | |
| Trees 12 – 18” dbh | 30% | 30% | 28% | 30% | 30% | 27% | 30% | 30% | 27% | 30% | 30% | 27% |
| Trees 18 – 23.9” dbh | 12% | 14% | 20% | 12% | 15% | 21% | 12% | 15% | 21% | 12% | 15% | 21% |
| Trees ≥ 24” dbh | 7% | 7% | 10% | 7% | 8% | 10% | 7% | 8% | 10% | 7% | 8% | 10% |
| TPA>18" | 14 | 17 | 26 | 14 | 17 | 27 | 14 | 17 | 27 | 14 | 17 | 27 |

| | Alternative A | | | Alternative B | | | Alternative C | | | Alternative D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subunit | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 | 2010 | 2020 | 2050 |
| Snags/Ac >12" | 3.48 | 4.37 | 8.06 | 3.48 | 5.80 | 7.63 | 3.48 | 5.80 | 7.63 | 3.48 | 5.80 | 7.63 |
| PP BA | 120 | 125 | 126 | 120 | 118 | 123 | 120 | 118 | 123 | 120 | 118 | 123 |
| GO BA | 26 | 28 | 32 | 26 | 28 | 33 | 26 | 28 | 33 | 26 | 28 | 33 |
| Logs/Ac | 2.25 | 3.30 | 7.32 | 2.25 | 2.09 | 6.46 | 2.25 | 2.09 | 6.46 | 2.25 | 2.09 | 6.46 |
| CWD>3" | 5.88 | 7.72 | 12.65 | 5.88 | 3.16 | 8.46 | 5.88 | 3.16 | 8.46 | 5.88 | 3.16 | 8.46 |
| Understory Index | 28.83 | 24.15 | 17.77 | 28.83 | 26.69 | 18.31 | 28.83 | 26.69 | 22.60 | 28.83 | 26.69 | 18.31 |
| **3-3** | | | | | | | | | | | | |
| Trees 12 – 18” dbh | 23% | 24% | 23% | 23% | 24% | 23% | 23% | 24% | 23% | 23% | 24% | 23% |
| Trees 18 – 23.9” dbh | 10% | 13% | 17% | 10% | 13% | 17% | 10% | 13% | 17% | 10% | 13% | 17% |
| Trees ≥ 24” dbh | 20% | 20% | 22% | 20% | 21% | 23% | 20% | 21% | 23% | 20% | 21% | 23% |
| TPA>18" | 12 | 14 | 20 | 12 | 14 | 20 | 12 | 14 | 20 | 12 | 14 | 20 |
| Snags/Ac >12" | 2.18 | 2.32 | 3.13 | 2.18 | 3.21 | 2.86 | 2.18 | 3.21 | 2.86 | 2.18 | 3.21 | 2.86 |
| PP BA | 84 | 91 | 105 | 84 | 87 | 102 | 84 | 87 | 102 | 84 | 87 | 102 |
| GO BA | 7 | 7 | 8 | 7 | 7 | 8 | 7 | 7 | 8 | 7 | 7 | 8 |
| Logs/Ac | 0.80 | 1.43 | 3.52 | 0.80 | 0.93 | 3.23 | 0.80 | 0.93 | 3.23 | 0.80 | 0.93 | 3.23 |
| CWD>3" | 5.88 | 6.69 | 8.67 | 5.88 | 2.31 | 5.09 | 5.88 | 2.31 | 5.09 | 5.88 | 2.31 | 5.09 |
| Understory Index | 122.94 | 101.86 | 59.37 | 122.94 | 106.15 | 62.14 | 122.94 | 106.15 | 88.51 | 122.94 | 106.15 | 62.14 |

| | Alternative A | | | Alternative B | | | Alternative C | | | Alternative D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Subunit** | **2010** | **2020** | **2050** | **2010** | **2020** | **2050** | **2010** | **2020** | **2050** | **2010** | **2020** | **2050** |
| **3-4** | | | | | | | | | | | | |
| Trees 12 – 18” dbh | 35% | 36% | 31% | 35% | 36% | 31% | 35% | 36% | 31% | 35% | 36% | 31% |
| Trees 18 – 23.9” dbh | 11% | 14% | 23% | 11% | 15% | 23% | 11% | 15% | 23% | 11% | 15% | 23% |
| Trees ≥ 24” dbh | 5% | 5% | 8% | 5% | 6% | 8% | 5% | 6% | 8% | 5% | 6% | 8% |
| TPA>18" | 14 | 17 | 29 | 14 | 17 | 30 | 14 | 17 | 30 | 14 | 17 | 30 |
| Snags/Ac >12" | 4.21 | 5.28 | 9.06 | 4.21 | 7.15 | 8.45 | 4.21 | 7.15 | 8.45 | 4.21 | 7.15 | 8.45 |
| PP BA | 137 | 141 | 144 | 137 | 135 | 140 | 137 | 135 | 140 | 137 | 135 | 140 |
| GO BA | 26 | 27 | 30 | 26 | 27 | 31 | 26 | 27 | 31 | 26 | 27 | 31 |
| Logs/Ac | 1.87 | 3.03 | 7.45 | 1.87 | 1.98 | 6.73 | 1.87 | 1.98 | 6.73 | 1.87 | 1.98 | 6.73 |
| CWD>3" | 6.24 | 8.29 | 13.63 | 6.24 | 3.41 | 9.12 | 6.24 | 3.41 | 9.12 | 6.24 | 3.41 | 9.12 |
| Understory Index | 64.61 | 59.63 | 52.47 | 64.61 | 63.03 | 53.14 | 64.61 | 63.03 | 58.14 | 64.61 | 63.03 | 53.14 |
| **3-5** | | | | | | | | | | | | |
| Trees 12 – 18” dbh | 33% | 34% | 31% | 33% | 34% | 31% | 33% | 34% | 31% | 33% | 34% | 31% |
| Trees 18 – 23.9” dbh | 11% | 14% | 21% | 11% | 14% | 22% | 11% | 14% | 22% | 11% | 14% | 22% |
| Trees ≥ 24” dbh | 5% | 6% | 8% | 5% | 6% | 8% | 5% | 6% | 8% | 5% | 6% | 8% |
| TPA>18" | 14 | 17 | 28 | 14 | 17 | 29 | 14 | 17 | 29 | 14 | 17 | 29 |
| Snags/Ac >12" | 3.94 | 4.97 | 8.75 | 3.94 | 6.74 | 8.19 | 3.94 | 6.74 | 8.19 | 3.94 | 6.74 | 8.19 |
| PP BA | 135 | 139 | 141 | 135 | 132 | 138 | 135 | 132 | 138 | 135 | 132 | 138 |

| | Alternative A | | | Alternative B | | | Alternative C | | | Alternative D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Subunit** | **2010** | **2020** | **2050** | **2010** | **2020** | **2050** | **2010** | **2020** | **2050** | **2010** | **2020** | **2050** |
| GO BA | 27 | 28 | 31 | 27 | 29 | 32 | 27 | 29 | 32 | 27 | 29 | 32 |
| Logs/Ac | 1.94 | 3.04 | 7.26 | 1.94 | 1.97 | 6.53 | 1.94 | 1.97 | 6.53 | 1.94 | 1.97 | 6.53 |
| CWD>3" | 6.20 | 8.21 | 13.45 | 6.20 | 3.38 | 8.97 | 6.20 | 3.38 | 8.97 | 6.20 | 3.38 | 8.97 |
| Understory Index | 21.91 | 18.81 | 14.35 | 21.91 | 21.10 | 14.77 | 21.91 | 21.10 | 17.94 | 21.91 | 21.10 | 14.77 |
| **4-4** | | | | | | | | | | | | |
| Trees 12 – 18” dbh | 33% | 36% | 57% | 33% | 37% | 55% | 33% | 37% | 55% | 33% | 37% | 55% |
| Trees 18 – 23.9” dbh | 0% | 9% | 24% | 0% | 9% | 25% | 0% | 9% | 25% | 0% | 9% | 25% |
| Trees ≥ 24” dbh | 0% | 0% | 2% | 0% | 0% | 2% | 0% | 0% | 2% | 0% | 0% | 2% |
| TPA>18" | 0 | 1 | 6 | 0 | 1 | 5 | 0 | 1 | 5 | 0 | 1 | 5 |
| Snags/Ac >12" | 0.62 | 0.90 | 2.23 | 0.62 | 1.08 | 2.16 | 0.62 | 1.08 | 2.16 | 0.62 | 1.08 | 2.16 |
| PP BA | 13 | 20 | 44 | 13 | 19 | 40 | 13 | 19 | 40 | 13 | 19 | 40 |
| GO BA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Logs/Ac | 0.00 | 0.09 | 0.88 | 0.00 | 0.09 | 0.91 | 0.00 | 0.09 | 0.91 | 0.00 | 0.09 | 0.91 |
| CWD>3" | 6.59 | 6.29 | 6.02 | 6.59 | 2.24 | 2.75 | 6.59 | 2.24 | 2.75 | 6.59 | 2.24 | 2.75 |
| Understory Index | 436.79 | 382.12 | 247.96 | 436.79 | 393.82 | 267.73 | 436.79 | 393.82 | 346.62 | 436.79 | 393.82 | 267.73 |

# Appendix 17. Summary of Habitat Changes by Alternative in MSO Restricted Habitat

**Table 225. Changes in Forest Structure Attributes Within MSO Restricted "Other" Habitat by Alternative by Subunit, Including Ponderosa Pine (% of SDI and PP) and Gambel Oak (GO)**

| Scale | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| **Subunit 1-1** | | | | | | | | | |
| % of SDI 12-18" DBH | 24 | 25 | 24 | 18 | 16 | 18 | 16 | 16 | 16 |
| % of SDI 18-24" DBH | 14 | 14 | 17 | 20 | 16 | 20 | 16 | 18 | 14 |
| % of SDI >24" DBH | 12 | 12 | 15 | 25 | 24 | 25 | 24 | 23 | 21 |
| TPA >18" DBH | 11 | 13 | 19 | 11 | 15 | 11 | 15 | 11 | 15 |
| PP Basal Area | 90 | 97 | 111 | 50 | 66 | 50 | 66 | 55 | 71 |
| GO Basal Area | 12 | 13 | 19 | 10 | 16 | 10 | 16 | 12 | 19 |
| All Basal Area | 116 | 127 | 152 | 69 | 99 | 69 | 99 | 80 | 115 |
| Snags 12-18" DBH | 1.0 | 1.4 | 3.1 | 2.3 | 1.0 | 2.3 | 1.0 | 0.9 | 1.2 |
| Snags >12" DBH | 1.4 | 1.8 | 4.0 | 3.1 | 1.7 | 3.1 | 1.7 | 1.3 | 1.9 |
| Snags >18" DBH | 0.4 | 0.4 | 0.9 | 0.8 | 0.7 | 0.8 | 0.7 | 0.4 | 0.7 |
| CWD | 3.5 | 4.4 | 6.8 | 2.6 | 4.6 | 2.6 | 4.6 | 5.5 | 6.4 |
| Logs per Acre | 0.8 | 1.2 | 3.0 | 1.6 | 3.5 | 1.6 | 3.5 | 2.3 | 3.3 |
| Understory Index | 228 | 194 | 138 | 449 | 283 | 449 | 283 | 393 | 241 |
| **Subunit 1-2** | | | | | | | | | |
| % of SDI 12-18" DBH | 25 | 27 | 29 | 20 | 21 | 20 | 21 | 18 | 19 |
| % of SDI 18-24" DBH | 11 | 12 | 16 | 19 | 15 | 19 | 15 | 17 | 13 |
| % of SDI >24" DBH | 7 | 7 | 9 | 19 | 18 | 19 | 18 | 17 | 15 |
| TPA >18" DBH | 10 | 13 | 19 | 10 | 15 | 10 | 15 | 11 | 15 |
| PP Basal Area | 101 | 108 | 119 | 49 | 66 | 49 | 66 | 55 | 72 |

