United States
Department of
Agriculture

Forest
Service

**Southwestern
Region**

Mountainaire HFRA Project

Environmental Assessment

Coconino National Forest

Mormon Lake Ranger District

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Chapter 1 – Purpose and Need

Document Structure

The Forest Service has prepared this Environmental Assessment in compliance with the National Environmental Policy Act (NEPA) and other relevant federal and state laws and regulations. This Environmental Assessment discloses the direct, indirect, and cumulative environmental impacts that would result from the Proposed Action and alternatives. The document is organized into five chapters and additional appendices:

- Purpose and Need: The chapter includes information on the history of the project proposal, the purpose of and need for the project, and the agency's proposal for achieving that purpose and need. This chapter also details how the Forest Service informed the public of the proposal and how the public responded.
- Alternatives: This chapter provides a more detailed description of the agency's Proposed Action as well as alternative methods for achieving the stated purpose. These alternatives were developed based on significant issues raised by the public and other agencies. This discussion also includes mitigation and monitoring measures. Finally, this chapter provides a summary table of the environmental consequences associated with each alternative.
- Affected Environment and Environmental Consequences: This chapter describes the environmental effects of implementing the Proposed Action and other alternatives. This analysis is organized by resource area. Within each section, the affected environment is described first, followed by the effects of the No-Action Alternative that provides a baseline for evaluation and comparison of the other alternatives that follow.
- Project Coordination: This chapter provides a list of preparers and agencies consulted during the development of the environmental assessment.
- References: This chapter provides a scientific bibliography of studies that support the environmental analysis.
- Appendices: The appendices provide more detailed information to support the analyses presented in the Environmental Assessment.

Background

Greater Flagstaff Forests Partnership (GFFP), a nonprofit organization based in Flagstaff, and the Coconino National Forest have established a cooperative agreement to work collaboratively to demonstrate new forest management approaches in improving and restoring ecosystem health of the ponderosa pine forests surrounding the greater Flagstaff area. This collaborative effort aims to involve the greater Flagstaff community to develop community-based solutions to local forest health and fuel reduction concerns. The Mountainaire HFRA project is the fourth large-scale project that GFFP has assisted the Coconino National Forest with project planning and design.

The Mormon Lake Ranger District has worked collaboratively with GFFP over the past year to jointly develop proposals to treat the Mountainaire vicinity. Since May 2004, the Forest Service

and GFFP have conducted numerous field trips and meetings to discuss project goals, existing and desired future conditions for the project area, and the Proposed Action.

The Purpose and Need for Action in this document is derived from the Project Initiation Letter, Need for Change Report, and comments from the GFFP Board of Directors on a Draft Proposed Action developed by GFFP and the Forest Service Interdisciplinary Team (IDT). During development of the Proposed Action, the Forest Service looked at environmental analysis options for the project. In February 2005, the Mormon Lake Ranger District decided that the project was an ideal candidate for analysis under the Healthy Forests Restoration Act (HFRA). The Purpose and Need for Action, the Proposed Action, and alternatives for this project have been prepared in accordance with HFRA requirements. See Appendix C – *Healthy Forests Restoration Act Authorities for the Mountainaire HFRA Project* for more information.

Scope of the Project

The Proposed Action and other alternative proposals analyzed in this document apply only to Coconino National Forest lands within the project area. While the Proposed Action and alternatives will reduce fuel loading in most areas, the risk of fire will only be reduced up to private land boundaries and cannot reduce the threat to structures within private lands. To reduce fire threat within private lands, these areas would need to be assessed and treated in tandem with actions proposed in this project. Environmental effects of the Proposed Action will be analyzed in an Environmental Assessment. These effects will only be analyzed for impacts to national forest lands and not to private property.

Project Area

The Mountainaire HFRA Project area is located southeast of Flagstaff in between Lake Mary Road and Interstate 17 on the Mormon Lake Ranger District. Land ownership of the area includes 15,237 acres of Coconino National Forest land and 1,332 acres of private land. In total, there are approximately 16,569 acres within the project area boundary.

Forest Plan Management Areas

The Coconino National Forest Plan (hereafter referred to as the Forest Plan) sets out broad management goals, objectives, standards and guidelines to guide management actions on the Coconino National Forest. The Forest Plan uses management areas to guide management of the national forest lands within the Coconino National Forest. Each management area provides for a unique combination of activities, practices, and uses. The Mountainaire HFRA project area includes five management areas. The Forest Plan contains a detailed description of each management area. Table 1-1 lists the acreages each management area within the project area.

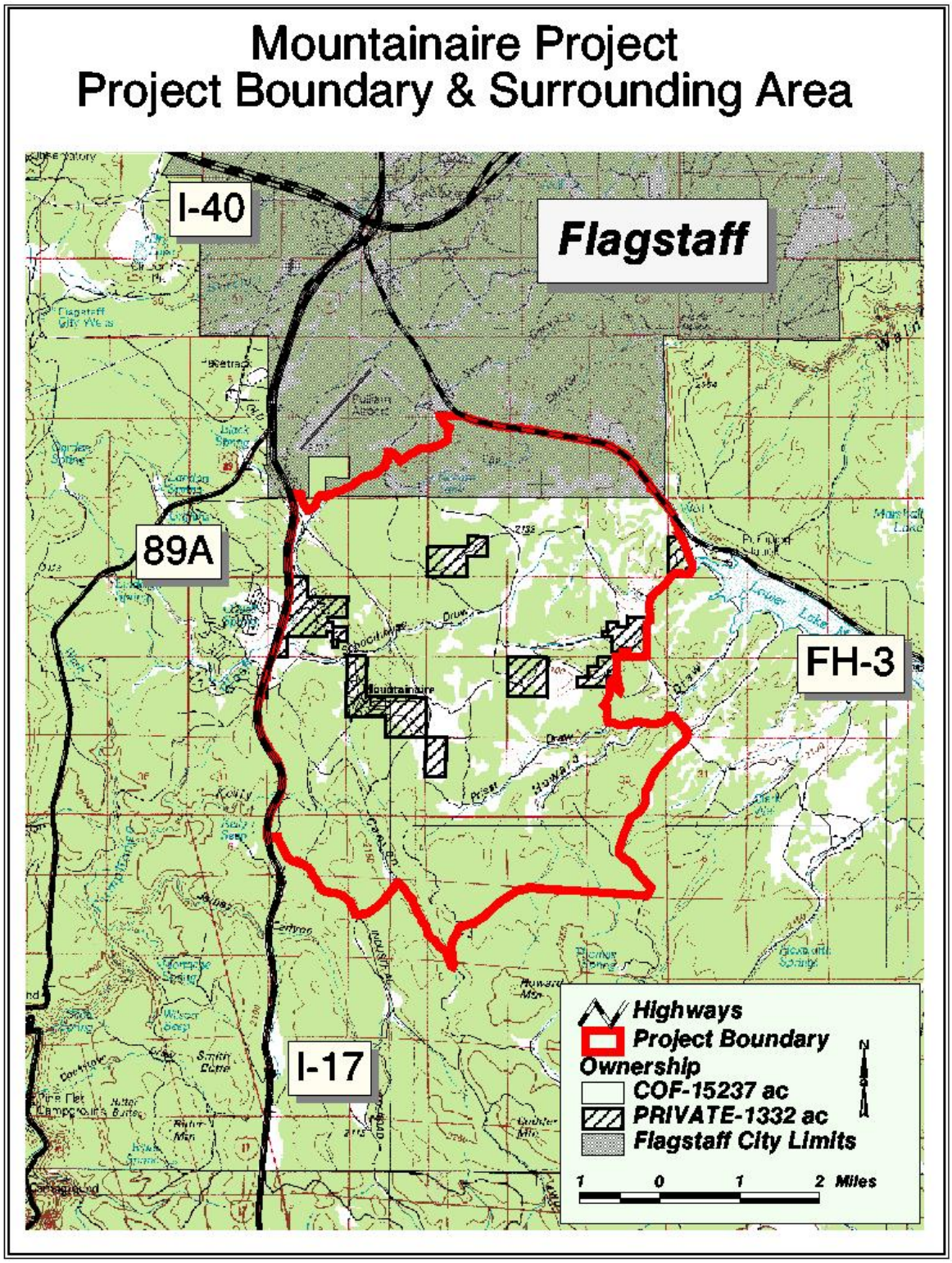

Figure 1-1. Mountainaire HFRA Project Area Boundary.

Table 1-1. Management areas located within the project area

Management Area	Description	Acres
003	Ponderosa Pine and Mixed Conifer < 40% Slopes	12,784
004	Ponderosa Pine and Mixed Conifer > 40% Slopes	140
005	Aspen	15
006	Unproductive Timber Land	1,021
009	Mountain Grassland	1,277

Purpose and Need for Action

The Forest Plan provides a framework that guides development of Desired Future Conditions at the site-specific project level, such as the Mountainaire HFRA project.

The process for developing Desired Future Condition (DFC) and Need for Change statements began with Forest Service IDT members collecting and modeling data to determine the existing conditions in the project area. The team then began reviewing Forest Plan direction related to management of the Mountainaire HFRA project area. The team reviewed all Forest Plan standards and guidelines and determined whether they are standard operating procedures for implementing activities or if they are intended to guide management practices towards a desired future condition of the forest. Standards and guidelines in the latter category were used as sideboards when the team developed DFC statements.

Many of these standards and guidelines are quantitative in nature and describe in detail a specific distribution of environmental resources. In contrast, other direction is couched in broad, qualitative terms and allows IDT and GFFP partners to interpret and clarify this direction as it pertains to this project.

As the team started discussing and developing desired future conditions for the project area, it considered goals for the entire project area in addition to discrete areas deemed important for biological or social needs. The DFC statements the team developed generally reflect Forest Plan language, however in many situations where direction was vague or overly broad, the team further defined their vision for the Eastside landscape in qualitative and quantitative terms. In many circumstances, the team also developed appropriate timeframes to meet these DFCs and considered the difference in conditions over time. Need for Change statements articulate the difference between the existing and desired future conditions.

All of this information was captured in a Final Report of the Need For Change Analysis (November 2004) While the Need for Change Report is broad in nature and covers many different resource areas within the project area, this Mountainaire HFRA Project Environmental Assessment only includes findings of that report related to forest restoration, fire hazard reduction activities, and transportation management. Other projects may be developed based on findings of the Need for Change analysis in separate NEPA documents in the future. The following section

briefly describes the existing conditions, desired future conditions, and the need for change of the Mountainaire HFRA Project for Wildlife and Fuels Risk, Fire-Adapted Forest and Grassland Structure, and the area's Transportation System.

Wildfire and Fuels Risk

Existing Conditions

The project area has not directly experienced a large wildfire for many years. The lack of fire has allowed dense vegetation and surface fuels to accumulate. Species composition and stand structure and densities have changed. The area was historically dependent on frequent low-intensity fires. Fire suppression has successfully excluded these historic fire intervals.

Fire Hazard Ratings

One method to evaluate the risk of wildfire to an area is to assign a fire hazard rating. Fire hazard rating is a relative measure of how virulently a wildfire could burn under the 90th percentile weather conditions that occur from April through July[1]. It is a relative measure to demonstrate fire resilience between stands and the difference in forest structure before and after treatment. It is a good indicator of how effectively and safely fire suppression crews can attack a wildfire and bring it under control.

Criteria for evaluating fire hazard rating includes canopy cover, tree stems per acre, height to the bottom of the live crown, dead and down fuel loading, slope steepness, and aspect. Because slope steepness and aspect will not change with treatment, their effects on fire behavior influence how much other criteria are altered in project design.

Canopy cover (percent of ground area that is directly covered with tree crowns) directly effects how easily a fire is able to transition into a crown fire by containing and accumulating heat below the crown layer. High canopy cover can prevent necessary heat dispersal. Canopy cover also affects how easily a crown fire can sustain itself and spread as a crown fire. The number of tree stems per acre also affects how easily a fire is able to transition into a crown fire. The height to the bottom of a live crown directly effects how easily a ground fire "torches" trees, produces firebrands, and transitions into a crown fire.

While neither dead and down fuels nor trees per acre is excessively high across much of the project area, high canopy closure values and low crown heights elevate the fire hazard beyond desirable levels for many areas. The existing fire hazard makes it very difficult for initial attack operations to control a wildfire starting under severe weather conditions that occur in April, May, June, September, and October. Table 1-2 describes existing values of some of these fire hazard rating criteria.

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[1] Fuel moisture and weather characteristics used to model fire effects include:
1-Hour fuel Moisture: 2%
10-Hour fuel Moisture: 3%
100-Hour fuel Moisture: 4%
20-Foot Wind Speed: 20mph
Air Temperature: 85 degrees F

Table 1-2. Fire Hazard Rating Criteria

Measure	Current Value	Desired Value
Height to Live Crown	1 – 25 feet	20+ feet
Dead and down fuel	3 – 12 Tons per Acre	5 – 7 Tons per Acre
Canopy Cover	16 – 89 %	40 – 50%
Stems per Acre Ponderosa Pine	10 – 500	Less than 300

Current fire hazard ratings of the project area:

Extreme	259 acres
Very High	1,064 acres
High	5,658 acres
Moderate	6,997 acres
Low	1,259 acres

Flame Lengths

Flame length is another measure of fire intensity and anticipated tree mortality from wildfire. Expected flame lengths within the area range from 3-5 feet. Critical flame lengths are the threshold distances where ground fire can move into the canopy of a site. Critical flame lengths in the area range from 7-9 feet. The current range between expected flame lengths and critical flame lengths is small. A smaller range allows a ground fire to transform into a crown fire easily since there is little distance to buffer the canopy from high ground flames. Dead and down fuel loading directly effects flame length and duration. The longer the flame length and duration, the more difficult it is to bring a fire under control. In addition, the longer the flame length and duration, the more likely a fire is able to transition into a crown fire.

Even though the expected flame lengths decrease as a fire hazard rating decreases, the probability of wildfire-induced mortality remains high among mature trees due to a low crown base height common throughout the project area. Fire modeling indicates an extremely high occurrence of wildfire-induced tree mortality (28 to 54 percent) among trees 8 inches to 26 inches DBH.

The current fuel conditions would likely generate dangerous fire behavior and undesirable fire effects if and when a wildfire occurs. Although it would be difficult to initiate a crown fire within most sites, once a fire is initiated or is carried in from a neighboring area, many sites have sufficient crown bulk density coupled with sufficient canopy cover to sustain a crown fire and spread it to other sites. Initial attack forces would have great difficulty in controlling a wildfire occurring in the area under severe weather conditions.

Human use (presence of roads, trails, and dispersed camping) of the area has also increased the risk of a human-caused fire ignition. There are numerous dispersed camping sites in the areas, none of which are designated.

Desired Future Conditions

A low or moderate fire hazard rating exists across a majority of the project area. Some sites may remain with moderate to high rating after treatment to accommodate other resource needs such as providing adequate habitat for wildlife species. However, most areas within a mile of private property will have a low or moderate rating, especially those areas in the direction of the prevailing wind.

Dead and down fuel loading supports habitat needs but is low enough to support low to moderate intensity burns on a regular basis. Expected flame lengths are below 3 feet. Crown base heights are high and critical flame lengths are above 15 feet.

Designated dispersed camping areas exist to reduce the risk of human-caused fire starts. Dispersed sites are signed and located in areas that have low to moderate fire hazards, are away from communities, and are away from wildlife habitat areas such as Mexican spotted owl (MSO) protected habitat or northern goshawk Post-Fledging Family Areas (PFAs).

Need For Change

Comparison of the existing condition of the project area and the desired condition indicates a need to:

- Reduce fire hazard ratings to low and moderate levels;
- Reduce flame lengths to 2-3 feet and increase critical flame lengths to 10-15 feet;
- Reduce fuel loads to 5-7 tons per acre;
- Increase crown base heights to 20 feet or greater;
- Reintroduce and maintain low to moderate intensity surface fire; and
- Designate dispersed camping sites to reduce human caused ignitions.

Fire-Adapted Forest and Grassland Structure

The existing and desired future conditions describe forest and grassland structure through three components: density of trees within the area; age, size, and species diversity; and the spatial arrangement of trees on the landscape.

Existing Conditions

Most of the lands in the project area are no longer functioning fire-adapted ecosystems. As described in the previous section, wildfire has been suppressed from this area for many years. The area is characterized by having a high number of trees per acre, moderately closed (40-60% canopy cover) to closed (60% and greater canopy cover) canopies, and little understory vegetative production and diversity.

Site Density

Some measures to determine site densities include canopy cover, basal area (area of the cross section of a tree at breast height that measures how much of a site is occupied by tree trunks), and the number of trees per acre in a given area.

In addition to contributing to crown fire hazard, thick canopies also shade out many understory plant species including smaller trees. All three of these measures are integral components of the overall tree density within the area. Existing and desired values for these measures are listed in Table 1-3.

Due to this high density of trees, there is competition among trees for resources such as soil nutrients, water, and sunlight. Stand Density Index (SDI) is a relative measure of site density based on the number of trees per acre and their mean diameter. It expresses the actual density in a site as a percent of the theoretical maximum density possible for trees of that diameter and species. This measure can help determine competition thresholds, which are very important in a moisture-limiting system.

Currently, the majority of forested Forest Service lands within the project area are above 35% SDI. Above this level, there is a significant increase in inter-tree competition, decrease in tree growth and vigor due to competitive stress, and an increase in susceptibility to insects, disease, and stand-replacing fire. The high density of trees in many areas is limiting the growth rates of larger trees, which are important components of wildlife habitat for Mexican spotter owl and northern goshawks as well as other species.

Grasslands and ponderosa pine savannahs (areas that transition from forested stands to meadow areas) are less dense than forested areas. They historically held moderately low numbers of ponderosa pines but have been logged in the past century. Remaining trees are mostly smaller trees or genetically undesirable. Many of these areas were planted with seedlings a few decades ago for future harvest. The resulting “plantations” are now dense areas of small diameter trees.

Age, Size, and Species Diversity

Vegetative Structural Stage (VSS) is a six-class vegetation scheme used to describe the developmental stages of a forest ecosystem. VSS for a given site is based on the size class that contributes the highest density to the total site density. It is a useful indicator of tree age and size distribution across a landscape. Most of the trees in the area are 5 to 18 inches or greater in diameter at breast height (DBH). Older, mature, yellow-barked ponderosa pines are rare due to past commercial logging activities. There are only 10 acres in the area that exhibit old growth ecosystem characteristics (components include large trees, down logs, snags, high canopy cover, etc.). Conversely, there are also relatively few forested areas with smaller diameter trees. Little natural regeneration is occurring for future tree recruitment. There is a shortage of large mature oak and pine trees as well as snags and down logs, which are important habitat components of wildlife habitat.

The majority of Gambel oak trees are under 10 inches diameter at the root collar (DRC). For example, there is an average of only 6 oaks per acre that are greater than 10 inches DRC within MSO restricted habitat. The majority of sites containing Gambel oak are located in the southern portion of the project area within the ponderosa pine cover type. Due to a history of illegal wood

cutting and proximity of the project area to Flagstaff, Mountainaire, and numerous parcels of private property, the majority of existing Gambel oak consist of small, young thickets with numerous stems. Due to high site densities, thickets are typically overtopped by pine, resulting in decreased oak growth and vigor.

Spatial Arrangement

The arrangement and patterns of old stumps in the area suggest that trees were often clumped in areas with openings in between clumps. Currently, trees cover much of the landscape, including areas that do not contain historic stumps. There are very few remaining natural openings within forested sites. The absence of fire has allowed areas to grow numerous trees. Openings typically have individual or small clumps of trees within them and typically have more understory plant species and plant productivity than areas with denser canopies.

Table 1-3. Existing and Desired Vegetative Structural Stage (VSS) Values.

VSS	Existing Distribution	Desired Distribution
VSS 1 - Grassy Openings	**9%**	**10%**
VSS 2 - Seedlings/saplings	**2%**	**10%**
VSS 3 - 5-11.9 inches	**27%**	**20%**
VSS 4 - 12-17.9 inches	**48%**	**20%**
VSS 5 - 18-23.9 inches	**14%**	**20%**
VSS 6 - 24 inches and greater	**1%**	**20%**

Desired Future Conditions

The desired future condition includes a multi-aged and diverse forest structure that supports frequent low intensity fires. The area is maintained by fire and natural processes.

Many of the forest and grassland structure values are guided by Forest Plan direction for wildlife species. Management direction for the Mexican spotted owl and northern goshawk guides vegetation treatment to maximize habitat components for these species. By managing for nesting, roosting, and foraging habitat characteristics desired by these two species, forest structure components will provide sufficient habitat for many other species including Management Indicator Species (MIS). Table 1-4 describes desired future conditions for forest structure and is organized by habitat designations. Those areas outside of MSO habitat and northern goshawk PFAs are termed northern goshawk foraging areas. These wildlife habitat areas are displayed in the Wildlife section in Chapter 3.

Site Density

Canopy cover ranges from 30-60% and improves understory productivity and diversity of species while still providing sufficient canopy densities to meet wildlife habitat needs in most areas.

Competition among trees is limited and growth rates for trees are improved, especially around larger trees.

Grassland and savannah areas hold historic numbers of trees and “plantation” areas have reverted back to historic conditions.

Age, Size, and Species Diversity

Tree age and size are more evenly distributed among VSS classes. Sites have an uneven aged stand structure with multiple age classes. This allows for the continuous replacement of trees in an area over time. The resulting uneven age structures are more resilient to fire or insect and disease attacks.

There is limited competition to Gambel oak, and an increasing amount of large oak trees greater than 10 inches DRC. The oak component exists at levels needed for wildlife habitat.

Spatial Arrangement

Groups or clumps of trees exist in many areas with variable canopy cover to allow for wildlife and prey species habitat, tree regeneration, and reduced fire hazard. Groups of trees are located in areas where historic evidences of trees exist or where best stand-structure exists at the time of implementation.

Openings in forested lands occur in the area, are typically ½ to 4 acres in size, and support greater productivity of plants and an increase of plant species. Opening size depends on wildlife habitat requirements and pre-treatment forest structure and spatial patterns.

Table 1-4. Forest and Grassland Density and Composition Values

Measure	Existing Conditions	Desired Future Conditions
Canopy Cover	Meadow and Savannah Areas No data	Meadow and Savannah Areas 0-40%
	Northern Goshawk Foraging Areas 32-71%	Northern Goshawk Foraging Areas 30-50%
	Northern Goshawk PFAs 42-68%	Northern Goshawk PFAs 40-60%
	MSO Protected Habitat 42-68%	MSO Protected Habitat 50% +
	MSO Restricted Habitat 34-81%	MSO Restricted Habitat 40-50%
	MSO Target/Threshold 60-71%	MSO Target/Threshold 50% +

Measure	Existing Conditions	Desired Future Conditions
Total basal area (ft2/acre) for all tree species	Meadow and Savannah Areas No data	Meadow and Savannah Areas 0-60
	Northern Goshawk Foraging Areas 23-287	Northern Goshawk Foraging Areas 20-100
	MSO Protected 88-142	MSO Protected 150
	MSO Restricted 51-208	MSO Restricted 80-150
	MSO Target/Threshold 132-157	MSO Target/Threshold 150
Stand Density Index	0-24% = 36% of the area	0-35% in Northern Goshawk Foraging areas, MSO restricted habitat. 0-45% in MSO Protected and Target/Threshold Habitat, and Northern Goshawk PFAs
	25-34% = 32% of the area	
	35-59% = 30% of the area	
	60%+ = 2% of the area	
Opening Size	Variable patterns and sizes	Northern Goshawk Foraging Habitat – ¼ to 4 acres
		Northern Goshawk PFAs ¼ to 2 acres
		Protected and Target/Threshold ¼ to ¾ acre
		Restricted ¼ to 2 acres

Need for Change

Comparison of the existing condition of the project area and the desired condition indicates a need for:

- Reduce canopy cover, basal area, and Stand Density Index values towards the desired future conditions represented in Table 1-4 for forest and grassland structure needs;
- Restore historic vegetative structure in meadows and savannah areas;
- Move VSS distribution towards values listed in Table 1-3 to create an uneven-age structure in forested stands; and
- Create or retain openings to promote understory diversity, and initiate VSS 1 and 2 classes.

Transportation System

Existing Conditions

The current inventoried forest road system within the Mountainaire Project area contains 107 miles of road with a road density of 3.88 miles per square mile.

Approximately 75.5 miles of designated open road system exist. The open road system is an inventoried road system with road numbers that the Forest Service maintains at a target maintenance levels. Maintenance levels include Level 4 (suitable for passenger car travel and provide comfort at moderate speeds), Level 3 (suitable for passenger car travel), Level 2 (high clearance 4-wheel drive vehicles). The majority of the Level 3 roads are near the perimeter of the project area. The roads within the interior are mostly Level 2 roads. Many of these roads are in meadows and most are in poor condition due to lack of maintenance. To avoid the muddy areas during the seasons of moisture, drivers are creating multiple routes called “braiding.”

Approximately .4 miles of road is closed except for occasional administrative use such as fire suppression or search and rescue operations. The road is gated to prevent public access.

Approximately 12.5 miles of roads were authorized for decommissioning in previous decisions but are still being used by the public currently due to ineffective closures.

Approximately 18.6 miles of user-created social roads exist. These are unauthorized non-system roads that have typically branched out from forest system roads.

The road system is too large to be adequately maintained by personnel and funding currently available. Many roads are a source of noise disturbance and resource damage. Table 1-5 describes the existing and desired transportation system values.

Table 1-5. Existing and Desired Transportation System Values

Road Type	Existing Conditions	Desired Future Conditions
Open System Roads	75.5 miles	40-50 miles
Closed System Roads (still being used by the public)	12.2 miles	0 miles
User Created/Social Non-System Roads	18.6 miles	0 miles
Administratively Closed Roads	.4 miles	No specific value
Road Total	106.7 miles	40-50 miles
Road Density	3.88 miles/square mile	2 miles/square mile

Desired Future Conditions

The open road system for the project area would consist of the minimum network necessary to satisfy both the current and foreseeable future needs. The minimum network is a road system that balances motorized access for resource management activities, fire suppression, and recreational opportunities with resident evacuation and resource protection concerns. User-created social roads are decommissioned. Decommissioning roads includes obliterating roads and rehabilitating road prisms back to natural conditions and contours.

Road densities approximate Forest Plan direction values of 2 miles per square mile of land. Roads accessing the east side of Lake Mary provide an emergency response route.

Need for Change

Comparison of the existing condition of the project area and the desired condition indicates a need to:

- Designate an open road system;
- Close roads for administrative access where roads cause resource impacts but are needed for emergency access; and
- Decommission user-created social roads and system roads that are causing resource impacts.

Proposed Action

The Proposed Action was designed by the Forest Service ID Team members and GFFP partners to best meet the Need for Change for Action of the project while meeting requirements of the Forest Plan and other guiding documents such as the *Integrated Treatment of Noxious or Invasive Weeds EIS.*

This action proposes to meet the purpose and need by thinning and/or prescribed burning about 15,173 acres of land in the project area. The existing road system would be used, only 1.3 miles (consisting of 3 segments) of temporary road would be constructed for hauling access. These segments would be obliterated after thinning activities are complete. In summary, the Forest Service would:

- ❑ Mechanically thin approximately 13,780 acres to achieve an average canopy cover of 30-60%, depending on resource objectives. Thinning would reduce wildfire risk and restore forest structure and diversity.
- ❑ Conduct initial prescribed burns on approximately 15,173 acres after thinning to reduce fuel loads and reintroduce low to moderate intensity surface fire.
- ❑ Conduct additional maintenance burns after initial prescribed burns to maintain fuel loads.
- ❑ Designate and maintain an open road system of 47.7 miles within the project area.
- ❑ Designate dispersed camping areas to reduce human-caused ignitions of wildfires.

Chapter 2 includes a complete description of Proposed Action activities, alternatives to the Proposed Action, comparison of alternatives, specific mitigation measures, and monitoring requirements.

Decision Framework

Based on the analysis in the Environmental Assessment, the Mormon Lake District Ranger will decide how to best reduce fuel loading and restore fire-adapted lands in the Mountainaire Project area in accordance with Forest Plan direction and desired future conditions. The responsible official will decide whether to implement an action alternative, a modified action alternative (if needed), or the no-action alternative. If an action alternative is selected, it will include:

- The location, design, and scheduling of the proposed mechanical treatment, burning, road management, other activities, or connected actions;
- The estimated timber volume, if any, to make available from the project area at this time;
- Access management measures; and
- Mitigation measures and monitoring requirements.

Relationship to Forest Plan

The Forest Service has two types of decisions: programmatic (e.g., the Forest Plan) and project level which implements the Forest Plan. The Mountainaire HFRA project EA is a project-level analysis; its scope is confined to addressing the significant issues and possible environmental consequences of the project. It does not attempt to address decisions made at a programmatic level.

The Forest Plan embodies the provisions of the National Forest Management Act of 1976, its implementing regulations, and other guiding documents. The Forest Plan sets forth in detail the direction for managing the land and resources of the Coconino National Forest. Where appropriate, the Mountainaire HFRA Project EA also tiers to the Forest Plan Final Environmental Impact Statement (USDA Forest Service 1987), as encouraged by 40 CFR 1502.20.

Public Involvement

The proposal was listed in the Coconino National Forest's Schedule of Proposed Actions in the fall of 2004. The proposal was provided to the public and other agencies for comment during scoping in March of 2005. To meet HFRA requirements and better inform the public of project progress and management intent, the district hosted a public meeting during the scoping period near the Mountainaire community and Flagstaff. As mentioned previously in the Background section of this Chapter, the District also worked closely with Greater Flagstaff Forests Partnership (GFFP) on all phases of planning and design for this project. See Appendix C – *Healthy Forests Restoration Act Authorities for the Mountainaire HFRA Project* for more information on collaboration with GFFP.

Using the comments from the public, other agencies, and GFFP, the interdisciplinary team developed a list of issues to address.

Scoping

The Council on Environmental Quality (CEQ) defines scoping as "...an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a Proposed Action" (40 CFR 1501.7). Among other things, the scoping process is used to invite public participation, to help identify public issues, and to obtain public comment at various stages of the environmental analysis process. Although scoping is to begin early, it is really an iterative process that continues until a decision is made.

In March of 2005, a scoping letter notifying the public of a 30-day comment period was sent to approximately 750 individuals and groups. This letter included the Purpose and Need for the project, the Proposed Action, monitoring measures, and design features that were built into the Proposed Action to mitigate environmental effects. This included federal and State agencies, Native American groups, municipal offices, businesses, interest groups, and interested individuals. Households in the Mountainaire community also received a copy.

The Approximately 20 individuals attended the public meeting on April 13, 2005. A total of 13 written public comments were received in response to the mailing and public meeting. Copies of these letters and the District's response to these comments are found in Appendix B - *Responses to Scoping Comments.*

Issues

Scoping and public involvement activities are used to identify unresolved issues about the effects of the Proposed Action. The Forest Service separated the issues into two groups: significant and non-significant issues. Significant issues were defined as those directly or indirectly caused by implementing the Proposed Action. Non-significant issues were identified as those: (1) outside the scope of the Proposed Action; (2) already decided by law, regulation, Forest Plan, or other higher level decision; (3) irrelevant to the decision to be made; or (4) conjectural and not supported by scientific or factual evidence. The Council for Environmental Quality (CEQ) NEPA regulations require this delineation in Sec. 1501.7, "…identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review (Sec. 1506.3)…" A list of non-significant issues and reasons regarding their categorization as non-significant may be found in the Comment Analysis Report in the project record. The following issues were determined to be significant and within the scope of the project decision. Issues are addressed through the Proposed Action, alternatives to the Proposed Action, and mitigation measures.

- Air Quality/ Smoke Management – Prescribed burning will impact air quality and could cause respiratory problems for some people.
- Prescribed Fire Control – Fire managers may lose control of prescribed fires and residences could be threatened.
- Elk Calving Habitat – Thinning may affect elk habitat and elk calving areas adjacent to the Mountainaire community.
- Road Closure – Proposed road closures may not effectively close roads in the project area.

- Wildlife Research Proposal – The collaboratively developed Wildlife Research Proposal should be incorporated into the Proposed Action to research effects of treatments on wildlife habitat.
- Thinning Diameter Limits – A thinning diameter cap should be implemented to retain large trees in the area.
- Soil Disturbance – Pile burning may have effects on soils and invasive plant spread and persistence.
- Insect and Disease – Thinning should be conducted in a manner that reduces the spread of bark beetles in the project area.
- Yellow Pine Retention – Stands with thick duff layers may experience mortality when burned.

Applicable Laws and Executive Orders

Shown below is a partial list of federal laws and executive orders pertaining to project-specific planning and environmental analysis on federal lands. Disclosures and findings required by these laws and orders are contained in Chapter 3 or the Decision Notice for this EA.

Multiple-Use Sustained-Yield Act of 1960

National Historic Preservation Act of 1966 (as amended)

Wild and Scenic Rivers Act of 1968, amended 1986

National Environmental Policy Act (NEPA) of 1969 (as amended)

Clean Air Act of 1970 (as amended)

Endangered Species Act (ESA) of 1973 (as amended)

Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974 (as amended)

National Forest Management Act (NFMA) of 1976 (as amended)

Clean Water Act of 1977 (as amended)

American Indian Religious Freedom Act of 1978

Archeological Resource Protection Act of 1980

Executive Order 11593 (cultural resources)

Executive Order 11988 (floodplains)

Executive Order 11990 (wetlands)

Executive Order 12898 (environmental justice)

Executive Order 12962 (aquatic systems and recreational fisheries)

Executive Order 13186 (Migratory Birds Treaty Act)

Project Record Availability

Additional documentation, including more detailed analyses of project-area resources, may be found in the project record located at the Mormon Lake Ranger District, 4373 S. Lake Mary Road, Flagstaff, Arizona, 86001. Certain documents are referenced throughout this EA. These records are available for public review pursuant to the Freedom of Information Act (5 U.S.C 552).

Chapter 2 - Alternatives

This chapter describes the Proposed Action and alternative management strategies considered by the Forest Service for the Mountainaire HFRA project. It includes a discussion of how alternatives were developed, an overview of mitigation and monitoring measures, a description of each alternative considered in detail, and a comparison of these alternatives. Chapter 2 is intended to present the alternatives in comparative form, sharply defining the issues and providing a clear basis for choice among options by the responsible official and the public (40 CFR 1502.14).

Some of the information used to compare alternatives at the end of Chapter 2 is summarized from Chapter 3 - Affected Environment and Environmental Consequences. Chapter 3 contains the detailed scientific basis for establishing baselines and measuring the potential environmental consequences of each of the alternatives.

Alternative Development Process

The Forest Service Interdisciplinary Team (IDT) used information from scoping, including the significant issues identified for the project (see Chapter 1), in conjunction with the field-related resource information to formulate alternatives to the Proposed Action. Each action alternative is also designed to meet the stated purpose and need for the Mountainaire HFRA project and the project-specific desired future conditions developed collaboratively with Greater Flagstaff Forests Partnership.

Each action alternative represents a site-specific proposal developed through intensive interdisciplinary evaluation of issues and the current and desired future conditions. Project area identification and design also made use of high resolution topographic maps and a large quantity of resource data available in geographic information system (GIS) format.

Forest Plan Consistency

All alternatives including the Proposed Action are consistent with the Coconino National Forest Plan. All applicable forest-wide and management area standards have been incorporated. The Forest Service uses many mitigation and preventive measures in the planning and implementation of land management activities. The application of these measures began during the planning and design phases of the project. Additional direction comes from the Regional Guide, and applicable Forest Service manuals and handbooks.

Thinning up to 12 inches DBH on 147 acres in the Mexican spotted owl Protected Activity Center (PAC) is proposed under all action alternatives. See Chapter 2 for a description of proposed activities. The Forest Plan guidelines state that harvest of trees can be performed in PACs in such a way that minimizes effects to the owl. Harvest in these areas should be from trees 9 inches or below DBH to abate fire risk.

Guidelines are defined in the Forest Plan as “preferred or advisable courses of action.” Standards are defined as “performance criterion indicating acceptable norms or specifications that actions must meet to maintain the minimum conditions for a particular resource.” While guidelines and standards have been interpreted on past Forest Service projects to be synonymous, there is a notable difference in their definition.

The proposed thinning is outside of the Forest Plan's 9 inch diameter recommendation but meets the intent and goals of the MSO recovery plan and Forest Plan. This proposal is truly a habitat-oriented and fuel reduction approach that was developed in collaboration with US Fish and Wildlife Service and GFFP to improve habitat, foraging, and fuel conditions in one portion of the PAC outside the nest site. These guidelines are only being exceeded to better meet the goals and objectives of habitat recovery as outlined in the recovery plan that can't be achieved within the 9-inch recommendation. See the description of effects to the MSO PAC in the Wildlife section of Chapter 3 for a thorough analysis of the differences in thinning treatments. A comparison of effects of thinning up to 9 inches and 12 inches was conducted to show differences in meeting habitat improvement and fuel reduction needs. With regard to this one exception, all applicable forest-wide and management area guidelines have been incorporated.

Alternatives Considered but Eliminated from Detailed Study

The Grand Canyon Trust, in their scoping comments, proposed an alternative that had a variable upper diameter limit for mechanical thinning. This comment shares some similarity with requests from the Center for Biological Diversity, which advocated for a uniform 16-inch upper diameter limit. Grand Canyon Trust proposed a management strategy that placed a 16-inch upper diameter limit in all sites within the project area with the exception of 9 sites that would be subject to an 18-inch diameter limit. All other trees over 16-inches identified for thinning would have to meet three additional criteria, including new collaboration measures.

The Forest Service held numerous meetings regarding large tree management with GFFP to attempt to resolve some large tree management issues. Much of this history is documented in *Appendix C – Healthy Forests Restoration Act Authorities for the Mountainaire HFRA Project.*

Part of the mission of GFFP is to plan projects in an efficient manner—one reason why this project is being analyzed under HFRA authority. The District does not have additional time to start the collaboration process over, as Grand Canyon Trust requested, and spend added time developing selection criteria and marking guidelines. The Mormon Lake District Ranger responded to Grand Canyon Trust's scoping letter to request clarification of the their interpretation of the large tree management rationale and criteria that GFFP (including Grand Canyon Trust) and the Forest Service developed together. A response was not received by the requested reply date, but was received approximately 2 months after the reply date.

Alternative 4 and the Proposed Action (Alternative 2) form the sideboards of environmental effects in regards to large tree management. Grand Canyon Trust's proposal, due to its "adaptive" nature, was predicted to have environmental effects between the Proposed Action and Alternative 4, but would be difficult to analyze without criteria that would have to be developed collaboratively. Given the timeframe for conducting the environmental analysis, and a lack of a timely response, the District proceeded with analyzing effects of Alternative 4 to accommodate the large tree issues identified in scoping. Under HFRA, if more than one additional alternative is proposed, the deciding official has sole discretion to select the additional alternative to analyze (Sec. 104)(c)(2).

Grand Canyon Trust's clarification letter provides some criteria for the removal of large trees in certain situations. The Mormon Lake District Ranger met with Grand Canyon Trust after receipt of this letter in attempt to resolve some of these issues regarding criteria. The District's response to these additional comments is located in Appendix B – *Responses to Scoping Comments*.

Alternatives Considered in Detail

The Proposed Action (Alternative 2) and 3 alternatives are considered in detailed analysis. Alternative 1 is the no-action alternative, under which the project area would receive no treatments at this time, and would remain subject to natural or ongoing changes only. The action alternatives represent different means of satisfying the purpose and need than the Proposed Action, by responding with different emphases to the significant issues discussed in Chapter 1. Maps of all alternatives considered in detail are provided. See Figure 1-1 for a map of the project area boundary.

Larger-scale maps of the area's existing conditions and proposed management activities (alternatives) are contained in the Project Record.

Alternative 1 (No Action)

No thinning, prescribed fire, or transportation system management activities would occur in the project area at this time. It does not preclude activities in other areas at this time, or from the Mountainaire HFRA project area at some time in the future. The Council on Environmental Quality (CEQ) regulations (40 CFR 1502.14d) require that a "no action" alternative be analyzed. This alternative represents the existing and projected future condition against which the other alternatives are compared.

The No Action alternative would have no outputs, provide no change in existing conditions, and does not meet the purpose and need for action. The No Action alternative does not move the project area towards the desired future conditions.

Alternative 2 (Proposed Action)

Alternative 2 was developed to best meet the Purpose and Need for Action. The proposal is the result of extended collaboration with Greater Flagstaff Forests Partnership. The following table provides a brief overview of proposed management activities and how they meet the need for change statements discussed in the previous chapter.

Section headings in this Proposed Action section are different from those in the *Purpose and Need for Action* section because management activities are designed to meet multiple project needs. However, similar measures, such as fire hazard ratings and canopy cover, will be described to link management actions to the Purpose and Need for Action.

While some vegetation treatments can maximize effectiveness of both fuel and fire risk needs as well as forest structure needs, other treatments emphasize one resource area over another. For example, in areas within close proximity to private lands, treatments are designed to best reduce the threat of wildfire. In contrast, treatments in MSO Protected Activity Centers or northern goshawk Post Fledgling Family Areas—while still reducing fuels and fire hazards—will emphasize the maintenance of important wildlife habitat and forest structure attributes. For many situations, treatment methods serve multiple resource area needs.

Figure 2-1. Map of Proposed Management Activities Under Alternatives 2 and 4

Summary of Management Actions

Table 2-1. Management Activities and Rationale for Alternative 2

Management Activity	Purpose and Need for Action
Mechanical thinning on approximately 13,780 acres	**Wildfire and Fuels Risk** - Reduce fire hazard ratings to low and moderate levels; - Increase crown base heights to 20 feet or greater; - Increase critical flame lengths to 10-15 feet; and - Create conditions where reintroduction of low to moderate intensity surface fire can occur; **Fire-adapted Forest and Grassland Structure** - Reduce canopy cover, basal area, and Stand Density Index values towards the desired future conditions represented in Table 3 for forest and grassland structure needs; - Restore historic vegetative structure in meadows and savannah areas; - Move VSS distribution towards values listed in Table 2 to create an unven-age structure in forested stands; and - Create or retain openings to promote understory diversity, and initiate VSS 1 and 2 classes.
Initial prescribed burning on approximately 15,173 acres	**Wildfire and Fuels Risk** - Reduce flame lengths to 2-3 feet; - Reduce fuel loads to 3-7 tons per acre; and - Reintroduce low to moderate intensity surface fire
Maintenance burning on approximately 15,173 acres	**Wildfire and Fuels Risk** - Maintain fuel loads to 3-7 tons per acre; - Maintain expected flame lengths to 2-3 feet; and - Maintain low to moderate intensity surface fires periodically

Management Activity	Purpose and Need for Action
Designating an open road system of 47.7 miles **Decommissioning 55.7 miles of user-created social road and system roads** **Closing 3.3 miles of road except for administrative access and emergency use** **Constructing and decommissioning (after use) 1.3 miles (3 segments) of temporary roads.**	**Transportation System** - Designate open road system; - Close roads for administrative access where roads cause resource impacts but are needed for emergency access; - Decommission user-created social roads that are causing resource damage; and - Provide access for thinning operations and skid trails.
Designating dispersed camping areas	**Wildfire and Fuels Risk** - Designate dispersed camping sites to reduce human caused ignitions.

Mechanical Thinning

Approximately 13,780[2] acres will be mechanically thinned within the area. Three types of thinning are proposed to meet different resource needs. These areas will be thinned to density levels and structural arrangements that are derived from the Forest Plan, scientific literature, and the Need for Change Report. The following sections further describe the three mechanical treatment types in more detail.

Thin-from-Below Treatments

Approximately 3,448 acres will receive a thin-from-below treatment in areas primarily south and west of private property. These areas are important to protect from wildfire due to common wind and fire movement patterns. In most areas, thin-from-below treatments will remove most small diameter trees and retain larger trees, leaving a more even-aged stand structure.

Thinning from below increases crown base height, decreases the height to which firebrands are lofted and the distance at which spot fires would be expected to occur, and reduces the ease with which a fire can “torch” trees and produce firebrands. It also reduces canopy closure, and therefore reduces heat accumulation below the crown. These results, collectively, will reduce fire hazard ratings.

[2] These acreages do not account for any deferrals due to layout, inoperability, financial efficiency, wildlife cover, etc. Actual number of acres would be lower after review from implementation staff and layout.

Uneven Age Treatments

Approximately 7,527 acres will receive an uneven-age treatment. Treatments will reduce expected flame lengths, lower fire hazard ratings, and increase crown base heights by removing some ladder fuels, although not to the same extent as thin-from-below treatments. The resulting uneven-age stands provide a heterogeneous forest structure; more age and size class diversity; wildlife habitat and hiding and thermal cover for wildlife species; and resiliency to environmental stress factors such as insect and disease outbreaks.

Most of these treatments are proposed to occur in areas that are important for wildlife habitat or where an increased growth rates of trees is important (such as old growth development).

Grassland and Savannah Restoration Treatments

Approximately 2,805 acres of grasslands and ponderosa pine savannah areas will be mechanically thinned to remove stocked "plantations" and restore meadow and savannah structure. Restoration in these areas would include thinning trees to densities based on historic numbers.

While site boundaries are fairly accurate in delineating forest structure or topographical differences between sites, actual management boundaries that divide forested areas from savannah or grassland areas would be identified in the field and guide management direction. Sites identified for grassland and savannah restoration would not receive uniform treatment. The number of remaining trees in grassland areas and savannah areas after treatment would be based on the number of evidences of pre-settlement trees. Remaining portions of sites that have similar forest structure values to adjacent forested sites would receive thinning treatments similar to those proposed for the adjacent sites.

Retained trees will be selected from the healthiest trees in a site, not necessarily the closest in distance to historic evidences. Genetically desirable, large trees would be prioritized for retention.

Table 2-2. Forest Densities by Thinning Type

Treatment Type	Acres	Existing Conditions*			Timeframe	After Thinning*		
		Trees per Acre	Basal Area	Canopy Cover		Trees per Acre	Basal Area	Canopy Cover
Thin-from-Below 40% Canopy Cover	2,919	56 - 499 (196)	51 - 160 (103)	46 - 72 (57)	Immediately after thinning	32 - 120 (63)	61 - 78 (71)	39 - 42 (40)
					20 years after thinning	30 - 115 (60)	86 - 97 (92)	44 - 51 (47)
					40 years after thinning	29 - 111 (58)	96 - 119 (107)	47 - 58 (52)
Thin-from-Below 50% Canopy Cover	529	54 - 389 (217)	93 - 208 (135)	55 - 78 (65)	Immediately after thinning	31 - 113 (77)	85 - 105 (92)	47 – 50** (49)
					20 years after thinning	30 - 109 (74)	108 - 160 (120)	51 - 69 (57)
					40 years after thinning	29 - 105 (71)	114 - 155 (139)	52 - 75 (61)

Treatment Type	Acres	Existing Conditions*			Timeframe	After Thinning*		
		Trees per Acre	Basal Area	Canopy Cover		Trees per Acre	Basal Area	Canopy Cover
Uneven Age Thin 30% Canopy Cover	515	89 - 303 (210)	55 - 122 (102)	36 - 64 (55)	Immediately after thinning	31 - 90 (51)	40 - 55 (48)	28 - 31 (30)
					20 years after thinning	29 - 240 (54)	65 - 77 (70)	36 - 43 (39)
					40 years after thinning	28 - 232 (52)	75 - 102 (88)	39 - 52 (46)
Uneven Age Thin 40% Canopy Cover	5,003	58 - 867 (280)	61 - 287 (121)	45 - 89 (60)	Immediately after thinning	36 - 788 (128)	59 - 79 (69)	38 - 43 (40)
					20 years after thinning	35 - 767 (147)	80 - 130 (93)	43 - 57 (49)
					40 years after thinning	35 - 737 (143)	96 - 147 (113)	48 - 68 (55)
Uneven Age Thin 50% Canopy Cover	2,009	64 - 467 (208)	53 - 170 (111)	44 - 73 (60)	Immediately after thinning	58 - 398 (96)	82 - 97 (92)	48 – 51** (49)
					20 years after thinning	56 - 387 (92)	109 - 136 (118)	53 - 61 (57)
					40 years after thinning	53 - 375 (89)	111 - 157 (136)	54 - 68 (61)

*Values for canopy cover, basal area, and trees per acre are ranges derived from Forest Service stand exam data and Forest Vegetation Simulator models. The mean values in parenthesis are values averaging across all sites with similar canopy cover objectives.

**Canopy cover values for northern goshawk PFA nest areas will remain at 60% after treatment, however areas surrounding nest portions will average closer to 50% canopy cover.

Forest Structure and Composition

This section describes forest and grassland structure needs for specific wildlife habitat areas. While all three mechanical thinning types remove trees to achieve wildfire and fuel risk needs to some extent, specific habitat and forest structure needs will influence thinning treatments.

Table 2-2 describes forest densities before and after the proposed thinning treatments. Canopy cover values will be averaged across an entire site (e.g. 40%), but the number of trees remaining and basal area will be influenced by existing age and size class distribution and the size and locations of openings in the area.

Not all values listed in Table 2-2 may meet the Desired Future Condition values immediately after treatment. For example, a basal area of 150 is desired for a Target/Threshold stand after treatment. While canopy cover may be met, the basal area value will not be achieved initially. Thus, while the canopy cover is met, the size of the trees in the area will not be met because of existing stand structure. It is important to note that while the proposed treatment in this site may not meet the desired basal area value immediately after treatment, the site will meet the 150 basal area goal much faster than if no treatment occurred at all. Lower stand densities will allow remaining trees to grow larger quicker than if no trees are thinned.

Forest Structure Common to all Treatment Areas

Site Density

Canopy cover was identified as the primary measure to display differences in thinning treatments since it is a measure common to numerous resource areas in determining treatment effectiveness. After thinning, canopy cover will range between 30-60% in the project area, depending on wildlife, fuels, and forest structure needs.

Age, Size, and Species Diversity

Treatments will be implemented to achieve desired VSS distribution across the landscape. VSS distribution is currently determined on a site-level basis. While this provides a good indicator of tree size and distribution within a site, it is not a good indicator of how tree size and age class are distributed across a project area. For example, a VSS 4 stand has 12-18 inch trees contributing the most basal area in the site than any other size class. It is likely that numerous clumps of smaller diameter trees and openings in this site exist as well. To achieve a more accurate distribution of VSS classes, treatments are designed to meet VSS distribution across the landscape and not within individual sites.

Mechanical treatments will primarily focus on removing small diameter trees to meet wildfire and fuels risk and forest structure needs. The three treatment types maximize the retention of large, mature trees. Where possible (away from private property), treatment will create or lead to the development of an uneven aged forest structures. In certain situations, trees between 16-24 inches DBH will be removed to meet ecological objectives. *Appendix C – Healthy Forests Restoration Act Authorities for the Mountainaire HFRA Project* describes these situations and the rationale for removal of large diameter trees.

Spatial Arrangement

Tree arrangement will vary after implementation. Variation in tree spacing, clump or group sizes, and canopy gaps will provide a mosaic pattern of individual and clustered trees interspersed among openings or meadow areas. A clump can consist of 3-20 trees of similar age and size, often occurring with interlocking crowns. Clumps can range from 0.1 to 0.5 acres in size. A group is a non-uniform distribution of trees, often including several clumps. Groups can occur up to 4 acres in size and are typically defined externally forest openings. Groups typically have some interlocking crowns within the structure, yet have openings in the crown as well. Groups will vary in density, spatial arrangement, and canopy covers across the landscape to meet a variety of project objectives.

Openings will be created or enhanced in forested stands and will range in size and shape, depending on wildlife habitat locations and Forest Plan requirements. This mixture of openings and tree patterns will achieve numerous fuel reduction and spatial distribution needs in the area. Openings will promote understory vegetation productivity and diversity, increase tree regeneration, and break up fuel loads, while clumps and groups can help maintain important wildlife habitat features such as interlocking canopies, prey species habitat, and thermal and hiding cover. Opening sizes for different wildlife habitat areas are listed in Table 2-3.

Table 2-3. Opening Sizes by Wildlife Habitat Areas

Wildlife Habitat Area	Opening Size
Northern Goshawk Foraging Areas	¼ to 4 acres
MSO Restricted	¼ to 2 acres
MSO Protected and Target/Threshold Habitat	¼ to ¾ acre
Northern goshawk PFAs	¼ to 2 acres

Northern Goshawk Foraging Areas

Those areas outside of MSO habitat and northern goshawk PFAs are termed northern goshawk foraging areas. Thinning in these areas includes thin-from-below treatment on 2,836 acres and uneven-aged treatment on 5,438 acres. Treatments in these areas are designed to maximize fuels reduction while still meeting Forest Plan direction for goshawk foraging areas. Canopy cover in these areas will range from 30-50% after treatment.

Approximately 514 acres of these areas will be thinned to 30% canopy cover to mimic historic stand densities. The number of trees left per historic evidence (tree stumps, old logs) will be determined on the ground but treatment will meet a minimum 30% canopy cover objective. Trees selected for retention will be based on existing forest structure.

Treatments will reduce canopy cover, basal area, trees per acre, and SDI. A more uneven-aged structure will remain after treatment. It will take some time to achieve forest structures that are truly uneven-aged in a lot of the project area since the forest is predominately even-aged currently.

Northern Goshawk Post Fledging Family Areas

Three northern goshawk Post Fledging Family Areas (PFAs) exist in the project area. PFAs will receive an uneven aged thin on approximately 857 acres. Thin-from-below treatment will occur on approximately 145 acres. Canopy cover and tree densities will be higher in the 180-acre nest areas (60% and greater) and lower in other areas of the site but will generally average 50% canopy cover across the site. The Seruchos PFA will not be thinned due to its overlap with the MSO Protected Activity Center. Thinning activities will emphasize improving nesting and roosting habitat, maintaining the yellow-barked pine component, and reducing fire risk to the nest stands as well as private property.

Mexican Spotted Owl Restricted Habitat

Thinning treatments in restricted habitat include both thin-from-below on 382 acres and uneven age management on 1,616 acres. Thinning will be designed to improve foraging habitat, maintain the large oak and yellow-barked pine component, and reduce the threat of fire to these areas and adjacent MSO Protected and Target/Threshold habitat. Canopy cover values after thinning will range from 40-50%.

Mexican Spotted Owl Target/Threshold Habitat

Two sites (305 acres) are designated as target/threshold habitat in the project area. Uneven age thinning will occur on 147 acres to maintain nesting and roosting habitat, increase diameter growth of large trees, and reduce fuels. The other 158 acres will receive a burn only treatment. Canopy cover values after thinning will range from 50% to 60%.

Mexican Spotted Owl Protected Habitat

Approximately 147 acres within the Mexican spotted owl Protected Activity Center (PAC) will receive an uneven age treatment up to 12 inches in diameter at breast height (DBH) to improve nesting and roosting habitat, maintain the large oak and yellow-barked pine component, increase growth rates of remaining trees, create small openings, and reduce fuels and fire hazard ratings. Treatment will prioritize the removal of small diameter trees near mature yellow-barked ponderosa pines and large oaks to reduce ladder fuels and competition to these trees.

Forest Plan direction offers guidance to meet the intent of the 1995 Recovery Plan for the MSO. Thinning up to 9 inches DBH is suggested as a guideline to achieve habitat improvement and fire risk abatement goals. After modeling treatments in the PAC, visiting this area during field trips, and discussing numerous treatment options, it was determined by the district, GFFP Board of Directors, and US Fish and Wildlife Service staff that uneven age thinning up to 12 inches would better meet the intent of the Recovery Plan than a 9-inch limit. Thinning up to 12 inches would enhance habitat components such as understory grasses, forbs and shrubs; reduce competition to large oak and mature yellow-barked pine trees; increase the growth rate of residual trees; and significantly reduce the fire hazard rating of the area over a longer period of time, while still maintaining ecosystem structure and function. Some trees under 12 inches DBH would remain to provide for an uneven-age structure. No thinning will occur within the 100-acre nest buffer. Existing canopy cover values after thinning will average 50% and greater.

See the Forest Plan Consistency section at the beginning of this chapter for more information on Forest Plan standards and guidelines relating to MSO protected habitat management.

Old Growth

The proposed thinning treatments will maintain and contribute towards the development of old growth structure and composition in the project area. Approximately 24% (3,574 acres) of the forested lands have been designated as old growth development areas to meet Forest Plan guidance for Vegetation Structural Stage (VSS) distribution and old growth management. Areas were selected based on existing forest structure, age class, and habitat features. While these areas will meet old growth structural objectives sooner than other areas, other areas will also be managed to increase tree growth and ensure the development of old growth areas over time.