| Scale | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| GO Basal Area | 22 | 24 | 28 | 18 | 24 | 18 | 24 | 21 | 28 |
| All Basal Area | 138 | 148 | 171 | 76 | 109 | 76 | 109 | 90 | 127 |
| Snags 12-18" DBH | 1.4 | 2.0 | 4.2 | 3.0 | 1.2 | 3.0 | 1.2 | 1.1 | 1.6 |
| Snags >12" DBH | 1.9 | 2.3 | 5.0 | 3.8 | 1.9 | 3.8 | 1.9 | 1.5 | 2.3 |
| Snags >18" DBH | 0.4 | 0.4 | 0.9 | 0.8 | 0.7 | 0.8 | 0.7 | 0.4 | 0.7 |
| CWD | 4.2 | 5.4 | 8.3 | 3.3 | 5.5 | 3.3 | 5.5 | 6.8 | 7.7 |
| Logs per Acre | 0.9 | 1.5 | 3.5 | 1.9 | 3.9 | 1.9 | 3.9 | 2.8 | 3.7 |
| Understory Index | 53 | 42 | 26 | 164 | 92 | 164 | 92 | 138 | 73 |
| **Subunit 1-3** | | | | | | | | | |
| % of SDI 12-18" DBH | 30 | 32 | 31 | 22 | 19 | 23 | 21 | 21 | 19 |
| % of SDI 18-24" DBH | 12 | 14 | 20 | 23 | 20 | 21 | 19 | 21 | 17 |
| % of SDI >24" DBH | 8 | 8 | 10 | 20 | 21 | 19 | 20 | 18 | 18 |
| TPA >18" DBH | 11 | 14 | 23 | 12 | 17 | 11 | 17 | 12 | 17 |
| PP Basal Area | 109 | 116 | 129 | 53 | 72 | 55 | 74 | 59 | 78 |
| GO Basal Area | 16 | 17 | 19 | 13 | 18 | 13 | 17 | 16 | 20 |
| All Basal Area | 137 | 147 | 169 | 73 | 106 | 75 | 107 | 85 | 122 |
| Snags 12-18" DBH | 1.7 | 2.4 | 4.9 | 3.3 | 1.2 | 3.7 | 1.4 | 1.4 | 1.6 |
| Snags >12" DBH | 2.0 | 2.8 | 5.9 | 4.1 | 2.1 | 4.6 | 2.2 | 1.8 | 2.4 |
| Snags >18" DBH | 0.4 | 0.4 | 1.0 | 0.8 | 0.8 | 0.9 | 0.8 | 0.4 | 0.8 |
| CWD | 4.5 | 5.6 | 9.0 | 3.4 | 5.7 | 3.6 | 6.0 | 7.3 | 8.2 |
| Logs per Acre | 1.7 | 2.2 | 4.6 | 2.3 | 4.6 | 2.6 | 5.0 | 3.4 | 4.5 |
| Understory Index | 55 | 45 | 28 | 169 | 95 | 163 | 92 | 147 | 77 |
| **Subunit 1-4** | | | | | | | | | |
| % of SDI 12-18" DBH | 28 | 30 | 33 | 23 | 24 | 23 | 24 | 21 | 22 |
| % of SDI 18-24" DBH | 9 | 11 | 17 | 19 | 17 | 19 | 17 | 17 | 14 |
| % of SDI >24" DBH | 5 | 5 | 7 | 16 | 16 | 16 | 16 | 15 | 13 |

| Scale | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| TPA >18" DBH | 9 | 12 | 19 | 9 | 15 | 9 | 15 | 10 | 15 |
| PP Basal Area | 108 | 116 | 129 | 49 | 69 | 49 | 69 | 56 | 76 |
| GO Basal Area | 18 | 19 | 22 | 14 | 20 | 14 | 20 | 17 | 23 |
| All Basal Area | 139 | 150 | 173 | 72 | 107 | 72 | 107 | 86 | 125 |
| Snags 12-18" DBH | 1.4 | 2.1 | 4.6 | 3.1 | 1.3 | 3.1 | 1.3 | 1.2 | 1.6 |
| Snags >12" DBH | 1.8 | 2.4 | 5.4 | 3.8 | 1.9 | 3.8 | 1.9 | 1.5 | 2.2 |
| Snags >18" DBH | 0.4 | 0.4 | 0.8 | 0.7 | 0.6 | 0.7 | 0.6 | 0.3 | 0.6 |
| CWD | 4.3 | 5.4 | 8.7 | 3.4 | 5.5 | 3.4 | 5.5 | 7.1 | 7.8 |
| Logs per Acre | 0.9 | 1.5 | 3.5 | 1.9 | 3.8 | 1.9 | 3.8 | 2.9 | 3.7 |
| Understory Index | 54 | 43 | 26 | 172 | 95 | 172 | 95 | 146 | 76 |
| **Subunit 1-5** | | | | | | | | | |
| % of SDI 12-18" DBH | 30 | 31 | 30 | 22 | 19 | 22 | 19 | 20 | 18 |
| % of SDI 18-24" DBH | 12 | 14 | 20 | 22 | 19 | 22 | 19 | 20 | 16 |
| % of SDI >24" DBH | 6 | 7 | 9 | 18 | 19 | 18 | 19 | 17 | 16 |
| TPA >18" DBH | 12 | 14 | 23 | 11 | 17 | 11 | 17 | 12 | 17 |
| PP Basal Area | 109 | 116 | 127 | 51 | 70 | 51 | 70 | 57 | 75 |
| GO Basal Area | 19 | 20 | 23 | 15 | 20 | 15 | 20 | 18 | 24 |
| All Basal Area | 140 | 150 | 171 | 75 | 108 | 75 | 108 | 87 | 124 |
| Snags 12-18" DBH | 1.8 | 2.5 | 4.9 | 3.3 | 1.3 | 3.3 | 1.3 | 1.4 | 1.6 |
| Snags >12" DBH | 2.2 | 3.0 | 6.0 | 4.1 | 2.1 | 4.1 | 2.1 | 1.9 | 2.5 |
| Snags >18" DBH | 0.4 | 0.4 | 1.1 | 0.9 | 0.8 | 0.9 | 0.8 | 0.4 | 0.8 |
| CWD | 4.3 | 5.6 | 9.1 | 3.5 | 5.8 | 3.5 | 5.8 | 7.3 | 8.2 |
| Logs per Acre | 1.1 | 1.7 | 4.3 | 2.3 | 4.6 | 2.3 | 4.6 | 3.4 | 4.5 |
| Understory Index | 52 | 42 | 27 | 167 | 94 | 167 | 94 | 143 | 76 |
| **Restoration Unit 1 Total** | | | | | | | | | |
| % of SDI 12-18" DBH | 30 | 31 | 30 | 22 | 19 | 22 | 20 | 20 | 18 |

| Scale | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| % of SDI 18-24" DBH | 12 | 14 | 20 | 22 | 19 | 22 | 19 | 20 | 16 |
| % of SDI >24" DBH | 7 | 7 | 10 | 19 | 20 | 19 | 19 | 17 | 17 |
| TPA >18" DBH | 11 | 14 | 23 | 11 | 17 | 11 | 17 | 12 | 17 |
| PP Basal Area | 108 | 115 | 127 | 52 | 70 | 52 | 71 | 57 | 76 |
| GO Basal Area | 17 | 19 | 22 | 14 | 19 | 14 | 19 | 17 | 23 |
| All Basal Area | 138 | 148 | 170 | 74 | 107 | 74 | 107 | 86 | 123 |
| Snags 12-18" DBH | 1.7 | 2.4 | 4.8 | 3.2 | 1.2 | 3.3 | 1.3 | 1.4 | 1.6 |
| Snags >12" DBH | 2.1 | 2.8 | 5.9 | 4.1 | 2.1 | 4.2 | 2.1 | 1.8 | 2.4 |
| Snags >18" DBH | 0.4 | 0.4 | 1.1 | 0.8 | 0.8 | 0.9 | 0.8 | 0.4 | 0.8 |
| CWD | 4.3 | 5.5 | 8.9 | 3.4 | 5.7 | 3.4 | 5.8 | 7.2 | 8.1 |
| Logs per Acre | 1.2 | 1.8 | 4.3 | 2.2 | 4.5 | 2.3 | 4.6 | 3.3 | 4.4 |
| Understory Index | 61 | 50 | 32 | 180 | 103 | 179 | 102 | 155 | 83 |
| **Subunit 3-1** | | | | | | | | | |
| % of SDI 12-18" DBH | 29 | 29 | 24 | 22 | 18 | 22 | 18 | 20 | 17 |
| % of SDI 18-24" DBH | 12 | 14 | 20 | 19 | 18 | 19 | 18 | 18 | 16 |
| % of SDI >24" DBH | 7 | 7 | 9 | 17 | 16 | 17 | 16 | 16 | 14 |
| TPA >18" DBH | 10 | 12 | 21 | 10 | 16 | 10 | 16 | 10 | 16 |
| PP Basal Area | 78 | 85 | 96 | 45 | 60 | 45 | 60 | 50 | 65 |
| GO Basal Area | 30 | 32 | 38 | 23 | 32 | 23 | 32 | 29 | 36 |
| All Basal Area | 126 | 137 | 163 | 80 | 115 | 80 | 115 | 96 | 131 |
| Snags 12-18" DBH | 1.6 | 2.0 | 3.4 | 3.5 | 1.1 | 3.5 | 1.1 | 1.3 | 1.6 |
| Snags >12" DBH | 2.0 | 2.4 | 4.5 | 4.4 | 2.0 | 4.4 | 2.0 | 1.8 | 2.5 |
| Snags >18" DBH | 0.5 | 0.5 | 1.1 | 0.9 | 0.9 | 0.9 | 0.9 | 0.4 | 0.9 |
| CWD | 3.1 | 4.2 | 7.3 | 2.7 | 5.6 | 2.7 | 5.6 | 5.2 | 6.7 |
| Logs per Acre | 1.3 | 1.8 | 3.9 | 2.0 | 4.3 | 2.0 | 4.3 | 2.9 | 4.1 |
| Understory Index | 65 | 52 | 31 | 157 | 88 | 157 | 88 | 132 | 72 |

| Scale | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| **Subunit 3-2** | | | | | | | | | |
| % of SDI 12-18" DBH | 29 | 29 | 23 | 22 | 17 | 23 | 18 | 20 | 16 |
| % of SDI 18-24" DBH | 13 | 15 | 21 | 21 | 19 | 21 | 20 | 19 | 17 |
| % of SDI >24" DBH | 8 | 8 | 11 | 18 | 18 | 17 | 18 | 16 | 16 |
| TPA >18" DBH | 11 | 13 | 22 | 11 | 17 | 11 | 17 | 11 | 17 |
| PP Basal Area | 77 | 83 | 94 | 47 | 61 | 48 | 63 | 51 | 65 |
| GO Basal Area | 28 | 30 | 36 | 21 | 29 | 21 | 29 | 26 | 33 |
| All Basal Area | 121 | 132 | 158 | 79 | 112 | 81 | 113 | 94 | 128 |
| Snags 12-18" DBH | 1.6 | 2.0 | 3.4 | 3.6 | 1.1 | 4.2 | 1.3 | 1.5 | 1.6 |
| Snags >12" DBH | 2.1 | 2.5 | 4.5 | 4.6 | 2.1 | 5.2 | 2.2 | 2.0 | 2.5 |
| Snags >18" DBH | 0.5 | 0.5 | 1.1 | 1.0 | 0.9 | 1.0 | 1.0 | 0.5 | 0.9 |
| CWD | 3.1 | 4.1 | 7.1 | 2.6 | 5.5 | 2.8 | 5.9 | 5.0 | 6.6 |
| Logs per Acre | 1.4 | 2.0 | 4.1 | 2.1 | 4.6 | 2.1 | 4.9 | 3.0 | 4.3 |
| Understory Index | 76 | 62 | 38 | 167 | 96 | 162 | 95 | 143 | 80 |
| **Subunit 3-3** | | | | | | | | | |
| % of SDI 12-18" DBH | 28 | 28 | 24 | 22 | 18 | 22 | 18 | 20 | 17 |
| % of SDI 18-24" DBH | 14 | 16 | 21 | 22 | 19 | 22 | 19 | 20 | 17 |
| % of SDI >24" DBH | 7 | 7 | 11 | 17 | 18 | 16 | 18 | 16 | 16 |
| TPA >18" DBH | 12 | 15 | 23 | 12 | 18 | 12 | 18 | 12 | 18 |
| PP Basal Area | 86 | 91 | 100 | 50 | 65 | 51 | 66 | 55 | 68 |
| GO Basal Area | 30 | 32 | 37 | 22 | 30 | 23 | 30 | 27 | 34 |
| All Basal Area | 134 | 144 | 167 | 85 | 118 | 85 | 118 | 98 | 132 |
| Snags 12-18" DBH | 1.8 | 2.3 | 4.0 | 4.3 | 1.3 | 4.5 | 1.3 | 2.5 | 1.8 |
| Snags >12" DBH | 2.2 | 2.9 | 5.2 | 5.5 | 2.3 | 5.7 | 2.4 | 3.2 | 2.8 |
| Snags >18" DBH | 0.5 | 0.5 | 1.3 | 1.1 | 1.0 | 1.1 | 1.0 | 0.7 | 1.0 |
| CWD | 3.6 | 4.8 | 8.3 | 3.2 | 6.4 | 3.3 | 6.6 | 5.7 | 7.7 |

| Scale | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| Logs per Acre | 1.5 | 2.1 | 4.7 | 2.3 | 5.3 | 2.4 | 5.4 | 3.2 | 5.1 |
| Understory Index | 59 | 49 | 31 | 148 | 84 | 146 | 83 | 128 | 71 |
| **Subunit 3-4** | | | | | | | | | |
| % of SDI 12-18" DBH | 30 | 32 | 32 | 22 | 21 | 22 | 21 | 20 | 20 |
| % of SDI 18-24" DBH | 12 | 14 | 20 | 22 | 19 | 22 | 19 | 20 | 16 |
| % of SDI >24" DBH | 6 | 6 | 9 | 18 | 19 | 18 | 19 | 16 | 16 |
| TPA >18" DBH | 12 | 14 | 23 | 11 | 17 | 11 | 17 | 12 | 17 |
| PP Basal Area | 114 | 122 | 134 | 52 | 72 | 52 | 72 | 58 | 78 |
| GO Basal Area | 18 | 19 | 21 | 14 | 19 | 14 | 19 | 17 | 22 |
| All Basal Area | 143 | 154 | 175 | 74 | 107 | 74 | 107 | 86 | 124 |
| Snags 12-18" DBH | 1.8 | 2.6 | 5.3 | 3.3 | 1.3 | 3.3 | 1.3 | 1.5 | 1.6 |
| Snags >12" DBH | 2.2 | 3.1 | 6.4 | 4.2 | 2.1 | 4.2 | 2.1 | 1.9 | 2.4 |
| Snags >18" DBH | 0.4 | 0.4 | 1.1 | 0.8 | 0.8 | 0.8 | 0.8 | 0.4 | 0.8 |
| CWD | 4.5 | 5.7 | 9.4 | 3.6 | 5.9 | 3.6 | 5.9 | 7.6 | 8.5 |
| Logs per Acre | 1.1 | 1.7 | 4.4 | 2.4 | 4.6 | 2.4 | 4.6 | 3.5 | 4.6 |
| Understory Index | 69 | 57 | 40 | 213 | 122 | 213 | 122 | 185 | 100 |
| **Subunit 3-5** | | | | | | | | | |
| % of SDI 12-18" DBH | 30 | 32 | 31 | 22 | 19 | 22 | 20 | 20 | 18 |
| % of SDI 18-24" DBH | 12 | 14 | 21 | 24 | 20 | 23 | 20 | 21 | 17 |
| % of SDI >24" DBH | 7 | 7 | 9 | 18 | 20 | 18 | 19 | 17 | 17 |
| TPA >18" DBH | 13 | 16 | 25 | 13 | 18 | 12 | 18 | 13 | 18 |
| PP Basal Area | 120 | 127 | 137 | 55 | 74 | 56 | 75 | 60 | 80 |
| GO Basal Area | 19 | 20 | 22 | 15 | 20 | 15 | 20 | 18 | 23 |
| All Basal Area | 152 | 162 | 181 | 78 | 112 | 79 | 113 | 90 | 128 |
| Snags 12-18" DBH | 2.0 | 2.9 | 5.7 | 3.7 | 1.3 | 3.9 | 1.4 | 1.9 | 1.7 |
| Snags >12" DBH | 2.4 | 3.4 | 6.9 | 4.7 | 2.2 | 4.9 | 2.3 | 2.4 | 2.6 |

| Scale | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| Snags >18" DBH | 0.4 | 0.5 | 1.3 | 1.0 | 0.9 | 1.0 | 0.9 | 0.5 | 0.9 |
| CWD | 5.0 | 6.4 | 10.5 | 4.1 | 6.6 | 4.1 | 6.7 | 8.4 | 9.4 |
| Logs per Acre | 1.9 | 2.6 | 5.5 | 2.9 | 5.5 | 3.0 | 5.7 | 4.2 | 5.5 |
| Understory Index | 60 | 51 | 37 | 202 | 114 | 195 | 111 | 177 | 94 |
| **Restoration Unit 3 Total** | | | | | | | | | |
| % of SDI 12-18" DBH | 29 | 29 | 26 | 22 | 18 | 22 | 19 | 20 | 18 |
| % of SDI 18-24" DBH | 13 | 15 | 21 | 22 | 19 | 22 | 19 | 20 | 17 |
| % of SDI >24" DBH | 7 | 7 | 10 | 17 | 18 | 17 | 18 | 16 | 16 |
| TPA >18" DBH | 12 | 14 | 23 | 12 | 17 | 12 | 17 | 12 | 17 |
| PP Basal Area | 95 | 101 | 112 | 50 | 67 | 51 | 67 | 55 | 71 |
| GO Basal Area | 26 | 27 | 32 | 20 | 27 | 20 | 27 | 24 | 30 |
| All Basal Area | 137 | 147 | 169 | 81 | 114 | 81 | 115 | 94 | 130 |
| Snags 12-18" DBH | 1.8 | 2.4 | 4.4 | 3.8 | 1.2 | 4.0 | 1.3 | 1.9 | 1.7 |
| Snags >12" DBH | 2.2 | 2.9 | 5.6 | 4.8 | 2.2 | 5.1 | 2.2 | 2.5 | 2.6 |
| Snags >18" DBH | 0.4 | 0.5 | 1.2 | 1.0 | 0.9 | 1.0 | 1.0 | 0.5 | 0.9 |
| CWD | 3.9 | 5.1 | 8.7 | 3.3 | 6.2 | 3.4 | 6.3 | 6.5 | 8.0 |
| Logs per Acre | 1.5 | 2.1 | 4.7 | 2.4 | 5.0 | 2.5 | 5.2 | 3.4 | 4.9 |
| Understory Index | 63 | 52 | 34 | 173 | 98 | 169 | 97 | 149 | 81 |
| **Subunit 4-3** | | | | | | | | | |
| % of SDI 12-18" DBH | 26 | 23 | 15 | 19 | 12 | 19 | 12 | 19 | 12 |
| % of SDI 18-24" DBH | 32 | 33 | 26 | 36 | 24 | 36 | 24 | 34 | 23 |
| % of SDI >24" DBH | 12 | 14 | 25 | 23 | 35 | 23 | 35 | 21 | 31 |
| TPA >18" DBH | 16 | 19 | 24 | 16 | 20 | 16 | 20 | 16 | 21 |
| PP Basal Area | 70 | 77 | 94 | 58 | 73 | 58 | 73 | 60 | 76 |
| GO Basal Area | 6 | 7 | 12 | 5 | 8 | 5 | 8 | 6 | 9 |
| All Basal Area | 81 | 92 | 119 | 67 | 90 | 67 | 90 | 71 | 97 |

| Scale | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| Snags 12-18" DBH | 0.9 | 0.9 | 1.3 | 2.7 | 0.8 | 2.7 | 0.8 | 2.1 | 0.9 |
| Snags >12" DBH | 1.2 | 1.5 | 2.8 | 3.9 | 2.1 | 3.9 | 2.1 | 2.9 | 2.2 |
| Snags >18" DBH | 0.4 | 0.5 | 1.5 | 1.2 | 1.3 | 1.2 | 1.3 | 0.8 | 1.3 |
| CWD | 2.8 | 3.2 | 4.7 | 1.7 | 4.0 | 1.7 | 4.0 | 3.3 | 4.9 |
| Logs per Acre | 2.0 | 2.3 | 3.8 | 2.1 | 4.7 | 2.1 | 4.7 | 3.0 | 4.8 |
| Understory Index | 126 | 103 | 63 | 175 | 112 | 175 | 112 | 164 | 100 |
| **Subunit 4-4** | | | | | | | | | |
| % of SDI 12-18" DBH | 26 | 26 | 23 | 19 | 17 | 19 | 17 | 17 | 16 |
| % of SDI 18-24" DBH | 12 | 14 | 18 | 19 | 16 | 19 | 16 | 18 | 14 |
| % of SDI >24" DBH | 9 | 9 | 11 | 19 | 18 | 19 | 18 | 18 | 16 |
| TPA >18" DBH | 11 | 14 | 21 | 11 | 16 | 11 | 16 | 12 | 16 |
| PP Basal Area | 80 | 86 | 95 | 45 | 58 | 45 | 58 | 50 | 62 |
| GO Basal Area | 31 | 33 | 40 | 24 | 34 | 24 | 34 | 29 | 38 |
| All Basal Area | 131 | 143 | 167 | 83 | 118 | 83 | 118 | 100 | 135 |
| Snags 12-18" DBH | 1.7 | 2.2 | 3.8 | 3.5 | 1.1 | 3.5 | 1.1 | 1.4 | 1.6 |
| Snags >12" DBH | 2.2 | 2.8 | 5.1 | 4.6 | 2.1 | 4.6 | 2.1 | 1.9 | 2.6 |
| Snags >18" DBH | 0.5 | 0.6 | 1.3 | 1.1 | 1.0 | 1.1 | 1.0 | 0.6 | 1.0 |
| CWD | 3.0 | 4.2 | 7.8 | 2.7 | 5.8 | 2.7 | 5.8 | 5.2 | 7.1 |
| Logs per Acre | 0.9 | 1.6 | 4.3 | 1.9 | 4.6 | 1.9 | 4.6 | 2.8 | 4.3 |
| Understory Index | 56 | 45 | 28 | 149 | 83 | 149 | 83 | 124 | 68 |
| **Subunit 4-5** | | | | | | | | | |
| % of SDI 12-18" DBH | 39 | 40 | 33 | 28 | 19 | 28 | 19 | 26 | 19 |
| % of SDI 18-24" DBH | 11 | 15 | 27 | 25 | 25 | 25 | 25 | 23 | 21 |
| % of SDI >24" DBH | 4 | 4 | 7 | 15 | 17 | 15 | 17 | 14 | 14 |
| TPA >18" DBH | 11 | 15 | 28 | 11 | 19 | 11 | 19 | 12 | 19 |
| PP Basal Area | 120 | 129 | 143 | 53 | 76 | 53 | 76 | 59 | 83 |

| Scale | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| GO Basal Area | 15 | 15 | 16 | 12 | 15 | 12 | 15 | 14 | 18 |
| All Basal Area | 144 | 155 | 176 | 71 | 106 | 71 | 106 | 82 | 123 |
| Snags 12-18" DBH | 2.2 | 3.3 | 6.3 | 3.9 | 1.3 | 3.9 | 1.3 | 1.8 | 1.7 |
| Snags >12" DBH | 2.6 | 3.7 | 7.4 | 4.6 | 2.1 | 4.6 | 2.1 | 2.1 | 2.5 |
| Snags >18" DBH | 0.3 | 0.4 | 1.2 | 0.7 | 0.8 | 0.7 | 0.8 | 0.3 | 0.8 |
| CWD | 4.6 | 6.0 | 10.1 | 3.8 | 6.1 | 3.8 | 6.1 | 8.1 | 8.9 |
| Logs per Acre | 1.2 | 1.9 | 5.0 | 2.7 | 5.0 | 2.7 | 5.0 | 4.1 | 5.0 |
| Understory Index | 50 | 41 | 26 | 177 | 94 | 177 | 94 | 154 | 76 |
| **Restoration Unit 4 Total** | | | | | | | | | |
| % of SDI 12-18" DBH | 28 | 27 | 24 | 20 | 17 | 20 | 17 | 18 | 16 |
| % of SDI 18-24" DBH | 13 | 15 | 20 | 21 | 17 | 21 | 17 | 19 | 16 |
| % of SDI >24" DBH | 8 | 9 | 11 | 19 | 19 | 19 | 19 | 18 | 17 |
| TPA >18" DBH | 12 | 14 | 22 | 11 | 16 | 11 | 16 | 12 | 16 |
| PP Basal Area | 84 | 91 | 100 | 47 | 62 | 47 | 62 | 52 | 66 |
| GO Basal Area | 27 | 29 | 35 | 21 | 30 | 21 | 30 | 25 | 33 |
| All Basal Area | 129 | 141 | 165 | 80 | 115 | 80 | 115 | 96 | 130 |
| Snags 12-18" DBH | 1.7 | 2.2 | 3.9 | 3.5 | 1.1 | 3.5 | 1.1 | 1.5 | 1.5 |
| Snags >12" DBH | 2.2 | 2.8 | 5.2 | 4.6 | 2.1 | 4.6 | 2.1 | 2.0 | 2.5 |
| Snags >18" DBH | 0.5 | 0.6 | 1.3 | 1.0 | 1.0 | 1.0 | 1.0 | 0.5 | 1.0 |
| CWD | 3.2 | 4.3 | 7.8 | 2.8 | 5.7 | 2.8 | 5.7 | 5.4 | 7.1 |
| Logs per Acre | 1.1 | 1.7 | 4.3 | 2.0 | 4.7 | 2.0 | 4.7 | 3.0 | 4.4 |
| Understory Index | 61 | 49 | 30 | 154 | 86 | 154 | 86 | 130 | 71 |
| **Subunit 5-1** | | | | | | | | | |
| % of SDI 12-18" DBH | 21 | 23 | 27 | 16 | 18 | 16 | 18 | 15 | 17 |
| % of SDI 18-24" DBH | 12 | 12 | 16 | 19 | 15 | 19 | 15 | 17 | 13 |
| % of SDI >24" DBH | 16 | 17 | 18 | 30 | 29 | 30 | 29 | 28 | 25 |