Sites designated as old growth development areas will reach old growth structural conditions in different time intervals and will exhibit varying forest structures over time. Some old growth areas may be more even-aged, with a single story of numerous large ponderosa pines and fewer VSS classes. Other areas may have a multi-storied tree component. All old growth development areas will contain openings of various sizes to increase regeneration and understory productivity and diversity. Many of the old growth development areas designated within the project area also

serve as key habitat areas for the northern goshawk, Mexican spotted owl, and Management Indicator Species. See Figure 2-2 for a display of areas identified for old growth development.

Slash Treatment

Slash treatment in most areas would consist of either whole tree skidding or machine piling and burning, depending on soil, vegetation, and smoke impacts. Whole trees that are skidded would be de-limbed at landings. Whole tree skidding would not be appropriate in areas that have sensitive plants populations and high densities of residual trees. Slash that remains where trees are cut would be machine piled and burned after the slash cures.

In stands where the initial fuel loading combined with thinning slash does not create broadcast burning problems, or in areas with sensitive soils or plant species, slash may be lopped and scattered to a 1-foot height. This slash would be consumed by prescribed fire after thinning is completed.

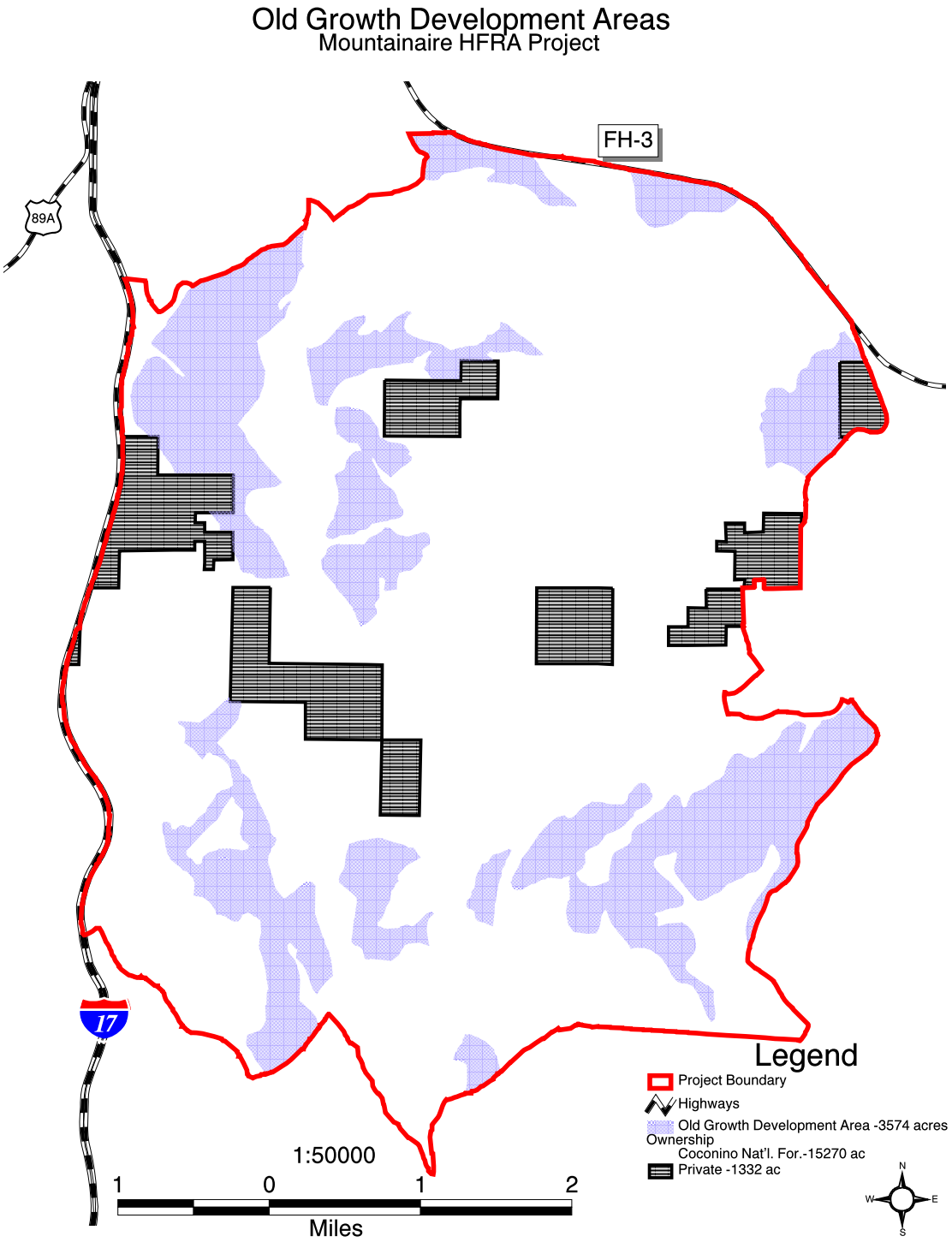
Slash would be left in some areas to provide hiding cover to wildlife species. See the Project Design Features and Mitigation Measures section for more detail.

Prescribed Burning

All areas proposed for mechanical treatment would be burned after thinning to remove activity-created slash, duff, and needle cast. After this initial burn, maintenance burning would be conducted periodically (every 4-15 years) to mimic the historic fire interval patterns in southwestern ponderosa pine forests. Maintenance burns aid in reducing fuels loads, raising crown base heights of live trees, maintaining openings, and promoting understory growth. Burning would occur when weather and environmental factors such as wind, fuel moistures, and humidity are suitable for burning.

In addition to areas mechanically treated, approximately 1,476 acres would receive a burn-only treatment. These areas that are deferred from mechanical entry include inoperable slopes and forested lands that already meet desired future conditions for canopy cover.

Figure 2-2. Proposed Old Growth Development Areas



Transportation System

The transportation system in the project area will include approximately 47.7 miles of designated open forest roads after thinning and initial prescribed burning activities are complete.

Approximately 3.3 miles of roads will be closed except for occasional administrative use such as fire suppression or search and rescue operations. These administratively closed roads will be gated to prevent access.

This transportation system would provides administrative access for firefighting and provides an arrangement and network of roads that balances the needs of reducing wildfire risk with public access and recreation experience, while meeting forest plan requirements. Approximately 2 miles of open road per square mile section will be maintained to move toward Forest Plan direction.

Agency staff conducted a comprehensive evaluation of the roads system in the project area. Roads not shown on the open road system will be decommissioned. Approximately 55.7 miles of road will be decommissioned to reduce road redundancy, maintenance costs, and impacts to resources such as wildlife habitat and watersheds. Of these 55.7 miles, 9.5 miles have already been authorized for decommissioning through other decisions but due to ineffective prior closure, are still being used currently. This decision will validate decommissioning on these roads.

Various techniques will be used to decommission roads, depending on the requirements necessary to ensure long-term success of the closure and rehabilitation. These techniques include scarifying roads with heavy equipment, reseeding, installing drainage structures, and barricading with rocks or activity generated slash.

Temporary Road Construction

To aid in thinning operations, approximately 3 segments of temporary road totaling 1.3 miles would need to be constructed to remove fuels after thinning. These segments would be decommissioned after treatment and reseeded.

Dispersed Camping Designation

Areas in the south end of the project area will be designated for dispersed camping opportunities. These areas are located in areas already used frequently by campers. While these areas would be located in areas with a low to moderate fire hazard and away from communities and important wildlife habitat areas, they would still provide access to popular recreational areas and travel routes. See Figure 2-4 for areas proposed for closure (dark gray shading).

Alternative 3

Alternative 3 is a modification of Alternative 2. This alternative includes recommendations from GFFP and the Arizona Game and Fish Department to manage certain areas for Abert Squirrel habitat and research opportunities.

Figure 2-3. Proposed Transportation System

This alternative is identical to Alternative 2 except for different thinning practices on a total of 1,310 acres of forested lands in three research areas north and northwest of the Mountainaire community. Figure 2-5 includes a display of these areas with details. All prescribed burning, transportation system proposals, and dispersed camping designations described in Alternative 2 will be followed.

Research Area Treatment Types

These three distinct treatment types are developed to maximize tassel-eared squirrel density and recruitment while meeting other ecological restoration goals in some areas to reduce fire risk and improve tree vigor.

Meso-Reserve Areas – 228 Acres

No thinning will occur in these areas so that canopy cover, basal areas, and tree densities can remain high. These areas range from 67 to 94 acres in size. Prescribed fire will be introduced to remove fuels and create smaller openings in these areas.

Matrix Areas – 472 Acres

Matrix areas will surround Meso-Reserves to reduce fire risk in the meso-reserves as well as provide foraging habitat for squirrels. These areas will receive an uneven-age treatment and thinned to 40% canopy cover.

Forest structure in these areas will mimic the grouping and clumping structure described in Alternative 2. Where possible, clumps will consist of 5 or more trees with interlocking crowns.

Full Restoration Areas – 610 Acres

Full restoration areas will surround matrix and meso-reserve areas to reduce fire risk in these areas. Uneven-age thinning in these areas will reduce basal area to 20-40 ft^2 per acre and reduce canopy cover to approximately 30% in many areas. The number of ponderosa pines retained in these areas will be based on the numbers of historic (pre-1870) tree evidences in the area. If replacement trees are greater than 16 inches DBH, 3 replacement trees will be left for every 2 evidences. If replacement trees are less than 16 inches DBH, 3 replacement trees will be left for each evidence. Replacement trees will be selected based on tree health and vigor.

Figure 2-4. Proposed Camping Prohibition

Research Area Locations

Three research areas will be established, each with a meso-reserve, matrix, and full restoration treatment component. The size and location of meso-reserve, matrix, and full restoration areas were designed to accommodate environmental conditions such as the existing stand structure, topography, soil conditions, fire risk, and adjacent treatments described in Alternative 2 – Proposed Action.

Western Area

- Meso-reserve Area – 67 acres
- Matrix Area – 181 acres
- Full Restoration Area – 224 acres

Central Area

- Meso-reserve Area – 94 acres
- Matrix Area – 155 acres
- Full Restoration Area – 152 acres

Eastern Area

- Meso-reserve Area – 67 acres
- Matrix Area – 136 acres
- Full Restoration Area – 234 acres

Monitoring

Arizona Game and Fish will conduct pre- and post-treatment monitoring to evaluate short-term effects of these treatments on wildlife habitat. Permanent plots will be located in each of the three research areas as well as outside these areas for comparison. This research is proposed by Arizona Game and Fish Department and Ecological Restoration Institute and will be conducted by these partners. There is no Forest Service research is proposed in these areas. See the GFFP scoping comments in the Project Record for more information on proposed research activities.

Alternative 4

Alternative 4 is a modification of the Alternative 2. All mechanical treatments described in Alternative 2 would occur although no 16 inch DBH or greater trees would be thinned. All prescribed burning, transportation system management proposals, and dispersed camping designation described in Alternative 2 would otherwise occur.

Figure 2-5. Map of Proposed Management Activities Under Alternative 3

Items Common to all Alternatives

Treatment Timeframe

The processes of fuel reduction and forest restoration are ongoing events. Restoration of a fire-adapted ecosystem will not be conducted in one treatment; rather numerous treatments would be required over time to restore lands in an adaptive and gradual manner. Mechanical treatment would occur first, followed by prescribed fire and subsequent maintenance burns. Thinning treatments in most areas will be effective for 20-25 years before additional mechanical thinning may be required.

Project Design Features and Mitigation Measures

The analysis documented in this EA discloses the possible adverse and beneficial impacts that may occur from implementing the actions proposed under each alternative. Measures have been formulated to mitigate or reduce adverse impacts. Applicable Forest Plan standards and guidelines, Best Management Practices, and Forest Service Manual and Handbook direction will be incorporated in project design and implementation. The following features are design elements that further detail management actions, mitigate environmental consequences, and establish priorities for implementation.

Soils and Watershed

- Best Management Practices (BMPs) will be incorporated into activities as a means to prevent or reduce the amount of pollution generated by non-point sources to a level compatible with water quality goals. Best Management Practices will be incorporated into applicable thinning, burning, and road management activities and are located in the Project Record.
- Specific BMPs are listed in Appendix E – Best Management Practices.

Wildlife Protection

Mexican Spotted Owl

- No thinning or burning will occur within the 100-acre nest stand of the Protected Activity Center (PAC).
- Pre- and post-treatment occupancy monitoring will be conducted in the PAC.
- MSO restricted habitat will be surveyed in the project the year of implementation or one year prior to implementation.
- In protected and restricted habitat where treatments are planned, pre- and post-treatment monitoring will be conducted to determine changes and trajectories in fuel levels; snag basal areas; live tree basal areas; volume of down logs over 12 inches in diameter; and basal area of hardwood trees over 10 inches in diameter at root collar.
- Mechanical thinning and broadcast burning will not occur within the PAC during the breeding season (March 1 to August 31).

- All prescribed burning activities inside the PAC including snag and log lining, line preparation, layout, and burning will be conducted outside MSO breeding season.

Bald Eagle

- Prescribed burning will not occur within a two-mile radius of an occupied nest site during the bald eagle breeding season (Jan 1- Aug 31)
- No Jake break use will be allowed and a 20 mph speed limit will be maintained within ¼ mile of the nest site.

Northern Goshawk

- Thinning and hauling within occupied northern goshawk PFAs will not occur during the breeding season (March 1 – September 30).
- Prescribed burn plans for the nest areas will minimize smoke impacts to nesting birds and minimize loss of nest trees.

Coopers's Hawk

- No thinning will occur within 15-acre buffers around Cooper's hawk nest sites located in sites 348/01 and 14, and 357/05.

Turkey

- There are 10 turkey roosts identified within the project area. An additional 6 potential roost trees will be identified prior to thinning treatments. These roost trees will not be thinned and duff and debris will be raked away from the base of roost trees prior to broadcast burning where litter depth layers are greater than 4 inches.
- Scattered patches of untreated slash will be left within one-half mile of dependable water sources for turkey nesting.

Wildlife Cover

- Maintain hiding cover at least 200 feet wide around known dependable waters in the area.
- No thinning will occur in the two known elk calving areas in location/sites 358/08 and 358/06 between May 15 and June 30.

Snags and Logs

- After burning each designated block, trees may be felled (approximately 12 inches DBH in size), to replace logs burned up during the prescribed fire to meet forest plan guidelines.
- Snags 18 inches in diameter and larger and 3 logs 12 inches midpoint diameter per acre will be fire lined before broadcast burning.

Vegetation Treatment

- Trees greater than 24 inches DBH will not be thinned.
- No yellow pines will be thinned. Old 'yellow barked' pine trees will have duff raked away from the bases where high litter depth (greater than 12 inches) may result in girdling and mortality.
- One group of reserve trees, with 3-5 trees per group, will be left per acre in openings greater than an acre in size.
- No oaks will be thinned. Oak mortality will be mitigated for in burn plans by raking duff from the base of large oaks (greater than 10 inches DRC) and not placing slash piles near oaks.
- Best locations for openings include but are not limited to: soils identified with TES that would promote the best revegetation/regeneration; areas with dwarf mistletoe infection; areas with genetically undesirable "apple" trees; clusters of low-vigor trees likely to die or deteriorate; areas with excess numbers of trees with similar diameters; and places where cutting would enhance wildlife habitat values.
- Openings will be irregular in shape and be no greater than 200 feet in width.
- Thinning activities should be conducted during the appropriate seasons to reduce the spread of bark beetles.

Aspen

- No prescribed burning will occur in aspen stands in Priest Draw. Precautions will be taken during prescribed burning to prevent damage to aspen exclosure fences.

Slash Treatment

- Piles shall be so located that burning will minimize damage standing live trees, snags, down logs, sensitive plants or physical improvements such as fences, poles, signs, and cattle guards.
- Large logs (greater than 12 inches) that exist on the landscape prior to treatment will not be piled during slash treatment.
- Where possible, piles will be located on old pile sites or previously used decking areas instead of creating new sites.

Sensitive Plants

- Slash piles, fire lines, and temporary road construction activities, and landing sites will not occur within identified populations of *Hedeoma diffusum*.

Non-Native and Invasive Weeds

- Best Management Practices as outlined in the *Three Forest Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds* will be followed to incorporate weed prevention and control into the project.
- Treatment equipment will be cleaned before entering treatment areas (not roadways) to prevent introduction of invasive weeds.
- To promote native species and hinder weed species germination, early spring burning is preferred (before May 31) to minimize Dalmatian toadflax reproduction and enhance *Hedeoma diffusum* habitat. Late fall burning is the second most preferable treatment window using a low intensity burn.
- After initial burning, monitoring will occur to assess needs for release of biological control targeting Dalmatian toadflax. Monitoring and release of biological control will follow basic procedures established by APHIS following release.

Recreation

- For public safety, camping will be prohibited within active thinning and burning areas. Thinning activities should be avoided (cutting and hauling) on the following holiday weekends: Memorial Day, Fourth of July, and Labor Day.

Cultural Resource Protection

- Historic and pre-historic cultural resources will be protected during project implementation. All ground-disturbing activities including vehicular use are prohibited within sites. The team archaeologist will flag sites prior to implementation and monitor the sites during burning activities. All sites may be hand thinned to blend in surrounding area treatments.
- Areas where temporary roads will be constructed and where road decommissioning will occur will be inventoried prior to implementation.

Range Management

- Grazing pastures will be made available during thinning activities.

Monitoring

Monitoring activities can be divided into Forest Plan monitoring and project-specific monitoring. The National Forest Management Act requires that National Forests monitor and evaluate their forest plans (36 CFR 219.11). The Forest Plan includes the monitoring and evaluation activities to be conducted as part of Forest Plan implementation. There are three categories of Forest Plan monitoring: Implementation monitoring, effectiveness monitoring, and validation monitoring.

Effectiveness and validation monitoring are not typically done as part of project implementation. Implementation monitoring, and any additional project-specific monitoring, are however important aspects of the project.

Implementation monitoring will assess if the project was implemented as designed and if it complies with Forest Plan direction. Routine implementation monitoring is a part of the administration of all project contracts and involves input from Forest Service specialists.

The Mountainaire HFRA Project will include the following implementation monitoring items:

- Fire-sensitive archeological monitoring for site damage from implementation.
- Habitat monitoring of MSO Protected, Restricted, and Target/Threshold Habitat to determine effectiveness of treatments in meeting habitat objectives.
- Fuels monitoring will occur after burning operations to determine if expected fire effects and fuel levels are achieved.
- Noxious weeds monitoring will occur to assess needs for biological control of dalmation toadflax.

Other monitoring activities that the GFFP Monitoring and Research Team develop may be conducted as part of this project if funding and/or volunteer assistance is provided by GFFP or other interested parties.

Comparison of Alternatives

This section compares outputs, objectives, and effects of the Proposed Action and alternatives for the Mountainaire HFRA project. The discussions of effects are summarized from Chapter 3, which should be consulted for a full understanding of these and other environmental consequences. Tables 2-4 and 2-5 provide an overview comparison of information from the alternative descriptions and Chapter 3 relevant to the issues.

Table 2-4. Comparison of Management Practices by Alternative

Practice	Alt. 1 No Action	Alt. 2 Proposed Action	Alt. 3	Alt. 4
Mechanical treatment (acres) Thin-from-below	0	3,448	3,448	3,859
Mechanical treatment (acres) Uneven-age thin	0	7,527	6,689	7,116
Mechanical treatment (acres) Full Restoration thin – based on historical evidences (wildlife research proposal area)	0	0	610	0
Mechanical treatment (acres) Restoration thin – grassland/savannah areas based on existing conditions	0	2,805	2,805	2,805
Meso-reserve wildlife areas	0	0	228	0
Initial Prescribed burning (acres)	0	15,173	15,173	15,173
Maintenance Burning (acres)	0	15,173	15,173	15,173
Temporary road construction and decommisioning	0	1.3 miles 3 segments	1.3 miles 3 segments	1.3 miles 3 segments

Table 2-5. Comparison of Management Effects by Alternatives

Environmental Effects	Alt. 1 No Action	Alt. 2 Proposed Action	Alt. 3	Alt. 4
Silvicultural Effects				
Canopy Cover (cc)	2,514 acres 0-40% cc 6,559 acres 40-60% cc 5,733 acres 60%+ cc	10,679 acres 0-40% 3,271 acres 40-59% cc 299 acres 60%+ cc	10,629 acres 0-40% cc 3,103 acres 40-60% cc 517 acres 60%+ cc	10,679 acres 0-40% cc 3,170 acres 40-60% cc 400 acres 60%+ cc
Acres of Uneven-Age Class	3,274	7,461	7,233	5,095
Acres of Even-Age Class	7,602	3,415	3,643	5,781
Competition to Yellow Pines and Oaks	Continuing at current levels and increasing over time w/ increased densities	Decreasing over 14,300 acres for approximately 20-40 years	Decreasing over 14,100 acres for approximately 20-40 years	Continuing at slightly reduced levels over 2,241 acres and increasing with increased densities; decreasing over 12,010 acres for 20-40 years
VSS Class Distribution (acres)	VSS 1 – 5% VSS 2 – 1% VSS 3 – 25% VSS 4 – 57% VSS 5 – 12% VSS 6 – <1%	VSS 1 – 20% VSS 2 – 0% VSS 3 – 9% VSS 4 – 43% VSS 5 – 28% VSS 6 – <1%	VSS 1 – 20% VSS 2 – 0% VSS 3 – 9% VSS 4 – 42% VSS 5 – 29% VSS 6 – <1%	VSS 1 – 15% VSS 2 – 0% VSS 3 – 9% VSS 4 – 48% VSS 5 – 27% VSS 6 – <1%
Acres with Maximum Percent SDI >35%	7,904	1,590	1,818	1,835
Openings – Size and Acres	Few openings greater than ½ acre over 14,251 acres	20% openings ½ to 4 acres in size over 14,251 acres	20% openings ½ to 4 acres in size over 14,023 cres	0-5% openings ½ acre in size over 2,241 acres; 20% openings ½ to 4 acres in size over 12,010 acres
Understory Development	Continuing at current levels and decreasing over time w/ increased densities	Increasing over 10,679 acres for 20-40 years	Increasing over 10,629 acres for 20-40 years	Increasing over 8,438 acres for 20-40 years
Total trees removed for uneven-age management and canopy cover objectives	0	1,507,300	1,505,100	1,503,250

Environmental Effects	Alt. 1 No Action	Alt. 2 Proposed Action	Alt. 3	Alt. 4
Large trees (16-20 inches DBH) removed for uneven-age management and canopy cover objectives	0	9,550	11,050	0
Estimated residual number of trees between 16-18 inches DBH after treatment[3]	115,400	106,600	105,500	115,400
Estimated residual number of trees greater than 16 inches DBH after treatment	256,800	247,200	243,850	256,800
Fire and Fuel Effects				
Fire Hazard Rating (number of acres with a Low rating)	8,256	15,724	15,590	15,724
Height to Live Crown	1' – 44'	5' – 44'	5' – 44'	5' – 44'
Tree Mortality from fire	9 – 99%	4 – 31%	4 – 31%	4 – 31%
Fuels (tons/acre)	1 – 12 tons/acre	3 – 7 tons/acre	3 – 7 tons/acre	3 – 7 tons/acre
Critical Flame lengths	1' – 17'	8' – 17'	1' – 17'	8' – 17'
Probability of Exceeding Emission Standards (if burned)	Likely	Unlikely	A few sites likely to exceed	A few sites likely to exceed
Visual and Scenic Resource Effects				
Visual Quality Obejective met	Yes	Yes	Yes	Yes
Watershed and Soil Effects				
Soil Quality and Productivity	No Impact	Minor Impacts	Minor Impacts	Minor Impacts
Sedimentation and Runoff Potential	No Potential	Little Potential	Little Potential	Little Pontential
Wildlife Effects				
Abert Squirrel Nesting Habitat High Quality/ Low Quality in acres	4,048/8,876	3,724/9,200	3,764/9,160	3,724/9,200
PAC Thinning - acres	0	147	147	147
Fire Hazard Rating in PAC (number of acres with low rating)	0	265	265	265
Fire Hazard Rating in MSO Restricted habitat (number of acres with low rating)	0	2,156	2,156	2,156
Acres of Wildlife Cover in Fire Management Analysis Zone	7,447	4,028	4,528	4,382
Acres of Wildlife Cover Outside Fire Management Analysis Zone	1,158	1,111	1,111	1,182
Estimated Loss of Snags	0%	20%	20%	20%
Acres of Elk Calving Habitat	275	275	275	176

[3] These residual numbers do not account for large trees thinned to meet other objectives such as the creation of openings, dwarf mistletoe reduction, savannah and grassland restoration, and yellow barked pine and oak protection.

Environmental Effects	Alt. 1 No Action	Alt. 2 Proposed Action	Alt. 3	Alt. 4
Prey base habitat for northern goshawk and Mexican spotted owl linked to understory diversity	Low	High	Highest	Moderate
Transportation System Effects				
Open system roads - miles	75.5	47.7	47.7	47.7
Closed system roads (but still used by the public)	12.2	0	0	0
User-created/Social non-system roads	18.6	0	0	0
Administratively closed roads (gated)	.4	3.3	3.3	3.3
Total Road Milage	106.7	51	51	51
Road Densities	3.88 miles/square mile	2	2	2
Recreation Effects				
Dispersed camping areas	0	2	2	2

Chapter 3 - Affected Environment and Environmental Consequences

This chapter provides information concerning the affected environment of the Mountainaire HFRA project area, and potential consequences to that environment. It also presents the scientific and analytical basis for the comparison of alternatives presented in Chapter 2. All effects, including direct, indirect and cumulative effects, are disclosed. Effects are quantified where possible, and qualitative discussions are also included. The means by which potential adverse effects will be reduced or mitigated are described (see also Chapter 2 and Appendix E – *Best Management Practices*).

The discussions of resources and potential effects take advantage of existing information included in the Coconino Forest Plan's FEIS, Mountainaire Project Need for Change Report, and project-specific resource reports and related information in the Project Record. Where applicable, such information is briefly summarized and referenced to minimize duplication. The Project Record for the Mountainaire HFRA project includes all project-specific information, including resource reports, the watershed analysis, and other results of field investigations.

Vegetation

Affected Environment

The project area consists of a total of 16,569 acres, with 15,237 acres of National Forest land and 1,332 acres of private land. Vegetation cover types within the project area include ponderosa pine (13,971 acres), aspen (15 acres), and meadows (1,252 acres). Approximately 84% of Forest Service lands within the project area are classified as Management Area 3 - Ponderosa Pine and Mixed Conifer Greater than 40% Slopes. Management Areas under the Flagstaff/Lake Mary Ecosystem Analysis (USDA Forest Service 2002) include the Lake Mary Watershed Management Area (9,975 acres) and the West Management Area (5,370 acres). There are several tanks and ephemeral streams throughout the project area which support perennial riparian vegetation. Lower Lake Mary is directly adjacent to the eastern portion of the project area. A forest of young to mid-aged ponderosa pine trees with a moderately closed to closed canopy forms a homogenous structure throughout most of the project area.

The majority of the project area consists of sandy loam and cobbly, clay loam soils. Over 90% of Forest Service lands within the project area have a high regeneration potential, while over 80% has a moderate to high revegetation potential. Approximately 87% of Forest Service lands have a slight to moderate erosion hazard. Nearly half of the Forest Service lands have a moderate to severe windthrow hazard.

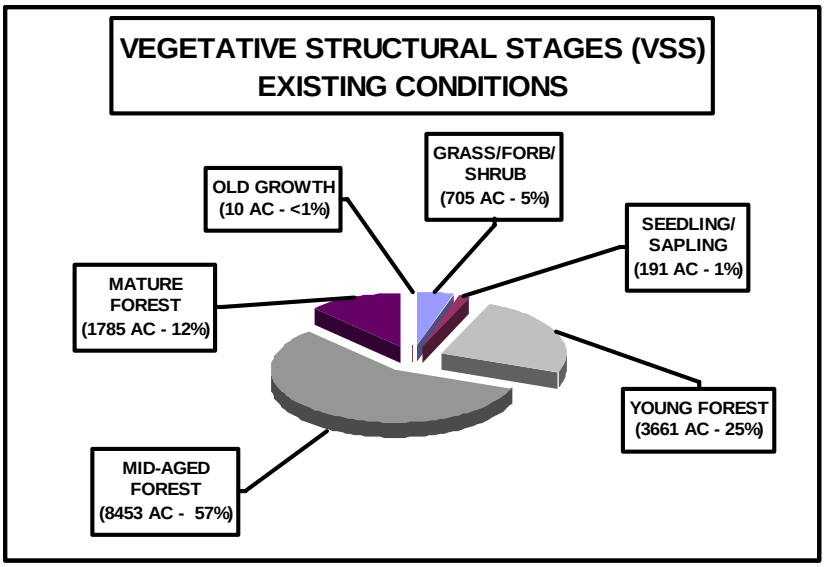
Age and Size Classes

Age and size classes for forest structure are often described by Vegetative Structural Stage (VSS) classes. Classes are determined by calculating the basal area within each diameter class. The VSS class with the highest calculated square foot basal area is the assigned structural stage for the site. The grass/ forb/shrub stage (VSS 1) consists of non-stocked openings and trees 0-1 inch diameter

at breast height (DBH). The seedling/sapling stage (VSS 2) consists of trees 1-5 inches DBH. The young forest stage (VSS 3) consists of trees 5-12 inches DBH. The mid-aged forest stage (VSS 4) consists of trees 12-18 inches DBH. The mature forest stage (VSS 5) consists of trees 18-24 inches DBH. The old-growth forest stage (VSS 6) consists of trees greater than 24 inches in diameter.

Currently, 57% of forested Forest Service land within the project area is mid-aged forest, while less than 1% is old-growth forest. Seedlings/saplings represent 1% of forested land within the project area. Approximately 8% of Forest Service land is classified as meadows. Existing Vegetative Structural Stages (VSS) by acres and percent of forested Forest Service land within the project area are illustrated in Figure 3-1. Meadows are not subject to VSS designations.

Figure 3-1. Existing Vegetative Structural Stages (VSS) by Acres and Percent of Forested Forest Service Land.



Existing crown canopy covers by acres and percent of forested Forest Service land within the project area are illustrated in Figure 3-2. Canopy cover is the percentage of the ground area that is directly covered with tree crowns. Canopy cover values were obtained from the Forest Vegetation Simulator. Stands are considered “open” if canopy cover ranges between 0 to 39%. Stands are considered “moderately closed” if canopy cover ranges between 40 to 59%. Stands are considered “closed” if canopy cover is 60% or greater.

Only 17% of the forested Forest Service land within the project area is considered to have an “open” canopy structure, whereas 83% is “moderately closed” or “closed.” According to vegetation management guidelines in the Forest Plan for landscapes outside of Northern goshawk post-fledging family areas, canopy cover for VSS 4, 5, and 6 should average 40+% (USDA Forest Service 1996). Currently, average crown canopy cover is 54% in VSS 4, 42% in VSS 5, and 48% in VSS 6 stands.

Figure 3-2a displays Forest ERA data for canopy cover across the project area. Forest ERA data is fairly consistent with canopy cover data obtained from stand exam and the Forest Vegetation Simulator in that the majority of the project area consists of "moderately closed" canopies.

Uneven and Even Aged Forest Structure

Throughout this document, the terms "sustainability" and "uneven-aged" are used repeatedly. The Dictionary of Forestry defines "sustainability" as "the capacity of forests, ranging from stands to ecoregions, to maintain their health, productivity, diversity, and overall integrity, in the long run, in the context of human activity and use." "Uneven-aged" is defined as an age arrangement in which the trees differ markedly in their ages. An uneven-aged stand, ideally, contains at least three age classes (Nyland 1996). An uneven-aged forest structure results in vertical stratification of the forest canopy. Canopy structure affects photosynthetic capacity, growth, productivity, and carbon dioxide exchange, controls microclimate in the understory, regulates inputs, such as precipitation and sunlight, to the forest floor, and creates habitat or vertical niches for many organisms. An uneven-aged forest canopy with a well-stratified vertical structure will support a more diverse biota than an even-aged canopy, resulting in increased biological diversity (Hunter 1990). Because many insects favor trees within a certain diameter range, uneven-aged stands tend to be more resilient to insect attack and mortality due to a diversity of age and size classes. Prior to Euro-American settlement, ponderosa pine forests in the southwest were uneven-aged.

Figure 3-2. Existing Crown Canopy Cover by Acres and Percent of Forested Forest Service Land.

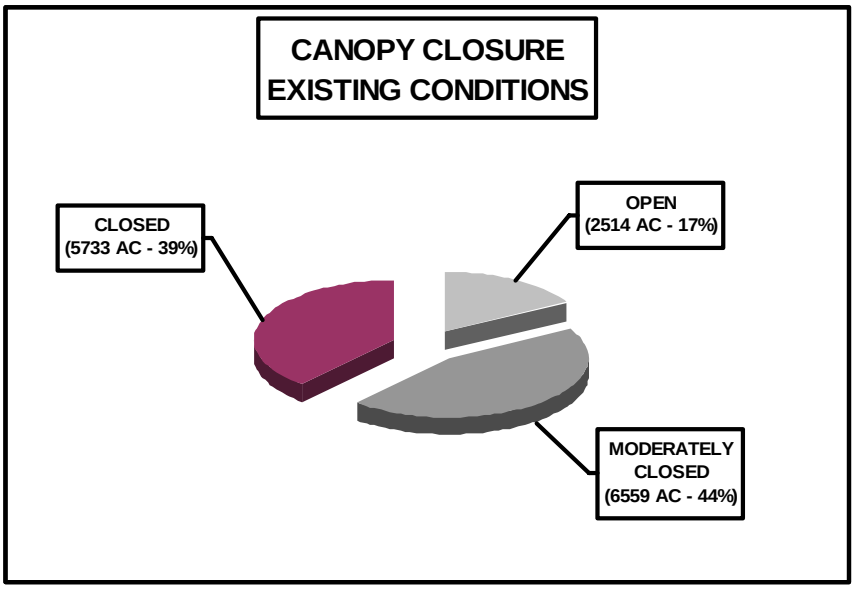
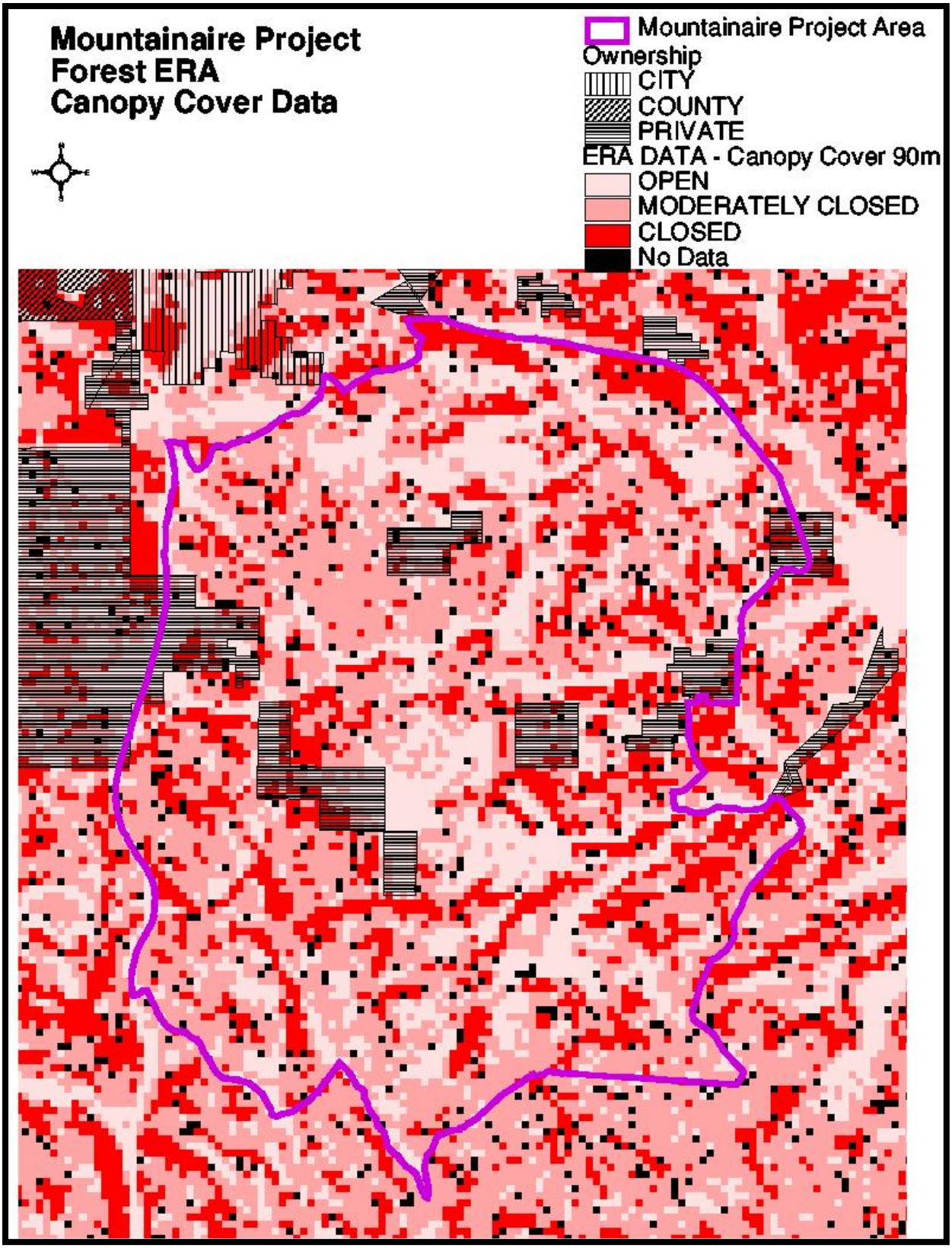


Figure 3-2a. Forest ERA Canopy Cover Data for the Mountainaire HFRA Project Area.



During the railroad logging era and subsequent high-grade timber harvesting, much of the older age classes were removed. In 1919, an unprecedented regeneration event occurred, resulting in massive amounts of pine seedlings. Due to fire suppression, these seedlings continued to grow in dense stands, forming a closed canopy across much of the landscape and effectively inhibiting much further regeneration of shade-intolerant ponderosa pine. As a result of these factors, ponderosa pine forests of the southwest are now predominantly "even-aged" or "two-aged", with few trees less than 5 inches DBH or greater than 24 inches DBH. "Even-aged" is defined as an age arrangement in which the trees have only small differences in their ages (Nyland 1996). Even-aged stands, such as lodgepole pine, are sustained ecologically through either catastrophic events, such as stand-replacing fire, or through management actions that mimic stand-replacing events, such as clear-cutting.

Site Density

Average trees per acre, basal area, canopy cover, and quadratic mean diameter by Vegetative Structural Stage (VSS) are displayed in Table 3-1. Because values can range dramatically within VSS classes, the values in Table 3-1 are expressed as ranges, with a weighted average in parentheses to provide a more accurate picture of stand density conditions. Across the majority of the project area, stand densities are over 200 trees per acre with basal areas greater than 90 ft^2 per acre. High stand densities result in intense competition between trees for moisture, nutrients, and sunlight, decreased tree vigor, increased susceptibility to successful bark beetle attack and mortality, decreased diameter growth, decreased "yellow" pine longevity, decreased natural regeneration, and decreased understory productivity. Eventually, those trees that are out-competed will die, resulting in increased fuel loading, increased fire hazard, and increased risk of bark beetle attack to residual trees.

Table 3-1. Stand Density Chacteristics by Vegetative Structural Stage (VSS).

VEGETATIVE STRUCTURAL STAGE	ACRES	TREES PER ACRE	BASAL AREA (SQ FT / AC)	CANOPY COVER (%)	QUADRATIC MEAN DIAMETER (INCHES)
1	705	ND	ND	ND	ND
2A	39	ND	ND	ND	ND
2B	153	ND	ND	ND	ND
3A	412	147-368 (279)	51-69 (62)	34-42 (38)	5.7-8.0 (6.7)
3B	1,603	89-758 (246)	55-116 (91)	41-62 (52)	5.2-11.2 (8.5)
3C	1,645	154-390 (276)	98-152 (130)	59-72 (65)	7.8-12.3 (9.4)
4A	1,195	38-296 (177)	23-72 (44)	16-41 (28)	4.0-14.9 (8.3)
4B	3,885	62-659 (194)	68-118 (97)	39-60 (52)	5.2-16.3 (10.4)
4C	3,374	106-789 (280)	117-287 (155)	60-89 (69)	5.5-15.0 (10.7)

VEGETATIVE STRUCTURAL STAGE	ACRES	TREES PER ACRE	BASAL AREA (SQ FT / AC)	CANOPY COVER (%)	QUADRATIC MEAN DIAMETER (INCHES)
5A	163	72-285 (182)	45-67 (57)	27-39 (34)	6.6-10.7 (8.1)
5B	908	58-867 (406)	80-115 (99)	44-57 (52)	4.9-15.9 (10.0)
5C	714	138-172 (161)	117-132 (122)	58-60 (59)	11.2-13.2 (11.8)
6B	10	54	120	55	20.2

*ND = No data available. Values are expressed as ranges, with a weighted average in parentheses.

Percent of maximum stand density index (SDI) for forested stands located within the project area is displayed in Table 3-2. Currently, only 18% of forested Forest Service lands within the project area are below 25% maximum SDI. Approximately 53% of the forested stands have densities above 35% of the maximum SDI, suggesting that over half of the stands within the project area are experiencing significant inter-tree competition. At these densities, individual trees exhibit reduced tree growth and vigor due to competitive stress. Unless the number of trees is reduced, individual stand densities will eventually approach the maximum stand density, with imminent, competition-based mortality occurring at approximately 50% to 60% of the maximum SDI. These maximum stand densities are not ecologically sustainable and are at high risk for successful bark beetle attack and mortality. Above 60% of the maximum SDI, individual trees exhibit very little or no growth due to a lack of adequate moisture, nutrients, and sunlight. Stands are at extreme risk of successful bark beetle attack and mortality and stand-replacing fire.

Table 3-2. Percent of Maximum Stand Density Index for Forested Sites.

Percent Maximum Stand Density Index (SDI)	Acres	Percent of Foreted Forest Service Lands
0-24%	2,625	18
25-34%	4,277	29
35-59%	6,848	46
60%+	1,056	7

Forest Health

The severity of dwarf mistletoe infection (*Arceuthobium vaginatum subsp. cryptopodum*) for the project area is displayed in Table 3-3. Dwarf mistletoe (DM) is a parasitic plant that infects ponderosa pine. Infection is spread via pressure-released seeds and expands at a rate of 1-2 feet per year (Conklin 2000). Dwarf mistletoe is considered a tree pathogen because infection results in reduced tree growth, reduced tree vigor, branch deformations, and shortened life span of the infected host. Additionally, in comparison to uninfected trees, trees infected with DM are more flammable due to the accumulation of resin and branch deformations (Conklin 2000). Since Euro-American settlement and the advent of fire suppression, DM populations in the southwest are thought to have increased with increased forest densities (Conklin 2000). A more open, park-like forest structure would have limited the spread of DM infection. Currently, twenty-three stands

within the project area contain some level of DM infection. Dwarf mistletoe infection is rated on an individual tree basis on a scale of 0 to 6, with 0 representing no infection and 6 representing a tree that is severely infected. For this project, DM infection across an entire stand was considered "severe" if the mean dwarf mistletoe rating (DMR) for the stand was 2.0 or greater. Dwarf mistletoe infection was considered "moderate" if the mean DMR for the stand was between 1.0 and 1.9. Dwarf mistletoe infection was considered "light" if the mean DMR for the stand was less than 1.0. Within the project area, two sites are severely infected, two sites are moderately infected, and nineteen sites are lightly infected with DM. Dwarf mistletoe infection ranges from 35 to 177 trees per acre in moderately to severely infected sites. Mortality ranges from 7 to 19 trees per acre in moderately to severely infected sites.

Table 3-3. The severity of dwarf mistletoe infection within the project area.

DWARF MISTLETOE SEVERITY	ACRES	MEAN DWARF MISTLETOE RATING (DMR)	TREES PER ACRE INFECTED WITH DM	TREES PER ACRE MORTALITY FROM DM
LIGHT 0-0.9	2,311	0.3	4 - 65	0 - 4
MODERATE 1.0-1.9	213	1.1	35 - 132	7
SEVERE 2.0+	352	2.3	111 - 177	17 - 19

High stand densities and SDI within certain portions of the project area signify moderate to high inter-tree competition and decreased tree vigor. Natural defense mechanisms against insect attack, such as the production of pitch, are limited at these densities, resulting in increased susceptibility to successful bark beetle attack and mortality. Currently, bark beetle activity within the project area is limited to pockets of mortality within stands of higher densities.

Species Diversity

Aspen

Aspen comprises approximately 15 acres within the project area. Approximately 12 acres of aspen are located in the eastern portion of the project area in Priest Draw. These aspen stands are relatively young in age and are currently exhibiting a combination of symptoms, including reduced crown canopies, high tree mortality in the overstory, encroachment of ponderosa pine, and browsing damage from elk. Aspen seedlings/saplings are present in large numbers throughout most of the stands in Priest Draw, however browsing damage by elk is evident. An additional 3 acres of aspen is located in the southern portion of Howard Draw. This aspen stand consists of less than five trees and is relatively old and decadent. No aspen regeneration was noted in this stand.

Gambel oak

The majority of stands containing 10 sq ft basal area of Gambel oak or greater (restricted habitat) are located in the southern portion of the project area within the ponderosa pine cover type. Due to the proximity of the project area to Flagstaff, Mountainaire, and numerous parcels of private property and a history of illegal wood cutting, the majority of existing Gambel oak consists of small, young thickets with numerous stems. The majority of oak within the project area are less

than 10 inches diameter at root collar (DRC). On average, there is only 6 Gambel oak per acre greater than 10 inches DRC. Additionally, existing Gambel oak is being heavily browsed by elk.

Understory Vegetation

Data was not collected on understory biomass within the project area. However, research at the Fort Valley Experimental Forest has shown that massive declines in herbaceous vegetation have occurred over the past century due to increased stand densities, increased canopy covers, and increased forest floor depth (Covington et al 1997). Visual assessments conducted within the project area concur with current research findings in that understory productivity is low, especially in areas with “closed” and “moderately closed” canopies.

Grasslands and Savannahs

Approximately 1,481 acres within the project area are classified as meadows by Terrestrial Ecosystem units. Approximately 1,800 acres within the project area are classified as pine savannahs based on their historic low densities of ponderosa pine, and their locations adjacent to grasslands. Within the project area, over 3,000 acres of meadows and savannah areas were reforested during the 1980s. Mortality within planted areas approached 50%. Plantations located in areas with low site productivity contain trees with heights ranging from 1 – 10 feet. Additionally, grasslands and savannahs have been experiencing pine encroachment for over 100 years due to fire suppression. In some areas, encroaching pine trees have reached diameters greater than 16 inches DBH, but due to poor site productivity, tree heights are much lower than those normally associated with trees of these diameters.

Environmental Consequences

Effects Common to All Alternatives

Aspen

Under all alternatives, the aspen stands located within the project area would continue to suffer from elk browsing, resulting in decreased regeneration, decreased growth, decreased health and vigor, increased mortality, pine encroachment, and eventual conversion of aspen to ponderosa pine or grassland. No treatment within the aspen stands would be an eventual type conversion from aspen to ponderosa pine or grassland and a further loss of genetic diversity between aspen clones. Additionally, aspen are a relatively thin-barked hardwood adapted to stand-replacing fire. Typically, fires of moderate intensity result in mortality of the overstory and regeneration of seedlings off of extensive root systems. Under all alternatives, aspen stands within Priest Draw will not be prescribed burned in order to protect the young aspen seedlings and saplings from fire-related mortality.

Alternative 1

Age and Size Classes

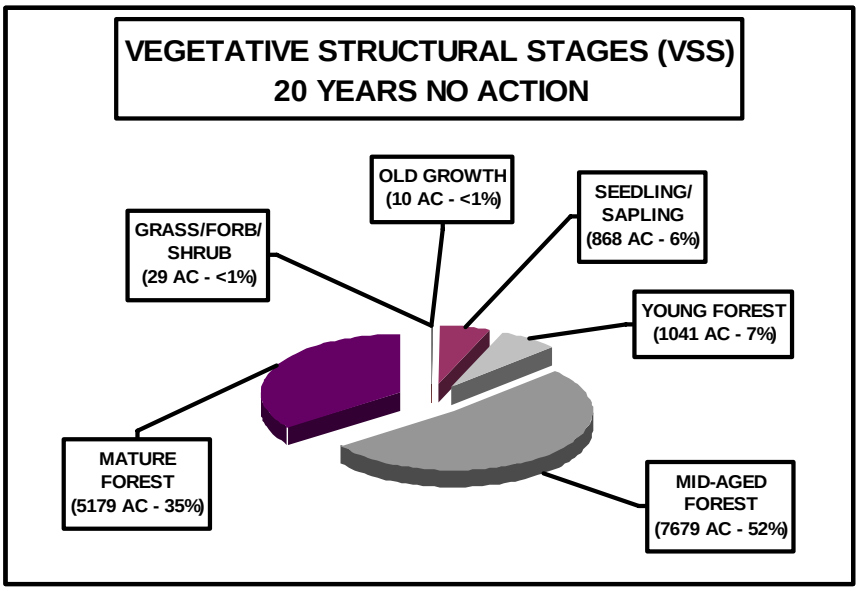
Vegetative Structural Stages by acres and percent of project area under Alternative 1 are displayed in Figure 3-3. Under Alternative 1, 45% of the forested acres within the project area would be

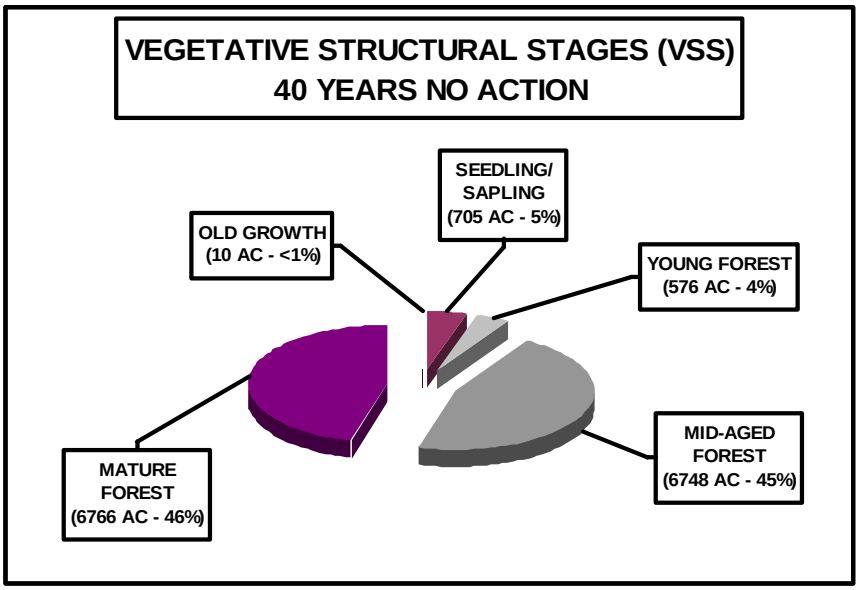
mid-aged forest within 40 years while 46% would be mature forest. Seedling/sapling and young forest would represent less than 5% of the forested acres and would mostly occur on inadequate sites in meadows that were planted in the 1980s. Seedling/sapling VSS classes within forested sites would be severely limited due to a lack of openings of adequate size in which pine seedlings can regenerate. The grass/forb/shrub stage would exist in limited amounts as small openings within forested areas and would decrease over time as tree canopies extend and close. Trees would grow into larger diameter classes and VSS classes at a much slower rate due to high stand densities and high competition between trees, resulting in stagnation of VSS classes and slower development of old growth forest structures.

Trees reaching maturity and changing their appearance from black bark to yellow bark will still occur at approximately 150 to 200 years old, but they will have smaller diameters than we usually associate with old trees, depending on density conditions within the site. Smaller diameter trees will continue to out-compete and crowd out the remaining older yellow pine and oak trees, resulting in decreased growth, vigor, and longevity. There will be few replacement trees of large diameter size into the yellow pine category for 50 to 100 years. Without openings of sufficient size for regeneration of shade-intolerant ponderosa pine and with limited old forest development, the recommended VSS distribution for the northern goshawk and a sustainable, uneven-aged forest structure would not be achieved in the foreseeable future. Forest structure would be predominantly even-aged or two-aged for decades into the future.

Crown canopy covers by acres and percent of project area under Alternative 1 are displayed in Figure 3-4. Within 20 years, 49% of the project area would have closed canopy conditions while only 14% would be “open.” Within 40 years, closed canopy conditions would increase to 58% of the project area, while open crown canopy conditions would decrease to 9%. Closed crown canopy conditions would continue to inhibit understory development, productivity, and diversity. Due to the shade-intolerance of ponderosa pine, natural regeneration would be severely limited under a closed canopy, resulting in a lack of VSS 1 and 2 classes. Mortality of smaller, over-topped black-barked pines would increase as stand densities increase, resulting in increased risk of bark beetle attack to residual trees.

Figure 3-3. Vegetative Structural Stages by Acres and Percent Under Alternative 1.

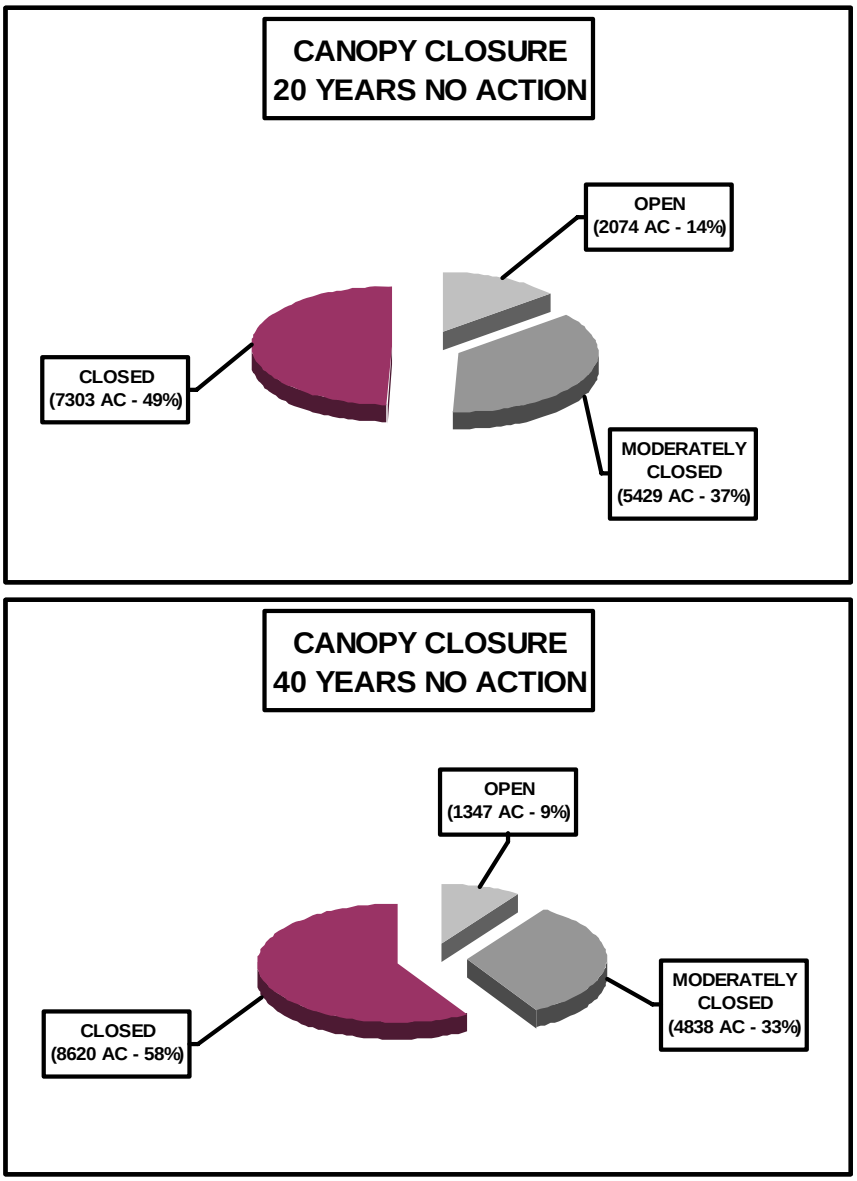




Site Density

Table 3-4 displays the estimated stand conditions under Alternative 1 projected over 40 years, including trees per acre, basal area, and canopy cover. Nearly 50% of the project area would have basal area values in excess of 150 square feet per acre within 40 years. Canopy cover values would also continue to increase over time, with nearly half of the project area exceeding 60% within 20 years. As a result of these high stand densities, quadratic mean diameter would continue to increase at a slower rate for a minimum of 40 years. Trees would move into larger diameter classes and VSS classes at a slower rate. Trees per acre would decrease over the next 40 year period due to competition-based mortality.

Figure 3-4. Canopy cover by Acres and Percent Under Alternative 1.



Stand Density Index

One of the major factors affecting stand structure and development, specifically the rate at which individual trees grow and advance through successional stages is inter-tree competition. "Competition" refers to density-related scarcity of one or more environmental factors necessary for growth, such as moisture, nutrients, and sunlight (Long 2005). Early in stand development and prior to crown canopy closure, individual trees are growing at their full potential due to a lack of competition with other trees. As stand development advances, relative densities increase as the size of individual trees increase and the crown canopy begins to close. Individual trees begin to experience some competitive interaction with other trees and self-pruning of lower branches begins. At this stage in stand development, individual trees begin to exhibit height growth differentiation due to genetics, microsite differences, and damage caused by biotic and abiotic

factors. As stands continue to develop, competition between trees continues to increase as trees increase in size. Growth rates for individual trees decrease as competition increases. Eventually, stands near the point of full site occupancy and self-thinning occurs due to competition-based mortality. At this stage of stand development, trees are growing at much less than full potential. Tree vigor is compromised and the risk of insect attack and mortality is high. One way in which to quantify stand development and the level of inter-tree competition is through Stand Density Index (SDI). SDI is a relative measure of stand density based on the number of trees per acre and the mean diameter (Reineke 1933). SDI expresses the actual density in a stand relative to the theoretical maximum density possible for trees of that diameter and species. SDI is useful in maintaining sustainable forest conditions because it can be used to measure competition thresholds, which are very important in a moisture-limiting system.

Table 3-5 displays percent of maximum stand density index by acres and percent of forested Forest Service lands within the project over 40 years. Within 40 years, only 7% of forested Forest Service lands within the project area would be at less than 25% of maximum SDI. Approximately 86% would be at or above 35% of maximum SDI within 40 years. Inter-tree competition increases significantly at these densities. Individual trees exhibit reduced tree growth and vigor due to competitive stress.

Table 3-4. Estimated Post-Treatment Conditions Under Alternative 1.

Proposed Treatment	Acres	Year	Alternative 2				Alternative 1			
			Trees per Acre	Basal Area	Canopy Cover	Quadratic Mean Diameter	Trees per Acre	Basal Area	Canopy Cover	Quadratic Mean Diameter
ASPEN - NO BURNING	15	EXISTING	ND	ND	ND	ND	ND	ND	ND	ND
		+20 YEARS	ND	ND	ND	ND	ND	ND	ND	ND
		+40 YEARS	ND	ND	ND	ND	ND	ND	ND	ND
GRASSLAND/SAVANNAH RESTORATION	2,805	EXISTING	ND	ND	ND	ND	ND	ND	ND	ND
		+20 YEARS	ND	ND	ND	ND	ND	ND	ND	ND
		+40 YEARS	ND	ND	ND	ND	ND	ND	ND	ND
BURN ONLY	1,476	EXISTING	35-368 (153)	43-142 (83)	29-60 (45)	5.7-18.5 (11.1)	35-368 (153)	43-142 (83)	29-60 (45)	5.7-18.5 (11.1)
		+20 YEARS	34-354 (146)	65-170 (106)	37-66 (53)	7.3-21.5 (12.9)	34-354 (146)	65-170 (106)	37-66 (53)	7.3-21.5 (12.9)
		+40 YEARS	32-341 (140)	81-190 (126)	42-77 (59)	8.6-23.6 (14.4)	32-341 (140)	81-190 (126)	42-77 (59)	8.6-23.6 (14.4)
THIN FROM BELOW TO 40% CC	2,919	EXISTING	32-120 (63)	61-78 (71)	38-42 (40)	10.2-20.7 (15.4)	75-499 (199)	85-160 (104)	42-72 (55)	5.8-16.9 (10.7)
		+20 YEARS	44-115 (61)	86-97 (91)	44-51 (47)	12.2-22.9 (17.8)	74-485 (188)	99-179 (131)	46-75 (62)	6.7-19.2 (12.3)
		+40 YEARS	51-111 (61)	96-119 (107)	47-58 (52)	13.7-24.6 (19.6)	73-464 (176)	109-192 (150)	50-77 (66)	7.7-21.1 (13.5)

Proposed Treatment	Acres	Year	Alternative 2				Alternative 1			
			Trees per Acre	Basal Area	Canopy Cover	Quadratic Mean Diameter	Trees per Acre	Basal Area	Canopy Cover	Quadratic Mean Diameter
THIN FROM BELOW TO 50% CC	529	EXISTING	31-113 (77)	86-105 (92)	48-52 (50)	11.8-24.8 (15.5)	54-467 (280)	93-208 (145)	49-78 (66)	7.1-20.2 (10.8)
		+20 YEARS	30-109 (74)	108-160 (121)	51-69 (57)	14.4-25.9 (18.0)	53-441 (255)	111-210 (167)	54-75 (71)	8.0-21.2 (12.2)
		+40 YEARS	29-105 (71)	114-194 (139)	52-75 (61)	16.0-26.9 (19.6)	52-411 (233)	125-208 (180)	58-79 (73)	8.7-22.0 (13.2)
UNEVEN-AGED THIN TO 30% CC	515	EXISTING	31-90 (51)	40-55 (48)	28-32 (30)	9.0-18.2 (13.7)	89-303 (210)	55-122 (102)	36-64 (55)	7.1-13.1 (9.8)
		+20 YEARS	29-88 (54)	65-77 (70)	36-43 (39)	7.2-20.3 (16.5)	87-292 (198)	84-167 (135)	48-74 (64)	9.0-14.5 (11.6)
		+40 YEARS	29-88 (52)	75-102 (88)	39-52 (46)	8.8-22.1 (18.3)	84-275 (182)	108-188 (155)	55-77 (68)	10.3-15.6 (12.9)
UNEVEN-AGED THIN TO 40% CC	5,003	EXISTING	36-788 (128)	59-79 (69)	38-42 (40)	4.5-20.0 (14.3)	58-867 (285)	80-287 (121)	44-89 (60)	4.9-17.0 (10.0)
		+20 YEARS	35-767 (147)	80-130 (93)	43-57 (49)	4.8-23.7 (16.1)	53-828 (258)	79-289 (146)	43-89 (66)	5.5-19.4 (11.5)
		+40 YEARS	35-737 (144)	96-147 (113)	48-68 (55)	5.7-22.6 (17.5)	52-775 (236)	96-285 (163)	49-88 (70)	6.2-21.1 (12.7)
UNEVEN-AGED THIN TO 50% CC	1,829	EXISTING	58-398 (97)	68-97 (92)	48-52 (50)	9.7-17.1 (14.1)	161-467 (242)	74-163 (118)	44-72 (59)	6.9-11.4 (9.6)
		+20 YEARS	56-387 (93)	94-136 (118)	49-61 (57)	11.9-19.1 (16.3)	147-441 (227)	103-185 (143)	55-75 (66)	8.0-12.7 (11.0)

Proposed Treatment	Acres	Year	Alternative 2				Alternative 1			
			Trees per Acre	Basal Area	Canopy Cover	Quadratic Mean Diameter	Trees per Acre	Basal Area	Canopy Cover	Quadratic Mean Diameter
		+40 YEARS	53-375 (89)	111-157 (136)	54-68 (61)	13.6-21.0 (17.9)	140-303 (211)	129-198 (160)	62-78 (69)	8.7-13.5 (12.0)
MSO PAC UNEVEN-AGED THIN TO 50% CC	180	EXISTING	82-95 (97)	96	50	13.6-14.7 (14.3)	195-311 (266)	132-142 (138)	64-68 (66)	9.1-11.1 (9.9)
		+20 YEARS	78-91 (83)	116-119 (117)	56-58 (57)	15.5-16.5 (16.1)	181-285 (245)	155-162 (159)	69-72 (71)	10.2-12.5 (11.1)
		+40 YEARS	75-87 (80)	132-138 (134)	60-62 (61)	17.0-17.9 (17.5)	168-245 (215)	165-171 (167)	72	11.1-13.7 (12.1)

*ND – No data available

Values are expressed as ranges, with weighted average in parentheses

Table 3-5. Percent of Maximum Stand Density Index by Acres and Percent of Forested Forest Service Lands.

Timeframe	Percent MAX STAND DENSITY INDEX (SDI)	ACRES	PERCENT OF FORESTED FS LANDS
20 years	0-24%	2,188	15
	25-34%	1,239	8
	35-59%	8,653	58
	60%+	2,726	18
40 years	0-24%	962	7
	25-34%	1,091	7
	35-59%	9,657	65
	60%+	3,096	21

Imminent, competition-based mortality will occur as individual stand densities eventually approach 50% to 60% of maximum SDI. Approximately half of forested stands would meet or exceed this threshold within 40 years, signifying ecologically unsustainable stand densities. Competitive stress would result in very little or no tree growth or vigor due to a lack of adequate moisture, nutrients, and sunlight. Existing old, “yellow” pines would experience decreased vigor and longevity. Trees in general would be unable to produce pitch to fight off bark beetle attack. Trees would also be more susceptible to attack from other insects and diseases. Within 40 years, over half of the forested lands within the project area will be at extreme risk of successful bark beetle attack and mortality.

Forest Health

Dwarf mistletoe infection would continue to spread throughout infected stands, expanding at a rate of 1-2 feet per year. Increased dwarf mistletoe infection would result in reduced tree growth, reduced tree vigor, branch deformations, and shortened life span of the infected host (Conklin 2000). Reduced tree vigor and altered pitch flow associated with dwarf mistletoe infection would result in compromise of a tree’s defense mechanisms to combat bark beetle attack. Reduced tree growth and shortened life span would result in stagnation of VSS classes. Additionally, the accumulation of resin and branch deformations associated with dwarf mistletoe infection would result in increased fire hazard.

Increased stand densities will result in increased inter-tree competition and decreased tree vigor. Natural defense mechanisms against insect attack, such as the production of pitch, would be limited, resulting in increased susceptibility to successful bark beetle attack and mortality. As stand densities continue to increase over time, those trees that are out-competed would die, thus attracting bark beetles to the project area and further increasing the risk of bark beetle attack to residual trees.

Species Diversity

Oak

Within the southern portion of the project area, pine would continue to compete with Gambel oak for moisture, nutrients, and sunlight, resulting in reduced tree growth, vigor, and longevity. There would be few replacement trees of large diameter size for at least 80 to 100 years.

Understory Vegetation

Understory productivity and diversity would continue to decrease over the next 40 years as stand densities increase and crown canopies close. With a lack of broadcast burning across the project area, understory production would be further inhibited by increasing fuel loads and a lack of nutrient recycling. As grassland and savannah areas continue to experience pine encroachment and increasing densities, understory productivity and diversity would decrease in these areas as well.

Grasslands and Savannahs

Grasslands and savannah areas would continue to experience pine encroachment. As pine increase in density over time, grasslands and savannahs would experience decreased understory productivity and diversity and loss of functionality in terms of hydrology, biodiversity, horizontal heterogeneity, and wildlife habitat diversity.

Alternative 2

Age and Size Classes

Vegetative Structural Stages by acres and percent of project area under Alternative 2 are illustrated in Figure 3-5. After implementation, the acres of young forest will decrease significantly, from 25% to 9% of forested lands within the project area. Mature forest will increase from 12% to 28% of forested lands while mid-aged forest will decrease from 57% to 43%. Because diameter growth is a function of tree density, trees will grow into larger diameter classes (and VSS classes) at a faster rate than the No Action Alternative. Forty years after implementation, mature forest will increase by 17% over the No Action Alternative. After 40 years, old-growth forest still comprises less than 1 percent of forested acres. It will require approximately 70-80 years before areas designated as Developing Old-Growth will reach the minimum age requirements for old-growth forest, as defined by the Coconino National Forest Plan. Under this alternative, 3,574 acres (23% of Forest Service lands) would be designated as Developing Old-Growth, exceeding Forest Plan Standards of 20%.

Developing Old-Growth stands would be arranged spatially across the project area and contain a degree of connectivity between stands. Old-growth forest structures would develop at a faster rate, as evidenced by the tremendous increase in mature forest over 40 years following treatment. Trees reaching maturity and changing their appearance from black bark to yellow bark (old trees) will still occur biologically at approximately 150 to 200 years old, but they will have larger diameters, in comparison with Alternative 1, depending on density conditions within the site.

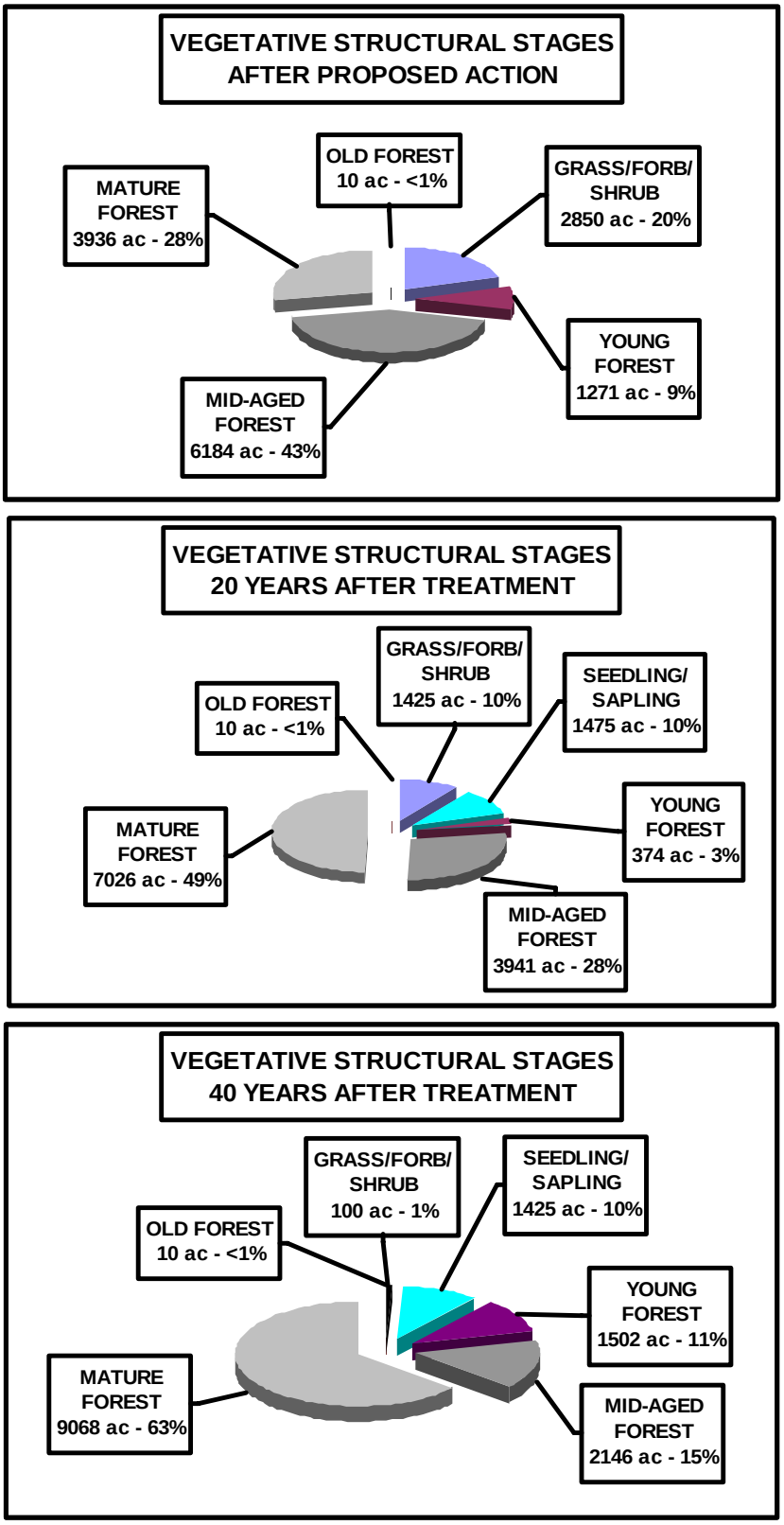
According to the Coconino National Forest Plan (USDA Forest Service 1996), the recommended VSS distribution for the Northern goshawk is:

- VSS 1 – Grass/Forb/Shrub – 10%
- VSS 2 – Seedling/sapling – 10%
- VSS 3 – Young Forest – 20%
- VSS 4 – Mid-Aged Forest – 20%
- VSS 5 – Mature Forest – 20%
- VSS 6 – Old-Growth Forest – 20%

Alternative 2 does not immediately result in the desired VSS distribution as outlined in the Coconino National Forest Plan. Current research has shown that obtaining the recommended VSS distribution for the Northern goshawk is not a matter of simply harvesting (Parker and Hummel 2002). Treated areas will progress towards the future forest conditions described in the Forest Plan. With additional treatments, the recommended VSS distribution for Northern goshawk could be reached in approximately 100 years.

Crown canopy covers by acres and percent of project area under Alternative 2 are described in Figure 3-5. According to FVS, “open” crown canopy conditions will increase from 17% to 75% after implementation, while “closed” crown canopy conditions will decrease from 39% to 2%. “Moderately closed” crown canopy conditions will also decrease from 44% to 23%. Because all of the thinning treatments under the Proposed Action involve the creation of openings, enhancement/creation of groups, and do not utilize spacing guidelines, the residual forest structure will be more variable and patchy. Due to this variable, patchy tree distribution, canopy cover will be higher within pine groups, with openings ¼ - 4 acres between groups. Small openings and more open crown canopy conditions will result in increased sunlight to the forest floor and an increase in grasses, forbs, shrubs, and seedlings/saplings, especially in the openings. However, the beneficial effects of thinning will be relatively short-lived. Forty years after implementation, “open” crown canopy conditions decrease to 24%, while “moderately closed” and “closed” crown canopy conditions increase to 76%. At this time, additional treatment will be required to decrease canopy cover, increase understory development, encourage natural regeneration, and maintain a patchy tree distribution. Additional treatment, however, will cause further site disturbance and short-term negative impacts on understory recovery.

Figure 3-5. Vegetative Structural Stages by Acres and Percent Under Alternative 2.



Clumps and Groups

Groups and clumps will vary in size. Groups and clumps will also vary in canopy cover, from “open” to “closed” canopies. Groups may be even- or uneven-aged, depending on existing stand structure. Thinning within groups will help promote diameter growth, tree vigor, and a diversity of structures. Residual tree densities will depend on densities of groups and clumps and the size of the openings between groups. Groups that are thinned and left with more “open” canopy covers with large, adjacent openings will have decreased inter-tree competition, increased health and vigor, increased understory production and natural regeneration, and will be more likely to develop uneven-aged structures. In comparison, groups that are not thinned and have primarily “closed” canopies, with smaller openings between groups, will demonstrate a higher level of inter-tree competition due to decreased growing space, decreased growth and vigor, less understory production, and will remain fairly even-aged.

MSO Protected Habitat Thinning

Thinning will occur in two stands within the Mexican Spotted Owl Protected Activity Center. Table 3-6 displays basal areas, trees per acre, canopy covers, and quadratic mean diameters of the proposed thinning to 12 inches DBH, in comparison to no treatment and thinning to 9 inches DBH. The proposed thinning to 12 inches DBH reduces densities to below 100 sq ft basal area and 100 trees per acre. Canopy cover for both sites will be reduced to approximately 51%. Quadratic mean diameter will increase after treatment due to the removal of smaller trees and the retainment of larger trees. Over the 40 years following treatment, diameter growth will remain higher than the No Action Alternative and the thinning to 9 inches DBH The effects of the proposed thin to 12 inches DBH will last for approximately 20-40 years longer than a thinning to 9 inches DBH. Thinning to 12 inches DBH results in lower stand densities, lower canopy covers, and increased diameters both after treatment and for 40 years into the future, resulting in decreased competition between trees, decreased tree stress, increased tree vigor, increased diameter growth, increased understory productivity and diversity, increased natural regeneration, a more uneven-aged stand structure, and decreased risk of successful bark beetle attack and mortality. Trees will grow into larger VSS classes at a faster rate. Existing old trees will exhibit improved longevity due to decreased competition. However, the beneficial effects of thinning to 12 inches will begin to decrease in 40 years. The crown canopy will close in 40 years and additional thinning will be required in 40 years to reopen the canopy, create openings for regeneration, decrease inter-tree competition, and stimulate understory production.

Figure 3-6. Areas Designated as Developing Old-Growth Under Alternative 2.

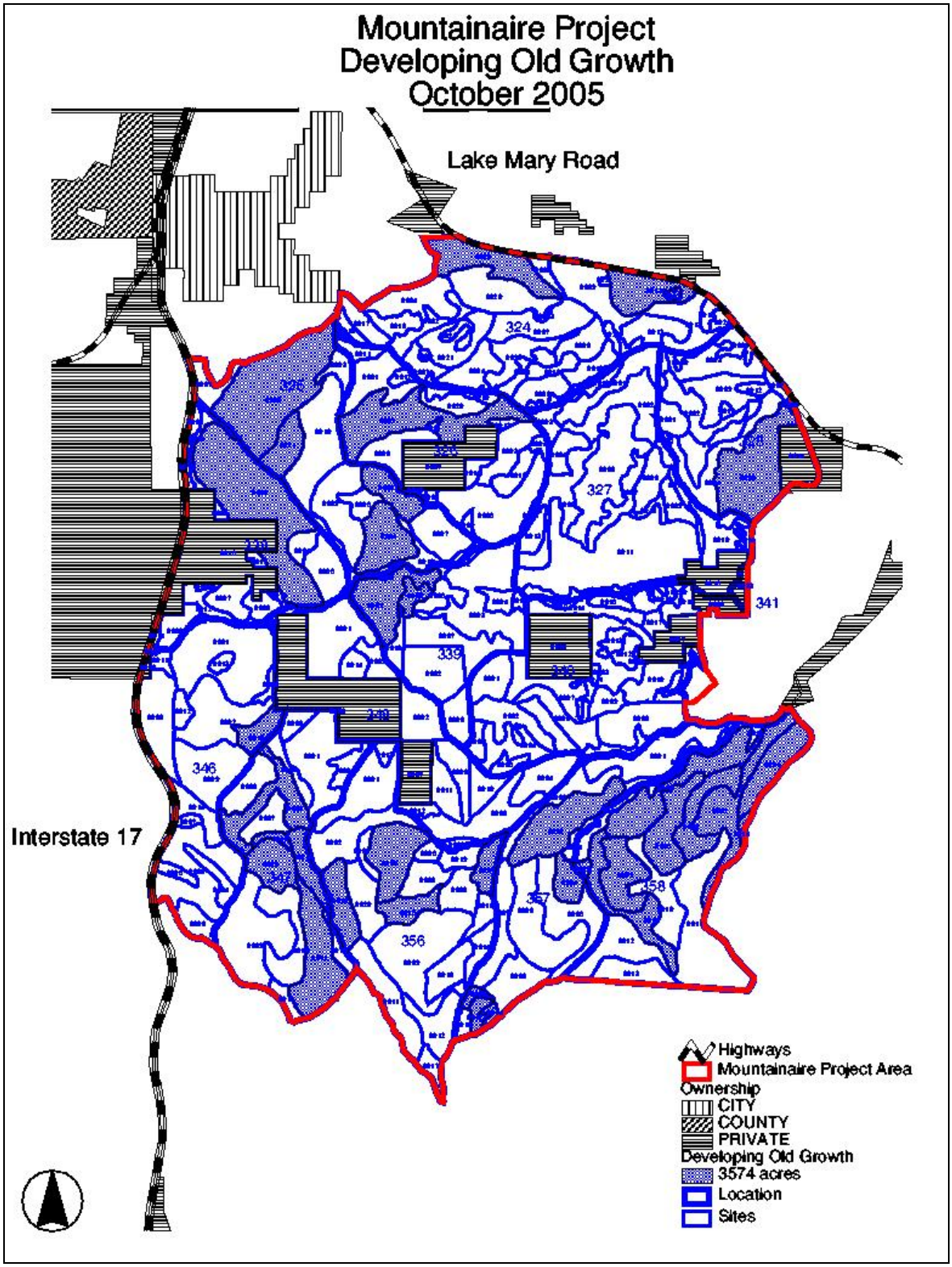
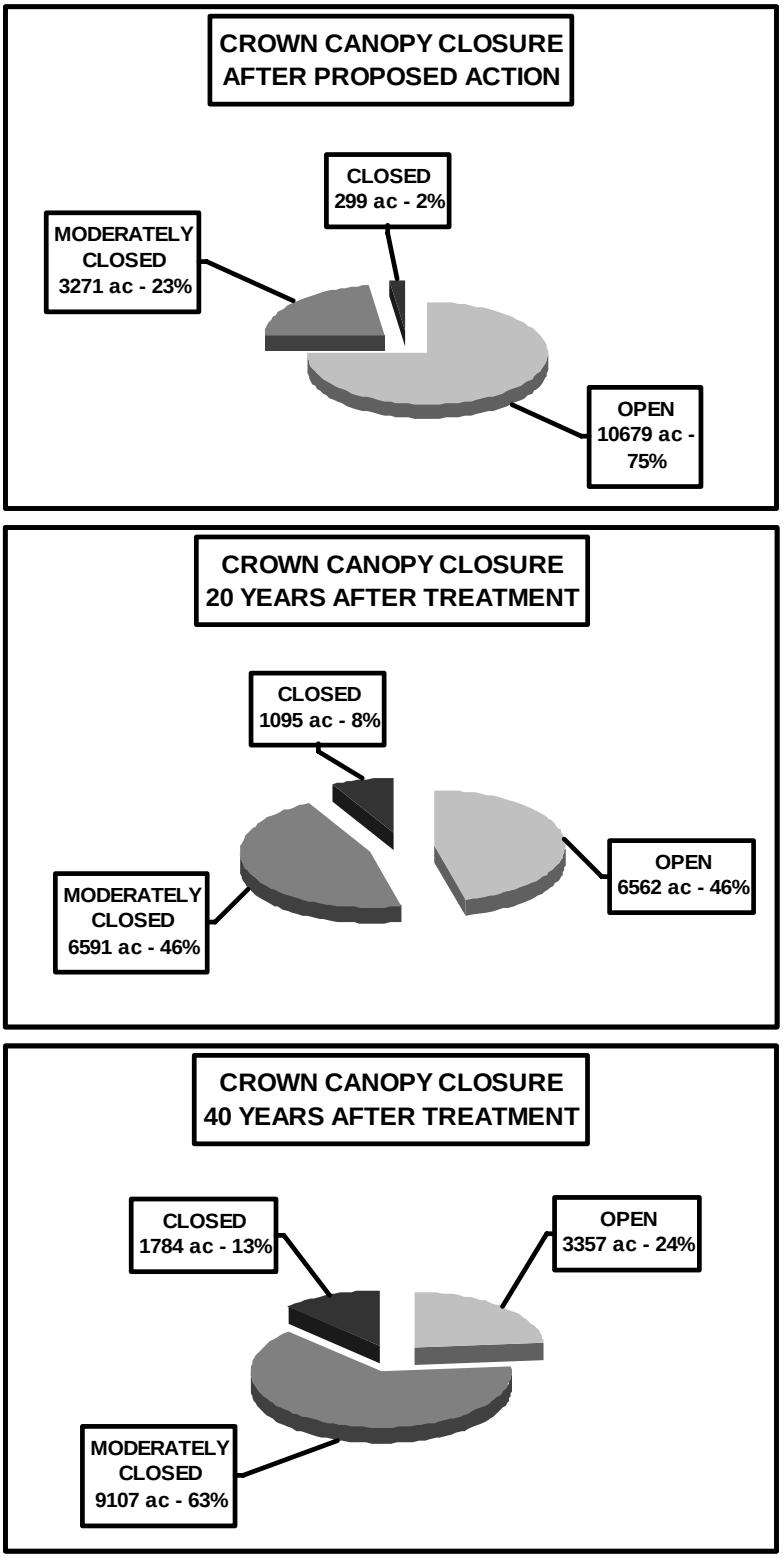


Figure 3-7. Crown Canopy Covers by Acres and Percent Under Alternative 2.



Large Tree Management

It is estimated that a total of approximately 1.5 million trees[4] will be thinned under Alternative 2 to meet canopy cover and uneven-aged management objectives. Of these trees to be thinned, 8,800 trees are between 16-18 inches DBH and 750 trees are between 18-20 inches DBH. The number of trees thinned greater than 16 inches DBH represents 0.6% of the total number of trees to be thinned. Comments received during scoping expressed an interest in a more detailed breakdown of existing size classes. Currently, areas proposed for "Thin from Below" and "Uneven-aged Thin" treatments hold a total of approximately 256,800 trees greater than 16 inches DBH, with approximately 115,400 trees (45%) between 16-18 inches DBH. The number of trees 16-18 inches DBH to be thinned under Alternative 2 represents 7.6% of the existing trees 16-18 inches DBH in these areas. Because of modeling limitations or a lack of data, FVS cannot estimate the number of trees greater than 16 inches DBH to be removed to meet other project objectives such as the creation of openings, thinning around oak clumps and yellow pine groups, and savannah/grassland restoration. In order to estimate the number of trees greater than 16 inches DBH to be thinned to create openings, detailed stem maps of the locations of these trees would be required. Most of these trees would range between 16-18 inches DBH. Background information on large tree management considerations, rationale for removal of large trees, and criteria for thinning is described in Appendix C.

Site Density

Table 3-7 displays trees per acre, basal area, canopy cover, and quadratic mean diameter under Alternative 2 projected over 40 years. After implementation, the number of trees per acre, basal area, and canopy cover will decrease significantly for all treatments except the Burn Only sites. After 40 years, the average number of trees per acre continues to be significantly less than Alternative 1 throughout all treatment areas except the Burn Only areas. However, basal area will return to pre-treatment levels within 20-40 years in all treatment areas except the Uneven-aged Thin to 30% and 40% canopy cover. Additionally, average crown canopy cover decreases significantly after implementation of Alternative 2. After 40 years, crown canopy cover continues to be below pre-treatment levels in all treatment areas except for the Uneven-aged thin to 50% canopy cover. Decreased stand densities and canopy cover will reduce competition between trees for moisture, nutrients, and sunlight and increase tree vigor and growth.

Thinning of smaller, black-barked pine trees around oak clumps and the drip lines of existing "yellow" pines will increase nitrogen, carbon, and water uptake of oak and "yellow" pines, thus

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[4] Stand exam data was collected using variable radius plots for trees greater than 5 inches DBH and 1/100-acre fixed area plots for trees less than 5 inches DBH. One limitation of variable radius plots is a tendency to overestimate the number of larger trees because the probability that a tree will be counted as "in" the plot is directly proportional to the diameter of the tree. FVS simulations use this data to output model estimate of trees thinned. These numbers are only estimates and should not be interpreted as the actual number of trees removed. Rather, they provide a context for comparing the number of trees removed, including large trees, by alternative.

decreasing inter-tree competition and stress and increasing tree vigor, growth, and longevity (Stone et al. 1999). Trees in general will be less susceptible to insect and disease outbreaks. Residual trees will have a decreased risk of bark beetle attack and mortality. Decreased competition will also result in increased diameter growth for individual pine trees. Under Alternative 2, the average QMD increases from 1.4 to 2.8 inches per 20 years, compared to an average increase of 1.0 to 1.8 inches per 20 years under Alternative 1. After 40 years, the beneficial effects of thinning on diameter growth begin to decrease and approach growth rates similar to Alternative 1. Within approximately 40 years, additional treatment will be required in areas thinned to 40-50% canopy cover to decrease stand densities and canopy cover.

Within sites thinned to 30% canopy cover, the effects of thinning are projected to last over 50 years due to lower residual stand densities and canopy covers post-treatment. Inter-tree competition will remain relatively low for over 50 years, resulting in significant increases in diameter growth. These sites are located in areas with rocky soils and poor site conditions that did not support high tree densities presettlement or in areas with severe dwarf mistletoe infection. According to the Coconino National Forest Plan, site quality is to be used in determining the distribution of residual stand densities. Thinning to 30% canopy cover will provide additional benefits to trees located on these low quality sites by maximizing the growth potential and vigor of individual trees and minimizing inter-tree competition. Trees will advance into larger VSS classes at a relatively faster rate. Understory productivity and diversity will resemble presettlement conditions. Thinning to 40 - 50% canopy cover within these areas would not provide the same degree of benefits to tree growth and vigor.

Table 3-7 displays percent of maximum stand density index by acres and percent of forested Forest Service lands over 40 years. Immediately after treatment, 56% of the area will be at or below 25% of max SDI. 34% of the area will be between 25-34% of maximum SDI. None of the project area will be above 60% maximum SDI. For the 20 year period following treatment, inter-tree competition will be low across the majority of the project area. Tree diameter growth, vigor, and longevity will increase significantly over current conditions. After 20 years, 19% of the area will be below 25% of max SDI, while 32% will be above 35% of maximum SDI. Within 40 years, 18% of forested Forest Service lands will be less than 25% of max SDI. Approximately 57% would be at or above 35% of maximum SDI within 40 years. Inter-tree competition increases significantly above 35% of max SDI. As SDI increases, individual tree growth decreases below full potential due to competitive stress. Trees exhibit decreased vigor and longevity. Imminent, competition-based mortality will occur due to self-thinning as individual stand densities reach 50% to 60% of maximum SDI. Approximately one-third of the area would meet or exceed this threshold within 40 years, signifying ecologically unsustainable stand densities and the need for additional thinning treatments.

Table 3-6. Comparison of Thinning Treatments Within the Mexican Spotted Owl Protected Activity Center.

SITE	YEAR	NO TREATMENT				THIN TO 9 INCHES DBH				THIN TO 12 INCHES DBH			
		BASAL AREA	TREES PER ACRE	CANOPY COVER	QUADRATIC MEAN DIAMETER	BASAL AREA	TREES PER ACRE	CANOPY COVER	QUADRATIC MEAN DIAMETER	BASAL AREA	TREES PER ACRE	CANOPY COVER	QUADRATIC MEAN DIAMETER
358/12	AFTER TREATMENT	124	156	61	12.1	119	138	60	12.6	96	82	51	14.7
	+ 20 YEARS	149	150	67	13.5	143	132	66	14.1	116	78	56	16.5
	+ 40 YEARS	169	144	71	14.6	162	127	69	15.3	132	75	60	17.9
358/13	AFTER TREATMENT	132	195	64	11.1	119	143	60	12.4	96	95	51	13.6
	+ 20 YEARS	162	188	71	12.6	147	137	67	14.0	119	91	58	15.5
	+ 40 YEARS	184	179	75	13.7	168	132	71	15.3	138	87	62	17.0

Under Alternative Two, 1,476 acres will receive a Burn Only treatment and all treated sites will receive a broadcast burn. Sites chosen for Burn Only treatments have existing canopy covers of less than 50%. Broadcast burning, in conjunction with thinning or existing open canopies, will have beneficial effects on understory productivity and diversity. According to research conducted on the San Juan National Forest in ponderosa pine, thinning in conjunction with prescribed burning resulted in a significant increase in herbaceous richness (Lynch et al. 2000). Research conducted at the Gus Pearson Natural Area found that thinning and prescribed burning in ponderosa pine resulted in significant increases in herbaceous biomass and species richness (Moore et al. 1992-1999). Research conducted at the Fort Valley Experimental Forest also found that thinning and prescribed burning resulted in significant increases in herbaceous production (Covington et al. 1997). Research conducted by Griffis et al. (2001) in ponderosa pine forests of northern Arizona found an increase in overall plant diversity and an increase in the abundance of graminoids in thinned and burned sites. Modeling in southwestern ponderosa pine found that thinning and prescribed burning in ponderosa pine resulted in significant increases in herbaceous production (Covington et al. 2001).

Additional benefits of prescribed burning include seed bed and site preparation. Research at Chimney Spring found good seedling establishment on burned sites, while unburned sites contained no seedlings (Sackett 1995). Furthermore, prescribed burning is essential to nutrient cycling in ponderosa pine ecosystems. Research at Chimney Spring found significant increases in ammonium levels and microbial nitrogen mineralization on burned plots, compared with control plots (Sackett 1995). Increases in nutrient levels were evident in both understory and overstory vegetation. Prescribed fire may also have negative effects, such as increased tree mortality. Smaller trees (less than 4 inches in diameter) are more susceptible to crown scorch, however survival is highly dependent upon burning season (Sackett 1995). Mature “yellow” pines are also susceptible to prescribed fire in terms of root damage, however survival is highly dependent upon forest floor depth at the base of the tree (Sackett 1995). Prescribed fire may also cause an increase in invasive exotic species, such as mullein, butter and eggs, and cudweed (Griffis et al. 2001, Sackett 1995).

Table 3-7. Percent of Maximum Stand Density Index of Forested Forest Service Lands Under Alternative 2.

Timeframe	% MAX STAND DENSITY INDEX (SDI)	ACRES	PERCENT OF FORESTED FS LANDS
Immediately after treatment	0-24%	8,222	56
	25-34%	4,994	34
	35-59%	1,590	11
20 years	0-24%	2,855	19
	25-34%	7,275	49
	35-59%	4,536	31
	60%+	140	1
40 years	0-24%	2,675	18
	25-34%	3,552	24

Timeframe	% MAX STAND DENSITY INDEX (SDI)	ACRES	PERCENT OF FORESTED FS LANDS
	35-59%	7,766	52
	60%+	814	5

Forest Health

One site in the northern portion of the project area will receive an Uneven-aged thin to 30% canopy cover to decrease a severe level of dwarf mistletoe (DM) infection. Thinning to 30% canopy cover is necessary to decrease DM infection to acceptable levels. Thinning to only 40% canopy cover would result in the retainment of infected trees in the overstory, the spread of DM to regeneration in the understory, and the spread of DM throughout the site Complete elimination of DM from the project area is neither practical nor desirable. Proposed treatments are not designed to completely eliminate dwarf mistletoe from the project area, but rather decrease infection to manageable levels and decrease the rate of spread. Although DM increases fire hazard and has many damaging effects on tree growth, it is a natural occurrence in ponderosa pine ecosystems and has many beneficial effects. Increased snag densities and witches' brooms in large, infected trees improve habitat values for several wildlife species. Additionally, infection areas are associated with increased insect populations and, therefore, present increased foraging opportunities for insect-feeding birds.

Although not a primary food source, many wildlife species feed on DM fruits, shoots, and infected bark (Conklin 2000). By decreasing crown canopy cover and creating a patchy tree distribution, the proposed treatments will decrease the rate at which infection spreads. According to Conklin (2000), dwarf mistletoe infection spreads at an average rate of 1-2 feet per decade. Furthermore, dwarf mistletoe populations in the southwest are thought to have increased since Euro-American settlement due to increased forest densities resulting from fire suppression. A more open, patchy forest structure would have limited the spread of dwarf mistletoe infection (Conklin 2000). Additionally, DM infection occurs more abundantly in the lower crown due to its mechanism of spread. The historic fire regime may have decreased the severity of infection through partial crown scorch and a "sanitizing" effect on lightly to moderately infected trees (Conklin 2000).

Broadcast burning will be conducted across infected areas to emulate the effects of the historic fire regime on dwarf mistletoe infection. Although decreasing crown canopy covers and broadcast burning will decrease the severity and spread of DM infection, the beneficial effects of the Proposed Action will be relatively short-lived. Within 40 years, canopy covers in most areas will begin to close and approach pre-treatment conditions. Additional thinning treatments will be required at this time to decrease canopy cover, maintain a patchy tree distribution, create openings in the canopy, and treat latent infection. Broadcast burning will also be required at decadal intervals to treat dwarf mistletoe infection. Without treatment, DM infection would continue to spread throughout sites and the project area.

Increased DM infection results in reduced tree growth, reduced tree vigor, branch deformations, and shortened life span of the infected host (Conklin 2000). Trees infected with dwarf mistletoe are more susceptible to insect attack, such as bark beetles, and diseases. Reduced tree growth and shortened life span result in stagnation of VSS classes. Additionally, in comparison to uninfected

trees, trees infected with dwarf mistletoe are more flammable due to the accumulation of resin and branch deformations (Conklin 2000). Conklin (2000) also states that areas infected with dwarf mistletoe often have higher fuel levels, compared to uninfected areas, resulting in more intense fires. Due to the damaging effects of DM on tree growth, the Coconino National Forest Land and Resource Management Plan states, "Silvicultural prescriptions emphasize treating dwarf mistletoe infections to bring them down to acceptable levels…" (USDA Forest Service 1996, p. 122-1.)

To decrease (not eliminate) the incidence and spread of DM infection within the Mountainaire Project area, some infected, overstory, black-barked trees 16-24 inches DBH would be removed. Retaining infected trees in the overstory would perpetuate the spread of infection to smaller trees in the understory. An example of such a situation where this would occur would be if a site contained a 16-inch DBH black-barked pine tree that was infected with dwarf mistletoe and a 14-inch DBH pine tree free from infection. In this case, the 16-inch DBH black-barked pine tree would be removed and the 14-inch DBH tree would be retained. If, however, the infected tree is greater than 24 inches DBH or is a yellow pine or group of yellow pines, then a 1 chain buffer will be cut around the tree or group to prevent the spread of infection.

Current stand conditions within the project area provide excellent habitat for increases in bark beetle and other insect populations. Bark beetles are attracted to trees under stress from competition and a lack of resources, such as water, nutrients, and sunlight. Decreasing stand densities will reduce competition between trees, resulting in increased tree vigor. Individual trees will be better able to defend themselves against bark beetle attack. After implementation, the risk of insect attack and mortality for residual trees will be greatly reduced across the project area. After the slash generated from thinning activities has been burned, the entire project area will be broadcast burned, further reducing the risk of mortality from bark beetles and other insects.

Species Diversity

Oak

Thinning of ponderosa pine around clumps of Gambel oak will result in decreased inter-tree competition for moisture, nutrients, and sunlight, increased growth, increased vigor, and increased longevity of oak. Gambel oak is a relatively slow-growing hardwood species. Therefore, increased growth rates in response to thinning will be less noticeable in oak, compared to pine. Maintenance burning will be required on a decadal basis to prevent regeneration from eventually overtopping oak clumps. Additional thinning will also be required around oak clumps within 20 – 40 years as the pine canopy grows laterally and begins to overtop oak clumps.

Understory Vegetation

According to research conducted in ponderosa pine around Flagstaff, restoration treatments result in changes in microclimate on the forest floor, specifically increased sunlight penetration to the forest floor, increased soil temperatures, and increased understory productivity (Meyer et al 2001). Additional studies have shown that understory response to thinning treatments is directly related to the intensity of the treatment and the use of prescribed fire (Griffis et al 2001). Based upon research, it is therefore reasonable to assume that thinning to 50% canopy cover, followed by broadcast burning, will result in increased understory productivity. However, thinning to 30% canopy cover, followed by broadcast burning, will result in greater relative increases in

understory productivity due to increased sunlight to the forest floor and increased soil temperatures.

Grasslands and Savannahs

Grasslands and savannahs will be restored to presettlement densities. Reducing densities in these areas will result in increased understory productivity and diversity and restore their functionality in terms of wildlife habitat, watershed production, fire hazard, and scenic values. Presettlement densities are an important reference condition for restoration because they are the densities that evolved in these areas over centuries with fire, drought, frost, wildlife, insects, and disease.

Alternative 3

Age and Size Classes

Vegetative Structural Stages by acres and percent of project area under Alternative 3 are illustrated in Figure 3-8. In comparison with Alternative 2, there would be very little change in VSS classes under Alternative 3. VSS 4 and 5 would change by 1% immediately following implementation of Alternative 3, while all other VSS classes would remain the same as the Proposed Action. After 20 years, VSS classes would be the same as under the Proposed Action. After 40 years, VSS 4 and 5 would differ from the Proposed Action by 2%. As with Alternative 2, the recommended VSS distribution for the Northern goshawk will not be attained immediately following treatment. Additional treatment will be required within 20-40 years in order for treated areas to progress towards the future forest conditions described in the Forest Plan. With these additional treatments, the recommended VSS distribution for Northern goshawk could be reached in approximately 100 years.

Canopy cover by acres and percent of project area under Alternative 3 are illustrated in Figure 3-9. In comparison with Alternative 2, there would be very little change in overall crown canopy cover. Immediately after implementation, “open” and “moderately closed” canopy conditions decrease by 1% each compared to Alternative 2, while “closed” canopy conditions increase by 2%. After 20 years, “open” canopy increases by 3%, “moderately closed” canopy decreases by 4%, and “closed” canopy increases by 1%. After 40 years, “open” canopy increases by 3%, “moderately closed” canopy decreases by 3%, and “closed” canopy remains the same as under Alternative 2.

Large Tree Management

It is estimated that a total of approximately 1.5 million trees[5] will be thinned under Alternative 3 to meet canopy cover, uneven-aged management, and restoration goals. Of these trees to be thinned, approximately 11,400 trees are between 16-18 inches DBH and 1,550 trees are between 18-20 inches DBH. The number of trees thinned greater than 16 inches DBH represents 0.9% of the total number of trees to be thinned. Currently, areas proposed for "Thin from Below", "Uneven-aged Thin", matrix, and full restoration treatments have a total of approximately 256,800 trees greater than 16 inches DBH, with approximately 115,400 trees (45%) between 16-18 inches DBH. The number of trees 16-18 inches DBH to be thinned under Alternative 3 represents 11% of the existing trees 16-18 inches DBH in these areas.

Because of modeling limitations or a lack of data, FVS cannot estimate the number of trees greater than 16 inches DBH to be removed to meet other project objectives such as the creation of openings, thinning around oak clumps and yellow pine groups, and savannah/grassland restoration. In order to estimate the number of trees greater than 16 inches DBH thinned to create openings, detailed stem maps of the locations of these trees would be required. Most of these trees would range between 16-18 inches DBH. Background information on large tree management considerations, rationale for removal of large trees, and criteria for thinning is described in Appendix C.

Of the total number of large trees to be thinned under Alternative 3, approximately 3,400 trees greater than 16 inches DBH would be thinned in the full restoration areas (610 acres) of the wildlife research proposal submitted by Arizona Game and Fish, Grand Canyon Trust, and the GFFP Board of Directors.

Site Density

Table 3-8 displays the estimated number of trees per acre, basal area, quadratic mean diameter, and canopy cover under Alternative 3 (Research Areas), in comparison with Alternative 2. Only the acres in Table 3-8 would change under Alternative 3. The rest of the project area would be treated as described under Alternative 2. Approximately 228 acres would change from an Uneven-aged Thin to 40-50% canopy cover to a Meso-Reserve. No trees would be thinned within the Meso-reserves. These Meso-Reserve areas would be burned only. For a minimum of 40 years after treatment, tree per acre, basal area, and canopy cover would remain significantly higher in these Meso-reserve areas, in comparison with Alternative 2, while quadratic mean diameters would be significantly smaller. These high stand densities will continue to increase, resulting in continued, intense competition between trees for moisture, nutrients, and sunlight, decreased tree

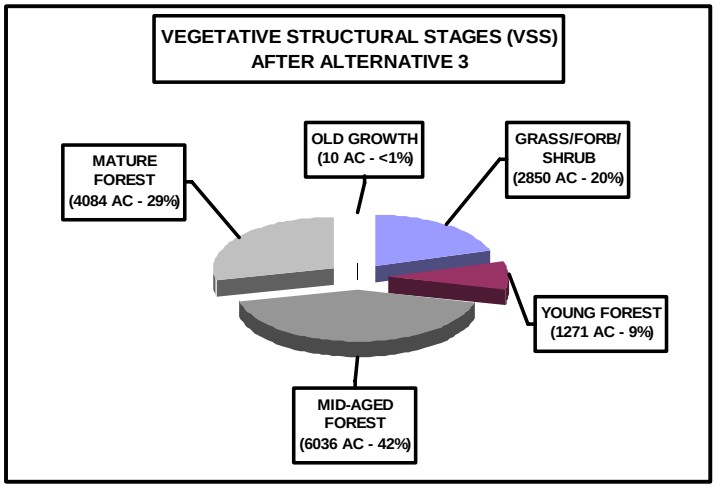
[5] Stand exam data was collected using variable radius plots for trees greater than 5 inches DBH and 1/100-acre fixed area plots for trees less than 5 inches DBH. One limitation of variable radius plots is a tendency to overestimate the number of larger trees because the probability that a tree will be counted as "in" the plot is directly proportional to the diameter of the tree. FVS simulations use this data to output model estimate of trees thinned. These numbers are only estimates and should not be interpreted as the actual number of trees removed. Rather, they provide a context for comparing the number of trees removed, including large trees, by alternative.

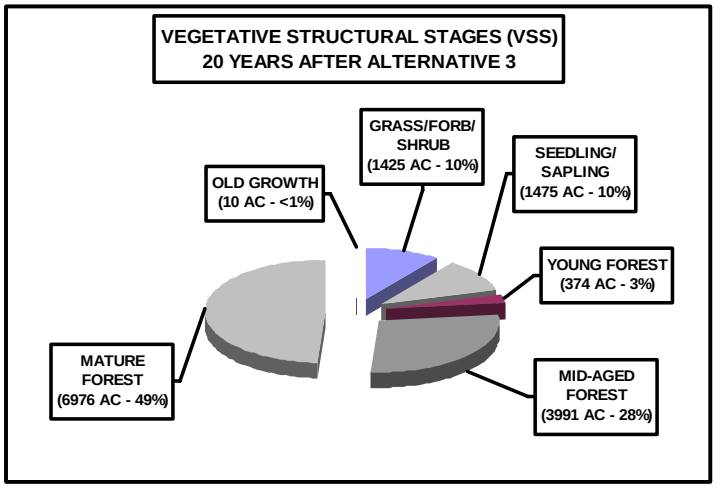
vigor, increased susceptibility to successful bark beetle attack and mortality, decreased diameter growth, decreased “yellow” pine and oak longevity, continued decline in understory productivity and diversity, continued absence of natural regeneration, and perpetuation of an unsustainable, even-aged forest structure. Eventually, those trees that are out-competed will die, further increasing fuel loading, fire hazard, and the risk of bark beetle attack to residual trees.

Broadcast burning without a reduction in canopy cover in the Meso-Reserve areas will result in only slight increases in understory productivity and the potential for high tree mortality due to torching. The majority of the increases in understory production will occur in areas where broadcast burning resulted in torching of individual or groups of trees. Natural regeneration is not expected to occur in these areas due to high canopy cover and the shade intolerance of ponderosa pine. Under Alternative 3, approximately 449 acres will be treated as Matrix, which involves an Uneven-aged Thin to 40% canopy cover. Within the Matrix areas, there would be very little difference between Alternatives 2 and 3 in terms of trees per acre, basal area, canopy cover, and quadratic mean diameter for at least 40 years after treatment.

Alternative 3 also involves restoration treatments across approximately 611 acres surrounding the Meso-reserves and Matrix areas. In comparison with Alternative 2, Restoration areas under Alternative 3 result in a significant decrease in the number of trees per acre, basal area, and canopy cover, both immediately after treatment and 40 years into the future. Low stand densities resembling presettlement conditions will significantly decrease competition between trees for moisture, nutrients, and sunlight, resulting in an increase in overall forest health. Individual trees will be more vigorous and therefore less susceptible to successful insect attack and mortality, including bark beetles. “Yellow” pines and large oaks will exhibit increased longevity with decreased competition. Understory productivity and diversity will increase significantly. Natural regeneration will be prolific and require broadcast burning at a return interval of once a decade to thin out young trees and maintain an open canopy. The resultant forest structure will be more sustainable, uneven-aged, and more closely resemble the forest structure that existed prior to European settlement and fire suppression. Decreased competition between trees will also result in significant increases in diameter growth over a minimum period of 40 years, as evidenced by a faster rate of increase in the quadratic mean diameter over the 40-year period post-treatment. Individual sites will progress through VSS classes at a faster rate. Individual trees will still begin to turn “yellow” at approximately 150 years old, however their diameters will be significantly larger than trees of the same age in higher density stands.

Figure 3-8. Vegetative Structural Stages Under Alternative 3.





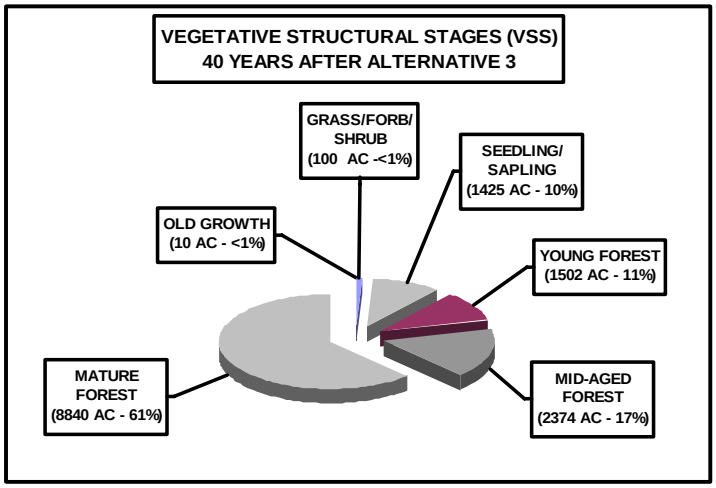


Figure 3-9. Crown Canopy Cover Under Alternative 3.

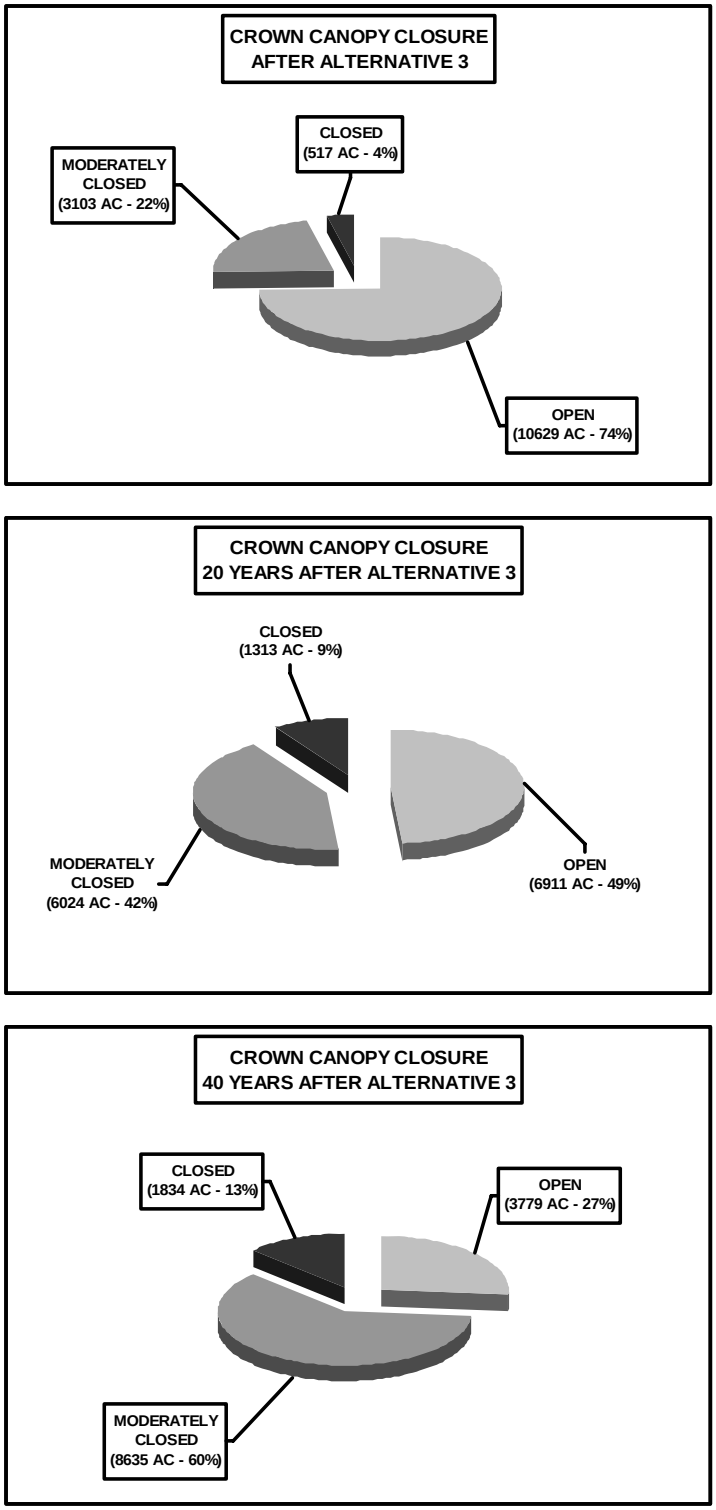


Table 3-8. Stand Density Characteristics Under Alternative 3.