| Scale | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| TPA >18" DBH | 14 | 15 | 20 | 13 | 16 | 13 | 16 | 13 | 16 |
| PP Basal Area | 97 | 105 | 119 | 54 | 71 | 54 | 71 | 59 | 77 |
| GO Basal Area | 11 | 12 | 15 | 9 | 13 | 9 | 13 | 11 | 15 |
| All Basal Area | 122 | 134 | 158 | 73 | 105 | 73 | 105 | 84 | 121 |
| Snags 12-18" DBH | 1.3 | 1.5 | 3.5 | 2.2 | 0.9 | 2.2 | 0.9 | 0.9 | 1.1 |
| Snags >12" DBH | 1.9 | 2.2 | 4.6 | 3.2 | 1.9 | 3.2 | 1.9 | 1.5 | 2.0 |
| Snags >18" DBH | 0.6 | 0.6 | 1.1 | 1.0 | 0.9 | 1.0 | 0.9 | 0.6 | 0.9 |
| CWD | 3.8 | 4.8 | 7.9 | 2.8 | 5.1 | 2.8 | 5.1 | 6.0 | 7.1 |
| Logs per Acre | 0.9 | 1.5 | 3.8 | 1.8 | 4.1 | 1.8 | 4.1 | 2.7 | 4.0 |
| Understory Index | 71 | 58 | 35 | 163 | 94 | 163 | 94 | 141 | 76 |
| **Subunit 5-2** | | | | | | | | | |
| % of SDI 12-18" DBH | 26 | 28 | 28 | 24 | 23 | 24 | 23 | 21 | 22 |
| % of SDI 18-24" DBH | 9 | 9 | 14 | 15 | 15 | 15 | 15 | 14 | 12 |
| % of SDI >24" DBH | 6 | 6 | 7 | 15 | 13 | 15 | 13 | 13 | 11 |
| TPA >18" DBH | 5 | 7 | 13 | 6 | 11 | 6 | 11 | 6 | 11 |
| PP Basal Area | 66 | 74 | 91 | 40 | 57 | 40 | 57 | 46 | 64 |
| GO Basal Area | 8 | 9 | 19 | 7 | 15 | 7 | 15 | 8 | 17 |
| All Basal Area | 90 | 104 | 139 | 59 | 94 | 59 | 94 | 72 | 110 |
| Snags 12-18" DBH | 0.9 | 1.2 | 2.4 | 2.4 | 1.1 | 2.4 | 1.1 | 0.9 | 1.3 |
| Snags >12" DBH | 1.2 | 1.4 | 2.9 | 2.9 | 1.5 | 2.9 | 1.5 | 1.1 | 1.7 |
| Snags >18" DBH | 0.2 | 0.2 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | 0.2 | 0.4 |
| CWD | 2.8 | 3.2 | 4.9 | 1.9 | 3.6 | 1.9 | 3.6 | 3.9 | 4.7 |
| Logs per Acre | 0.4 | 0.7 | 1.8 | 0.9 | 2.2 | 0.9 | 2.2 | 1.3 | 2.0 |
| Understory Index | 115 | 88 | 45 | 208 | 117 | 208 | 117 | 174 | 95 |
| **Restoration Unit 5 Total** | | | | | | | | | |
| % of SDI 12-18" DBH | 24 | 26 | 28 | 21 | 21 | 21 | 21 | 19 | 20 |

| Scale | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| % of SDI 18-24" DBH | 10 | 11 | 15 | 17 | 15 | 17 | 15 | 15 | 13 |
| % of SDI >24" DBH | 10 | 10 | 11 | 21 | 18 | 21 | 18 | 19 | 16 |
| TPA >18" DBH | 8 | 10 | 16 | 8 | 13 | 8 | 13 | 9 | 13 |
| PP Basal Area | 77 | 85 | 101 | 45 | 62 | 45 | 62 | 51 | 69 |
| GO Basal Area | 9 | 10 | 17 | 7 | 14 | 7 | 14 | 9 | 16 |
| All Basal Area | 102 | 115 | 146 | 64 | 98 | 64 | 98 | 77 | 114 |
| Snags 12-18" DBH | 1.1 | 1.3 | 2.8 | 2.3 | 1.0 | 2.3 | 1.0 | 0.9 | 1.2 |
| Snags >12" DBH | 1.4 | 1.7 | 3.5 | 3.0 | 1.6 | 3.0 | 1.6 | 1.2 | 1.8 |
| Snags >18" DBH | 0.4 | 0.4 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.4 | 0.6 |
| CWD | 3.1 | 3.8 | 6.0 | 2.2 | 4.1 | 2.2 | 4.1 | 4.7 | 5.6 |
| Logs per Acre | 0.6 | 1.0 | 2.5 | 1.3 | 2.9 | 1.3 | 2.9 | 1.8 | 2.7 |
| Understory Index | 99 | 77 | 41 | 191 | 109 | 191 | 109 | 162 | 88 |
| **All Other Restricted Total** | | | | | | | | | |
| % of SDI 12-18" DBH | 29 | 30 | 28 | 22 | 19 | 22 | 19 | 20 | 18 |
| % of SDI 18-24" DBH | 13 | 14 | 20 | 22 | 19 | 22 | 19 | 20 | 17 |
| % of SDI >24" DBH | 7 | 7 | 10 | 18 | 19 | 18 | 19 | 17 | 16 |
| TPA >18" DBH | 12 | 14 | 23 | 11 | 17 | 11 | 17 | 12 | 17 |
| PP Basal Area | 100 | 106 | 117 | 51 | 68 | 51 | 68 | 56 | 73 |
| GO Basal Area | 22 | 24 | 28 | 17 | 24 | 17 | 24 | 21 | 27 |
| All Basal Area | 137 | 147 | 169 | 78 | 111 | 78 | 112 | 91 | 127 |
| Snags 12-18" DBH | 1.7 | 2.4 | 4.5 | 3.6 | 1.2 | 3.7 | 1.3 | 1.7 | 1.6 |
| Snags >12" DBH | 2.2 | 2.9 | 5.7 | 4.5 | 2.1 | 4.7 | 2.2 | 2.2 | 2.5 |
| Snags >18" DBH | 0.4 | 0.5 | 1.1 | 0.9 | 0.9 | 1.0 | 0.9 | 0.5 | 0.9 |
| CWD | 4.1 | 5.3 | 8.7 | 3.3 | 6.0 | 3.4 | 6.1 | 6.7 | 8.0 |
| Logs per Acre | 1.4 | 2.0 | 4.5 | 2.3 | 4.8 | 2.4 | 4.9 | 3.4 | 4.7 |
| Understory Index | 63 | 51 | 33 | 175 | 100 | 173 | 99 | 151 | 82 |

**Table 226. Changes in Forest Structure Attributes Within MSO Threshold Habitat by Alternative by Subunit, Including Ponderosa Pine (% of SDI and PP) and Gambel Oak (GO)**

| Scale | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| **Subunit 1-3** | | | | | | | | | |
| % of SDI 12-18" DBH | 24 | 23 | 27 | 25 | 25 | 22 | 24 | 25 | 25 |
| % of SDI 18-24" DBH | 32 | 34 | 33 | 38 | 35 | 38 | 33 | 37 | 34 |
| % of SDI >24" DBH | 2 | 3 | 7 | 3 | 8 | 3 | 9 | 3 | 8 |
| TPA >18" DBH | 35 | 38 | 40 | 38 | 41 | 37 | 38 | 38 | 40 |
| PP Basal Area | 108 | 113 | 123 | 95 | 107 | 86 | 99 | 98 | 109 |
| GO Basal Area | 54 | 55 | 53 | 56 | 55 | 56 | 56 | 56 | 55 |
| All Basal Area | 186 | 193 | 215 | 175 | 205 | 167 | 200 | 178 | 207 |
| Snags 12-18" DBH | 1.6 | 2.6 | 4.5 | 2.4 | 3.5 | 2.0 | 2.9 | 1.8 | 3.5 |
| Snags >12" DBH | 1.8 | 3.2 | 5.9 | 2.9 | 4.8 | 2.5 | 4.1 | 2.2 | 4.8 |
| Snags >18" DBH | 0.2 | 0.6 | 1.5 | 0.5 | 1.3 | 0.5 | 1.1 | 0.4 | 1.3 |
| CWD | 8.4 | 9.3 | 12.7 | 4.1 | 7.1 | 4.3 | 6.8 | 9.5 | 11.6 |
| Logs per Acre | 10.7 | 10.9 | 12.8 | 6.5 | 8.4 | 6.8 | 8.1 | 10.8 | 12.0 |
| Understory Index | 18 | 16 | 11 | 22 | 13 | 26 | 14 | 21 | 13 |
| **Subunit 1-5** | | | | | | | | | |
| % of SDI 12-18" DBH | 25 | 25 | 26 | 28 | 21 | 19 | 19 | 28 | 21 |
| % of SDI 18-24" DBH | 17 | 19 | 23 | 27 | 32 | 27 | 26 | 26 | 32 |
| % of SDI >24" DBH | 3 | 3 | 5 | 4 | 8 | 5 | 9 | 4 | 8 |
| TPA >18" DBH | 21 | 25 | 31 | 26 | 37 | 24 | 30 | 26 | 38 |
| PP Basal Area | 151 | 154 | 160 | 96 | 114 | 85 | 104 | 99 | 116 |
| GO Basal Area | 62 | 61 | 58 | 63 | 64 | 63 | 65 | 62 | 63 |
| All Basal Area | 220 | 224 | 235 | 167 | 198 | 156 | 190 | 169 | 199 |
| Snags 12-18" DBH | 2.3 | 3.2 | 4.2 | 3.7 | 2.2 | 2.7 | 1.7 | 2.3 | 2.5 |
| Snags >12" DBH | 3.0 | 3.7 | 5.2 | 4.1 | 3.2 | 3.1 | 2.5 | 2.8 | 3.5 |

| Scale | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| Snags >18" DBH | 0.6 | 0.5 | 1.0 | 0.4 | 0.9 | 0.4 | 0.8 | 0.4 | 1.0 |
| CWD | 5.9 | 8.4 | 13.1 | 3.6 | 6.8 | 4.0 | 6.9 | 9.6 | 12.0 |
| Logs per Acre | 2.1 | 2.9 | 5.5 | 2.0 | 4.2 | 2.6 | 4.2 | 3.1 | 4.9 |
| Understory Index | 10 | 9 | 8 | 26 | 15 | 32 | 17 | 25 | 14 |
| **Restoration Unit 1 Total** | | | | | | | | | |
| % of SDI 12-18" DBH | 25 | 24 | 26 | 27 | 23 | 20 | 21 | 27 | 23 |
| % of SDI 18-24" DBH | 24 | 26 | 28 | 32 | 33 | 32 | 30 | 32 | 33 |
| % of SDI >24" DBH | 3 | 3 | 6 | 4 | 8 | 4 | 9 | 4 | 8 |
| TPA >18" DBH | 28 | 31 | 35 | 32 | 39 | 30 | 34 | 32 | 39 |
| PP Basal Area | 131 | 134 | 142 | 96 | 111 | 85 | 102 | 98 | 113 |
| GO Basal Area | 58 | 58 | 56 | 59 | 60 | 59 | 61 | 59 | 59 |
| All Basal Area | 204 | 209 | 226 | 171 | 202 | 161 | 195 | 173 | 203 |
| Snags 12-18" DBH | 2.0 | 2.9 | 4.3 | 3.1 | 2.8 | 2.3 | 2.3 | 2.1 | 3.0 |
| Snags >12" DBH | 2.4 | 3.4 | 5.5 | 3.6 | 4.0 | 2.8 | 3.3 | 2.5 | 4.1 |
| Snags >18" DBH | 0.5 | 0.5 | 1.2 | 0.4 | 1.1 | 0.5 | 1.0 | 0.4 | 1.1 |
| CWD | 7.1 | 8.8 | 12.9 | 3.8 | 6.9 | 4.1 | 6.8 | 9.6 | 11.8 |
| Logs per Acre | 6.1 | 6.7 | 9.0 | 4.1 | 6.2 | 4.6 | 6.1 | 6.7 | 8.3 |
| Understory Index | 14 | 13 | 9 | 24 | 14 | 29 | 16 | 23 | 14 |
| **Subunit 3-1** | | | | | | | | | |
| % of SDI 12-18" DBH | 25 | 23 | 17 | 20 | 15 | 18 | 15 | 20 | 15 |
| % of SDI 18-24" DBH | 19 | 21 | 25 | 23 | 25 | 23 | 22 | 23 | 25 |
| % of SDI >24" DBH | 9 | 9 | 12 | 10 | 14 | 11 | 15 | 10 | 13 |
| TPA >18" DBH | 23 | 26 | 35 | 26 | 34 | 25 | 31 | 26 | 34 |
| PP Basal Area | 96 | 99 | 102 | 81 | 87 | 73 | 80 | 83 | 88 |
| GO Basal Area | 61 | 62 | 66 | 63 | 70 | 64 | 71 | 63 | 68 |
| All Basal Area | 182 | 189 | 208 | 173 | 201 | 166 | 197 | 175 | 201 |