YEAR	ACRES	ALTERNATIVE 3					ALTERNATIVE 2				
		Treatment	TREES PER ACRE	BASAL AREA	QUADRATIC MEAN DIAMETER	CANOPY COVER	TREATMENT	TREES PER ACRE	BASAL AREA	QUADRATIC MEAN DIAMETER	CANOPY COVER
AFTER TREATMENT	228	MESO-RESERVES	159-228 (201)	117-160 (132)	10.3-11.6 (11.0)	60-72 (64)	UNEVEN-AGED THIN TO 40-50% CC	54-119 (83)	69-92 (79)	11.9-15.3 (13.8)	40-50 (44)
+20 YEARS			148-209 (186)	147-179 (158)	11.9-13.5 (12.6)	67-75 (70)		52-114 (79)	94-123 (106)	14.0-18.2 (16.2)	48-59 (53)
+40 YEARS			137-193 (172)	166-192 (174)	13.0-14.9 (13.7)	71-77 (73)		50-110 (77)	111-144 (125)	15.5-20.3 (18.0)	53-64 (58)
AFTER TREATMENT	449	MATRIX	43-80 (57)	62-72 (70)	13.1-17.5 (15.3)	39-42 (40)	UNEVEN-AGED THIN TO 40-50% CC	43-119 (60)	62-92 (71)	11.9-17.5 (15.0)	40-50 (41)
+20 YEARS			44-77 (55)	87-103 (94)	15.4-20.6 (18.0)	46-53 (49)		41-114 (58)	87-123 (96)	14.0-20.6 (17.8)	46-59 (49)
+40 YEARS			42-74 (57)	101-130 (112)	16.6-22.7 (20.0)	50-59 (54)		42-110 (56)	101-144 (114)	15.5-22.1 (19.7)	50-64 (54)
AFTER TREATMENT	611	RESTORATION	24-44 (32)	44-55 (51)	13.4-20.2 (17.1)	28-32 (30)	BURN ONLY, UNEVEN-AGED THIN TO 40-50% CC	39-143 (68)	62-92 (73)	9.0-18.5 (15.1)	40-50 (43)

YEAR	ACRES	ALTERNATIVE 3					ALTERNATIVE 2				
		Treatment	TREES PER ACRE	BASAL AREA	QUADRATIC MEAN DIAMETER	CANOPY COVER	TREATMENT	TREES PER ACRE	BASAL AREA	QUADRATIC MEAN DIAMETER	CANOPY COVER
+20 YEARS			23-43 (31)	61-78 (72)	17.9-23.7 (20.8)	34-42 (39)		37-137 (65)	86-123 (101)	11.1-21.5 (18.0)	45-59 (52)
+40 YEARS			22-41 (30)	73-101 (87)	20.2-26.1 (23.3)	39-50 (44)		36-110 (63)	98-144 (120)	12.8-24.2 (20.3)	48-64 (56)

*Basal area is in square feet per acre. Quadratic mean diameter is in inches. Canopy cover is in percent.

Table 3-9 displays stand density index (SDI) under Alternative 3, in comparison with Alternative 2, for sites within Research Areas. In the Meso-reserve areas, stand density index would remain high, indicating continued intense competition between trees, reduced tree vigor, and increased risk of insect attack and mortality, including bark beetles. In the Matrix areas, there would be very little change in SDI under Alternative 3, in comparison with Alternative 2. In the restoration areas, SDI would be significantly lower than Alternative 2. Competition between trees would continue to be significantly reduced for a minimum of 40 years in the Restoration areas, resulting in increased tree vigor, significant increases in diameter growth, and decreased risk of insect attack and mortality.

Table 3-9. Stand Density Index Under Alternative 3.

		ALTERNATIVE 3			ALTERNATIVE 2		
ACRES	YEAR	TREATMENTS	STAND DENSITY INDEX	% MAX SDI	TREATMENTS	STAND DENSITY INDEX	% MAX SDI
228	AFTER TREATMENT	MESO-RESERVES	193-270 (218)	43-60 (49)	UNEVEN-AGED THIN TO 40-50% CC	106-158 (130)	24-35 (29)
	+20 YEARS		230-291 (250)	51-65 (55)		136-197 (162)	30-44 (36)
	+40 YEARS		250-303 (266)	55-67 (59)		155-223 (184)	34-50 (41)
449	AFTER TREATMENT	MATRIX	103-114 (109)	23-25 (24)	UNEVEN-AGED THIN TO 40-50% CC	103-158 (111)	23-35 (25)
	+20 YEARS		124-153 (137)	28-34 (31)		124-197 (141)	28-44 (31)
	+40 YEARS		138-183 (159)	31-41 (35)		138-223 (162)	31-50 (36)
611	AFTER TREATMENT	RESTORATION	68-84 (75)	15-17 (17)	BURN ONLY, UNEVEN-AGED THIN TO 40-50% CC	103-158 (115)	23-35 (26)
	+20 YEARS		85-112 (99)	19-25 (22)		119-197 (148)	26-44 (33)
	+40 YEARS		98-137 (114)	22-31 (25)		131-223 (173)	29-50 (39)

Forest Health

In comparison with Alternative 2, there would be little change in the levels of dwarf mistletoe infection with the matrix and restoration areas. Stand exam data collected within the meso-reserves shows no evidence of dwarf mistletoe infection. The risk of insect attack and mortality would be higher within meso-reserves due to higher stand densities and increased inter-tree competition and decreased tree vigor.

Species Diversity

Oak

Because the majority of oak is located in the southern portion of the project area and the research areas are located in the north, there would be little change in the effects on oak growth, vigor, and longevity than described in Alternative 2.

Understory Vegetation

Within the meso-reserves, understory productivity and diversity would remain low due to high stand densities and canopy covers. After broadcast burning, a slight increase in understory production may occur, especially in areas where the crown canopy is decreased by fire. However, understory production will return to current levels within the meso-reserves within 10 - 20 years after burning as crown canopies close.

Grasslands/Savannahs

There would be no significant difference in grassland and savannah structure from Alternative 2.

Alternative 4

Age and Size Classes

Table 3-10 displays Vegetative Structural Stages under Alternative 4 for stands that would have trees greater than 16 inches thinned under Alternative 2 to meet objectives for canopy cover and/or uneven-aged forest structure.

Over the 40-year period following treatment, VSS classes will differ slightly between Alternatives 2 and 4. With a 16-inch diameter limit, sites 356/07 and 358/08 would develop into mature forest at a slower rate. Retaining all trees greater than 16 inches DBH within these stands would result in higher residual stand densities and canopy covers, higher inter-tree competition, decreased tree growth and vigor, and slower development of mature and old VSS classes.

Designated old growth development areas would develop at a slower rate under Alternative 4 because of the large number of trees greater than 16 inches DBH. These areas would exhibit higher residual stand densities; fewer, smaller openings; and increased mortality of yellow pines. The presence of large, black-barked pine trees around the drip lines of old, yellow pines would result in competition between trees for moisture, nutrients, and sunlight. Old yellow pines would experience decreased vigor and longevity, compared to Alternative 2. As a result, old trees would experience increased susceptibility to successful bark beetle attack and mortality and increased

risk of mortality due to crown fire in stands that contain a large component of trees greater than 16 inches DBH (approximately 1,600 acres). With or without a 16-inch diameter limit, ponderosa pine trees will begin to turn yellow at approximately 150 years of age. However, due to higher residual densities in these stands resulting from a diameter limit, yellow pines will have smaller diameters than we normally associate with old trees due to decreased growth rates. Old-growth forest currently represents less than 1% of the project area and is severely lacking across the entire forest due to past logging practices. Old-growth forest is not only characterized by a certain number of trees greater than 16 inches DBH; it is a system with structure and function. It is important to maintain/create old-growth ecosystems because their structures represent what is likely to be the most biologically diverse portion of the successional sequence (Hunter 1990). Because of their biological diversity, old-growth forest structures provide habitat for a diverse array of wildlife species. As old-growth forest has decreased in abundance over the past century, so have wildlife species populations that depend upon old-growth, such as the Mexican spotted owl. Under Alternative 4, over 400 acres of "Uneven-aged Thin" would be converted to "Thin from Below," resulting in an even-aged or two-aged forest structure that is less biologically diverse.

Additional effects of Alternative 4 include a decreased number and size of openings for natural regeneration. Experience with past and ongoing thinning projects, such as the Woody Ridge and Fort Valley projects, has demonstrated difficulties with the creation of openings across 20% of the project area without the removal of trees greater than 16 inches DBH. In areas with a large component (greater than 30 large trees per acre) of trees greater than 16 inches DBH, a 16-inch diameter limit would result in a decrease in the number and size of openings. Within the project area, over 1,600 acres have greater than 30 trees per acre greater than 16 inches DBH. This decrease in openings ¼ - 4 acres in size would result in decreased horizontal and vertical heterogeneity and further deviation from the historic, patchy tree distribution that occurred presettlement. Furthermore, trees greater than 16 inches DBH are generally greater than 50 feet in height with large crowns and contribute a significant shading effect. A lack of openings of adequate size would result in a decreased amount of regeneration due to the shade-intolerance of ponderosa pine. Without regeneration and the formation of grass/forb/shrub and seedling/sapling vegetative structural stages (VSS 1 and 2) across the project area, the Forest Plan VSS distribution and a sustainable, uneven-aged forest structure would not be attained.

Forest structure would be more homogenous in terms of tree spacing and include fewer definable clumps and groups in some areas.

Table 3-10. Vegetative Structural Stages for Sites Requiring Large Tree Thinning to Achieve Uneven-age Class and Canopy Cover Objectives.

Site Number	Timeframe	Alternative 2 VSS	Alternative 4 VSS
0003250011	After Treatment	4A	4A
	+20 Years	5A	5A
	+40 Years	5B	5B
0003260005	After Treatment	5A	5A
	+20 Years	5A	5A

Site Number	Timeframe	Alternative 2 VSS	Alternative 4 VSS
	+40 Years	5B	5B
0003480014	After Treatment	5A	5A
	+20 Years	5A	5A
	+40 Years	5A	5A
0003560007	After Treatment	5A	4A
	+20 Years	5A	5B
	+40 Years	5B	5B
0003560010	After Treatment	4A	4A
	+20 Years	5A	5A
	+40 Years	5B	5A
0003580001	After Treatment	5A	5A
	+20 Years	5A	5A
	+40 Years	5A	5A
0003580008	After Treatment	5A	4B
	+20 Years	5B	5C
	+40 Years	5B	5C
0003580009	After Treatment	5B	5B
	+20 Years	5B	5C
	+40 Years	5B	5C

In order to meet canopy cover goals, nearly 700 acres would require every tree under 16 inches DBH to be removed to meet canopy cover goals, resulting in an even-aged or two-aged forest structure. For example, under Alternative 2, Site 325/011 would receive an Uneven-aged Thin to 40% canopy cover. Eight trees per acre 16-18 inches DBH would be thinned to reach 40% canopy cover while maintaining an uneven-aged forest structure. This stand currently has approximately 50% of its trees per acre in the 16-17 inch diameter class. The residual stand structure under Alternative 2 would contain 41 trees per acre, with approximately 30 trees per acre greater than 16 inches DBH.

A 16-inch cap would require all trees under 16 inches DBH to be removed to reach a canopy cover of 40%. The resulting stand structure would be predominantly even-aged, with over 70% of the residual trees per acre between 17-19 inches DBH, while there would be no trees under 16 inches DBH. With the removal of all trees less than 16 inches DBH to meet canopy cover objectives and a lack of openings of adequate size, regeneration of shade-intolerant ponderosa pine would be severely limited, furthering an even-aged forest structure into the future.

Additionally, a diameter limit would retain all trees greater than 16 inches DBH, regardless of form or defect. For example, a 16-inch pine with poor form or defects, such as crook, sweep, poorly formed crowns, porcupine damage, or forked tops, would be chosen as a leave tree over a 15-inch pine with good form and no defect. Trees greater than 16 inches DBH with genetically inherited defects would be left on site to pass on these defects to future generations.

Table 3-11 displays canopy cover values for selected stands under Alternative 4, in comparison with the Proposed Action. On over 526 acres, a 16-inch diameter cap would result in higher residual canopy covers both immediately after treatment and 40 years after treatment. For example, under the Alternative 2, stand 358/09 would receive a "Thin From Below to 50% canopy cover." Fifteen trees per acre between 16-18.0 inches DBH and 7 trees per acre between 18-19 inches DBH would be thinned to reach 50% canopy cover. Under Alternative 4, a 16-inch diameter cap would result in a higher residual canopy cover. Thinning all trees under 16 inches DBH would only decrease canopy cover to 61%. Forty years after treatment, canopy cover continues to be significantly higher with a 16-inch diameter cap, resulting in significant decreases in understory productivity and diversity and natural regeneration.

Stand Density

Table 3-11 displays trees per acre, basal area, and quadratic mean diameter for selected stands under Alternative 4, in comparison with the Proposed Action. Higher residual stand densities would exist in several stands across the project area. For example, under the Proposed Action, stand 358/08 would receive an "Uneven-aged Thin to 40% canopy cover." Thirty-one trees per acre between 16-18.0 inches DBH would be thinned to reach 40% canopy cover while maintaining an uneven-aged forest structure. Residual stand structure would contain 44 trees per acre, with approximately 30 trees per acre greater than 16 inches DBH. Residual basal area under the Proposed Action would be 72 sq ft. Under Alternative 4, a 16-inch cap would result in a higher residual stand density. If all trees less than 16 inches DBH are removed, basal area would decrease to only 113 sq ft, with 60 trees per acre. The resulting stand structure would be predominantly even-aged, with over 70% of the residual trees per acre between 16-18 inches DBH, while there would be no trees under 16 inches DBH. Higher residual stand densities would result in increased competition between trees for moisture, nutrients, and sunlight. With increased competition, individual trees would experience decreased growth rates and decreased tree vigor. Old forest would develop at a slower rate. Stands would be at an increased risk of insect attack and mortality.

Table 3-12 displays SDI for selected stands under Alternative 4. Stand density index increases significantly as the result of a 16-inch diameter cap for stands that contain a large component of trees greater than 16 inches DBH and stands that cannot meet canopy cover goals (approximately 1,835 acres). Additional acres cannot be calculated for stands with higher residual SDI due to the creation of fewer, smaller openings. For example, in stands such as 358/08 and 358/09, a 16-inch cap would result in significant increases in SDI over a 40-year period following treatment, in comparison to Alternative 2. Under Alternative 4, a 16-inch diameter limit would result in increased inter-tree competition, with some stands reaching the point of imminent, competition-based mortality within 20 - 40 years. Diameter classes most affected by competition-based mortality will be either those trees left in the lowest canopy positions (16 – 18 inches DBH) or the oldest trees unable to out-compete the younger, more vigorously-growing age classes (old, "yellow" pines). As mortality occurs within the oldest and youngest age classes, the stand will become more even-aged over time. Older VSS classes would develop at a slower rate due to

higher residual densities. With increased competition and mortality, individual trees will be at increased risk for successful insect attack and mortality, including bark beetles.

Table 3-11. Stand Density Charactertics Under Alternative 4.

Site	Timeframe	Alternative 2				Alternative 4			
		Trees per acre	Basal Area	Quadratic Mean Diameter	Canopy Cover	Trees per acre	Basal Area	Quadratic Mean Diameter	Canopy Cover
0003260005	AFTER TREATMENT	37	73	19.1	40	40	81	18.9	44
	+20 YEARS	35	91	21.8	46	38	100	21.5	49
	+40 YEARS	34	104	23.7	50	36	113	23.4	53
0003560007	AFTER TREATMENT	44	76	17.8	40	40	88	19.9	45
	+20 YEARS	43	90	19.7	46	39	101	21.8	49
	+40 YEARS	41	101	21.3	49	37	110	23.4	52
0003580008	AFTER TREATMENT	44	72	17.4	40	60	113	18.5	55
	+20 YEARS	42	129	23.7	57	58	174	23.4	68
	+40 YEARS	40	145	25.8	61	56	186	24.8	71
0003580009	AFTER TREATMENT	45	99	20.1	50	67	136	19.3	61
	+20 YEARS	43	122	22.8	55	64	161	21.4	66
	+40 YEARS	41	134	24.4	58	61	172	22.7	68

Table 3-12. Stand Density Index Under Alternative 4.

STAND NUMBER	TIME FRAME	Alternative 2		Alternative 4	
		STAND DENSITY INDEX	% MAX SDI	STAND DENSITY INDEX	% MAX SDI
0003580008	AFTER TREATMENT	106	24	163	36
	+20 YEARS	168	37	227	50
	+40 YEARS	183	41	239	53
0003580009	AFTER TREATMENT	138	31	192	43

STAND NUMBER	TIME FRAME	Alternative 2		Alternative 4	
		STAND DENSITY INDEX	% MAX SDI	STAND DENSITY INDEX	% MAX SDI
	+20 YEARS	162	36	218	48
	+40 YEARS	173	38	228	51

Forest Health

Under Alternative 4, overstory trees greater than 16 inches DBH infected with dwarf mistletoe would not be thinned. Retaining infected trees in the overstory would perpetuate the spread of infection to smaller trees in the understory. With increased canopy covers, increased stand densities, and a lack of openings or the creation of smaller openings resulting from a 16-inch diameter cap, dwarf mistletoe infection would continue to spread throughout infected stands, expanding at a rate of 1-2 feet per year. Increased dwarf mistletoe infection would result in reduced tree growth, reduced tree vigor, branch deformations, and shortened life span of the infected host (Conklin 2000). Reduced tree vigor and altered pitch flow associated with dwarf mistletoe infection would result in compromise of a tree's defense mechanisms to combat bark beetle attack, resulting in increased risk of attack and mortality. Reduced tree growth and shortened life span would result in stagnation of VSS classes. Additionally, the accumulation of resin and branch deformations associated with dwarf mistletoe infection would result in increased fire hazard.

Under Alternative 4, higher residual stand densities in stands with a large component of trees greater than 16 inches DBH would result in increased inter-tree competition, decreased tree growth, and decreased tree vigor. Natural defense mechanisms against insect attack, such as the production of pitch, would be lowered due to competitive stress, resulting in increased susceptibility to successful insect attack and mortality, including bark beetles. As stand densities continue to increase over time, those trees that are out-competed would die, thus attracting bark beetles to the project area and further increasing the risk of bark beetle attack to residual trees. During years of drought, bark beetle populations are capable of building up to epidemic levels in stands with high densities and then spreading to adjacent stands, overwhelming trees under little or no stress by sheer numbers.

Species Diversity

Oak

Under Alternative 4, trees greater than 16 inches DBH would not be thinned around clumps of Gambel oak. Competition between pine and oak for moisture, nutrients, and sunlight would remain high, resulting in decreased oak growth and vigor. Large oak would experience decreased longevity. Oak of all sizes would be more susceptible to disease and insect attack and mortality.

Understory Vegetation

Under Alternative 4, a 16-inch diameter cap would result in higher residual stand densities, higher canopy covers, and a decrease in the number and size of openings. With decreased sunlight to the forest floor, understory development would be significantly inhibited, resulting in decreased productivity and diversity in comparison to Alternative 2.

Grassland and Savannah Restoration

Under Alternative 4, a 16-inch diameter cap would result in higher residual stand densities within grassland and savannah restoration areas. Retaining seed sources within these areas would increase the rate of pine encroachment. As tree densities increase in these areas over time, understory productivity and diversity would continue to decrease. Grasslands and savannahs would lose their functionality over time in terms of hydrology, biodiversity, horizontal heterogeneity, wildlife habitat diversity, and natural fire breaks.

Cumulative Effects

Past, present (ongoing), and future activities considered in the cumulative effects analysis are listed in Table 3-13. In the late 1800s and early 1900s, several events, including fire exclusion, livestock grazing, and high-grade timber harvesting, occurred over approximately 75% - 98% of the project area and in adjacent areas. These events resulted in disruption of a historic fire regime that consisted of frequent, low-intensity surface fires. In 1919, climatic events favored dense ponderosa pine regeneration. At that time, understory production was greatly decreased by grazing and offered little competition with pine regeneration. As fire suppression and sawlog harvesting continued into the 20th century, regeneration from 1919 continued to increase in density. In the mid- to late 1900s, commercial thinning treatments in and adjacent to the project area removed a large proportion of the mature and old trees, contributing to a more even-aged forest structure. After the 1990s, the majority of the treatments in and adjacent to the project area consisted of precommercial thinning treatments that reduced the density of younger forest, mainly through even spacing of residual trees.

Although these treatments did provide some short-term improvement to forest health, vigor, and growth rates by reducing stand densities and increasing the growing space of individual trees, they also caused further departure from the variable, patchy tree distribution that typified the historic ponderosa pine forest structure. Additionally, blending treatments were used to produce a single age class deemed “more manageable” in the context of timber harvesting. These past events have resulted in increased stand densities, decreased age and size class diversity, increased canopy covers, altered stand structure, changes in successional dynamics, altered insect and disease dynamics, decreased understory productivity and diversity, decreased tree vigor, increased fuel accumulation and continuity, increased crown fire potential, increased fire size and intensity, and a more even-aged forest structure (Long 2003).

Figure 3-10 depicts changes in trees per acre by size class on non-reserved forest lands in New Mexico and Arizona. The graph depicts changes that are typical of southwest ponderosa pine around Flagstaff due to past events and activities, and describes a reference condition before these activities took place. The density of trees has increased significantly over time, especially in diameter classes of trees less than 13 inches. This increase in smaller size classes combined with

past management activities has resulted in decreased size class diversity and a more even-aged forest structure.

Currently, two projects near the Mountainaire Project area are proposed for 2007 – 2008. Both the Eastside and Elk Park Meadows Projects are undergoing NEPA analysis. The Kachina Village Forest Health Project is located adjacent to the western portion of the project area. Thinning within Kachina to varying densities is ongoing. The emphasis of these projects is to reduce hazardous fuel accumulation, improve forest health, and promote the development of VSS distributions recommended by guidelines for the Northern goshawk.

Cumulative Effects Common to All Alternatives

Under all alternatives, prescribed burning will not be conducted in the aspen stands located in Priest Draw to protect aspen seedlings/saplings from fire-related mortality. The installation of exclosure fences and thinning of ponderosa pine encroachment was approved under the Priest Draw Aspen Protection Project. These activities will protect aspen seedlings/saplings from elk browsing, decrease inter-tree competition, increase growth and vigor, decrease branch and canopy dieback, decrease mortality rates among overstory and understory trees, and increase aspen regeneration. Preservation of lower elevation aspen clones results in increased biodiversity at the stand and project level and increased genetic diversity between aspen clones across the landscape.

Figure 3-11 illustrates how these project areas and the current landscape consist of “moderately closed” to “closed” canopies, according to Forest ERA data

Alternative 1

There are no cumulative effects for this project under Alternative 1.

Alternative 2

Thinning treatments in Alternative 2 and many ongoing and proposed projects involve the creation of openings and enhancement of clumps and groups, creation of a variable density structure, and employ a diversity of thinning treatments (thin from below, uneven-aged, intermediate treatments). Alternative 2, in combination with ongoing projects adjacent to the project area, will result in a landscape which is more open, variable, groupy, and uneven-aged that may last up to 40 years into the future. A mosaic of varying forest structures, patterns, densities, and size classes results in increased horizontal and vertical heterogeneity, increased biological diversity, improved forest health, and a more sustainable forest structure at the landscape-level. A more sustainable forest structure is more resilient and capable of maintaining its health in the face of perturbation. Alternative 2 and ongoing treatments will result in a decreased risk of insect attack and mortality at both the project and landscape levels. Also, the risk of a crown fire of sufficient intensity to significantly alter forest structure would be reduced. These treatments will also result in faster development of a landscape-level VSS distribution recommended for the Northern goshawk by creating openings for regeneration and increasing tree growth and vigor. The creation of openings across the landscape will also result in increased understory abundance, increased diversity at the landscape scale, and increases in insects that serve as prey bases for a suite of wildlife species. Lastly, by focusing on the removal of smaller diameter trees, this and other projects will retain and produce larger diameter trees for both ecological and social/aesthetic values.

Alternative 3

The cumulative effects of Alternative 3 would be the same as Alternative 2, with the following exception. Stand densities in meso-reserves areas (228 acres) receiving a “Burn Only” treatment would remain high and continue to increase well into the foreseeable future. There is a slight risk that these high density areas may act as bark beetle “sinks”, attracting bark beetles to the area, or allowing existing populations to increase and contribute to the surrounding forest an increased risk of attack and mortality. The risk is small, however, due to the non-contiguous nature of the meso-reserve areas.

Alternative 4

Alternative 4, in combination with past management activities, would result in further departure from the uneven-aged, patchy forest structure that existed historically in the area. Stands that contain a large component of trees greater than 16 inches DBH would exhibit a more even-aged or two-aged forest structure well into the foreseeable future, contributing less size class diversity, vertical stratification, and biological diversity to the surrounding landscape. This alternative would contribute less mature and old trees to the surrounding landscape well into the foreseeable future because VSS 6 would develop at a slower rate and experience higher mortality.

The landscape would be less resilient to perturbation due to decreased size class diversity. The risk of landscape-level insect attack and mortality would be higher than Alternative 2. The project area would contribute less biological diversity and species richness to the surrounding landscape due to increased residual canopy covers, a lack of openings, and continued pine encroachment in grasslands and savannahs.

Figure 3-10. Changes in Stand Density in Southwestern Ponderosa Pine Non-Reserved Forests in New Mexico and Arizona.

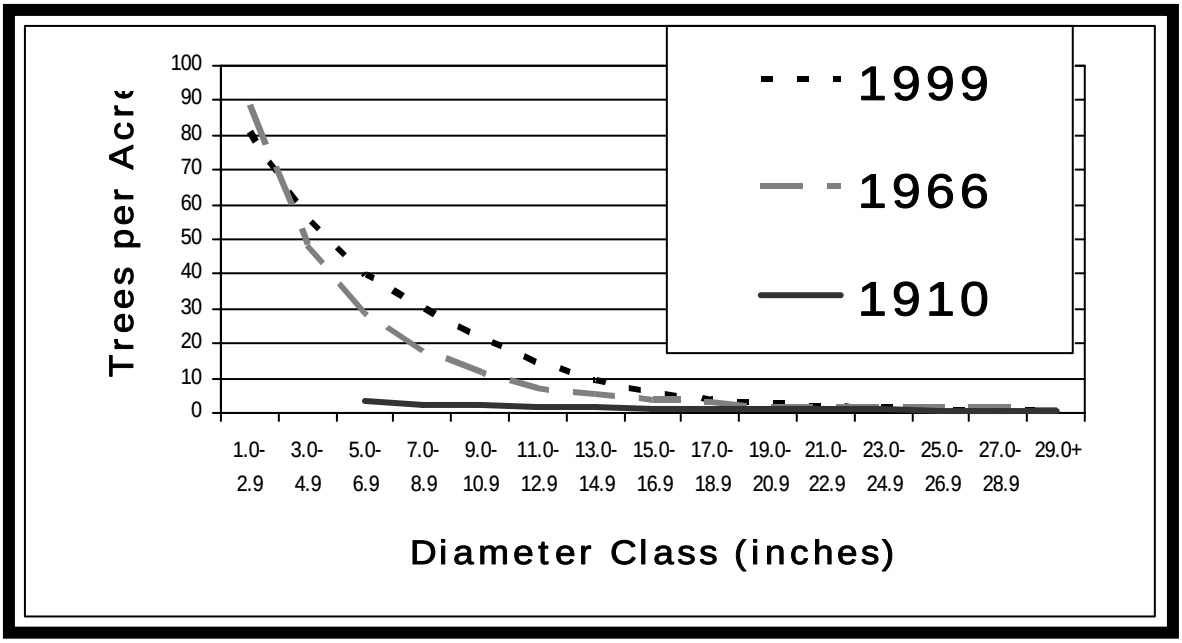


Figure 3-11. Forest ERA Canopy Cover Data Within the Greater Flagstaff Area.

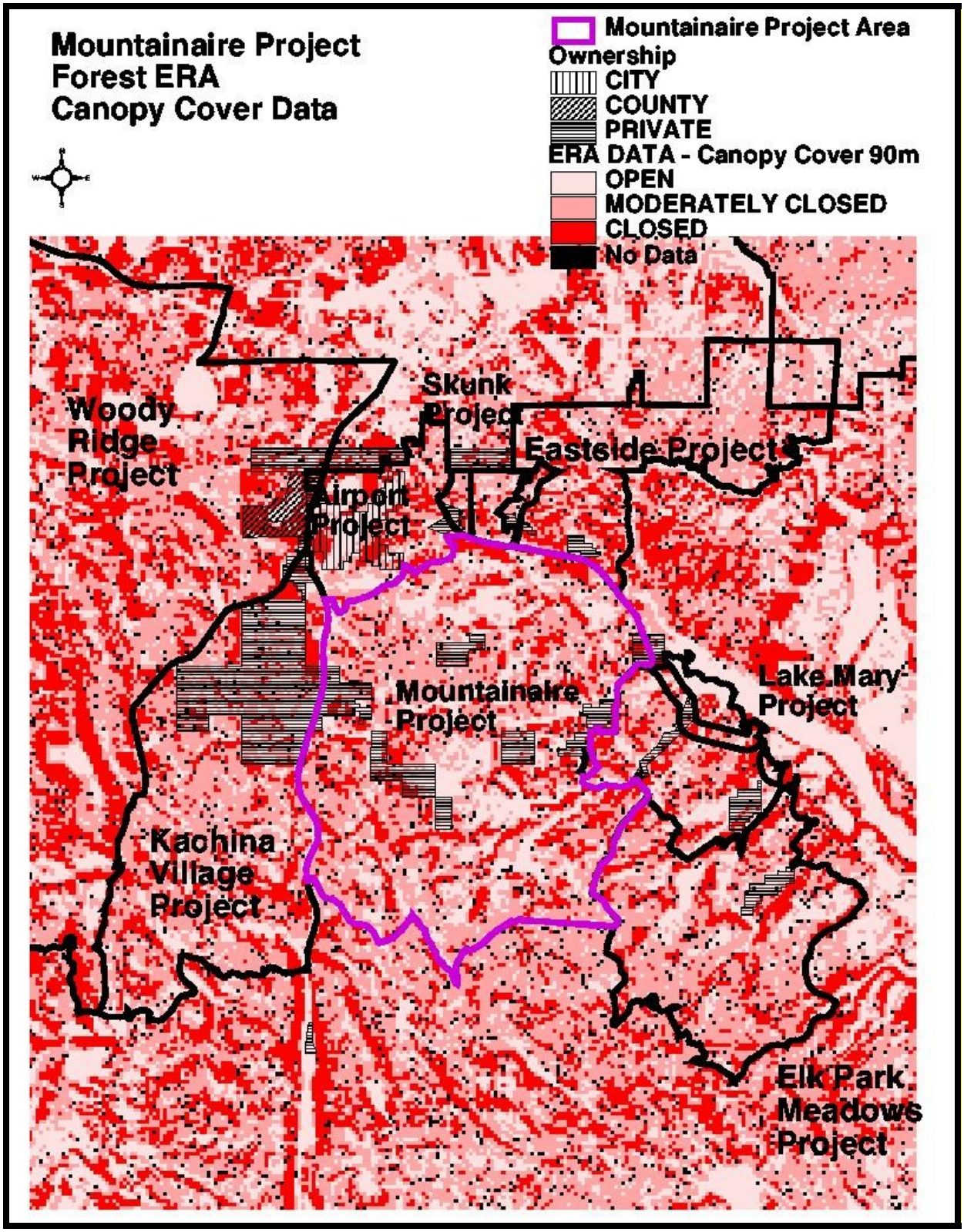


Table 3-13. Past and Ongoing Treatments In and Adjacent to the Project Area.

Activity	Occurrence	Percent of Project Area	Environmental Effects
Livestock Grazing	Late 1800's – Present	75% and adjacent stands	Reduced understory abundance and surface fuel. Contributed to the disruption of the natural, surface fire regime and conditions conducive to regeneration of ponderosa pine.
Railroad Logging	Late 1800's – Early 1900's	75% and adjacent stands	Reduced density of mature sawtimber and "yellow" pines. Decreased crown canopy cover. Opened up growing space, resulting in increased regeneration of ponderosa pine and a more even-aged forest structure.
Fire Suppression	Early 1900s - Present	98% and adjacent stands	Active fire suppression contributed to increased tree densities, accumulation of pine litter, decreased understory production, increased fire hazard, and decreased forest health.
Sawlog Harvest	1920s	75% and adjacent stands	Reduced density of mature sawtimber and "yellow" pines. Decreased crown canopy cover. Opened up growing space, resulting in increased regeneration of ponderosa pine and a more even-aged forest structure.
Sawlog Harvest	1960s	75% and adjacent stands	Further reduced density of mature sawtimber and yellow pines. Contributed to a more even-aged forest structure.
Precommercial Thinning	1970s	50% and adjacent stands	Reduced density of young forest. Some improvement to forest health, vigor, structure, and growth.
Kellam Fire	1980s	2%	Wildfire
Commercial Thinning	1980s - 1990s	45% and adjacent stands	Further reduced density of mature sawtimber. Contributed to a more even-aged forest structure.
Reforestation	1980s - 1990s	10%	Majority of reforestation done in meadows. Approximately 50% of seedlings planted failed.
Salvage Cut	1987 - 1988	1%	Removed small and large sawtimber burned in wildfire. Decreased density of snags and logs.
Seed Tree/Shelterwood Seed Cut	1987 - 1999	3%	Further reduced density of mature sawtimber. Decreased incidence of dwarf mistletoe infection. Increased regeneration and understory productivity.

Activity	Occurrence	Percent of Project Area	Environmental Effects
Kellam Fire	1990s	2%	Wildfire
TSI Precommercial Thinning	1990 - Present	4% and adjacent stands	Reduced density of young forest. Some improvement to forest health, vigor, structure, and growth.
Skunk Thinning	2004	903 acres adjacent to north portion of project area	Further reduced density of young forest. Some improvement to forest health, vigor, structure, and growth.
Dispersed Recreation	Ongoing	100% and adjacent stands	Affects localized soil condiitons (compaction), visual quality (littering), and wildlife (user trails).
Illegal Firewood Cutting	Ongoing	100% and adjacent stands	Reduces density of large diameter pine, oak, and aspen trees, snags, and logs.
Priest and Howard Draw	Ongoing	Less than 1%	Channel restoration, meadow restoration, and road cover.
Kachina Village Forest Health Project	Ongoing	11,100 acres adjacent to western portion of project area on west side of I-17	Reduce density of young and mid-aged forest and create openings. Some improvement to forest health, vigor, structure, and growth.
Priest Draw Aspen Protection Project	Ongoing	Less than 1%	Reduce density of encroaching pine and fencing for the protection of aspen seedlings/saplings
Eastside Project in Limestone Area	2007	5522 acres adjacent to northern portion of project area	Reduce density of young and mid-aged forest. Creation of openings for regeneration. Improve forest health, growth, vigor, and structure. Increase understory productivity.
Elk Park Meadows Project	2008	5048 acres adjacent to eastern portion of project area	Reduce density of young and mid-aged forest. Creation of openings for regeneration. Improve forest health, growth, vigor, and structure. Increase understory productivity.
Airport Project	Pending Land Exchange	1922 acres adjacent to northwest portion of project area	Reduce density of young forest. Some improvement to forest health, vigor, growth, and structure.

Fire and Fuels

Affected Environment

Fire Hazard Ratings

Fire hazard rating is a relative measure of how virulently a wildfire might burn under the 90 percentile weather conditions that occur from April through July. It is a relative measure from stand to stand and from pretreatment to post treatment. It is a good indicator of how effectively and safely fire suppression crews can attack a wildfire and bring it under control.

Current fire hazard ratings of the project area:

Extreme	259 acres
Very High	1,064 acres
High	5,658 acres
Moderate	6,997 acres
Low	1,259 acres

*Data, models, assumptions, metrics, and accuracy in determining fire hazard rating are located in the Fire and Fuels Report.

The current fuel conditions would likely generate dangerous fire behavior and undesirable fire effects when a wildfire occurs. The modeling indicated considerable torching and spot-fires as much as 6/10 of a mile a head of an intense surface fire. Although it would be difficult to initiate a crown fire within most sites, once initiated or if carried in from a neighboring area, many sites had sufficient crown bulk density coupled with sufficient canopy closure to sustain a crown fire and spread it through other stands. Initial attack forces would have great difficulty in controlling a wildfire occurring in this area under severe weather conditions. The forest condition after a high intensity wildfire would not meet management direction in the Forest Plan for a variety of resources.

Fire hazard rating is derived by accumulating hazard points associated with canopy closure, tree stems per acre, height to the bottom of the live crown, dead & down fuel loading, slope steepness, and aspect. While we cannot affect a change in slope steepness or aspect, their effects on fire behavior may influence how much we attempt to reduce other contributors. Another factor considered is the presence of numerous roads, trails, and dispersed camping within this project area. Human use of this project area increases the risk of a human caused fire start. Some sites within the project area may retain a higher fire hazard condition because of important wildlife considerations or because they are inaccessible by mechanized equipment. This may require further hazard reduction in the surrounding sites to mitigate the higher hazard condition of un-thinned sites.

Fuel crews collected field data including percent of canopy closure, height to bottom of live-crown, tree height, tree diameter, dead fuel loading, and tree stems per acre in 2002.

Table 3-14. Elements contributing to Fire Hazard Ratings and Current Values.

Fire Hazard Element	Current Values
Height to Live Crown	1 – 25 feet
Dead and down fuel	3 – 12 Tons per Acre
Canopy Closure	16 – 89 %
Fuel Type	Ponderosa Pine
Stems per Acre Ponderosa Pine	10 – 500
Aspect and Percent of Slope	Uncontrollable

Within some sites of the project area, the higher fire hazards are driven by all of these criteria. While in other sites the higher fire hazard is derived from spikes in 2 or 3 criteria. While neither dead and down fuel loads nor stems per acre were found to be severe across much of the project area, canopy closures and crown base heights drove the fire hazard beyond desirable levels for a wildland urban intermix.

Height to the bottom of live crown directly effects how easily a fire “torches” trees producing firebrands as well as how easily a fire transitions into a crown fire. Number of tree stems per acre also affects how easily a fire is able to transition into a crown fire. Thinning from below increases height to bottom of live crown, decreases the number of stems per acre, decreases canopy closure, and so reduces the ease with which a fire can “torch” trees, produce firebrands, and transition to a crown fire.

Dead & down fuel loading directly effects flame length and heat duration. The longer the flame length and heat duration the more difficult it is to bring a fire under control. Also the longer the flame length and duration, the more likely a fire is able to transition into a crown fire.

Canopy closure effects how easily a fire is able to transition into a crown fire by containing and accumulating heat below the crown layer. It can prevent necessary heat dispersal. Canopy closure also affects how easily a crown fire can sustain itself and spread as a crown fire.

During severe weather conditions heat could accumulate under canopy closures greater than 50% and result in tree-torching and pockets of trees torching with multiple spot fire ignitions. Although existing fire behavior programs can not model this, fire from a relatively light fuel load has frequently been observed to climb the trunks of trees during drought conditions and torch the tree tops even though ground fire flame lengths have been less than 3’. Only a more open canopy and reduced crown bulk density can mitigate this fire behavior problem.

Modeling Variables

To say that the forest or a community will be safe after treatment under treated conditions would be misleading. There are too many variables that can generate difficult fire behavior. Weather inputs cannot be used to measure how much safer an area will become after treatment, but they

are valuable in comparing relative fire hazard ratings across stands and relative to pre- and post-treatments effects.

The fuel moisture and weather characteristics used to model the fire effects are the same as those used for Flagstaff Center projects since the year 2000, in order to maintain consistency when comparing fire hazard. Many of these conditions can occur throughout the year, but occur locally most often in May, June, and early July.

1-Hour Fuel Moisture: 2%

10-Hour Moisture: 3%

100-Hour Moisture: 4%

20-Foot Wind Speed: 20mph

Air Temperature: 850F

Flame Length

Flame length is a reliable indicator of fire intensity and probable tree mortality. It can also indicate how effectively action alternatives meet other fire-related objectives.

Flame lengths under existing condition within much of the project area would be expected to exceed 4 feet. The existing fire hazard makes it very difficult for initial attack forces to control a wildfire starting under severe weather conditions that occur in April, May, June, September, and October.

Table 3-15. Expected Flame Length by Fire Hazard Rating

Extreme	Very High	High	Moderate	Low
Flame Length 4.5’	Flame Length 4.5’	Flame Length 3.5’ – 4.5’	Flame Length 3.5’ – 5’	Flame Length 2.5’

The fire suppression forces making the initial attack on wildfires that may occur within the project area are wildland fire engines. These initial attack forces can generally take effective suppression action against wildfires with flame lengths of less than 4 feet. Fires with flame lengths longer than 4 feet generally require bulldozers and even air tankers. It might even require an indirect-attack strategy, which requires considerably more distance and time than can be afforded this close to developments.

Even though the expected flame lengths decreased as the hazard rating decreased, the probability of wildfire-induced mortality remained high among mature trees due to a low crown base height common throughout the project area. The modeling indicated an extremely high occurrence of wildfire induced tree mortality (28 to 54 percent) among trees 8” to 26” diameter at breast height (DBH). Average critical flame length for tree-torching and transitioning to a crown fire is relatively low (7’ – 9’). The expected ground fire flame lengths ranged from 2.5’ to 5’. This is not a large margin for error.

Fire Regime and Condition Class

Field measures to precisely determine the area's condition class were not taken since rating by fire regime and condition class was adopted after the field surveys for this project were completed. The project area is clearly a Fire Regime I, where a fire recurrence of less than 35 years with a low percentage of overstory replacement would be expected under historical conditions. Reviewing the field data taken for this project suggests that most of the project is in Condition Class II (a moderate departure from the natural historical regime of vegetation characteristics, fuel composition, fire frequency, severity and pattern). A wildfire occurring under existing conditions would result in more severe effects than should occur for the natural Fire Regime.

ForestERA Data

The ForestERA's maps of Fire Hazard and Predicted Crown Fire Behavior are valuable measures of relative fire behavior from one part of the forest to another. One can see from these maps that much of the Coconino National Forest and the area around Flagstaff are vulnerable to severe fire behavior. The community of Mountainaire is adjacent to the project area. Flagstaff and its suburbs are within 3 miles to the northwest, north, and northeast. The most common wind direction is out of the southwest. The next most common is out of the south.

The ForestERA's map of Predicted Crown Fire Behavior indicates much of the area southwest of Flagstaff and Mountainaire is likely to generate active crown fire, while most of the project area is likely to experience passive crown fire. Passive crown fires result in torching and multiple spot fires. Since the fire behavior model they use to derive this map is not dynamic, it may underestimate active crown fire potential. On the ForestERA's fire hazard map the BTU's per square foot appear to be in range of the data taken from our field surveys. Their hazard map indicates flames lengths would be in excess of 4 feet.

The ForestERA's Fire Risk map indicates a probability of a fire larger than 50 acres occurring in a given area. Their map indicates such a fire could start in or around the project area. Since factors associated with wildfire ignitions change, the forest service's analysis focuses more on vegetation characteristics and topography that affect how virulently a fire will burn should one be ignited than on how likely a fire will be ignited in a given area.

Environmental Consequences

Alternative 1

Alternative 1 does nothing to address the fuel treatment purposes of this project. The existing fire hazard makes it very difficult for initial attack forces to control a wildfire starting under severe weather conditions that occur in April, May, June, September, and October.

When a wildfire occurs expected flame lengths would exceed 5 feet, making it difficult and unsafe for initial attack crews to control a wildfire occurring under modeled conditions. The critical flame lengths (treetop ignition) commonly range 6'-12'. Many of the sampled stands had two to three times the crown bulk density necessary to sustain a crown fire. Canopy closure exceeded 50% in many stands and closed-in to 65+% canopy cover over the course of 20 years.

Mortality of Ponderosa pine trees 8-14” diameter at breast height (DBH) would range as high as 99%. Ponderosa pine trees 16” DBH and greater could suffer mortality rates as high as 56%. Mortality of oak trees 10” diameter at root crown (DRC) and greater would be expected to reach 100% in most stands.

The indirect effects of not taking action would allow the fire hazard to worsen over time as vegetation grows and fuel accumulates. Competition between trees for moisture, nutrients, and sunlight would continue resulting in decreased tree vigor, increased susceptibility to infestation, disease and then mortality. Those trees that die, further increase the fuel load, the fire hazard, and increase the risk of successive attacks on remaining trees. The indirect effect may be the loss of habitat and wildfire damage to the private property around Mountainaire.

Alternative 2

The fire hazard ratings after implementation of Alternative 2 are listed in Table 3-16. Some acres are still rated with a High hazard rating. They may have been reduced from a higher rating to only a High rating. These areas are either inaccessible, which limits thinning opportunities, or they may have been deferred to meet certain wildlife habitat needs.

Table 3-16. Alternative 2 Treatment Acres by Fire Hazard Rating

Extreme	Very High	High	Moderate	Low
0 acres	0 acres	> 500 acres	890 acres	14,834 acres

Alternative 2 addresses the purpose and need by reducing the crown bulk density (thinning), reducing the canopy closure (thinning), increasing the effective crown base height in most stands (thinning and prescribed burning), reducing expected flame length (prescribed burning), and reducing the number and shortening the distance at which spot fires would be expected to occur (thinning and prescribed burning).

Areas Thinned to 30% Canopy Cover

In areas thinned to an uneven-age with 30% canopy closure, flame lengths after treatment would be expected to range between 0.5 and 3 feet, making initial attack of a wildfire occurring under modeled conditions safe and effective. The critical flame lengths (treetop ignition) would range between 11’-17’. The sampled stands would have a crown bulk density of 0.0014 to 0.0025 lbs/Ft^3. This in conjunction with the canopy openness is not enough to sustain a crown fire. The remaining 30% canopy cover would fill increase to no more that 40% over the course of 20 years.

Prescribed burning would be relatively easy to execute and maintain. Should a wildfire occur after this treatment it is unlikely that state air quality standards would be exceeded. Wildfire-induced mortality of Ponderosa pine trees 8-14” diameter at breast height (DBH) would not be expected to exceed 31%. Wildfire mortality of Ponderosa pine trees 16” DBH and greater would not likely exceed 9%. Wildfire mortality of oak trees 10” diameter at root crown (DRC) could reach 41%, but would not be expected to exceed 19%.

Areas Thinned to 40% Canopy Cover

In areas thinned to an uneven-age with 40% canopy closure, flame lengths after treatment would be expected to range between 1 and 3 feet. Initial attack of a wildfire occurring under modeled conditions would be safer and more effective than in areas thinned to 50% canopy closure. The critical flame lengths (treetop ignition) commonly range 10'-14'. The sampled stands had a crown bulk density of 0.0027 to 0.0036 lbs/Ft3. This is near the threshold needed to sustain a crown fire (0.0023 lbs/ Ft^3), but coupled with 40% canopy closure it is unlikely. Tree-torching and spot-fires would occur more often than in areas thinned to 30% canopy closure. The remaining 40% canopy cover would fill increase to no more that 50% over the course of 20 years.

Prescribed burning (in areas thinned to uneven-age with 40% canopy closure) would be relatively easy to execute and maintain due to the open nature of the canopy and slow forest litter accumulation. Should a wildfire occur after treatment it is unlikely to exceed state air quality standards. Wildfire-induced mortality of Ponderosa pine trees 8-14" diameter at breast height (DBH) would be expected to reach only as high as 31%. Wildfire mortality of Ponderosa pine trees 16" DBH and greater would not likely exceed 9%. Wildfire mortality of oak trees 10" DRC could reach 62%, but would not be expected to exceed 40%.

Areas Thinned to 50% Canopy Cover

In areas thinned to an uneven-age with 50% canopy closure, flame lengths after treatment would be expected to range between 3 and 4 feet. Initial attack of a wildfire occurring under modeled conditions would be safer and more effective than the existing condition. The critical flame lengths (treetop ignition) commonly range 8'-13'. The sampled stands had a crown bulk density of 0.0051 to 0.0061 lbs/Ft^3. This is about twice the amount needed to sustain a crown fire, but with only 50% canopy closure it would be difficult for a wildfire to spread as an active crown. Tree-torching and spot-fires would occur more often than in areas thinned to 40% canopy closure and much more common than in areas thinned to 30%. The remaining 50% canopy cover would fill increase to no more that 60% over the course of 20 years.

Fire crews could execute and maintain prescribed burns in these areas, although the difficulty of burning increases as canopy closure increases. These areas may be burned less often because the higher canopy closure requires a narrower range of weather prescriptions to burn correctly. Should a wildfire occur after treatment it is possible that state air quality standards would be exceeded due to the necessity of cooler prescribed burning and faster accumulation of forest litter. Wildfire mortality of Ponderosa pine trees 8-14" diameter at breast height (DBH) may be higher than would occur under a more open canopy, because flames climb tree trunks more easily with less opportunity for heat to vent through the canopy. Wildfire mortality of Ponderosa pine trees 16" DBH and greater would not likely exceed 9%. Wildfire mortality of oak trees 10" DRC and greater would not be expected to exceed 62%.

Even-Age versus Uneven-Age Treatments

Stands that would most likely contrast the differences between uneven-age thinning and even-aged thinning (thin-from-below) were modeled to show differences in fire hazards. When the fire behavior models were applied to these representative stands, they were not able to discern a great difference in fire effects between even-age and uneven-age thinning from a fire behavior standpoint. As an uneven-age prescription is applied to this project, too few small trees are left in

the stands to create a sharply higher fire hazard. The uneven-age prescription resulted in a slightly lower crown base height, but also a slightly lower crown bulk density than when using the thin-from-below prescription.

If a different uneven-age thinning prescription was applied that resulted in retaining a much greater number of small trees and if those trees had a lower crown base height than surrounding mature trees, the uneven-aged thinning could result in an effective crown ladder and a greater crown fire potential. Models do not indicate that the proposed uneven-age prescription will leave a sufficient number of small trees with lower branches to greatly increase the fire hazard.

Table 3-17. Comparison of Wildfire-Induced Mortality Among Ponderosa Pine

Species and Size		Location and Site		
		325:0010	347:0001	357:0002
Ponderosa Pine Up to 8" DBH	Existing Condition	98%	99%	99%
	All other proposed treatments	31%	31%	31%
Ponderosa Pine 10" DBH	Existing Condition	37%	98%	72%
	All other proposed treatments	22%	22%	22%
Ponderosa Pine 12" DBH	Existing Condition	16%	98%	45%
	All other proposed treatments	16%	16%	16%
Ponderosa Pine 14" DBH	Existing Condition	12%	84%	19%
	All other proposed treatments	12%	12%	12%
Ponderosa Pine 16+" DBH	Existing Condition	9%	56%	37%
	All other proposed treatments	9%	9%	9%
Oak 10+" DRC	Existing Condition	100%	100%	100%
	Thin Uneven Age to 30% Canopy Closure	4%	19%	41%
	All other proposed treatments	14%	36%	62%

(Modeling of other stands had similar results and is included in the Project Record.)

Summary of Fire Effects Across the Project Area

Thinning to a 30% canopy cover takes the crown bulk density to below the threshold for sustaining a crown fire. The 40% canopy cover dramatically reduces crown bulk density , but leaves it high enough for group torching. Thinning to 50% canopy cover reduces crown bulk density, but leaves it sharply higher than thinning to 40% canopy cover.

Thinning to 30% results in the slowest forest litter accumulation and the most “green breaks” of native grasses and annuals. This would in turn result in the lowest expected flame lengths and the slowest rates of spread in all but a few weeks of the year. Cool season grasses do not usually fully cure before the onset of the monsoons. It would provide for the easiest and most effective prescribed burning program.

Because of slower litter accumulation and the addition of grass barriers thinning to 40% canopy closure should result in lower flame lengths and lower rates of spread than the prescriptions thinning to 50% canopy cover. Some models cannot distinguish this.

The Fuel Management Analyst program is more sensitive to varying crown base height and crown bulk density. The BEHAVE 3 model can provide a better fitting ground fuel model and is sensitive to herbaceous fuel moisture. Fire behavior analysis is most accurate when multiple models are compared in light of their unique limitations. Fuel models must be selected for their fire behavior characteristics, not necessarily for their vegetative descriptors. The following table compares outputs of the two behavior models used in this analysis.

Table 3-18. Comparison of Effects Between Fire Behavior Models

Alternative B: Crown Bulk Density, Expected Flame Length, Critical Flame Length, and Rate of Spread		**BEHAVE3 Model**	**Fuel Mgt Analyst Model**		
		Representative Stand	**325:0010**	**347:0001**	**357:0002**
Crown Bulk Density (lbs/Ft3)	Existing Condition	N/A	0.0075	0.0115	0.0093
	Thin **Uneven** Age to **30%** Canopy Closure	N/A	0.0021	0.0014	0.0021
	Thin **Uneven** Age to **40%** Canopy Closure	N/A	0.0028	0.0027	0.0033
	Thin **Uneven** Age to **50%** Canopy Closure	N/A	0.0061	0.0051	0.0053
	Thin **From Below** to **40%** Canopy Closure	N/A	0.0045	0.0033	0.0036
	Thin **From Below** to **50%** Canopy Closure	N/A	0.0065	0.0056	0.0055
Expected Flame Length (Feet)	Existing Condition	5'	5.9'	5.9'	5.9'
	Thin **Uneven** Age to **30%** Canopy Closure	0.7'	2.3'	2.3'	2.3'
	Thin **Uneven** Age to **40%** Canopy Closure	1.3'	3.4'	3.3'	3.3'
	Thin **Uneven** Age to **50%** Canopy Closure	4.2'	3.4'	3.3'	3.3'
	Thin **From Below** to **40%** Canopy Closure	1.3'	3.4'	3.3'	3.3'
	Thin **From Below** to **50%** Canopy Closure	4.2'	3.4'	3.3'	3.3'
Critical Flame Length (Feet)	Existing Condition	N/A	12.2'	6.0'	10.9'
	Thin **Uneven** Age to **30%** Canopy Closure	N/A	16.9'	11.6'	15.8'
	Thin **Uneven** Age to **40%** Canopy Closure	N/A	13.9	10'	13.9'

Alternative B: Crown Bulk Density, Expected Flame Length, Critical Flame Length, and Rate of Spread		BEHAVE3 Model	Fuel Mgt Analyst Model		
		Representative Stand	325:0010	347:0001	357:0002
	Thin **Uneven** Age to **50%** Canopy Closure	N/A	13.1	7.5'	12.5'
	Thin **From Below** to **40%** Canopy Closure	N/A	14.2	10.9'	13.9'
	Thin **From Below** to **50%** Canopy Closure	N/A	13.3'	8.3'	12.5'
Expected Rate of Spread (Chains/Hr)	Existing Condition	11	23.5	23.3	23.3
	Thin **Uneven** Age to **30%** Canopy Closure	2	5.4	5.3	5.3
	Thin **Uneven** Age to **40%** Canopy Closure	3	12.7	12.5	12.5
	Thin **Uneven** Age to **50%** Canopy Closure	12	12.7	12.5	12.5
	Thin **From Below** to **40%** Canopy Closure	3	12.7	12.5	12.5
	Thin **From Below** to **50%** Canopy Closure	12	12.7	12.5	12.5

(Modeling of other stands had similar results and is included in the project record.)

Alternative 2 would maintain fuel treatment effectiveness for approximately 20 years through periodic prescribed burning and without additional thinning. Alternative 2 would have a short-term increase in wildfire hazard potential while treatments are occurring. While the proposed thinning reduces crown fire ladders, canopy closure, and crown loading, the thinning slash will be piled on site increasing the dead & down fuel loading until the piles are burned. Until the material composing these piles dries out they do not pose a significant hazard. These piles will be burned soon after they dry out. By timing thinning activities and piling activities so that the slash piles do not pose a hazard for more than a few months. These short term effects can be mitigated. This short-term increase is offset by the long-term decrease in wildfire hazard.

Alternative 3

The fire hazard after implementation of Alternative 3 is listed in the table below. Some acres are still rated with a High hazard rating. They may have been reduced from a higher rating to only High to meet certain wildlife habitat needs. They may have been inaccessible necessitating limited thinning, or they may have been deferred thinning entirely to meet certain wildlife habitat needs.

Table 3-19. Alternative 3 Treatment Acres by Fire Hazard Rating

Extreme	Very High	High	Moderate	Low
0 acres	0 acres	>500 acres	924 acres	14,666 acres

Alternative 3 addresses the purpose and need by reducing the crown bulk density (thinning), reducing the canopy closure (thinning), increasing the effective crown base height in most stands (thinning and prescribed burning), reducing expected flame length (prescribed burning), and reducing the number and shortening the distance at which spot fires would be expected to occur (thinning and prescribed burning).

The net effect of Alternative 3 on total acres by Hazard Rating is that High increases by 134 acres, Moderate increases by 34 acres, and Low decreases by 168 acres. The direct effect of Alternative 3 addresses the purpose and need nearly as well as Alternative 2, but introduces an Abert squirrel habitat experiment among some stands in the northern area of the project. This alternative leaves 3 Meso-Reserves (dense areas) surrounded my Matrix areas (more open) that are in turn bordered by Restoration cuts (more open still) in an effort to provide squirrel habitat while containing the fire hazard posed by dense interlocking tree crowns.

Meso-reserve Areas

Within the Meso-Reserve areas, flame lengths—even after treatment—would be expected to range between 3.4 and 5 feet, making initial attack of a wildfire occurring under modeled conditions difficult. The critical flame lengths (treetop ignition) would vary between 1’-10’, making tree-torching likely. Canopy cover would remain between 59% and 72%. The sampled stands had a crown bulk density of 0.0060 to 0.0090 lbs/Ft3. This coupled with the high canopy closure is more than enough to sustain a crown fire.

To retain the stand structure within the Meso-Reserves, prescribed burning would have to be executed under cool and damp conditions. Fuel reduction would be minimal. Should a wildfire occur after treatment it is likely that smoke from the Meso-Reserve stands will exceed state air quality standards. Wildfire-induced mortality of Ponderosa pine trees 8-14” DBH could reach as high as 99%. Wildfire mortality of Ponderosa pine trees 16” DBH and greater would be near 10%.

Matrix Areas

Within the surrounding Matrix cuts, flame lengths after treatment would be expected to range between 1.5 and 3.4 feet, making initial attack of a wildfire occurring under modeled conditions relatively safe and effective. The critical flame lengths (treetop ignition) would vary between 9’-17’. Canopy closure would be reduced to between 30% and 40%. The sampled stands had a crown bulk density of 0.0019 to 0.0039 lbs/Ft3. This spans the threshold needed to sustain a crown fire (0.0023 lbs/ Ft^3), but given the canopy openness, it would be difficult for a wildfire to spread as a crown fire.

Within the Matrix cuts, prescribed burning would be relatively easy to execute and maintain due to the open nature of the canopy and slow forest litter accumulation. Should a wildfire occur after

treatment it is unlikely to exceed state air quality standards. Even after treatment, wildfire-induced mortality of Ponderosa pine trees 8-14” diameter at breast height (DBH) would be expected to reach only as high as 31%. Wildfire mortality of ponderosa pine trees 16” DBH and greater would not likely exceed 9%.

Full Restoration Areas

Within the bordering Restoration cuts, flame lengths after treatment would be expected to range between 0.5 and 2.3 feet, making initial attack of a wildfire occurring under modeled conditions safe and effective. The critical flame lengths (treetop ignition) would vary between 12’-16’. The sampled stands had a crown bulk density of 0.0013 to 0.0031 lbs/Ft3. This spans the threshold needed to sustain a crown fire (0.0023 lbs/ Ft^3), but in conjunction with the canopy openness a wildfire could not spread as a crown fire. The remaining trees would be arranged in groups or clusters. While some clusters might torch-out from a wildfire, it is impossible for a crown fire to spread uninhibited across the Restoration Cut. Canopy closure would be reduced to 30%.

Within the Restoration cuts, prescribed burning would be easy to execute and maintain due to the open nature of the canopy and slow forest litter accumulation. Should a wildfire occur after treatment it is unlikely to exceed state air quality standards. Wildfire-induced mortality of Ponderosa pine trees 8-14” DBH would not be expected to exceed 31%. Wildfire mortality of Ponderosa pine trees 16” DBH and greater would not likely exceed 9%.

The Meso-Reserves would remain vulnerable to severe wildfire behavior. However, by surrounding them with the Matrix cuts and Restorations cuts, initial attack crews would likely be able to prevent a wildfire from spreading very far beyond the Meso-Reserves. Within the Meso-Reserves, expected flame lengths, wildfire tree mortality, and smoke emissions would be higher than Alternative 2. Fire behavior and fire effects within the Matrix Cuts would be similar to those stands that are thinned to uneven-aged 40% canopy closure. Fire behavior and fire effects within the Restoration Cuts would be similar to those stands that are thinned to uneven-aged 30% canopy closure.

Alternative 4

The fire hazard after implementation of Alternative 4 is listed in the table below. Some acres are still rated with a High hazard rating. They may have been reduced from a higher rating to only High to meet certain wildlife habitat needs. They may have been inaccessible necessitating limited thinning, or they may have been deferred to meet certain wildlife habitat needs.

Table 3-20. Alternative 4 Treatment Acres by Fire Hazard Rating

Extreme	Very High	High	Moderate	Low
0 acres	0 acres	>500 acres	1,090 acres	14,634 acres

Alternative 4 addresses the purpose and need by reducing the crown bulk density (thinning), reducing the canopy closure (thinning), increasing the effective crown base height in most stands (thinning and prescribed burning), reducing expected flame length (prescribed burning), and

reducing the number and shortening the distance at which spot fires would be expected to occur (thinning and prescribed burning).

The net effect of Alternative 4 on total acres by Fire Hazard Rating is that the total area with Moderate ratings increases by 200 acres, and the total area with Low ratings decreases by 200 acres. Modeling with the Forest Vegetation Simulator indicates that this alternative would have to remove trees greater than 16" DBH in 8 stands to achieve the canopy closure desired by the Proposed Action for those stands. Modeling indicated that canopy closures as low as 50% could be achieved with a 16"DBH cap in all but 2 of the 8 stands. Achieving the desired canopy closure across the project area was more difficult and resulted in slightly higher crown bulk densities.

For example, in the 8 stands mentioned above the crown bulk density was higher with a 16" cap than with Alternative 2. One stand had a crown bulk density of 0.0028 lbs/Ft^3. The other stands ranged from 0.0036 to 0.0080 lbs/Ft^3. This exceeds the threshold needed to sustain a crown fire (0.0023 lbs/ Ft^3). Loss of individual tree crowns and tree groups would likely be higher under this alternative, but with a canopy closure generally less than 50% it would be difficult for a wildfire to spread as a crown fire.

Flame lengths after this treatment would be expected to range between 1.5 and 3.4 feet (similar to Alternative 2), making initial attack of a wildfire occurring under modeled conditions relatively safe and effective. The critical flame lengths (treetop ignition) would vary between 11'-15'. The flame lengths resulting from this diameter cap that would be critical for treetop ignition were worse than Alternative 2 in four of the 8 stands.

Prescribed burning would be relatively easy to execute and maintain. Should a wildfire occur after treatment it is unlikely to exceed state air quality standards. Modeling of wildfire-induced mortality of ponderosa pine trees 8-14" DBH indicated it would not be expected to exceed 31%. Modeling of wildfire mortality of ponderosa pine trees 16" DBH and greater indicated that it would not likely exceed 9%.

However, when a diameter limit is imposed across the project area, there is less opportunity to arrange the remaining trees and space tree clusters a protective distance from one another. Fire-induced mortality may be higher than Alternative 2, because heat impact will be greater with less opportunity to vent through the canopy (arrangement of retained trees is limited by diameter cap). When a wildfire occurs, a slightly higher incidence of individual tree crown torching and tree group torching would be likely under this alternative across the project area. A slightly higher incidence of individual tree crown torching and tree group torching would be likely under this alternative, even outside of the 9 stands mentioned above. This in turn would increase the number of fire brands produced and the number of spot fires ignited would be expected to increase. While this alternative does not increase the fire hazard rating outside of the 9 stands mentioned above, it does increase the difficulty of fire control.

Cumulative Effects

Alternative 1

A cumulative effect of the no action alternative is an increase the number of acres of national forest that are vulnerable to severe fire effects. The vegetation type across the project area requires periodic fire to remain balanced. Fuel conditions have reached a point where fire effects

are more severe than desired and more severe than would naturally occur. The fire hazard and fuel profile increases with time as the vegetation grows and dies.

Another cumulative effect of the no action alternative increases the possibility that a wildfire can get established and burn with sufficient intensity to exceed the capability of emergency response personnel. Wildfires in the wild-land/urban interface place particularly high demands on emergency response personnel. Such a fire threatens multiple structures and multiple groups of people in a very short span of time. Firefighting resources must be deployed to protect the people and properties that lie in the fire's path, thus leaving fewer personnel to actually bring the fire under control. This generally results in larger wildfires and greater resource damage to the national forest.

The treatments within these projects do not eliminate the chance of a crown fire, but greatly reduce the chance of a crown fire initiating within their bounds. By leaving a large area like Mountainaire untreated, there is an increased risk of a crown fire starting in Mountainaire and spreading as a crown fire through an adjacent area that has been treated.

Finally, Alternative 1 leaves the area in Condition Class II (a moderate departure from the natural historical regime of vegetation characteristics, fuel composition, fire frequency, severity and pattern). As time passes, the area would transition to a Condition Class III (a severe departure from the natural historical regime of vegetation characteristics, fuel composition, fire frequency, severity and pattern) and further result in destructive wildfires outside of their natural fire regime.

Alternative 2

The prevailing winds for this project area are out of the southwest. The area analyzed for the cumulative fire effects of this project includes those projects that are west, southwest, south, and southeast of Flagstaff. It constitutes most of the forested land subject to the prevailing winds driving a wildfire into Flagstaff or its surrounding communities.

The time period analyzed for the cumulative fire effects of this project includes a twenty-five year period from 2000 to 2025. Prior to that time the only activities in the area that affected the fire hazard were aggressive fire suppression and the continuing growth of forest vegetation. After 2025 models indicate that the continuing growth of forest vegetation will cause the fire hazard to approach current conditions in many respects; canopy closures will fill-in, crown bulk densities will increase, and the number of new trees and shrubs will lower the effective crown base height.

Fuel reduction treatments within the Wildland/Urban interface should reduce expected fire behavior to a level at which a small number of personnel can quickly and effectively control a wildfire. This is beneficial, reducing the possibility that wildfires can get established and reducing the intensity with which wildfires can burn. This further reduces the probability that the demand on emergency response personnel will be exceeded and reduces the threat to life and private property, as well as national forest lands. Wildfires can be controlled with fewer acres burned resulting in less damage to National Forest lands. Also, wildfires burn less severely resulting in less resource damage to each acre burned.

The cumulative effect of this project adds such a fuel treatment to those that lie in the path of the prevailing winds around Flagstaff and its suburbs (Ft. Valley Restoration, A-1 Multi-Product, Mars Hill, Arboretum, Airport, Woody Ridge, Kachina Village, Lake Mary Fuel Reduction, and

Skunk Fuel Reduction). The treatments within these projects do not eliminate the chance of a crown fire, but greatly reduce the chance of a crown fire initiating within their bounds.

By treating a large area like Mountainaire, we reduce the risk of a crown fire starting in Mountainaire and spreading as a crown fire through an adjacent area that has been treated. Alternative 2 has the greatest reduction in crown fire potential and severe fire behavior over time. Alternative 4 has the next greatest reduction and then Alternative 3. These differences between them are not great.

These projects accumulate in the neighborhood of 45,000 acres analyzed and 27,000 acres proposed for treatment. As more acres that are treated in this way these benefits accumulate. As these projects are accomplished we expect the fire hazard rating for all acres analyzed to shift as shown in the following table.

Table 3-21. Expected Cumulative Change in Fire Hazard Rating Expressed as a Percentage of All Projects Analyzed to Date .

Occurrence	Extreme	Very High	High	Moderate	Low
Pre-Treatment	16%	17%	25%	27%	13%
Post-Treatment	6%	6%	14%	25%	49%

The Flagstaff Center anticipates two additional project areas east of the Mountainaire project (Marshall and Elk Park). These two might require analysis of an additional 20,000 acres. The perimeters of these proposals have not been finalized. It is difficult to speculate how many of those acres might receive thinning treatments since neither fire hazard nor equipment-access has been assessed. It is expected that most of those acres would be prescribe-burned.

The Flagstaff Center anticipates three additional project areas north and east of the Flagstaff (Schultz Pass, Jack Smith, and Eastside). These project areas would have no effect on the fire behavior or fire hazard of the Mountainaire project area.

Since existing conditions and proposed treatments vary widely across these projects and even within individual projects, it is difficult to summarize the fire effects. It is accurate to state that fire-induced tree mortality across all size classes will be dramatically reduced by these treatments. It is also accurate to state that wildfires occurring in these treated areas will be easier to control and burn less severely with less acreage burned than if the areas were left untreated. These projects combine to form a defensible space around Flagstaff and its surrounding communities.

The Fire Regime would of course remain a type I (Open forest maintained by frequent mixed intensity fires), but the condition class would move very close to a Condition Class I, where vegetation composition, structure, and fuels are similar to those of the natural regime and do not predispose the system to risk of loss of key ecosystem components. A wildfire occurring under post-treatment conditions would be characteristic of the natural fire regime behavior, severity, and patterns.

Alternative 3

The cumulative effects of Alternative 3 are similar to those of Alternative 2. Alternative 3 only slightly increases the total number of acres through which a fire can spread virulently (Meso-Reserves). Because of the limited size, number, and the strategic location of the Meso-Reserves, they have little cumulative effect on the project or the area surrounding Flagstaff. They do add to the overall expense of implementing hazard reduction for this project.

Like Alternative 2, the Fire Regime remains a type I (Open forest maintained by frequent mixed intensity fires) and the condition class would move very close to a Condition Class I, where vegetation composition, structure, and fuels are similar to those of the natural regime and do not predispose the system to risk of loss of key ecosystem components. A wildfire occurring under post-treatment conditions would be characteristic of the natural fire regime behavior, severity, and patterns.

Alternative 4

The cumulative effect of Alternative 4 slightly increases the total number of acres through which a crown fire might spread, since it restricts how trees are spaced from each other. Leaving larger trees also slightly increases crown bulk density and may slightly shorten the length of time that canopy openness is effective. Selecting which trees over 16” DBH should be removed for fire hazard on a tree-by-tree basis will add to the overall expense of implementing hazard reduction for this project. Otherwise, cumulative effects of this alternative would be similar to the cumulative effects of Alternative 2.

Like Alternative 2, the Fire Regime remains a type I (Open forest maintained by frequent mixed intensity fires) and the condition class would move very close to a Condition Class I, where vegetation composition, structure, and fuels are similar to those of the natural regime and do not predispose the system to risk of loss of key ecosystem components. A wildfire occurring under post-treatment conditions would be characteristic of the natural fire regime behavior, severity, and patterns.

Air Quality

Affected Environment

Smoke from prescribed fire must meet federal, state, and local air quality regulations. The basic framework for controlling air pollutants in the United States is mandated by the 1970 Clean Air Act (CAA), as amended in 1999 and 1990. The EPA has established National Ambient Air Quality Standards (NAAQS) for specific pollutants emitted in significant quantities throughout the country that may be a danger to public health and welfare.

All forest burning activities are regulated and administered by Article 15, Forest and Range Management Burn Rules (10/8/96). The Arizona Department of Environmental Quality (ADEQ) strictly models emissions/pollutants from all prescribed burning within the state. Any prescribed burn planned by the Forest Service must be approved by ADEQ on a daily basis. ADEQ will not allow more acres burned per day, per air shed, than is acceptable with current air quality forecasts. The Forest Service burn boss is responsible for monitoring smoke plume trajectories to

assure impacts are within predicted values. The Forest Service burn boss will make changes as needed when unpredicted weather threatens stronger impacts.

The prevailing winds for this project area are out of the southwest. However, as fronts pass winds can arrive from any compass direction for a period ranging from a few hours to 3 days. Atmospheric inversions can prevent smoke from dispersing. Within the project area inversions occur between October and December more than at other times of the year. Stagnant atmospheric conditions result from low mixing heights and light transport winds. These conditions when they occur, may last from 12 hours to 7 days (Arizona Department of Environmental Quality, Fort Collins Weather Database).

The project area is split between the Little Colorado River airshed and the Verde River airshed. The community of Mountainaire is surrounded by the project. The community of Kachina Village is located immediately west of the project. Other suburbs of Flagstaff and Flagstaff itself are within 15 miles of the project. The Forest Highway 3 corridor passes the project on the north. Interstate Highway 17 passes the project on the west side. There is a high level of recreation activity, especially in the summer months, within the vicinity of the project area.

Air quality surrounding the project area is generally good. However, smoke from wood-burning stoves and haze from automobile traffic can be seen at times during the winter months. Prescribed burning from other fuel treatment projects generates emissions that must be balanced with the air mass' ability to disperse on any given day.

Environmental Consequences

Alternative 1

No direct effects would occur since pile burning or prescribed burning would not occur. However, emissions from a wildfire occurring within the project area have been modeled. The amount of fuel consumed and the smoke generated by a wildfire occurring under Alternative 1 would be geometrically greater than that under the action alternatives. The resulting smoke would spread wider and farther than under prescribed-burning. Nighttime smoke would reach farther and impact the surrounding communities more severely. Smoke would exceed air quality standards in both volume and duration.

The current fuel and vegetative conditions would generate severe fire effects. Even after a wildfire was extinguished there would be bare soil areas that when exposed to wind would continue to produce air pollutants (dust). A wildfire occurring within the project area under the modeled weather conditions described in the Fire and Fuels section of this chapter would probably require indirect attack for successful suppression. This would result in a larger fire with greater emissions than one occurring after implementing any of the action alternatives.

Effects Common to All Action Alternatives

Alternatives 2,3, and 4 seek to reduce the fire hazard while retaining as many nutrients on site as possible. Each of these alternatives propose burning the piled thinning slash (Alternatives 2 and 4 13,780 acres, Alternative 3 13,552 acres), as well as, prescribed burning of the forest floor (16,588 acres). A direct effect of each of the action alternatives is that smoke from prescribed

burning will have short-term impacts on local air quality. These effects come from three sources: 1) pile burning of slash generated from thinning trees, 2) initial prescribed-burning the forest floor in small blocks, and 3) maintenance-burning of the forest floor. Emissions generated by these actions have been modeled for the project area.

Pile-burning is a relatively efficient combustion, producing far fewer emissions than both wildfires (pre-treatment) and initial-entry prescribed-burning. Piles can be burned during rain and snowstorms with excellent smoke dispersion and little diurnal smoke flow into canyons or basins. Proper pile burning consumes a majority of the piled fuel before atmospheric cooling begins leaving little fuel to produce smoke for nighttime subsidence flows.

Some smoke from pile burning may still subside into the neighborhoods in and around the project area. Pile burning immediately adjacent to subdivisions may cause short-term (1 day) smoke impacts to a subdivision. Public notification of burning will take place prior to ignition of both types of burning.

The initial prescribed-burning of the forest floor produces considerably more emissions than pile-burning, but less than most wildfires burning in the same (pre-treatment) fuel bed. The initial broadcast burning of each block in the project area will generate smoke for as long as 72 hours after ignition. The emissions from implementing would generally meet National and State Ambient Air Quality Standards because we can select the weather conditions under which we burn and control the size of the area burned on any given day. Table 3-22 displays modeled volumes.

Table 3-22. Impacts to Air Quality by Type of Fire

Comparison of Burn Emissions	Existing Condition Wildfire	Post Treatment Wildfire	Pile Burn	Initial Prescribed Burn	Maintenance Prescribed Burn
Ground Fuel Consumed Tons per Acre	8	2	Not Applicable	7	2
TSP Total Emissions Tons	30	0.3	6	13	3
Air Quality Standards	Exceeded	Unlikely	Unlikely	Rarely Exceeded	No

Successive maintenance burns on a given block (initiated to mimic the 3 to 15-year natural burning cycle) will generate far less smoke volume and have virtually no smoke after sunset of ignition day. Hence there would be no nighttime smoke (subsidence flow) impacts from maintenance burning. The emissions from implementing would generally meet National and State Ambient Air Quality Standards because we can select the weather conditions under which we burn and control the size of the area burned on any given day.

The high level of recreation activity that occurs in the summer months is not likely to be impacted by smoke because very little prescribed-burning is conducted during those times. Hunters and other people recreating in the project area in the fall and spring could be impacted by smoke from prescribed-burning. This could last for as long as 72 hours during the initial prescribed-burning, but only 6 hours during the maintenance prescribed-burning.

Smoke plume trajectories indicate that the communities north and east of the project area and Forest Highway 3 itself may be impacted by smoke when burning. Short-term air quality degradation and reduced visibility may be experienced in the smoke plume trajectories. After sunset, cooling atmospheric conditions will carry smoke down drainages like water flows. These down canyon flows reach the communities around the project area in the early morning hours.

These early morning flows may carry smoke down slope and reduce visibility along Forest Highway 3 and Interstate Highway 17 adjacent to the project area. These portions will be posted with appropriate signs warning motorists of reduced visibility. Ignition of each day's block would be completed in the afternoon, thus limiting the smoke generated after atmospheric cooling begins. Smoke impacts would be much worse should a wildfire occur under modeled weather conditions without the implementation of one of the action alternatives.

Indirect Effects

The reduction in the fuel load and the increased openness of the canopy will allow future broadcast burning under a wider range of weather conditions than the existing conditions. The ability of burn managers to limit undesirable smoke impacts is increased by having a wider range of weather parameters within which to burn. The areas thinned to 30% canopy closure would allow the widest range of prescribed burning weather and lowest risk of smoke impacts. The areas thinned to 40% would allow the next widest range and the areas thinned to 50% would allow the next widest.

Air quality standards would not be exceeded should a wildfire occur, except in a few isolated stands (Meso-Reserves, some of the stands left with 50% canopy closure, and the MSO PACs).

Cumulative Effects

Alternative 1

The natural fire regime for this ecosystem is frequent surface fires that generally do not involve much of the tree canopy. These would occur at 3 to 15 year intervals. This is a necessary function of this ecosystem. Most of the project area has not experienced fire in over 70 years. By not burning periodically the fuels have accumulated to an unnatural level contributing to more severe fire effects and smoke impacts when wildfires occur. This is a cumulative effect of vegetative growth, aggressive wildfire suppression, and insufficient prescribed-burning. While these actions minimized suppression costs, resource damage, and protected private property in the short-term, they have contributed to an increasing forest fuel problem.

The Coconino National Forest averages about 400 wildfires a year. Roughly half of these are human-caused with the balance caused by lightning. On average there are 85 days a year in which multiple wildfires start. The vast majority of these fires are stopped at 1/10th of an acre. Large destructive fires pull the average-annual-wildfire-acres up to 4,000 acres a year. Smoke from a

wildfire occurring under Alternative 1 will by itself exceed air quality standards. As more area is left untreated, smoke from a wildfire occurring under Alternative 1 could accumulate with emissions from other wildfires and further exceed air quality standards. This is another cumulative effect of Alternative 1.

All Action Alternatives

Although smoke from a wildfire occurring after treatment under Alternatives 2,3 or 4 would be unlikely to exceed air quality standards by itself, it could combine with the emissions of other wildfires and the accumulation may exceed air quality standards. As stated above, the Coconino National Forest averages 400 wildfires a year and 85 days a year having multiple fire-starts. This cumulative effect is not very likely under the 3 action alternatives because fuel loading will be greatly reduced by the proposed treatments. This cumulative effect would also be unlikely because after treatment, the wildfires could be controlled at a smaller size, burning fewer acres, and fewer days, thus producing less smoke.

As stated earlier, this project straddles two airsheds (Little Colorado River and Verde River). There are many other forest burning projects that affect one of these airsheds (A-1 Multi-Product, Airport, Apache Maid, Arboretum, Bald Mesa, Blue Ridge, East Clear Creek, Ft. Valley Restoration, Good Enough/Tule, IMAX, Kachina Village, Lake Mary Fuel Reduction, Mars Hill, Mint, Pocket Baker, Ritter, Rocky, Sinks, Skunk Fuel Reduction, Spearmint, Valley, Victorine, and Woody Ridge).

However, since ADEQ limits total acres burned per day per air shed, daily emissions from prescribed-burning do not accumulate to exceed air quality standards. The number of days per year in which prescribed burning occurs is likely to increase as projects are implemented, but exceeding air quality standards will not be an effect. Further, these projects combine to reduce future smoke impacts. The following table displays estimates of current forest prescribed-burning with estimated capacity assuming normal weather patterns.

Table 3-23. Current Prescribed Burning Compared to Forest Capability

Estimation of Current Forest Annual Prescribed Burning with Capability	Initial Prescribed "Burning	Est. Burn Days	Maintenance Prescribed Burning	Est. Burn Days	Prescribed Pile Burning	Est. Burn Days
Current Execution	13,000 A.	37 Days	7,000 A.	8 Days	1,700 A.	17 Days
Capability With Typical Weather	17,000 A.	50 Days	11,000 A.	18 Days	8,500 A.	43 Days

Smoke from pile-burning may combine with smoke from wood-burning stoves and automobile smoke on some days when inversions are strongest during the winter.

In stands with more closed canopies, forest floor fuel accumulates more quickly. In stands where canopies are denser, prescribed-burning can only be executed under a narrower window of weather conditions. Denser canopies result in fewer opportunities to burn and this in turn is likely

to result in less frequent prescribed-burning of those areas. Fuel accumulates more quickly and is prescribe-burned less often resulting in greater smoke impacts. This a cumulative effect that is only slightly more likely under Alternatives 3 and 4.

Wildlife

The following section summarizes existing conditions and effects from all alternatives to threatened, endangered, and Forest Service sensitive species (TES), management indicator species, and migratory bird priority species that may occur or may have habitat within the project area, wildlife cover and key habitat components such as snags and downed logs.

Threatened and Endangered Species

Mexican Spotted Owl

Affected Environment

The project area contains two dominant vegetation types – ponderosa pine/Gambel oak (3,079 Forest Service acres, 20%) and ponderosa pine (10,892 acres, 71%). Meadows and (1,252 acres, 8%) and aspen (15 acres 1%) make up the remaining vegetation types. There are several ephemeral streams throughout the project area that support perennial riparian vegetation.

Protected Habitat

One Mexican spotted owl (MSO) Protected Activity Center (PAC) is partially within the project boundary (Lake No. 1 #040526). The MSO PAC is 927 acres, with a total of 665 MSO PAC acres within the project boundary (Figure 3-10). Protected habitat includes steep slopes greater than 40%. There are 140 acres of steep slopes within the project area, all of which are within the PAC. Of the 665 PAC acres within the project area, 582 are outside the nest core. The MSO Recovery Plan (USDI 1995) allows for fire risk abatement activities in the PAC except in the nest core.

The PAC has a moderately closed canopy (average 57% canopy cover) with few openings one-quarter acre or larger. Understory production and diversity are limited. Fire hazard ratings are moderate to high. See the Fire and Fuels section for an explanation of fire hazard ratings.

All sites are multi-storied with a wide range of tree sizes. Eighty-seven percent of the area has a VSS 3 (diameters 5”-12”) class; the remainder of the area has larger trees in the VSS 4 (12”-18”) size class. Yellow-barked and large trees greater than 18” diameter are scattered throughout. Oak and pine snags have been harvested for fuelwood and are in low (< 0.5/ac) numbers. There are moderate levels (average of 3 logs per acre > 12”DBH and 8’ long) of fallen trees and woody debris. The PAC is easily accessible from the Forest Service road system and social trails are developed within it.

Sites Proposed for Thinning

Existing conditions for the two sites, Location 358, Sites 12 and 13, within the PAC do not meet threshold conditions and do not exhibit identifiable features such as a sizeable number of large trees or a considerable hardwood component. See Figure 2-1 for site location.

These sites are densely stocked with 141 to 200 trees per acre. Both sites have a VSS 3 class with eleven to twenty trees per acre 18” and larger. There are no openings within the canopy and sunlight is not adequate to maintain or enhance the oak component. The dense stand structure inhibits understory production necessary for MSO prey. Fire hazard for these sites are at the higher end of moderate.

ForestERA Data

The MSO data layer predicts the extent of MSO potential nesting and roosting habitat across the assessment area. For the Mountainaire HFRA project area, nesting and roosting habitat corresponds with the pine oak habitat and PACs. On both the project and landscape levels there appears to be a strong correlation with high quality recruitment and high density squirrel habitat. With the exception of the five PACs along Walnut Canyon in the Marshall Mesa area, the majority of the PACs and nesting habitat on the Mormon Lake Ranger District are south of the project area.

Restricted Habitat

Restricted habitat is a subset of ponderosa pine/Gambel oak habitat. Restricted habitat within pine/oak is defined by having at least 10% of the site basal area consisting of oak greater than 5” diameter at root collar (DRC). There are 2,262 acres of restricted MSO habitat within the project area (Figure 3-13).

The restricted habitat has a moderately closed to closed canopy (average 60% canopy cover) with few openings one-quarter acre or larger. Understory production and diversity are limited. Fire hazard ratings are moderate to extreme with just under half of the restricted habitat higher than the moderate rating.

Seventy-six percent of the restricted habitat is multi-storied with a wide range of tree sizes. The remaining area consists of single storied, even aged sites. Over half of the restricted habitat (59%) has a VSS 3 (diameters 5”-12”) class with the remainder (34%) of the restricted habitat having larger trees in the VSS 4 (12”-18”) size class, and a small portion (7%) with trees 24” and greater.

Figure 3-12. Protected Habitat Within the Mountainaire HFRA Project Area

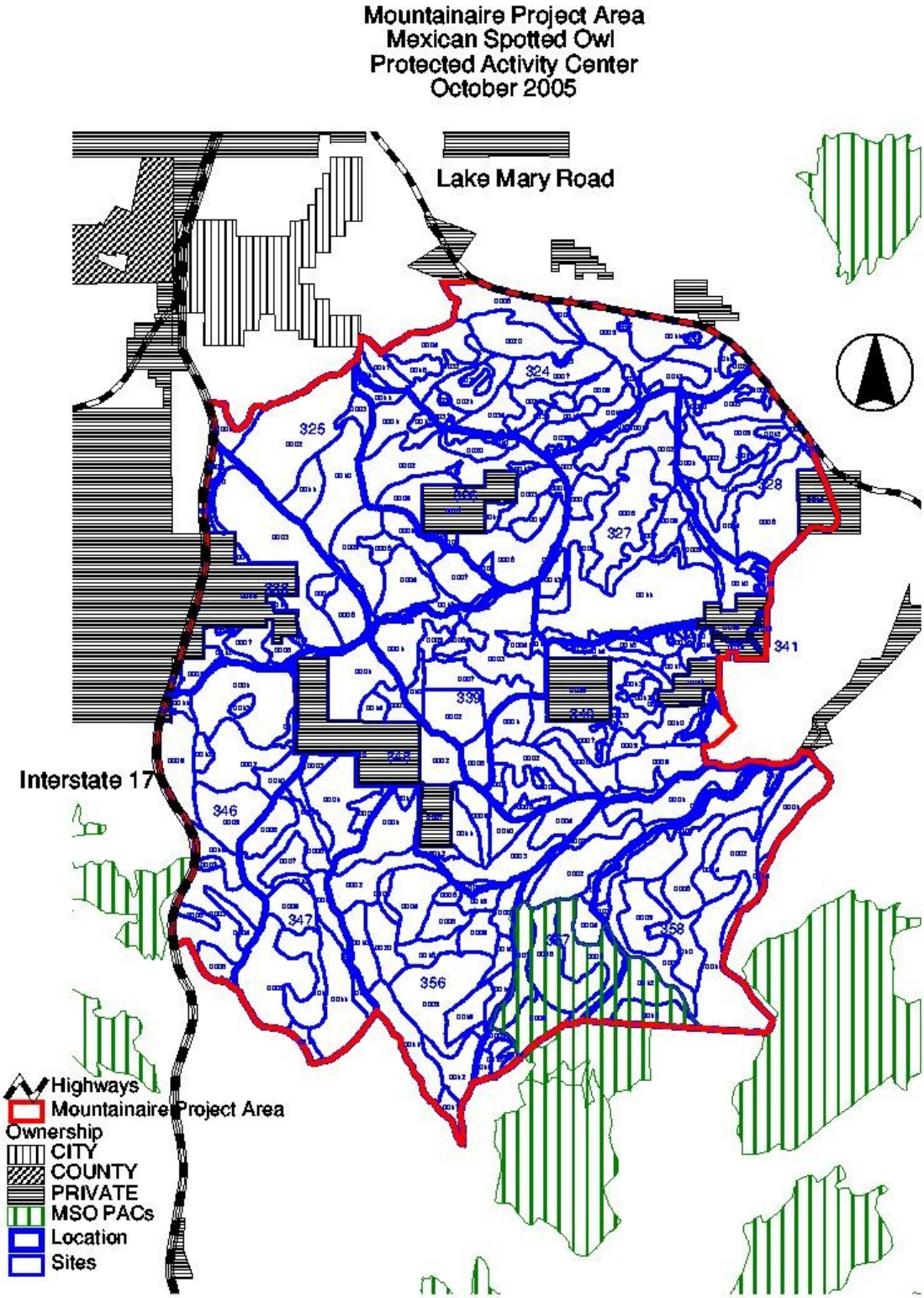
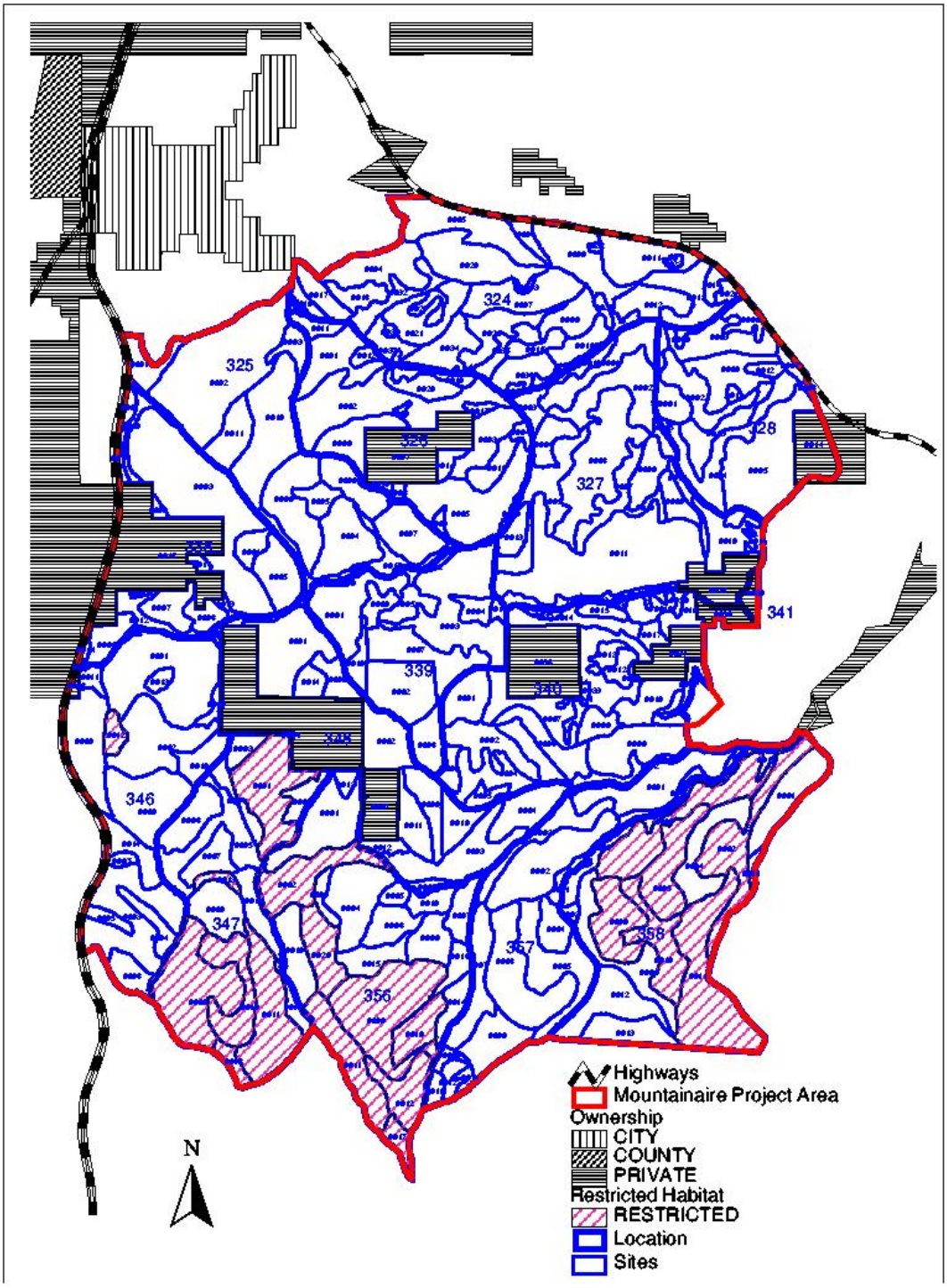


Figure 3-13. Restricted Habitat Within the Mountainaire HFRA Project Area.



Oak and pine snags have been harvested for fuelwood and are in low (less than 0.5 per acre) numbers. There are moderate levels of fallen trees and woody debris (average of 3.0 logs per acre > 12”DBH and 8’ long). The restricted habitat is easily accessible from the Forest Service road system and there are a large number of social trails developed within it.

Target and threshold habitats are managed for future nesting and roosting habitat, and are subsets of restricted habitat. No sites meet threshold habitat values. Ten to eleven percent of the restricted habitat outside of the Urban Rural Influence Zone (URIZ) is identified to meet Forest Plan guidelines. Two sites (Location 358, Sites 002 and 006) are designated as target habitat, totaling 295 acres (13% of restricted habitat). Both sites have a moderate fire hazard rating.

Designated Critical Habitat

Critical habitat is designated by U.S. Fish and Wildlife Service (FWS) to prevent any further deterioration of habitat and contribute towards the species’ conservation. For the MSO, critical habitat includes areas within mapped boundaries that are protected or restricted habitat and include one or more or the primary constituent habitat elements. There are 2,385 acres of critical habitat within the project area.

Environmental Consequences

Alternative 1

Habitat conditions for wildlife would remain in their current condition, not withstanding natural processes. This alternative would have no direct effect on MSO. However, dense forest conditions would still exist and the high fire hazard rating would continue to place spotted owl habitat at risk to stand-replacing fire. If a crown fire were to occur in MSO habitat, habitat components for nesting, roosting, and foraging would be reduced or eliminated. If a ground fire occurred, it is likely that ladders fuels would carry fire into the dense canopies and turn into a passive or active crown fire.

Tree densities would continue to be high, slowing tree growth into larger diameter classes. Habitat for MSO prey would continue to be limited by high tree densities with closed canopies. Ponderosa pine would continue to compete with oak for moisture, nutrients and sunlight resulting in reduced tree growth, vigor and longevity of oak. Desired MSO habitat components would not develop. See Table 3-25 for a description of predicted stand conditions under this alternative.

Forest Road 235B would continue to provide access to and through the PAC nest core. Traffic and recreation would potentially disturb nesting and foraging owls.

Effects Common to All Action Alternatives

There would be no direct effects from thinning activities as timing restrictions will limit disturbance to owls during the breeding season. Activities associated with prescribed burning and thinning treatments conducted outside of the breeding season normally do not result in negative effects to the MSO. The project area has been surveyed according to approved protocols. Effects from proposed treatments to adult and young owls outside of PACs are unlikely.

Prescribed Burning

Smoke created from broadcast burning would affect MSO. Smoke tends to settle into low-lying areas during the nighttime, and could potentially affect owls in and adjacent to the project area. Prevailing winds from the southwest would generally impact PACs to the northeast of burning activities with smoke. There are two PACs potentially impacted: The Lake No. 1 PAC in the project area, and the Marshall Mesa PAC located approximately two miles northeast of the project boundary. Smoke may drift into PACs from burning and this could occur in the spring within the breeding seasons, but effects would be short-term (3-5 days) and low intensity (drift smoke). Mexican spotted owls are known to return to PACs after fires and smoke events have ceased. Short-term impacts from smoke would be reduced by coordinating and timing the type of burning with wind direction, topography, time of year, and distance to PACs. All prescribed fire activities inside the PAC including snag and log lining, fire line preparation and construction, and prescribed burning will be conducted outside of the MSO breeding season between September 1 and February 28. This mitigation will greatly reduce disturbance to owls from project implementation.

The fire hazard potential within the PAC and restricted habitat will be reduced. Table 3-24 reflects the change in fire hazard rating by acres within restricted and protected habitats.

Table 3-24. Fire Hazard Change to MSO Protected and Restricted Habitat for All Action Alternatives.

Fire Hazard Rating	Existing PAC Acres	Post-treatment PAC acres	Existing Restricted Acres	Post-treatment Restricted Acres
Extreme	0	0	61	0
Very High	0	0	410	0
High	400	0	480	0
Moderate	265	400	1311	106
Low	0	265	0	2156

Thinning Activities

Thinning activities may indirectly affect MSO by changing the owl's habitat structure including snags, downed logs, woody debris, multi-storied canopies, and dense canopy cover. Prescribed burning could also reduce habitat components such as woody debris. There is the potential for owls to relocate. Ganey (2003) concludes that in some cases, it may be necessary to manage for lower basal areas and provide openings in the canopy to provide adequate sunlight to maintain oaks in well-developed sites. The proposed thinning and burning may change the structure of MSO prey species' habitat, affecting the abundance and composition of prey species. Although disturbance of prey species' habitat and harm from thinning and prescribed fire may have negative effects to prey species in the short-term (generally one year, depending on climate and moisture), the proposed treatments may increase the diversity of vegetative conditions and provide for a diverse prey base. Empirical models of factors that influence availability of Mexican spotted owls five common prey species indicate that microhabitat manipulation can influence abundance of the Mexican vole, followed by the long-tailed vole, Mexican woodrat, deer mouse, and the brush mouse (Ward 2001). Ward (2001) found that the total available

biomass (kg) of mice and voles provided the strongest correlation with reproductive output. Model results indicated that abundance (g/ha) of the two vole species could be influenced by manipulating grass-forb height, whereas abundance of Mexican woodrats, the preferred prey, might be influenced by promoting shrub diversity and increasing large log cover. Block et al. (2005) concluded that downed logs were not a strong predictor of habitat use by any of the three prey species studied, including the woodrat, in ponderosa pine/Gambel oak habitat, but found them closely associated with rocks and shrub cover.

PAC Thinning

Two treatment options—thin up to 9 inches and thin up to 12 inches for the two sites within the PAC were analyzed to show differences in treatment effects. Table 3-25 is a comparison of no treatment, thin to 9 inches and thin to 12 inches, within the Lake No. 1 PAC. The Recovery Plan for the Mexican spotted owl (USDI 1995) recommends a combination of thinning trees 9 inches diameter, removing fuels, and prescribing fire to reduce fire hazard and improve habitat conditions for owl prey. While the MSO Recovery Plan recommends no harvest of trees greater than 9 inches in diameter in PACs, the Forest Plan, which adopts the Recovery Plan direction, includes this 9 inch diameter limit as a guideline. See the Forest Plan Consistency section in Chapter 2 for more detail on this Forest Plan direction. The following bullet statements show the effects of thinning up to 9 inches DBH and 12 inches DBH and how these two treatments compare in meeting the intent of the Recovery Plan and the Forest Plan.

- Thinning up to 12 inches allows trees within these two sites to have larger quadratic mean diameters over thinning up to 9 inches over time. Treatments in Site 12 would increase the average large tree (greater than 16 inches) diameter by 5.5 inches over fifty years. Treatments in Site 13 would increase the average large tree diameter by 7.1 inches over fifty years. This diameter growth is approximately three times greater than the growth in fifty years compared to thinning up to 9 inches. These large trees are desirable for nesting and roosting.

- Thinning up to 12 inches provides the flexibility to maintain and enhance oaks, create small openings in the canopy, and grow larger trees over time without reducing canopy cover and basal area below recovery plan values. Canopy cover will return to existing conditions within forty years after treatment and basal area will return to existing conditions within 30 years after treatment. A 9 inch diameter limit would reduce the ability to maintain or enhance these components.

- Thinning trees up to 12 inches will enhance key microhabitat features required by Mexican spotted owl prey by increasing grass-forb height as well as shrub diversity in the understory. Indirect effects of habitat modification due to thinning trees up to 12 inches DBH within MSO PACs will not measurably modify the forest structural stages within these sites. Thinning pine trees up to 12 inches in diameter would improve forage and roosting habitat; reduce competition among trees for nutrients, sunlight, and moisture; and reduce fuels in the area. Thinning trees up to 9 inches in diameter would not increase grass and forb height or shrub diversity to the extent that cutting up to 12 inches would.

- Thinning would also reduce tree mortality in these areas once fire is reestablished on the ground. Thinning around oaks and yellow pines would open up these areas. Thinning dense clumps of trees would reduce competition and improve future tree growth. Some

small openings would be created in these two stands although retention of MSO habitat characteristics is more important than the creation of openings for regeneration. Openings would provide sunlight to maintain or enhance oaks and the understory. Thinning to 12 inches would remove more smaller diameter trees in these two stands to achieve these goals. Thinning up to 9 inches would leave more trees between 9 and 12 inches, limiting the size and function of openings, and leaving more competition among trees for moisture, nutrients, and sunlight.

- The lining of large logs prior to burning will maintain them as microhabitat components. Thinning and prescribed fire will promote establishment, sprouting, and growth of New Mexican locust, Gambel oak, and buck brush which are closely associated with woodrats and brushmice (Block et al. 2005).

- The relative proximity of the PAC to the Wildland Urban Interface (WUI) is notable. Because of this, there is an increased risk for fire originating in the WUI and spreading to the PAC. Conversely, risk of fire originating in these stands can threaten the WUI and communities. Fuel reduction treatments within the PAC that also maintain the unique habitat characteristics within a PAC can have simultaneous benefits for both the communities in the WUI and the PAC. Mechanical thinning and prescribed fire will indirectly benefit the Mexican spotted owl by reducing the threat of potentially harmful wide-scale stand replacing fires. Thinning stands up to 12 inches would result in significant fire hazard reduction, changing the rating from the high end of moderate to low. Thinning the two stands up to a 9 inch diameter has little effect on the fire hazard, moving both stands to the low end of moderate.

Thinning in sites adjacent to the owl PAC, in addition to the proposed thinning in the two sites, would provide added protection to owl habitat from a large wildfire event. In site 12 of the PAC, canopy closure (approximately 10%) and the number of trees per acre (about 156 to 82 per acre) would be reduced, and effective crown base height would rise to fifteen feet. In Site 13, canopy closure (~6%) and the number of trees per acre (about 160 to 60 per acre) would be reduced, and effective crown base height would rise to fifteen feet.

The Forest Service (FS) will work closely with U.S. Fish and Wildlife Service (FWS) in developing silvicultural and burning prescriptions within the two sites in the PAC. The FS and FWS will jointly inspect the tree “mark” prior to and after thinning to evaluate treatment effectiveness. Additionally, pre and post treatment assessments of habitat conditions and owl occupancy will be conducted. This on-the-ground coordination will aid in meeting MSO habitat improvement goals.

The ability to meet objectives for MSO PAC, restricted and target/threshold habitat is not limited by a 16-inch diameter limit or the research proposal.

Table 3-25. Comparison of Thinning Treatments Within the Lake No. 1 MSO PAC

		NO TREATMENT				THIN TO 9 INCHES DBH				THIN TO 12 INCHES DBH			
SITE	YEAR	BASAL AREA	TREES PER ACRE	CANOPY COVER	QUADRATIC MEAN DIAMETER	BASAL AREA	TREES PER ACRE	CANOPY COVER	QUADRATIC MEAN DIAMETER	BASAL AREA	TREES PER ACRE	CANOPY COVER	QUADRATIC MEAN DIAMETER
358/12	AFTER TREATMENT	124	156	61	12.1	119	138	60	12.6	96	82	51	14.7
	+ 20 YEARS	149	150	67	13.5	143	132	66	14.1	116	78	56	16.5
	+ 40 YEARS	169	144	71	14.6	162	127	69	15.3	132	75	60	17.9
358/13	AFTER TREATMENT	132	195	64	11.1	119	143	60	12.4	96	95	51	13.6
	+ 20 YEARS	162	188	71	12.6	147	137	67	14.0	119	91	58	15.5
	+ 40 YEARS	184	179	75	13.7	168	132	71	15.3	138	87	62	17.0

Cumulative Effects

Historical silvicultural practices of removing large-sized trees and suppression of fires have helped create the current forest structure. Cumulative effects were analyzed based on the likelihood of disturbances (smoke, visual and auditory) to impact owls within and adjacent to the project area. Visual and auditory disturbances were limited to an area within the project area and a one-half mile buffer from the project boundary. A review of all projects (past, present and reasonably foreseeable) that have the potential to impact owls during implementation was conducted. See Table 3-13 for a listing of projects. Review with the fuels management specialist concluded that smoke from broadcast and pile burning in the Munds Park Project, Seruchos Timber Sale, and Kachina Valley Forest Health Project areas would have similar short-term direct (3-5 days) and low intensity (drift smoke) effects of smoke to individual MSO.

Burning inside PACs occurs outside the breeding season for all projects. Burning outside of PACs during the breeding season is conducted in a manner that minimizes smoke impacts to MSO. However, it is anticipated that burning activities on portions of the Mountainaire HFRA project could occur simultaneously with burning activities on portions of the Kachina and Munds Park projects. While there are numerous burning operations planned in areas adjacent to the Mountainaire HFRA project area, ADEQ standards limit the total amount of burning allowed in the airshed at a given time. Thus, smoke impacts to PACs are limited.

There is a slight chance that daytime drift smoke from Munds will reach the Lake No.1 PAC. This would occur over a 1-2 day period of time each year. There is a greater chance that daytime drift smoke from Kachina project burning could move into the Lake No. 1 PAC. This would occur over a 3-5 day per of time each year. Nighttime smoke would most likely move toward Oak Creek and away from the PAC. Disturbances are localized and short-term in duration and will not affect the reproduction and overall distribution of the species.

Other cumulative effects come from vegetation modification activities such as timber sales and grazing. The PAC is within the Mud and Tinney range allotments; the restricted habitat is within four different allotments that include, Mud, Tinney, Casner Park-Kelly Seep and Lake Mary allotments; and the entire target and threshold habitat is within the Lake Mary Allotment. All allotments are currently grazed within the exception of Lake Mary, currently identified as a grass bank. Utilization study cages are placed within PACs on the Mud and Tinney allotments and are monitored two times a year to ensure that acceptable utilization levels are not exceeded. If utilization exceeds recommended limits grazing adjustments are made the following season. Cumulative effects of prescribed burning and grazing are not expected, as pastures generally are not grazed for one season after prescribed burning to allow forage growth and seed crop production. If small portions of a pasture are burned, effects to forage are mitigated through herding and salt and water placement.

Treatments in owl habitat can affect the prey base immediately by impacting individuals of prey species due to habitat disturbance of prey species' habitat and harm from fire or mechanical operations. Conversely, prey species diversity will increase with increased diversity of vegetation structural stages and improvement of understory vegetation. Over time, a more diverse prey base would enable different prey species to prosper during variable climatic conditions, thus improving food availability. Vegetation treatments in adjacent

projects will help improve tree vigor and growth, and vegetative structural stage diversity, thus promoting the growth of larger trees and habitat components for MSO. Cumulatively, these adjacent project activities combined with this project's activities will not affect the reproduction or overall range of the MSO.

Existing roads provide access to MSO nest areas and increase the potential for recreation activities and fuelwood cutting to occur. Illegal fuelwood cutting of oak is ongoing. The Mountainaire Community Trails Project includes future proposed activities that may beneficially affect Mexican spotted owls in the Mountainaire HFRA Project area by closing trails in restricted habitat. Road closures will not only reduce potential disturbance from humans to owls but will reduce access thereby minimizing the potential loss of large oaks and snags and downed logs to fuelwood cutting.

Treatments in the Mountainaire HFRA project area will provide protection from stand replacing crown fires to MSO protected and restricted habitat not only within the project boundary but also in areas northwest of the project, specifically the Marshall Mesa area.

Bald Eagle

Affected Environment

Bald eagles are primarily winter visitors to the Coconino National Forest, occupying all habitat types and elevations. Wintering eagles arrive in the fall, usually late October or early November, and leave in early to mid-April. They feed on fish, waterfowl, terrestrial vertebrates, and carrion. Eagles are often seen perched in trees or snags near water or next to roadways where they feed on road-killed animals. At night, small groups (usually 2-12) or individual eagles roost in clumps of large trees in protected locations such as hillsides or drainages. Eagles usually roost adjacent to or very near food sources.

Nesting Habitat

A small, resident population of bald eagles breeds in Arizona and New Mexico. These eagles place their nests on cliff ledges and in live trees or snags along major rivers and reservoirs. In Arizona, eagles are known to breed along the Salt, Verde, and Bill Williams rivers, on Tonto Creek, Lynx Lake and Roosevelt Lake in central Arizona, and Lower Lake Mary in northern Arizona. Known nesting on the Coconino National Forest is along Lower Lake Mary and the Verde River, one and one-quarter and twenty miles from the boundary of the project, respectively. The Lower Lake Mary nest was first located in July of 2004 when bald eagles were seen constructing the nest but were not using it. The eagles did not attempt to nest until the following summer (2005) when they fledged one young eagle. A seasonal bald eagle closure order (Order No. 04-05-01-W) has been issued for this nesting territory limiting motorized and non-motorized use during the breeding season (January 1 to August 31). There is no nesting or potential nesting habitat within the project area based on the absence of habitat and nesting structures common to nesting bald eagle sites in the Southwest. There are no wetlands in the project area and it is unlikely that this area will provide nest sites for bald eagles in the future.

Roosting Habitat

There are no known summer or winter roosts within the project boundary. There is one known winter roost site located one and one-quarter mile east of the project area and was documented to be used by eagles during the summers of 2004 and 2005. This location is where the newly discovered nesting eagle pair successfully fledged one young the summer of 2005. There is one site one-half mile southwest of the project and west of Interstate 17 identified to have vegetative and topographic attributes similar to other Forest roost sites and has been identified as a "potential roost."

Foraging Habitat

Eagles forage widely and opportunistically on carrion, waterfowl or fish on the Forest. Waterfowl and fish distribution are driven by amount and timing of precipitation and fish stocking by the Arizona Game and Fish Department. Eagles are expected to use any open water that would support waterfowl. Other than Lower Lake Mary, there are no significant water bodies in the project vicinity, although eagles may feed on mammalian prey in project area. Another important habitat factor is the presence of large trees, snags, or ledges for foraging perches. Bald eagles have been observed perching in snags and dead-topped trees within and at the fringes of the project area.

Environmental Consequences

Alternative 1

Habitat conditions would remain in their current condition, not withstanding natural processes. Because there would be no habitat altering activities or disturbance associated with project implementation, this alternative would have no direct effect on the bald eagle. However, dense forest conditions would still occur and the high fire hazard potential would continue to place bald eagle nesting and roosting habitat at risk to stand-replacing fire.

Tree densities would continue to be high, which would slow tree growth into larger diameter (> 18-inch) trees important for roosting and perching.

Effects Common to All Action Alternatives

Direct effects to the bald eagle would be from activities that cause disturbances (smoke, auditory or visual) to eagles within or adjacent to the project. Direct effects to nesting eagles would come from burning activities within two miles of the eagle closure during the breeding season (January 1 – August 31). Burning and smoke accumulation during times when eagles are incubating eggs and tending nestlings and young could cause adults to leave the area. This in turn could cause reproductive failure for the year.

During the daytime, smoke normally travels 1000-2000 feet above the ground. Light drift smoke could occur within the eagle roost/nest site for three to four hours during the day with most smoke moving up and over the site. Smoke tends to settle in canyons and low-lying areas during the nighttime. At night smoke would settle to the ground and flow downslope for approximately one-half to one mile from the eagle closure. When burning activities occur in

the area south and west of the eagle site, smoke could drift from the project area and be pulled out through Priest and Howard Draws funneling toward the eagle roost/nest and potentially creep into the roost/nest location. During the winter months smoke would settle into adjacent drainages with little impact to the elevated roost location. Burning will not occur within a two-mile radius of an occupied nest site during the bald eagle breeding season.