| Scale | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| Snags 12-18" DBH | 2.9 | 3.8 | 4.2 | 3.1 | 2.4 | 3.0 | 2.3 | 2.6 | 2.6 |
| Snags >12" DBH | 3.6 | 4.9 | 6.4 | 4.1 | 4.7 | 3.9 | 4.3 | 3.7 | 5.0 |
| Snags >18" DBH | 0.7 | 1.1 | 2.2 | 1.0 | 2.3 | 1.0 | 1.9 | 1.0 | 2.4 |
| CWD >3" | 3.7 | 6.0 | 11.1 | 2.5 | 6.8 | 2.6 | 6.6 | 6.3 | 10.2 |
| Logs per Acre | 0.9 | 2.4 | 7.5 | 1.8 | 6.0 | 2.1 | 5.9 | 2.7 | 6.9 |
| Understory Index | 20 | 17 | 12 | 24 | 14 | 27 | 15 | 23 | 14 |
| **Subunit 3-2** | | | | | | | | | |
| % of SDI 12-18" DBH | 29 | 26 | 17 | 22 | 13 | 19 | 13 | 22 | 12 |
| % of SDI 18-24" DBH | 19 | 22 | 29 | 25 | 29 | 25 | 25 | 25 | 29 |
| % of SDI >24" DBH | 10 | 11 | 14 | 12 | 16 | 13 | 17 | 12 | 16 |
| TPA >18" DBH | 24 | 28 | 40 | 28 | 39 | 27 | 35 | 28 | 39 |
| PP Basal Area | 114 | 117 | 119 | 94 | 100 | 86 | 93 | 96 | 101 |
| GO Basal Area | 47 | 47 | 49 | 48 | 52 | 49 | 54 | 48 | 51 |
| All Basal Area | 179 | 186 | 203 | 166 | 196 | 159 | 191 | 167 | 195 |
| Snags 12-18" DBH | 3.3 | 4.5 | 4.6 | 3.4 | 2.3 | 3.4 | 2.1 | 3.1 | 2.4 |
| Snags >12" DBH | 4.0 | 5.6 | 7.3 | 4.4 | 5.0 | 4.4 | 4.4 | 4.1 | 5.2 |
| Snags >18" DBH | 0.7 | 1.1 | 2.7 | 1.0 | 2.7 | 1.0 | 2.3 | 1.0 | 2.8 |
| CWD | 4.3 | 6.5 | 12.0 | 2.7 | 7.0 | 2.8 | 6.9 | 6.4 | 10.3 |
| Logs per Acre | 1.3 | 2.9 | 8.7 | 2.2 | 6.7 | 2.5 | 6.6 | 3.3 | 7.7 |
| Understory Index | 21 | 18 | 13 | 26 | 15 | 30 | 17 | 26 | 16 |
| **Subunit 3-3** | | | | | | | | | |
| % of SDI 12-18" DBH | 24 | 23 | 20 | 21 | 18 | 19 | 18 | 21 | 18 |
| % of SDI 18-24" DBH | 19 | 21 | 24 | 23 | 24 | 23 | 23 | 23 | 24 |
| % of SDI >24" DBH | 8 | 8 | 11 | 9 | 12 | 9 | 12 | 9 | 12 |
| TPA >18" DBH | 23 | 25 | 33 | 25 | 33 | 25 | 31 | 25 | 33 |
| PP Basal Area | 101 | 104 | 107 | 84 | 90 | 78 | 86 | 86 | 92 |

| Scale | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| GO Basal Area | 62 | 63 | 66 | 64 | 69 | 64 | 71 | 64 | 68 |
| All Basal Area | 187 | 193 | 212 | 175 | 203 | 170 | 200 | 177 | 203 |
| Snags 12-18" DBH | 2.6 | 3.4 | 4.1 | 3.3 | 2.8 | 3.1 | 2.6 | 2.8 | 2.9 |
| Snags >12" DBH | 3.4 | 4.4 | 6.1 | 4.3 | 4.8 | 4.0 | 4.4 | 3.8 | 5.0 |
| Snags >18" DBH | 0.8 | 1.0 | 2.0 | 1.0 | 2.0 | 1.0 | 1.8 | 1.0 | 2.0 |
| CWD | 4.4 | 6.5 | 11.4 | 2.7 | 7.1 | 2.8 | 6.9 | 6.4 | 10.3 |
| Logs per Acre | 1.9 | 3.1 | 7.6 | 2.2 | 6.2 | 2.4 | 6.0 | 3.3 | 7.1 |
| Understory Index | 18 | 16 | 12 | 22 | 13 | 25 | 14 | 22 | 13 |
| **Subunit 3-5** | | | | | | | | | |
| % of SDI 12-18" DBH | 29 | 28 | 26 | 30 | 22 | 23 | 21 | 31 | 22 |
| % of SDI 18-24" DBH | 22 | 25 | 30 | 31 | 35 | 31 | 30 | 30 | 35 |
| % of SDI >24" DBH | 4 | 4 | 8 | 6 | 10 | 6 | 12 | 6 | 11 |
| TPA >18" DBH | 26 | 29 | 38 | 31 | 41 | 28 | 35 | 30 | 42 |
| PP Basal Area | 133 | 137 | 145 | 100 | 116 | 87 | 106 | 102 | 118 |
| GO Basal Area | 53 | 53 | 51 | 54 | 56 | 54 | 57 | 54 | 55 |
| All Basal Area | 198 | 203 | 217 | 166 | 195 | 154 | 187 | 168 | 196 |
| Snags 12-18" DBH | 3.6 | 4.6 | 5.3 | 4.3 | 2.7 | 3.5 | 2.4 | 3.1 | 3.0 |
| Snags >12" DBH | 4.0 | 5.2 | 6.8 | 4.7 | 4.0 | 3.9 | 3.4 | 3.6 | 4.3 |
| Snags >18" DBH | 0.4 | 0.6 | 1.4 | 0.4 | 1.3 | 0.4 | 1.0 | 0.5 | 1.3 |
| CWD | 6.5 | 8.5 | 13.5 | 3.6 | 7.0 | 3.9 | 6.8 | 9.2 | 11.8 |
| Logs per Acre | 4.1 | 5.1 | 8.8 | 3.2 | 5.9 | 3.8 | 5.8 | 5.1 | 7.5 |
| Understory Index | 25 | 24 | 19 | 37 | 25 | 44 | 27 | 36 | 24 |
| **Restoration Unit 3 Total** | | | | | | | | | |
| % of SDI 12-18" DBH | 26 | 25 | 19 | 22 | 17 | 19 | 17 | 22 | 16 |
| % of SDI 18-24" DBH | 19 | 21 | 26 | 24 | 27 | 24 | 24 | 24 | 27 |
| % of SDI >24" DBH | 8 | 8 | 11 | 10 | 13 | 10 | 14 | 9 | 13 |

| Scale | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| TPA >18" DBH | 24 | 26 | 36 | 27 | 36 | 26 | 32 | 27 | 36 |
| PP Basal Area | 107 | 110 | 113 | 87 | 95 | 80 | 88 | 89 | 96 |
| GO Basal Area | 57 | 58 | 61 | 59 | 64 | 60 | 65 | 59 | 63 |
| All Basal Area | 185 | 192 | 209 | 171 | 200 | 165 | 196 | 173 | 200 |
| Snags 12-18" DBH | 3.0 | 3.9 | 4.4 | 3.4 | 2.6 | 3.1 | 2.4 | 2.9 | 2.7 |
| Snags >12" DBH | 3.7 | 4.9 | 6.5 | 4.3 | 4.7 | 4.1 | 4.2 | 3.8 | 4.9 |
| Snags >18" DBH | 0.7 | 1.0 | 2.1 | 0.9 | 2.2 | 0.9 | 1.8 | 0.9 | 2.2 |
| CWD | 4.4 | 6.6 | 11.7 | 2.8 | 7.0 | 2.9 | 6.8 | 6.7 | 10.5 |
| Logs per Acre | 1.8 | 3.1 | 7.9 | 2.2 | 6.2 | 2.5 | 6.1 | 3.3 | 7.2 |
| Understory Index | 20 | 18 | 13 | 26 | 16 | 29 | 17 | 25 | 16 |
| **All Threshold Total** | | | | | | | | | |
| % of SDI 12-18" DBH | 25 | 24 | 22 | 24 | 19 | 20 | 19 | 24 | 19 |
| % of SDI 18-24" DBH | 21 | 24 | 27 | 28 | 30 | 28 | 26 | 27 | 30 |
| % of SDI >24" DBH | 6 | 6 | 9 | 7 | 11 | 7 | 12 | 7 | 11 |
| TPA >18" DBH | 26 | 28 | 36 | 29 | 37 | 28 | 33 | 29 | 37 |
| PP Basal Area | 117 | 120 | 126 | 91 | 102 | 82 | 94 | 93 | 103 |
| GO Basal Area | 58 | 58 | 58 | 59 | 62 | 60 | 63 | 59 | 61 |
| All Basal Area | 193 | 199 | 217 | 171 | 201 | 163 | 195 | 173 | 201 |
| Snags 12-18" DBH | 2.5 | 3.5 | 4.4 | 3.3 | 2.7 | 2.8 | 2.4 | 2.5 | 2.8 |
| Snags >12" DBH | 3.1 | 4.3 | 6.1 | 4.0 | 4.4 | 3.5 | 3.8 | 3.2 | 4.6 |
| Snags >18" DBH | 0.6 | 0.8 | 1.7 | 0.7 | 1.7 | 0.7 | 1.5 | 0.7 | 1.7 |
| CWD | 5.6 | 7.6 | 12.2 | 3.2 | 7.0 | 3.4 | 6.8 | 8.0 | 11.1 |
| Logs per Acre | 3.7 | 4.7 | 8.4 | 3.0 | 6.2 | 3.4 | 6.1 | 4.9 | 7.7 |
| Understory Index | 17 | 16 | 11 | 25 | 15 | 29 | 16 | 24 | 15 |

**Table 227. Changes in Forest Structure Attributes in MSO Target Habitat by Alternative by Subunit, Including Ponderosa Pine (% of SDI and PP) and Gambel Oak (GO)**

| Scale | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| **Subunit 1-1** | | | | | | | | | |
| % of SDI 12-18" DBH | 36 | 35 | 30 | 35 | 24 | 27 | 22 | 35 | 25 |
| % of SDI 18-24" DBH | 12 | 15 | 23 | 19 | 27 | 20 | 21 | 19 | 26 |
| % of SDI >24" DBH | 7 | 7 | 9 | 9 | 11 | 10 | 13 | 8 | 11 |
| TPA >18" DBH | 14 | 18 | 29 | 19 | 31 | 17 | 24 | 19 | 30 |
| PP Basal Area | 132 | 137 | 141 | 106 | 116 | 84 | 97 | 109 | 119 |
| GO Basal Area | 23 | 24 | 25 | 24 | 27 | 25 | 29 | 24 | 26 |
| All Basal Area | 167 | 175 | 192 | 144 | 173 | 124 | 161 | 147 | 175 |
| Snags 12-18" DBH | 3.3 | 4.3 | 6.5 | 4.7 | 4.4 | 3.8 | 3.3 | 3.3 | 4.7 |
| Snags >12" DBH | 3.8 | 4.9 | 8.2 | 5.2 | 6.3 | 4.3 | 4.8 | 3.8 | 6.6 |
| Snags >18" DBH | 0.5 | 0.6 | 1.7 | 0.5 | 1.9 | 0.5 | 1.4 | 0.5 | 1.9 |
| CWD | 6.4 | 7.9 | 13.1 | 3.5 | 7.9 | 3.9 | 7.3 | 8.6 | 12.1 |
| Logs per Acre | 5.3 | 6.0 | 9.8 | 3.9 | 7.5 | 4.6 | 7.1 | 6.3 | 9.2 |
| Understory Index | 112 | 103 | 89 | 142 | 105 | 180 | 118 | 137 | 103 |
| **Subunit 1-3** | | | | | | | | | |
| % of SDI 12-18" DBH | 30 | 30 | 29 | 31 | 25 | 25 | 23 | 31 | 26 |
| % of SDI 18-24" DBH | 11 | 13 | 20 | 17 | 23 | 17 | 19 | 16 | 23 |
| % of SDI >24" DBH | 7 | 8 | 9 | 9 | 11 | 10 | 12 | 9 | 11 |
| TPA >18" DBH | 13 | 15 | 24 | 16 | 26 | 15 | 21 | 16 | 25 |
| PP Basal Area | 113 | 118 | 126 | 93 | 105 | 80 | 93 | 96 | 108 |
| GO Basal Area | 25 | 27 | 30 | 27 | 32 | 28 | 33 | 27 | 31 |
| All Basal Area | 151 | 160 | 180 | 134 | 165 | 122 | 157 | 137 | 167 |
| Snags 12-18" DBH | 2.5 | 3.2 | 5.4 | 3.8 | 3.9 | 3.2 | 3.2 | 2.5 | 4.2 |
| Snags >12" DBH | 2.9 | 3.7 | 6.8 | 4.3 | 5.3 | 3.6 | 4.4 | 3.0 | 5.6 |

| Scale | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| Snags >18" DBH | 0.5 | 0.5 | 1.4 | 0.5 | 1.4 | 0.5 | 1.2 | 0.5 | 1.4 |
| CWD | 6.1 | 7.4 | 11.6 | 3.3 | 6.8 | 3.5 | 6.5 | 7.9 | 10.6 |
| Logs per Acre | 5.2 | 5.7 | 8.4 | 3.6 | 6.4 | 4.1 | 6.2 | 5.9 | 8.0 |
| Understory Index | 39 | 32 | 22 | 50 | 29 | 61 | 32 | 47 | 28 |
| **Subunit 1-4** | | | | | | | | | |
| % of SDI 12-18" DBH | 19 | 19 | 18 | 14 | 11 | 11 | 10 | 14 | 12 |
| % of SDI 18-24" DBH | 28 | 28 | 24 | 33 | 26 | 34 | 24 | 33 | 26 |
| % of SDI >24" DBH | 18 | 19 | 24 | 22 | 28 | 24 | 30 | 22 | 28 |
| TPA >18" DBH | 32 | 34 | 35 | 34 | 36 | 32 | 33 | 34 | 36 |
| PP Basal Area | 117 | 120 | 125 | 98 | 108 | 89 | 100 | 99 | 109 |
| GO Basal Area | 17 | 18 | 24 | 18 | 25 | 18 | 26 | 18 | 25 |
| All Basal Area | 154 | 162 | 185 | 139 | 171 | 131 | 165 | 140 | 172 |
| Snags 12-18" DBH | 2.8 | 2.8 | 3.2 | 2.6 | 1.0 | 2.2 | 0.8 | 2.2 | 1.1 |
| Snags >12" DBH | 4.2 | 4.4 | 5.7 | 4.1 | 3.1 | 3.7 | 2.7 | 3.7 | 3.3 |
| Snags >18" DBH | 1.4 | 1.6 | 2.5 | 1.5 | 2.1 | 1.5 | 1.9 | 1.5 | 2.2 |
| CWD | 5.7 | 7.0 | 10.9 | 2.9 | 6.0 | 3.1 | 5.7 | 7.6 | 9.8 |
| Logs per Acre | 3.3 | 4.4 | 9.1 | 3.0 | 6.8 | 3.3 | 6.6 | 4.8 | 8.3 |
| Understory Index | 33 | 28 | 19 | 43 | 24 | 50 | 27 | 42 | 23 |
| **Subunit 1-5** | | | | | | | | | |
| % of SDI 12-18" DBH | 29 | 29 | 28 | 29 | 24 | 23 | 21 | 30 | 24 |
| % of SDI 18-24" DBH | 12 | 14 | 19 | 17 | 22 | 17 | 18 | 16 | 22 |
| % of SDI >24" DBH | 7 | 7 | 9 | 9 | 11 | 10 | 12 | 9 | 11 |
| TPA >18" DBH | 14 | 16 | 24 | 17 | 26 | 16 | 22 | 17 | 26 |
| PP Basal Area | 117 | 121 | 126 | 94 | 105 | 80 | 92 | 97 | 107 |
| GO Basal Area | 30 | 31 | 34 | 32 | 37 | 33 | 39 | 32 | 36 |
| All Basal Area | 161 | 170 | 188 | 142 | 174 | 129 | 166 | 146 | 175 |

| Scale | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| Snags 12-18" DBH | 2.5 | 3.2 | 5.4 | 3.8 | 3.8 | 3.0 | 3.0 | 2.5 | 4.1 |
| Snags >12" DBH | 3.0 | 3.8 | 6.8 | 4.3 | 5.2 | 3.5 | 4.1 | 3.0 | 5.5 |
| Snags >18" DBH | 0.5 | 0.6 | 1.3 | 0.5 | 1.4 | 0.5 | 1.2 | 0.5 | 1.4 |
| CWD | 6.0 | 7.6 | 12.1 | 3.3 | 6.9 | 3.5 | 6.6 | 8.1 | 11.0 |
| Logs per Acre | 4.0 | 4.7 | 7.6 | 3.0 | 5.9 | 3.5 | 5.6 | 4.8 | 7.2 |
| Understory Index | 29 | 25 | 18 | 41 | 23 | 52 | 27 | 38 | 22 |
| **Restoration Unit 1 Total** | | | | | | | | | |
| % of SDI 12-18" DBH | 30 | 29 | 28 | 30 | 24 | 24 | 22 | 30 | 25 |
| % of SDI 18-24" DBH | 12 | 14 | 19 | 17 | 23 | 18 | 19 | 17 | 23 |
| % of SDI >24" DBH | 7 | 8 | 10 | 10 | 12 | 11 | 13 | 9 | 11 |
| TPA >18" DBH | 14 | 16 | 24 | 17 | 26 | 16 | 22 | 17 | 26 |
| PP Basal Area | 115 | 120 | 126 | 94 | 105 | 80 | 93 | 97 | 108 |
| GO Basal Area | 27 | 29 | 31 | 29 | 34 | 29 | 36 | 29 | 33 |
| All Basal Area | 156 | 165 | 184 | 138 | 169 | 125 | 161 | 141 | 171 |
| Snags 12-18" DBH | 2.5 | 3.3 | 5.4 | 3.8 | 3.8 | 3.1 | 3.0 | 2.5 | 4.1 |
| Snags >12" DBH | 3.0 | 3.8 | 6.8 | 4.3 | 5.2 | 3.6 | 4.2 | 3.1 | 5.5 |
| Snags >18" DBH | 0.5 | 0.6 | 1.4 | 0.5 | 1.4 | 0.5 | 1.2 | 0.5 | 1.5 |
| CWD | 6.0 | 7.5 | 11.8 | 3.3 | 6.8 | 3.5 | 6.5 | 8.0 | 10.8 |
| Logs per Acre | 4.6 | 5.2 | 8.1 | 3.3 | 6.2 | 3.8 | 6.0 | 5.4 | 7.7 |
| Understory Index | 37 | 31 | 22 | 48 | 28 | 60 | 32 | 46 | 27 |
| **Subunit 3-1** | | | | | | | | | |
| % of SDI 12-18" DBH | 37 | 35 | 23 | 35 | 22 | 33 | 21 | 35 | 22 |
| % of SDI 18-24" DBH | 12 | 15 | 21 | 16 | 21 | 16 | 20 | 16 | 21 |
| % of SDI >24" DBH | 2 | 2 | 5 | 2 | 6 | 2 | 7 | 2 | 6 |
| TPA >18" DBH | 10 | 14 | 24 | 14 | 24 | 14 | 24 | 14 | 24 |
| PP Basal Area | 82 | 87 | 91 | 77 | 84 | 72 | 80 | 79 | 86 |

| Scale | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| GO Basal Area | 45 | 45 | 42 | 45 | 45 | 46 | 46 | 45 | 43 |
| All Basal Area | 144 | 157 | 186 | 149 | 184 | 145 | 182 | 151 | 183 |
| Snags 12-18" DBH | 2.9 | 4.1 | 6.5 | 4.9 | 5.0 | 4.4 | 4.5 | 3.7 | 5.5 |
| Snags >12" DBH | 3.3 | 4.6 | 8.2 | 5.4 | 6.7 | 4.8 | 6.1 | 4.2 | 7.2 |
| Snags >18" DBH | 0.5 | 0.5 | 1.7 | 0.5 | 1.7 | 0.5 | 1.5 | 0.5 | 1.7 |
| CWD | 3.9 | 5.8 | 11.9 | 2.3 | 8.3 | 2.3 | 8.1 | 5.9 | 11.4 |
| Logs per Acre | 0.9 | 2.0 | 6.9 | 1.4 | 6.2 | 1.5 | 6.0 | 2.0 | 6.7 |
| Understory Index | | | | | | | | | |
| **Subunit 3-2** | | | | | | | | | |
| % of SDI 12-18" DBH | 26 | 25 | 21 | 25 | 21 | 23 | 19 | 25 | 21 |
| % of SDI 18-24" DBH | 16 | 17 | 17 | 18 | 17 | 18 | 16 | 18 | 17 |
| % of SDI >24" DBH | 7 | 8 | 12 | 9 | 13 | 9 | 13 | 9 | 13 |
| TPA >18" DBH | 13 | 15 | 21 | 15 | 21 | 15 | 20 | 15 | 21 |
| PP Basal Area | 82 | 87 | 94 | 78 | 88 | 73 | 84 | 80 | 90 |
| GO Basal Area | 34 | 35 | 37 | 36 | 39 | 36 | 40 | 35 | 38 |
| All Basal Area | 133 | 145 | 172 | 135 | 170 | 132 | 168 | 137 | 170 |
| Snags 12-18" DBH | 1.9 | 2.3 | 3.8 | 3.1 | 2.9 | 2.8 | 2.6 | 2.3 | 3.3 |
| Snags >12" DBH | 2.4 | 2.9 | 5.3 | 3.7 | 4.4 | 3.3 | 3.9 | 2.8 | 4.7 |
| Snags >18" DBH | 0.4 | 0.6 | 1.5 | 0.6 | 1.5 | 0.6 | 1.3 | 0.6 | 1.5 |
| CWD | 3.6 | 5.0 | 9.0 | 1.9 | 5.9 | 2.0 | 5.8 | 4.8 | 8.3 |
| Logs per Acre | 0.8 | 1.6 | 4.6 | 1.1 | 4.1 | 1.2 | 4.0 | 1.5 | 4.4 |
| Understory Index | 64 | 52 | 33 | 60 | 34 | 64 | 35 | 58 | 34 |
| **Subunit 3-3** | | | | | | | | | |
| % of SDI 12-18" DBH | 26 | 27 | 26 | 27 | 25 | 24 | 23 | 28 | 25 |
| % of SDI 18-24" DBH | 11 | 12 | 16 | 14 | 18 | 14 | 16 | 14 | 17 |
| % of SDI >24" DBH | 6 | 6 | 8 | 7 | 9 | 8 | 10 | 7 | 9 |