Log Hauling

Direct effects to nesting and roosting eagles would come from visual and auditory disturbances from repeated entries into the nest/roost territory by trucks using the selected haul route for timber removal from Location 358, Sites 1-14 which utilize Forest Roads 296 and 296A. These roads are located in the bald eagle closure area and project implementation would likely require the use of this haul route during the bald eagle breeding and/or roosting season. For Location 358, approximately 820 truckloads would be hauled using this route[6]. Using an estimate of twenty loads per day, it would take the contractor a minimum of eight weeks to remove all of the timber. There is a six week window (September 1 – October 15) between the breeding season and winter roosting season where hauling activities would not likely adversely affect the bald eagle. Due to the number of truckloads and potential weather and road conditions that may limit the ability to haul during the winter months, hauling activities could take place during both the winter roosting season (October 15 – April 15) and the breeding season (January 1 to August 31). The Draft Bald Eagle Conservation Strategy (Arizona Game and Fish Department 1999) recommends that projects and activities causing disturbance to winter roosting bald eagles be avoided October 15 to April 15. Disturbance during the winter has the potential to reduce the use of foraging areas and limit food intake, increase activity levels and associated energy costs, and force eagles to live in areas where resources are less adequate, thus lowering the carrying capacity for the site. Wintering eagles so affected could exhibit higher mortality and lower productivity, although these affects have not been documented (Fraser 1985, Stalmaster 1987:159-162 in Stalmaster 1998). Disturbance during the nesting season could increase the potential for nest failure and lowered nesting success. Use of this haul route will have an adverse effect to bald eagles, if they are present in the area during implementation. Typically, eagles do not nest in northern Arizona and unusually high lake levels in 2005 were thought to contribute to their ability to nest in this location. We are not sure if these birds will attempt to nest again, especially if lake levels decline or return to normal. Monitoring eagle activity at this location over the next few years will provide valuable information that can be used to reduce impacts during the more critical time periods if necessary. Effects would occur over one to three breeding/roosting seasons and would last approximately forty to fifty days with approximately twenty trucks passing on the road by the site per day. Other steps we will implement in an attempt to reduce impacts to eagles using this nest/roost will be to require a speed limit of 15 to 20 miles per hour and a no “Jake” brake restriction within one-quarter mile of the site. Additionally, every attempt will be made to complete hauling through the nest site in the late summer and early fall (July through October).

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[6] Volume of timber to be removed by truck was estimated from approximate cubic feet of timber/acre removed on similar fuels reduction treatments within the urban – interface.

Mechanical thinning activities are not expected to affect breeding eagles because there will be no activities within one and one-quarter mile of the nest site during the breeding season thus there would not be any auditory effects to nesting eagles.

Under all action alternatives, proposed mechanical treatments, broadcast burning and timber hauling may cause visual or auditory disturbance to foraging bald eagles. 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.

There are no anticipated adverse effects to prey species or prey species habitat. Indirect effects are more likely to occur when project treatments 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. Prescriptions will be designed to maintain clumps and groups of large trees across the landscape further reducing impacts to potential habitat.

Thinning would improve old tree longevity. Lining of yellow pines and snags will reduce potential mortality to these components from burning activities. All action alternatives include recruitment of trees into developing old-growth habitat over at least 20% of the area that may be used as future winter roost sites for bald eagles.

Alternative 4

Alternative 4 would move trees into the older VSS structural stages at a slower rate. Although more trees 18 inches will remain immediately after treatment more sites would remain even-aged immediately after treatment and would not provide for developing structural stages as quickly. A 16 inch diameter limit would also hinder the ability to protect and enhance old yellow pines by preventing the thinning of larger black-barked ponderosa pine around trees. Old growth would develop at a slower rate slowing the development of potential additional winter roost sites within the project boundary.

Cumulative Effects

The area for analysis includes the area that is within two miles of eagle nests, roosts, and high use winter foraging areas (Interstate 17, Federal Highway 3). Under the action alternatives, there may be effects to the one nest/roost site which could affect the numbers, distribution or reproduction of the bald eagle from hauling activities within the designated nest and roost buffer zone. There may be an added effect from the Elk Park fuels reduction project, as project implementation would have similar effects to nesting and roosting eagles from project implementation. The haul route selected to remove timber from the southeastern portion of the Mountainaire HFRA project will likely be the same route required for the Elk Park Meadows project unless easements across private lands can be secured prior to implementation. Impacts would be limited to this nest/roost site.

Short-term disturbance to foraging or roosting bald eagles during thinning and broadcast burning activities may cause eagles to forage and roost in nearby areas for the duration of the activity. Short-term (the time it takes to complete implementation) impacts of burning the project area in addition to the Kachina Valley or Munds Park projects will not cause a negative effect since burning is not likely to occur in these areas simultaneously. These effects, combined with APS hazard tree removal for powerlines and ADOT and County

hazard tree removal for highways, will reduce the number of snags and large trees for perching along high use winter foraging areas in the analysis area.

Black-footed Ferret

Affected Environment

There are no records of black-footed ferret in the project area or vicinity. Four Gunnison's prairie dog towns occur in the central and northern portions of the project, three of which are abandoned. In 1998 prairie dog towns covered approximately 291 acres (72, 48, 48, 123 acres). These towns are part of the Heckethorn complex and were found to be abandoned during surveys (Randazzo 1998). The towns were surveyed again in 2004 and a portion of the 123-acre town was found to be active. The Heckethorn complex is not considered suitable for re-introduction of black-footed ferrets as they are mostly abandoned and the threats from private land ownership, including canine distemper from domestic dogs (Coconino National Forest 2000).

Environmental Consequences

Alternative 1

There are no direct effects to black–footed ferrets as none occur in the project area.

Alternative 1 will not treat meadows or meadow edges and will continue to have trees encroaching these habitats over time and reducing potential habitat in meadow and savanna habitats for Gunnison's prairie dog, a primary prey species.

Effects Common to All Action Alternatives

Indirect effects to the black-footed ferret include effects to ferret habitat, ferret prey species, or prey species habitat. There are no anticipated adverse effects to prey species or prey species habitat.

Grassland and savanna restoration treatments would improve and increase available habitat for Gunnison's prairie dog, a primary prey species. All action alternatives increase available habitat for prairie dogs by 18% with 2,870 acres of grassland and savannah enhancement treatments.

Alternative 4

A 16-inch diameter limit would result in higher residual stand densities within grassland and savannah restoration areas. Retaining seed sources within these areas would increase the rate of pine encroachment. As tree densities increase in these area over time, understory productivity and diversity would decrease.

A 16-inch diameter limit would inhibit the ability to maintain grasslands and savannahs to presettlement conditions potentially affecting the quality of available habitat for prairie dogs over time.

Cumulative Effects

The area for cumulative effects analysis is the project area boundary. Under all action alternatives there is no effect to the numbers, distribution or reproduction of the black-footed ferret so there is no added effect from past, present, or foreseeable future projects.

SENSITIVE SPECIES

Table 3-26. List of sensitive species that are present or have habitat in the project area

SPECIES NAME	SCIENTIFIC NAME	LISTING STATUS
Birds		
Northern goshawk	*Accipiter gentilis*	S3, SEN, WSC
American peregrine falcon	*Falco pereginis anatum*	S3, SEN, WSC
Mammals		
Navajo Mountain Mexican vole	*Microtus mexicanus navaho*	S1, SEN, WSC
Amphibians		
Northern leopard frog	*Rana pipiens*	S2, SEN, WSC
Invertebrates		
Blue-black silverspot butterfly	*Speyeria nokomis nokomis*	N1, SEN
Mountain silverspot butterfly	*Speyeria nokomis nitocris*	N3, SEN
Spotted skipperling	*Piruna polingii*	N3, SEN

Northern Goshawk
Affected Environment

The northern goshawk uses a wide variety of forest stages in ponderosa pine and mixed conifer habitat. The goshawk preys on small mammals and medium sized birds. It prefers sites of moderately closed to closed canopy cover for nesting and more open areas for foraging. All ponderosa pine and mixed conifer above the Mogollon rim is considered goshawk habitat, including associated pine or mixed conifer stringers that may extend below the rim. Nest sites are typically located in later successional stages, especially old growth (VSS 6). Reynolds et al. (1992) demonstrated that nest sites typically have a vegetative structural stage class of VSS 5B to VSS 6. Post-fledging family areas (PFAs) have patches of dense trees, developed herbaceous or shrubby understories, snags, downed logs, and small openings that provide cover and prey species. Fledglings develop their hunting skills in these areas. Foraging areas, by virtue of their size, are a mosaic of various successional stages and cover types.

Goshawk foraging use is associated with ponderosa pine vegetation. Although juniper or pinyon-juniper habitat types are not heavily used by northern goshawks, some foraging may occur in these habitat types, especially in transition areas between ponderosa pine and pinyon-juniper habitats.

Threats to northern goshawks are generally related to timber management. However, fire suppression, livestock grazing, drought, and toxic chemicals may also be involved (Reynolds et al., 1992). Large-scale wildfires are also threats to northern goshawks. Declines in

goshawk populations may be related to decreases in prey populations associated with changes in structure and composition of forests.

Three northern goshawk PFAs are located within the project boundary. They are: #040502 Seruchos, #040507 Upper Pumphouse, and #040522 Faye. The project area and ½ mile beyond the boundary was surveyed for northern goshawks in 2002 according to Region 3 Forest Service protocol. No goshawks were found during that survey period.

The majority of the Seruchos PFA overlaps the Lake No. 1 Mexican spotted owl PAC (040526). The spotted owl standards and guidelines will take precedence over the northern goshawk standards and guidelines at overlapping sites.

Vegetative Structural Stage (VSS)

The Forest Plan states that the desired vegetative structural stage (VSS) classes for spruce-fir, mixed conifer, and ponderosa pine forests, within and outside PFAs is 10%, 10%, 20%, 20%, 20%, and 20% for VSS classes 1 through 6, respectively.

The existing Vegetative Structural Stages (VSS) distributions within PFAs and foraging areas does not meet Forest Plan guidelines. Sites within PFAs still lack optimal nesting sites. Optimal nest sites for northern goshawk have a vegetative structural stage classification of VSS 5B through VSS 6 (Reynolds et al. 1992). Currently there is a lack of optimal nest sites across the project area.

Canopy Cover

Canopy cover is also lacking in PFAs and does not meet Forest Plan direction. While canopy cover values for VSS 5 within the goshawk PFAs are met, values for VSS 4 and VSS 6 are not met. The Canopy Cover outside PFAs, in foraging areas meets the Forest Plan guidelines.

Table 3-27. Canopy Cover Distribution in Ponderosa Pine Vegetation Type Outside the Northern Goshawk PFAs.

VSS	Current Acres	Current Percent Acres	Current VSS Canopy Cover Percentage	Forest Plan Direction For Canopy Cover percentage
4A	494	16		VSS 4 should average 40+%
4B	3269	40		
4C	2639	32		
4 Total	6402	88	51%	
5A	227	.2		VSS 5 should average 40+%
5B	916	11		
5C	576	.7		
5 Total	1719	11.9	50%	

VSS	Current Acres	Current Percent Acres	Current VSS Canopy Cover Percentage	Forest Plan Direction For Canopy Cover percentage
6A	0	0		VSS 6 should average 40+%
6B	10	.1		
6C	0	0		
6 Total	10	.1	55%	

VSS subclasses: (A) <40% canopy cover; (B) 40-59% canopy cover; (C) >60% canopy cover.

Table 3-28. Canopy Cover Distribution Within the Post-fledging Family Areas (PFAs) for VSS 4-6 sites, Ponderosa Pine Vegetation Type Only.

	Upper Pumphouse PFA (040507)			Seruchos PFA (040502)			Faye PFA (040522)			
VSS	Existing Acres	Existing Percent Acres	Average percent	Existing Acres	Existing Percent Acres	Average percent	Existing Acres	Existing Percent Acres	Average percent	**Forest Plan Direction For Canopy Cover percentage**
4A	0	0	0% (1/3) and 0% (2/3)	0	0	9% (1/3) and 0% (2/3) 0 acres 60+%	18	3	17% (1/3) and 11% (2/3) 87 acres 50+% and 56 acres 60+%	VSS 4 average canopy cover should be 60+% (1/3) and 50+% (2/3)+%
4B	0	0		116	19		422	68		
4C	0	0		0	0		57	9		
4 Total	0	0		116	19		497	80		
5A	0	0	58%	0	0	44%	7.1	1	33%	VSS 5 average canopy cover 50+%
5B	0	0		13	2		0	0		
5C	376	95		0	0		0	0		
5 Total	376	95		13	2		7.1	1		
6A	0	0	0%	0	0	0%	0	0	0%	VSS 6 average canopy cover 50+%
6B	0	0		0	0		0	0		
6C	0	0		0	0		0	0		
6 Total	0	0		0	0		0	0		

VSS classes 4=12-17.9 inches DBH, 5=18-23.9 inches DBH, 6=24+ inches DBH. A=<40% canopy cover, B=40-59% canopy cover, C=60+% canopy cover.

ForestERA Data

The ForestERA northern goshawk nesting habitat data layer is a prediction of the extent of nesting and post-fledging habitat. Within the project area this habitat overlaps with two of the three PFAs[7]. On a landscape-scale nesting and post-fledging habitat corresponds with the Abert squirrel high quality recruitment and high density habitat and is found within the same contiguous blocks.

Environmental Consequences

Alternative 1

Habitat conditions for wildlife would remain in their current condition, not withstanding natural processes. This alternative would have no direct effect on goshawks. However, dense forest conditions would still occur and the high fire hazard potential would continue to place goshawk habitat at risk with respect to stand replacing fire. The desired conditions for sustaining breeding season habitat for goshawks and their prey would never be attained.

Effects Common to All Action Alternatives

There are potential direct effects from smoke and thinning treatment. Smoke could affect nesting and feeding behavior. Goshawk may be flushed from nest sites and/or change their foraging behavior due to smoke accumulation. This could cause goshawks to expend more energy and/or cause them to be detectable to predators during movements. Smoke from broadcast burning may disturb individual birds, although this would be a short-term effect and activities would be temporally and spatially separated, which would reduce overall effect. These smoke and auditory and visual disturbances would be short-term and will not affect the overall distribution of northern goshawk.

Avoiding burning near goshawk nesting areas during critical periods in the goshawks life cycle is important. Smoke accumulation during times when goshawks are incubating eggs and tending nestlings and fledglings could cause adults to leave the area; this in turn could cause reproductive failure for the year. Smoke effects are short-term (1-3 days). Impacts from smoke are reduced by the coordination of timing and type of burning with wind direction, topography, time of year and distance to goshawk nesting area.

Prescribed burning or thinning activities may indirectly affect the goshawk by changing the goshawks habitat structure (snags, downed logs, woody debris, vegetative structural stages, and dense canopy cover). In addition the proposed activities may change the structure of goshawk prey species' habitat, affecting the abundance and composition of prey species. Although treatments, especially prescribed burning, may have adverse effects to prey species and their

[7] The Faye PFA has been in question as it was designated based on shell fragments and there are no known nest locations or actual sightings. Stand data does not identify this PFA as high quality nesting habitat.

habitat in the short term, the proposed treatments may increase diversity of vegetative conditions, which would provide for a diverse prey base.

It is estimated that there may be up to 20% loss of snags and 50% loss of downed logs during broadcast burning (Randall-Parker and Miller 1999) although many will be protected using appropriate ignition and piling techniques, and lining of most snags and large logs. In addition, after burning, trees will be felled to replace logs burned up during prescribed fire to meet forest plan guidelines.

Reduction of snags and logs would have a negative impact on numbers of prey items, thus prey availability, for northern goshawk. The impact of this effect is expected to lessen in the short-term as snags fall and become logs. The number of snags would continue to be in short supply, due to an existing shortage of snags. The number of snags is expected to increase in the future as other trees grow, age, and die. Under all action alternatives, the fire hazard potential within the PFAs and foraging areas is reduced.

All action alternatives will, where existing, maintain canopy cover values as identified in desired conditions in both foraging areas and PFAs. PFAs will maintain an average 50% canopy cover and nest sites will maintain a 60% canopy cover where existing.

Vegetative Structural Stages (VSS)

Treatments described in all action alternatives would alter VSS class distribution, changing the project area from one dominated by VSS 3 more toward the desired future condition, although still not meeting the desired future condition. None of the action alternatives will result immediately in the desired VSS class distribution as outlined in the Forest Plan for the northern goshawk. Trees will grow into the larger diameter classes at a faster rate than Alternative 1 (no action). Over forty years the quadratic mean diameter (QMD) in PFAs will increase approximately six inches more than the no action alternative. All action alternatives would offer higher quality nesting habitat over time (VSS 5 and 6 with 60% canopy cover) due to the increase in the acres of VSS 5 and 6 sites over the forty years following treatment.

The ability to meet objectives for VSS within PFAs and foraging areas is not limited by the research proposal (Alternative 3).

Alternative 4

A 16-inch diameter limit would reduce the ability to create openings one-quarter to four acres in size, as recommended by the Northern Goshawk Management Recommendations (Reynolds 1992). A reduction of openings will limit natural regeneration and the ability to develop VSS1 and VSS2 across the landscape; reduce horizontal and vertical diversity; and reduce understory productivity and diversity. This will decrease the abundance and availability of prey.

Canopy Cover

All action alternatives will meet Forest Plan guidelines for the northern goshawk management by maintaining an average of 40% canopy cover within VSS 4, 5, and 6 classes in foraging areas. Existing low canopy cover values in these VSS 4, 5, and 6 classes within PFAs will continue to be low.

The ability to meet objectives for canopy closure for PFAs and foraging areas is not limited by the research proposal. All three research area units are located outside of PFAs in goshawk foraging areas. The average canopy cover in these foraging areas will be similar to those described in Alternative 2. The denser canopies of the meso-reserve areas will compensate for the surrounding full restoration treatments with lower canopy cover values. The Abert squirrel is one of fourteen northern goshawk prey species. The research proposal will maximize Abert squirrel densities and recruitment opportunities, and move towards target canopy cover values needed to provide abundant and sustainable populations of prey species.

The ability to meet objectives for canopy closure for PFAs and foraging areas is not limited by a 16-inch diameter limit. The Forest Plan guidelines are based on canopy cover averages across the project area and although a 16-inch diameter limit will increase canopy cover percentages in approximately 526 acres of foraging habitat, prescriptions will still be designed to meet an average canopy cover of 40% in VSS 4, 5 and 6 across foraging areas within the project.

Cumulative Effects

For the northern goshawk cumulative effects were analyzed based on the likelihood of disturbances (smoke, auditory and visual) to impact goshawks within or adjacent to the project area. Visual and auditory disturbances were limited to an area within the project area and one-half mile buffer from the project boundary. There is one additional PFA, Zuni, within one-half mile of the project boundary. Existing human use in the Zuni, Pumphouse and Faye PFAs is high. Road density is high, and there are many miles of social roads and trails in localized areas. High human use, combined with high road and trail densities, have the potential to impact northern goshawks by providing access to nest areas and increasing the potential for disturbance to nesting goshawks. The Mountainaire Need for Change analysis identified roads and trails in PFAs within the Mountainaire HFRA project as a priority for closure and the Mountainaire Community Trails Project is anticipated to improve habitat within these goshawk post-fledgling family areas.

There is an added indirect effect regarding vegetation modification activities. Other projects where modification of goshawk habitat occurs within the Mountainaire HFRA Project area are: ADOT tree removal along Highway 17, Coconino County tree removal along Federal Highway 3, APS hazard tree removal along powerlines, development of private lands and Federal lands acquired through the Townsite Act. Cumulative effects are not expected to affect the reproduction or overall distribution of northern goshawks.

American Peregrine Falcon

Affected Environment

The peregrine falcon was removed from the Federal List of Endangered Wildlife in August 1999, and it is now a Region 3 Forest Service sensitive species (USDI, 1999). The essential habitat for the peregrine falcon includes rock cliffs for nesting and a large foraging area. Suitable nesting sites occur on rock cliffs with a mean height of 200 to 300 feet. The subspecies anatum breeds on isolated cliffs and is a permanent resident on the Coconino National Forest. Peregrine falcons are aerial predators that do not typically hunt within forested sites. They prey mainly on birds found in wetlands, riparian areas, and meadows within a 10 to 20 miles radius from the nest site. Prey

items also include bats and small mammals. The peregrine breeding season is from March 1 to August 31.

The project area includes vegetation communities of ponderosa pine, pine/Gambel oak and grasslands. The project area lacks steep cliff sites potentially suitable for nesting by this species. Peregrine falcons are not known to nest in the project area or immediate vicinity. The nearest known eyrie is over four miles from the project. There are at least eight nest locations within a 20-mile radius from the project and peregrines likely forage in the project area.

The main threat to the peregrine falcon is the continued contamination of its environment by synthetic organochlorine contaminants (e.g. DDT). These contaminants result in eggshell thinning and direct mortality to this species. Other threats include disturbance from rock climbing near eyries and mortality from encounters with powerlines.

Environmental Consequences

Alternative 1 – No Action Alternative

There are no direct effects from Alternative 1. There would be no change to the prey species base under Alternative 1, and no change in falcon hunting patterns within associated forest structure.

Effects Common to All Action Alternatives

For all action alternatives there would be no direct effects to this species from project activities.

Indirect effects from vegetation modification would occur. Thinning can 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. Conversely, prey species diversity will increase with increased diversity of vegetative structural stages and improved understory vegetation. A more diverse prey base enables different prey species to prosper during variable climatic conditions thus food availability improves. Thinning of the forest would increase sight distance for foraging peregrine falcons which facilitates hunting conditions for foraging peregrine falcons.

Cumulative Effects

There is an additive indirect effect regarding vegetation modification activities. Other projects where thinning occurs can 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. Projects are implemented at different times and/or different locations, thus disturbances to the prey base are minimized. Activities of these projects do not affect the reproduction or overall distribution of peregrine falcons.

Navajo Mountain Mexican Vole
Affected Environment

There are no documented populations or sightings of voles in the project area; however suitable habitat exists. Navajo Mountain Mexican voles occupy meadows and riparian areas above the

Mogollon Rim associated with ponderosa pine or other coniferous forests. They also occur within forested areas where tree densities are low. They rely on grasses and other herbaceous vegetation for food or cover. Forest structure with increased forest canopy and reduced herbaceous production, probably have reduced the amount, quality and distribution of vole habitat. Suitable habitat within the project area is currently 35% of Forest Service lands (1,267 acres of grassy opening and meadows, and 4,094 acres of sites of "A" canopy (<40% canopy closure)).

Environmental Consequences

Alternative 1

There would be no disturbance under Alternative 1 and no direct effects.

Alternative 1 will continue to limit habitat for this species. Currently 71% of the project area is in a dense condition. Dense forest sites provide low quality habitat for the Mexican vole. Meadows would not be rehabilitated, thus there would not be any benefits to these species. Favorable habitat would decrease over time as conifers encroach on meadows and canopy closure increases.

Under Alternative 1 the high fire hazard potential would persist; a large crown wildfire event would have the potential to affect many individuals.

Effects Common to All Action Alternatives

Disturbance during thinning and broadcast burning activities may occur to individual voles; some individuals may be lost. Such activities would occur across the project area at different times; therefore, activities would be temporally and spatially separated which reduces impacts to this species. Effects would be short-term. There would be no effects to population viability of voles.

Broadcast burning removes cover and food of Navajo Mountain Mexican vole. Meadows ands open areas would rebound after broadcast burning; herbaceous vegetation would be more vigorous, and meadow and understory habitats would be healthier.

Benefits to voles would occur due to the reduction of dense forest canopy and increased growth in the herbaceous vegetation on the forest floor project-wide for all action alternatives.

Alternative 4

Alternative 4 would have less grassy openings providing a slightly less benefit to overall vole habitat compared to the other action alternatives.

Cumulative Effects

Recreation activities will be curtailed in some areas, thus herbaceous vegetation can become reestablished, improving habitat conditions for voles. In other areas recreational activities will occur, such as hiking, biking, and camping, thereby eliminating these areas as habitat for voles. Recreation and road travel at current levels continues to pose an adverse affect to voles due to soil and vegetation disturbance and soil compaction. Forest and range management practices that promote herbaceous growth could lead to increased vole populations. Development of private

land has the greatest potential impact to vole habitat. Cumulatively, these projects and activities do not affect the overall distribution of Navajo Mountain Mexican vole.

Northern Leopard Frog

Affected Environment

The northern leopard frog occurs in the northern portion of Arizona, usually in montane streams and wetlands that have aquatic vegetation but also in wet meadows at higher elevations. This leopard frog is generally restricted to permanent waters. Selected sites on the Coconino were surveyed in 1993 and included Kelly Tank and Twin Tanks within and adjacent to the project boundary. No reptiles or amphibians were found (AGFD 1995).

There are no known existing or historic locations of northern leopard frogs within or adjacent to the project. Best potential habitat is Twin Tanks, Kellum Tank, Lake No. 1, Priest Tanks and several other tanks within the project boundary and Pumphouse Wash and Kelly Tank immediately adjacent to the project.

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 livestock grazing, predation and competition by introduced bullfrogs and potential introduction of chytrid fungus.

Environmental Consequences

Alternative 1

Habitat conditions for wildlife would remain in their current condition, not withstanding natural processes. This alternative would have no effect on northern leopard frog. However, dense forest conditions would still occur and the high fire hazard potential would persist. Large crown-wildfires could adversely affect potential habitat by destruction of understory and overstory vegetation. As a result overland flow would increase, and soil erosion would increase with potentially high sediment loads. Water quality would be adversely affected on a wide-scale basis.

Effects Common to All Action Alternatives

There are no direct effects to northern leopard frog eggs, larvae, or adults from mechanical treatment and prescribed burning.

Indirect effects would result from onsite soil or ash inflow into waters. An inflow of ash and sediment into a water body could smother eggs and tadpoles and displace adults, if frogs are present. Sediment and ash inflow can also inhibit respiration in macroinvertebrates resulting in reduced density and composition of macroinvertebrates. Rinne and Neary (1996) found a 7 to 10 fold decrease in macro-invertebrate density and a 25-75% drop in diversity after a major runoff event. A reduction in the amount of prey species can ultimately affect leopard frog numbers and reproduction. Water quality could be impacted on a short-term basis; however, impacts will be minimized by implementation of best management practices. Under all action alternatives a 200’

wide buffer around all dependable waters would be maintained and would greatly reduce the amount of sediment and ash introduced to frog habitat.

Cumulative Effects

No cumulative effects to northern leopard frogs would occur from implementation of any of the alternatives, when added to past, present and reasonably foreseeable future activities. Implementation of Best Management Practices curtails soil erosion and minimizes the potential for inflow into potential northern leopard frog habitat.

Invertebrates

Three sensitive species of invertebrates have potential habitat within the project. They are spotted skipperling, mountain silverspot butterfly, and blue-black silverspot butterfly. These three butterfly species inhabit moist meadows, seeps, springs, and streams within ponderosa pine and mixed conifer vegetation types, and in some cases other habitat types with riparian areas. The two silverspot butterfly species have life cycles where they utilize Viola species, adults feed on thistles.

Affected Environment

There are no documented populations of these butterfly species within the project area, however suitable habitat does exist at several tanks, springs and wet meadows. Best potential habitat is Twin Tanks, Kellum Tank, Lake No. 1 and several unnamed tanks within the project boundary and Pumphouse Wash and Kelly Tank immediately adjacent to the project.

Environmental Consequences

Alternative 1

Alternative 1 would not impact these species. Under Alternative 1 meadows would not be rehabilitated, thus there would not be any benefits to these species. Favorable habitat would decrease over time as conifers encroach on meadows and canopy closure increases and understory productivity and diversity decreases. High fire hazard potential in the project area would persist.

Effects Common to All Action Alternatives

Under all action alternatives activities would occur within and near meadows. Some individuals may be impacted by treatment activities. These activities would be minimal and short term.

Indirect effects would result from vegetation modification activities such as thinning and broadcast burning. These activities would disturb or remove understory vegetation, in effect reducing availability to adult butterflies and/or caterpillars. These are short-term effects and will be minimized due to activities being temporally and spatially separated. In contrast, reducing the canopy closure, removing trees in and at edges of meadows, restoring meadows and broadcast burning will encourage the development of understory vegetation, increasing availability of food and reproductive sites for these species over the long-term.

Improvement to meadows in all action alternatives will be beneficial to these butterfly species. Reducing the canopy closure, removing encroaching trees in and at the edges of meadows will be beneficial to these species.

Alternative 4

Alternative 4 would have less grassy openings providing a slightly less benefit to overall invertebrate habitat compared to the other action alternatives.

Cumulative Effects

There are additive cumulative effects of reduction of understory vegetation by ungulate grazing within the project area. A portion of the area is currently set aside as a seed bank and is not being grazed by livestock reducing the potential for cumulative impacts. Elk will continue to reduce vegetative understory in meadows and around waters.

Snags and Logs

Snags and logs are important elements of the structure and function of ponderosa pine forests type and are important to bird and small mammal communities. The Forest Plan identifies both standards and guidelines for 10K blocks that state to manage for a minimum of 200 snags per 100 acres across 50% of forested land. In ponderosa pine forests, standards and guidelines are to manage for a minimum of 2 snags per acre across 50% of forested land, 3 logs per acre, and 5-7 tons of wood debris per acre.

Affected Environment

Snags in the ponderosa pine type on the Forest are being lost faster than they are being replaced, and large snags are lost at a disproportionate rate to small snags, resulting in a downward trend. This trend is greatest on the northern portion of the Forest, where illegal fuelwood cutting greatly affects snag densities. Areas of a stable to slightly increasing trend are located in protected canyons, wilderness, and portions of the southern end of the Forest, but overall densities are below Forest Plan guidelines. Snags and logs are deficit across the project area.

Loss of snags and logs from prescribed burning does occur and is estimated to be 20% loss of snags and 50% loss of logs (Randall-Parker and Miller 2000). Randall-Parker and Miller (2000) also found that snags continue to fall and provide new logs on the forest floor at a rate of 2 logs/25 acres/year.

Table 3-29. Existing Snag and Log Conditions and Forest Plan direction

Measure of Change	Existing Condition	Forest Plan Direction
Snag Density	Average = .12/Acre Range of 0 – 1.1/Ac Over 13, 971 Acres Gambel oak: very few oak snags documented in pine/oak habitat.	Average = 2 snags per acre Retain substantive amounts in MSO habitat.

Measure of Change	Existing Condition	Forest Plan Direction
Snag Quality Species	Ponderosa pine: 12”DBH and 15’ tall	MSO restricted and protected habitat:18” DBH Foraging areas: 12”DBH and 30’ tall Gambel oak: On steep slopes, > 10” DRC, otherwise large oaks.
Snag Location	Lightly distributed across all areas.	Restricted and Protected Habitats, PFAs, old growth, along I- 17, ridgelines, adjacent to meadows, key water sources.
Logs and Woody Debris Density	Average = 1.6 Range of 0- 15.4	Average = 3 logs/acre 6-7 tons woody debris/acre
Log Measurements	12”DBH and 8’ long 15%= 12”-14” DBH 25% = 14” – 18” DBH 60% = > 18” DBH	12”DBH and 8’ long
Log Location	PFAs have greater amounts but do not meet plan standards.	MSO restricted and protected habitats, PFAs, old growth, within ¼ mile of key water sources.

Environmental Consequences

Alternative 1

The high fire hazard potential in the project area would persist and in the event of a large crown-wildfire, widespread loss of snags and logs would occur. High tree densities continue to limit growth of large diameter trees and thereby limit replacement snags and logs.

Effects Common to All Action Alternatives

There will be a direct effect of loss of snags and logs during broadcast burning, however these effects will be minimized since snags necessary to meet wildlife management objectives will be fire-lined. Loss of large logs will be minimized though ignition techniques and possibly fire-lining. Felling large trees between 12 and 16 inches after burning to replace logs consumed by prescribed burning will provide additional habitat.

Although fire can have a detrimental affect on pre-burn snags, it can cause live trees to die and become snags after fire. With the retention of yellow pine trees and old growth recruitment site management, some trees would in time naturally convert to snags. This natural conversion of snags to logs would contribute to additional numbers of snags and logs on the ground. Trees may grow to become larger snags if there is less competition among trees for moisture, nutrients, and

sunlight. Larger diameter snags (greater than 18” DBH) are necessary to meet Forest Plan guidelines.

Alternative 3

Meso reserves would have more mortality, thus more snags, due to increased competition between trees for moisture, nutrients, and sunlight. However, due to the increased competition, the snags would be smaller and may not meet snag guidelines for obtaining snags 18 inches and larger. Removal of trees around large trees, “yellow” pines and oaks in matrix and full restoration treatments should protect existing snags and enhance conditions for growing larger recruitment snags.

Alternative 4

A 16-inch diameter cap would retain all trees greater than 16 inches providing a greater number of trees that could convert to snags and logs. The remaining trees greater than 16 inches and existing old, “yellow” pines would experience decreased vigor, growth, and longevity, compared to Alternatives 2 and 3. Snags would typically be more plentiful but smaller compared to Alternatives 2 and 3.

Cumulative Effects

Past timber harvest and illegal fuelwood activities have reduced snag densities to below Forest Plan recommendations. Snags were removed during forest harvest because of potential fire and safety hazards, and many thought they had poor aesthetic value and were indicative of an unhealthy forest. Snags are especially vulnerable to bark beetle infestation, illegal fuelwood cutting, and ongoing projects that remove hazard trees such as APS hazard tree removal along powerlines and ADOT tree removal along Interstate 17.

The past outbreak of bark beetle infestations has killed trees thus creating snags, therefore increasing snags in pockets across the landscape. However, insect attacks result in rapid deterioration of snags, decreasing their longevity and value to wildlife. Some bug-killed trees will topple over and become downed logs. Bug killed logs will compensate for a portion of the loss of large logs due to burning activities.

Wildlife Cover

Hiding and thermal cover are important attributes of the forest for wildlife habitat. Hiding cover is defined as “vegetation capable of hiding 90% of a standing deer or elk from human view at a distance of 200 feet or less.” Tree trunks and foliage as well as shrubs and herbaceous vegetation offer hiding cover. Topographic features, such as rock outcroppings and terrain breaks, also serve as hiding cover. Thermal cover is defined as “a stand of coniferous trees tall enough to allow animal movement and bedding with a high degree of crown closure.” Thermal cover offers protection from heat and cold. High tree crown closure also provides hiding cover from aerial predators (Forest Plan pg 124).

Affected Environment

There are approximately 3,226 acres (21%) outside the Fire Management Analysis Zone (FMAZ) and 12,012 acres (79%) of Forest Service lands within the FMAZ project area. Mexican spotted owl target and PAC habitat along with steep slopes currently provide for the cover requirements outside of the FMAZ. These locations are located in areas currently used by wildlife due to cover values (i.e. elk calving, movement corridors). Cover requirements are exceeded within the FMAZ.

The area outside the FMAZ within the project boundary is not completely within one 10K block. As no one 10K block encompasses this part of the project, wildlife cover was analyzed on a stand basis across project acreage outside the FMAZ (wildlife cover depicted herein is an index of available cover in the project area). Table 3-30 includes current and desired values of thermal and hiding cover.

Table 3-30. Wildlife Cover Within the Project Area.

Measure of Change	Existing Conditions	Forest Plan Direction
Percent Cover Within FMAZ	Hiding 1% Thermal 2% Combination 59% Total 62%	Hiding 0-15% Thermal 0-15% Combination 0-15% Total 0-15%
Percent Cover Outside FMAZ	Hiding 4% Thermal 3% Combination 42% Total 49%	Hiding 10% Thermal 10% Combination 10% Total 30%

Environmental Consequences

Alternative 1

Under Alternative 1 there would be no change from existing conditions. Current conditions exceed Forest Plan direction. A surplus of hiding cover for wildlife will be maintained across the project area. However, dense forest conditions would still occur and the high fire hazard would continue to place wildlife cover at risk with respect to stand-replacing fire.

Effects Common to All Action Alternatives

Horizontal and vertical diversity are both important components of cover. All action alternatives will maintain hiding cover at least 200 feet wide around dependable waters and along the travel corridor identified in the northeast portion of the project. Key wildlife cover areas are near Priest and Howard Draws, Kelly Canyon and other steep slopes and drainages across the project. These

areas provide important travelways and cover for black bear, deer, turkey and other big game species. These areas are considered too steep to implement mechanical treatments and will likely continue to provide cover. All action alternatives will still provide cover for most species and will meet Forest Plan direction.

Alternative 2

The Proposed Action will reduce hiding and thermal cover across 3,888 acres (26%) of the project area. There will be a reduction of approximately 3,419 acres within the FMAZ and 469 acres outside of the FMAZ. This reduction will still provide adequate cover for most species and meet Forest Plan direction.

Specifically, areas with an un-even aged thin to 40% or 50% canopy cover will retain both hiding and thermal cover values. Areas thinned from below to 40% or 50% canopy cover will lose hiding cover values. Sites with VSS 2 or VSS 3 designations will maintain hiding cover values where steep slopes are present and provide cover effects. Grassland and Savannah Restoration treatments will remove both hiding and thermal cover values. Restoration treatments will remove both hiding and thermal cover values. Sites treated with prescribed fire only (no thinning) will maintain cover qualities.

Alternative 3

Generally, restoration treatments do not provide hiding cover. This alternative would maintain hiding and thermal cover in meso and matrix areas by 450 acres more than the Proposed Action and will reduce hiding cover by 50 acres more than the Proposed Action. Overall, this will result in a total of 500 acres more thermal and hiding cover than the Proposed Action.

Alternative 4

Of the eight sites identified four of those will move from a uneven aged to an even-aged or two-aged treatment. This would reduce hiding cover over 176 acres but improve thermal cover within all of these sites by increasing canopy cover.

Cumulative Effects

The area for analysis is the project boundary. Roads and trails within cover sites provide access to recreation activities thereby reducing the effectiveness of that cover for some species due to human disturbance.

Management Indicator Species

A working draft Forest-wide assessment entitled "Management Indicator Species Status Report for the Coconino National Forest" (USDA Forest Service 2002) summarizes current knowledge of population and habitat trends for species identified as MIS for the Coconino National Forest. Population trends need to be monitored as the Forest Plan is implemented, and relationships to habitat changes over time determined (36 CFR 219.19). Below are descriptions of each of the management indicator species identified for management areas (MA's) within the analysis area, and a discussion of the relationship of the effects of each project alternative on forest level population and habitat trends for each of these species.

Management indicator species (MIS) for this project are evaluated based on management area types located within the project area. The management areas (MAs) listed in Table 3-31 are present within the project boundary. Table 3-31 lists MIS that were considered but dropped from detailed analysis because habitat they are indicators for does not exist in the analysis area. These are a subset of the Forest-wide management areas and management indicator species. Refer to the Forest Plan for a complete list of management areas and associated management indicator species.

Analysis Methods

The following evaluation criteria were used for MIS to compare environmental consequences for all alternatives:

- Indicator Habitat Quantity
- Indicator Habitat Quality

Models – ForestERA Tassel-eared Squirrel Density and Recruitment data layers (ForestERA 2004) were used to compliment Forest Service stand exam data in identifying higher quality squirrel habitat within the project. Additionally, these layers were used to provide a landscape context for implementation activities within the project.

ForestERA Northern Goshawk Nesting Habitat data layers (ForestERA 2004) were also used to compliment Forest Service stand exam data in identifying high selection nesting habitat within the project. These layers were also used to provide a context for implementation activities within the project.

Table 3-31. Coconino National Forest Management Indicator Species

Management Area (MA)	MIS Species	Habitat
MA 3 (Ponderosa Pine and Mixed Conifer with <40 percent Slopes), MA 4 (Ponderosa Pine and Mixed Conifer with >40 percent Slopes), and MA 6 (Unsuitable Timber Land in Ponderosa Pine)	Abert Squirrel	Early seral ponderosa pine
MA 3 and MA 4	Northern Goshawk	Late seral ponderosa pine
MA 3 and MA 4	Pygmy Nuthatch	Late seral ponderosa pine
MA 3 and MA 4	Turkey	Late seral ponderosa pine
MA 3, MA 4, and MA 6, and MA 7 (Pinyon-juniper Woodland with <40 percent Slopes) and MA 8 (Pinyon-juniper Woodland with >40 percent Slopes)	Elk	Early seral ponderosa pine, mixed conifer, and spruce-fir
MA 3, MA 4, and MA 6	Hairy Woodpecker	Snag component of ponderosa pine, mixed conifer, and spruce-fir
MA 3 and MA 4	Mexican Spotted Owl	Late seral mixed conifer and spruce-fir
MA 3 and MA 4	Red Squirrel	Late seral mixed conifer and spruce-fir
MA 5 (Aspen)	Yellow-bellied (Red-naped) Sapsucker	Late seral and snag component of aspen
MA 5 and MA 6 and MA 7 (Pinyon-juniper Woodland with <40 percent Slopes) and MA 8 (Pinyon-juniper Woodland with >40 percent Slopes)	Mule Deer	Early seral aspen and pinyon-juniper
MA 7 and MA 8	Juniper (Plain) Titmouse	Late seral and snag component of pinyon-juniper
MA 9 (Mountain Grasslands)	Elk, Antelope	Early and late seral grasslands

Table 3-32. Management Indicator Species Considered But Eliminated from Detailed Analysis

MA	MIS Species	Habitat
MA 3 and 4	Mexican Spotted Owl	Late seral stage of mixed conifer and spruce/fir
MA 3 and 4	Red Squirrel	Late seral stage of mixed conifer and spruce/fir
MA 7 and 8	Juniper (Plain) Titmouse	Late seral and snag component of pinyon-juniper
MA 12	Lincoln's Sparrow	Late seral, high elevation riparian (≥7000')
MA 12	Lucy's Warbler	Late seral, low elevation riparian (<7000')
MA 12	Yellow-breasted Chat	Late seral, low elevation riparian (<7000')
MA 12	Macroinvertebrates	Late seral, high and low elevation riparian
MA 12	Cinnamon Teal	Wetlands/aquatic

Table 3-33. Management Indicator Species Considered and Acres of Habitat within Project

MANAGEMENT AREA (MA)	MANAGEMENT INDICATOR SPECIES	ACRES HABITAT IN PROJECT AREA ON FS LANDS
MA 3 (Ponderosa Pine and Mixed Conifer with <40% Slopes)	Abert squirrel, red squirrel, Mexican spotted owl, elk, northern goshawk, pygmy nuthatch, turkey, and hairy woodpecker	12,784 (84%)
MA 4 (Ponderosa Pine and Mixed Conifer with >40% Slopes)	Abert squirrel, red squirrel, Mexican spotted owl, elk, northern goshawk, pygmy nuthatch, turkey, and hairy woodpecker	140 (.9%)
MA 5 (Aspen)	Yellow bellied sapsucker, mule deer	15 (.01%)
MA 6 (Unsuitable Timber Land in Ponderosa Pine)	Elk, mule deer, Abert squirrel, and hairy woodpecker	1021 (6.7%)
MA 9 (Mountain grassland)	Antelope, elk	1277 (8.4%)

Table 3-34. Summary of MIS Habitats on the Mountainaire HFRA Project with CNF Trends

Species	Forest Habitat Trend	Forest Population Trend	Acres Habitat in Project Area
Abert Squirrel	Stable	Inconclusive	4557
Northern Goshawk	Declining	Inconclusive	10248
Pygmy Nuthatch	Declining	Stable	10248
Turkey	Declining	Increasing	10248
Elk	Stable	Stable	5834
Hairy Woodpecker	Pipo snags declining	Stable-to-slightly increasing	14805
Yellow-bellied (Red-naped) Sapsucker	Declining	Declining	15
Mule Deer	Aspen declining	Declining	15
Antelope	Stable-to-declining	Declining	1277

Table 3-35. Effects to MIS Habitat Quantity by Alternative

MIS Species	Current Forest-wide Habitat	Alternative 1 (No Action)	Alternative 2 (Proposed Action)	Alternative 3 (PA with research proposal)	Alternative 4 (PA with 16" diameter limit)
Abert Squirrel	538,564	0	-436 / -0.1	-436 / -0.1	-436 / -0.1
Northern Goshawk	161,436	0	-118 / -0.1	-118 / -0.1	-118 / -0.1
Pygmy Nuthatch	161,436	0	-118 / -0.1	-118 / -0.1	-118 / -0.1

MIS Species	Current Forest-wide Habitat	Alternative 1 (No Action)	Alternative 2 (Proposed Action)	Alternative 3 (PA with research proposal)	Alternative 4 (PA with 16" diameter limit)
Turkey	161,436	0	-118 / -0.1	-118 / -0.1	-118 / -0.1
Elk	725,875	0	-436 / 0.0	-436 / 0.0	-436 / 0.0
Hairy Woodpecker	700,000	0	0	0	0
Yellow-bellied Sapsucker	Undetermined	0	0	0	0
Mule Deer	Undetermined	0	0	0	0
Antelope	187311	0	1277 / 0.7	1277 / 0.7	1277 / 0.7

Abert Squirrel
Affected Environment

The Forest Plan designates the Abert Squirrel as an MIS for early seral stage ponderosa pine forests. More recent research indicates that this species best habitat is the intermediate to older age forest (trees 9 to 12"with trees from 18-22 inches DBH preferred), where groups of trees have crowns that are interlocking or close. Uneven-aged stand management is thought to benefit the Abert Squirrel. Heavy thinning, such as which occurs at the urban – interface and as part of restoration treatments, reduces habitat quality due to resulting low tree densities and a lack of interlocking crowns (USDA 2002). Within the project area, dense sites of ponderosa pine suitable for Abert squirrels occur throughout. The forest-wide habitat trend for Abert Squirrel is stable, since the age class distribution of ponderosa pine has essentially remained dominated by mid-seral stages, with some loss of old-growth and older trees (USDA 2002).

There is very little forest-specific data to determine population trends at the forest level.

Data from a few studies indicate stable populations within the study areas, but these research projects were limited to only a few locations on the forest and occurred over 2-3 year periods (USDA 2002). Arizona Game and Fish does not quantify small game populations, but does compile data on the number of squirrels killed per hunter day. From 1988-1999, statewide information indicates a stable trend for hunter harvest of squirrels.

Abert squirrels are currently found throughout the project area. Abert squirrel nesting habitat includes high canopy cover with interlocking canopies, multi-storied sites, and high basal area with 18" diameter trees distributed throughout. The project area currently exhibits good quality habitat for Abert Squirrel. Goshawk PFAs and MSO protected and restricted habitats, steep slopes, cover and old growth areas make up approximately 28% of the forested lands within the project. These habitats provide many of the characteristics necessary for high quality Abert squirrel habitat with the exception of a high basal area. Only fifteen percent of existing MSO habitat and none of the PFAs acres have a 150 basal area or greater. Cover that is not currently located within PFAs or MSO habitat will add slightly to the 28% value. Across the project area (within and outside of the FMAZ), Dodd's (1998 and 2003a, b) recommendations for high quality nesting habitat across 35% of the landscape occur, except for the high basal area (> 150) recommendation.

ForestERA Data

The ForestERA Tassel-eared Squirrel Density and Recruitment models were built using a tree classification methodology and point count data from 320 locations in the ForestERA assessment area. The majority of the project is low to moderate for both squirrel density and recruitment habitat. Within the project high quality squirrel habitat and densities are found in the northwest and the southeast corner of the project (Appendix B). The better habitat correlates with areas identified as developing old growth, Mexican spotted owl PACs and target threshold habitat.

On a landscape-level, the Mountainaire area currently provides very little high quality recruitment habitat or high squirrel densities. Areas to the northeast in Marshall Mesa and immediately south of the project continuing south and west of Mormon Lake provide larger, contiguous blocks of moderate to high quality recruitment habitat with moderate to high squirrel densities. Another large contiguous block of moderate to high quality for both squirrel densities and recruitment habitat occurs west of the project area on the west side of Highway 89A and continues north of Interstate 40 to the Fort Valley area and on up along the west side of the San Francisco Peaks. Vegetation treatments in the Woody Ridge, Fort Valley and Elk Park areas will likely reduce this habitat somewhat.

Table 3-36. Abert Squirrel Nesting Habitat Characteristics

Habitat	Basal Area of 150 sq. ft./acre	18" Diameter Trees	50-90 Acre Patches in VSS3 and VSS4	Canopy Closure of 55%	Stand Structure
Protected Habitat (665 Acres)	All <150	Retain Existing average of 39 TPA ≥ 18"	Large Patches. All VSS3 and VSS4	Average 58%	All sites are Multi storied
Restricted Habitat (2230 Acres)	446 ≥ 150 1784 < 150	Retain and develop average of 32 TPA ≥ 18"	Large Patches VSS5 = 305 ac VSS3 and VSS4 = 1957ac	Average 60%	76% Multi storied 24% Single storied
Goshawk PFAs (1000 Acres)	All acres <150 BA	Retain and Develop	Manage for 20% = VSS3 20% VSS4	Average >50%	Mostly Multi storied Managed for Multi storied
Old Growth acres that do not overlap with above. (100 acres)	100 acres ≥ 150 BA	Retain and develop	100-300 acres moving VSS 3 to VSS 4,5,6	Manage for minimum canopy cover of 40%	Multi storied
Steep slopes Outside of above areas (53 acres)	53 acres ≥ 150 BA	Retain	Contiguous with old growth	"C" canopy	Multi storied

Habitat	Basal Area of 150 sq. ft./acre	18" Diameter Trees	50-90 Acre Patches in VSS3 and VSS4	Canopy Closure of 55%	Stand Structure
Meso Reserves (228 acres)	BA 110-165 ft^2 per acre	Retain	228 acres untreated habitat	Range of 55-72%	All sites multi storied

Environmental Consequences

Alternative 1

Habitat conditions for wildlife would remain in their current condition, not withstanding natural processes. This alternative would have no effect on Abert squirrel forest-wide habitat or population trends. However, dense forest conditions would still occur and the high fire hazard potential would continue to place squirrel habitat at risk with respect to stand replacing fire. The project area would continue to be lacking in the higher basal areas that provide high quality nesting habitat. Foraging habitat would continue to be limited as tree basal areas will remain lower and densities higher reducing tree growth rates and limiting cone production.

Effects Common to All Action Alternatives

Indicator habitat quantity is the same for all action alternatives immediately after treatment. Changes occurring in VSS structural stage reduce indicator habitat by approximately 436 acres (10%) across the project area. Habitat quality will be reduced in all alternatives although the project area will continue to provide recruitment, nesting and foraging habitat for Abert squirrels. This reduction in habitat quality is too small to alter the Forest-wide habitat or population trends.

Alternative 2

The Proposed Action will reduce the best nesting habitat to lower quality nesting habitat by approximately 8%. Canopy closures and basal areas will be reduced overall but will continue to average 50% canopy cover and maintain higher basal areas within MSO PACs, PFAs, steep slopes, and other sites. There will not be a noticeable difference in the number of 18" trees across the landscape. Low quality nesting habitat (> 90 BA and > 30 CC) will be met over 35% of the landscape. The areas identified by ForestERA data layers as the best habitat within the project for higher squirrel densities and recruitment habitat are mostly located within MSO protected and target threshold habitats and in PFAs. Habitat quality within these areas will be retained for squirrels maintaining the higher quality habitat within the project.

Alternative 3

This alternative was designed to maximize Abert squirrel densities and recruitment while meeting other ecological restoration goals, such as fire risk reduction and improved tree vigor. Alternative 3 will reduce the best nesting habitat by approximately 7%. High quality nesting habitat, with the exception of the basal area requirement, will be maintained and enhanced across 28% of the project area. Meso-reserves with extensive interlocking canopies provide habitat for squirrel nest

placement, movements, and protection from predators. The higher basal areas and canopy cover associated with meso reserves are also correlated with productivity of hypogeneous fungi (States and Gaud 1977), an important food source for squirrels. Three meso reserves having patches of interlocking trees 50-90 acres in VSS 3 and VSS 4 with a canopy closure of at least 55% and patches have high basal area and pockets of trees 18+ inches in diameter dispersed throughout will be maintained. Matrix and full restoration treatment areas surrounding the meso-reserves will reduce fire risk associated with the reserves. Matrix and full restoration components can improve cone production, which would improve squirrel foraging options throughout the project.

Low quality nesting habitat (> 90 BA and > 30 CC) will be met over 35% of the landscape.

Alternative 4

This alternative will have 383 more acres of even-aged treatments reducing the multi-storied component within squirrel habitat. On the other hand, retaining trees 16-inch diameter and greater will increase basal areas and groups of trees with interlocking crowns improving habitat conditions favorable for squirrel recruitment and fitness.

Cumulative Effects

There is no effect to Forest-wide habitat or population trends and there is no added effect from past, present or foreseeable projects. Past fuel reduction treatments in the urban interface have reduced habitat quality due to resulting low tree densities and lack of interlocking crowns (USDA 2002). MSO protected habitat and northern goshawk PFAs have similar habitat qualities as those required for higher quality Abert squirrel habitat and densities. These protected habitats are scattered across the landscape thereby providing habitat for squirrels within these urban - interface projects and across the landscape. Urban – interface treatments have maintained large trees across the landscape and are reducing competition between trees for water and nutrients, thereby moving toward the larger VSS size classes important for Abert squirrels.

Treatments in the Mountainaire HFRA project will provide protection from stand-replacing crown fires to high quality squirrel habitat and densities not only within the project area but also in areas northwest of the project, specifically the Marshall Mesa area.

Elk

The Forest Plan designates elk as an MIS for early seral stages of ponderosa pine, mixed conifer, and spruce-fir habitat types. Grasslands and early-seral stage woodlands are also important to this species. Elk are associated with the deciduous thickets and early-seral stages of forests that contain an interspersion of the grass/forb vegetation type. Forest-wide population trend is essentially stable. There was an increase in elk numbers in the early to mid 1990’s with a gradual decline back to late 1980’s levels.

Affected Environment

The analysis area provides summer range for elk with some elk calving areas located in the southwest portion of the analysis area and is located within Arizona Game and Fish Department’s Game Management Unit (GMU) 7M and 6A. Game Management Unit 6A shows a generally stable trend in elk numbers although GMU 7 shows a generally increasing trend (USDA 2002).

Environmental Consequences

Alternative 1

Habitat conditions for wildlife would remain in their current condition, not withstanding natural processes. This alternative would have no effect on the forest-wide habitat or population trends for elk. However, dense forest conditions would still occur and the high fire hazard potential would persist. Dense forest conditions would do nothing to reduce grazing pressure to aspen, oak meadows and riparian habitats which are documented to be impacted by elk grazing.

Effects Common to All Action Alternatives

No thinning will occur in the two elk calving areas (358/08 and 358/06) between May 15 and June 30 to reduce any potential for disturbance. All action alternatives will reduce the amount of early seral stage ponderosa pine through meadow restoration projects and increase mountain grassland habitat. Restoration treatments will provide increased foraging opportunities for elk. Open canopy areas would increase by 8,126 acres increasing the habitat quality (~1% of Forest-wide habitat) and distributing elk foraging throughout the project. This will have the added benefit of reduce grazing pressure to aspen and oak. Much of the grassland habitats would move from early seral ponderosa pine to grass/forb/shrub habitat with no change in habitat quantity and a slight increase in quality. This increase in habitat quality is too small to alter Forest-wide population and habitat trends.

Public comment to the Proposed Action voiced a concern that thinning may effect elk habitat and calving areas. Approximately 275 acres in the southeast portion of the project have been identified as elk calving. None of the alternatives would cause disturbance in elk calving areas. Mitigation for all action alternatives includes a timing restriction that insures no thinning or burning will take place in the two known elk calving sites between May 15 and June 30 to limit disturbance to elk in these key reproductive areas. Alternative 1 will have no effect to elk calving areas. Alternatives 2, and 3 would have less impact to elk calving as these sites will receive and uneven-aged thinning designed to maintain both thermal and hiding cover for elk. Alternative 4 would require an even-aged thin from below that would leave no trees under 16-inches in diameter. This would reduce hiding cover in 99 acres of elk calving habitat and would limit its effectiveness to provide cover for young elk calves. Under Alternative 4, one additional stand (77 acres), identified as hiding cover, would require all trees under 16 inches diameter to be removed to reach a canopy cover of 40%. This would remove hiding cover for elk in this stand.

Thinning will reduce cover for elk within the wildland urban – interface but will increase and distribute forage across the project area. All action alternatives will maintain hiding cover at least 200 feet wide around dependable waters and along the travel corridor identified in the northeast portion of the project. All action alternatives will still provide cover for elk and will meet Forest Plan direction.

Elk populations are stable on the Forest and this project will not impact forest-wide population trends for elk.