| Scale | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| TPA >18" DBH | 11 | 14 | 20 | 14 | 21 | 13 | 19 | 14 | 21 |
| PP Basal Area | 99 | 104 | 112 | 87 | 99 | 80 | 92 | 90 | 102 |
| GO Basal Area | 34 | 35 | 36 | 35 | 39 | 36 | 40 | 35 | 38 |
| All Basal Area | 152 | 163 | 185 | 146 | 178 | 139 | 174 | 149 | 179 |
| Snags 12-18" DBH | 2.2 | 2.7 | 4.7 | 3.6 | 3.6 | 3.1 | 3.0 | 2.6 | 3.9 |
| Snags >12" DBH | 2.6 | 3.2 | 5.8 | 4.1 | 4.7 | 3.5 | 4.0 | 3.0 | 5.0 |
| Snags >18" DBH | 0.5 | 0.5 | 1.2 | 0.4 | 1.1 | 0.4 | 1.0 | 0.4 | 1.2 |
| CWD | 4.7 | 6.3 | 10.6 | 2.6 | 6.6 | 2.7 | 6.4 | 6.0 | 9.4 |
| Logs per Acre | 2.1 | 2.7 | 5.4 | 1.8 | 4.5 | 2.0 | 4.4 | 2.7 | 5.2 |
| Understory Index | 42 | 35 | 24 | 46 | 27 | 52 | 29 | 44 | 26 |
| **Subunit 3-4** | | | | | | | | | |
| % of SDI 12-18" DBH | 25 | 25 | 26 | 27 | 23 | 21 | 21 | 27 | 24 |
| % of SDI 18-24" DBH | 12 | 13 | 17 | 16 | 20 | 17 | 17 | 16 | 20 |
| % of SDI >24" DBH | 8 | 8 | 10 | 10 | 12 | 11 | 12 | 10 | 11 |
| TPA >18" DBH | 14 | 16 | 22 | 17 | 24 | 16 | 21 | 17 | 24 |
| PP Basal Area | 110 | 114 | 120 | 89 | 100 | 78 | 90 | 93 | 102 |
| GO Basal Area | 33 | 35 | 38 | 36 | 42 | 36 | 43 | 36 | 41 |
| All Basal Area | 159 | 168 | 186 | 142 | 174 | 132 | 168 | 146 | 176 |
| Snags 12-18" DBH | 2.1 | 2.8 | 4.9 | 3.3 | 3.4 | 2.6 | 2.7 | 2.2 | 3.7 |
| Snags >12" DBH | 2.7 | 3.3 | 6.1 | 3.9 | 4.6 | 3.2 | 3.8 | 2.7 | 5.0 |
| Snags >18" DBH | 0.6 | 0.6 | 1.2 | 0.6 | 1.2 | 0.6 | 1.0 | 0.6 | 1.2 |
| CWD | 5.8 | 7.4 | 11.7 | 3.1 | 6.4 | 3.3 | 6.2 | 7.9 | 10.5 |
| Logs per Acre | 3.3 | 4.0 | 6.7 | 2.6 | 5.1 | 2.9 | 5.0 | 4.1 | 6.2 |
| Understory Index | 30 | 25 | 18 | 41 | 22 | 49 | 25 | 38 | 22 |
| **Subunit 3-5** | | | | | | | | | |
| % of SDI 12-18" DBH | 28 | 28 | 26 | 27 | 21 | 22 | 19 | 27 | 22 |

| Scale | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| % of SDI 18-24" DBH | 16 | 18 | 22 | 22 | 25 | 22 | 21 | 22 | 24 |
| % of SDI >24" DBH | 11 | 11 | 14 | 13 | 16 | 14 | 18 | 13 | 16 |
| TPA >18" DBH | 19 | 21 | 28 | 21 | 29 | 20 | 25 | 21 | 29 |
| PP Basal Area | 116 | 121 | 128 | 96 | 107 | 83 | 96 | 99 | 110 |
| GO Basal Area | 22 | 23 | 26 | 23 | 28 | 24 | 29 | 23 | 28 |
| All Basal Area | 152 | 161 | 181 | 135 | 166 | 123 | 158 | 138 | 168 |
| Snags 12-18" DBH | 2.7 | 3.3 | 4.9 | 3.6 | 3.1 | 3.0 | 2.5 | 2.5 | 3.4 |
| Snags >12" DBH | 3.4 | 4.1 | 6.6 | 4.4 | 4.8 | 3.8 | 4.0 | 3.3 | 5.1 |
| Snags >18" DBH | 0.7 | 0.8 | 1.8 | 0.8 | 1.7 | 0.8 | 1.5 | 0.8 | 1.7 |
| CWD | 6.0 | 7.3 | 11.5 | 3.2 | 6.7 | 3.4 | 6.4 | 7.9 | 10.5 |
| Logs per Acre | 4.9 | 5.6 | 9.0 | 3.6 | 6.8 | 4.0 | 6.5 | 5.9 | 8.4 |
| Understory Index | 80 | 71 | 56 | 97 | 66 | 113 | 72 | 94 | 65 |
| **Restoration Unit 3 Total** | | | | | | | | | |
| % of SDI 12-18" DBH | 26 | 26 | 25 | 27 | 23 | 23 | 21 | 27 | 23 |
| % of SDI 18-24" DBH | 13 | 15 | 17 | 17 | 19 | 17 | 17 | 17 | 19 |
| % of SDI >24" DBH | 7 | 8 | 11 | 9 | 12 | 10 | 13 | 9 | 12 |
| TPA >18" DBH | 13 | 16 | 22 | 16 | 23 | 15 | 21 | 16 | 23 |
| PP Basal Area | 100 | 105 | 112 | 87 | 98 | 79 | 91 | 90 | 100 |
| GO Basal Area | 31 | 33 | 35 | 33 | 37 | 33 | 38 | 33 | 36 |
| All Basal Area | 148 | 159 | 181 | 141 | 173 | 133 | 169 | 143 | 174 |
| Snags 12-18" DBH | 2.2 | 2.7 | 4.5 | 3.4 | 3.3 | 2.9 | 2.8 | 2.4 | 3.6 |
| Snags >12" DBH | 2.7 | 3.3 | 5.9 | 4.0 | 4.7 | 3.5 | 4.0 | 3.0 | 5.0 |
| Snags >18" DBH | 0.5 | 0.6 | 1.4 | 0.6 | 1.3 | 0.5 | 1.2 | 0.6 | 1.4 |
| CWD | 4.8 | 6.3 | 10.5 | 2.6 | 6.4 | 2.8 | 6.3 | 6.3 | 9.5 |
| Logs per Acre | 2.5 | 3.2 | 6.1 | 2.1 | 4.9 | 2.3 | 4.8 | 3.2 | 5.8 |
| Understory Index | 53 | 45 | 32 | 59 | 36 | 67 | 38 | 57 | 35 |

| Scale | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| **All Target Total** | | | | | | | | | |
| % of SDI 12-18" DBH | 28 | 28 | 27 | 29 | 23 | 24 | 22 | 29 | 24 |
| % of SDI 18-24" DBH | 13 | 14 | 19 | 17 | 21 | 17 | 18 | 17 | 21 |
| % of SDI >24" DBH | 7 | 8 | 10 | 9 | 12 | 10 | 13 | 9 | 11 |
| TPA >18" DBH | 14 | 16 | 23 | 17 | 25 | 16 | 22 | 17 | 25 |
| PP Basal Area | 109 | 114 | 120 | 91 | 102 | 80 | 92 | 94 | 105 |
| GO Basal Area | 29 | 30 | 33 | 31 | 35 | 31 | 37 | 31 | 35 |
| All Basal Area | 152 | 162 | 183 | 139 | 171 | 129 | 164 | 142 | 172 |
| Snags 12-18" DBH | 2.4 | 3.0 | 5.0 | 3.6 | 3.6 | 3.0 | 2.9 | 2.5 | 3.9 |
| Snags >12" DBH | 2.9 | 3.6 | 6.4 | 4.2 | 5.0 | 3.6 | 4.1 | 3.0 | 5.3 |
| Snags >18" DBH | 0.5 | 0.6 | 1.4 | 0.5 | 1.4 | 0.5 | 1.2 | 0.5 | 1.4 |
| CWD | 5.5 | 7.0 | 11.3 | 3.0 | 6.7 | 3.2 | 6.4 | 7.3 | 10.3 |
| Logs per Acre | 3.7 | 4.4 | 7.3 | 2.8 | 5.7 | 3.2 | 5.5 | 4.5 | 6.9 |
| Understory Index | 44 | 37 | 26 | 53 | 31 | 63 | 35 | 50 | 31 |

# Appendix 18. Summary of Treatments in MSO Critical Habitat by Alternative

**Table 228. Changes in MSO Habitat Components, Including Ponderosa Pine (% of SDI) and Gambel Oak (GO) by Individual PAC**

| | Existing Condition | Alternative A | | Alternative B | | Alternative C | | Alternative D | |
|---|---|---|---|---|---|---|---|---|---|
| Critical Habitat Unit | 2010 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 | 2020 | 2050 |
| **UGM-11** | | | | | | | | | |
| % of SDI 12-18" DBH | 31 | 31 | 29 | 28 | 24 | 28 | 24 | 28 | 24 |
| % of SDI 18-24" DBH | 13 | 15 | 21 | 19 | 23 | 19 | 23 | 18 | 21 |
| % of SDI >24" DBH | 7 | 8 | 10 | 12 | 15 | 12 | 15 | 12 | 13 |
| TPA >18" DBH | 13 | 16 | 26 | 15 | 24 | 15 | 24 | 16 | 24 |
| Ponderosa Pine BA | 114 | 120 | 128 | 90 | 102 | 87 | 100 | 94 | 106 |
| Gambel Oak BA | 19 | 20 | 23 | 19 | 23 | 19 | 23 | 20 | 24 |
| All BA | 150 | 159 | 178 | 124 | 151 | 122 | 149 | 132 | 158 |
| Snags 12-18" DBH | 2.5 | 3.2 | 5.6 | 4.1 | 3.7 | 4.2 | 3.6 | 2.7 | 4.1 |
| Snags >12" DBH | 3.0 | 3.8 | 7.0 | 4.8 | 5.1 | 4.9 | 4.9 | 3.2 | 5.4 |
| Snags >18" DBH | 0.5 | 0.6 | 1.4 | 0.7 | 1.3 | 0.7 | 1.3 | 0.6 | 1.3 |
| CWD | 5.1 | 6.7 | 10.8 | 3.5 | 7.2 | 3.2 | 6.8 | 7.3 | 10.2 |
| Logs per Acre | 2.0 | 2.8 | 6.1 | 2.3 | 5.6 | 2.3 | 5.5 | 3.4 | 6.0 |
| Understory Index | 43 | 36 | 24 | 86 | 51 | 87 | 51 | 75 | 43 |
| **UGM-12** | | | | | | | | | |
| % of SDI 12-18" DBH | 24 | 25 | 25 | 20 | 19 | 19 | 18 | 19 | 18 |
| % of SDI 18-24" DBH | 13 | 14 | 17 | 19 | 17 | 19 | 16 | 17 | 15 |
| % of SDI >24" DBH | 12 | 13 | 15 | 23 | 23 | 23 | 23 | 21 | 20 |
| TPA >18" DBH | 12 | 14 | 20 | 12 | 17 | 12 | 17 | 13 | 17 |
| Ponderosa Pine BA | 97 | 104 | 116 | 62 | 77 | 60 | 75 | 67 | 83 |
| Gambel Oak BA | 15 | 17 | 21 | 14 | 18 | 14 | 19 | 15 | 21 |
| All BA | 126 | 136 | 159 | 87 | 115 | 85 | 114 | 96 | 128 |
| Snags 12-18" DBH | 1.2 | 1.7 | 3.6 | 2.6 | 1.7 | 2.5 | 1.6 | 1.2 | 2.0 |
| Snags >12" DBH | 1.7 | 2.2 | 4.6 | 3.4 | 2.7 | 3.3 | 2.5 | 1.7 | 2.9 |
| Snags >18" DBH | 0.5 | 0.5 | 1.0 | 0.8 | 1.0 | 0.8 | 0.9 | 0.5 | 0.9 |
| CWD | 4.1 | 5.1 | 8.0 | 2.9 | 5.4 | 2.8 | 5.3 | 6.1 | 7.6 |
| Logs per Acre | 1.6 | 2.1 | 4.0 | 1.9 | 4.2 | 2.0 | 4.1 | 2.9 | 4.3 |
| Understory Index | 199 | 172 | 128 | 376 | 245 | 380 | 246 | 333 | 211 |
| **UGM-13** | | | | | | | | | |
| % of SDI 12-18" DBH | 29 | 29 | 26 | 23 | 19 | 24 | 19 | 22 | 19 |
| % of SDI 18-24" DBH | 14 | 16 | 21 | 21 | 20 | 21 | 20 | 20 | 18 |
| % of SDI >24" DBH | 7 | 8 | 10 | 16 | 17 | 15 | 17 | 15 | 15 |
| TPA >18" DBH | 13 | 15 | 24 | 13 | 20 | 13 | 20 | 14 | 20 |
| Ponderosa Pine BA | 97 | 103 | 112 | 62 | 76 | 62 | 76 | 66 | 80 |