Alternative 4

Alternative 4 would have less grassy openings providing a slightly less benefit to overall elk habitat compared to the other action alternatives. Elk forage would not be distributed as evenly throughout the project and would have a slightly lower likelihood of reducing grazing pressure to oak and aspen.

Cumulative Effects

Roads and trails within elk habitat provide access to recreation activities thereby potentially disturbing elk. The Mountainaire Community Trails project will address the trail system in and around Mountainaire and will likely reduce the overall miles of trail.

Hairy Woodpecker

The Forest Plan designates the hairy woodpecker a MIS for snags in ponderosa pine, mixed conifer, and spruce-fir forests for suitable nesting and feeding habitat. Hairy woodpeckers are most abundant in mature forests with large old trees suitable for cavity nesting and are also common in medium-aged forests. Hairy woodpeckers prefer forests with dense canopies (Bushman and Therres 1988). They use tree cavities for roosting and winter cover and may excavate new cavities in fall to be used for roosting (Sousa 1987). This species is experiencing loss of suitable breeding habitat in the form of snags, both range-wide and in Arizona. According to Latta et al. (1999), hairy woodpeckers are uncommon throughout their range yet common in their preferred habitat in Arizona.

Affected Environment

Data from the Coconino National Forest, as well as statewide data, indicate that hairy woodpecker populations are stable, or slightly increasing on the Forest. Forest-wide, the snag component in ponderosa pine forest has declined, but has increased in mixed conifer and spruce-fir forest due to wildfire and insect outbreaks/disease (USDA 2002). Hairy woodpeckers are fairly common in conifer forest types within the analysis area.

Environmental Consequences

Alternative 1

Habitat conditions for wildlife would remain in their current condition, not withstanding natural processes. This alternative would have no effect on hairy woodpecker. However, dense forest conditions would still occur and the high fire hazard potential would persist.

Effects Common to All Action Alternatives

Management of old growth, target/threshold, Mexican spotted owl PACs and restricted habitat, northern goshawk PFAs and snags will provide habitat for the hairy woodpecker. All action alternatives progress sites to larger VSS classes providing for more recruitment snags. There may be some losses of snags overall slightly reducing habitat quality across the project area. This loss

of snags will not alter the habitat quality enough to render it unusable and will have no effect to the Forest-wide habitat or population trend for the hairy woodpecker.

Cumulative Effects

Private land development will reduce habitat for these species. Removal of hazard trees for powerlines and highway safety will reduce snags and reduce habitat for snag dependant species. These projects combined with any of the action alternatives are not expected to reduce habitat quality enough to alter Forest-wide population or habitat trends.

Northern Goshawk

Affected Environment

The Forest Plan designates this species a MIS for late seral stages of ponderosa pine forests. Goshawks are relatively abundant and widespread, and although population trends are difficult to determine, there is no hard evidence of a considerable decline overall, but populations could be declining in some areas (NatureServe 2001). On the Coconino National Forest, 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 these last 11 years; however, this does not signify a corresponding trend in population numbers. It is likely that non-breeding goshawks would not be observed. 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. Although the forest has some information on territory occupancy and reproduction, these data are not designed to detect changes in population trend. Total number of territories has increased and the statewide Breeding Bird Survey (BBS) data indicates a significant increase, but some indicators of occupancy and productivity appear to be declining on the forest, although year-to-year variability is high.

Environmental Consequences

(Please see northern goshawk analysis under the Sensitive Species section for a more detailed analysis).

Alternative 1

This alternative would have no effect on forest-wide habitat or population trends.

Effects Common to All Action Alternatives

The areas identified by ForestERA data layers as the predicted high quality nesting habitat within the project are mostly located within MSO protected and target threshold habitats, designated developing old growth and in PFAs. Habitat quality within these areas will be retained for goshawks maintaining the higher quality habitat within the project. All action alternatives are expected to have no effect to the Forest-wide habitat or population trends for the northern goshawk.

Cumulative Effects

Treatments in the Mountainaire Project area will provide protection from stand replacing crown fires to predicted high quality northern goshawk nesting habitat not only within the project boundary but also in areas northwest of the project, specifically the Marshall Mesa area.

There is no effect to Forest-wide habitat or population trends therefore there is no added effect from past, present or foreseeable projects.

Pronghorn Antelope

The Pronghorn antelope is designated as a management indicator species for early and late seral grassland type, which is represented by Management Areas (MA) 9, 10 and 11 in the Coconino National Forest Plan. Pronghorn were selected as indicators of grassland modification and were raised as a public issue during development of the Forest Plan (Goodwin 1980).

A number of factors identified that affect pronghorn include: severe weather, amount and timing of precipitation, long-term climatic trends, habitat fragmentation, diet overlap with other grazers, reductions in fawn hiding cover, woody vegetation encroachment, fences, human disturbance and development, water availability, predators, parasites and diseases, and nutritional concerns (Nelson 1925, Neff 1986, Neff and Woolsey 1979, O'Gara 1986, Smith et al. 1986, Le Count 1987, Lee et al. 1998, AGFD 2002, Dubay 2002, Ockenfels 1996 in USDA 2002).

Forest-wide population estimates of pronghorn were made in the 1980's and ranged from around 1005-1700; populations were thought to be increasing (USDA Forest Service and Arizona Game and Fish Department (AGFD) 1981, USDA Forest Service and AGFD 1990, USDA Forest Service 1982; USDA Forest Service 1987b in USDA 2002). The forest-wide pronghorn antelope trend is declining, although not equally on the Forest.

Affected Environment

The analysis area is located within Arizona Game and Fish Department's Game Management Unit (GMU) 7M and 6A. Game Management Unit 7 populations appear to be stable, while other GMUs appear to be declining with only 20-35 fawns per 100 does in many years.

Little pronghorn habitat occurs within the project area. Grasslands are limited and there is no pinyon-juniper woodland. Montane grasslands provide very limited pronghorn habitat due to the degree of human development, fencing, and meadows and openings have been negatively affected by pine encroachment and plantations (established in approximately 10% of the project area), fragmenting habitat for pronghorn. No fawning areas are documented in the project area. Pronghorn have been reported to move through the project area.

ForestERA Data

The ForestERA Pronghorn Habitat Suitability layer was built using slope and canopy cover as predictor values. The Mountainaire project is located between Forest Highway 3 and Interstate 17 and these highways provide a barrier to pronghorn movement to the west, north and northeast. Most habitat occurs to the south and southeast of the project. Savannah and grassland treatments will help connect open areas and potentially provide opportunities to develop travel corridors to areas south of the project that pronghorn use for fawning.

Environmental Consequences

Alternative 1

Habitat conditions for wildlife would remain in their current condition, not withstanding natural processes. Meadows would not be rehabilitated, thus there would not be any benefit to this species. Favorable habitat would decrease over time as conifers encroach on meadows. This alternative would have no effect on Forest-wide habitat or population trends. However, dense forest conditions would still occur and the high fire hazard potential would persist.

Effects Common to All Action Alternatives

Restoration of meadows and savannah grasslands in all action alternatives will be beneficial to this species. Openings will be maintained, enhanced, and created which provide a movement corridor through the project area. Vegetative species composition and diversity will increase and the distribution and diversity of vegetative ground cover will improve. All alternatives would result in no loss of habitat for pronghorn although there would be a small increase in habitat quality (<1% of Forest-wide habitat). This increase in habitat quality is too small to alter Forest-wide habitat and population trends.

Cumulative Effects

There is no effect to Forest-wide habitat or population trends therefore there is no added effect from past, present or foreseeable projects.

Pygmy Nuthatch
Affected Environment

The Forest Plan designates the Pygmy nuthatch an MIS for late seral stage ponderosa pine forests. The pygmy nuthatch is generally associated with mature ponderosa pine forests. It prefers open, park-like sites of old, yellow pines. It is also found in dense pine forests, as long as large trees and snags are present. The pygmy nuthatch is also tied to old, large oak trees and cavities. This nuthatch requires dead trees or dead-top trees where it builds nests in cavities. Both in Arizona and North America, moderate threats exist on breeding and wintering grounds. Populations are thought to be stable on the Coconino National Forest and statewide. Ponderosa pine snags, a key component for this species, are currently being lost faster than they are replaced and may affect populations of the pygmy nuthatch in the future (USDA 2002).

Environmental Consequences

Alternative 1

Habitat conditions for wildlife would remain in their current condition, not withstanding natural processes. This alternative would have no direct effect on pygmy nuthatch. However, dense forest conditions would still occur and the high fire hazard potential would persist.

Effects Common to All Action Alternatives

Trees will grow into the larger diameter classes at a faster rate than Alternative 1 (no action). All action alternatives would offer higher quality nesting habitat over time due to the increase in the acres of VSS 5 and 6 sites over the forty years following treatment. Management of old growth, target/threshold, Mexican spotted owl PACs and restricted habitat, northern goshawk PFAs and snags in all action alternatives will provide habitat for the pygmy nuthatch. There will be no effect to the Forest-wide habitat or population trend for the pygmy nuthatch.

Cumulative Effects

Private land development will reduce habitat for these species. Removal of hazard trees for powerlines and highway safety will reduce snags and reduce habitat for snag dependant species.

Turkey

The Forest Plan designates turkey as a MIS for late seral stage ponderosa pine forests, based on roost habitat requirements. Although the age class distribution of ponderosa pine has remained dominated by mid-seral stage sites, there had been some loss of old growth and older trees, resulting in a decline in forest-wide habitat trend for late seral- ponderosa pine habitat. Turkey roosts and nesting habitat occur in steep drainages and on hills. Turkey populations on the CNF declined in the early 1990s and have increased since the mid 1990s in probable response to favorable overwintering conditions, changes in hunt design in the GMU, and contributions to overall mast production from trees from the 1919 seed year. The age class distribution of ponderosa pine has remained the same during Forest Plan implementation. Late seral stage trees have remained largely unchanged on slopes greater than 40 percent. The loss of large old trees occurred on slopes less than 40 percent during the early stages of Forest Plan implementation. The rate of loss due to timber harvest is now much reduced and harvest of trees over 24 inches DBH rarely occurs. Other factors affecting turkey populations are lack of cover in key areas (including travel corridors), water availability, and forage availability are important factors (USDA 2002).

Affected Environment

Turkey habitat in the project area consists of ponderosa pine forest with openings and small meadows for foraging during the summer months. Ponderosa pine and Gambel oak mast are the key habitat attributes, and steep drainages and hillsides provide nesting and roosting habitat. Known turkey roosting areas are south of the private lands along Kelly Canyon. A turkey hen with poults was reported in Location 348 Site 01 in mid-June indicating turkeys are nesting south of the Mountainaire community.

There is an average of 0.4 roosts per 640 acres (1 section= 1square mile=640 acres). These roosts are not evenly distributed across the project and do not reach the desired number per section as stated in the Forest Plan. The roosts are mostly clustered at the south end of the project and are associated with the pine/oak habitat. There are currently 2.4 yellow ponderosa pine trees per acre 16” and greater which could provide roosting habitat

Although late seral ponderosa pine habitat has declined since the Forest Plan was written, and turkey population trends in the early 1990's probably declined, data from the last five years show that populations are increasing on the Coconino National Forest.

Environmental Consequences

Alternative 1

Habitat conditions for wildlife would remain in their current condition, not withstanding natural processes. This alternative would have no effect on turkey. However, dense forest conditions would still occur and the high fire hazard potential would persist.

Effects Common to All Action Alternatives

Turkey nesting and roosting habitat overlaps with MSO restricted and protected habitats. In these habitats, all yellow-barked ponderosa pine trees will be retained while old tree longevity is improved. Furthermore, old growth recruitment areas and target/threshold sites are identified within turkey habitat and will add to the potential of increasing numbers of turkey roost tree groups. Forest Plan standards and guidelines will be met for turkey. Timber harvesting and slash treatment activities will be deferred in turkey nesting areas from April 15 through June 30 in an attempt to reduce impacts to nesting turkeys that often conceal nests in slash on the forest floor.

In actual or potential turkey nesting sites, scattered patches of untreated slash within one-half mile of dependable water will be left. Patches are at least one-quarter 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 determined that nesting is still occurring in the area. These guidelines are designed to improve nesting habitat by providing slash on the forest floor for protection and concealment of turkey nests. These guidelines will be evaluated and adjusted, if necessary.

Two turkey roost tree groups per section, in actual or potential turkey habitats will be retained. Trees will grow into the larger diameter classes at a faster rate than Alternative 1 (no action). All action alternatives would offer higher quality roosting habitat over time due to the increase in the acres of VSS 5 and 6 sites over the forty years following treatment.

The Mountainaire HFRA Project will have no effect to the Forest-wide trend for turkey habitat or populations.

Cumulative Effects

There is no effect to Forest-wide habitat or population trends and there is no added effect from past, present or foreseeable projects.

Red-naped (Yellow-bellied) Sapsucker

The Forest Plan designates the red-naped sapsucker a MIS for the late seral stage and snag component of aspen. Red-naped sapsuckers nest primarily in aspen, or in deciduous/mixed conifer forest, often near water. Live trees are preferred although dead trees (usually spruce or other conifers) are used at times. This species excavates a new hole each year. They extricate sap and soft cambium layer around willows, cottonwoods, aspen, and walnuts. Nest trees are a

minimum DBH of 10 inches with a minimum height of 15 feet. They favor groups of large aspens near heads of higher elevation canyons during the summer.

Affected Environment

On the Forest, mid- to late-seral stage aspen are declining, due to both natural causes and management actions to regenerate sites. Some early seral stage sites are being created through wildfire and management activities, but recruitment is limited primarily due to grazing by animals. The forest-wide snag distribution of aspen has been declining through out the Forest Plan implementation period. Currently, most aspen on the Forest is in the older age classes, providing habitat for sapsuckers, but future Forest-wide trends are of concern, since aspen regeneration remains an on-going problem.

Available population data on the Forest comes from Christmas bird count, Breeding Bird Surveys, and long-term research conducted along the Mogollon Rim. Collectively, these data indicate that red-naped sapsucker populations fluctuate overtime, but are stable overall on the Coconino National Forest (USDA 2002).

Environmental Consequences

Alternative 1

Habitat conditions for wildlife would remain in their current condition, not withstanding natural processes. This alternative would have no effect on Forest-wide trends population and habitat trends. However, dense forest conditions would still occur and the high fire hazard potential would persist.

Effects Common to All Action Alternatives

Habitat conditions for the red-naped sapsucker would remain in their current condition, not withstanding natural processes. There are no treatments proposed for aspen. The action alternatives would have no effect on Forest-wide trends population and habitat trends.

Cumulative Effects

The Priest Draw Aspen Habitat Protection project will fence twelve of the fifteen acres of aspen within the Mountainaire HFRA Project boundary. This will provide protection from browsing by livestock and wild ungulates and allow these sites to develop into mature aspen sites thereby providing habitat for the red-naped sapsucker.

Mule Deer

The Forest Plan designates the mule deer as an MIS for early-seral stages of aspen and pinyon-juniper woodlands. Early seral stages of ponderosa pine, mixed conifer, and chaparral habitats are also important for this species. Mule deer are primarily browse on green shoots and fruits of shrubs and trees, but also feed on grasses and forbs. Mule deer populations have not done well on the Forest since Forest Plan implementation, due to many factors, such as disease, poaching, climatic conditions, and habitat changes resulting in a declining Forest-wide trend (USDA 2002).

Affected Environment

Although age class distribution has remained relatively stable in pinyon-juniper, the vigor of understory components, such as grasses, forbs and browse species, continues to be affected in areas with numerous young pinyon-juniper trees. Creation of early seral aspen and pinyon-juniper through wildfire or management actions has not occurred at a sufficient enough scale to positively influence browse production that would benefit mule deer (USDA 2002). Consequently the Forest-wide habitat trend for mule deer has declined overall.

The project area occurs within a portion of GMU 7. There appears to be a population interchange with the herd on GMU 9 on the adjacent Kaibab National Forest (AGFD 2003 in USDA 2002). The highest densities of mule deer are found in previously burned areas north of the San Francisco Peaks and the project area. Arizona Game and Fish data for GMU 7 and 6A shows a decline in number of mule deer seen per hour and the number of fawns per 100 does (USDA 2002).

Environmental Consequences

Alternative 1

Habitat conditions for wildlife would remain in their current condition, not withstanding natural processes. This alternative would result in no loss of habitat for mule deer. This alternative would have no effect on Forest-wide trends population and habitat trends. However, dense forest conditions would still occur and the high fire hazard potential would persist.

Effects Common to All Action Alternatives

There are no treatments proposed for aspen and no loss of habitat for mule deer. The action alternatives would have no effect on Forest-wide trends population and habitat trends.

Cumulative Effects

There is no effect to Forest-wide habitat or population trends therefore there is no added effect.

Migratory Birds

ForestERA Avian Species Richness data layers (Forest ERA 2004) were reviewed to identify where predicted passerines species richness was the highest within the project area and to provide a context for implementation activities within the project.

There are no Important Bird Areas (IBAs) or important wintering areas within the project area. The closest IBA is at Lake Mary. The following section describes each habitat type found within the project area and the associated bird species of concern that are or have the potential to be found in the project area. Northern goshawk and Mexican spotted owl are discussed in the proceeding sections. Table 3-37 lists migratory bird species considered, but not taken through detailed analysis because no habitat occurs and/or the analysis is outside the geographic range of

the species. Table 3-38 lists the migratory birds of concern by habitat and those that have the potential to be found in the project area.

Table 3-37. Migratory Bird Species Considered but Eliminated from Detailed Analysis

Bird Species	Habitat/Eliminate Rationale
Gray Flycatcher	Pinyon Juniper
Pinyon Jay	Pinyon Juniper
Gray Vireo	Pinyon Juniper
Black-throated Gray Warbler	Pinyon Juniper
Juniper Titmouse	Pinyon Juniper
Elegant Trogon	High Elevation Riparian
McGillivray's Warbler	High Elevation Riparian
Red-faced Warbler	High Elevation Riparian
Water Pipit	Alpine
Swainson's Thrush	Spruce-fir
Pine Grosbeak	Spruce-fir
Golden-crowned Kinglet	Spruce-fir
Three-toed woodpecker	Spruce-fir

Table 3-38. Priority bird species by habitat (Latta et al. 1999) and those that are or have the potential to be found within the project area

Bird Species	**Habitat**
Olive-sided flycatcher	Ponderosa pine
Cordilleran flycatcher	Ponderosa pine
Purple martin	Ponderosa pine
Red-naped sapsucker	Aspen
Ferruginous hawk	High elevation grassland
Swainson's hawk	High elevation grassland
Burrowing Owl	High Elevation grassland

Affected Environment

Habitat Types

Pine and Pine-Gambel Oak

Ponderosa pine habitat type occurs throughout the project area. Gambel oak is most prevalent in the southern portion of the project area. Four species have been identified as species of concern in pine-pine/oak habitats. They are northern goshawks, olive-sided flycatchers, Cordilleran flycatchers, and purple martins.

The ForestERA avian species richness model (ForestERA 2004) was used to predict the number of species that would be found in areas of pine or pine-oak habitat on the project and on a landscape scale. Areas of high species richness in the project are generally within the MSO PAC, northern goshawk PFAs and in the meso and matrix treatments identified in Alternative 3 for the Abert squirrel research. On a landscape-scale areas northeast of the project in the Marshall Mesa area provide high species richness as do areas to the south.

Aspen

Aspen habitat is limited with 15 acres occurring by Priest Draw. The red-naped sapsucker has been listed as a species of concern in aspen habitat.

High Elevation Grassland

High elevation grassland habitat types include the mountain meadows and savannah grassland areas. Three species have been identified as species of concern in high elevation grasslands. They are ferruginous hawk, Swainson's hawk and burrowing owl.

Species

Olive-sided Flycatcher

Olive sided flycatchers prefer forest edges and natural or human-made openings in spruce-fir, mixed conifer, and ponderosa pine forest types. They nest high in coniferous trees and forage primarily on flying insects. Management recommendations include maintenance of creation of opening, management for uneven-aged forest structure, and retention of tall snags or dead-topped trees during salvage operations (Latta 1999).

Cordilleran Flycatcher

Cordillian flycatchers breed predominately in pine, but also spruce, fir, and aspen forests. They prefer mist and shaded forest. This species is a facultative secondary cavity-nester that also uses rock crevices, tree roots, and forks in small branches. Numbers of birds have been found to be positively correlated with canopy cover, within stand variability of tree sizes (most abundant in sites with five to twenty percent of pine basal area comprised of one to five inch DBH stems), and snag density. Flycatchers need snags and downed logs for nesting. This species is a rare cowbird host. Management recommendations include retention of 2 or more snags per acre, tree densities of 383 or greater ponderosa pines per acre with high variability in size classes, and avoidance of mechanical thinning of tree canopies and snags (Latta 1999).

Purple Martin

In Arizona pine forests, purple martins prefer areas with high snag density adjacent to or in open areas. They are secondary cavity-nesters and forage primarily on flying insects. Management recommendations include creating and retaining large snags (Latta 1999).

Red-naped Sapsucker

The red-naped sapsucker is considered a "double keystone" species for it's role in excavating cavities and drilling sap wells, which are both used by a variety of other species for nesting and feeding (Natureserve 2002). The red-naped sapsucker is found foraging in coniferous forests that include aspen and other hardwoods, as well as riparian areas. The sapsucker generally nests in aspen trees or snags. This highly migratory species, travels to neotropical areas and also descends to lower elevations in winter.

Ferruginous Hawk

Ferruginous hawks historically nest in open shrublands, woodlands, and grasslands in southeastern and northern Arizona. 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 1999). Ferruginous hawks forage in montane grasslands in the Flagstaff vicinity. Management recommendations include the reduction of chemical control of prairie dogs, particularly in suitable nesting habitat and treatment to control exotic species encroachment of grasslands.

Swainson's Hawk

These birds eat grasshoppers during migration and on wintering grounds. They have a wider variety of food sources than ferruginous hawks including lizards, snakes, birds, ground squirrels, voles, pocket gophers. Non-breeders hunt communally and eat primarily insects. These hawks are not as sensitive to human disturbance as ferruginous hawks.

Burrowing Owl

Burrowing 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.

Environmental Consequences

Alternative 1

Under this alternative there would be no changes in the project area. Habitat conditions for birds would generally remain the same, notwithstanding natural processes. Alternative 1 would have no direct effect on migratory birds. However, dense forest conditions would continue to place forest-dwelling migratory bird habitat at risk with respect to stand-replacing fire.

Effects Common to All Action Alternatives

Northern goshawk and Mexican spotted owl are discussed in previous pages of this report. Proposed activities may affect these species directly through habitat modification, or indirectly through changes in prey populations.

Species Richness is associated with pine and pine oak habitats. Most of the high species rich areas are associated with MSO PACs and goshawk PFAs in the project and treatments are designed to maintain habitat components important for these species as well as forest-dwelling passerine birds.

Alternative 3 will maintain habitat in additional areas of high species richness in meso-reserves and matrix treatments.

Olive-sided flycatcher is associated with forest openings and edges with numerous dead trees and live, mature pines. Disturbances to individuals from thinning and burning will be short-term. This species has been linked to burned areas of ponderosa pine (Altman 1997, Blake 1982, Lowe et al. 1978 in Latta et al. 1999), and burning will likely have short-term beneficial effects by increasing insect abundance post burn. Effects from vegetation modification and burning treatments will be beneficial due to the creation of openings and more edge effect, the retention of snags and large trees.

Cordilleran flycatcher is associated with mid- to late-successional stages with dense canopy cover and drainages that create a cool microclimate. Disturbances to individuals from thinning and burning will be short-term. Through vegetation modification this project will create some open habitat, which favors early successional birds, not mid-to late successional ones like the flycatcher. However, the project area will continue to support mostly mid-successional stages, which favors this species. Alternative 3 will maintain more areas with within stand variability of tree sizes including some comprised of one to five inch diameter stems.

Purple martin is associated with open-canopy, open mid-story and open understory cover, and high snag density. A lack of snags likely limits the abundance and distribution of this species in the project area. The more open understory created by thinning and burning activities favors this species, and burning will likely have short-term beneficial effects by temporarily increasing insect abundance. Alternatives 2 and 3 will provide slightly more open canopy habitat within the project than Alternative 4.

Red-naped sapsucker nests in snags in mature to old aspen sites. It is worthy to note that drought conditions and ungulate grazing over the past several years have affected aspen sites in the project area. The remaining living aspen are severely stressed and are primarily seedlings. A separate project, Priest Draw Aspen Improvement, will fence off ten acres of aspen within the project area in an effort to reduce livestock and wild ungulate grazing and provide young seedlings an opportunity to develop into mature aspen over time.

Swainson’s hawk is uncommon during June, July and during migration. The amount of openings within the project and the four prairie dog colonies provide prey availability for Swainson’s hawks. Due to the creation of openings within the project, there will be increased prey availability within the project. It is expected there will be no detectable effect to Swainson’s hawk.

Ferruginous hawk is a migrant or uncommon during the winter. Due to the creation of openings within the project, there will likely be increase prey availability for ferruginous hawks. It is expected that there will be no detectable effect to ferruginous hawks.

Burrowing owl nests in burrows in dry, open grasslands. They also inhabit grass, forbs, and open shrub stages of pinyon pine and ponderosa pine habitats. There are four existing prairie dog colonies that provide potential burrows for nest sites, however, there are no known populations of burrowing owls within the project. Due to the creation of openings and grassland and savannah restoration treatments within the project, there will likely be increased prey availability for burrowing owls. Prairie dog colonies will be maintained in all alternatives. There will be no detectable effect to burrowing owls.

Cumulative Effects

The cumulative effects analysis area is the project area. Ongoing recreational activities may result in disturbance of migratory birds although the Mountainaire Community Trails Project may reduce road and trail density overall. Private land development will reduce habitat for these species. Removal of hazard trees for powerlines and highway safety will reduce snags and reduce habitat for snag dependant species. Present and future activities have common objectives to improve current conditions by improving soil conditions, reducing competition of trees, managing for return of the large tree components and providing snags, logs and coarse woody debris in sufficient quantity to provide for raptor species.

Treatments in the project area will provide protection from stand-replacing crown fires to high species rich habitats not only within the project area but also in areas northwest of the project, specifically the Marshall Mesa area.

No significant cumulative effects to migratory birds would occur from implementation of any alternative when added to past, present and reasonably foreseeable future actions.

Cultural Resources

A total of 38% of the project area has been intensively (100%) surveyed. The forest is required to survey all ground disturbing activities at 100% and locations that are likely to have historic properties based on forest models in low site density areas. Percentages of survey in areas of low site density are consulted on individually with the Arizona SHPO and usually are around 15 to 20%. Areas of historically high site densities are surveyed at 100% per the Region 3 2004 Programmatic Agreement.

Affected Environment

The Mountainaire Project was inventoried by Crossley (2004) and has 28 known archaeological sites within the project boundary. These heritage properties consist of prehistoric and historic archaeological sites ranging in age from a few thousand years ago (late Archaic through Protohistoric) to the early 20th century. Examples of site types found in the project are prehistoric lithic scatters representing temporary hunting camps, historic logging camps and railroads, and late 19th to early 20th Century pioneer homesteads. Twenty five sites are eligible historic properties under the National Register of Historic Places. Some of these sites have heavy fuel buildups and in the event of an intense fire are threatened with increased heat and fire effects from those fuels.

Environmental Consequences

Alternative 1

The continued increase of fuel loading on heritage resources will contribute to the potential for catastrophic fires occurring in archaeological properties. High heat intensity, along with the associated fire suppression actions (ground disturbing activities) has the potential to adversely affect heritage resources.

Effects Common to All Action Alternatives

Regular prescribed fires at a low to moderate intensity will remove fuels from fire tolerant sites (sites that can be burned) and remove the surrounding fuels from sites that cannot be burned due to flammable artifact and features associated with those fire intolerant sites.

Cultural resources will be protected from catastrophic fires and associated suppression actions through the removal of heavy fuels. There will be little effect to cultural sites if prescribed fire intensities are kept at low to moderate intensity level around these sites. The alack of mechanical thinning or other ground disturbing activities near these sites will also reduce effects to sites. Hand thinning is acceptable in these areas and may be used.

Vandalism may occur and increase if visibility is increased in some areas due to the removal of cover vegetation and fuels. There may be increased soil erosion in some sites if prescribed fires burn too hot and remove all ground cover in and adjacent to sites. In addition, prescribed fires that are too hot may kill trees on or adjacent to sites. Tree uprooting our of or onto sites may effect these sites. Hand felling trees in these areas may mitigate uprooting effects.

Cumulative Effects

Eligible heritage resources will be protected from wildfires if fuel loads are reduced on fire tolerant sites and surrounding fuels are removed adjacent to fire intolerant sites. Increased visibility of archaeological sites within the project area and outside of the area, may increase vandalism to sites outside of the project area.

Landscape Aesthetics

Analysis of landscape aesthetics of National Forest Landscapes employs the use of the Visual Management System (VMS; the system in use until 1998) and the subsequent Scenery Management System (SMS). Both systems begin with an assessment of the inherent scenic qualities in the landscape as seen by the “viewing public” from viewing positions usually defined by existing roads, trails, observation points, and residential areas. Visual Quality Objectives (VQOs in the Visual Management System) or Scenic Integrity Levels (SILs in the Scenery Management System) are derived from a combination of viewer concern for scenic quality, the position of the potential viewer on the landscape, and the inherent scenic qualities of the landscape. Management activities are analyzed by a comparison of existing condition with the predicted VQO or SIL level attained following the activity. The initial assessment of the project area for assignment of management objectives was done using the Visual Management System and so this assessment will continue to use VMS terminology and concepts. This assessment will not include any further analysis of private lands within the project area.

Affected Environment

Visual Quality Objectives (VQOs) defined in the Forest Plan for the area are:

- Retention (R) along the I-17 and FH3 road corridors within the foreground viewing position (up to ½ mile distance) which allows for no visible evidence of management activity or human alteration;

- Modification (M) in areas unseen from primary roads and trails which allows for visible alterations to the natural appearing landscape that blend with the natural appearing landscape; and
- Partial Retention (PR) for a few isolated areas of the within the project area, which allows for alterations to the natural appearing landscape which are subordinate to it.

Revisions to the Visual Management System (VMS) since the initial Forest VMS inventory linking the VMS to the ROS system (1996 national direction) result in most of the "M" area within the Mountainaire project area converting to a more stringent PR VQO. Another revision based on Forest Plan direction which calls for an update of the initial inventory at the time of project analysis results in a change of status of Forest Roads 235, 132, and 762 from concern level 3 to concern level 2 which would also result in a PR VQO as seen within foreground from the roads. The net result of an updated VQO inventory is that the R VQO area would remain the same but all of the previous M VQO area would convert to a PR VQO.

Historic descriptions and photos of the forested area near Flagstaff, which would have represented the project area, describe a relatively open landscape dominated by large "yellow pine" parks typical of the Flagstaff character type (Character Types of Arizona and New Mexico, USDA). Research suggests that a more open forest with less ground litter and more big trees—typical of the historic forest—is more appealing to most people than the typical stands found on the Colorado plateau today. Historic conditions prior to the intensive management that followed European settlement represents the most scenic condition, and the highest level of scenic integrity, that has existed on the Colorado plateau ever since.

Overall existing scenic integrity could be defined as "moderate" meaning that the landscape appears slightly altered but with the natural appearing landscape dominant. Alterations to the natural appearing landscape within the project boundary (including private lands) include roads and trails, power lines, and residential developments. Over the past several years increased recreation use of areas adjacent high use access roads and residential developments have resulted in increasing visible evidence of human activity such as fire rings, compacted bare ground, litter, and additional unauthorized roads and ATV tracks. All of these additional elements in the landscape detract from its natural appearance and degrade the areas' scenic integrity resulting in a "low" scenic integrity rating that equates to a "modification" VQO for the specific areas affected.

In contrast, most of the project area located away from the residential areas and high use Forest roads have high scenic integrity that equates to the prescribed R and PR VQOs defined in the Forest Plan. Past management has altered the vegetative pattern from the more desirable open pine stands with more big trees to the present less desirable condition with more dense stands of smaller trees. Even though the resulting landscape looks unaltered and natural to the casual observer and meets the original scenic objectives (VQOs) set forth in the Forest Plan, the existing scenic condition falls short of the potential scenic quality inherent in the historic ponderosa pine forest with its open meadow strung along the major drainages in the area and the open "parks" dominated by large yellow barked trees.

Environmental Consequences

Alternative 1

The "No Action" alternative will result in a landscape that will continue to meet visual quality objectives defined in the Forest Plan but will continue to fall short of meeting the long term scenic potential of the area as a whole. Visitors to the area will see a mostly natural appearing landscape with minor evidence of human activity, aside from the existing road system. The existing vegetative pattern of variable density ponderosa pine stands with large areas dominated by "over stocked" small diameter pine trees will continue to define the areas' landscape character.

The No Action alternative results in a vegetative pattern that tends to decrease the viability of larger, older trees and to favor conditions that result in dense stands of smaller diameter trees. Crowding by smaller trees for moisture and nutrients will tend to accelerate mortality in the larger trees as well as to put them at risk of mortality by wild fire. The long term result will likely be a decrease in the number and extent of large "yellow pine" across the landscape. The ability of the landscape to reach the maximum inherent scenic potential that existed historically will be compromised with this alternative compared to any of the action alternatives.

Effects Common to All Action Alternatives

All Action alternatives will result in a landscape that will experience short term disruptions of existing scenic quality, but which will meet all visual quality objectives within a relatively short time (within 2 growing seasons or less). It will result in a more diverse vegetative mosaic that will generally be less dense and more transparent, and therefore more interesting to the typical person viewing it.

The Proposed Action alternative will help the area attain it's long term scenic potential by increasing the viability of older trees, increasing the growth rate of smaller trees, and by creating and maintaining a more diverse and more interesting vegetative pattern mosaic across the affected landscape. The ability of the landscape to reach the maximum inherent scenic potential that existed historically will be enhanced with this alternative.

Cumulative Effects

Alternative 1

The No Action alternative will maintain the existing landscape character that is presently most common through out the Flagstaff character type. Recent trends in management of forest lands on the Colorado plateau will result in less dense tree stands across the landscape affected by this alternative. In the long term under the No Action alternative this area will either be a remnant of what is now the dominant landscape character, or it will appear like other burned or partially burned landscapes. Either appearance will likely be less appealing to most people than the landscapes resulting from other local management actions, which will contrast with this area.

All Action Alternatives

Any of the Action Alternatives will result in landscape patterns that will blend with other local landscape patterns resulting from recent management initiatives and trends to help create a more scenic landscape character for the Flagstaff character type in the long term. These alternatives will generally enhance the scenic quality of the affected landscape significantly more than continued implementation of the No Action (Alternative 1) alternative. The difference in scenic quality between the two alternatives will increase over time as the vegetative pattern favored by the action alternatives management scenarios matures.

Soils and Watershed

Affected Environment

The Mountainaire Fuels Reduction Project is located in the Oak Creek 5th code watershed of the Verde River and the Walnut Canyon 5th code watershed of the Little Colorado. Elevations range from around 6800 feet in the northern portion of the project area, to around 6300 feet at far western portion. The following table is a summary of number of gross project acres within the Oak Creek 5th code and Walnut Canyon 5th code watersheds and the percent of the project area within the watersheds.

Table 3-39. Watersheds and Acreage Within the Project Area.

Watershed and Size	Project Area Acres	Percent of Project Area within Watershed
Oak Creek 5th Code Watershed 297,709 acres	6,257	2.1
Walnut Canyon 5th Code Watershed 124,308 acres	10,345	8.3

The majority of runoff occurs during the fall and winter months (October to April). Snowmelt, from late February to mid-May produces most of the runoff. Occasional winter frontal storms also produce runoff from heavy or prolonged rain events. Very little runoff occurs during the months of mid-May to October.

Thirteen Terrestrial Ecosystem Survey (TES) Map units exist within the project area. Each unit describes an area with similar slope, vegetation, climate, and physical soil properties. The survey units contain predictions and limitations of soil and vegetation behavior for selected land uses. The survey also highlights hazards or capabilities inherent in the soil and the impact of selected uses on the environment.

Table 3-40. Terrestrial Ecosystem Survey Map Unit Descriptions of the Project Area.

Map Unit	Size (acres)	Landform
53	1,266 acres	Valley plains. This component is unsuited for timber production, but is well suited to forage production. Soil condition is impaired, resulting from historic livestock grazing and current elk grazing.

Map Unit	Size (acres)	Landform
55	215	Valley plains. This component is unsuited for timber production, but is well suited to forage production. Soil condition is unsatisfactory, resulting from historic livestock grazing and current elk grazing.
536	7,605	Elevated plain. This component has a moderate erosion hazard. Maintenance of vegetative ground cover is essential to prevent sheet and rill erosion. Natural regeneration and re-vegetation potentials are high.
537	1,411	Elevated plain. This component has a severe erosion hazard. Maintenance of vegetative groundcover is essential to prevent sheet and rill erosion. Shallow soils and surface rock fragments limit most management activities. Natural regeneration, reforestation and revegetation potentials are low.
550	457	Map Unit 550 – (457 acres) Landform – Elevated plain. This component has a moderate erosion hazard. Maintenance of vegetative ground cover is essential to prevent sheet and rill erosion.
555	44	Escarpments. Due to its northern aspect and cooler, moister conditions, this component supports a mixed conifer climax community. This component has a moderate erosion hazard. Maintenance of vegetative ground cover is essential to prevent sheet and rill erosion.
565	128	Elevated plain. This map unit has a severe erosion hazard. Maintenance of vegetative groundcover is essential to prevent sheet and rill erosion. These soils are subject to trafficability problems and soil damage (compaction, puddling and displacement) when wet.
578	319	Elevated plain. This component has a slight erosion hazard. Upon removal of over-story, juniper, and oak may offer significant plant competition.
579	583	Elevated plain. These soils are subject to trafficability problems and soil damage (compaction, puddling and displacement) when wet. These problems can be mitigated or avoided by restricting ground disturbing activities to periods when the soils are dry. Shallow soils and surface rock fragments limit most management activities. Upon removal of the overstory, significant plant competition could occur.
582	2,018	Elevated plain. This component has a slight erosion hazard. Natural regeneration and re-vegetation potentials are high.
484	1,232	Hills / scarp slopes of plains. This component has a moderate to severe erosion hazard depending on slope. Maintenance of vegetative ground cover is essential to prevent sheet and rill erosion.
585	1,085	Elevated plains. Shallow soils and surface rock fragments limit most management activities

Map Unit	Size (acres)	Landform
586	207	Elevated plains. These soils are subject to trafficability problems and soil damage (compaction, puddling, and displacement) when wet.

Organic matter consists of humus, litter, and dead woody material on or in the soil. These materials are important because they increase infiltration, improve aeration and retention of moisture, support microbial activity, and are reservoirs for short and long term nutrient supply. Coarse woody debris (CWD) is material from tree limbs, boles, and roots greater than 3 inches in diameter. Coarse woody debris performs such functions as protection of forest floor, seedlings and wildlife, and acts as a sink for nutrients such as sulfur, phosphorous, and nitrogen. In the project area, where fire frequencies historically are often less than 10 years, CWD has probably increased in abundance due to extenuation of fire frequency over the last 100 years.

Environmental Consequences

Alternative 1

There will be no change in soil condition from current conditions. 1 will perpetuate stand conditions that are conducive to the occurrence of intense wildfire. If and when such an event occurs in the area, severe fire effects on hydrologic function could occur.

Wildfire can have major effects on vegetation, ground cover, and soil properties, resulting in reduced infiltration and increased overland flow. Intense wildfire can reduce soil surface resistance to erosion resulting in accelerated soil erosion, particularly because of heavy summer precipitation. Peak discharges are likely to increase because of wildfire, and water quality is likely to decrease due to increased sediment loads.

As forest canopy and protective organic matter is consumed by severe fire, interception would be reduced and soil erosion could increase. Changes in forest canopy cover creating large openings can effect snow accumulation and melt patterns and consequently the timing, quantity, and quality of runoff from severely burned watersheds. Changes in soil and watershed conditions become more significant as fire size and intensity increase.

Heating may cause changes in soil properties such as the reduction of structure, reduction of porosity, and change of soil color. Burning reduces soil organic matter, and plant and litter cover. In most cases, soil erosion by wind and water is increased. The severity and duration of accelerated erosion depend on slope, soil texture, recovery of plant material, severity and extent of burning, and post fire precipitation timing and intensity. Duration of the effects of fire on soil structure range from 1 year to many decades depending on the severity of the fire and rate of recovery (Wells et al. 1979).

High degrees of soil heating can destroy soil structure, affecting soil pore size distribution and overall porosity. This reduces infiltration rates and increases overland flow. Soil water repellency is increased as organic matter is heated. The more severe the fire, the deeper the water repellant layer unless heating is so intense that surface organic matter is destroyed.

Effects Common to All Action Alternatives

The most important direct effect on soil condition from the action alternatives will be from mechanical activities (machine piling, feller bunching, and skidding). Ground cover will be disturbed through mechanical actions. Skid trails will tend to compact the ground and, in some cases, channel water. This is estimated to occur over < 10% of the areas that are mechanically treated. The expected duration of effects is less than 10 years. Additional loss of ground cover will occur through the burning phase of the project. The combination of thinning to open the stand and burning will likely result in the promotion of herbaceous vegetation over ground litter as the major component of ground cover. Stand canopy conditions and fuel loading will be reduced so that the potential effects of intense wildfire are reduced.

Provided that mitigation measures are followed, there will be only minor impacts to on-site soil quality and productivity from the proposed activities. Some minor soil compaction from skidding equipment will occur in all mechanical treatment areas, and some on-site soil loss would occur on soils with moderate and severe erosion hazards. Best Management Practices including skid trail location prior to felling, attention to wet weather operations, and effective erosion control treatments will minimize adverse soil effects on soils with moderate and severe erosion hazards.

To provide for long-term soil productivity, roughly 5 tons per acre of CWD will be retained in the project area, and will be retained through both piling techniques and burning under conditions where organic matter is not totally consumed. Reductions in soil porosity may occur from loads that compact soils or from the removal of ground cover and organic matter. Best Management Practices such as designating skid trails to limit the extent of disturbance, operating equipment under relatively dry conditions, utilizing proper equipment size, and maintaining soil cover will preserve soil porosity. Compaction will be minimized on all soil units.

Some potential off-site effects include sedimentation from ground disturbing activities, and potential short term increases in runoff from disturbed surfaces. Adequate buffers have been developed on all major drainages in the area. Only a small portion of anticipated soil loss will travel off site and enter ephemeral stream channels. Most of this sediment will remain in storage rather than move downstream into Oak Creek. Other potential effects include long term decreases in accelerated soil erosion from road closures, and reduction in the potential effects of intense wildfire within the treated watersheds. Each of these effects may have a slight influence on water quality within the Oak Creek drainage and in Lower Lake Mary.

Prescribed Burning

Fire effects on soil, water, and watershed resources may range widely due to variability in resource conditions, season, intensity of burning, and timing, and intensity of precipitation before and after burning. Fire may have perceived negative, beneficial, or benign effects, which may persist for short or long periods.

The degree to which soil is heated depends on a variety of factors including soil moisture, fuel loading, fuel moisture, fuel distribution, and soil texture. The peak temperature and duration of heating greatly influence subsurface soil temperature. The amount of change in soil properties is largely dependent on the amount of energy radiated downward into the underlying duff and mineral soil. Their amount of heat radiated downward increases as fire severity increases. Low severity fires burning only surface fuels do not significantly heat the soil surface. Soil

temperatures do not rise substantially where repeated cool-burning fires are used to reduce fuel buildup (Debano et al. 1998).

All action alternatives will effectively reduce the probability of intense wildfire within the treatment areas. Alternative 4 will accomplish some of this, but to a lesser extent. In all action alternatives, prescribed burning will have the effect of reducing litter accumulations and most likely promoting herbaceous vegetation. Short-term reductions in ground cover will result where litter is totally consumed (Previous experience on the Forest, and Sackett et al. 1993) shows that this bare soil is covered by litter or vegetation within one to two years. Total consumption of ground cover will be patchy and will not adversely affect overall ground cover. Pile burning of logging slash is not expected to have any significant effects on soil characteristics, Seymour and Tecle, 2003.

Grassland and Savannah Restoration Treatments

Roughly 2,805 acres of mountain meadow and pine savannah will be thinned to remove stocked plantations and restore a more historic meadow and savannah structure. In most of these areas, fuels hazard reduction will also occur as overly dense thickets will be thinned. Alternatives 2 and 3 will be the most effective in restoring meadow and savannah conditions, while alternative 4 will severely limit opportunities to remove open grown, undesirable seed source trees.

Transportation System

The Proposed Action will require approximately 1.3 miles of Temporary Road construction. Temporary roads are defined as roads associated with a timber harvest contract, not intended to be a part of the forest development transportation system, and not necessary for resource management (FSM 77-5.7/27/94). Potential undesirable consequences of forest roads include adverse effects on hydrology, habitat fragmentation, predation, invasion by exotic species, degraded water quality, use conflicts, destructive human actions (for example, trash dumping, illegal camping, fires), and loss of soil productivity.

Forest roads affect site productivity in the roadbed and log landing area by removing and displacing topsoil, altering soil properties (compaction), changing microclimate, and accelerating erosion. Roads my also contribute to invasion by exotic (non-native) plant and animal species dispersed by wind, water, vehicles, and other human activities, as the disturbed areas serve as an avenue for establishment of exotic species into a new landscape. Invasion by exotic species may have unwanted biological and ecological effects if those species are able to displace natives or disrupt the structure and function of an ecosystem. Currently, over 100 miles of road, exist within the project area. Many of these roads will require some degree of maintenance for project activities.

The Proposed Action intends to decommission 55.7 miles of existing roadway by closing, scarifying, and re-vegetating. These areas will not likely return to full productivity for many years, but will become stable after only a few years. The area of rehabilitated roadway amounts to roughly 135 acres.

Table 3-41. Proposed Road Management Activities

Alternative	Temporary Road	Open Road System	Decommissioned Roads
Alternatives 2,3,4	1.3 miles	47.7 Miles	55.7 Miles
No Action	0	103	0

Forest Roads influence hydrologic processes in several ways. Compacted surfaces tend to intercept precipitation from rainfall and runoff from adjacent areas, concentrating flow, and essentially increasing drainage efficiency and runoff quantity.

Depending on the landscape position of forest roads, surface erosion from road surfaces and ditches may have the effect of introducing above background sediment input to streams. Roads adjacent to, or frequently crossing stream channels, have a higher likelihood of introducing sediment to stream channels than those located on ridgetops or midslope. Increased sediment delivery to streams after road building has been well documented in the research literature for the Pacific Northwest and Idaho Megahan and Kidd 1972, Rice and others, 1972. Rates of sediment delivery from unpaved roads are highest in the first years after building (Megahan and Kidd 1972). Inadequate maintenance of forest roads often results in them being chronic sources of sediment. It is thought that roads contribute more sediment to streams than does any other land management activity. At least in the Northwest, it is believed that most of the sediment from timber harvest activities is related to roads and road building.

The Mountainaire area is relatively flat and not prone to mass soil failure as is documented in the Northwest. The basalt soils in the Mountainaire area are fairly resistant to erosion, and produce little sediment from the road system, even though many of the roads are poorly maintained. No perennial streams are present in the area, and road crossings of even ephemeral stream channels are rare.

Extensive research has demonstrated that improved road design, construction, and maintenance can reduce road-related surface erosion at the scale of individual road segments. Key factors are road location, particularly layout relative to stream systems, road drainage, surfacing, and cut slope and fill slope treatments. Many studies have shown that surfacing materials and vegetation measures can be used to reduce the yield of fine sediment from road surfaces.

Alternative 2

Under the Proposed Action, 1,385 treatment acres (9%) occur on soils with severe erosion hazard, 7239 treatment acres (46%) occur on soils with moderate erosion hazard, and 6439 acres (41%) occur on soils with slight erosion hazard. Provided that mitigation measures are followed, there will be only minor impacts to on-site soil quality and productivity from the proposed activities.

Table 3-42. Treatment acres listed by TES Units and Erosion Hazard for Alternative 2

Map Unit	Broadcast Burn	Grassland Restoration	Savannah Restoration	Thin to 40% CC	Thin to 50% CC	Uneven Age 30% CC	Uneven Age 40% CC	Uneven Age 50% CC	Erosion Hazard
53	4	582	125	62	5	10	10	47	Slight
55	11	86	40	0	0	0	13	0	Slight
536	462	268	1525	1370	280	89	2061	767	Moderate
537	95	71	42	347	36	105	224	376	Slight
550	0	21	2	22	0	0	251	121	Moderate
555	0	4	0	19	0	21	0	0	Severe
565	23	0	4	22	0	0	11	50	Severe
578	3	0	0	158	0	578	160	4	Slight
579	88	0	0	0	0	111	185	37	Slight
582	153	19	42	653	38	0	886	217	Slight
584	206	15	9	94	79	25	622	181	Severe
585	380	0	9	22	91	0	455	125	Slight
586	52	2	2	87	0	0	29	33	Slight
Sum	1477	1068	1800	2856	529	939	5007	1958	

Alternative 3

In alternative 3, slight modifications from the Proposed Action were designed to accommodate the wildlife research proposal will have differ little in soil and water effects from the Proposed Action.

Alternative 4

Alternative 4 is similar to Proposed Action except that it limits opportunities to accomplish fuels and forest health objectives by imposing a 16” diameter limit.

Opportunities to remove larger, stunted trees in the meadow and savannah restoration areas will be severely restricted, thus reducing recovery of grassland and meadow function. While stand canopy conditions and fuel loading will be reduced so that the potential effects of intense wildfire are reduced in all action alternatives, this effect will be somewhat reduced in alternative 4, although there will be little difference in effects from alternatives 2 and 3.

Cumulative Effects

The cumulative effects of land disturbing activities can be seen as on site, or downstream of the activity. On-site effects include changes to soil characteristics, vegetation, and nutrient cycling. Downstream effects may include changes in the amount and timing of overland flow, and sediment transport. An appropriate area to consider cumulative effects area is the Pumphouse 6th code watershed (31,641 acres) for the Oak Creek portion (6470 acres), the project area to Lower Lake Mary watershed (7177 acres) and Walnut Canyon 6th code (42,064) for the walnut portion of the project area (2956 acres).

A ten year time period is reasonable to consider when evaluating cumulative effects for soil and watershed because any on or offsite effects from ground disturbing activities generally become negligible after this period of time. The effects from a major wildfire would be an exception, but none have occurred in either watershed for many years. Within the last 10 years, few Forest Service activities have occurred in the Mountainaire area. These activities will be considered in terms of potential on-site cumulative effects. These projects include:

- Livestock Grazing permitted on the Casner Park/Kelly Seep, Lake Mary, and Mud Springs allotments (2,363 acres).
- Pumphouse watershed vegetative treatments with pile burning (776 acres).
- Dispersed recreation, primarily along Forest Road 237.
- High densities of roads that have developed over time.

Other activities adjacent to the project area within these two watersheds include:

- Thinning and prescribed burning on 11,100 acres in the Kachina Valley forest Health Project area adjacent to the western portion of the Mountainaire HFRA project area.
- Thinning and prescribed burning on 903 acres in the Skunk Canyon project area adjacent to the northern portion of the Mountainaire HFRA project area.
- Thinning and prescribed burning on 5,048 acres in the Elk Park Meadows project area adjacent to the eastern portion of the Mountainaire HFRA project area.
- Thinning and prescribed burning on 5,522 acres in the Limestone area (Eastside Project) adjacent to the northern portion of the Mountainaire HFRA project area.

Grazing Allotments

The Pumphouse watershed contains the following grazing allotments: Kelly/Casner (3,221 acres), Lake Mary (2,563 acres), and Mud Springs (118 acres). The Lake Mary Allotment is not normally grazed by livestock.

The Walnut canyon watershed contains the following grazing allotments: Kelly/Casner (2,022 acres), Lake Mary (5,988 acres), and Mud /Tinny Springs (1,244 acres). The Lake Mary Allotment is not normally grazed by livestock and has been in grassbank status since 1995.

Livestock Grazing is evaluated and regulated through the individual Allotment Management Plans. Rangeland Best Management Practices are prescribed through the process of developing the Allotment Management plan.

Development, Recreation, and Transportation

Most of the land within the watersheds is owned by the Coconino National forest. There are substantial Private ownerships in Mountainaire, Kachina Village, and Forest Highlands. State of Arizona lands are also present, and are managed in a similar fashion to Forest lands. It is likely that private lands within the watershed will continue to develop over time. State and County laws regulate floodplain development and non-point source pollution from construction activities.

Table 3-43. Land Ownership in Watersheds

Watershed Name and Size	City of Flagstaff	Coconino N.F.	Coconino County	Private	State
Punphouse 31,641 acres	209 - .7%	24,620 – 78%	158 - 0.5%	3,249 – 10%	3,406 – 11%
Lower Lake Mary 21,258 acres	0	0	20,022 – 95%	0	1,076 – 5%
Walnut 41,735 acres	170 – <1%	35,829 – 86%	2,902 – 7%	3,005 – 7%	160 <1%

All vegetation and soil disturbing land uses that reduce water infiltration rates or remove excessive amounts of vegetative cover from sites can increase runoff and sediment from storm events. The goal for managing the road system on the Coconino National Forest within these watersheds is to limit overall road densities to two miles per square mile. With the exception of private land development, few if any new roads need to be constructed for activities proposed in the watersheds. Some roads have been closed or obliterated recently and additional closures and obliterations are expected in the future. Existing open forest system roads will be maintained at levels suited to their uses and locations. As timber sales continue to decline, so will the periodic road maintenance associated with sales. Funding appropriated for maintenance of forest system roads is also declining. Some funds have and will be invested in road closures, obliteration, and drainage maintenance. Reducing the road system and maintaining open roads will reduce soil disturbance activities.

Recreational use in each watershed is moderate to high. Recreation uses will probably increase in the future. Individuals and groups use the area and activities include hiking, horseback riding, bicycling, jeep driving, off-highway vehicle driving, dispersed camping, and camping in developed campgrounds to name a few. In some places throughout the watershed, recreation uses could a loss of vegetative ground cover, soil compaction, localized erosion, increased runoff and biological pollution. The proposed changes in recreation and road management will substantially improve soil condition in areas that are currently degraded.

Assuming that soil and water mitigation measures are employed, the harvest and burning treatments proposed in alternatives 2, 3 and 4 would have little incremental cumulative effect on soil condition and water quality when considered with the effects of other projects, both past and in the foreseeable future. The ground disturbing effects in the Kachina Village project are minor, and will be moderated substantially by the time the Mountainaire project begins. Impacts from livestock grazing have been reduced over time as trends in allotment management are towards less frequent stocking, particularly on the Lake Mary allotment. The Pumphouse and Skunk treatments have had no discernable adverse effects on soil condition so contribute nothing to cumulative effects.

Treatments in alternative 2, 3, and 4, are designed to reduce the likelihood of landscape level wildfire and the watershed disturbing effects associated with such a fire. Improvements in road and recreation management would improve soil condition in the long term, and consequently have a positive effect on soil condition and perhaps downstream water quality.

Alternative 1 could result in the greatest impact to soil condition and water quality if a fire occurred, and therefore, the greatest cumulative effect. A severe crown fire would result in large increases in soil movement and runoff for at least a few years.

Recreation

Like much of the Peaks and Mormon Lake Ranger Districts, the Mountainaire HFRA Project area is commonly and regularly used by the public for recreational purposes. However, unlike other areas of the districts, there are few public recreational facilities or trails managed by the Forest Service, and little management presence in the project area.

Recreational use of the project area has historically included dispersed camping, recreational driving, hunting, and hiking and walking – particularly around the community of Mountainaire. In recent years use by all-terrain vehicles (ATVs) and motorcycles riding cross-country and on social trails has increased as has rock climbing (bouldering) and disc golf.

Of these uses recreational driving, ATV and motorcycle use have had the most resource impacts, including extensive damage to meadows, rutting and braiding of roads due to use in wet conditions, and the development of extensive social trail and road networks.

Affected Environment

Recreational Driving

Currently many of the roads in the project area are used for recreational driving. This type of use is defined as use of both Forest Development Roads and social roads by full-sized motor vehicles for purposes other than commuter travel. For example, this would include use to enjoy the forest surroundings, seek wildlife, access dispersed camping sites or rock climbing areas, or for seeking the challenge of driving rough roads in muddy conditions. Unfortunately the latter is the most common and most damaging type of recreational driving use in the project area. Many of the roads in the project contain braids, low-spots and washouts which can cause some road users to attempt to avoid these spots further braiding the road, while others will drive into them for the challenge and further damage the road surface.