| Critical Habitat Unit | Existing Condition 2010 | Alternative A 2020 | Alternative A 2050 | Alternative B 2020 | Alternative B 2050 | Alternative C 2020 | Alternative C 2050 | Alternative D 2020 | Alternative D 2050 |
|---|---|---|---|---|---|---|---|---|---|
| Gambel Oak BA | 27 | 28 | 32 | 22 | 28 | 22 | 28 | 25 | 31 |
| All BA | 141 | 151 | 172 | 97 | 129 | 97 | 129 | 109 | 141 |
| Snags 12-18" DBH | 2.0 | 2.7 | 4.5 | 4.0 | 1.9 | 4.2 | 1.9 | 2.2 | 2.3 |
| Snags >12" DBH | 2.5 | 3.2 | 5.9 | 5.0 | 3.0 | 5.2 | 3.0 | 2.8 | 3.4 |
| Snags >18" DBH | 0.5 | 0.6 | 1.3 | 1.0 | 1.1 | 1.0 | 1.1 | 0.6 | 1.1 |
| CWD | 4.1 | 5.4 | 9.2 | 3.3 | 6.5 | 3.3 | 6.6 | 6.4 | 8.5 |
| Logs per Acre | 1.8 | 2.5 | 5.4 | 2.4 | 5.4 | 2.5 | 5.5 | 3.5 | 5.4 |
| Understory Index | 67 | 57 | 39 | 155 | 91 | 152 | 90 | 135 | 77 |
| **UGM-14** | | | | | | | | | |
| % of SDI 12-18" DBH | 30 | 31 | 26 | 30 | 26 | 30 | 26 | 30 | 26 |
| % of SDI 18-24" DBH | 15 | 16 | 22 | 17 | 22 | 17 | 22 | 17 | 22 |
| % of SDI >24" DBH | 8 | 9 | 13 | 9 | 14 | 9 | 14 | 9 | 13 |
| TPA >18" DBH | 14 | 17 | 26 | 17 | 26 | 17 | 26 | 17 | 26 |
| Ponderosa Pine BA | 98 | 103 | 110 | 96 | 105 | 96 | 105 | 100 | 108 |
| Gambel Oak BA | 15 | 15 | 17 | 15 | 18 | 15 | 18 | 15 | 17 |
| All BA | 136 | 147 | 170 | 140 | 165 | 139 | 164 | 144 | 167 |
| Snags 12-18" DBH | 2.3 | 3.0 | 5.2 | 4.2 | 4.8 | 4.3 | 4.8 | 3.0 | 5.1 |
| Snags >12" DBH | 2.9 | 3.7 | 6.9 | 4.9 | 6.5 | 4.9 | 6.4 | 3.7 | 6.8 |
| Snags >18" DBH | 0.6 | 0.7 | 1.7 | 0.7 | 1.7 | 0.7 | 1.7 | 0.7 | 1.7 |
| CWD | 5.6 | 6.9 | 10.9 | 3.3 | 7.8 | 2.9 | 7.4 | 6.9 | 10.9 |
| Logs per Acre | 3.5 | 4.4 | 7.9 | 3.1 | 7.0 | 2.7 | 6.7 | 4.4 | 8.0 |
| Understory Index | 53 | 41 | 25 | 53 | 31 | 53 | 31 | 48 | 28 |
| **UGM-15** | | | | | | | | | |
| % of SDI 12-18" DBH | 33 | 35 | 38 | 35 | 38 | 36 | 37 | 35 | 38 |
| % of SDI 18-24" DBH | 10 | 14 | 24 | 15 | 25 | 15 | 25 | 14 | 24 |
| % of SDI >24" DBH | 5 | 5 | 8 | 5 | 8 | 5 | 9 | 5 | 8 |
| TPA >18" DBH | 9 | 11 | 20 | 11 | 20 | 11 | 20 | 11 | 20 |
| Ponderosa Pine BA | 76 | 82 | 94 | 79 | 91 | 78 | 91 | 81 | 94 |
| Gambel Oak BA | 10 | 11 | 12 | 11 | 12 | 11 | 12 | 11 | 12 |
| All BA | 98 | 107 | 129 | 104 | 125 | 102 | 125 | 106 | 128 |
| Snags 12-18" DBH | 2.0 | 2.5 | 4.2 | 3.5 | 4.0 | 3.8 | 3.9 | 2.8 | 4.2 |
| Snags >12" DBH | 2.4 | 3.0 | 5.6 | 3.9 | 5.3 | 4.3 | 5.2 | 3.3 | 5.5 |
| Snags >18" DBH | 0.4 | 0.4 | 1.3 | 0.5 | 1.3 | 0.5 | 1.3 | 0.5 | 1.3 |
| CWD | 5.6 | 6.4 | 9.1 | 3.4 | 6.6 | 2.5 | 5.8 | 6.3 | 9.1 |
| Logs per Acre | 1.3 | 1.9 | 4.6 | 1.5 | 4.4 | 1.2 | 4.3 | 1.9 | 4.7 |
| Understory Index | 181 | 156 | 101 | 164 | 110 | 165 | 110 | 159 | 103 |

# Appendix 19. Surface Fuel Loading by Alternative

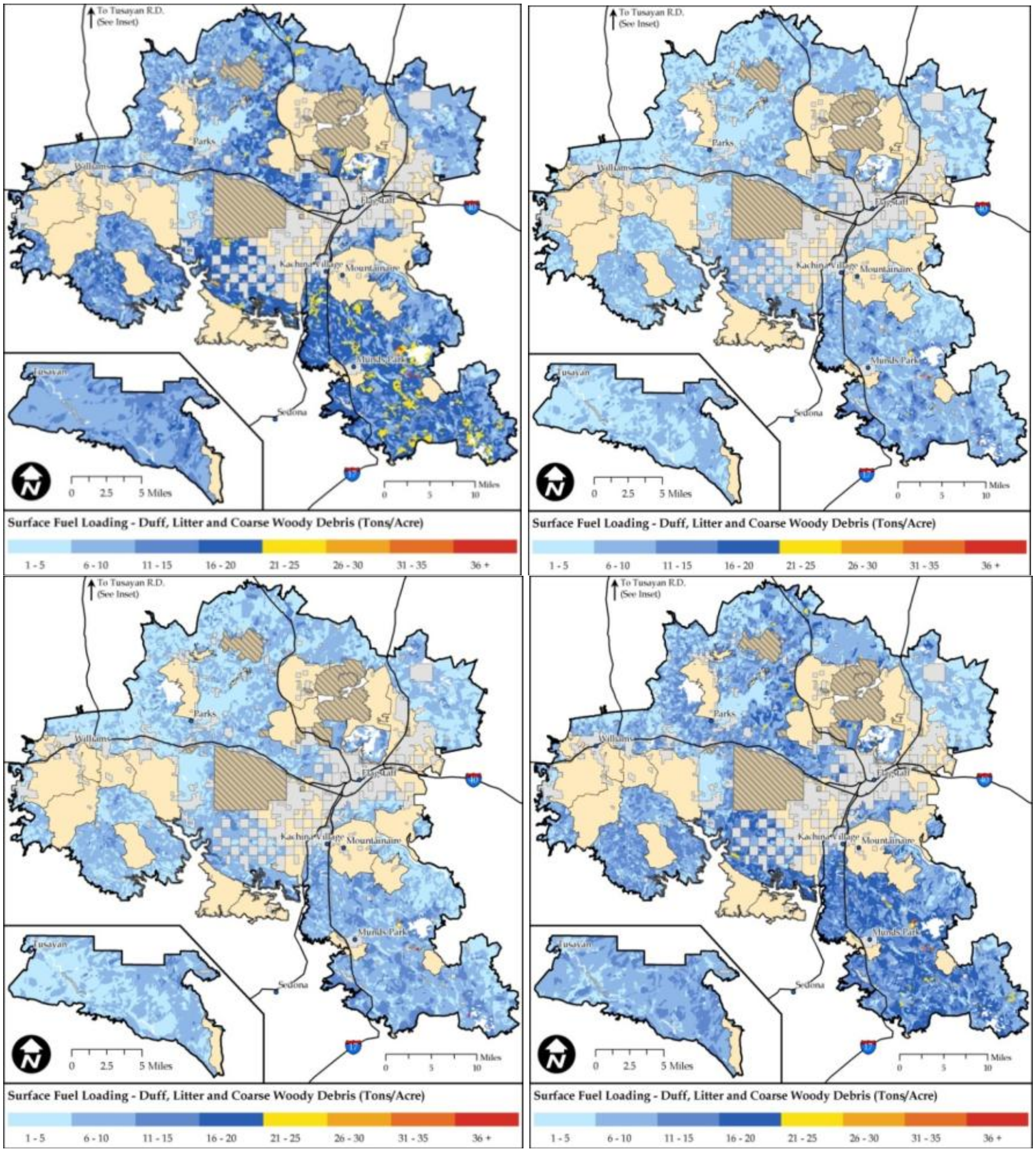


**Figure 151. Surface fuel loading by alternatives (clockwise starting in the upper left) A, B, C, and D**

Alternatives B and C would have the lowest percent of acres with fuel loads exceeding 20 tons/acre. Alternative D has the most acres of high fuel loading (exceeding 20 tone/acre) of the action alternatives and alternative A (no action) has the highest overall ratings of fuel loading.

# Appendix 20. Livestock Allotments in 4FRI

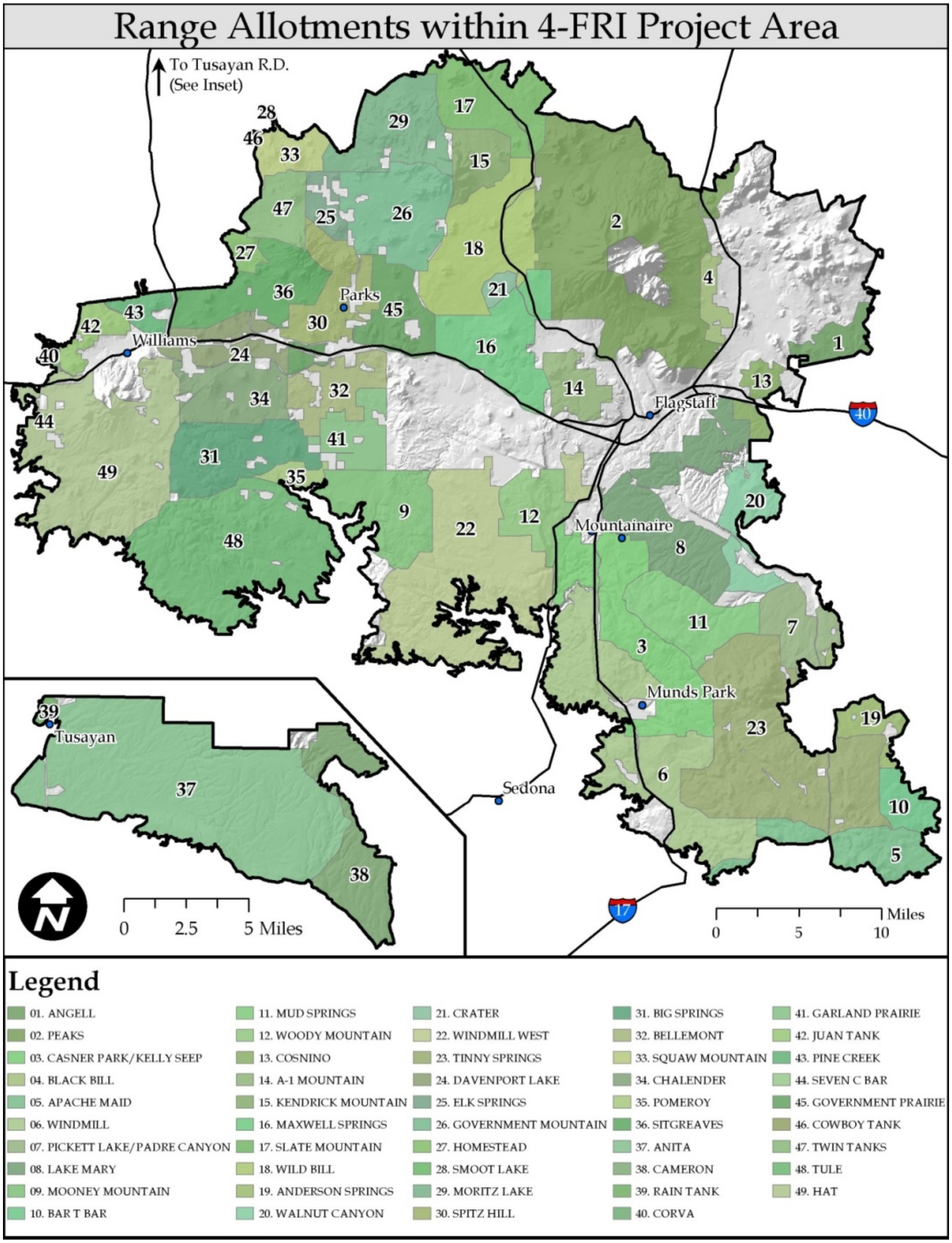


**Figure 152. Map of Range Allotments in the 4FRI Project Area**