While the district has no road use data for the project area (traffic counts, etc.) it is reasonable to assume recreational driving use of the road network in the project area is similar to that of other areas on the Mormon Lake Ranger District and Coconino National Forest.

Dispersed Camping

A survey of the project area conducted in 2002 found a total of 214 campsites of which 6% were highly impacted, 34% moderately impacted, and 60% slightly impacted. These sites are located primarily off Forest Roads 235, 700 and 866. In comparison to other areas of the Forest, like the

Kachina Village project area, dispersed camping use is relatively light. Use is believed to be largely during the fall hunting seasons but use by rock climbers has increased slightly.

Rock Climbing

In recent years the rock climbing community, both in Flagstaff and increasingly nation-and world-wide, has discovered the numerous limestone outcrops and overhangs on the Peaks and Mormon Lake Ranger Districts. As a result, areas like Priest Draw, once the domain of a handful of local boulderers have now become featured areas in guidebooks and even featured in major bouldering films.

Bouldering is a type of rock climbing where the climber does not used any rope or fixed hardware for protection from falls, only the outreached arms of friends and the cushion of think portable pads. Of all types of rock climbing bouldering is perhaps the simplest and “cleanest” but is not without its resource impacts.

The nature of bouldering involves repeated attempts on short, often close to the ground, yet extremely challenging “problems.” As a result climbers will spend hours in the same spots over many days leading to loss of vegetative cover below the outcrop or boulder. Climbing use also leads to the development of social trails along outcrops and up steep slopes to access boulders and outcrops. Chalk used by climbers to dry the hands and improve their grip leaves white marks on the rock, which, however is washed off by rains.

Rock climbing use in the project area is focused on limestone outcrops and boulders in the Priest and Howard Draw areas. Due to the size and type of the rock outcrops the use is all bouldering (un-roped climbing close to the ground) with no known fixed anchors or roped climbing occurring. The area has seen dramatically increased use in recent years and is now featured in several guidebooks, drawing climbers from other areas.

Prior to the Priest/Howard Draw Project , the meadows in both draws as well as the watershed were being negatively impacted by the poor condition of the road system and by off-road driving. While much of the use was to access rock climbs, there was some “mud-bogging” occurring as well as occasional use as a transportation route between the Mountainaire and Lake Mary areas. In response to these negative impacts, roads through both Priest and Howard Draws were decommissioned, a closure to cross-country motorized travel was implemented, and a non-motorized trail was constructed along the north edge of Priest Draw to provide climbing access. Subsequently the meadows in both draws have healed.

ATV and Motorcycle Use

ATV and motorcycle use is prevalent throughout the project area, with use following existing roads in the southern half and on social trails and roads in the northern half. There is a similar analysis of social trail use in the latent community use discussion. In recent years an extensive network of social trails has evolved in the project area from cross-country travel by ATVs and motorcycles. These trails, developed from repetitive use often cause unnecessary resource damage as they are not planned and designed with thoughts of sustainability or using accepted trail design and construction practices. Social trails often develop when users fail to find the recreational opportunity they seek on Forest System trails. Currently the only system trail in the

project area is the climbing access trail in Priest Draw constructed in 2003. This trail is closed to motorized use.

Most of the existing motorized social trails in the project area link existing Forest roads to create longer loop riding opportunities. There are also loop single-track motorcycle trails found in the project area. Under current Forest Plan direction this use is legal and legitimate; however the associated resource damage is not. GPS location and condition surveys have shown that the trails in the northern half of the project area receive light to moderate use – defined as one to two users daily.

Latent Community Use

As is the case in other urban interface areas on the Forest, there is a high level of recreational use of the Forest around the Mountainaire community. , the project area immediately adjacent to the community of Mountainaire serves as the communities backyard. Survey of the lands around the community boundary revealed the evidence of fairly intensive public use, including numerous social trails, including some used by ATVs and motorcycles, and the occasional “fort” constructed by children. Much of the use is non-motorized, pedestrian use in the form of people walking, hiking, exercising, walking pets from their homes. This use is endemic to such areas and often not problematic.

A review of legal easements and public access to National Forest indicated that while all of the existing legal access points are in use by the public, there is also access to the Forest occurring across private lands. In addition a number of existing social trails, particularly motorized social trails on the Forest are located very close to the property boundary and as a result are a nuisance use. Such use often raises dust and creates unacceptable noise levels while leading to rutting and erosion problems.

Other Recreational Uses

Like most parts of the Forest, the Mountainaire project area includes some unique, non-traditional recreation uses. The most prominent of which is disc golf and a potentially growing use is geocaching. There is currently a popular disc golf course in the northwest corner of the project area. The course includes some minor constructed features but overall is causing little resource damage. Geocaching is an activity that is slowly growing across the National Forest System and at least one such cache is thought to exist in the project area.

Environmental Consequences

As the direct and indirect effects on recreational driving, dispersed camping, ATV/motorcycle use, latent community recreational use, and other recreational uses are substantively the same for both action alternatives, they will be discussed together, following an analysis of the effects of the no action alternative.

Alternative 1

While the action alternatives present changes to existing recreational use in the project area, the no-action alternative would allow existing recreational uses to continue. Existing levels and

opportunities for dispersed camping would remain unaffected as would the number of miles of system and social roads and social trails currently open to motorized and non-motorized recreational use. Other uses, such as disc golf would likely continue in the project area, as would the day-to-day latent use of the National Forest adjacent to the community of Mountainaire for recreational purposes such as walking and hiking.

There are potential indirect effects on these recreational uses from vegetative structural changes as a result of wildfire. Fires of greater intensity or scope, including stand replacing fires can result in changes to the landscape, its character, and visual quality that reduce the quality of recreational experiences such as recreational driving and ATV/motorcycle use. In addition, areas currently used for dispersed camping or other recreational uses such as rock climbing or disc golf would likely be less appealing for these activities after such a fire. The effects of less intensive fires, similar to the effects of initial prescribed and maintenance burning, would result in a similar diminishment of the quality of recreational opportunity, but for a shorter duration.

Effects Common to All Action Alternatives

Recreational Driving

Mechanical treatments will have no direct effect on the amount of recreational driving opportunities, but will likely have effects on the quality of the experience for some forest visitors. The immediate and substantial change in appearance of treated stands results in an effect on the visual quality of the recreational driving experience. A complete discussion of these effects can be found in the Landscape Aesthetics section of this Chapter.

Initial and maintenance prescribed burning will have little effect on recreational driving. Temporary road closures and smoke during burns present short term disturbance to driving opportunities and the quality of those opportunities. The effect, however, is insignificant as it is very localized with hundreds of miles of Forest Roads nearby unaffected and will last only a short duration with no permanent effects.

Changes proposed to the transportation system, including the closure of approximately 59 miles of system and social roads and improvements to open road segments will have effects on both the quality and quantity of recreational driving opportunities. The road closures (both administrative closures and decommissioning) present a loss of 55% of the total miles of roads currently available in the project area for recreational driving. While the closure of more than half of the available recreation driving opportunity appears significant, the approximately 59 miles proposed for closure represent a small potions of the greater forest-wide road network that includes several hundred miles of open roads. The roads remaining open in the project area connect to several open roads adjacent to the project area providing ample recreational driving opportunities. Importantly, road densities will get closer to achieving road density standards of the Forest Plan.

The proposed dispersed camping closures would have no direct effect on recreational driving opportunities.

Indirect Effects

Mechanical treatments, burning, and proposed camping prohibitions are unlikely to have any indirect effects on recreational driving opportunities. The changes proposed to the transportation

system in the project area are likely to have the indirect effect of displacing recreational driving to other forest roads and other areas. When considering the forest transportation as a whole, looking in and outside of the project area, the changes in road use levels associated with a displacement of some use from the project area is likely to be negligible.

Dispersed Camping

In order to reduce the risk of fire starts in areas that could threaten resources or private property, the action alternatives propose designating areas open to camping and areas closed to camping. This in effect retains dispersed camping opportunities while reducing fire start risk as well as impacts from unmanaged dispersed camping in some areas. The issuance, subsequent signing and enforcement of a Forest Order closing portions of the project area to dispersed camping (insert map reference) would have perhaps the most direct effect on dispersed camping. Of the 214 sites surveyed in the project area approximately 75% would be closed to camping.

Mechanical treatments to stands in the areas to remain open to dispersed camping will likely result in immediate changes to the quality and quantity of camping opportunities. The disturbance from mechanical thinning (temporary and skid road construction and use, tree removal, ground vegetation disruption, slash piles, etc.) can disrupt both the aesthetic and physical qualities that make a campsite desirable. While sites could be rendered unusable by mechanical treatments, these effects will not be long-lived. As initial ground disturbance heals, slash piles are burned and the beneficial effects of treatments become evident, the sites will likely be desirable again. In addition, there are ample opportunities for dispersed camping outside the project area and within a short distance.

Direct effects of initial and maintenance burning on dispersed camping would be minimal. Generally campers in areas to be burned are asked to leave for the duration of the burn for their safety. Smoke from burning could cause discomfort to campers in the project area during burning but usually disperses within 24 hours. For the duration of a few months after initial and maintenance burning, ash on the forest floor is likely to make camping less pleasurable as it tends to blow in light breezes and stick to surfaces like shoes, tents and clothing. This effect on the quality of the dispersed camping experience, however, would be short-lived.

The changes proposed to the transportation system will have similar effects on dispersed camping as would the area closures to dispersed camping in that the closure of roads causes a reduction of access to specific sites. Considering the relatively light amount of dispersed camping use in the project area, the direct effects of the area camping closures, mechanical treatments, burning and changes in the transportation system area expected to be minimal.

Indirect Effects

The indirect effects on dispersed camping opportunities from mechanical treatments, burning, changes in the transportation system and area camping closures would be similar to direct effects. It is likely that dispersed camping use will be displaced to other sites both inside and outside of the project area by the various actions. Some of this displacement is likely to be short term, as the effects of mechanical treatments and burning are relatively short-lived, while displacement from road closures and area closures to camping would be long-term if not permanent. As a result of this displacement use of existing sites to remain open within the project area and sites outside the project area may see increases in use. This use is likely to lead to some effects to these sites from

the increased use. However, as the overall amount of dispersed camping use to be displaced is relatively low, the associated effects of displace to other sites can also be seen as insignificant.

Rock Climbing

Direct effects on rock climbing use from treatment activities will be minimal and of short duration. Due to the success of the existing rehabilitation efforts in both draws, the largely open grassland condition, and existence of rock outcrops and some steep terrain, there will be limited mechanical treatment. It is likely that treatments will consist of hand thinning some trees, possibly mechanical pilling of slash, and burning. These activities will cause only temporary disturbance to rock climbing opportunities from noise and smoke and will only minimally and temporarily impact visual quality. As there are no changes to the transportation used for rock climbing access there will be no effects from this action. The most heavily used campsites in the project area are located in the Priest and Howard Draw areas and are outside the proposed prohibition on camping. As climbers and others would still be able to camp in this area the proposed dispersed camping prohibitions would have no direct effects.

Indirect Effects

There are no foreseeable indirect effects on rock climbing from any of the proposed treatments or actions.

ATV and Motorcycle Use

Mechanical treatments in stands where social trails exist will have dramatic and immediate effects on the trails and the quality of recreational experience derived from them. The disturbance from mechanical thinning (temporary and skid road construction and use, tree removal, ground vegetation disruption, slash piles, etc.) while temporary can obliterate sections of trails making them hard to follow and in some cases unusable. The duration of this effect is likely to last a few years, until treatments are completed and subsequent prescribed burning occurs.

Initial prescribed burning and maintenance burning will have little direct effect on social trails as the trails are often used as burn block line by Forest Service staff and are unaffected by heat and flame.

ATV and motorcycle riding opportunities will be affected to a greater extent by changes to the transportation system proposed in the action alternatives. The decommissioning of 55.7 miles of system and social roads and administrative closure of an additional 3.3 miles or road will reduce the overall road mileage currently available to recreational ATV and motorcycle riders by approximately 55%. The remaining 47.7 miles of roads will continue to provide riding opportunities.

While there is a correlation between camping and ATV and motorcycle use, in that many campers ride these machines while camping, the designation of dispersed camping areas is unlikely to have a direct effect on ATV and motorcycle riding opportunities.

Indirect Effects

While the direct effect of mechanical treatments may be to only a short segment of trail—often less than 10 feet—treatments can have the indirect effect of making an entire trail system

unusable. With many short segments disturbed or disrupted, the system in turn becomes discontinuous. More importantly disruption of a trail system by mechanical treatments can displace use to other areas not yet treated or not planned for treatment. A critical point to remember is that these trails systems are user-created and have evolved through use without being planned, developed or authorized by the Forest Service. So, their disturbance and even obliteration by mechanical treatment can serve to curb use of eroding and other problematic sections of trail. While the de facto closure can have benefits, the displaced use could evolve in more sensitive locations like Goshawk PFAs and MSO PACs.

There are no significant indirect effects on ATV and motorcycle use from initial prescribed burning, maintenance burning, or the designation of dispersed camping areas. Indirect effects of changes in the transportation system are similar to those from mechanical treatments in that motorized use displaced from closed system and social roads is likely to result in the development of new social trails and roads in other areas.

Latent Community Use

Treatments proposed around the community will have the immediate effect of noise and public safety hazards during mechanical treatment, and the disturbance to social trails and routes used by the public from vegetation removal, slash piles and other treatment effects. These effects, while short-lived will likely seem longer term to adjacent residents and regular forest users. Initial and maintenance burning will provide a similar, immediate nuisance effect from smoke, and a slightly longer term post-burn effect from the presence of ash, stump holes and other hazards. The burning will, however, help to alleviate some of the effects.

While much of the social trail network adjacent to the community will be obliterated by treatments and subsequent burning, this effect should not be seen as significant. First, treatments will aid in the closure of nuisance routes – those that are leading to resource impacts or social impacts to adjacent homeowners. Secondly as these are not constructed routes and have evolved from use, the post-treatment more open forest type will allow for new routes to develop over time. In effect there will be no net loss of opportunity.

The proposed changes in the transportation system will have the effect of eliminating motorized access for ATVs and motorcycles from the community. This is a problematic use type adjacent to private lands due to the noise and dust generated by the activity. The remaining open transportation system will provide ample riding opportunities and will have the effect of drawing the motorized use quickly out and away from private lands. Closure of social trail routes to motorized use adjacent to the community will alleviate the existing negative social impacts.

The proposed prohibitions on dispersed camping will have little discernable direct effect on latent community use, as there is currently little if any camping use immediately adjacent to the community. The prohibition will, however, extend an added level of protection from wildfire to the community by distancing possible fire starts from escaped campfires from the community.

Indirect Effects

Treatments and burning will likely have the indirect effect of displacing latent community use short distances spatially as users avoid slash piles, stump holes and other effects of treatment. As a result new social trail networks will likely evolve adjacent to the community. The current

network of social trails, with the exception of those used by motor vehicles is causing little negative impacts and it is reasonable to assume new trails that evolve would similarly have few impacts.

Changes in the transportation system will have a similar indirect effect of displacing motorized uses immediately adjacent to the community to other locations. Impacts associated from this, including the development of new motorized social trails will be monitored and mitigated as necessary. Reasonably foreseeable management actions regarding cross-country motorized travel and access and travel management will address these issues.

The proposed prohibition on dispersed camping will have no discernable indirect effects on latent community use.

Disc Golf

Mechanical treatments in the stands where disc golf is played will initially dramatically change course conditions and character. Trees and clumps of trees that were obstacles or golf holes may be removed. As the result of treatments the course will become mostly unrecognizable to most users. It is likely that treatments will affect the entire area where disc golf is played. While the effect will be lasting, in that treated stands are being fundamentally altered, the stands will still provide excellent disc golf opportunities post-treatment.

The effects of initial prescribed burning and maintenance burning will be minimal to disc golf opportunities. Burning can cause short duration loss of disc golf opportunity, but after initial hazards from burning have ceased there will be little effects other than nuisance of ash.

Actions proposed for the transportation system in the project area are likely to have little direct effect on disc golf opportunities. Roads currently used to access disc golf opportunities will remain open, and overall improvements to the transportation system will result in improved quality of access. As is discussed in the recreational driving and ATV/motorcycle opportunity sections, despite the net loss of open road mileage, the improvements to the remaining road system provide highly quality access.

The proposed dispersed camping closures and limitations will have no direct effects on disc golf, as it is generally a day-use activity.

Indirect Effects

It is likely that in the short term, mechanical treatments will have the indirect effect of displacing disc golf use to other areas. This could mean increased use of other courses outside the project area, or the establishment of new courses within the project area. As described above, there are relatively few resource impacts from disc golf and as such the displacement of use is likely to have few if any impacts.

There are no foreseeable indirect effects on disc golf from initial and maintenance burning, changes to the transportation system or dispersed camping prohibitions.

Geocaching

The direct and indirect effects on geocaching from the action alternatives can be seen as minimal. Geocaches tend to be small, often the size of a coffee can or ammunition can and are purposefully challenging to find. None of the proposed actions would limit the ability for new or additional geocaches to be placed. Mechanical treatments are unlikely to adversely affect a geocache. A cache could be lost during initial or maintenance burning. Changes to the transportation system are unlikely to affect geocaching as caches are usually located away from roads and are found by walking. Dispersed camping prohibitions will have no effect on geocaching.

Cumulative Effects

The actions considered in this discussion are those that have occurred in the recent past (10 years), as well as those reasonably foreseeable actions. Management activities that occurred prior to this time helped create the current condition described under the affected environment section. The people that recreate in the Mountainaire area are primarily: adjacent landowners, day-use visitors, and few campers. Since people can range far and wide in search of recreation interests, it is difficult to choose an area for considering cumulative effects. For this discussion, actions to consider are those that occur in areas immediately within or adjacent to the project area.

These include:

- Development of non-motorized trails as part of the Mountainaire Community Trails Project.
- Ongoing rock climbing use in the Priest and Howard Draw areas.
- Ongoing dispersed camping on lands surrounding the project area.
- Ongoing dispersed recreation including disc golf in and around the project area.
- Ongoing latent community use and social trail use in and around the project area.
- Upcoming, local, regional and national motorized access and travel management policy changes.

The continuation of Semi-Primitive Motorized recreation settings will add to the presence of that setting in the surrounding landscape. Surrounding areas are also likely to maintain and enhance some Semi-Primitive Motorized settings. The exact amount is unknown.

Although it is difficult to estimate where displaced campers may go, we estimate that major forest roads outside of the camping closure area and project area may see increased use. As the current and historic camping use in the project area has been dispersed in nature, it is reasonable to assume that displaced campers will continue to seek this type of use. With that in mind, displaced campers are unlikely to make use of public and private developed campgrounds in the Flagstaff area, or developed campgrounds in the Oak Creek or Sedona area. Some users may be displaced to designated dispersed sites in the nearby Kachina Village area. Displaced campers may add to current camping impacts in these areas causing a slight increase in resource impacts.

Ongoing statewide and national policy development for the management of off-road and trail motorized use will in time affect the project area. Currently studies are ongoing to establish a policy structure directing National Forests to eliminate cross-country travel in most areas and designate routes open to motorized use. Such an action would likely further limit ATV and motorcycle opportunities in the project area while at the same time providing for enhanced opportunities on district, forest, and region wide basis.

Under the no action alternative Roaded Natural settings may increase over time and Semi-Primitive settings may decrease. This would offset other areas where Semi-Primitive settings are likely to increase due to road and vegetation management, including the Kachina Village and Woody Ridge areas.

Continuation of resource impacts due to poor location and wet weather use of system and social roads and motorized routes will add to deleterious trends in adjacent areas.

Continuation of dispersed camping in the project area may lead to similar deleterious trends, including the continued potential of a human-caused wildfire. The cumulative effects of a wildfire would likely be more extensive than those of prescribed or management ignited fire as wildfires tend to burn with greater intensity. The area affected by a fire would likely be less desirable for recreational activities affecting the setting and users' experience. The area would likely be closed until it was safe to re-enter and rehabilitation work was completed. Should a high intensity fire occur, many recreation activities might be displaced to the surrounding landscape, adding impacts to surrounding lands and increasing competition and possibly conflict between users.

Rare and Sensitive Plants

Threatened and Endangered Species

The project area does not include any locations or potential habitat for Threatened or Endangered plant species.

Sensitive Native Plant Species

The project area includes Flagstaff pennyroyal (*Hedeoma diffusum Greene*), a species on the Region 3 Sensitive species list. Numerous populations of this species occur throughout the project area.

Flagstaff pennyroyal

Flagstaff pennyroyal (*Hedeoma diffusum*) is a small perennial, mat-like herb that grows on dolomitic limestone outcrops or limestone derived soils in ponderosa pine forests. It has square, wiry stems and small oval opposite leaves. The flowers are blue and occur in clusters of one to three at the nodes.

Affected Environment

Two major population areas for this species were determined; the first includes the project area and extends roughly from Flagstaff, east to Marshall Lake and Fisher Point, then south to the vicinity of Mountainaire, then to Lower Lake Mary. A second population area is near the rim of Oak Creek Canyon and its tributaries (Boucher, 1984; Phillips, 1984). The elevation range of this species is 4500 to 7000 feet. This species is endemic to Northern Arizona and is found on the Coconino and Prescott National Forests. In the population area near Flagstaff, Flagstaff pennyroyal occurred in three distinctive habitats in the ponderosa pine forest; rock pavement, cliffs and limestone breaks. Forest canopy cover ranged from zero to 86%, averaging 26.5% (Phillips, 1984).

Goodwin (1983) established a series of Interim Guidelines for management activities in Flagstaff pennyroyal populations and in its potential habitat. These guidelines are still accepted as Forest Policy and are addressed in the Forest Plan on page 65. The Management Plan for *Hedeoma diffusum Greene* Elden, Flagstaff, Mormon Lake, and Sedona Ranger Districts (Boucher, 1984) was prepared in response to a proposal to list Flagstaff pennyroyal as a threatened species. Boucher concluded that Flagstaff pennyroyal was more abundant than originally thought when the species was proposed for listing.

A series of permanent monitoring plots for this species were established in 1985 to monitor populations in various areas within known Flagstaff pennyroyal habitat (Boucher, 1985). One of these permanent monitoring locations is near Mountainaire. All monitoring plots have been monitored four times since their establishment in 1985: by Boucher (1985), by B.G. Phillips in 1989, in 1996 and 2002 by D. Crisp. Data from each of these visits is on file, but long-term trends have not been analyzed. The data from 1996 show decreases in Flagstaff pennyroyal during severe drought. Additionally, during the 2002 visit human impacts appear to be increasing in some areas, with campsites established on or near the two most remote sites. At the Mountainaire site, human activities appeared to increase in recent years and the monitoring plot is covered with a thick layer of pine needles and litter.

Environmental Consequences

Alternative 1

Dead and down fuels will continue to increase, which in turn could negatively affect the vigor of Flagstaff pennyroyal. Goodwin (1983) observed decreases in plant vigor and population density in areas of heavy litter accumulation. He suggested that complete fire exclusion could have detrimental effects on Flagstaff pennyroyal.

Fire hazard will continue to increase therefore increasing the risk of severe wildfire in many areas of the project area. Severe wildfires often result in complete removal of tree canopy, complete loss of ground cover and understory plant community and alteration of soil structure and nutrients. These changes could adversely affect the habitat and populations of Flagstaff pennyroyal by damaging soil, killing existing plants and by reducing or destroying the seed bank of Flagstaff pennyroyal.

The use of existing social roads that may exist and creation of others within Flagstaff pennyroyal populations and habitat will continue. This could adversely affect Flagstaff pennyroyal populations and potential habitat within the project area.

No regulation of dispersed camping within the project area could lead to increased human impacts to Flagstaff pennyroyal. Examples of potential human impacts include campfire construction in populations such as those observed at Harding Point and Bear Sign Canyon.

Effects Common to All Action Alternatives

Direct effects under Alternative 2 would include alteration of habitat or deaths of individual plants or population groups. Factors contributing to these effects would include disturbance from tree thinning, pile burning, road construction or decommissioning. Tree removal, burning or road construction or decommissioning may cause mortality of individual plants. Habitat could be altered through mechanical alteration of the dolomitic limestone substrate by equipment used in various management activities.

Avoiding the location of slash piles, fire lines, temporary road construction activities, and landing sites in identified populations of *Hedeoma diffusum* will reduce impacts the species.

The timing of burning is important. Burning during the hot, dry period immediately before the onset of monsoons might kill individuals and populations of Flagstaff pennyroyal. Prescribed burns during the hot, dry period immediately before monsoons are unlikely due to high fire danger that is typically present during that time. Prescribed burning could also benefit Flagstaff pennyroyal by removing heavy litter accumulation resulting from absence of fire.

Light to moderate disturbance from timber harvest would not adversely affect Flagstaff pennyroyal, which tends to be found in relatively open areas with less than 30% canopy Goodwin (1984). Tree thinning might benefit Flagstaff pennyroyal by reducing tree canopy and stand density. Reducing the stand density index below 35% in many of the treatment areas would benefit all understory plants including Flagstaff pennyroyal in addition to reducing inter-tree competition. However, this reduction in the stand density index could have a potentially negative effect in areas where invasive exotic plants such as Dalmatian toadflax already occur in the habitat of Flagstaff pennyroyal or in areas where management actions could introduce invasive exotic plants. There are several areas within the project area where Dalmatian toadflax (*Linaria dalmatica*) has already been detected in or near populations of Flagstaff pennyroyal. These areas have been identified as high priority for noxious weed treatment within the project area. Dalmatian toadflax increases after disturbance and can dominate the understory, out-competing Flagstaff pennyroyal and its native associated plant species. Increases in Dalmatian toadflax in Flagstaff pennyroyal habitat have been documented locally after prescribed fire (Phillips and Crisp, 2001).

Designated dispersed camping may aid in reducing direct impacts to these species.

Cumulative Effects

Cumulative effects to Flagstaff pennyroyal (*Hedeoma diffusum*) include disturbance, destruction of individual plants and alteration of habitats. In the recent past, the Forest Service has initiated activities that may have affected Flagstaff pennyroyal include, but are not necessarily limited to,

Airport Fuels Reduction Project broadcast burn, Fort Tuthill to Kachina Village Trail, grazing on Windmill allotment, Kachina Village FHP, Lake Mary Fuels Reduction Project, Pumphouse Multi-product Timber Sale, Skunk Fuels Reduction, recreation activities and facilities, road construction and maintenance. Effects of these projects have been addressed individually.

Cumulatively, these projects and activities have not affected the overall distribution of Flagstaff pennyroyal. Many of these activities have been mitigated by following the guidance of "The Management Plan for Hedeoma diffusum Greene Elden, Flagstaff, Mormon Lake, and Sedona Ranger Districts" (Boucher, 1984). Activities on non-federal lands such as State and private lands have also contributed to cumulative effects on Flagstaff pennyroyal including timber harvest, fuels reduction projects, and recreational use on state trust lands that contain suitable habitat for Flagstaff pennyroyal and land use practices on private land with suitable habitat. Development on private parcels in suitable habitat including in areas such as Mountainaire have affected the amount of suitable habitat in these areas.

Noxious and Invasive Exotic Weeds

Invasive exotic plants can affect composition, structure and function of native ecosystems and can affect factors such as fire interval, species composition within communities, and successional pathways. Recently, invasions by exotic species were identified as one of the four major threats by the Chief of the Forest Service. Invasive exotic plants found within the project area and included in this discussion are diffuse knapweed (*Centaurea diffusa Lam.*), Dalmatian toadflax (*Linaria dalmatica (L.) P.Mill*) and cheatgrass (*Bromus tectorum L*).

Affected Environment

Diffuse knapweed

Diffuse knapweed is an annual or short-lived perennial from the Mediterranean region that grows 1-2 feet tall and has a single strong taproot. During the first year of life, diffuse knapweed seeds germinate and form seedlings, which then grow into rosettes. These rosettes then over-winter and grow into mature plants. At maturity, diffuse knapweed forms an upright stem with many spreading branches. Flower heads form at the ends of the stems and are surrounded by spiny bracts. Flower color ranges from white to purple. Diffuse knapweed is allelopathic, preventing growth of other species within its population. As a result, it can form monocultures, where only diffuse knapweed is present.

There are two known infestations of diffuse knapweed in the project area, in Compartment 325 stand 1 and in Compartment 346 stand 3. The infestation in Compartment 325 stand 1 was estimated at 0.1 acre in 2002 when the Peaks Wildlife Crew detected it. The infestation in Compartment 346 stand 3 was estimated at more that five acres when detected by Chris Murphy and Dan Russell in 1997.

Dalmatian toadflax

Dalmatian toadflax is an introduced perennial weed that can grow up to 3 feet tall and propagates from both seed and underground rootstalks. One plant can produce up to one half million seeds, as well as lateral roots up to 10 feet from the plant (Lajeunesse, 1999). This species is widely

dispersed throughout the ponderosa pine communities on the Coconino National Forest. In recent surveys, Dalmatian toadflax was the most frequently detected noxious weed species in the project area. Areas on the north end of the project area are the most heavily infested. There are 230 reported locations for Dalmatian toadflax in the project area and all of these locations were 1/10 acre or less when reported. Most of the locations were found and reported in 2003 but Dalmatian toadflax infestations probably existed in the area long before surveys were taken.

Cheatgrass

Cheatgrass is an erect winter and spring annual grass from Europe that can grow to a height of two feet. The plant is a prolific seed producer and the density of this species has more to do with available sites (bare soil) for germination than the number of seeds produced. The presence of cheatgrass has increased the fire frequency in grassland and sagebrush ecosystems (Zouhar, 2003). Shorter periods between fires in these ecosystems will eventually cause the loss of native plants not adapted to fire and the replacement of these by non-native annual grasses. Cheatgrass is also common in ponderosa pine forests throughout the western United States. Cheatgrass can provide a flammable link between open areas and forested areas, allowing fires to move from one habitat type into another (Zouhar, 2003). Live cheatgrass plants can be killed by fire, but seeds survive relatively severe fires and colonize recently burned areas. Additionally, offsite colonization into recently burned areas often occurs. Several techniques to control cheatgrass have been investigated, including timing of burns, herbicide treatments, grazing and competitive planting. Controlling cheatgrass requires elimination of live cheatgrass plants on the site, prevention of seed formation and elimination of emerging seedlings. Cheatgrass tends to be very persistent once it becomes established (Zouhar, 2003).

In 2003, ten populations of cheatgrass were detected in the project area. There are two additional locations reported by a surveyor employed by Coconino County in 2001. Most of these locations are in the north and east portions and all were reported to be 1/10 acre or less when reported. These locations represent the first documented occurrences of cheatgrass in the area, although others almost certainly occur. In the past, occurrences of cheatgrass have not been documented in noxious weed surveys. Therefore, the extent of cheatgrass infestations in the Mountainaire project area and across the Forest is poorly understood. Heavily disturbed areas, such as juniper pushes, heavily grazed areas, and old fire sites tend to be areas of infestations. Therefore, heavily disturbed sites in the project area may contain additional infestations.

Environmental Consequences

Alternative 1

No noxious weed treatments would occur in the project area except those accomplished by other entities such as treatment of right-of-ways by Arizona Department of Transportation, and release of biological control agents provided by APHIS.

Fire hazard will continue to increase therefore increasing the risk of severe wildfire in many areas of the project area. Factors that contribute to fire hazard ratings that would be reduced through management actions such as canopy cover, trees per acre and dead and down fuel loading will not be reduced. The risk of wildfire transitioning to crown fires will continue to increase in many areas of the project area. Severe wildfires often result in complete removal of tree canopy,

complete loss of ground cover and understory plant community and alteration of soil structure and nutrients. These conditions provide potential sites for noxious weed invasion through creation of bare soil, increased light and absence of competition from desirable plant species. Therefore, increases in fire hazard and severity that will occur with no action could also increase the risk of noxious weed invasions in the project area.

The risk of disease and insect outbreaks will continue to increase resulting in increased likelihood of tree mortality. Factors accompanying tree mortality include reduction or complete loss of tree canopy, increased light and reallocation of available resources making areas of severe disease and insect outbreaks more susceptible to noxious weed invasions.

Noxious weed populations will remain untreated and continue to expand. Table 3 shows the predicted growth rates for diffuse knapweed (Centaurea diffusa), Dalmatian toadflax (Linaria dalmatica), and cheatgrass (Bromus tectorum) infestations reported in the project area. Growth predictions are taken from the Final Environmental Impact Statement for the Integrated Treatment of Noxious or Invasive Weeds, Coconino, Kaibab and Prescott National Forests (2005) (page 16).

Table 3-44. Potential growth of Invasive exotic plants reported in the project area with no treatment[8].

Species	Location	Date reported	Initial acreage	Predicted annual growth rate	Estimated acreage in 2005	Estimated acreage 10 years from reported date of infestation (s)
Diffuse knapweed	Compartment 346 stand 3	1997	>5	14%	>14.26	>18.5 (2007)
Diffuse knapweed	Compartment 325 stand 1	2002	0.1	14%	0.14	0.37 (2012)
Dalmatian toadflax	Scattered throughout	2003*	23X0.1= 2.3	7%	2.8	4.5 (2012)
Cheatgrass	Scattered throughout	2003*	12X0.1= 1.2	14%	1.68	4.2 (2012)

Effects Common to All Action Alternatives

Management actions outlined in the Proposed Action could potentially increase the acreage and/or density of the existing noxious weed infestations within the project area. Management actions such as tree removal, slash pile burning, broadcast burning, road construction and road decommissioning will create disturbance. Although disturbance is a natural process in our

[8] The increase for each year was computed by using the acreage for the previous year multiplied by the rate of growth. Acreages for different species will increase at different rates based on the predicted rate. For example, one acre of diffuse knapweed will increase at an annual rate of 14% and would increase to 3.71 acres at the end of ten years if not controlled. By comparison, an acre of Dalmatian toadflax while increase at an annual rate of 7% and be 1.97 acres at the end of ten years with no control.

landscape, it can contribute to the spread of invasive exotic plants by creating potential sites for invasion.

Treatments that reduce the tree canopy and lower the stand density index below 35% will benefit understory plants by allowing more sunlight, increasing available nutrients and temporarily decreasing interspecies competition as well as intra species (between tree) competition, and increases in bare soil. However, these factors also provide favorable conditions for invasive exotic plants and could increase the size and density of existing populations and increase the risk of new invasions.

Burning is a disturbance that can release nutrients, reduce plant competition, increase the amount of available sunlight light and increase bare soil. Management actions proposed for various areas of the project include machine piling and burning or broadcast burning. Broadcast burning may occur in areas where trees have been cut to meet the fuel reduction objectives of this project as well as in some areas where burning is the only treatment used. The effects of broadcast burning are similar to those of tree removal and may contribute to expansion of existing noxious weed populations and introductions of new populations. Pile burning will create locally severely burned areas at pile sites. Consequences include but are not limited to the reduction or loss of the seed bank on these sites (Korb, 2001; Crisp, 2004); death or reduction of soil organisms on the pile sites (Raison, 1979; Ballard, 2000; Korb et al., 2004) and development of hydrophobic soil (Ballard, 2000). Slash pile sites are more prone to invasion from invasive exotic plants than surrounding areas and may contribute to the persistence and spread of invasive exotic plants in treated areas.

These management actions can be mitigated by following the Best Management Practices as identified in Appendix B of the *Final Environmental Impact Statement for the Integrated Treatment of Noxious or Invasive Weeds, Coconino, Kaibab and Prescott National Forests (2005*).

Diffuse knapweed

Diffuse knapweed has been identified as the highest priority noxious weed species within the project area. There are two known populations of diffuse knapweed in the project area. One population is in Location 325, Site 1 and the other in Location 346, Site 3 (Table 3-44). The proposed treatments are thin from below to 40% canopy and thin from below 30% canopy, respectively. The open conditions of these stands after treatment along with disturbance within the stand during tree cutting could cause rapid expansion of these populations throughout the stands and into adjacent stands. Treating diffuse knapweed infestations before management activities occur will reduce the risk of rapid expansion.

Pile burning or broadcast may also increase the populations of diffuse knapweed. The large taproot of diffuse knapweed might allow it to survive fire. Low severity fire probably would not kill diffuse knapweed unless it is severe enough to kill the root crown (Zouhar, 2001). Therefore, diffuse knapweeds would survive prescribed burning. Additionally, diffuse knapweed produces large numbers of seed, giving it an advantage in fire-prone environments. Seeds that survive burning are available to grow and produce an infestation in the immediate post-fire environment. Seeds can persist in the soil and there can be an “aerial seed bank” from seeds that persist on mature diffuse knapweed plants that remain on site. The presence of bare ground from prescribed fire or pile burning benefits diffuse knapweed (Zouhar, 2001).

The two known populations of diffuse knapweed occur along major roads that are used to access the project area as well as providing public access to the area. Routine maintenance operations such as blading can contribute to the spread of invasive exotic plants along roadways by transporting seeds from infested sites to new areas. Best Management Practices and mitigation measures will minimize this impact.

Dalmatian toadflax

Tree thinning or prescribed burning in areas with established Dalmatian toadflax infestations could lead to increases in current infestations and perhaps provide favorable habitat for additional populations. Seeds may be dispersed from off-site seed sources into recently burned areas or open areas that provide perfect habitat for Dalmatian toadflax, free of competition from other species. Activities such as road construction and deconstruction could also contribute to increases of Dalmatian toadflax in the project area by producing disturbed sites, bare soil and by transporting seeds from infested sites to new areas. Best Management Practices for road maintenance should be incorporated into the project.

The continued expansion of Dalmatian toadflax within Flagstaff pennyroyal habitat could negatively affect the sensitive species. The populations of Dalmatian toadflax within the habitat of Flagstaff pennyroyal have been identified as the second priority for treatment within the project area. The remaining Dalmatian toadflax populations within the project area but not within known populations of Flagstaff pennyroyal have been identified as the third priority for treatment within the project area.

Cheatgrass

The presence of bare soil is an important factor contributing to the spread of cheatgrass. Management activities that contribute to the increase in bare ground, including thinning, burning road construction, deconstruction and maintenance could contribute to the increase in cheatgrass. Treatment of cheatgrass as addressed in the Final Environmental Impact Statement for the Integrated Treatment of Noxious or Invasive Weeds, Coconino, Kaibab and Prescott National Forests (2005) is generally limited to certain areas containing rare cacti on the North Kaibab Ranger District, Kaibab National Forest. However, cheatgrass is addressed in this document due to recent concern over the distribution of it within fuels reductions and the effects management actions on it distribution, frequency and density.

If prescribed burning occurs in the spring when cheatgrass plants are young and before seed has formed, control of this species may be successful.

Alternative 3

There would be no disturbance from tree removal in the meso-reserve areas but the effects of burning would be similar to those discussed in Alternative 2 in most areas. With no tree removal, burning in some areas might be more intense, with higher risk that individual tree or group “torching” would occur. When this occurs, there are localized areas disturbance characterized by tree mortality, removal of canopy, increased light, removal of litter and existing understory plants and high levels of localized disturbance. These localized areas may be more at risk for invasion by invasive plants including Dalmatian toadflax. There are numerous Dalmatian toadflax populations in the meso-reserve area.

Figure 3-14. Distribution of Hedeoma, Dalmatian toadflax and Diffuse Knapweed in the Project Area.

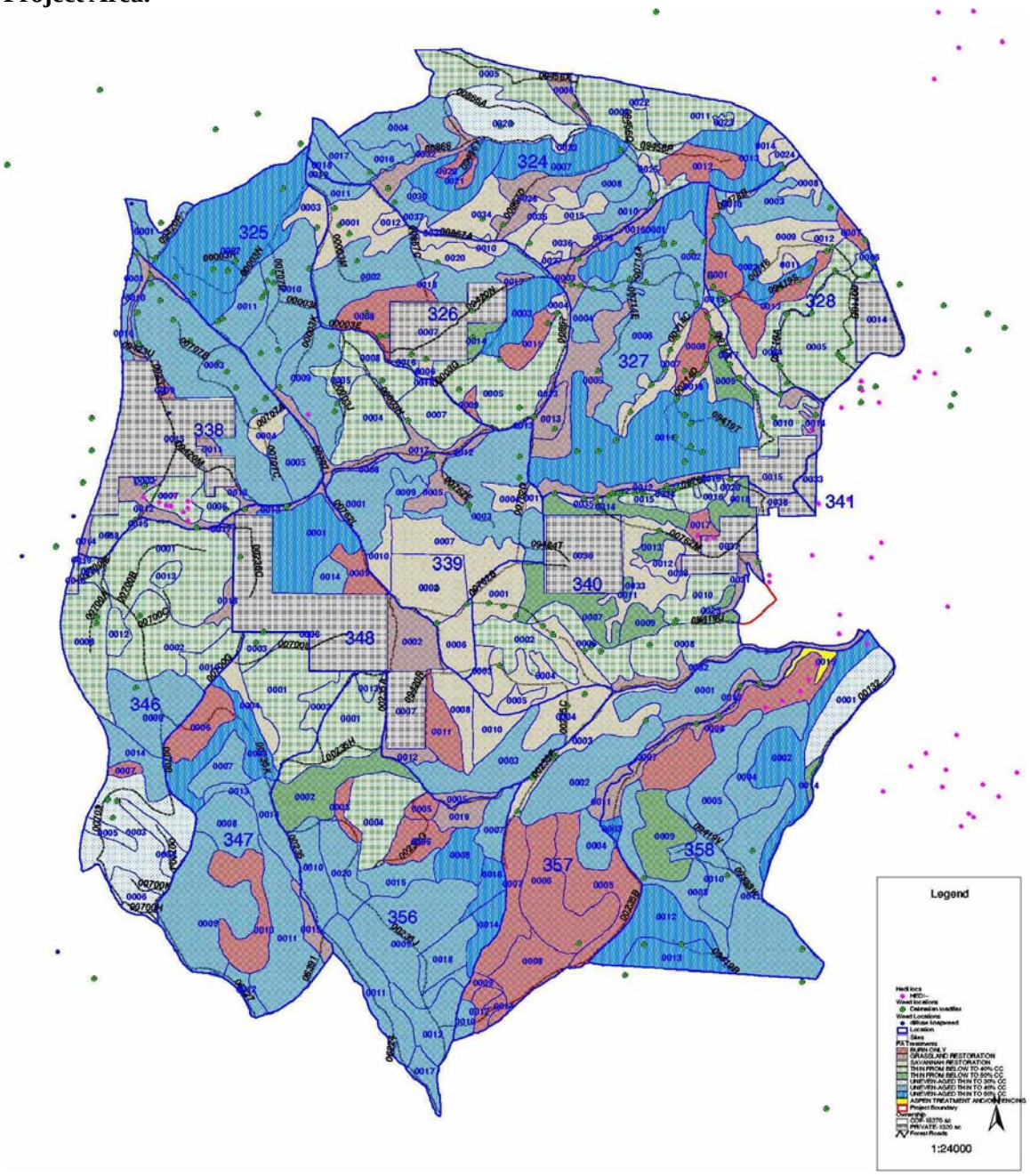
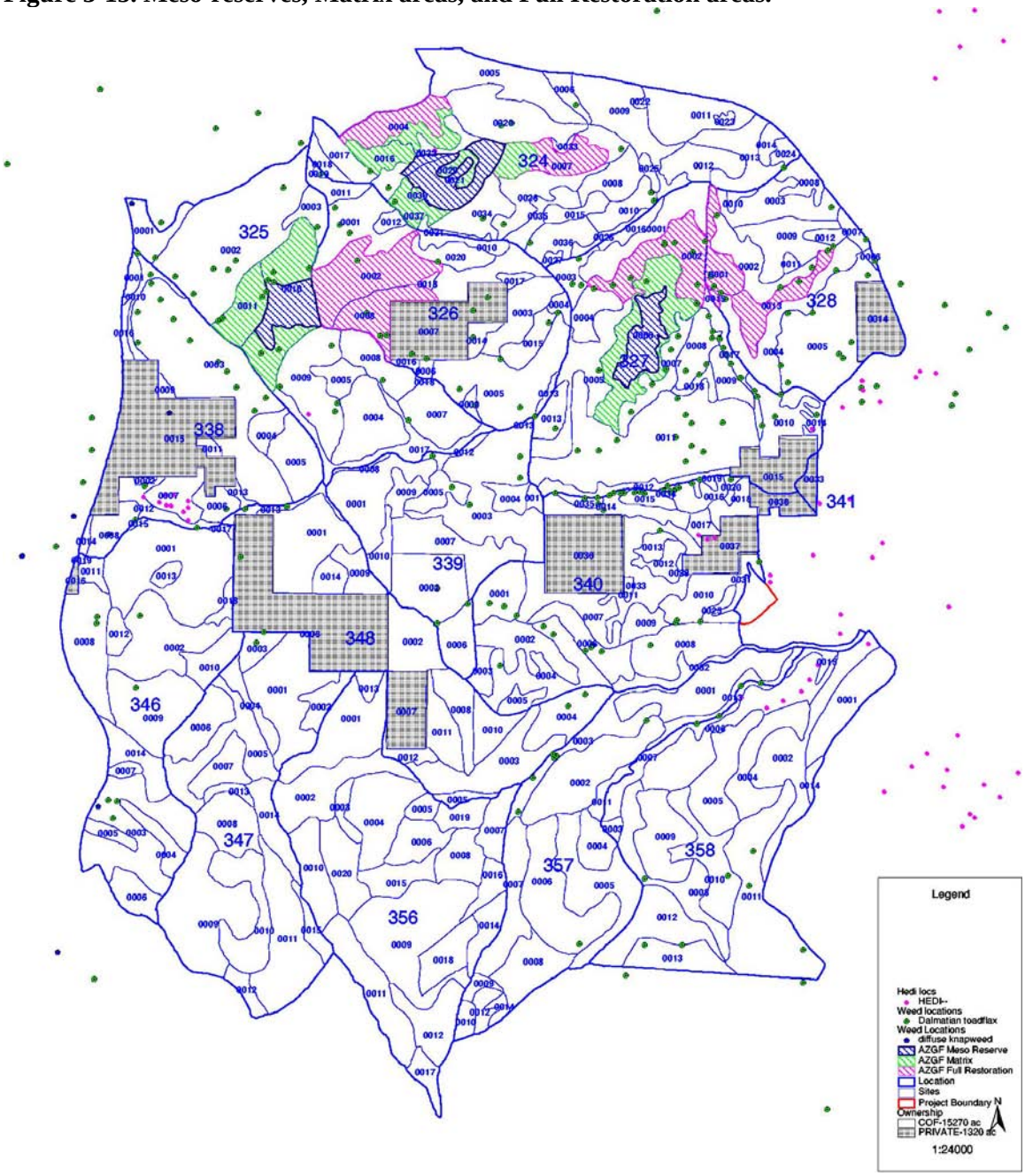


Figure 3-15. Meso-reserves, Matrix areas, and Full Restoration areas.



Open areas created in the matrix and full restoration would be more susceptible to invasion than uncut areas due to disturbance, bare soil, more sunlight and initial lack of competition from other more desirable plant species. The creation of openings in areas where there are no known populations would help mitigate spread of noxious weeds in these disturbed areas.

Cumulative Effects

Cumulative effects to noxious or invasive plants include many past activities that contributed to the introduction and spread of these species within the project area and onto the Coconino National Forest as a whole. Many times the source of each introduction into a specific area is unknown. However, activities such as vehicle travel and contaminated seed and feed products deliver propagules to specific areas. To become successfully established, these propagules must enter an appropriate habitat or an unoccupied niche. these niches are produced by disturbance, creating bare soil and reducing existing vegetation cover.

Past ground-disturbing activities that have contributed to bare soil and reduction include, but are not necessarily limited to, Airport Fuels Reduction Project broadcast burn, Fort Tuthill to Kachina Village Trail, grazing on Windmill allotment, Kachina Village FHP, Lake Mary Fuels Reduction Project, Pumphouse Multi-product Timber Sale, Skunk Fuels Reduction, various prescribed fires and wildfires, recreation activities and facilities, and road construction and maintenance. Many of these activities occurred before the relationship between ground-disturbing activities and the introduction and expansion of noxious or invasive plants was locally recognized. Recent projects such as the Skunk Fuels Reduction project have recognized and mitigated the effects of noxious or invasive plants by incorporating a series of best management practices.

There have been many ground-disturbing activities on non-federal lands that cannot be managed through Forest Service actions. Examples of this include the establishment and management of public and private roadways, management activities such as grazing, timber harvest and prescribed burning on non-federal lands, and private land use. Other recent activities that may affect noxious and invasive plant populations include control efforts undertaken by various agencies. These include, but are not limited to, herbicide treatments, manual control, and biological control. Arizona Department of Transportation executes herbicide treatments on federally controlled highways in northern Arizona including the I-17 corridor immediately adjacent to the Mountainaire project. This area was identified as an area of concern and proposed for treatment in 2005. Additional control efforts include the releases of biological control insects on Dalmatian toadflax populations east of the Mountainaire project boundary and on diffuse knapweed immediately adjacent to the northwest corner of the Mountainaire project. These actions will aid in the overall reduction of noxious or invasive plants on the Forest and immediately adjacent to the project area. The biological control insects were introduced in 2005. If successfully established, these insects can spread into the project area.

In the past, there have been several manual control efforts within or adjacent to the project area which have aided in reducing the acreage and density of noxious or invasive plants. These include several weed pulls by Forest Service Personnel and others targeting Mediterranean sage (Salvia aethiopis) along Lake Mary Highway. These efforts have substantially reduced the acreage and density of the infestation and prevented it from entering the project area. Another example of manual control is a series of weed pulls conducted by Forest Service personnel and volunteers in an area adjacent to the project area, which focused on reducing Dalmatian toadflax infestations in

populations of Flagstaff pennyroyal. These have reduced the conflicts between Dalmatian toadflax and Flagstaff pennyroyal and improved the habitat of Flagstaff pennyroyal.

Economics

The Recreation and Landscape Aesthetics sections of this chapter describe the social aspects of recreation opportunity and scenery resources. This section report describes social aspects of the Flagstaff area communities and details the effects of the alternatives on the Flagstaff economy. There were no significant issues identified regarding economic concerns.

Affected Environment

Community Socio-Economic Information

Flagstaff is the largest city and regional hub of Northern Arizona. It also serves as the seat for Coconino County. The local population in Flagstaff is 61,270 while Coconino County holds 129,570 residents (2004 data). Principle economic activities in Coconino country include government jobs; the leisure and hospitality (tourism) sector; and trade, transportation and utilities jobs. While some natural resource-based industries still exist, numbers have been in steady decline over the past few decades. According to 2001 data for the city of Flagstaff, only 4 logging establishments (out of 116 in Arizona) are in operation with few employees. New scientific and high-tech research and development industries have recently located in Flagstaff.

Additional social and economic information can be found in the community profile for Coconino County created by the Arizona Department of Commerce located at *http://www.azcommerce.com/doclib/COMMUNE/Coconino%20County.pdf.*

Additional Information specific to Flagstaff can be found in the Flagstaff Community Profile at: *http://www.azcommerce.com/doclib/COMMUNE/flagstaff.pdf*

Additional community economic status information is included in the Project Record.

Environmental Consequences

Effects Common to All Alternatives

Implementation of restoration activities on the Mountainaire HFRA project will be a combination of Forest Service “force account” work done by Forest Service employees and contracted work done by private enterprises under the direction of the Forest Service. The following is a cast up of which portions of implementation will likely be contracted and which portions will likely be implemented under force account. This scenario could change depending on Forest Service staffing and budgets, and economic and market trends in timber removal and utilization.

Table 3-45. Projected Responsible Parties for Implementation of the Mountainaire HFRA Project.

Activity	Private Contractor	Forest Service Staff
Thinning and removal of trees greater than 5 inches DBH	X	
Thinning and removal of trees less than 5 inches DBH (Pre-Commercial Thinning)	X	X
Treat slash generated from thinning by lopping and/or piling	X	
Road Obliteration	X	X
Road Maintenance	X	
Pile burning		X
Broadcast burning		X
Noxious weed eradication and/or avoidance to control spread in certain areas as related to contract activities		X

Activities to be accomplished through contracts may contribute slightly to jobs in the agriculture sector of the Flagstaff economy but will not cause a significant change. Conversely, the no action alternative may affect local logging businesses but would not affect the Flagstaff economy, due the industry's small contribution to the diverse Flagstaff economy.

There is an increased potential for stand replacing wildfire under Alternative 1. The Coconino County and Flagstaff community profiles show strong links to tourism, which could be negatively affected by large fires either in the short term during times of heavy smoke, or in the long term with the degradation of outdoor recreation experiences and opportunities. The exact effect of large fires near Flagstaff is unknown and would depend on the location and extent of the fire. Wildlife habitat provides revenues to the State of Arizona through hunting permits. A stand replacing fire could detract from wildlife populations and negatively affect the number of permits issued for the area where the fire occurred. A reduction in outdoor recreation opportunity could affect local community income in the form of gas, hotel, grocery, outdoor equipment and other related receipts.

Local contractors that perform thinning and road maintenance and obliteration work are typically keeping busy with contracts previously available through government agencies or with contracts let in the private sector.

All three action alternatives maintain the natural landscape that supports Flagstaff's and Coconino County's tourism industry by providing opportunities for outdoor recreation and scenic backdrops to popular highways, parks, and home sites. Changes in tourism affect hotel, restaurant and outdoor equipment businesses, gas stations, grocery stores, retail stores, and the community tax structure.

Recent large fires within the region, resulting from overly dense forests and drought and climatic stress have raised the awareness of the community concerning healthy forests. All three action alternatives would allow for a reduction in tree densities across a large landscape that might improve the public's perception of safety and well being in case of wildfire. Alternative one

would leave the forest in its current condition and local residents may have a reduced feeling of safety and well being in relation to wildfire. No alternative eliminates fire risk completely.

Costs of Implementation

The Forest Service will implement activities with allocated project funds. Local communities do not fund costs of implementation. Implementation costs are one factor considered by the deciding official when determining a course of action.

Table 3-46 list the following agency costs of implementation are estimates based on recent, similar project costs. Because current timber markets are variable and previous timber sale contracts on the Woody Ridge and Kachina projects did not solicit any bids, Table 3-46 assumes that all activities would be implemented through service contracts. In likelihood, some areas may sell as timber sale contracts, thus totals shows the estimated maximum amount of agency funds that may need to spent to implement project activities.

Table 3-46. Project Costs by Activity

Activity	Cost in Dollars per Unit	Total
Thinning and Slash Piling with Road work included	$300 per acre[9]	13,780 x 300 = $4,134,000
Pile Burning in Urban Interface	$50 per acre	13,780 x 50 = $689,000 Estimate 200-500 acres per year
Broadcast burning in the Urban Interface	$200 per acre	15,256 x 200 = $3,051,200 Estimate 100-500 acres per year
Maintenance burning	$40 per acre	15,256 x 40 = $610,240 Estimate 100-500 acres per year to begin after broadcast is complete
Road Obliteration	$400 per mile	55.7 miles x 400 = $22,280

Alternative 4

Retaining trees greater than 16” DBH does not greatly offset the cost of services. Current markets for these trees are variable and current contracts bids are not showing large differences in bid values for areas with and without diameter caps. Should markets develop and competition begins for wood material, then the value of goods (all diameters of trees) may rise. If future markets develop, larger diameter blackjack trees would create a higher value of goods and could provide a small offset to the cost of services. A diameter limit could have negative effect on the economics

[9] These values are derived from recent bids on contracts for similar projects such as the Woody Ridge and Kachina Valley projects.

of a forest thinning project (Larson 2001). However, it is not expected that in the near future the cost of goods will exceed the cost of services resulting in revenue to the government. A market does not currently exist in Northern Arizona that makes larger 16 inch plus trees more valuable than smaller diameter trees.

Cumulative Effects

This project, in tandem with other fuel reduction and thinning projects, (see Table 3-13 in the Vegetation section) offers numerous contracts to provide local employment opportunities and revenue in the logging and road construction/maintenance fields. A majority of these projects (Fort Valley, Kachina Valley, Woody Ridge projects) have been developed collaboratively with Greater Flagstaff Forests Partnership and have been consecutively planned over the last few years. While planning efforts will be completed by 2007 (Eastside and Jack Smith/Schultz projects) for Forest Service and GFFP projects, implementation will take longer to complete. It is estimated that contracts will be offered for all of these GFFP projects through the next decade.

The amount of timber offered through these projects may help stabilize local operators in the short-term (10-15 years) and may also lead to increased investment in utilization opportunities for materials removed from these areas.

Chapter 4 – Project Coordination

This environmental assessment was prepared by the USDA Forest Service, Coconino National Forest, Mormon Lake Ranger District

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